THE PHYTOCHEMISTRY OF THE HORTICULTURAL PLANTS OF QATAR

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The Scientific and Applied Research Centre
University of Qatar

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FOREWORD

This is the third publication in a series on "Ecological, Biological, Chemical and Economical Aspects of Plants in Qatar"; a project sponsored by the Scientific and Applied Research Centre of the University of Qatar from 1979.

The first in this series, "Ecology and Flora of Qatar" was published in 1981, the second "The Phytochemistry of the Flora of Qatar", followed in 1986 and the third "The Phytochemistry of the Horticulture Plants of Qatar" is now in your hands.

With Arab folklore medicine well visualized in the background and with the recent world trend to go back to mother nature and to the use of plants' active ingredients as remedies for several ailments, the authors tried to achieve this goal. About 120 plants from forty five different families were collected and identified. All available information concerning their known active ingredients, medicinal and economical uses was recorded; a sum of 2300 references covering the literature up to 1986. A thorough chemical survey of Qatar indigenous plants was recorded.

I consider this book as a world-wide reference for all those concerned with science, nature and beauty.

PROFESSOR DR. MOHAMED OMAR ABDEL-RAHMAN
Director, Scientific and Applied Research Centre
Qatar University

INTRODUCTION

Plants not only provided man with food and fabric but also cured him from several diseases. Medication by herbs was the sole way against a lot of diseases. The early medicines of Pharaons (3,000 B.C), the Greek (400 B.C.; Hippocratis), the Roman (37 B.C.; Disoscorides) as well as those of the middle ages examplified by the Arab physicians (Avicenna 980–1037; Rhazes 865–925) relyed mainly on plants for therapy. In the recent days attention is re-directed towards the drug plants for less side-effect troubles.

Plants also greatly reduce the amount of dust in the biosphere. It has been found that a single hectare of forest captures 40 to 70 tonnes of dust a year. In this way they are considered as anti-pollutants. Plants also act as humidifiers in arid places, in the sense they moisten the air and make it easier to breathe.

Horticultural plants are spreading in the City of Doha decorating the roads, the streets, the public gardens, the 'roundabout' and almost in every place in the city. These plants have, unfortunately, received no attention, except for some pamphlet lists published by the concerned Ministry on some dozen species accompanied by abridged comments of very little scientific value. In the last few years, the Government of Qatar embarked on its programme of social and economic development; and a touch of beauty has impressed citizens as well as the visitors of Doha. Now, Doha has acquired a green aspect. This, together with the importance of learning more about the plants, have prompted the authors to survey the horticultural species in Qatar. However, a few wild shrubs or trees have also been described, on account of their considerable abundance in some streets, either as an escape from the desert or because they are still standing after urbanization.

This work represents a part of a programme financed by the Scientific and Applied Research Center (Qatar University) in promoting the development of all natural resources of the country.

January 1988

A.M. RIZK
A.S. AL-NOWAIHI

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I ACANTHACEAE

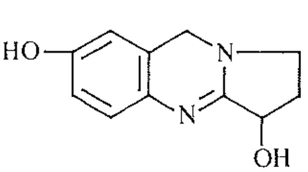
C-Glycosylflavones e.g. embinin and vicenin-2 have been identified in this family from the genera *Ecobolium* (Nair *et al.*, 1975) and *Siphonoglossa* (Hilsenbeck, 1980; Hilsenbeck and Mabry, 1983). Luteolin appears as a characteristic flavone of Acanthaceae, being detected in flowers and leaves of the eleven species investigated by Nair *et al.*, (1965). Despite the fact that iridoids are very common in Scrophulariaceae and other related families, iridoid glucosides have been detected in a few species of the Acanthaceae (Hegnauer and Kooiman, 1978). Thus schanzhiside methyl ester, barlerin (8-*O*- acetylshanzhiside methyl ester) are known from *Barleria prionitis* (Taneja and Tiwari, 1975; Damtfot *et al.*, 1982), catalpol from *Mackaya bella* (Hegnauer and Kooiman, 1978), and hygrophiloside from *Hygrophila difformis* (Jensen and Nielsen, 1985). Several quinazoline alkaloids occur in *Adhatoda vasica.*

1 *ADHATODA*

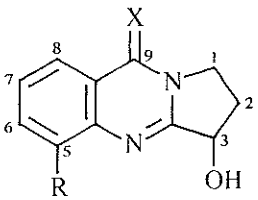
1 *Adhatoda vasica* Nees
Common name: *Barlier of Paris*
Arabic name: *Adhatoda*

The different parts of the plant (leaves, inflorescences, roots) contain quinazoline alkaloids. The roots contain vasicinol (1), (identical with 6-hydroxypeganine isolated by Spaeth and Kesztler-Gandini, 1960 from the leaves of the same plant), vasicine (2) (Rajagoplan *et al.*, 1961; Bhatnagar *et al.*, 1965), 9-acetamido-3,4-dihydropyrido-[3,4-b]-indole (3), deoxyvascinone (4) (Jain *et al.*, 1980), vasicol (5) (Dhar *et al.*, 1981), adhatonine, vasicol, vasicinone (6) and visicinolone (7) (Jain and Sharma, 1982).

Vasicine, vasicinone, vasicinine and betaine were identified from inflorescences of the plant (Ikram *et al.*, 1965; Choudhury and Chakrabarti, 1977; Choudhury, 1979). Other quinazoline alkaloids have been also identified from the plant *viz.* vasicoline (8), adhatodine (9), vasicolinone (10), anisotine (11), peganine (Johne *et al.*, 1971) and 1, 2, 3, 9-tetrahydro-5-methoxypyrrolo [2, 1-b]-quinazoline-3-ol (12) (Chowdhury and Bhattacharyya, 1985). Glycosides and N-oxides of both vasicine and vasicinone have been

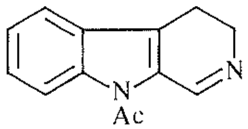


1 Vascinol
(Bhatnagar *et al.*, 1965)



2 Vasicine : R = H, $X = H_2$
6 Vasicinone : R = H, X = O
12 : $R = OCH_3$, $X = H_2$

(Chowdhury and Bhattcharyya, 1985)



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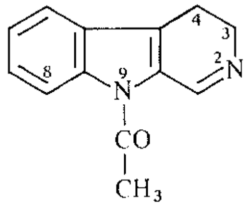
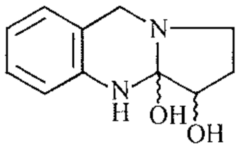


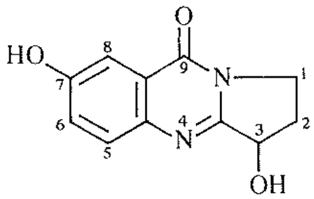
4 Deoxyvasicinone

(Jain *et al.*, 1985)



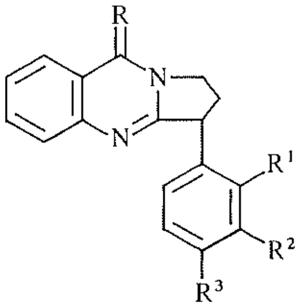
5 Vasicol

(Dhar *et al.*, 1981)



7 Vasicinolone

(Jain and Sharma, 1982)



8 Vasicoline : $R = H_2$, $R^1 = N(CH_3)_2$, $R^2 = R^3 = H$
9 Adhatodine : $R = H_2$, $R^1 = H$, $R^2 = COOCH_3$, $R^3 = NHCH_3$
10 Vasicolinone: $R = O$, $R^1 = N(CH_3)_2$, $R^2 = R^3 = H$
11 Anisotine : $R = O$, $R^1 = H$, $R^2 = COOCH_3$, $R^3 = NHCH_3$

(Johne *et al.*, 1971)

detected in *A. vasica* (Pandita *et al.*, 1983). A dimer (probably an artifact of the isolation procedure) containing vasicine and vasicinone was recently identified from the leaf extract (Thapa, 1985).

Leaves and flowing tops of *A. vasica* contain 0·79% and 0·47% vasicine respectively (Ikram and Huq, 1966). The plant is rich in its alkaloidal content in months of August-October, reaching 2% (moisture-free basis), of which vasicine was ~95% (Pandita *et al.*, 1983).

The flowers contain 2′, 4-dihydroxychalcone 4-glucoside (Bhartiya and Gupta, 1982).

The fatty acids of the seel oil (amounting to 25·8%) were identified as arachidic (3·1%), behenic (11·2%), lignoceric (10·7%) cerotic (5·0%), oleic (49·9%) and linoleic (12·3%) (Handa *et al.*, 1956). β-Sitosterol (Handa *et al.*, 1956) and β-sitosterol-β-D-glucoside (Jain *et al.*, 1980) were isolated from the seeds and roots respectively. The plant has been early reported as a source of yellow dye (Mell, 1931). *A. vasica* leaves contain compounds of the nature of mustard oil (Mithal and Schroff, 1954). The roots contain *O*-ethyl-α-D-galactoside (Jain *et al.*, 1980).

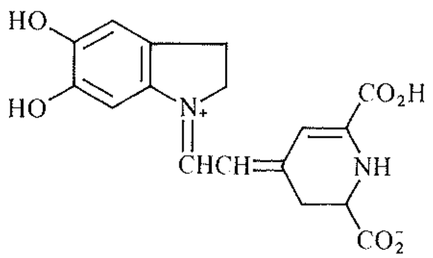
A. vasica has been recommended for various ailments of the respiratory system. Vasicinone has been reported as a bronchodilator principle (Mehta *et al.*, 1963). The leaves possess insecticidal properties against pests of storage (Srivastava *et al.*, 1965).

II AIZOACEAE

Several triterpenoid sapogenins have been identified in *Glinus* species (Abegaz and Tecle, 1980) and *Mollugo* species (Chopin *et al.*, 1982; Barau *et al.*, 1986). The leaves of *Tetragonia tetragonoides* contain acyclic diterpenes and norditerpene aldehydes (Aoki *et al.*, 1982). *C*- Glycosylflavonoids were identified from *Mollugo oppositifolia* (Chopin *et al.*, 1984).

1 *CARPOBROTUS*

Scanty information is available about the constituents and/or uses of this genus. The flowers of *C. acinaciformis* contain the following pigments: betanin, isobetanin, betanidin, isobetanidin, lampranthin II, isolampranthin-II and 2-decarboxybetanidin (13) (Piattelli and Impellizzeri, 1970).



13 2-Decarboxybetanidin
(Piattelli and Impellizzeri, 1970)

1 *Carpobrotus edulis* N.E.Br.
(= *Mesembryanthemum edule* L.)
Common name: *Hottentot fig*
Arabic name: *Ghasool*

Earlier preliminary investigation of *C.edulis* revealed the presence of tannins (Stephen-Lewis, 1939). Phytochemical screening of the plant revealed the presence of alkaloids and flavonoids (Rizk *et al.*, 1988).

2 *Dorotheanthus gramineus* Schwant
(= *Mesembryanthemum gramineum*)
Common name: *Fig Marigold*
Arabic name: *Ghasool*
Phytochemical screening of *D. gramineus* revealed the presence of alkaloids (Rizk *et al.*, 1988).

3 *Lampranthus spectabilis*
(= *Mesembryanthemum spectabile* Haw.)
Common name: —
Arabic name: *Ghasool*
Phytochemical screening of *L. spectabilis* revealed the presence of alkaloids (Rizk *et al.*, 1988).

III AMARANTHACEAE

Plants of the family Amaranthaceae are mostly hardy, weedy, herbaceous and fast growing cereal like plants that produce high protein grains (Opute, 1979b). They aslo contain flavonoids (e.g. *Aerva* and *Amaranthus* species) and triterpenoids (e.g. *Aerva* species) (Rizk, 1986).

1 *ALTERNANTHERA*

Scanty information is available about the constituents of *Alternathera* species. *A. philoxeroides* contains saponin which yields on hydrolysis glucose, ribose, rhamnose and oleanolic acid, an anticarcinogenic substance (Dogra and Ojha, 1978). The vegetative and reproductive organs of *A. sessilis* are said to yield hydrocyanic acid (Watt and Beryer-Brandwijk, 1962). Stigmasterol, β-sitosterol, an alkane and saturated esters have been isolated from the latter species (Lin and Chen, 1975).

1 *Alternanthera amoena* Voss
Common name: *Joy weed*
Arabic name: *Alternanthera*
Phytochemical screening of *A.amoena* revealed the presence of alkaloids and saponins (Rizk *et al.*, 1988).

2 *AMARANTHUS*

Amaranths are receiving attention as potential new crops to improve nutrition in the Third World and as potential health food products. Archeological records show that amaranth seeds have long been used for food and may have been among the earliest New World domesticates. Amaranths are presently cultivated as pseudocereals in both Old and New Worlds (Coons, 1982).

Analyses have shown that *Amaranthus* species may accumulate dangerous levels of nitrate (Hill and Rawate, 1982). The seeds contain glutinous and nonglutinous starchs (Okuno and Sakaguchi, 1981). The seed of *A. hypochondriacus* contains 10·99% lipids, 15% protein and 63% starch, the starch being similar to the premium priced starch of waxy maize. The protein quality is not only richer in essential amino acids including lysine and methionine, but also it is of higher effeciency comparable to that of casein. The lipid content of the grain amaranths range from 16·95% for the common weed, *A. spinosus* to 9·75% for the garden ornamental, *A. arthropurpureus*. The non-polar lipid fraction represents about 90% of the total lipid extract in all species investigated. Of this value triglycerides dominate, amounting to over 90%, the remaining portion comprising largely of sterols and sterol esters. Flavonoids occur in fifty four *Amaranthus* species; two of them are rutin and quercetin (Bech *et al.*, 1977). *A. spinosus* and *A. blitum* contain saponins and alkaloids respectively. The roots of *A. viridus* contain amasterol which inhibits seed germination and growth of seedlings in lettuce and inhibits growth of *Helminthosporium oryzi.* (Rizk, 1986).

A comparative study of the fatty acids and sterols of weedy and vegetable species of *Amaranthus* species showed that the major sterol was spinasterol which ranged from 46 to 54% by weight of the total sterol mixture. Δ^7-Stigmasterol occurred in the next higher amount with lesser amounts of ergosterol, stigmasterol and 24-methylene-cycloartenol. Linoleic acid was present in the greatest amounts with lesser amounts of oleic, palmitic, stearic, myristic, linolenic, arachidic and lignoceric acids (Fernando and George, 1985).

1 *Amaranthus tricolor* L.
(= *A. salicifolius* Hort not Veitch)
Common name: *Amarnth*
Arabic name: *Amaranthus*

The fatty acid composition of the seed lipid (amounting to 9.92%) of *A.tricolor* is as follows: myristic, 0·3%; palmitic, 19·8%; stearic, 4·4%; oleic; 20·2%; linoleic, 53·7%; linolenic, 0·4% and arachidic 1·1% (Opute, 1979b). The plant contains large amounts of vitamin C (Mitsuda, 1938, 1949).

The mean absorption of carotene from *A. tricolor*, in adults on a low-fat diet is 58% (Rao and Rao, 1970). A significant rise in serum vitamin A of undernourished children was observed after feeding the green leafy plant (Lala and Reddy, 1970).

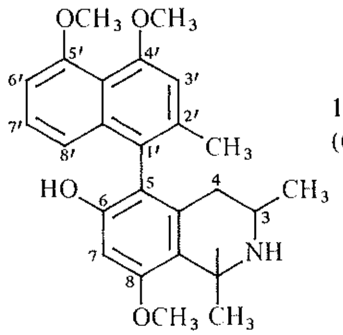
3 *CELOSIA*

The constituents of only few species of *Celosia* have been reported. Two acylated betacyanins: celosianin (*p*-coumaroylbetanidin-5-*O*-glucopyranosylglucoside) and isocelosianin (feruloylisobetanidin 5-*O*-glucopyranoside) were identified from *C. cristata* (Minale *et al.*, 1966).

In Africa the young shoot of *C. trigyna* is used as a remedy for tapeworm and round worm especially in children. The leaf and flower of the same species have been used for diarrhoea and excessive mensturation (watt and Breyer-Brandwijk, 1962).

1 *Celosia argentea* L.
Common name: *Cock's comb*
Arabic name: *Orfel-Deek*

C. argentea contains hordenine, β-sitosterol and ancistrocladine (14) (Mehta *et al.*, 1981). The green leaves contain 19·5% protein, in which total phenols amount to 500 mg/100 gm. The protein is low in available lysine (1·6 gm/16 gm nitrogen) and the digestibility with pepsin–trypsin is low (58·5%) (Oke *et al.*, 1982). The plant contains 12·5% oxalic acid at 2 weeks approaching the lethal level, but this drops to about 9% at 7 weeks (Oke, 1968). The lipid content and the fatty acid composition of the two varieties of *C. argentea* are shown in Table 1.



14 Ancistrocladine
(Govindachari and Parthasarthy, 1971)

Table 1: Total lipid and fatty acid composition of *C. argentea* (Opute, 1979b)

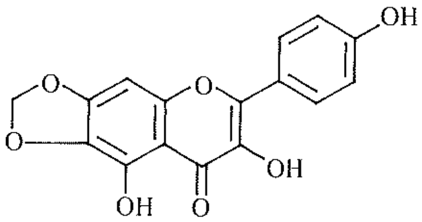
	Total lipid	fatty acids %						
		14:0	16:0	18:0	18:1	18:2	18:3	20:0
Green variety	12.73	0.3	29.1	2.3	26.9	39.6	0.5	7.1
Red variety	12.64	0.2	28.7	3.1	24.7	40.7	0.4	1.2

4 *GOMPHRENA*

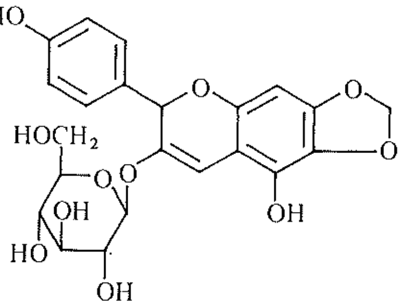
Flavonoids (mainly methylated with an unsubstitued B-ring) have been identified from certain *Gomphrena* species e.g. *G. boliviana* (Buschi *et al.*, 1982) and *G. martiana* (Buschi *et al.*, 1979–1981). Triterpenoids, alcohols, sterols, ecdysterone and protoalkaloids (choline and betaine) were detected in several *Gomphrena* species (Banerji *et al.*, 1971, Buschi and Pomilio, 1982 a, b, 1983).

1 *Gomphrena globosa* L.
Common name: *Globe Amaranth*
Arabic name: *Madanah*

The leaf of *G. globosa* contains both gomphrenol (15) (3, 5, 4′-trihyroxy, 6, 7 methylenedioxy flavonol) (Bouillant *et al.*, 1978 a, b,) and the expectorant 4′, 5-dihydroxy-6, 7-methylenedioxy flavanol 3-*O*-β-D-glucoside (16) (Liu *et al.*, 1981).



15 Gomphrenol
(Bouillant *et al.*, 1978b)



16 (Liu *et al*, 1981)

The plant is used in the West Indies and Brazil for cough (Watt and Breyer-Brandwijk, 1962). Elsewhere it is consumed as a pot herb (Duke and Ayensu, 1985a).

IV AMARYLLIDACEAE

Aekaloids have been identified from several genera of the family Amaryllidaceae. Examples of these alkaloids are lycorine, lycorenine, galanthine, galanthamine, tazettine, narcissine . . . etc. (Fahmy *et al.*, 1960; Boit, 1961; Snieckus, 1971–1975; Claudio, 1975).

The presence of other classes of compounds in the family is also reported e.g. chromones from bulbs of *Pancratium biflorum* (Ghosal *et al.*, 1982) and flavans from bulbs of *Zephyranthes flava* (Ghosal *et al.*, 1985).

The flavonoid analysis (flavonols, *C*-glycoflavones and proanthocyanidins) some of thirty Liliiflores, including a dozen of Agavaceae *sensu lato* has been recently reported by Laracine *et al.* (1985). Several criteria, including the caryology and phytogeography, allowed the latter authors to define this botanical group in the broadest sense and to propose a division into five sub-families: *Agavoideae*, *Dracenoideae*, *Phormioideae*, *Doryanthoideae* and *Xanthorrhoeoideae*. Relations between Agavaceae and other members of Liliiflores are probably closer with Amaryllidaceae than with Liliaceae, particularly with regard to biochemical characters, whether flavonic or not (Laracine *et al.*, 1985). According to Williams (1975), members of the families related to Liliaceae *viz.* Amaryllidaceae, Agavaceae and Xanthorrhoeaceae contain only flavonols.

1 *AGAVE*

Steroidal saponins have been identified from the leaves of several *Agave* species. Tigogenin and hecogenin are the major sapogenins identified from the hydrolysate of the different species. Among the other identified species are: gitogenin, yuccagenin, neotigogenin, diosgenin, manogenin, smilagenin, yamogenin, rocogenin and chlorogenin (Marker *et al.*, 1943; Davilla and Martin Panizo, 1958, Serova and Madaeva, 1958; Wall *et al.*, 1962; Dixit *et al.*, 1974; Blunden *et al.*, 1978, 1980; Pkheidze and Kereselidze, 1978; Cuellar Cuellar and Diaz, 1977, 1979; Varshney *et al.*, 1981, 1982a). A spirostanol glucoside has been recently isolated from the root of *A. cantala* (Sharma and Sati, 1982).

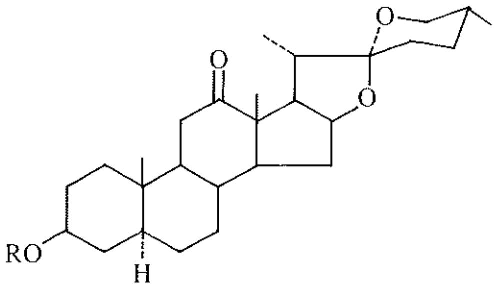
1 *Agave americana* L.
Common name: Century plant, so called from the erroneous notion that it blooms only when 100 years old.
Arabic name: Sabbar

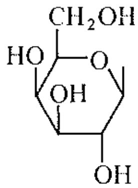
Nine steroid saponins have been isolated from the leaves of *A. americana viz.* agavosides (or agavsaponins) A, B, C, C′, D, E, F, G, and H (Bobeiko, 1974; Bobeiko and Kintya, 1975; Bobeiko *et al.*, 1975; Kintya and Bobeiko, 1975; Kintya *et al.*, 1975a, b, 1976; Wilkomirski *et al.*, 1975). Most of the spiroketal glycosides are derivatives of hecogenin. Agavosides A, B and C′ are glycosides of rocogenin (Kintya and Bobeiko, 1979). Galactose, glucose, xylose and rhamnose in various amounts constitute the carbohydrate moiety of the saponins (Bobeiko, 1974; Bobeiko *et al.*, 1975; Petricic and Kalodera, 1981). The main sapogenin of *A. americana variegata*, *A. americana medio-pecta*, *A. americana mexicana* and *A. americana alba-marginata* is hecogenin. *A. americana alba marginata* also contains traces of chlorogenin, whereas *A. americana medio-pecta* contains traces of both chlorogenin and $\Delta^{9,11}$-dehydro hecogenin. *A. americana variegata* contains traces of smilagenin, tigogenin, gitogenin and chlorogenin and *A. americana mexicana* contains traces of tigogenin and chlorogenin (Morales-Mendez and Moreno 1974; Pkheidze and Kereselidze, 1978). The tip of *A. americana* leaf contains hecogenin, the upper part of the base contains hecogenin and traces of chlorogenin, and the lower part of the base contains hecogenin, chlorogenin, and traces of tigogenin (Pkheidze and Kereselidze, 1978).

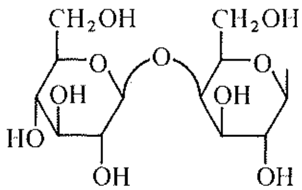
The leaves of *A. americana* contain $\sim 1\%$ hecogenin (Petricic and Kalodera, 1981). The flowers contain 0·5% chlorogenin and two flavonol glycosides: kaempferol-3-glucoside and kaempferol-3-rutinoside (Subramanian and Nair, 1970).

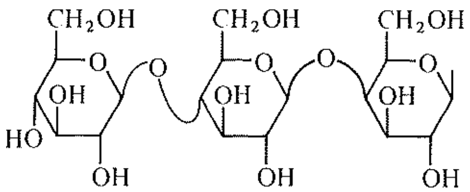
A. americana contains an aminopeptidase enzyme, in which lysine is the *N*-terminal residue, whereas either leucine or isoleucine is the *C*-terminal residue (Du Toit *et al.*, 1978). The leaf also contains piscidic acid (Nordal and Ogner, 1964), an acrid volatile oil as well as agave gum and oxalic acid and oxalates (Watt and Breyer-Brandwijk, 1962). The gum of *A. americana* bears a close resemblance to those of *Acacias*. The constituent sugars are the same (D-galactose, D-glucuronic acid, L-arabinose and L-rhamnose), the acid being bound $\beta 1 \rightarrow 6$ to galactose as is usual (Stephen *et al.*, 1966).

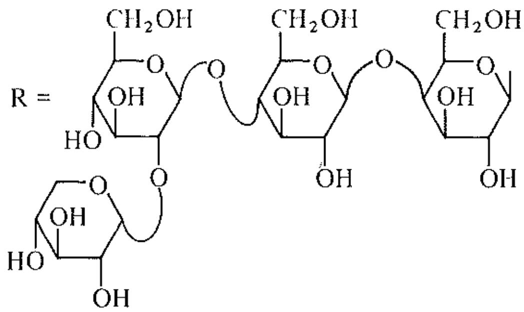
Though the plant has been suspected of being toxic to stock under field conditions, yet the pulp, obtained from the leaf and mixing it with meal or dry hay has also been used



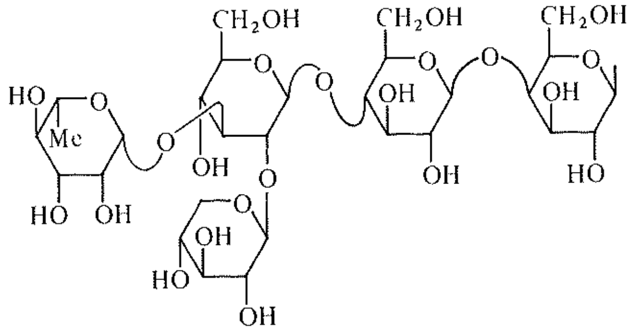
17 Agavoside A : R =  Galactose

18 Agavoside B :R =  Galactose, Glucose

19 Agavoside C : R =  Galactose, Glucose 1:2

20 Agavoside C′ : R = 

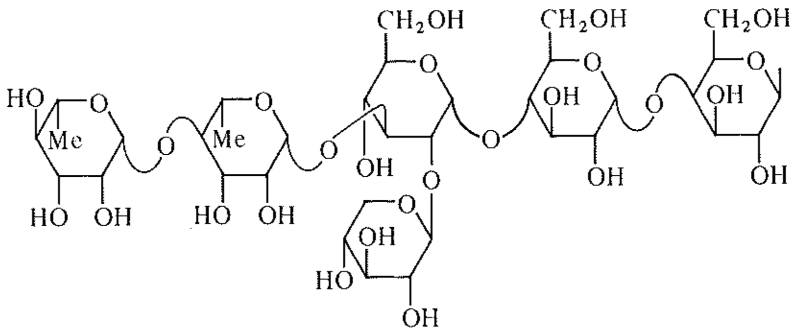
21 Agavoside D : R =



Galactose, Glucose,
Xylose, Rhamnose
1:2:1:1

22 Agavoside E :

R =



Galactose, Glucose,
Xylose, Rhamnose
1:2:1:2

(Kintya and Bobeiko, 1975)

23 Agavoside F : R = Galactose, Glucose, Xylose, Rhamnose 1:2:1:3

(Kintya *et al.*, 1975)

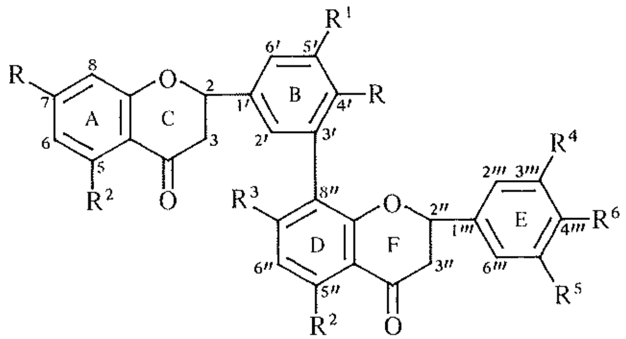
for feeding domestic stock. On account of its saponin content, the root is used in Mexico as detergent in washing clothes (Watt and Breyer-Brandwijk, 1962). Leaves of *Agave* species yield fibers.

A. americana is used as duiretic, laxative, emmenagogue, and as antisyphilitic (Watt and Breyer-Brandwijk, 1962; Duke and Ayensu, 1985a).

V ANACARDIACEAE

Anacardiaceae is the main source of mono-(Lamberton, 1959) and di-phenols (Majima, 1922; Symes and Dawson, 1953) substituted in the aromatic ring with long aliphatic chains (Cojocaru *et al.*, 1986).

The flavonoid myricetin is of common occurrence in the Anacardiaceae (Reznik and Egger, 1960). Myricetin 7, 4′-dimethyl ether and myricetin 3-*O*-rhamnoside have been isolated from *Rheus lancea* (Nair *et al.*, 1983) and *R. parviflora* (Nair *et al.*, 1977) respectively. The nut shells of *Semecarpus anacardium* contain several biflavonoids e.g. semecarpuflavonone (27), galluflavanone (28), jeediflavanone (29) and others (24–26) (Rao *et al.*, 1973; Ishratullah *et al.*, 1977; Murthy, 1983a, b, 1985).



24: $R = R^2 = R^4 = R^6 = OH, R^1 = R^3 = R^5 = H$
25: $R = R^2 = R^3 = R^6 = OH, R^1 = R^4 = R^5 = H$
26: $R = R^3 = R^6 = OH, R^1 = R^2 = R^4 = R^5 = H$
27 Semecarpuflavanone : $R = R^3 = R^4 = R^5 = R^6 = OH, R^1 = R^2 = H$
28 Galluflavanone : $R = R^1 = R^3 = R^4 = R^5 = R^6 = OH, R^2 = H$
29 Jeediflavanone : $R = R^2 = R^3 = R^4 = R^6 = OH, R^1 = R^5 = H$

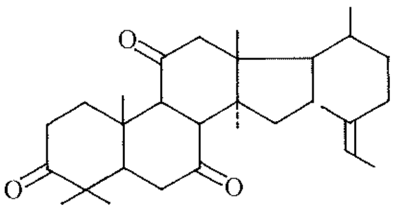
(Murthy, 1985)

Certain plants of the family Anacardiaceae, especially the wide-spread members of the genus *Toxicodendron*, have long been known to cause irritation, inflammation and blistering of the skin of sensitive individuals (Lampe and Fagerstrom, 1968; Evans and Schmidt, 1980). Active principles of these plants, collectively known as urushiol, are mixtures of homologous longchain phenolic compounds (Evans and Schmidt, 1980). A new allergenic compound identified as 3-(pentadec-10-enyl)-catechol has been recently isolated from *Lithraea caustica* (Gambaro *et al.*, 1985).

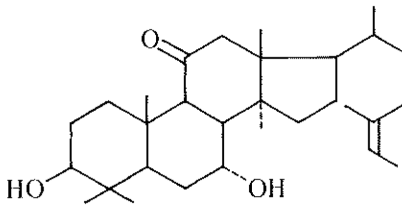
1 *SCHINUS*

1 *Schinus terebenthefolius* Radd.
Common name: *Brazilian pepper tree*
Arabic name: *Filfil areed*

The leaves of *S. terebenthefolius* contain masticadienoic acid, 3-α-hydroxymasticadienoic acid, another triterpene acid, triacontane and β-sitosterol. The berries contain two triterpenes *viz.* terebinthone (30) and schinol (31) (Kaistha and Kier, 1962 a, b; Kier *et al.*, 1963). The bark contains simiarenol and sitosterol (Campello and Marsaioli, 1974).



30 Terebinthone



31 Schinol

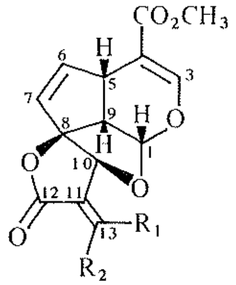
(Kier *et al.*, 1963)

The fruits have paralyzing effect on birds, upon ingestion. *S. molle* L. has been reported to contain essential oil (Cremoni, 1928; Ottolino, 1948), tannins (Gonzalez, 1931) and quercetin (Dominguez *et al.*, 1971).

VI APOCYNACEAE

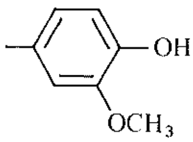
Indole alkaloids have been isolated from several plants of this family which is represented by four tribes and 32 genera (Leeuwenberg, 1980, Kisakürek and Hesse, 1980). Steroid alkaloids of Apocynaceae have been reviewed by several authors (e.g. Ganguly, 1969; Goutarel, 1971; Laine and Goutarel 1972, 1976). Characteristic pregnanes are known in apocynaceous plants (Tschesche, 1961).

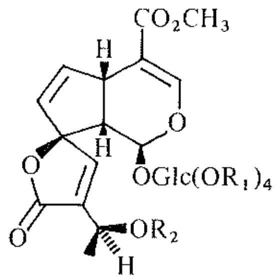
Flavonoids represented by flavonols derived from kaempferol and quercetol have been identified in several genera. The main phenolic acids of the family are protocatechuic and *p*-coumaric acids (Duret and Paris, 1972). Among the monosides, isoquercitroside was widely distributed. Among the biosides, rutoside was found in almost all species, frequently accompanied by nicotifloroside. Robinoside was identified in some species (Paris and Duret, 1974). A rather rare group of iridoids contains a spiro-lactone ring as an additional feature and comprises isoplumericin (32), plumericin (33) plumieride (35), plumieride coumarate (36), plumieride coumarate glucoside, allamandin (37), allamandicin (38), allamandin (39), oruwacin (34) and plumieride were isolated from several plants of the family Apocyanaceae *viz. Allamanda* species (Pai *et al.*, 1970; Kupchan *et al.*, 1974; Coppen, 1983), *Morinda lucida* (Adesogan, 1979), *Nerium* species (Basu and Chatterjee, 1973) and *Plumeria* (Schmid *et al.*, 1952; Halpern and Schmid, 1958; Adam *et al.*, 1979).



32 Isoplumericin : $R_1 = H, R_2 = CH_3$

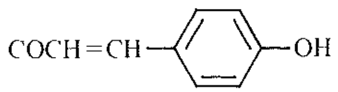
33 Plumericin : $R_1 = CH_3, R_2 = H$

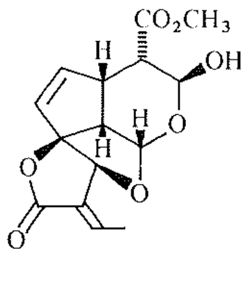
34 Oruwacin : R_1 =  $-OH, R_2 = H$



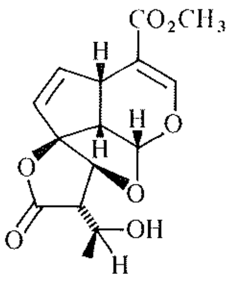
35 Plumieride : $R_1 = R_2 = H$

36 : $R_1 = H, R_2 =$



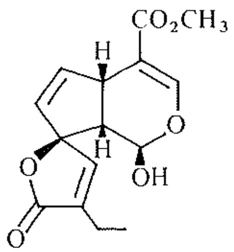


37 Allamandin



38 Allamandicin

(Coppen, 1983)



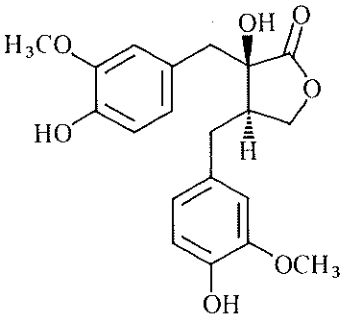
39 Allamadin

Ursolic acid (614) has been identified from various Apocynaceae (Bocharova, 1966).

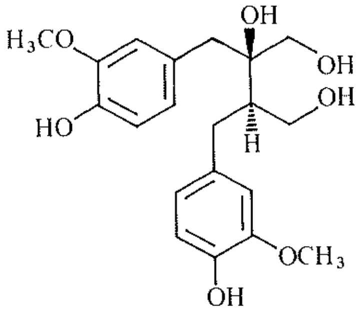
1 *CARISSA*

Various plants of the genus *Carissa*, which contains about thrity species are used in folk medicine. The presence of cardioactive substance has been demonstrated in some species (Bisset, 1957, Vohra and De, 1963; Chatterjee and Roy, 1965). Odoroside H (72) has been identified in *C. spinarum* (Bisset, 1957) and roots of *C. ovata* var. *stolonifere* and *C. lanceolata* (Mohr *et al.*, 1954). Odoroside H, digitoxigenin, 14,15-anhydrodigitoxigenin (together with glucose and D-digitalose) were identified from the hydrolysis of the polar glycoside from *C. carandas* (Rastogi *et al.*, 1967).

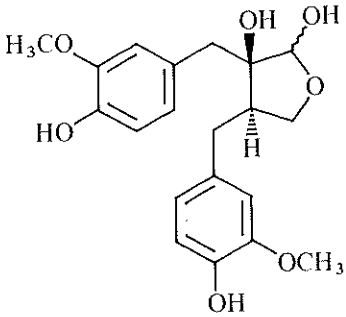
The root of *C. edulis* contains ca 5% lignans, identified as (−) nortrachelogenin (40), carinol (41), and carissanol (42), (+)−lariciresinol (43), (−) secoisolariciresinol (44) and (−) olivil (45) (Achenbach *et al.*, 1983). Carinol was early identified from *C. caandas* (Pal *et al.*, 1975). *C. edulis* also contains the inosit derivative quebrachitol (46),



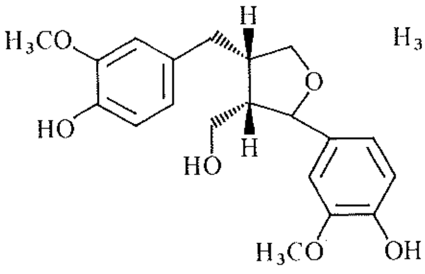
40 (−) Nortrachelogenin



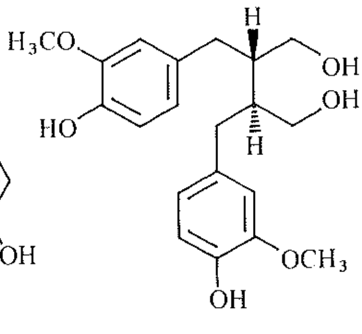
41 Carinol



42 Carissanol

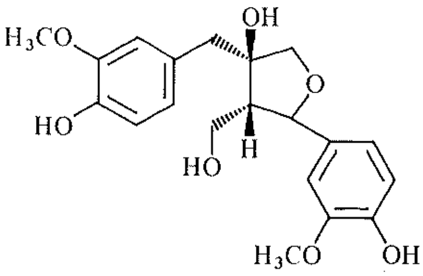


43 (+) Lariciresinol



44 (−) Secoisolariciresinol

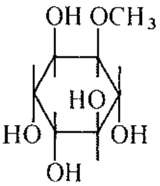
(Achenbach *et al.*, 1983)



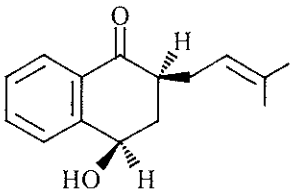
45 Olivil

(Achenbach *et al.*, 1983)

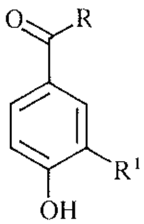
(in the twigs) (Plouvier, 1965), 2-hydroxyacetophenone, catalponol (47) (Inouye *et al.*, 1971; Shingu *et al.*, 1971) and the following aromatic compounds: vanillin (48), coniferaldehyde (49), scopoletin (50), isofraxidin (51), 4-hydroxy-(3-hydroxypropoinyl)-benzane (52) and 2-hydroxyacetophenone (Achenbach *et al.*, 1983; Bentley *et al.*, 1984). Caffeic acid was identified from the root of *C. spinarum* (Raina *et al.*, 1971).



46 Quebrachitol

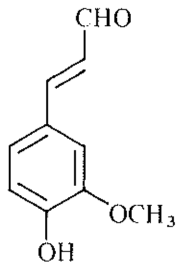


47 Catalponol

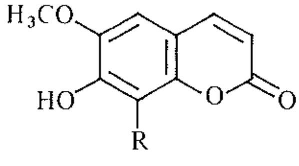


48 Vanillin : R = H, $R^1 = OCH_3$

52 : $R = CH_2{-}CH_2OH$, $R^1 = H$



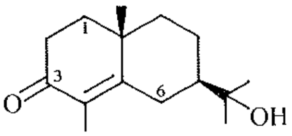
49 Coniferaldehyde



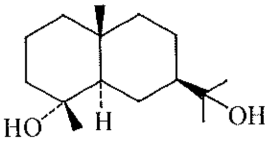
50 Scopoletin : R = H
51 Isofraxidin : $R = OCH_3$

(Achenbach *et al.*, 1983)

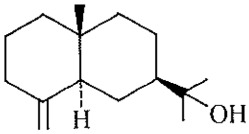
The root of *C. edulis* contains about 5% sesquiterpenes (Achenbach *et al.*, 1985). Eudesmane-type sesquiterpenes seem to be typical constituents of the genus *Carissa* (Achenbach *et al.*, 1985); carissone (53), the main sesquiterpene of *C. edulis*, has also been found in *C. lanceolata, C. carandas* and *C. congesta* (Mohr *et al.*, 1954; Joshi and Boyce, 1957; Pakrashi *et al.*, 1968). By contrast only one plant not belonging to the genus *Carissa* is known to contain carissone (Bohlmann *et al.*, 1977). *C. edulis* contains carissone, cryptomeridiol (54) β-eudesmol (55), hydroxylated carissones (56–58) and the germacrane type sesquiterpene (59) (Achenbach *et al.*, 1985). Carindone (60), a C_{31}-terpenoid and ursolic acid were isolated from *C. carandas* (Singh and Rastogi, 1972) and *C. bispinosa* (Motawi and Hammouda, 1962) respectively. Recently, carissol (61, an epimer of α -amyrin) has been identified from fruits of *C.carandas* (Naim *et al.*, 1985).



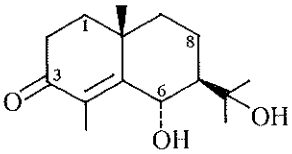
53 Carissone



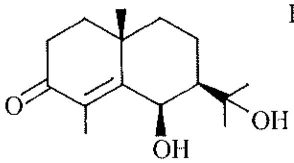
54 Cryptomeridiol



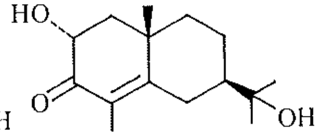
55 β-Eudesmol



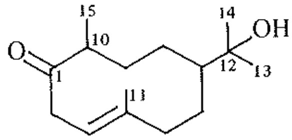
56



57

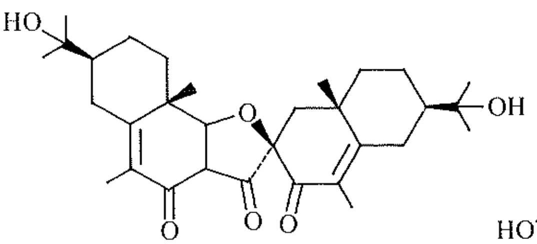


58



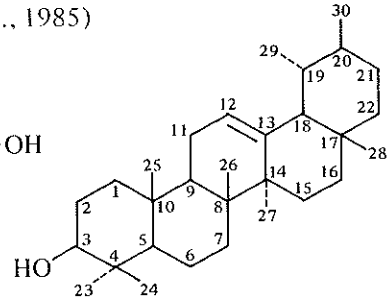
59

(Achenbach *et al.*, 1985)



60 Carindone

(Singh and Rastogi, 1972)



61 Carissol

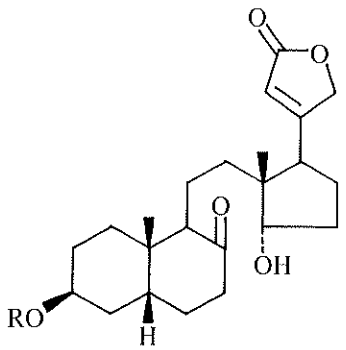
(Naim *et al.*, 1985)

1 *Carissa grandiflora* DC.
Common name: *Natal-plum*
Arabic name: *Karissa*

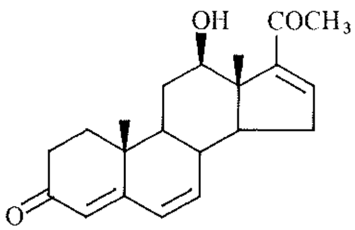
The plant contains caffeic acid, carindone, carissone, cardenolides (Zaki *et al.*, 1981a), lupeol, ursolic acid and β-sitosterol (Zaki *et al.*, 1981b). The volatile oil of the flowers contains myrcene, limonene, camphene, Δ^3-carene, dipentene, *p*-cymene, υ-terpinene, farnesol, nerolidol, dihydrojasmone, α-terpineol, methylheptanone, piperitone, linalyl acetate and geraniol (Zaki *et al.*, 1981b).

2 *NERIUM*

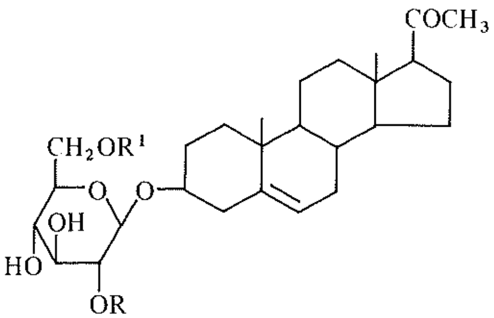
Many cardiac glycosides including oleandrin have been isolated from the leaves of oleander, *Nerium odorum* Sol. (= *N. indicum* Mill) and *N. oleander* L. Among them, adynerin, an 8, 14-epoxycardenolide glycoside, is known as a characteristic companion glycoside of oleander leaves (Takemoto and Kometani, 1954; Janiak *et al.*, 1963; Yamauchi *et al.*, 1983). Abe and Yamauchi (1979) isolated from the leaves of several horticultural strains of oleander, oleasides A–E, inactive glycosides with novel structures which are biogenetically considered to be derived from gentiobiosyl adynerin. Nerioside



62 Nerioside R = D-Diginose
(Abe and Yamauchi, 1978)



63 Neridienone A
(Yamauchi *et al.*, 1974)



64: R = R^1 = H
65: R = H, R^1 = D-Glucose
66: R = D-Glucose, R^1 = H
67: R = R^1 = D-Glucose

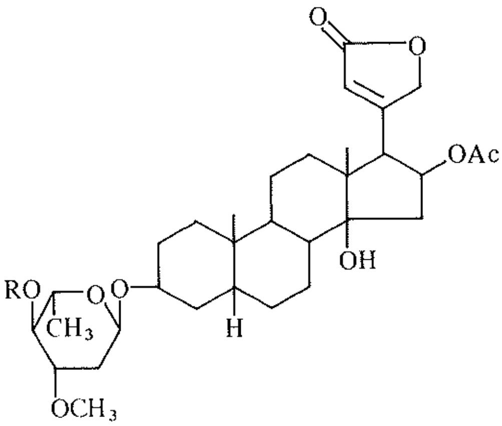
(Yamauchi *et al.*, 1972)

(62) a cardenolide with unusual framework occurs in leaves of *N. odorum* (Abe and Yamauchi, 1978). Neridienone A (12 β-hydroxypregna-4, 6, 16-triene-3, 20-dione, (63) and pregnenolone glucosides (64-67) have been isolated from the root bark (Yamauchi *et al.*, 1974) and trunk bark (Yamauchi *et al.*, 1972b) of *N. odorum* respectively.

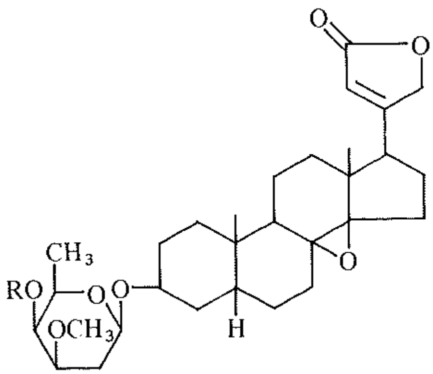
Triterpenoids (e.g. α-amyrin, oleanolic acid and ursolic acid) have been identified from the leaves (Nuki, 1951; Cheng, 1966), flowers (Lin *et al.*, 1975) and root bark (Satyanaryana *et al.*, 1975) of oleander species. Rutin (Nakaoki, 1949) and Kaempferol 3-glucoside (Lin *et al.*, 1975) were isolated from the leaves and flowers of oleander respectively. The root bark of *N. odorum* also, contains kaempferol (Satyanarayana *et al.*, 1975), 2, 4-dihydroxyacetophenone and 4-hydroxyacetophenone (Yamauchi *et al.*, 1972 a). Plumericin (33), the lactonic constituent of *Plumeria rubra* has been found to occur in *N.indicum* (Basu and Chatterjee, 1973). *n*-Paraffins, β-phenylethyl acetate, benzyl acetate, campesterol, stigmasterol, β-sitosterol, β-phenylethyl alcohol, benzyl alcohol and fatty acids like lauric, tridecanoic, myristic, pentadecanoic, palmitic, heptadecanoic, stearic, oleic, nonadecanoic, eicosanoic and docosanoic acids were identified from the flower of *N. indicum* f. *plenum* (Asakawa *et al.*, 1969). Cyclitols were identified from the roots of oleander (Jaeger *et al.*, 1959).

1 *Nerium oleander L.*
Common name: *Oleander*
Arabic name: *Dafla, Ward el-himar*

The plant has been shown to have a digitalis-like action and has been regarded as intermediate between *Digitalis* and *Strophanthus* (Queraltó, 1942). The effect is due to the presence of cardiac glycosides. The leaves of *N. oleander* contain several cardenolide glycosides *viz.* oleandrin (68), deacetyloleandrin, adynerin (70), neriantin, neritaloside,

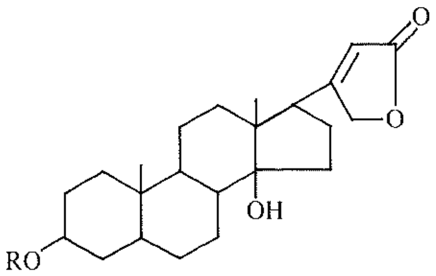


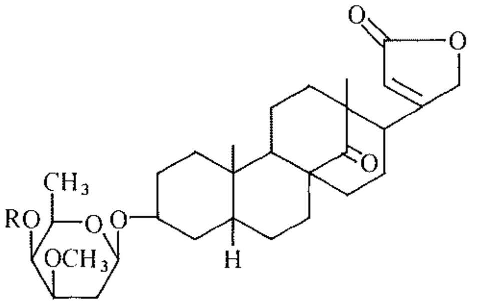
68 Oleandrin: (R = H)
69 Gentiobiosyl oleandrin: (R = gentiobiose)



70 Adynerin: (R = H)
71 Gentiobiosyl adynerin: (R = gentiobiose)

(Yamauchi *et al.*, 1983)





72 Odoroside H : R = D-Digitalose
73 Odoroside A : R = D-Diginose

74 Oleaside A : (R = H)
75 Oleaside E : (R = gentiobiose)

(Yamauchi *et al.*, 1983)

odoroside-A (73), odoroside H (72), urechitoxin, strospeside, cortenerin, cornerin, foliandrin, neriin, and folinerin (e.g. Varlakov, 1940; Shass, 1941; Schindel and Braun, 1944; Pearson, 1948; Goerlich, 1954; Tschesche and Grimmer, 1954; Fauconnet and Pouly, 1962; Tschesche *et al.*, 1964; Basilico, 1966; Fayez and Negm, 1973; Karawya *et al.*, 1973). The leaves also contain cardenolides with an unusual framework *viz.* oleasides A-F (74, 75) (Abe and Yamauchi, 1979). Oleagenin (the aglycone of oleasides A-F) is 3 β-hydroxy-15(14 → 8) abeo-5 β-(8*R*)-14-oxocard-20 (22)-enolide. The suger moieties of the oleasides are D-diginose (oleaside A), D-digitalose (oleaside B), β-D-glucosyl-D-diginose (oleaside C), 4-*O*-β-D-glucosyl-D-digitalose (oleaside D), β-gentiobiosyl-D-diginose (oleaside E) and 4-*O*-β-gentiobiosyl-D-digitalose (oleaside F) (Abe and Yamauchi, 1979).

Gitoxigenin, uzarigenin, strospeside and odoroside H were identified from the flowers (Chiarlo, 1964a). The highest content of cardiac glycosides occur in stem bark (0·96%), followed by leaves (0·63%), flowers (0·55%) and stems (0·50%) (Karawya *et al.*, 1970b).

The leaves of *N. oleander* contain the following flavonoids: quercetin, rutin (quercetin 3-*O*-rhamnoglucoside), quercitrin (quercetin 3-*O*-rhamnoside), isoquercitrin (quercetin 3-*O*-glucopyranoside), and kaempferol-3-rhamnoglucoside (Wagner and Luck, 1955; Hoerhammer *et al.*, 1956; Hoerhammer and Wagner, 1957; Dominguez *et al.*, 1967; Hiermann *et al.*, 1982). In leaves, the flavonoid content is maximum in April, but flower buds are the richest (Paris and Duret, 1972).

The different parts of plant contain α-amyrin, oleanolic acid, ursolic acid (Karawya *et al.*, 1970a,c; Fayez and Negm, 1973; Hassan *et al.*, 1977), β-sitosterol, stigmasterol and campesterol (Karawya *et al.*, 1970c, Fayez and Negm, 1973). The plant also contains choline (Karawya *et al.*, 1970a), a cyanogenic glucoside (Watt and Breyer-Brandwijk, 1962) and rubber (Fernández and Núñez (1946). The leaves, stems and flowers contain 0.005, 0.002 and 0.001% alkaloids respectively; the essential oil content in the flower is 0.03% (Alakishieva, 1953). The seeds of *N. oleander* yield 11% 9-D-hydroxy-*cis*-12-octadecanoic acid (Powell *et al.*, 1969). The oil of pods and seeds contains caproic, caprylic, capric, lauric, palmitic, oleic and stearic acids (Dominguez and Villarreal, 1963). The main fatty acid constituents of the flowers are oleic, palmitic, linolenic and linoleic acids (Chiarlo, 1964b).

All parts of the plant including the latex are poisonous, and human poisoning has frequently been reported. The nectar is said to impart poisonous properties to honey and it has been stated that even smelling of the flower is suspected for producing toxic effects (Watt and Breyer-Brandwijk, 1962).

Some of the glycosides have cardiotonic and diuretic action, the cardiac action of certain cardenolides have been found to be three times more effective than digitoxin (from *Digitalis*), to be less cumulative and more easily washed out. A decoction of the leaf is emmenagogue and abortifaciant and is used as a malaria remedy. The bark is used as a raticide and an insecticide (Watt and Breyer-Brand-wijk, 1962). The use of the plant in the treatment of cancer has been also reported (Hartwell, 1967).

3 *PLUMERIA*

Plants from the genera *Plumeria* and *Allamanda* (Apocynaceae) are a source of the rather rare lactone-containing iridoids isoplumericin (32), plumericin (33), plumieride (35), plumieride coumarate (36) and plumieride coumarate glucoside (Coppen, 1983; Coppen and Cobb, 1983). They have been identified from several *Plumeria* species e.g. *P. alba* (e.g. Coppen and Cobb, 1983), *P. acutifolia*, *P. bracteata* (Wanner and Zorn-Ahrens, 1972), *P. obtusifolia* (Adam *et al*, 1979) and *P. multiflora* (Little and Johnstone, 1954) and *P. rubra* (Mahran *et al.*, 1974a; Coppen and Cobb, 1983). Fulvoplumierin was isolated from the stem bark of *P. rubra* (Rao and Anjaneyulu, 1967; Mahran *et al.*, 1973) and *P. acutifolia* (Grumbach *et al.*, 1952; Schmid and Beneze, 1953; Rangaswami *et al.*, 1961).

The decorticated stem of *P. rubra* contains (in addition to the iridoids) amyrin and lupeol (Tandon *et al.*, 1976). The bark of *P. obtusifolia* contains a series of lupeol fatty esters with the carbon numbers 16, 18, 20 and 21-28 in the fatty acid part, as well as lupeol, lupeol acetate, sitosterol, stigmasterol and campesterol (Schmidt *et al.*, 1983). Rutin, quercetin and quercitrin occur in *P. rubra* (Mahran *et al.*, 1974b). Bornesitol (a cyclitol) has been identified from the leaves of *P. acutifolia* (Nishibe *et al.*, 1971b).

1 *Plumeria alba* L.

Common name: *Temple tree* or *Frangipani*

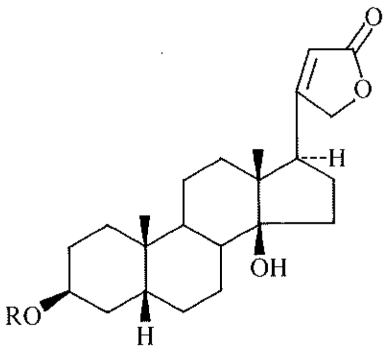
Arabic name: *Yasmin Hindi*

The different plant parts (roots, stems, leaves and flowers) contain iridoids: plumieride (35), plumieride coumarate (36) and plumieride coumarate glucoside (Harrison *et al.*, 1973; Coppen and Cobb, 1983) and the flavonoid rutin (Harrison *et al.*, 1973). The flowers contain both rutin and hyperoside (quercetin -3-*O*-galactoside) (Gunasingh and Nagarajan, 1980). The bark contains α-and β-amyrin acetate, β-amyrin, β-sitosterol, scopoletin and plumieride (Rangaswami and Rao, 1960).

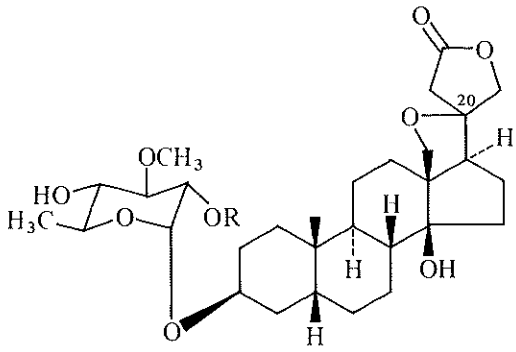
P. alba is a rubber source in some African countries. The fresh root is used as a remedy for "piaws", the sharp latex for warts and skin eruptions, the aromatic wood in place of sandalwood and the fruit is edible (Watt and Breyer-Brandwijk, 1962). The root bark is purgative, alterative and detergent (Rangaswami and Rao, 1960).

4 *THEVETIA*

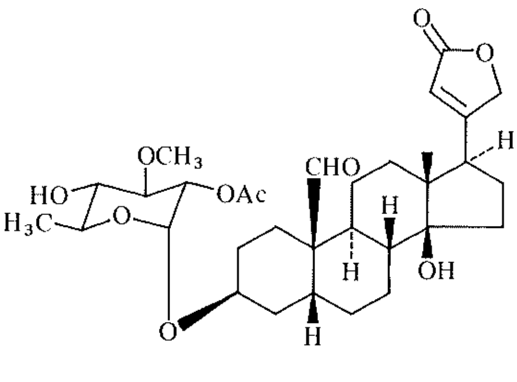
Cardiotonic glycosides and iridoids have been identified from plants of the genus *Thevetia*. Other than *T. peruviana* (*T. neriifolia*) mentioned below in details, cardenolides were detected in several species e.g. *T. ahouia* (Jolad *et al.*, 1981), *T. gaumeri* (Méndez *et al.*, 1951), *T. iccotli* (Boriani and Busacchi, 1938a), *T. thevetoides* (Cruz *et al.*, 1979), *T. yccotli* (Boriani and Busacchi, 1938b). Examples of these cardiac compounds are neriifolin (77), 18, 20-oxido-20, 22-dihydroneriifolin (78) butanolide glycoside (79) and 3′-*O*-methylevomonoside (80). The seeds of *Thevetia* species were reported as an alternative source of digitoxigenin (Cruz *et al.*, 1977). The latter compound is obtained by oxidation of neriifolin (Muchowski and Iriarte, 1976).



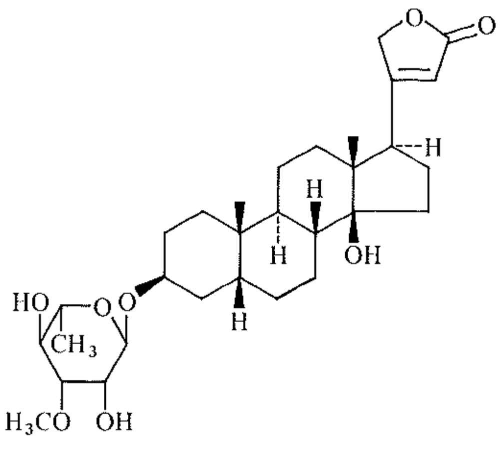
76 Digitoxigenin : R = H
77 Neriifolin : R = 6-deoxy-3-*O*-methyl-α-L-glucosyl
(Muchowski and Iriata, 1976)



78 Oxidodihydroneriifolins
(Cruz *et al.*, 1979)



79 (Cruz *et al.*, 1979)



80 3′-*O*-Methylevomonoside
(Jolad *et al.*, 1981)

1 *Thevetia peruviana* (Pers.) Merr.
Common name: *Yellow oleander*
Arabic name: *Teevitia*

The seeds of *T. peruviana* contain cradiotonic substances: thevetin, thevetoxin, neriifolin (77), cerberin (monoacetylneriifolin) and ruvoside (Portilla G., 1954; Lang and Sun, 1964; Sun and Libizov, 1964). Thevetin was isolated also from the kernels (Huang *et al.*, 1965), which have been reported to contain cardiac glycosides more than stem, leaf or flower of *Nerium indicum* (Cosme *et al.*, 1958). Thevetin, a bitter glucoside with a powerful cardiac action is also present in the bark of the root and stem but not found in the leaf and fruit pulp (Watt and Breyer-Brandwijk, 1962). Bisset *et al.* (1962) reported the properties of 24 monoglycosides isolated from *T. peruviana* and gave evidence of the identity of theveneriin and ruvoside, and similarity of neriifolin and thevefolin. Aucuboside was identified as the chromogen of leaves and fruits of *T. peruviana* (Paris and Etchepare, 1966b). The seeds of *T. neriifolia* Juss. (Syn. *T. peruviana* Merr.) (Rangaswami and Rao, 1958) contain thevetin, cerberin, neriifolin, thevefolin, theveneriin, peruvoside (Ayyar, 1928; Ghatak, 1932; Chen and Chen, 1934; Lahiri *et al.*, 1938; Frèrejacque, 1945, 1956; Rangaswami and Rao, 1958; Aleshkina and Berezhinskaya, 1962). Iridoids containing theveside were detected in various *T. neriifolia* tissues (Osisiogu, 1975).

Two phenylpropanoids identified as methyl β-(2-hydroxy-4-carboxy) phyenylacetate and β-(2-hydroxy-4-carboxy) phenylacetic acid, besides lupeol acetate were isolated from flowers of *T. neriifolia* (Gunasegaran and Nair, 1983). L(+) Bornesitol (a cyclitol) was isolated from the stems and leaves of *T. neriifolia* (Nishiba *et al.*, 1971a). The seed oil of the latter species is rich in plamitic, oleic and linoleic acids (Qazi *et al.*, 1973).

5 *VINCA*

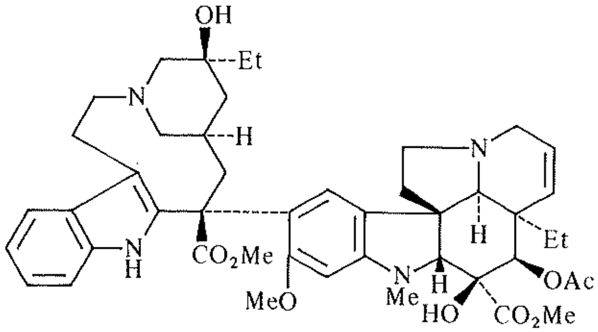
The genus *Vinca* (and in particular *V. rosea*) is well reported for producing biologically active indole alkaloids having novel structural patterns (Taylor and Farnsworth, 1973). Examples of *Vinca* species which yield indole alkaloids are *V. difformis* (Gosset *et al.*, 1962), *V. erecta* (Khalmirzaev *et al.*, 1975, 1980), *V. herbacea* (Babaev *et al.* 1975, Dzhakeli, 1978; Gasic *et al.*, 1984), *V. major* (Trojanek and Hodkova, 1962), *V. minor* (Trojanek *et al.*, 1962; Voticky *et al.*, 1977), *V. ovalis* (Langlois and Potier, 1971), *V. pusila* (Mitra *et al.*, 1981) and *V. rosea* (mentioned below in details).

Iridoids (e.g. catalpol, harpagide, ajugol and aucubin) occur in *V. minor* and *V. major* (Bianco *et al.*, 1984).

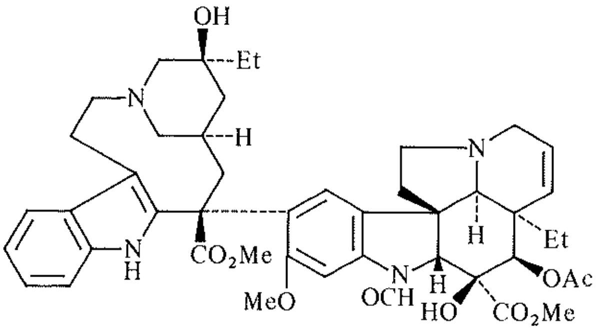
1 *Vinca rosea* L.
(= *Catharanthus roseus* Don.)
Common name: *Periwinkle*
Arabic name: *Winka*

Several important folklore activities have been reported for *Catharanthus roseus* (*Vinca rosea*) but the one which led to the initial, independent studies was the possibility of an oral insulin substitue. Neither a Canadian group nor the Eli Lilly group (U.S.A) could substantiate the hypoglycemic activity of crude extracts, but the latter group did find anti-leukemic activity. An intensive search for the active principles led to the isolation of vincaleukoblastine and leurosine. Subsequent work, principally by the Lilly group, has led to the isolation of over ninety alkaloids, several of which display anticancer activity, but todate only two of these are commercially available (Cordell, 1981).

Vinblastine (81) and vincristine (82) (Neuss *et al.*, 1964) were proved effective against blood cancer. Among the other alkaloids identified from the leaves of *Vinca rosea* (*Catharanthus roseus*) are the following ones: caroside, carosine, pleurosine, neoleurosidine, catharicine, vindolidine, neoleurocristine, vincarodine (Svoboda *et al.*, 1962); catharanthine (83) (Gorman and Neuss, 1963); sitsirikine (Kutney and Brown, 1963); perivine (Gorman and Sweeny, 1964); lochrovine, perimivine, vincoline, lochrovidine, lochrovicine, vincolidine (Svoboda *et al.*, 1964); catharosine (Moza and Trojanek, 1965); dihydrositsirikine, isositsirkine (Kutney and Brown, 1966); leurocolombine, vinamidine, pseudovincaleukoblastinediol (Tafur *et al.*, 1975); vindoline (85), ajmalicine (86) (Ali *et al.*, 1979); 16-epi-19-*S*-vindolinine-*N*-oxide, fluorocarpamine-*N*-oxide (Atta-ur-Rahman and Bashir, 1983); bannucine (89) (Atta-ur-Rahman *et al.*, 1986); cleavamine (84), leurosine, leuorsidine, lochnerine (87), serpentine (88),

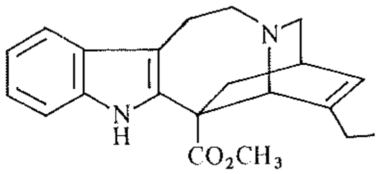


81 Vinblastine
(= Vincaleukoblastine)

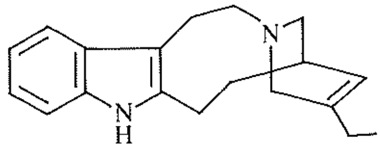


82 Vincristine

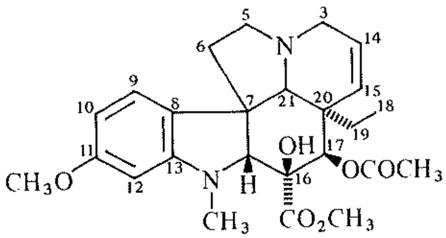
(Cordell, 1981)



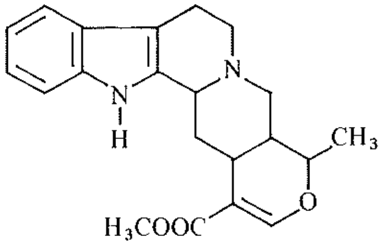
83 Catharanthine



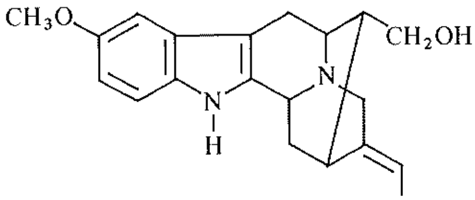
84 Cleavamine



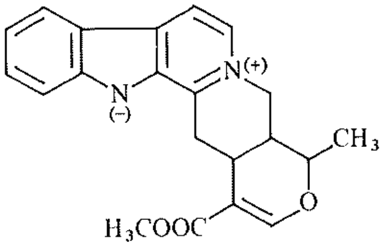
85 Vindoline



86 Ajmalicine

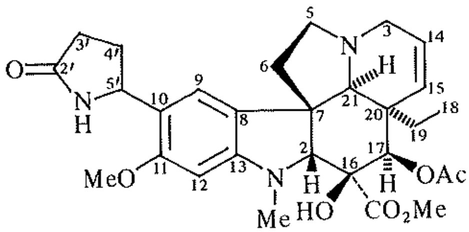


87 Lochnerine

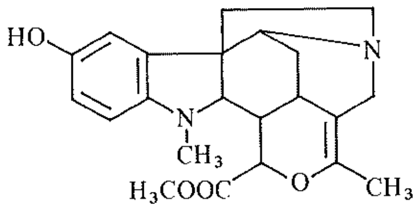


88 Serpentine

(Cordell, 1981)



89 Bannucine
(Atta-ur-Rahman *et al.*, 1986)



90 Akuammine
(Cordell, 1981)

Some alkaloids of *Vinca rosea*

vincamine, akuammine (90) and many others (Svoboda and Blake, 1975; Creasey, 1975; Cordell, 1981; Atra-ur-Rahman *et al.*, 1983, 1984, 1985).

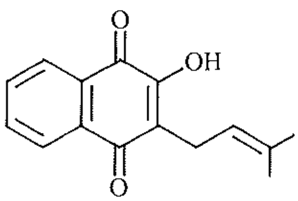
The alkaloids are well distributed in the whole plant. Vinosidine, lochnerivine, leurosivine, alstonine and cavincine have been identified from the roots (Svoboda, 1963, Ciulei *et al.*, 1965).

The plant also contains the following non-alkaloid constituents:

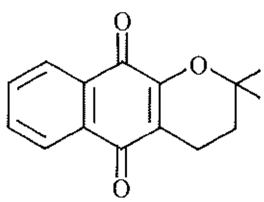
- Anthocyanins, camphor, choline, hirsutidin, kaempferol, quercetin, lochnerallol, lochnerol, malvidin, mannoside, petunidin, *o*-protocatechuic acid, β-sitosterol and tannins (Farnsworth, 1961).
- L(+)-Bornesitol (a cyclitol) from the roots (Nishibe *et al.*, 1973).
- Monoterpene glycosides: deoxyloganin, loganin, sweroside, dehydrologanin (Bhakuni and Kapil, 1972).
- Ursolic acid (Farnsworth, 1961; Bocharova, 1966) and oleanolic acid (Ali *et al.*, 1979).

VII BIGNONIACEAE

Lapachol (91), a naphthaquinone has been known since 1858, and is the most abundant quinone in the wood of various Bignoniaceae found mainly in tropical America, for example 7·64% in *Tecoma araliaceae* and is sometimes visible in yellow deposits (Thomson, 1971). *Bignonia tecoma*, and no doubt other species, was used as a dyewood in Brazil (Thomson, 1971). Lapachol occurs in heartwood of several genera of the Bignoniaceae (Hegnauer, 1964) (especially the tribe *Tecomeae* (Thomson, 1971), *Tabebuia flavescencs* (Orth, 1960), *T. guayacan* (Wise *et al.*, 1951), *T. avellanedae* (Burnett and Thomson, 1967), *Tecomella undulata* (Singh *et al.*, 1972), *Paratecoma peroba* (Livingstone and Whiting, 1955) and several *Tecoma* species (e.g. Hegnauer, 1964; Gupta *et al.*, 1969). Other quinones also occur in the family Bignoniaceae e.g. α- and β-lapachones (92, 93), deoxylapachol (94), dehydro α-laphacone (xyloidone) (95) from *Tabebuia avellanedae* (Burnett and Thomson, 1967), lomatiol (96) and others from *Paratecoma peroba* (Sandermann *et al.*, 1968; Thomson, 1971).

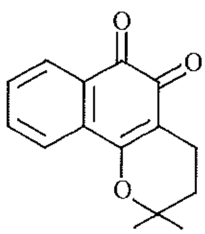


91 Lapachol

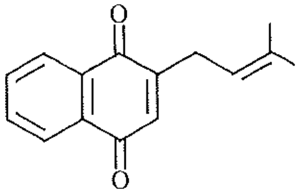


92 α-Laphacone

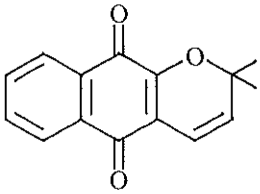
(Thomson, 1971)



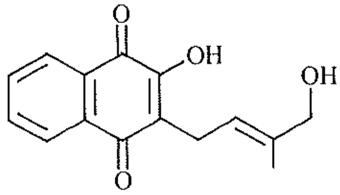
93 β-Laphacone



94 Deoxylapachol



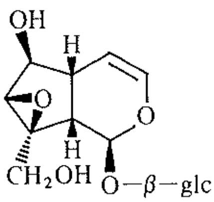
95 Xyloidone
(= Dehydro-α-laphacone)
(Thomson, 1971)



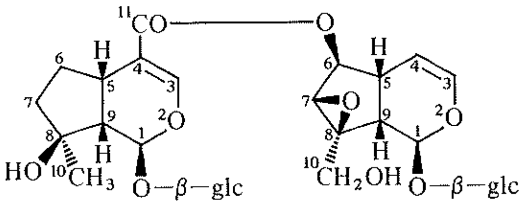
96 Lomatiol

Other than *Tecoma* species (mentioned below in details), iridoids and flavonoids have been identified from several genera of the family Bignoniaceae. Examples of the flavonoids isolated are pinocembrin 7-β-neohesperidoside from the fruits of *Sparattosperma vernicosum* (Kutney *et al.*, 1970); chrysin-7-rutinoside from the leaves of *Dolichandrone falacta* (Subramanian *et al.*, 1972); baicalein, baicalein glycosides, scutellarein from *Oroxylum indicum* and quercetin and kaempferol 3-sophorosides from *Pajanelia longifolia* (Subramanian and Nair, 1972a). Quercetin-3-glycosides, quercetin and others have been identified from several genera of the Bignoniaceae (Subramanian *et al.*, 1972b).

Argylia radiata contains the following iridoids: catalpol (97), plantarenaloside, 7-deoxy-8-*epi*-loganic acid, 7-deoxygardoside and two dimeric iridoid glucosides: argylioside (98) and radiatoside (Bianco *et al.*, 1985, 1986 a,b,c; Garbarino, 1985).



97 Catalpol

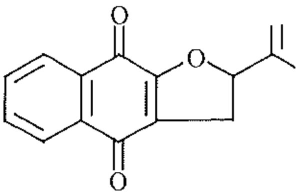


98 Argylioside
(Bianco *et al.*, 1986c)

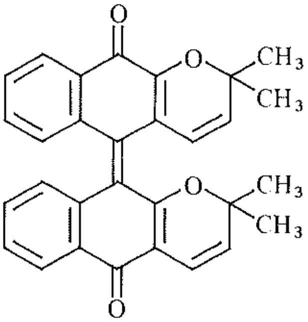
Earlier investigation of some Bignoniaceae showed that these plants consistently yielded flavones, sterols, traces of alkaloids and occasionally quinones and saponosides (Pernet, 1956).

1 *TECOMA*

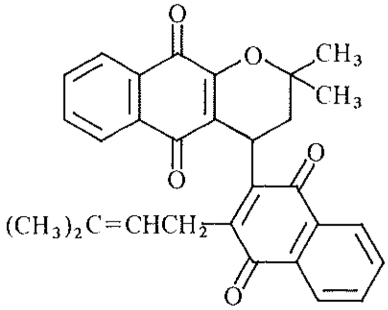
Lapachol has been isolated from the heartwood of several *Tecoma* species e.g. *T. araliaceae* (Thomson, 1971), *T. undulata* (Gupta *et al.*, 1969), *T. pentaphylla* (Rohatgi *et al.*, 1983). The latter species also contains α-lapachone (92), β-lapachone (93), dehydro-α-lapachone (95), dehydro-iso-α-lapachone (99), tecomaquinone I (100) and tecomaquinone II (101) (Rohatgi *et al.*, 1983).



99 Dehydro-*iso*-α-lapachone
(Thomson, 1971)

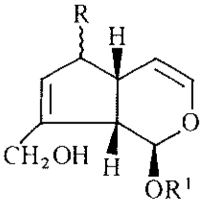


100 Tecomaquinone I

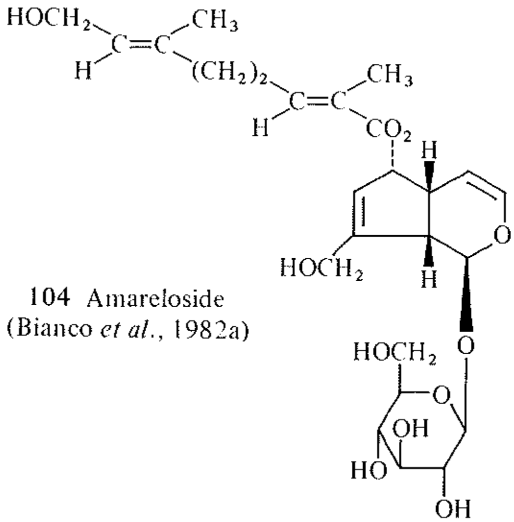


101 Tecomaquinone II
(Rohatgi *et al.*, 1983)

Iridoids have been identified from *Tecoma* species e.g. 6-α hydroxy epimer of aucubin (102) together with its ester derivatives and amareloside (104) from *T. chrysantha* (Bianco *et al.*, 1981a, 1982a-c) and 6-epimonomelittoside from *T. heptaphylla* (Bianco *et al.*, 1983).



102 6-Epiaucubin : (R = α-OH, R' = β-glucosyl)
103 Aucubin : (R = β-OH, R' = β-glucosyl)
(Bianco *et al.*, 1982c)



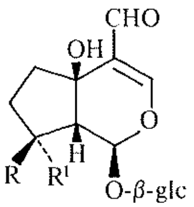
104 Amareloside
(Bianco *et al.*, 1982a)

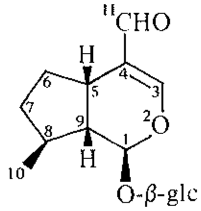
Dimeric and higher polymeric flavonols with antitumour activity were isolated from the bark of *T. caraiba* (De Oliveira *et al.*, 1972). *T. fulva* contains two alkaloids: tecomanine and actinidine and the methyl ester of 4-methoxy-*trans*-cinnamic acid (Hilz *et al.*, 1973).

1 *Tecoma stans* HBK.
(= *Stenolobium stans* Seem)
Common name: *Yellow bells*
Arabic name: *Tikoma*

Investigation of *Tecoma stans* led to the isolation of several substances belonging to different classes:

— Iridoids: plantarenaloside (105) (Popov, 1978), Stansioside (106) (Bianco *et al.*, 1979) and 5-deoxy-stansioside (107) (Bianco *et al.*, 1981b)





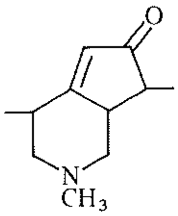
105 Plantarenaloside: R = H, $R^1 = CH_3$

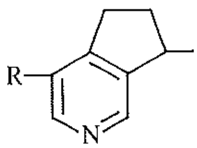
106 Stansioside : $R = CH_3$, R^1 = H

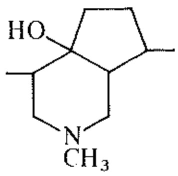
107 5-Deoxystansioside

(Bianco *et al.*, 1981b)

— Monoterpene alkaloids (Pyrindan alkaloids) : Tecomine, (Hammouda and Motawi, 1959), tecomanine (108), actinidine, 4-noractinidine (109), boschniakine (110), an *N*-normethylskytanthine (111), (Dickinson and Jones, 1969; Dohnal, 1976), alakloid C (112) (Jones *et al.*, 1971; Ferguson and Marsh, 1975), Δ^5-dehydroskytanthine and δ-skytanthine (Gross *et al.*, 1973).







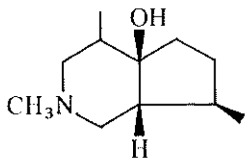
108 Tecomanine

109 Noractinidine : R = H

110 Boschniakine : R = CHO

(Dickinson and Jones, 1969)

111 *N*-Normethylskytanthine



112 Alkaloid C

(Ferguson and Marsh, 1975)

— The naphthaquinone lapachol (Dohnal, 1976).

— Phenolic acids: *p*-hydroxyphenyllactic, caffeic, and ferulic acids (Sugumaran *et al.*, 1975)

— A flavonoid: quercetin 3-*O*-glucoside (Hostettmann *et al.*, 1979).

— Indolic compounds: indole, tryptophan, tryptamine and skatole (Kunapuli and Vaidyanathan, 1984).

— Carotenoids: β-carotene and zeaxanthin (Taha, 1954), phytoene, phytofluene I, phytofluene II, ε-carotene, mutatochrome and pigment × (Premachandra *et* *al.*, 1974). Xanthophylls detected in the flower petals are: 5, 6, 5′, 6′-diepoxycryptoxanthin, 5,6-monoepoxycryptoxanthin, cryptoxanthin, *cis*-violaxanthin and antheraxanthin (Premachandra *et al.*, 1974).

— Anthranillic acid and its glucoside (Kunapuli and Vaidyanathan, 1984), β-sitosterol (Maheshwari and Banerjee, 1970) and 3-*trans*-9-*cis*-12-*cis*-15-*cis*- octadecatetraenoic acid (~19% of the total fatty acids of the seed oil) (Hopkins and Chisholm, 1965).

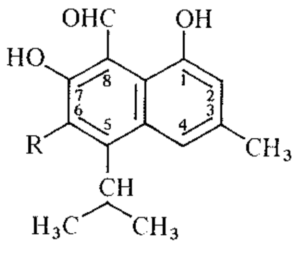
VII BOMBACACEAE

1 *BOMBAX*

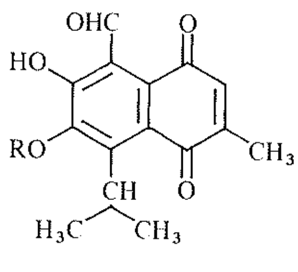
Relatively little information is available about the constituents of this genus. *B. munguba* has been early developed in Brazil as a source of cellulose for nitration (Reise, 1930). The seed of *B. aquaticum* (*Pachira aquatica*) contains 58·0% fat with palmitic acid as the major fatty acid constituent (Berbert, 1981).

1 *Bombax malabaricum* DC.
(= *Salmalia malabaricum*)
Common name: *Silk tree, Cotton tree*
Arabic name: *Bombax*

A polysaccharide consisting of D-galactose, L-arabinose and L-rhamnnose in the molecular ratio of 5:4:3 has been isolated from the dried stamens of the flowers of *B. malabaricum*. The polysaccharide is highly branched and a most probable structure has been assigned to it showing a back bone consisting of β-1:4-linked D-galactopyranosyl and β-1:3-linked-L-arabinopyranose units with β-linked galactose and α-linked L-rhamnose and L-arabinose units as end groups (Agrawal *et al.*, 1972). The gum of *B.*



113 Hemigossypol : R = OH
114 Hemigossypol-6-methylether : R = OCH_3

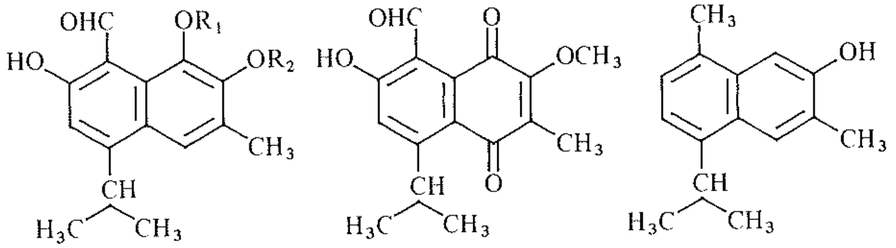


115 : R = H
116 : R = CH_3

(Sankram *et al.*, 1981)

malabaricum has been early reported as a substitute for gum tragacanth (Bal and Prasad, 1943).

The root bark has been early reported to contain a naphthol and two naphthaquinones (115, 116) (Seshadri *et al.*, 1973). Later Sankram *et al.* (1981) stated that the previously reported hemigossypol-6-methylether (114) is isohemigossypol-1-methylether (117). The latter authors also identified, from the root bark, isohemigossypol-1,2-dimethylether (118), 8-formyl-7-hydroxy-5-isopropyl-2-methoxy-3-methyl-1,4-naphthaquinone (119) and 7-hydroxycadalene (120).

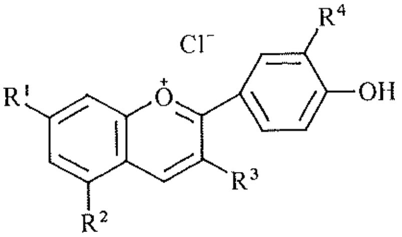


117 : $R_1 = CH_3$, $R_2 = H$ 119 120 7-Hydroxycadalene

118 : $R_1 = R_2 = CH_3$

(Sankram *et al.*, 1981)

The flowers contain two anthocyanins: pelargonidin-5-β-D-glucopyranoside (121) and cyanidin-7-methylether-3β-D-glucopyranoside (122) (Niranjan and Gupta, 1973).



(121) : $R^1 = R^3 = OH$, $R^2 = \beta$-D-glucose, $R^4 = H$
(122) : $R^1 = OCH_3$, $R^2 = R^4 = OH$, $R^3 = \beta$-D-glucose
(Niranjan and Gupta, 1973)

The Indian cotton tree (*B. malabaricum*) contains 48·3% cellulose (Dhingra *et al.*, 1949). The fiber obtained from the seed covering looks like cotton fiber (Oguri *et al.*, 1938). The structure of the fibre of *B. malabaricum* as a potential pulpwood has been reported by Deshpande (1955).

The dry, skin-free, white pulpy portions of roots from plants two years old, contain proteins (1·2%), fats (0·9%), starch (71·2%), pectous matter (6·0%), cellulose (2·0%), tannins (0·4%), montannins (0·1%), and sugars (arabinose and galactose) (8·2%) (Ghose, 1935).

Salmalia malabaricum (also known as *Bombax malabaricum*) (Bhatnagar, 1965) contains the following substances:

— a gum consisting of L-arabinose, D-galactose, and D-galacturonic acid and traces of rhamnose (Bose and Dutta, 1963a,b,1965).

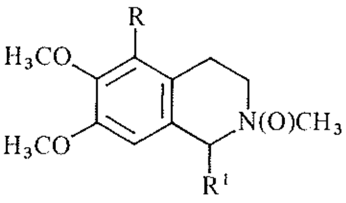
— 3′, 4′, 5′, 7-Tetrahydroxy-6-methoxyflavan-3-*O*-β-D-gluco-pyranosyl-α-D-xylopyranoside, β-sitosterol and triacontanol from the roots (Chauhan *et al.*, 1980). The chemical composition of the calyx of *S. malabaricum* (protein, carbohydrates, ash, trace elements) has been reported by Bhatnagar (1965).

IX CACTACEAE

Alkaloids have been isolated from several genera of the family Cactacea. Of the 120 cactus species examined by Agurell (1969) 40% contained alkaloids. The alkaloid-bearing cactus species and their constituent alkaloids have been reviewed by Mata and McLaughlin (1981). The cactus alkaloids manily belong to the phenethylamine and tetrahydroisoquinoline groups. Examples of the alkaloids identified from the Cactaceae are:

Phenyethylamines: hordenine, tyramine, *N*-methyltyramine, from many cactus species (Braga and McLaughlin, 1969; De Vries *et al.*, 1971; Knox *et al.*, 1983), mescaline, *N*-methylmescaline from *Lophophora* and *Pelecyphora* species (Pallares, 1960; Neal and McLaughlin, 1972), and several others (Bruhn and Bruhn, 1973; Meyer *et al.*, 1983).

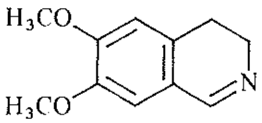
Tetrahydroisoquinolines: Tehuanine *N*-oxide (123) from *Pachycereus pringlei* copterocereine *N*-oxide (124) from *Pterocereus gaumeri* (Pummangura *et al.*, 1982) and dehydroheliamine (125) from *Carnegica gigantea* (Ordaz *et al.*, 1983).



123 Tehuanine *N*-oxide : $R = OCH_3$, $R^1 = H$

124 Copterocereine *N*-oxide : $R = OH$, $R^1 = CH_2OH$

(Pummangura *et al.*, 1982)



125 Dehydroheliamine

(Ordaz *et al.*, 1983)

A survey of leaves and thorns of twenty two species of Cactaceae showed the presence of several classes of flavonoids: flavones (apigenin, baicalein), flavonols (quercetin, kaempferol, isorhamnetin, flavonol-3-methyl ethers), flavanones (naringenin and its 4′

7-diamethylether), flavononols (taxifolin and aromadendrin) (Burret *et al.*, 1982). Recently Iwashina *et al.* (1982, 1984, 1986) reported the isolation of several kinds of flavonoids from the tepals of many cactaceous plants. Rare flavonols *viz.* quercetin 3-methyl ether and its 7-*O*-glucoside and 4′-*O*-glucoside (neochilenin) were isolated from eleven cactaceous plants belonging to three genera (Iwashina *et al.*, 1984). The destribution of flavonol glycosides and their sugar forms in subfamily *Cereoidea* has been recently reported by Iwashina and Ootani (1986). The betacyanin, betanin occurs in the thirty four species of the family Cactaceae examined by Piattelli and and Imperato (1969). Many of the examined species also contain phyllocactin, while betanidin and some other betacyanins have a more limited occurrence.

Many of the *Cactus* genera e.g. *Cereus*, *Opuntia* and *Notocactus* contain mucilages (e.g. Moyna and DiFabio, 1978; McGarvie and Haralambos, 1979). The chemical composition of the mucilages has been found consistent with a role in the storage of moisture in Cactaceae, and may be used to provide a useful method of taxonomy within the family (Mindt *et al.*, 1975).

1 *CEREUS*

Preliminary chemical investigation of thirty-one cactic (mostly *Cereus* species of the globular varieties) showed the presence of alkaloids, flavonoids, cardiac glycosides, sugars, saponins and carbonyl compounds, including cacticin, narcissin, retusine and opuntiol (Dominguez *et al.*, 1969). Alkaloids have been identified from several *Cereus* species e.g. tyramine, 3-nitrotyramine, hordenine, candicine and 2-nitro-4-hydroxyphenethylamine from *C. aethiops* (Ruiz *et al.*, 1973), *C. jamacaru* (Bruhn and Lindgren, 1976), and *C. validus* (Neme *et al.*, 1977; Nieto *et al.*, 1982). The pulp of *C. triangularis* contains a polysaccharide (15%) which consists of galactose, arabinose, rhamnose and galacturonic acid (Tabak and Pueschel, 1969).

Six kinds of flavonoids have been isolated from the tepals of Ceroideae species namely, kaempferol 3-*O*-glucoside and 3-*O*-rhamnosylglucoside, and quercetin 3-*O*-glucoside and 7-*O*-glucoside from *Echinocereus triglochidiatus* var. *gurneyi* (Miller and Bohm, 1982), and also isorhamnetin 3-*O*-galactoside (cacticin) and 3-*O*-rhamnosylglucoside (narcissin) from *Cereus grandiflorus* (Hoerhammer *et al.*, 1966).

The seeds of *Cereus* species have been reported as a good source of protein and fats. The cactus fruit rind unlike its white pulp contains citric, fumaric, maleic, malonic and oxalic acids (Pant, 1973). *C.jamacaru*, when dried makes valuable additions to feed for cattle (Maderios, 1958).

1 *Cereus peruvianus* Mill.
Common name: *Hedge cactus*
Arabic name: *Seras*

The mucilage of *C. peruvianus* has some similarity to both pectic polysaccharides and gum exudates (Mindt *et al.*, 1975). The leaves contain phorbic acid (Nordol *et al.*, 1965). Phytochemical screening of *C. peruvianus* revealed the presence of alkaloids, sterols and/or terpenes (Rizk *et al.*, 1988).

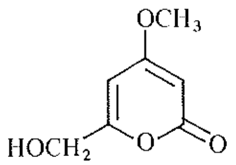
2 *OPUNTIA*

The composition and characteristics of the mucilages of several *Opuntia* species have been reported. They have some similarity to both pectic polysaccharides and gum exudates, and so may provide an alternative source of raw materials (Mindt *et al.*, 1975). *O. dillenii* seeds contain a mucilagenous matter (0·5%) which consists of arabinose and galactose in the molar ratio (1:3) (Srivastava and Pande, 1974). The structural characteristics of mucilages from certain cactus plants, including *O. aurantiaca* and *O. brasiliensis* showed that they are formed of arabinose, galactose, rhamnose and galacturonic acid with less amounts of xylose (Moyna and DiFabio, 1978). *O. vulgaris* has been reported as a source of pectin (Diacone and Massa, 1948).

Flavonoid pigments have been identified from the flowers of several *Opuntia* species. The flowers of all six taxa of *Opuntia* (prickly pear), examined by Clark and Parfitt (1980) produced the same flavonoids *viz.* quercetin and isorhamnetin 3-glucosides and *β*-rutinosides, isorhamnetin 3-rhamnogalactoside and kaempferol 3-galactoside. The presence of such flavonoids has been also reported by other works from the different species e.g. *O. dillenii* (Nair and Subramanian, 1961, 1964), *O. elatior* (Shabbir and Zaman, 1968), *O. lindheimeri* (Rosler *et al.*, 1966) and *O. vulgaris* (Paris, 1951).

Phenylethylamine alkaloids occur in the genus *Opuntia* e.g. mescaline, tyramine, 3-methoxytyramine, and *N*-methyltyramine from *O. clavata* (Vanderveen *et al.*, 1974), *O. cylindrica* (Turner and Heyman, 1960) and *O.spinosior* (Pardanani *et al.*, 1978).

Opuntiol (126, 6-hydroxymethyl-4-methoxy- α-pyrone) has been identified from *Opuntia* species e.g. *O. elatior* (Ganguly *et al.*, 1965) and *O. polyacantha* (Telang, 1973).



126 Opuntiol
(Ganguly *et al.*, 1965)

Several organic acids were also detected e.g. malic and succinic acids from *O. dillenii* (Hajarnavis, 1964) and *p*-hydroxybenzoic, vanillic and ferulic acids from *O. fragilis* (Abramovitch *et al.*, 1968). The yellow prickly pear *Cactus opuntia* (*O. compressa*) contains cyanidin 3-rhamnoside pervailed with slight trace of petunidin 3-diglucoside while in the red fruit a great amount of the latter was found with small amount of the former anthocyanin (Duro and Condorelli, 1971). *O. vulgaris* contains fridelin, friedelan-3 α-ol, taraxerone and taraxerol (chatterjee *et al.*, 1976). Partially identified triterpenes were also isolated from *O. pachypus* (Molina and Hoet, 1977).

1 *Opuntia ficus-indica* Mill.
Common name: *Indian Fig*
Arabic name: *Teen shoukyi*

The polysaccharide of *O. ficus indica* consists of a mixture of mucilage and pectin (Karawya *et al.*, 1980). The mucilage extracted from the cladodes (modified stems) contains residues of D-galactose, D-xylose, L-arabinose, L-rhamnose and D-galcturonic acid (Amin, 1970, McGarive and Parolis, 1979, 1981). The mucilage has a uronic content of ~10% and molecular weight of 4.3×10^6 (Trachtenberg and Mayer, 1981). In addition to the mucilage (acidic fractions), the stems contain neutral carbohydrate-containing polymers consisting of two glucans and a glycoprotein containing arabinose and galactose (Paulsen and Lund, 1979).

The flowers of *O. ficus-indica* contain several flavonoids *viz.* penduletin, kaempferol, luteolin, quercitrin, rutin (El-Moghazy *et al.*, 1982) and isorhamnetin glycoside (Arcoleo, 1961; Arcoleo *et al.*, 1961-1962).

The fruits contain two betacyanins: betanin and isobetanin (Piattelli and Minale, 1964). The pulp of fruits has been reported to contain 0.084–0.090 mg/kg carotene. The presence of a xanthophyll of the lutein or zeaxanthin type was early established (Cocuzza, 1946). Later indicaxanthine, a β-xanthine has been isolated from the yellow fruits (Piattelli *et al.*, 1964a, b).

Both the stem segments (Dawidar and Fayez, 1961) and flowers (Arcoleo *et al.*, 1964–1965) contains β-sistosterol. The plant contains at least seven non-volatile acids, including malic and citric acids (Nordal *et al.*, 1966). The major glycerides of the seed oil are palmitoyldilinolein and linoleoyldiolein (Petronici *et al.*, 1969).

The fruit, although the outer skin looks waxy, contains no fat, but the juice contains 12·8% of glucose and fructose together, but no sucrose. The fruit juice of a species with bright red fruits contains 6·57–20 mg % of ascorbic acid and 3·14 mg % of dehydroascorbic acid. The fruit juice contains a natural yeast, known as *Saccharomyces opuntiae*, which is the reason for its spontaneous fermentation (Watt and Breyer-Brandwijk, 1962). The constituents of the fruit, respectively for the peel, the pulp and the seeds are: water 86·19, 92·95, 33·36; fats 17·81, 7·04, 66·63; glucose 0·12, 0·07,-; dextrin 5·54, 0·16; total nitrogen 0·10, 0·8, 3·48; protein 0·06, 0·05, 1·32; ash 0·15, 0·35, 1·24% (Piccoli, 1943). Crude fibre, water, ash, and ascorbic acid are generally lower in the fruits, and calcium and iron are higher (Rojas, 1958). The total solids content, total acidity and total pectins decrease during the full ripening of the fruits. The ripe fruit is most suitable for human consumption while the unripe fruit is best as animal forage (Bicalho and Penteado, 1982). The amino acid content of the fruit is acceptable being deficient in lysine (Vidal and Varela, 1968). The digestability and nutritive value of the phylloclades and fruits of *O. ficus-indica*, employed in animal feeding have been reported by Maymone and Malossini (1961).

The prickly pear (*O. ficus-indica*) has also been considered as a source of fibre (Watt and Breyer-Brandwijk, 1962).

X CANNACEAE

1 *CANNA*

The tubers of *Canna* species are edible. They are rich in starch which amonts to 14·7% in *C. generalis* (Fujimoto *et al.*, 1984). Properties of edible *Canna* starch (Hassid and

Dore, 1937; Inatsu *et al.*, 1983; Fujimoto *et al.*, 1984) as well as the digestibility and nutritive values have been reported (French, 1938).

1 *Canna indica* L.
Common name: *Indian shot*
Arabic name: *Sonbol*

The roots contain 3·6% protein, 0·7% fat, 90·2% total carbohydrates 4·0% fiber, 5·3% ash, 130 mg calcium and 220 mg phosphorus (Duke and Ayensu, 1985a).

The root is decocted with rice or mutton for treating gonorhea and amenorrhea, and the smoke from burning is insecticidal.

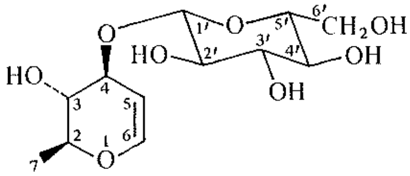
XI CARYOPHYLLACEAE

The family Caryophyllaceae is characterized by the presence of zwitterionic anthocyanins (Terahara *et al.*, 1986) and *C*-glycosylflavonoids (Dubois *et al.*, 1982, 1984). Aglycones with β-amyrin skeleton occurs in most Caryophyllaceae. The simple aglycone of that order oleanolic acid and others with higher oxidation degree with additional acid-containing functional groups were also found (Kondratenko *et al.*, 1981). Gypsogenin is the main aglycone of the triterpenoid glycosides (Yukhananov *et al.*, 1971; Yukhananov and Sapunova, 1976), but other aglycones were also found (Kondratenko *et al.*, 1981). Monosaccharides of the carbohydrate chains include, apart from L-ribose found in glycosides of *Clematis vitalba*, D-glucuronic acid, D-glucose, D-fucose, L-rhamnose, D-quinobiose, D-xylose and L-arabinose (Kondratenko *et al.*, 1981). Cyclitols (D-pinitol and D-ononitol) occur in several species (Plouvier, 1962).

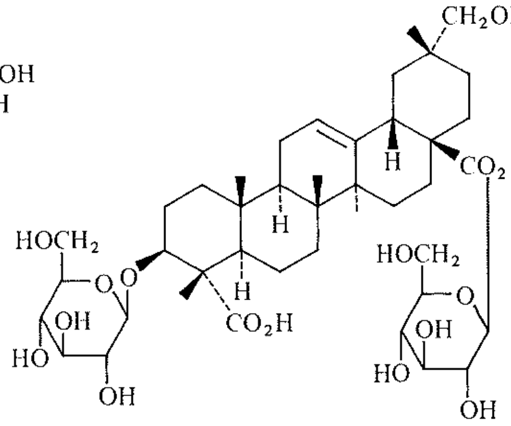
1 *DIANTHUS*

Anthocyanins, including those substituted with malic acid e.g. pelargonidin 3-malyglucoside and cyanidin 3-malyglucoside, have been identified from several carnations (*Dianthus* species) (Terahara *et al.*, 1986). Flavonoids including several *C*-glycosides were isolated from many *Dianthus* species e.g. neoavroside (an apigenin 6-*C*-glucoside) from *D. deltoides* (Boguslavskaya and Beletskii, 1978); saponaretin, isosaponarin, vitexin and luteolin *O*-glycosides from *D. pseudosquarosus* (Darmograi and Khimenko, 1978); orientin and homoorientin from *D. superbus* (Seraya *et al.*, 1978), chrysoeriol *C*-glycosides from *D. dicolor, D. ramosissimus* and *D. versicolor* (Boguslavskaya *et al.*, 1983) and others (Bandyukova and Shinkarenko, 1965). Chalcones (Harborne, 1966), and pyran glycosides (e.g. sapopyroside (127), and barbapyroside, (an isomer of sapopyroside) also occur in *Dianthus* species (Shimizu *et al.*, 1982; Plouvier, 1984; Plouvier *et al.*, 1986).

Dianthus saponins which yield (on hydrolysis) gypsogenic acid, have been isolated from *D. superbus* var. *longicalycinus* (Shimizu and Takemoto, 1967). Recently Oshima



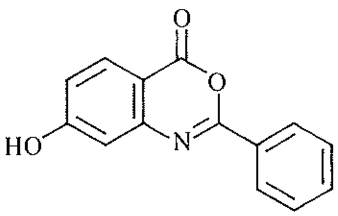
127 Sapopyroside
(Plouvier, 1984)



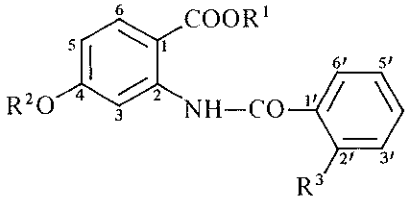
128 Dianoside C
(Oshima *et al.*, 1984)

et al. (1984) elucidated the structures of four triterpenoid saponins, dianosides C (128), D, E, and F from the same species. The presence of other constituents has been also reported e.g. β-diketones from *D. caryophyllus* (Horn and lamberton, 1962).

Dianthalexin, (129 a benzoxazinone) and dianthramides A and B (130, 131) (phytoalexins) have been identified as components of carnation (*D. caryophyllus*) in response to elicitation and to infection by *Phytophthora parasitica* (Ponchet *et al.*, 1984).



129 Dianthalexin



130 Dianthramide A :
$R^1 = H$, $R^2 = CH_3$, $R^3 = OH$

131 Dianthramide B :
$R^1 = CH_3$, $R^2 = H$, $R^3 = OH$

(Ponchet *et al.*, 1984)

1 *Dianthus chinensis*
Common name: *Rainbow pink*
Arabic name: *Qoronful*

The seeds contain 18·1% protein and 6% fat (Duke and Ayensu, 1985a). Phytochemical screening of the plant revealed the presence of coumarins, saponins and alkaloids (Rizk *et al.*, 1988).

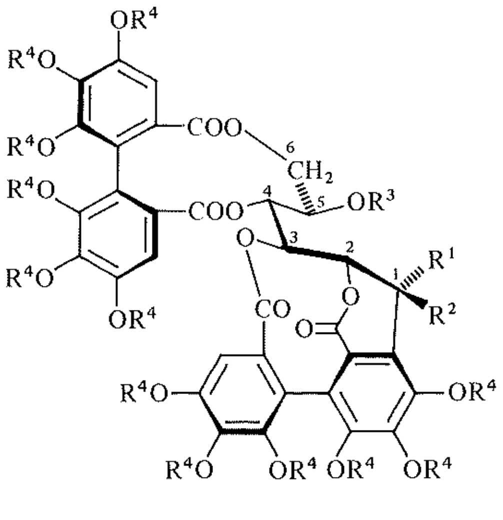
The plant is used by Koreans to remove eczema and malignant skin cancer. The herb is also anthelmintic, diaphoretic and duiretic (Duke and Ayensu, 1985a).

XII CASUARINACEAE

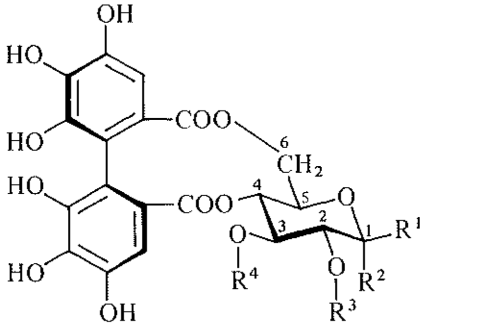
1 *CASUARINA*

Plants of *Casuarina* species are regarded as rich tannin resources. A number of ellagitannins have been identified from these species e.g. casuarictin (135) (1-*O*-galloyl-2, 3-4, 6-di-*O* [(*S*)-hexahydroxydiphenoyl]-*β*-D-glucose), casuarinin (132), pedunculagin (136) (2, 3-4, 6-di-*O*- [(*S*)-hexahydroxydiphenoyl]-D-glucose), tellimagrandin I (137) (2, 3-di-*O*-galloyl-4, 6-*O*- [(*S*)-hexahydroxydiphenoyl]-D-glucose), casuariin (133), stachyurin (134), strictinin (138) and isostrictinin from *C. stricta* (Okuda *et al.*, 1981a, 1982a,b).

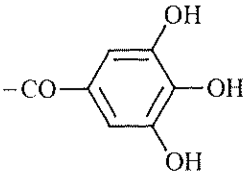
Kaempferol and quercetin along with ellagic acid have been identified from several *Casuarina* species (Bate-Smith, 1962; Natarajan *et al.*, 1971). Quercetin 3-glucoside, quercetin 3-glucuronide and kaempferol 3-glucuronide seem to play an important role in the biochemistry of the four *Casuarina* species studied by Saleh and El-Lakany (1979). The presence of biflavonoids (e.g. cupressuflavone) in *Casuarina* species has been reported by Natarajan *et al.*, (1971).

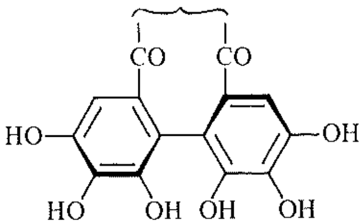


		R^1	R^2	R^3	R^4
132	Casuarinin :	H	OH	gall	H
133	Casuariin :	H	OH	H	H
134	Stachyurin :	OH	H	gall	H



	R^1	R^2	R^3	R^4
135 Casuarictin :	O-gall	H	(S)-HHDP	
136 Pedunculagin :	H,OH		(S)-HHDP	
137 Tellimagrandin :	H,OH		gall	gall
138 Strictinin :	O-gall / H,OH	H	H	H

gall =


(S)-HHDP =


(Okuda *et al.*, 1982a)

1 *Casuarina equisetifolia* L.
Common name: *Horsetail-tree*
Arabic name: *Gazwarina*

The bark and root bark of *C. equisetifolia* contain tannins (Petard, 1952; Roux, 1957; Venkataraman and Barat, 1957). The bark contains catechin, gallocatechin (Osima and Ito, 1939; Roux, 1957), (−)-epicatechol, (−)-epigallocatechol, gallic acid, protoca-

Table 2:

	Plant acids	Polyols	Amino acids
Bark	Shikimic acid quinic acid (traces)	Dextrose Fructose Sucrose 5 unidentified compounds	Aspartic acid, threonine, serine, glutamic acid, proline, glycine, alanine, valine, methionine, isoleucine, leucine, tyrosine, phenylalanine, asparagine, histidine, r-aminobutyric acid, ornithene, argenine (traces)
Leaf	Shikmic acid quinic acid	Dextrose Fructose Sucrose 4 unidentified compounds	Aspartic acid, threonine, serine, asparagine, proline, glutamic acid, glycine, alanine, valine, citrubine, methionine, isoleucine, leucine, tyrosine, phenylalanine, ornithene, argenine
Wood	Quinic acid (traces)	Dextrose Fructose 2 unidentified compounds	Aspartic acid, serine, glycine, methionine, isoleucine, leucine.

techuic acid, methyl gallate, (+)-catechol and (+)-gallocatechol. The tannin content in the bark and root bark is 10–12% (Venkataraman and Barat, 1957; Madhusudanamma *et al.*, 1979) and 14·95% (Venkataraman and Barat, 1957) respectively. Reexamination of casuariin (isolated from the bark), originally reported to be *d*-gallocatechol has shown it to be a mixture of gallocatechol and *d*-pyrocatechol (Roux, 1957).

The leaves of *C. equisetifolia* contain several flavonoids and phenolics identified as: five kaempferol glycosides: 3-arabinoside, 3-glucoside (isoquercitrin), 3-glucuronide, 3-rhamnoside and 3-rutinoside; eight quercetin glycosides: 3-arabinoside, 3-galactoside, 3-glucoside, 3-glucuronide, 3-rhamnoside, 3-rutinoside, 3-sophoroside and 3-xyloside; myricetin 3-glycoside; condensed proanthocyanidine; hydrolysable tannins, ellagic acid and cinnamic acids. Quercetin 3-glucoside represents the major flavonol component (Usmani *et al.*, 1970; El-Ansari *et al.*, 1977; Saleh and El-Lakany, 1979).

The bark, beans and wood of *C. equisetifolia* contain alicyclic acids (shikimic and quinic acids), polyols (including dextrose, fructose and sucrose) and amino acids (Table 2) (Madhusudanamma *et al.*, 1978).

The wood is used in pulping and paper making kraft, and semi-chemical cooking of *C. equisetifolia* gives pulp in a yield of 51·4–68·0% with improved strength properties for the use in the production of corrugating medium (Guha and Kabiba, 1981). There are several reports on the decomposition of lignin and cellulose components of the wood and pulping and paper making properties of *C. equisetifolia* (e.g. Chowdhary, 1962; Aggarwal and Singh, 1965; Maheswari *et al.*, 1979). Both hardboard and chipboard have been produced from the plant (Jain and Singh, 1964).

XIII CHENOPODIACEAE

The plants of this family have been reported to contain alkaloids (e.g. quinolizidine type from *Anabasis* and *Salsola* species and indole type from *Arthrophytum* species (Rousseau *et al.*, 1966; Rizk, 1986), saponins (e.g. from *Anabasis*, *Chenopodium* and *Cornulaca* species) and sesquiterpenes of the eudesmane and guaian types (e.g. *Chenopodium* species) (Rizk, 1986). The presence of ecdysone-type hydroxylated steroids has been demonstrated in several *Chenopodium* species (Bathory *et al.*, 1982; Rizk, 1986). Ascaridole is the most characteristic component of the essential oil from the Chenopodiaceae and is responsible for the anthelmintic properties of these oils (de Pascual-T.*et al.*, 1981).

1 *KOCHIA*

The constituents of only few *Kochia* species have been reported revealing the presence of alkaloids in four species (Borkowski and Drost, 1965), oleanolic acid in *K. trichophylla* (Tandon and Agarwal, 1966) and hydrocarbons and alcohols from the same species (Tandon and Agarwal 1966; Siddiqui *et al.*, 1970). *K. prostrata* possesses antiinflammatory effect (Alidzhanov *et al.*, 1967).

1 *Kochia scoparia*
Common name: *Summer cypress*
Arabic name: *Kokhia*

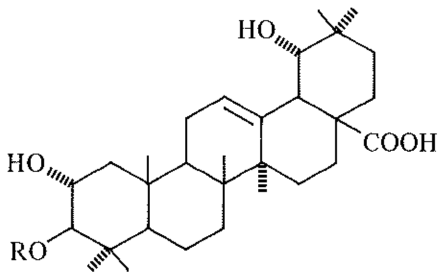
The aerial parts of the plant contain, in addition to choline, the alkaloids harman, harmaline and a tetrahydro-β-carboline derivative (Drost-Karbowska, 1978; Drost-Karbowska *et al.*, 1978). The saponins of the seeds yield oleanolic acid on hydrolysis (Kernan *et al.*, 1973). The flowering tops contain 2.2% betaine (Hegnauer, 1964). The sterols of the plant were identified as campesterol, stigmasterol (89% of the sterols) and β-sitosterol (Shu and Shin, 1969). The plant is rich in protein and carbohydrates (Duke and Ayensu, 1985a), and gives positive tests for flavonoids (Rizk *et al.*, 1988). The chemical composition (protein, fiber, nitrogen-free extract, fat and ash) as well as the digestibility of the plant as a forage crop in Canada have been reported (Bell *et al.*, 1952).

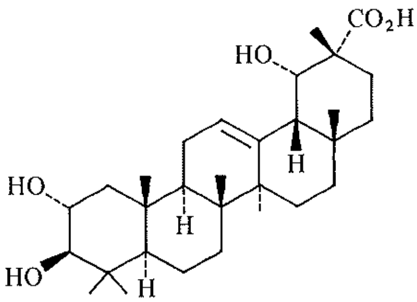
In Argentina, *K. scoparia* has been considered responsible for a large number of cases of photosensitization in cattle, sheep and horses (Kingsbury, 1964). On the other hand, the seeds after removal or inactivation of the saponins, are used as a component of diet of turkey poultry (Coxworth and Salmon, 1972). The fruits and leaves possess cardiotonic, duiretic properties and anti-rheumatic activity (Chopra *et al.*, 1969; Drost-Karbowska *et al.*, 1978; Duke and Ayensu, 1985a).

XIV COMBRETACEAE

1 *TERMINALIA*

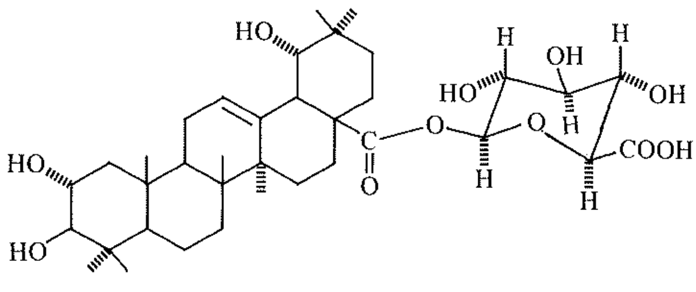
The different parts (e.g. root, bark, heartwood) of *Terminalia* species contain a variety of triterpene acids which occur both free or as glycosides. Examples of the triterpenoids identified from the heartwood of *Terminalia* species are oleanolic acid, maslinic acid, arjunolic acid, and terminolic acid from *T. alata* (Mallavarapu *et al.*, 1980; Mallavarapu and Muralikrishna, 1983); arjunglucoside from *T. arjuna* (Tsuyuki *et al.*, 1979); and tomentosic acid from *T. tomentosa*. (Row and Subba Rao, 1962b). The bark of *T. arjuna* contains arjunic acid (139) (Row *et al.*, 1970) and terminoic acid (140) (Ahmad *et al.*, 1983). The isolation of terminic acid (141), along with several triterpenoid glycosides (arjunosides, 142–145) was reported from the root bark of *T. arjuna*(Anjaneyulu and



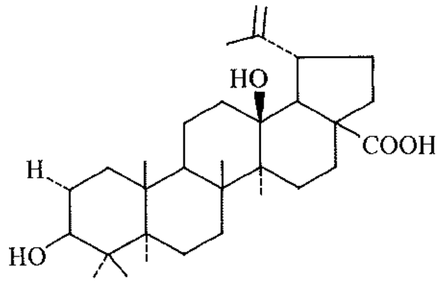


139 Arjunic acid : R = H
142 Arjunoside I : R = β– D(+)–galactose
143 Arjunoside II : R = β– D(+)-glucosyl-L(–)-2-deoxyrhamnose
144 Arjunoside IV : R = α-L(–)-rhamnopyranose

140 Terminoic acid
(Ahmad *et al.*, 1983)

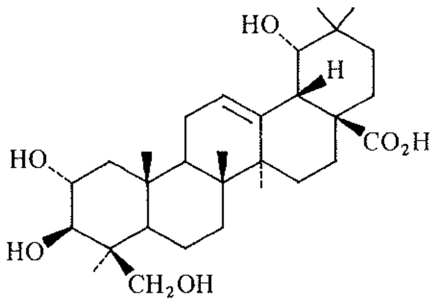


145 Arjunoside III
(Anjaneyulu *et al.*, 1982a)

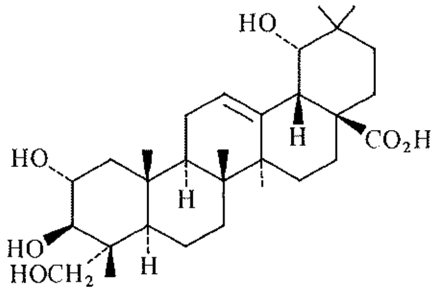


141 Terminic acid
(Anjaneyulu and Prasad, 1983)

Prasad, 1982a, b, 1983). Sericic acid (146) and its glycoside (sericoside) were isolated from the roots of *T. sericea* (Bombardelli *et al.*, 1974). 3-Acetylmaslinic acid has been recently isolated from the root bark of *T. alata* together with oleanolic acid, arjunic acid, arjunolic acid and arjunetin (Anjaneyulu *et al.*, 1986b). The presence of other triterpenoids has been also reported e.g. arjungenin (147) (Honda *et al.*, 1976).

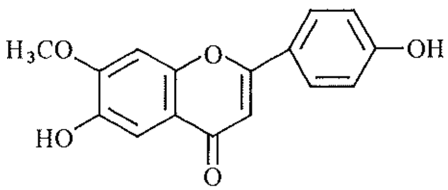


146 Sericic acid
(Bombardelli *et al.*, 1974)

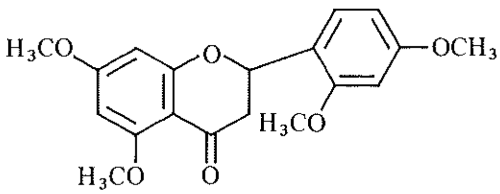


147 Arjungenin
(Honda *et al.*, 1976)

Several phenolic compounds have been identified from *Terminalia* species. The stem of *T. arjuna* contains the flavone arjunolone (148) (Sharma *et al.*, 1982), while the fruit contains a flavanone identified as arjunone (149) (Nagar *et al.*, 1979a,b). Quercetin occurs in the barks and leaves of *T. macroptera* (Prista *et al.*, 1975), and leaves of *T. triflora* (Morinto *et al.*, 1975). Leucodelphinidin and a hydroxystilbene glycoside have been isolated from *T. arjuna* (Row and Subba Rao, 1962) and *T. sericea* (Bombardelli *et al.*, 1975) respectively.

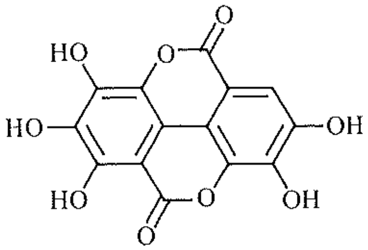


148 Arjunolone
(Sharma *et al.*, 1982)



149 Arjunone
(Nagar *et al.*, 1979b)

The roots and stem bark of *T. laxiflora* and the stem bark of *T. avicennioides* and *T. glaucescens* contain tannins as a major constituent (Ekong and Idemudia, 1967). In India the myrabalan drupes of commerce come from several species besides *T. chebula*, including *T. pallida*, *T. travancorensis* and *T. citrina* (Edwards, 1945). Tannin content generally assumed as 33% may vary from 20 to 50%. The tannins of several other species have been reported. The tannins of *T. myriocarpa* bark consist of a mixture of hydrolyzable and condensed tannins. Ellagic, methyl derivative, gallic, chebulinic and chebulagic acids are the main constituents of ellagitannins and leucocyanidin (Barua *et al.*, 1967a). These phenolic acids (or some of them) together with flavellagic acid (150) occur in many *Terminalia* species e.g. *T. arjuna*, *T. citrina*, *T. pallida* and *T. travencoriensis* (Heathway, 1956), *T. bellerica* (Heathway, 1956; Row *et al.*, 1961; Row and Murty, 1970), *T. chebula* (Rao *et al.*, 1961; Khalique and Nizamuddin, 1972) and *T. paniculata* (Row and Raju, 1965, 1967). Terchebin, a yellow tannin was isolated from the fruits of *T. chebula* (Schmidt *et al.*, 1967a). The bark of *T. myriocarpa* contains 4, 4′, 5, 5′, 6, 6′-hexahydrodiphenic acid dilactone (Dhoubhadel and Singh, 1981).



150 Flavellagic acid
(Row and Raju, 1967)

The barks of *Terminalia* species are good sources of oxalic acid (12–21%) (Bhatia and Ayyar, 1980). Gum exudates have been obtained from *Terminalia* species e.g. *T. tomentosa* (Audichyra *et al.*, 1969), *T. sericea* and *T. superba* (Anderson and Bell, 1974a). They have a complex sugar composition, e.g. those of the latter species contain galacturonic, glucuronic and 4-O-methylglucuronic acids, as well as galactose, arabinose, rhamnose and xylose.

Terminalia species are widely used in folk medicine. The bark of *T. arjuna*, for example, is highly reputed as a heart stimulant and tonic (Ali *et al.*, 1966). The wood of *Terminalia* trees is utilized in pulping e.g. *T. tomentosa* and *T. paniculata* (Saraf *et al.*, 1980).

1 *Terminalia catappa* L.
Common name: *Indian almond*
Arabic name: *Looz Hindi*

The plant yields edible fruit with an average weight of 22·7 gm which is decreased to 5·5 gm on drying; the dried fruit consists of 50% fibrous covering, 42% husk and 8% kernel. The dried kernel contains water, 4·9%; fat, 54·6%; proteins, 27·9%; crude fiber, 2·5%; ash, 1·1% and nitrogen-free extract, 9% (Asenjo and Goyco, 1943). The fibrous cover, husk and endocarb contain 6·35% tannins, and 25·16% pentosans, raw material for the manufacture of furfural (Beri *et al.*, 1968). The oil obtained from the kernels resembles the "almond oil" obtained form *Prunus amygdalus* (Beri *et al.*, 1968), and its use for the same purposes as peanut or cotton seed oils has been early reported (Cruz and West, 1932). The fatty acid composition of the seed oil is as follows: myristic, 0·14%; palmitic, 34·37%, palmitoleic, 2·37%; stearic, 6.80%; oleic, 25·15%; linoleic, 30·95% and linolenic, 0·19% (Abdullahi and Amin, 1980). The fruit contains 0.18 mg/100 gm carotene (Floch, 1958), and cyandin 3-glucoside (Lowry, 1976).

The study of the amino acid showed that leucine, phenylalanine, methionine and valine were most prominent in the flower, less so in the bud and tender leaf, and absent in the mature leaf. Cystine was found only in the ripe fruit (Airan and Barnabas, 1953).

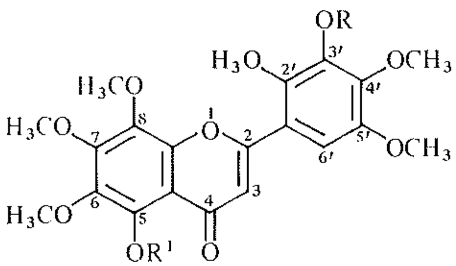
The leaves, fruit and bark of *T. catappa* contain several polyphenols (and carboxylic compounds), including corilagin, gallic acid, ellagic acid and unidentified flavonoids (Rayudu and Rajadurai, 1966). The heartwood contains terminolic acid, ellagic acid derivatives and three unidentified triterpenoids (Idemudia, 1970).

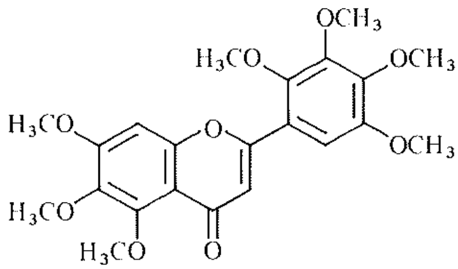
XV COMPOSITAE

The plant of the family compositae are known to contain several interesting compounds such as sesquiterpene lactones which occur mainly in this family. Over than 90% of the known sesquiterpene lactones have been isolated from this family. The family is also rich with flavonoids, particularly methylated ethers, coumarins, several phenolics, di-and triterpenes, acetylenes, essential oil and alkaloids (Rizk, 1986).

1 *AGERATUM*

Ageratum is a genus botanically and chemically closely related to *Eupatorium*, a genus which has been shown to produce sesquiterpene lactones and flavonoids (Quijano *et al.*, 1970). Plants of the genus *Ageratum* are known to contain chromenes e.g. agerato-

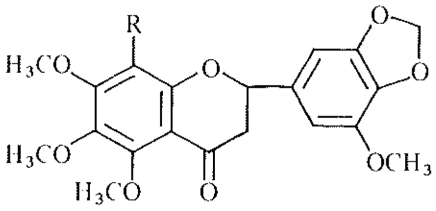




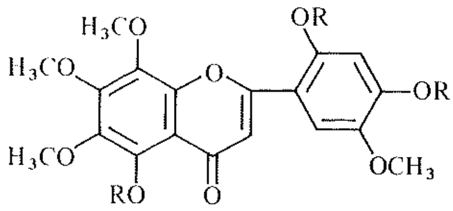
151 Agehoustin C : R = H, R^1 = CH_3
152 Agehoustin D : R = R^1 = H
153 Agehoustin A : R = R^1 = CH_3

154 Agehoustin B

(Quijano *et al.*, 1985)



155 Agerocrynin A : R = H
156 Agerocrynin B : R = CH_3



157 Agerocrynin C : R = CH_3
158 Agerocrynin D : R = H

(Quijano *et al.*, 1980)

chromene, which have anti-juvenile hormone like effects (Alertsen, 1955; Kasturi *et al.*, 1973; Bowers *et al.*, 1976) benzofurans (Anthonsen and Chantharasakul, 1970), terpenoids (Bohlmann *et al.*, 1981a, 1983) and flavonoids (Quijano *et al.*, 1982b, 1985).

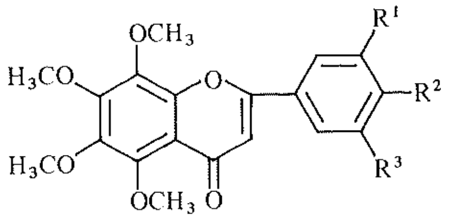
Many polyoxygenated flavonoids have been isolated from *A. houstonainum* (e.g. agehoustins A-D) (151–154) (Quijano *et al.*, 1982b, 1985), and *A. corymbosum* (e.g. agecorynins A-D) (155–158) (Quijano *et al.*, 1980). *A. maxicanum* contains several kaempferol and quercetin glycosides (Mionskowski and Gill, 1973, 1975,). A chalcone and a lignan, sesamin have been identified from *A. strictum* (Quijano *et al.*, 1982a).

Several diterpenes, triterpenes, *ent*-labdane and eudesmane derivatives have been isolated form *A. fastigiatum*. (Bohlmann *et al.*, 1981a,1983). The roots contain germacrene D and dehydronerolidol derivatives (Bohlmann *et al.*, 1981a). Several farnesene derivatives including some tetrahydropyran derivatives, coumarins, and a sesquiterpene lactone derived from daucane were also identified from the roots of the same species (Bohlmann *et al.*, 1983). Taraxasterol (*A. strictum*; Quijano *et al.*, 1982a), lupeol and its $\Delta^{9(11)}$ and Δ^{12}-isomers and glutionl (*A. fastigiatum*; Bohlmann *et al.*, 1981) have been identified from the aerial parts.

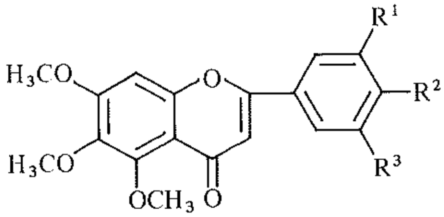
1 *Ageratum conyzoides* L.
Common name: *Blue Mink*
Arabic name: *Borgman*

The plant contains the following substances:

— Flavonoids: quercetin and kaempferol 3-rhamnoglucosides, kaempferol 3,7-diglucoside (Gill *et al.*, 1978) and twelve polyoxygenated flavones *viz*: ageconylflavones A (165; 5,6,7-trimethoxy 3′,4′-methylenedioxyflavone), B (169; 5,6,7,3′-tetra-methoxy-4′-hydroxyflavone) and C (170; 5,6,7,3′,5′-pentamethoxy-4′-hydroxyflavone), linderoflavone B (159), eupalestin (160), nobiletin (161), 5′-methoxynobiletin (162), 5,6,7,5′-tetramethoxy-3′,4-methylenedioxyflavone (165), sinesetin (167), 5,6,7,3′,4′,5′-hexamethoxyflavone (168), 5,6,7,8,3′-pentamethoxy-4′ hydroxyflavone (164) and 5,6,7,8,3′,5′-hexamethoxy-4′-hydroxyflavone (Vyas and Mulchandani,1986). Conyzorigun, a chromone isolated from *A. conyzoides* by Adesogan and Okunade (1978), has been recently shown by Vyas and Mulchandani (1984) to be the flavone eupalestin (160).



159 Linderoflavone B : $R^1 + R^2 = OCH_2O$, $R^3 = H$
160 Eupalestein : $R^1 + R^2 = OCH_2O$, $R^3 = OCH_3$
161 Nobiletin : $R^1 = R^2 = OCH_3$, $R^3 = H$
162 5′-Methoxynobiletin : $R^1 = R^2 = R^3 = OCH_3$
163 : $R^1 = OCH_3$, $R^2 = OH$, $R^3 = H$
164 : $R^1 = R^3 = OCH_3$, $R^2 = OH$



165 Ageconylflavone A : $R^1 + R^2 = OCH_2O$, $R^3 = H$
166 : $R^1 + R^2 = OCH_2O$, $R^3 = OCH_3$
167 Sinensetin : $R^1 = R^2 = OCH_3$, $R^3 = H$
168 : $R^1 = R^2 = R^3 = OCH_3$
169 Ageconylflavone B : $R^1 = OCH_3$, $R^2 = OH$, $R^3 = H$
170 Ageconylflavone C : $R^1 = R^3 = OCH_3$, $R^2 = OH$

(Vyas and Mulchandani, 1986)

— Chromenes: ageratochromene, and 6-demethoxyageratochromene (Lu, 1982) which are anti-insect hormones. The essential oil also contains 7-methoxy-2, 2-dimethylchromene (Kasturi and Abraham, 1974). The chromenes of the plant are reported as antigonadotropic hormones; they exert ovicidal action and induces sterility after topical treatment of both young last instar larvae and females of *Dysdercus flavidus* at emergence by inhibiting ovarian development (Fagoonee and Umrit, 1981).

— Triterpenoids: friedelin (Hui and Lee, 1971) and mixture of sterols (stigmasterol and β-sitosterol.

— Volatile oil (0·2% of fresh material) which has a powerful and agreable odour due to the presence of a phenol ester (about 5% calculated as eugenol) (Joly, 1937; Watt and Breyer-Brandwijk, 1962). The oil exhibits antibacterial activity (Sharma *et al.*, 1979).

A. conyzoides is used for the relief of abdominal pain, digestive disorders, as a tonic and stimulant and a remedy for fever, colic, diarrhoea and rheumatism (Watt and Breyer-Brandwijk, 1962).

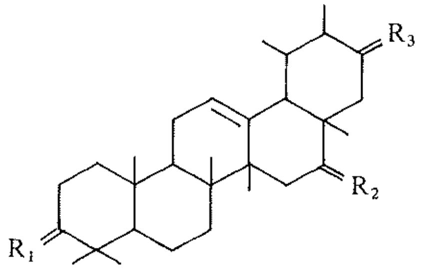
2 *CALENDULA*

Other than *C. officinalis*, which have been thoroughly investigated, the constituents of only few species have been reported. Acetylenes, carotenes and flavonoids were identified from these species (Rizk, 1986).

1 *Calendula officinalis* L.
Common name: *Marigold*
Arabic name: *Hawan*

Several triterpenes have been isolated from the different parts of *C. officinalis*. The flowers are a very rich source of pentacyclic triterpene alcohols possessing different numbers of hydroxyl groups. Kasprzyk and Pyrek (1967, 1968) published several papers describing the mono-and dihydroxyalcohols of the oleanane, lupane and ursane types isolated from *C. officinalis* flowers. Calendol, early detected in *C. officinalis* by Kasprzyk (1951) has been later identified as ψ-taraxasterol (Stevenson, 1961). Triterpene triols and tetrols also occur in the flowers. Among these compounds were found α-amyrin (171), two diols with an α-amyrin skeleton, brein (172), ursadiol (173) (Sliwowski *et al.*, 1972), and a triol (174) (Kasprzyk and Wilkomirski (1973). Sterols, monols and diols in both free form and ester-bound with higher fatty acids have been detected (Kasprzyk *et al.*, 1969b, 1970; Wojciechowski *et al.*, 1972; Wilkomirski and Kasprzyk, 1979). The presence of triterpenic glycosides in the flowers has been also reported (e.g. Ksprzyk and Wojciechowski, 1967). The esters represent about 20% of the total sterols occuring in flowers of *C. officinalis*, 10% of monols and 98% of triterpene diols. Sterols and triterpene monols are esterified with acetic, lauric, myristic and palmitic acids. Triterpene diols are esterified with lauric, myristic and palmitic acids (Wojciechowski *et al.*, 1972).

171 α-Amyrin : R_1 = H,OH, R_2 = R_3 = H_2
172 Brein : R_1 = R_3 = H,OH, R_2 = H_2
173 Ursadiol : R_1 = R_2 = H,OH, R_3 = H_2
174 Ursatriol : R_1 = R_2 = R_3 = H,OH



(Kasprzyk and Wilkomirski, 1973)

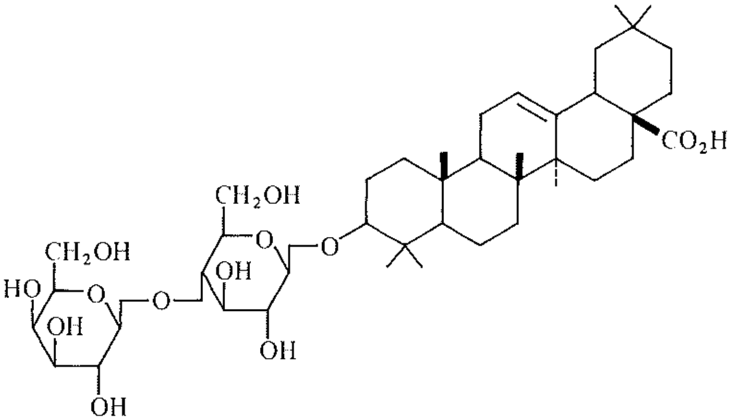
The triterpene monols are found mainly in the chromoplast fraction (68% of the total) with smaller amounts in the cell debris, microsomal, and supernatant fractions; the mitochondrial fraction is almost devoid of these compounds. Triterpene diols are present exclusively in the chromoplast fraction (Adler and Kasprzyk, 1976). The triterpenes isolated from the flowers of *C. officinalis* are summarized in Table (3). Eighteen *n*-paraffins ranging from C_{18} to C_{35} occur in the petals (Movchan, 1960; Stevenson, 1961; Suchy and Herout, 1961; Komae and Hayashi, 1971) as well as calendin and ceryl alcohol (Valadon, 1977). β-Sitosterol, stigmasterol and isofucosterol occur in the flowers as glycosides (Kasprzyk *et al.*, 1969a) and acetates (Kasprzyk *et al.*, 1969b). The flowers also contain the following sterols: campesterol, 24-methylene cholesterol, cholesterol, a 4 β-methysterol, 4-methylstigmasta-7,24(28)-dien-3-β-ol and possibly 4-β-methylergosta-7,24(28)-dien-β-ol (Valadon, 1977).

The petals contain several carotenes (tetraterpenes: phytofluene, β-carotene, β-zeacaroten, ε-carotene, υ-carotene, lycopene, flavochrome, mutachrome, mutaxanthin,

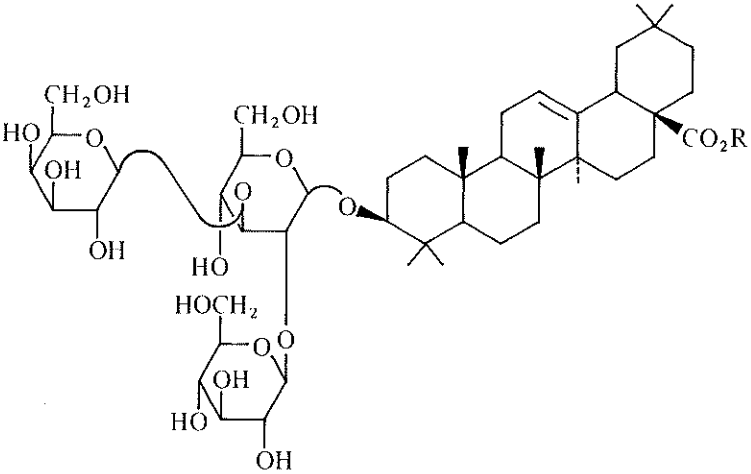
Table 3: Triterpenes of *C.officinalis* flowers

Triterpenes	References
I-*Monols*	
1-α-Amyrin	Kasprzyk and Pyrek (1968); Kasprzyk *et al.* (1965, 1969a)
2-β-Amyrin	
3. Lupeol	
4. Oleanolic acid	Winterstein and Stein (1931); Zimmermann (1946); Gedeon and Mayer (1954)
5. Taraxasterol	Kasprzyk and Pyrek (1968)
6. ψ-Taraxasterol	Kasprzyk *et al.*, (1969)a.
II-*Diols*	
7. Arnidiol	Zimmermann (1946)
8. Brein	Kasprzyk and Pyrek (1968)
9. Calenduladiol	
10. Erythrodiol	Wojciechowski *et al.* (1972)
11. Faradiol	Zimmermann (1946)
12. Maniladiol	Pyrek (1977)
13. Ursadiol	Silowski *et al.* (1973); Pyrek (1977)
III-*Triols*	
14. Heliantriol A	Pyrek (1979b).
15. Heliantriol B_0	
16. Heliantriol B_1	
17. Heliantriol B_2	
18. Heliantriol C	Wikomirski (1985)
19. Heliantriol F	
20. Longispinogenine	
21. Lapenetriol	
22. Ursatriol	

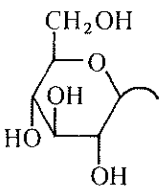
aurochrome auroxanthin, lutein, lutein epoxide, 9-*cis*-lutein, 9′-*cis*-lutein, luteoxanthin, *cis*-luteoxanthin, flavoxanthin, *cis*-flavoxanthin, chrysanthemaxanthin, violeoxanthin and possibly neoxanthin (Zechmeister and Cholnoky, 1932a,b; Goodwin and Osman, 1953; Goodwin, 1954; Movchan, 1960; Shtenbok, 1958; Valadon, 1977; Toth and Szabolcs, 1981). Lycopene, mutaxanthin and 9-*cis*-antheraxanthin occur only in orange petals and not in the yellow ones (Toth and Szabolcs, 1981).



175 Calenduloside A
(Vecherko *et al.*, 1971a)



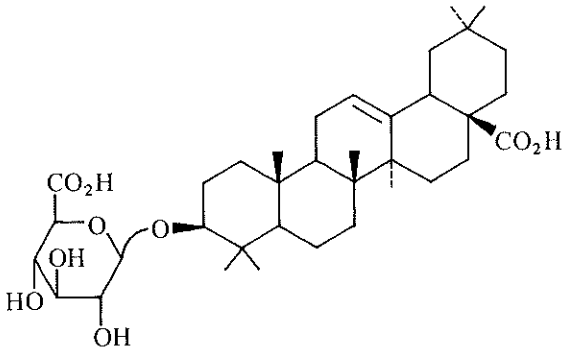
176 Calenduloside C : R = H
177 Calenduloside D : R =



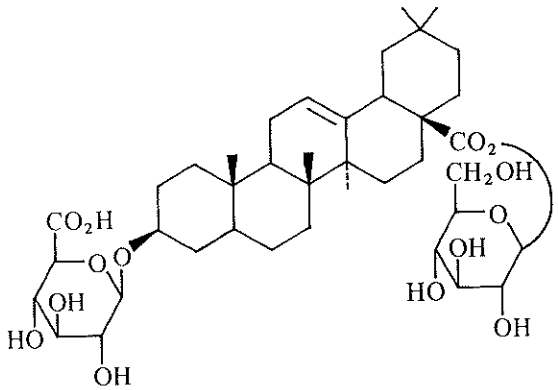
(Vecherko *et al.*, 1975)

The flowers also contain flavonoids *viz*. isorhamnetin-3-rutinoside (narcissin), isorhamnetin 3-glucoside and quercetin (Friedrich, 1962; Grigorescu and Contz, 1966; Valadon 1977) and the following phenolic acids: *p*-hydroxybenzoic, gentisic, vanillic, caffeic, syringic, salicylic and *o*-hydroxyphenylacetic acids (Swiatek and Gora, 1978). The presence of the same three flavonoids in the plant has been reported by Biryuk and Chernobai (1972). The inflorescenes also contain caryophyllene (Biryuk and Chernobai, 1975), chlorogenic acid, traces of pyrogallol tannins (Dedio, 1983), and compounds similar to pyrethins (Khanna *et al*., 1979).

The roots contain a series of triterpenoid glycosides (calendulosides A-H) (Vecherko *et al*., 1969–1975; Wojciechowski *et al*., 1971*a*; Vecherko and Zinkevich, 1973).



178 Calenduloside E
(Vecherko and Zinkevich, 1973)



179 Calenduloside F
(Vecherko *et al*., 1973)

The following substances have been identified from the 3- and 14-day-old seedlings and in the leaves of *C. officinalis*: cholestanol, campestanol, stigmastanol, cholest-7-en-3-β-ol, 24-methylcholest-7-en-7β-ol, stigmast-7-en-3β-ol, cholesterol, campesterol, sitosterol, 24-methylcholesta-5,22-dien-3β-ol, 24-methylenecholesterol and stigmasterol

(Adler and Kasprzyk, 1975). Tocopherol (α, υ and δ) occur in the leaves (Janiszowska and Korczak, 1980).

The fatty acids of the plant and the seeds contain calendic acid, *trans*-8, *trans*-10, *cis*-12-octadecatrionic acids as the major components together with α-dimorphecolic and 9-hydroxy-*trans*-10-*cis*12 octadecadienoic acids (Valadon, 1977; Takaagi and Yutaka, 1981; Noda, 1984).

The drugs from *Calendula* are well known in Central Europe where they are usually used as an infusion for treating urological, rheumatic, digestive and nervous troubles. The petals have protistocidal activity. Extracts of the seeds have phytohaemagglutinin activity, while extracts of the whole plant show oestrognic activity (Valadon, 1977).

Dimorphecolic acid, a major fatty acid of *Calendula* has a potential for commercial use in protective coatings, urethane foams, chemical adducts, as synthetic intermediates or components of plastics and resins. A 0·3–0·5% carbonate extracts of *Calendula* in toothpaste have been suggested to increase the therapeutic and prophylactic effect of the paste on paradental tissue. *C. officinalis* extracts are also used in cosmetology. A cream formulation containing 12% *C. officinalis* extract gives good vaso-protective activity (Valadon, 1977). The volatile oil has antibiotic activity (Gracza and Sasaz, 1968).

The saponins found in the plant have sudorific and emmenagogue properties; and are effective as spermatocides and antiblastocyst (Valadon, 1977).

3 *CENTAUREA*

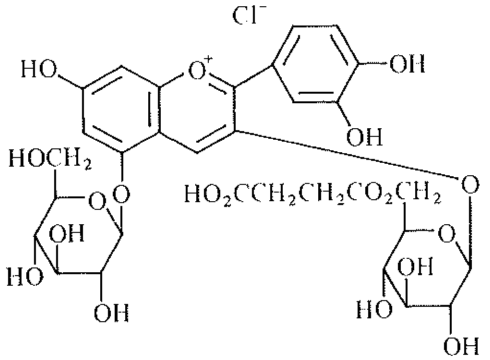
Centaurea species are known to contain, in addition to flavonoids and polyacetylenes, a wide variety of sesquiterpene lactones many of which are biologically active (e.g. cytotoxic, phytotoxic, antineoplastic and allergenic) (Rizk, 1986). Examples of the sesquiterpene lactones isolated from *Centaurea* species are cynaropicirin from *C. americana* (Ohno *et al.*, 1973) centaurepensin from *C. hyssopifolia* and repin from *C. repens* (Stevens, 1982).

1 *Centaurea babylonica* L.
Common name: —
Arabic name: *Centoria*

Phytochemical screening of *C. babylonica* revealed the presence of alkaloids, flavonoids and terpenoids (Rizk *et al.*, 1988).

2 *Centaurea cyanus*
Common name: *Cornflower*
Arabic name: *Anber*

The first identified composite anthocyanin was that of the blue cornflower, *Centaurea cyanus*. This was cyanidin 3,5-diglucoside called cyanin after the plant source. This isolation, accomplished by Willstaetter and Everst in 1913, remains a landmark in the history of anthocyanin chemistry because this was the first such pigmant to be obtained in a crystalline form from any plant (Harborne, 1977). This work was repeated later by two teams in Japan (Takeda and Tominaga, 1983; Tamura *et al.*, 1983) with more up-to-date and the structure was revised as cyanidin 3-O-(6-O-succinyl-β-D-glucoside)-5-β-D-glucoside (180; succinylcyanin).



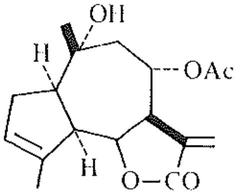
180 (Tamura *et al.*, 1983)

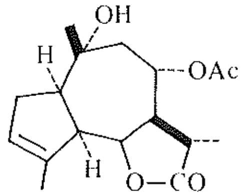
The plant contains several flavonoids *viz.* apiin, quercemetrin, swertisin, isoswertisin (Harborne, 1977), apigenin 4′-*O*-glucoside 7-*O*-glucuronide (Asen and Horowitz, 1974) and a biflavonoid which yields on acid hydrolysis 7-*O*-methylapigenin (genkwanin) (Asen and Jurd, 1967). A malonyl flavone identified as apigenin 4′-O-(6-O-malonyl-β-D-glucoside) 7-O-β-D-glucuronide has been recently identified from the blue pigment of the flower (Tamura *et al.*, 1983). Several polyenic and polynic compounds have been identified from *C. cyanus* (Hellstroem and Loefgren, 1952; Bohlmann *et al.*, 1957). The flowers also contain chlorogenic, neochlorogenic and caffeic acids (Murrav'eva and Rubenchikova, 1986), *n*-nonacosane, triterpenic and steroid compounds (Kowalewski *et al.*, 1966).

The plant, and in particular the flower, is used as a mild astringent, diuretic and as an eye-wash (Watt and Breyer-Brandwijk, 1962). The tea of the flowerheads is considered as tonic and stimulant (Lewis and Elvin-Lewis, 1977). It also possesses a smoothing effect on conjunctivities.

4 *CHRYSANTHEMUM*

Chrysanthemum species contain sesquiterpene lactones (e.g. cumambrin A (181) and dihydrocumambrin A (182) from *C. coronarium*; El-Masry *et al.*, 1984), coumarins (e.g. herniarin, umbelliferone and scopoletin from *C. segetum* (Oeksuez and Wagner, 1982), flavonoids (e.g. acaciin and luteolin 7-glucoside from *C. indicum*; Chatterjee *et al.*, 1981; He *et al.*, 1982) and polyacetylenes (Bohlmann *et al.*, 1980). The value of pyrethrum flowers (*C. cinerariaefolium*) as an insecticide is well known. The insecticidal action of the plant is due to the presence of pyrethrins (mixtures of ketoesters) which are concentrated in the flower head (Head, 1966). Several monoterpenoids and sesquiterpenoids have been identified from the volatile oils of these species (Rizk, 1986).





181 Cumambrin A 182 Dihydrocumambrin A

(El-Masry *et al.*, 1984)

1 *Chrysanthemum carinatum L.*
Common name: *Tricolour Chrysanthemum*
Arabic name: *Okhowan*

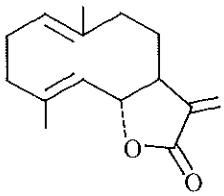
The plant contains two flavonols: quercetin 7-glucoside and patuletin 7-glucoside (Harborne *et al.*, 1970) and sesquiterpene lactones (tanacetin and parthenolide) (Bloszyk and Drozdz, 1978). The root and aerial parts contain the following polyacetylenes: *cis*, *cis*- and *cis*, *trans*-2(5-methylmercapto-4-peten-2-ynylidene)-1, 6-dioxaspiro[4, 4]-nona-3,7-dienes, *cis*, *cis*-and *cis*, *trans*-2-(5-methylmercapto-4-peten-2-ynylidene)-1, 6-dioxaspiro[4, 5] dec-3-ene, *cis*, *cis*-2-(5-methylsulphonyl-4-penten-2-ynylidene)-1, 6-dioxaspiro [4, 5] dec-3-ene. The plant also contains spiro ketalenol ether polyynes with CH_3S groups, and two benzene derivatives o-AcC_6H_4 CH(OAc) $(C{:}C)_2$ H and *cis-p*-$CH_3OC_6H_4COC{:}CCH{:}CHSCH_3$ (Bohlmann and Kapteyn, 1967).

2 *Chrysanthemum frutescens* L.
Common name: *Paris Daisy*
Arabic name: *Arawlah*

The plant contains a thiophene compound identified as 5-(2-thienyl)-1, 3-pentadiene-1-(*N*-isobutyl) carboxamide (Winterfeldt, 1963). The roots contain the following polyacetylenes: *trans-trans*-tetradeca-2, 4-dien-1-oic acid isobutylamide, *trans-trans*- undeca-2, 4-dien-8, 10-diyn-1-oic acid isobutylamide (Bohlmann and Zdero, 1967) and *all-cis* $CH_3R\text{-}(C{:}C)_2CH_2CH{:}CH(CH_2)_5CH{:}CH_2$ (where R = *cis*-CH:CH or CH_2CH_2) (Bohlmann *et al.*, 1968).

5 *COSMOS*

The flowers of *Cosmos* species contain several pigments which belong to different groups *viz.* anthocyanins (e.g. cyanidin 3-rutinoside) and resorcinol-based chalcones and aurones e.g. sulphurein (6-glucoside of sulphuretin), coreopsin and several others from *C. sulphureus* (Geissman, 1942; Shimokoriyama and Hattori, 1953; Geissman and Jurd, 1954; Puri and Seshadri, 1954; Harborne, 1977). *C. sulphureus* also contains other flavonic pigments and organic acids (Hattori *et al.*, 1956). The fatty acids of the seed oil of *C. sulphureus* contain vernolic acid (6·8%) (Mannan *et al.*, 1983). The same species also contains several polyacetylenes (Bohlmann *et al.*, 1966). *Cosmos* species also contain sesquiterpene lactones (e.g. costunolide) with antitumour activity (Wagner, 1977).



183 Costunolide

(Wagner, 1977)

1 *Cosmos bipinnatus* Cav.
Common name: *Cosmos*
Arabic name: *Cozmea*

The flowers of *C. bipinnatus* contain several flavonoids *viz.* cosmosiin (apigenin glucoside) and rutin (Nakaoki, 1935; Yasue *et al.*, 1968). Other flavonoids and caffeic and chlorogenic acids also occur in the flowers (Saito, 1979). The flowers also contain inositol (Nakaoki, 1935). The leaves contain 0·1% nelumboside (quercetin 3-glucoglucuronide) (Nakaoki *et al.*, 1961), and astringent tannins (procyanidin) (Bate-Smith, 1961, 1980). The latter finding is unique among Compositae in containing proanthocyanidins (Bate-Smith, 1980).

The plant (except the roots) contains a polyacetylene, cosmene (*trans*, *trans*-$H(CH{:}CH)_2\ (C{\vdots}C)_3CH{:}CH\ CH_3$) (Bohlmann *et al.*, 1964). The seed contains *β*-sitosterol-*β*-D-glucoside, fructose, glucose, the amino acids L-valine, L-leucine, L-threonine and L-phenylalanine (Nigam *et al.*, 1963a) and 9-hydroxy-*trans*-10-*cis*-12-and 13-hydroxy-*cis*-9-*trans* 11-octadecadienoic acids (Mokrris *et al.*, 1960).

6 *GAZANIA*

Scanty information is available about the constituents of this genus. The carotenoids gazaniaxanthin (the 5,6′-*cis*-isomer of rubixanthin), lutein and probably υ-carotene have been identified from the flowers of *Gazania rigens* (Schoen, 1938; Guy Valadon, 1977). Gazaniaxanthin appears to be restricted to *Gazaniza* (Valadon and Mummery, 1971). Gazaniolide, a sesquiterpene lactone together with triterpenes were isolated from *G. krebsiana* (Bohlmann and Zdero, 1979a). *G. splendens* var. *variegata* yields rubber (0·7%) and resin (13·3%) (Metcalfe, 1948).

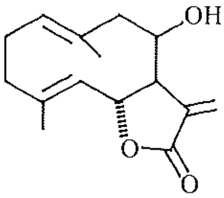
1 *Gazania longiscapa* DC.
Common name: *Gazania treasure flower*
Arabic name: *Gazania*

Phytochemical screening of the plant revealed the presence of alkaloids and flavonoids (Rizk *et al.*, 1988).

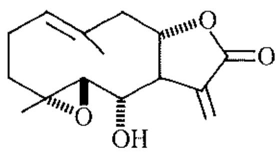
The root of *G. longiscaps*, mixed with *Aloe* species is used as a purgative (Watt and Breyer-Brandwijk, (1962).

7 *HELIANTHUS*

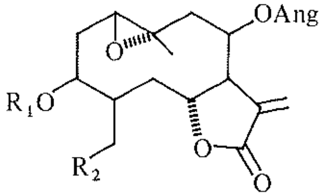
The species of *Helianthus* have proved to be rich sources of sesquiterpene lactones, with germacrolides and helianoglides being the principal structural types reported (Gershenzon and Mabry, 1984; Malek *et al.*, 1984). In addition, certain species also contain diterpene carboxylic acids with labdane, kaurane, artisirane and trachylobane



184 Eupatolide

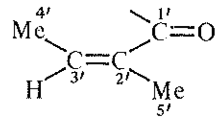


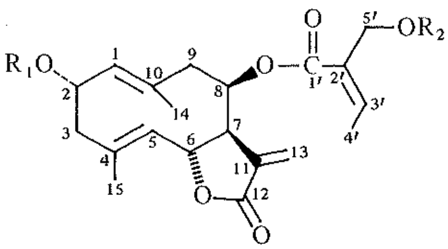
185 Simsiolide



186 Agrophyllin C
$R_1 = R_2 = H$

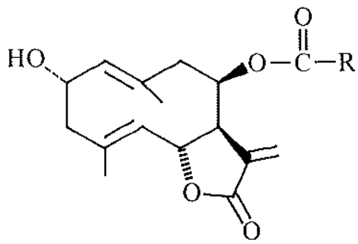
(Watanabe *et al.*, 1986)

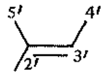
Ang : 

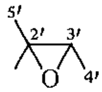


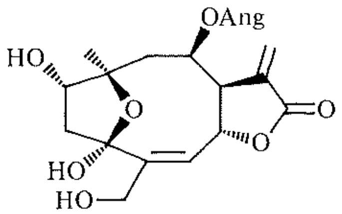
187 Deacetyleupaserrin : $R_1 = R_2 = H$
188 Eupaserrin : $R_1 = H$; $R_2 = Ac$

(Ohno and Mabry, 1979)



189 Mollisorin-A : R = 

190 Mollisorin-B : R = 



191 Niveusin A Ang = angelate
(Malek *et al.*, 1984)

Some sesquiterpene lactones of *Helianthus* species carbon skeletons (Herz *et al.*, 1983; Herz and Kulanthaivel, 1984; Pearce *et al.*, 1986). Examples of the sesquiterpene lactones and diterpenes isolated from *Helianthus* species are shown in Tables (4, 5).

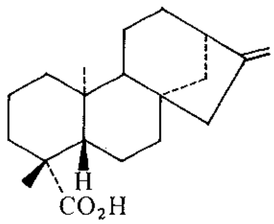
Table 4: Sesquiterpene Lactones of some *Heianthus* Species

Species	Sesquiterpene lactones	References
1. *H. agrophyllus*	Agrophyllone B, agrophyllin C (186), eupatolide (184), simsiolide (185)	Watanabe *et al.* (1982, 1986); Stipanovic *et al.*, 1985)
2. *H. annuus*	mentioned later in details	
3. *H. ciliaris*	Ciliarin	Ortega *et al.* (1970).
4. *H. debilis*	17,18-Dihydrobudlein A	Spring *et al.* (1986).
5. *H. gracilentus*	Desacetyleupaserrin, niveusin A (191), mollisorin B (190)	Malek *et al.* (1984).
6. *H. maximilliani*	Trifruticin, acetyltrifruticin, deoxytrifruticin, Acetyldeoxytrifruticin	Herz and Kumar (1981) a.
7. *H. mollis*	Mollisorin-A (189), mollisorin-B, eupaserrin (188), desacetyl-eupaserrin (187)	Ohno and Mabry (1979)
8. *H. niveus*	Niveusin C, 3-acetylniveusin	Watanabe *et al.*, (1986)
9. *H. pumilus*	Eupaserrin, desacetyleupaserrin, nevadensin	Herz and De Groote (1977); Herz and Kumar (1981)c;
10. *H. tuberosus*	Heliangin	Iriuchijima *et al.*, (1966); Morimoto *et al.*, (1966).

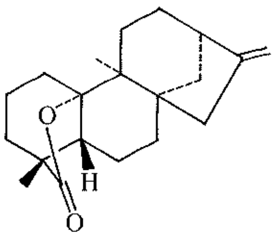
Leaf and ray flower flavonoids were characterized from the 15 species of *Helianthus* series *Corona-solis* studied by Schilling and Mabry (1981). Leaf flavonoids consist of a mixture of 6-methoxyflavone aglycones, flavonol glycosides, and in some species, anthocholors. Ray flowers contain anthochlor and flavonol glycosides. Examples of the flavonoids, identified from *Helianthus* species are hymenoxin (5, 7-dihydroxy-3′, 4′, 6, 8-tetramethoxyflavone (204) from *H. angustifolius* (Waddell, 1973); and *H. simulans* (Herz *et al.*, 1983); hispidulin (201), pectolinarigenin (202) from *H. grosseserratus* (Herz and Kumar, 1981b) and nevadensin (203), hymenoxin (204) sudachitin (205) and acerosin (206) from *H. strumosus* (Herz and Kulanthaivel, 1984).

Table 5: Diterpenes of some *Helianthus* species

Species	Diterpenes	Reference
1-*H. ciliaris*	Ciliaric acid (197)	Bjeldans and Geissman (1970)
2-*H. debilis*	(−)-Kaur-16-en-19-oic acid (192), tetrachyrin (193)	Ohno *et al.* (1979)
3-*H. grosserratus*	Grandifloric acid (195), 17-hydroxy-*ent*-isokaur-15-enoic acid (196), ciliaric acid	Herz and Kumar (1981b)
4-*H. laciniatus*	Ciliaric acid (197)	Ortega *et al.* (1972).
5-*H. occidentalis*	Ciliaric acid, (−)-*cis*-and (−)-*trans*-ozic acid (198, 199), occidentalic acid (194)	Stipanovic *et al.* (1979), Herz *et al.* (1983).
6-*H. petiolaris*	Ciliaric acid; *ent*-kauranoic acid	Herz and Kulanthaivel (1984)
7-*H. strumosus*	*ent*-primara-7, 15-dienoic acid (200), *ent*-7-oxopimara-8, 15-dienoic acid.	Herz and Kulanthaivel (1984)

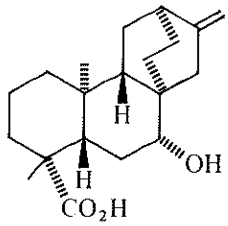


192 (−)Kaur-16-en-19-oic acid



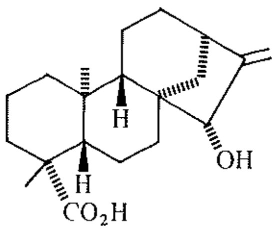
193 Tetrachyrin

(Ohno *et al.*, 1979)

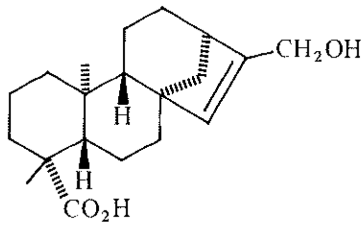


194 Occidentalic acid

(Herz *et al.*, 1983)

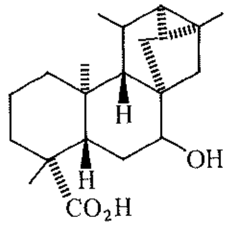


195 Grandifloric acid

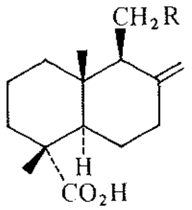


196 17-hydroxy-*ent*-isokaur-15-enoic acid

(Herz and Kumar, 1981b)



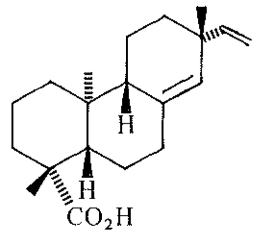
197 Ciliaric acid



198 (−)-*cis*-ozic acid
R = *cis*-CH=CCH$_3$CH=CH$_2$

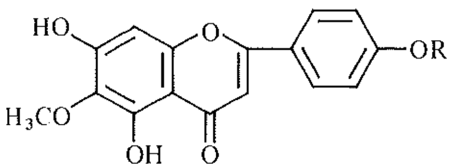
199 (−)-*trans*-ozic acid
R = *trans*-CH=CCH$_3$CH=CH$_2$

(Stipanovic *et al.*, 1979)



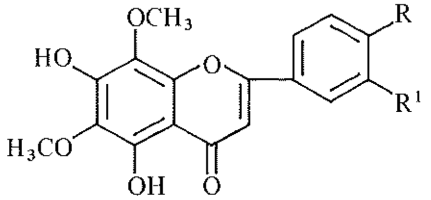
200 *ent*-Pimara-8(14), 15-dien-19-oic acid

(Herz and Kulanthaivel, 1984)



201 Hispidulin : R = H
202 Pectolinarigenin : R = CH$_3$

(Herz and Kumar, 1981 b)



203 Nevadensin : R = H, R^1 = OCH$_3$
204 Hymenoxin : R,R^1 = OCH$_3$
205 Sudachitin : R = OCH$_3$,R^1 = OH
206 Acerosin : R = OH, R^1 = OCH$_3$

(Herz and Kulanthaivel, 1984)

1 *Helianthus annuus* L.
Common name: *Sunflower*
Arabic name: *Abbad El-shams*

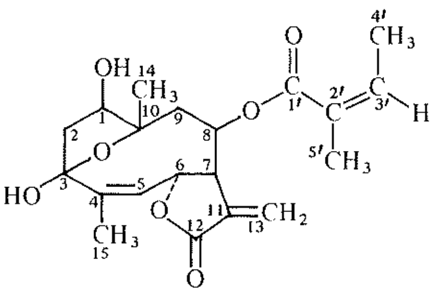
Among the oil seeds which are important to human and animal nutrition as a source of protein, the seeds of sunflower (*H. annuus*) are of great interest. Although they range after soyabeans, cottonseeds, and peanuts, in Europe they are in the first position. In contrast to the rape seeds, the sunflower seeds do not contain any toxic substance (Schwenke *et al.*, 1978). The seeds of *H. annuus* are also the source of an almost tasteless and odourless fixed oil which is used as a salad oil and for the manufacture of margarine. It is said to be inferior to linseed oil in the manufacture of paints and varnishes. The oil is said to be useful as a diuretic and an expectorant (Watt and Breyer-Brandwijk, 1962).

The seeds of *H. annuus* contain fixed oil, the yield of which is 22–25% from undecorticated seed and 40–52% from the decorticated. The oil of the plant growing in India, assays 49·41% oleic acid, 40·48% linoleic acid, 5·46% stearic acid, 4·27% palmitic acid and 0·38% myristic acid. In contrast to the seeds, the lipid pericarp contains behenic and lignoceric acids and does not have capric acid (Dublyanskaya, 1970).

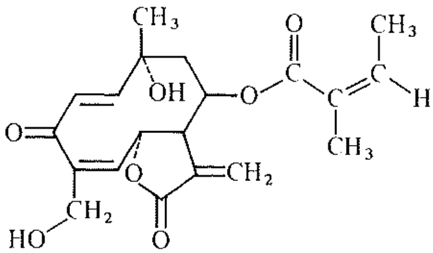
The plant contains, also, several classes of compounds; the components of which are summarized as follows:

1 *Sesquiterpene Lactones*

In the sunflower, *H. annuus*, several sesquiterpene lactones were found (Spring *et al.*, 1981, 1982a) which may protect the plants against animal and microbial enemies. Two of these substances, niveusin C (207, Ohno and Mabry, 1980; Herz and Kumar, 1981a) and 15-hydroxy-3-dehydrodesoxyfruticin (208) were proven to have a strong cytotoxic and plant growth-inhibiting effect (Spring *et al.*, 1982b). The distribution and concentration of niveusin and 15-hydroxy-3-dehydrodesoxy-fruticin in different tissues of sunflower seedlings have been recently investigated by spring *et al.* (1985). Both compounds were found mainly in leaves, with the greatest amounts in leaves close to apex. The young leaves and the upper of the stem of *H. annuus* contain, also the following sesquiterpene lactones: annuithrin (209) (Spring *et al.*, 1981), niveusin B (210), a germacranolide of the trifruticin-type (214) and 3-ethoxyniveusin (Spring *et al.*, 1982a), agrophyllin-A (211), agrophyllin-B (212), tigitanin-A (213) and 4, 5-dihydroniveusin A (Melek *et al.*, 1985).

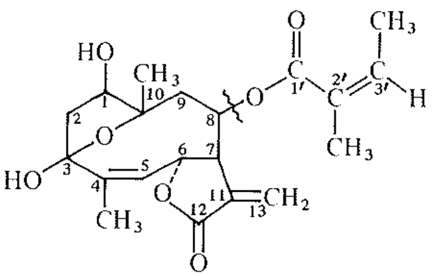


207 Niveusin C

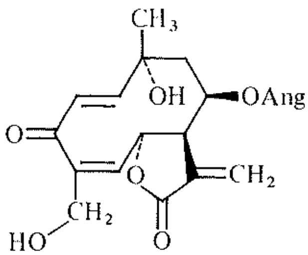


208 15-Hydroxy-3-dehydrodesoxyfruticin

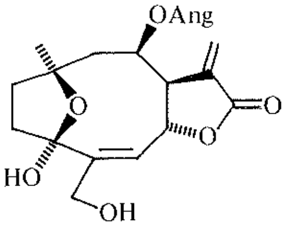
(Spring *et al.*, 1985)



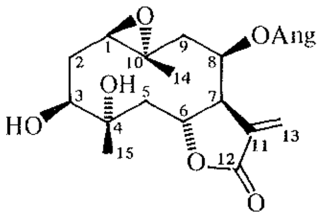
209 Annuithrin
(Spring *et al.*, 1981)



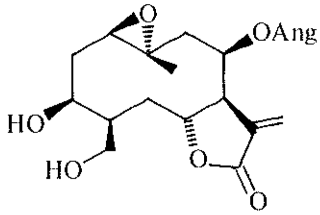
214 Ang = Angelate
(Spring *et al.*, 1982a)



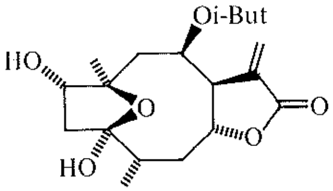
210 Niveusin B

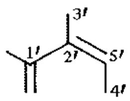


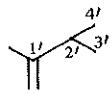
211 Agrophyllin A



212 Agrophyllin B



Ang = 

i-But = 

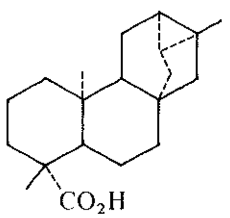
213 Tigitanin-A

(Melek *et al.*, 1985)

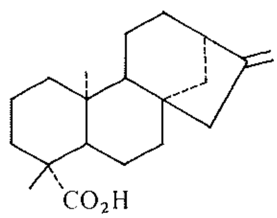
2 *Diterpenes*

Both neutral and acidic diterpenoids have been isolated from the flowers of *Helianthus annuus*:

a. *Diterpenoid acids*: Trachyloban-19-oic- acid (215), (−)-kaur-16 en-19-oic acid (216) (Pyrek, 1970); *ent*-15-beyeren-19-oic acid and a mixture of 15β-esters (including acetate, angelate and isovalerate) of *ent*-15 β-hydroxy-16 kauren-19-oic acid and *ent*-15β-hydroxytetrachyloban-19-oic acid (Ferguson *et al.*, 1982) and two esters of *ent*-kaur-16-en-19-oic and *ent*-trachyloban-19-oic acid with thujanol (Pyrek, 1984).



215 Trachyloban-19-oic acid



216 Kaur-16-en-19-oic acid

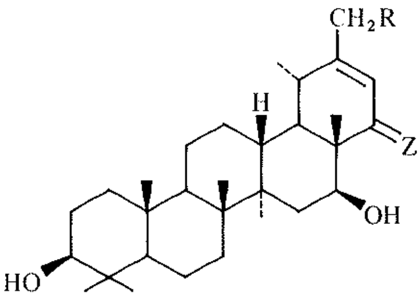
(Pyrek, 1970)

b. *Neutral diterpenoids*: *ent*-Kaur-16-en-19-al, *ent*-trachyloban-19-al, *ent*-kauran-16β-ol, *ent*-kauran-16 α-ol, *ent*-kauran-16β, 19-diol, *ent*-atisan-16 α-ol and *ent*-atisan-16β-ol (Pyrek, 1984).

The stems also yield small amounts of trachyloban-19-oic acid and (−) kaur-16-en-19-oic acid as active antimicrobial constituents (Mitscher *et al.*, 1983). The leaves also contain ciliaric acid, grandifloric acid and *ent-iso*-kaur-15(16)-en-19-oic-acid (Melek *et al.*, 1985).

3 *Triterpenes*

Considerable quantities of triterpenic monols and diols occur not only in the flowers and the seeds, but also in the shoots and roots (Kasprzyk and Janiszowska, 1971). Lupeol, traxasterol, ψ-taraxasterol, α-amyrin (monols), calenduladiol, faradiol, brein and etythrodiol (diols) were identified from the shoots of *H. annuus* (Kasprzyk and Janiszowska, 1971). The flowers contain several triterpenoid saponins (also named helianthosides e.g. A-C) (Chirva *et al.*, 1968; Pyerk, 1979a). The triterpenoid fraction of the saponins consists of oleanolic acid, echinocystic acid (Jachymczyk and Kasprzyk, 1962; Chirva *et al.*, 1968; Cheban *et al.* 1969; Wojcienchowski *et al.*, 1971b) and ψ-taraxene derivatives (e.g. heliantriols C and F) (Pyrek, 1979a).



217 Heliantriol C :
R = H, Z = α-OH, β-H

218 Heliantriol F :
R = OH, Z = H_2

(Pyrek, 1979a)

4 *24-Alkylsterols*

The unsaponifiable lipid of degummned *H. annuus* seed oil contains the following sterols: 24-methyllathosterol, 24-ethyllathosterol, 24-methylcholesterol, 24-ethylcholesterol, 24-ethyl-*trans*-22-dehydrocholesterol, 24-methyl-*trans*-22- dehydrocholesterol, 24Z- ethylidenecholesterol (isofucosterol), 24-methylene-25-methylcholesterol, 24-methylenelathosterol (epi-sterol), 24Z-ethylidenelathosterol (Δ^7-avenasterol), 24-ethyl-24(25)- dehydrolathosterol (pepostrol) (Matsumoto *et al.*, 1984).

5 *Carotenes*

The flowers contain the following carotenoids: taraxanthin (luteinepoxide), lutein, violaxanthin and cryptoxanthin, combined with stearic, palmitic, myristic, lauric and acetic acids (Egger, 1968; Toth and Szabolcs, 1970), 9-*cis*-lutein, 9′-*cis*-lutein, and *all-trans*-lutein epoxide (Toth and Szabolcs, 1981).

6 *Phenolic compounds*:

a. *Flavonoids*: quercetin 3-glucoside from the petals (Swain and Williams, 1977).

b. *Phenolic acids*: Caffeic, *p*-coumaric, o-hydroxybenzoic, *p*-hydroxybenzoic, cinnamic, syringic and chlorogenic acids, from the seeds (Pomenta and Burns, 1971; Leung *et al.*, 1981). Some of these acids may exist in glycosidic form than in ester form (Leung *et al.*, 1981).

7 *Volatile oil*:

Analysis of the volatile oil (0·4–0·6 ml/100 dried corollas) showed the presence of bornyl acetate, linalyl acetate, methyl acetate, terpinyl acetate, artemisia ketone, borneol, camphor, *p*-cymene, 1, 8-cineole, citral, limonene, isomenthol, linalool, menthol, α-pinenene, β-pinene, α-terpinene and terpineol (Popescu, 1979). Recently Etievant *et al.* (1984) detected in the volatile oil 84 components among which 20 terpene hydrocarbons, 9 alcohols, 3 phenols, 6 esters and 19 oxygenated compounds were identified. The major compounds identified include α-pinene, sabinine, β-pinene and limonene.

8 *Waxes*:

The contents of waxes amount to 0·002% in the kernels, 1% in the seed shell and 0·42–0·46% in the fruit shells (Rzhekhin *et al.*, 1968). The various fractions of waxes contain saturated hydrocarbons C_{15-35}(mainly C_{27}, C_{29}, C_{31}), esters, sterols, fatty acids from C_{14} to C_{28} and vanillin (Ivanov *et al.*, 1968; Popov *et al.*, 1970a).

9 *Other constituents*:

H. annuus contains in addition to the above substances several others e.g. hexahydro-2H-azepin-2-one (a caprolactam), a growth inhibitor from seedlings (Hasegawa *et al.*, 1983) and, quinic acid form seed kerels (Pomenta and Burns, 1971). The leaf contains citric, malic, malonic, lactic, succinic, aconitic and fumaric acids (Watt and Breyer-Brandwijk, 1962).

The tubers of *Helianthus* species are characterized by a great abundance of inulin. Inulin consists of approximately 20–30 fructose units and has a molecular weight of 3000–5000. The fructofuranose units are joined by 1, 2-linkages. Since inulin is cleaved by the body into fructose (fructofuranose), it is tolerated better than carbohydrates by diabetics. Inulin is also the starting material for the technical preparation of fructose (Wagener, 1977). Helianthin, the main protein, in the sunflower seed, is rich in glutamic acid, aspartic acid and arginine; lysine and the sulphur-containing amino acids are limiting. It (helianthin) represents a typical 115 globulin with a molecular weight near 3000,000 (Schwenke *et al.*, 1978, 1979).

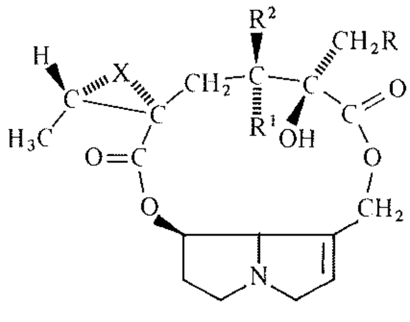
A pectin yield of ~22% with ~81% purity was obtained with sunflower heads after removal of the seed (Kopsic and Caruso, 1978). The whole plant, without the seed, contains an average of 11% pectins (Luedtke, 1961). The pectic acid of the sunflower is a linear polymer of (1 → 4) linked α-D-galacturonic acid units (Zitko and Bishop, 1966). The sunflower heads contain a glycoprotein, the carbohydrate moiety of which is composed of galacturonic acid, galactose (major), glucose, arabinose and xylose and also a rhaman. The latter is a glycoprotein, the carbohydrate portion of which consists of galactose (major), glucose, xylose and rhamnose residues (Abdel-Fattah *et al.*, 1976).

The protein content of the oil cake of *H.annuus* is 48–51%. The percentages of protein components showed the suitability of oil cake as a protein supplement (Khan *et al.*, 1969). The roots contain 0·002% (on fresh weight basis) actinomycin-like protein (Abutalybov and Zholkevich, 1979). Sunflower-seed hulls from different locations and varieties give readily hydrolyzable polysaccharides 20–25%, difficultly hydrolyzable polysaccharides 32–39%, uronic acids 6·5–7·76%, pentosans 24–29%, lignin 25–30%, proteins 3·50–7·0%, fats and waxes 0·77–7·0% and ash 1·70–2·76% (Kolosova and Potyagllo, 1957). The use of sunflower seed meal as a protein source (Sameh *et al.*, 1970) and as a feed (Dmitrochenko *et al.*, 1966; Semin, 1966) has been reported by several workers.

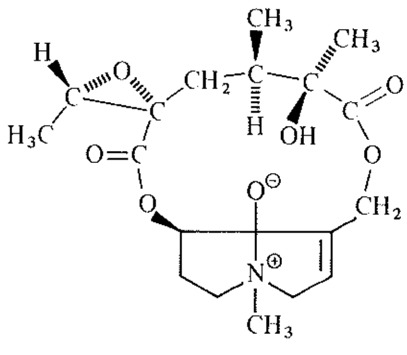
The leaf of the sunflower is used in Caucasus as a malaria remedy. The leaf and/or flower have been used in several countries as a duiretic, febrifuge, stimulant and in the treatment of bronchiectasis (Watt and Breyer-Brandwijk, 1962).

8 *SENECIO*

The genus *Senecio* is known to contain pyrrolizidine alkaloids (as characteristic components) and sesquiterpenes of the furanoeremophilane type (Bohlmann *et al.*, 1986; Rizk, 1986). In many agricultural countries, ingestion of the extremely widespread ragworts (*Senecio* species) is responsible for more deaths to livestock than from all other plants together. The fatal disease is characterized by lesions in the liver, and the toxic metabolites are thought to be pyrrole derivatives of the pyrrolizidine alkaloids (Mattocks, 1971). Examples of the terpene derivatives isolated from *Senecio* species are aegyptolide, decompostin I. decompostin II, istanbulin A and istanbulin B (Rizk, 1986). *Senecio* species also contain flavonoids, polyacetylenes, benzofurans and saponins (Rizk, 1986).

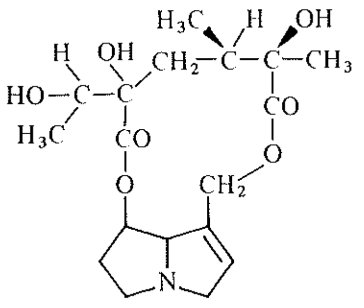


219 Jacobine : $R = R^1 = H$; $R^2 = CH_3$; $X = O$
220 Senecionine : $R = R^1 = H$; $R^2 = CH_3$; $X = \Delta^{5,6}$
221 Seneciphylline : $R = H$; $R^1 + R^2 = CH_2$; $X = \Delta^{5,6}$
222 Otosenine : $R = OH$; $R^1 = H$; $R^2 = CH_3$; $X = \Delta^{5,6}$

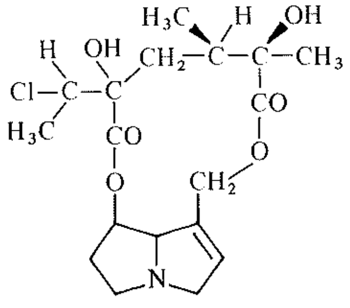


223 Retrorsine

(Klasek *et al.*, 1975)



224 Jacoline



225 Jaconine

(Bull *et al.*, 1968)

1 *Senecio cineraria* DC.
Common name: *Dusty Miller*
Arabic name: *Snanir*

The plant contains several pyrrolizidine alkaloids *viz.* senecionine, seneciphylline, jacobine, jacoline, jaconine, otosenine and retrorsine (Adams and Govindachari, 1949; Alekseev *et al.*, 1962; Habib, 1974; Klasek *et al.*, 1975; Dvorackova *et al.*, 1978). The capitulums of *S. cineraria* contain vanillic, *p*-hydroxybenzoic and chlorogenic acids as well as isorhamnetin, quercetin and unidentified flavonoids (Cezard *et al.*, 1984).

9 *TAGETES*

The genus *Tagetes* has been reported to produce substances with biological importance (Ickes *et al.*, 1973). Thiophenes which comprise a distinct class of natural products characteristic of the Asteraceae (Compositae) (Bohlmann *et al.*, 1973) have been identified from several *Tagetes* species. The potent nematocidal properties of thiophenes (isolated from *Tagetes* species) have been reported by several workers (Uhlenbroek and Bijloo, 1958, 1959; Horn and Lamberton, 1963; Bakker *et al.*, 1979; Liliana Munoz *et al.*, 1982). They are cultivated as control measures of soil nematodes (Uemura, 1979). In addition to nematodes, bacteria and yeast the effects of these compounds have been demonstrated with algae, insects and various other test organisms (Downum and Towers, 1983). Roots are the major source of the thiophenes. Leaves, flower petals and the pappus of achenes also have been found to contain low concentration of these derivatives (Downum and Towers, 1983). Examples of the thiophenes identified from *Tagetes* species are α- terithienyl and 5-(3-buten-1-ynyl)-2, 2′-bithienyl form *T. jaliscien-cis* roots (Castro and Liliana Munoz, 1982); α-terthienyl and the dithienyl acetylenecarbinolic derivative from *T. microglosa* roots (Castro and Castro, 1978); 5-(4-chloro-3-hydroxybut-1-ynyl)-2, 2′-bithienyl and various others from*T. minuta* roots (Atkinson *et al.*, 1965; 1966), and 3,4-diacetoxybutinylbithiophene from roots and hypoctyls of young *T. patula* seedlings (Pensl and Suetfeld, 1985). The possible confusion of pyrethrins with thiophenes in *Tagetes* species has been reported by Hogstad *et al.* (1984).

A number of flavonoids i.e. patuletin, quercetagetin (226) and their glucosides patulitrin and quercetagetrin (227), allopatuletin (quercetagetin 5-methyl ether), tagetiin and kaempferitrin have been isolated from the flowers of *Tagetes* species and in particular from *T. patula* (Rao and Seshadri, 1941; Bannerjee and Seshadri, 1956; Morita 1957; Tarpo, 1967–1971; Ickes *et al.*, 1973; Bhardwaj *et al.*, 1980a). *T. florida* contains several coumarins *viz.* 7-methoxycoumarin, 6, 7-dimethoxycoumarin, 6, 7, 8-trimethoxycoumarin and 7-hydroxycoumarin dimethylallylic ether (Rios and Flores, 1976). Benzofurans *viz.* 4-hydroxydehydrotremetone (isoeuparin) and hydroxytremetone also occur in certain *Tagetes* species (Bohlmann and Zdero, 1979b; Suetfeld *et al.*, 1985).

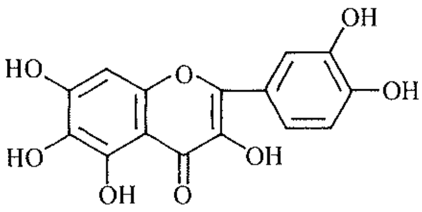
A number of carotenoids i.e. α-carotene β-carotene, υ-carotene, helenien, helinine, xanthophyll, violaxanthin, neoxanthin, rubichrome, rubixanthin epoxide, lutein, a dipalmitic ester of lutein, anthraxanthin, α-cryptoxanthin, phytofluene and galenine have been isolated from *Tagetes* species (Karrer *et al.*, 1947; Cucu and Tarpo, 1958; Tarpo and Cucu, 1961; Alam *et al.*, 1968; Ickes *et al.*, 1973; Kasumov, 1984).

Tagetes species (marigolds) are also known as essential oil plants. Esdragole constituents > 95% of the volatile oil of *T. filifolia* (Bohrmann and Youngken, 1968) and constitutes one of the four main components of the oil of *T. florida* (Guzman and Manjarrez, 1962). Tagetone (*cis*-and *trans*-form) occurs in the oil of several *Tagetes* species e.g. *T. filifolia* (Gustavo *et al.*, 1951), *T. glandulifera* (Boehm *et al.*, 1963), *T. minuta* (Gustavo *et al.*, 1951; Handa *et al.*, 1963) and *T. signata* (Chopra *et al.*, 1963a). Several other constituents have been identified from the volatile oils e.g. citral and *d*-limonene from *T. filifolia* (Gustavo, 1947), *cis*-and *trans* ocimenones from *T. minuta* (De Villiers *et al.*, 1971) limonene, aromadendrene, α-terpineol, eudesmol and linalool from several *Tagetes* species and 5-isobutyl-3-methyl-2-furanocarbaldehyde from *T. glandulifera* (Maurer and Hauser, 1984).

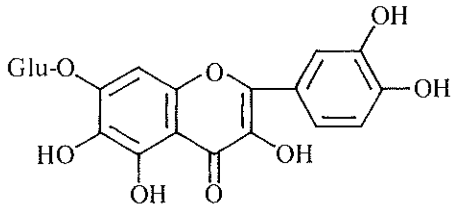
1 *Tagetes erecta* L.
Common name: *African marigold*
Arabic name: *Katifa*

The powdered petals constitute a good source of carotenoid pigments. This cheap preparation has found considerable application in aviculture where it is used as an additive in order to give a yellow-orange colour to the poultry eggs and fat (Gomez *et al.*, 1978a,b). Addition of shade-dried orange marigold flower meal to chicken feed at ⩾0·4% increased the colour of the resulting egg yolks as much did a feed containing 50% yellow corn (Narahari *et al.*, 1981). In the powdered petals lutein (3, 3′-dihydroxy-α-carotene) constitutes up to 85 to 90% of the total carotenoid content (Quackenbush and Miller, 1972). In the plant, most of the lutein is found esterified to one or two fatty acids (Gomez *et al.*, 1978a). Among the identified esters are lutein dipalmitate, dimyristate, and monomyristate esters (Philip and Berry, 1975), xanthophyll palmitate stearate and xanthophyll palmitate myristate (Gau *et al.*, 1983). Up to seventeen different carotenoids have been isolated from marigold petals (Quackenbush and Miller, 1972). Helenien (a dipalmitic acid ester of lutein) amounts to 0·74% of the flowers (Tarpo and Cucu, 1961). The only difference between yellow and orange flowers of *T. erecta* was in the total carotenoids (Valadon and Mummery, 1967).

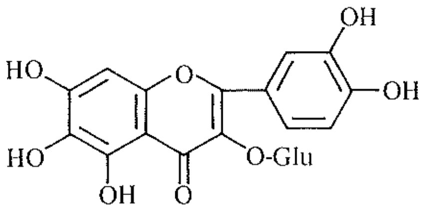
Flavonoids have been identified from the different parts of *T. erecta*. The flower heads contain quercetagetin, 8-hydroxyquercetagetin, quercetagetrin and 6-hydroxykaempferol-7-*O*-glucoside (Mahl, 1938; El-Emary and Ali, 1938; Bhardwai *et al.*, 1983). The leaves contain tagetiin, kaempferol, kaempferol-7-*O*-rhamnoside, and kaempferitrin (Morita, 1957; El-Emary and Ali, 1983). Quercetagetin and quercetagitrin occur in the seeds (Kaloshina and Mazulin, 1983).



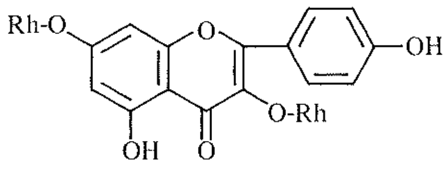
226 Quercetagetin



227 Quercetagetrin



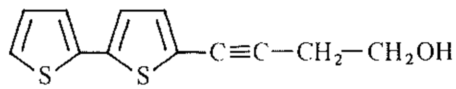
228 Tagetiin



229 Kaempferitrin

(El-Emary and Ali, 1983)

All parts of the plant contain thiophenes i.e. 5-(4-hydroxy-1-butenyl)-2, 2′-bithienyl (230), 5-(4-acetoxy-1-butenyl)-2, 2′-bithienyl (231), 5-(3-buten-1-ynyl)-2, 2′-bithienyl (232) and 2, 2′, 5′, 2″-terthienyl (233; α-terthienyl) (Sease and Zechmeister, 1947; Zechmeister and Sease, 1947, Downum and Towers, 1983); 5′-ethynyl-5-(prop-1-ynyl)-2, 2′-bithienyl (Bohlmann *et al.*, 1967) and dithienylacetylene (235) from the flowers (Bohlmann and Kocur, 1975).



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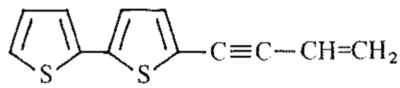

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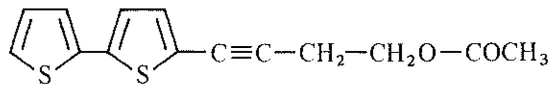

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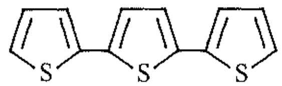
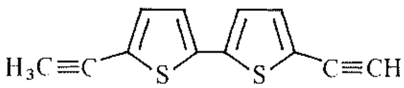


234

(Downum and Towers, 1983)



235 (Bohlmann and Kocur, 1975)

The flowers yield the following sterols and methylsterols: stigmasterol, β-sitosterol, 28-isofucosterol, campesterol, 24-methylenecholesterol, cholesterol, 4β-methylstigmasta-7, 24 (28)-dien-3-β-ol and 4-β-methylergosta-7, 24 (28)-dien-3-β-ol (Pyrek, 1969).

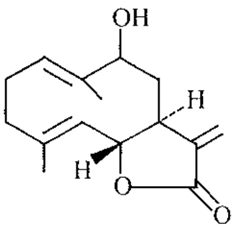
The volatile oil of *T. erecta* contains high concentrations of the acyclic and bicylic monoterpenes e.g. tagetone, limonene, linalool and ocimene (Rodriguez and Mabry, 1977). The yield, constants and composition of the oil has been reported by Chopra *et al.*, 1963b).

The fatty acids of the plants are: lauric (trace), myristi (7·1%), palmitic (38·2%), stearic (12·6%), oleic (17·1%) and linoleic (25·7%) acids (Gomez *et al.*, 1978). The seed oil contains two isomeric α-hydroxy conjugated dienoic acids (Hegnauer, 1977).

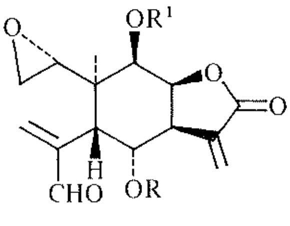
Six pyrethrins were prepared from the plant (Khanna *et al.*, 1975; Kamal, 1977). The total pyrethrin content is higher in floral heads (0·90%) (Khanna *et al.*, 1975).

10 *ZINNIA*

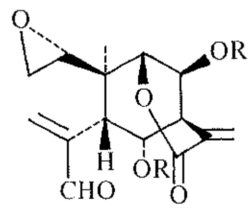
Zinnia species contain sesquiterpene lactones (Romo *et al.*, 1971; Quijano *et al.*, 1975; Kisiel, 1978; Bohlmann *et al.*, 1979), mainly elemanolides (Bohlmann *et al.*, 1979; 1981b; Herz and Govindan, 1981, 1982; Maldonado *et al.*, 1985), but some also guaianolides (Romo *et al.*, 1971; Bohlmann *et al.*, 1979) and germacranolides (Kisiel, 1978; Bohlmann *et al.*, 1981b). Elemanolides with different combinations of ester and hydroxyl functions at C-6 and C-9 (Romo *et al.*, 1971; Bohlmann *et al.*, 1971) and with an acetal function (Herz and Govindan, 1981; Ortega *et al.*, 1983) as well as δ-elemanolides (Herz and Grovindan, 1982; Ortega and Maldonado, 1982) have been identified from several *Zinnia* species. Eudesmaloides have been also isolated from certain *Zinnia* species (Bohlmann *et al.*, 1981b). Examples of these sesquiterpene lactones are haageanolide (236) form *Z. haageana* (Kisiel, 1978), zinaflorins I-III (237–239) form *Z. pauciflora* (Quijano *et al.*, 1975; Ortega *et al.*, 1983), zinarosin form *Z. acerosa* (Romo *et al.*, 1971) and Juniperin (240) from *Z. juniperifolia* (Ortega and Maldonado, 1982).



236 Haageanolide
(Kisiel, 1978)



237 Zinaflorin I : R = R1 = Ang
238 Zinaflorin II : R = Ang, R1 = H
(Maldonado *et al.*, 1985)

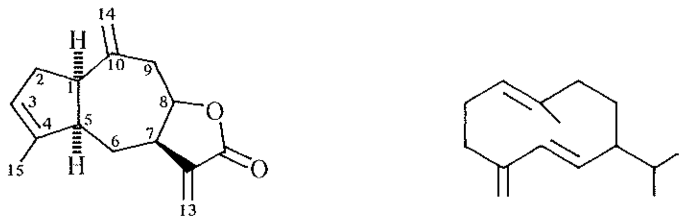


239 Zinaflorin III : R = Meacr, R' = Ac
240 Juniperin : R = α-OHiBu, R' = Ang
(Maldonado *et al.*, 1985)

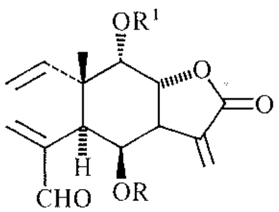
The yellow flower colour of *Z. linearis* has been shown to be based on the aurones, sulphurein and maritimein, and the related chalcone marein (Harborne *et al.*, 1983).

1 *Zinnia elegans Jacq.*
Common name: *Youth and age*
Arabic name: *Zinnia*

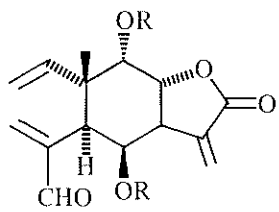
The roots of *Z. elegans* contain ziniolide (241) and the aerial parts contain germacrene D (242) and the elemanolides (243–246) and (247–250) (Bohlmann *et al.*, 1981b) and haageanolide (236) (Kisiel, 1982). The colouring matter of the flowers of the yellow-white double variety of *Z. elegans* has been early identified as an apigenin glucoside (Nakaoki, 1940). Recently the leaves and flowers have been reported to contain eight



241 Ziniolide 242 Germacrene D
(Bohlmann *et al.*, 1979)



243 R = H, R' = Ang
244 R = H, R' = Meacr
245 R = Ang, R' = H
246 R = Meacr, R' = H



247 R = H, R' = Ang
248 R = H, R' = Meacr
249 R = Ang, R' = H
250 R = Meacr, R' = H

flavonoids which are derivatives of luteolin and quercetin (Jadwiszczok and Dembinska Migas, 1981).

The petal contains cyanidin 3, 5-diglucoside (Harborne, 1977). The plant also contains the following alkaloids: nicotine, nornicotine and anabasine (Swain and Williams, 1977). The fatty acids of the seed oil are: palmitic (13·2%), stearic (8·9%), oleic (7·3%) and linoleic (61·2%) acids (Badami and Shanbhag, 1973).

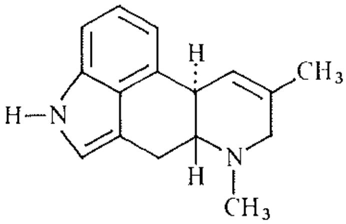
XVI CONVOLVULACEAE

The family Convolvulaceae contains several ergoline-type alkaloids, a group of alkaloids previously known to occur in certain lower fungi, particularly the genus *Claviceps*. They have been identified from several genera e.g. *Rivea*, *Ipomoea*, *Argyreia*, *Cuscuta*, and *Stictocardia* (Hofmann, 1961; Der Marderosian, 1966,1967a,b; Ginest, 1965,1966; Stauffacher *et al.*, 1965, 1969; Chao and Der Marderosian, 1973a,b). The unique occurrence of ergoline-type alkaloids in the Convolvulaceae represents a very interesting chemotaxonomic problem. The alkaloids include ergine, isoergine, chanoclavines-I and II, elymoclavine, lysergol, isolysergol, agroclavine, festuclavine, penniclavine, cycloclavine, ergometrine (ergonovine), ergometrinine, lysergic acid, lysergene, molliclavine, setoclavine and isosetoclavine (Der Marderosian, 1967; Niwaguchi and Inoue, 1969, Chao and Der Marderosian, 1973b; Heacock, 1975). The occurrence of several other substances in the family has been also reported e.g. flavonoids, coumarins (Rizk, 1986) and resin glycosides (Wagner, 1974).

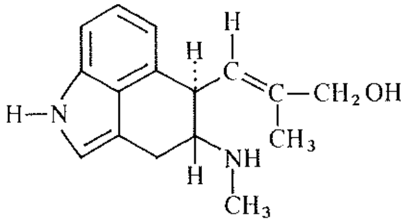
1 *IPOMOEA*

Ergoline alkaloids have been identified from several *Ipomoea* species and in particular from the seeds. (Beyerman *et al.*, 1963, Taber *et al.*, 1963; Banerjee and Bhatnagar, 1974; Wilkinson *et al.*, 1986, 1987). Of all species (of the family Convolvulaceae), containing ergoline alkaloids thus far reported, most are in the tribe *Ipomoeae.* (Chao and Der Marderosian, 1973b). Examples of the ergot alkaloids which have been identified from *Ipomoea* species are summarized in the following:

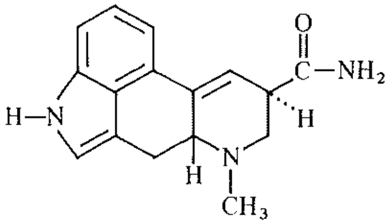
1. *I. cardiophylla* : ergosine and ergosinine (Chao and Der Marderosian, 1973b).
2. *I. fistulosa* : agroclavine and α-dihydrolysergol (Umar *et al.*, 1980).
3. *I. hederaceae* (seeds): chanoclavine, elymoclavine, penniclavine, agroclavine, ergonovine and ergonovinine (Wilkinson *et al.*, 1986).
4. *I. lacunosa* (seeds): chanoclavine, elymoclavine, penniclavine ergonovine and festuclavine (Wilkinson *et al.*, 1986).
5. *I. petaloides* (seeds) : lysergol (Ferrai, 1979).
6. *I. violacea* : agroclavine, chanoclavines-I, II and III, elymoclavine, festuclavine, lysergol, isolysergol, penniclavine, ergine, isoergine, ergometrine, ergometri-



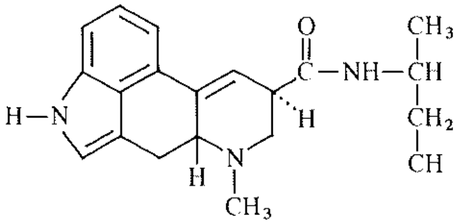
251 Agroclavine



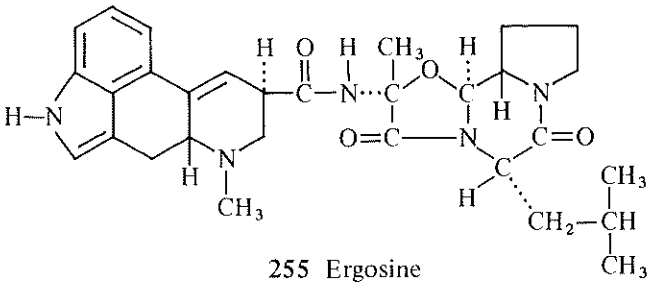
252 Chanoclavine



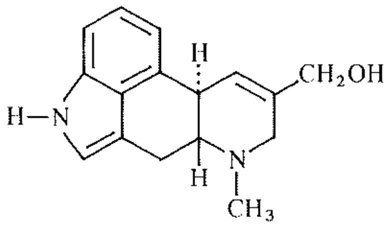
253 Ergine



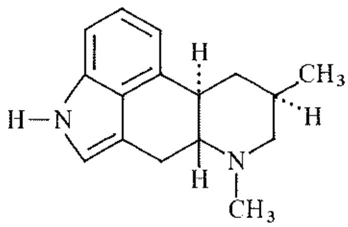
254 Ergometrine



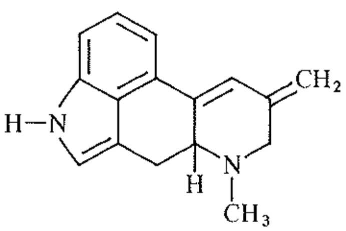
255 Ergosine
(= Ergosinine)



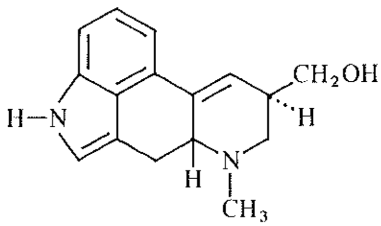
256 Elymoclavine



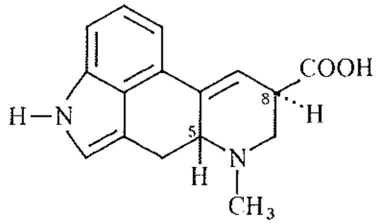
257 Festuclavine



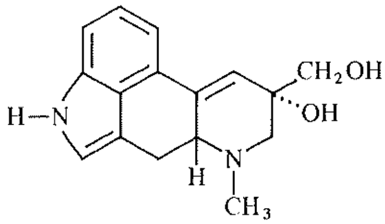
258 Lysergene



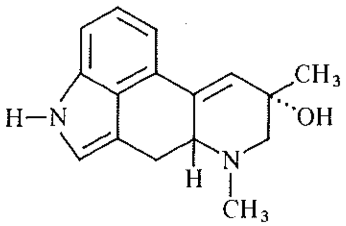
259 Lysergol



260 Lysergic Acid



261 Penniclavine



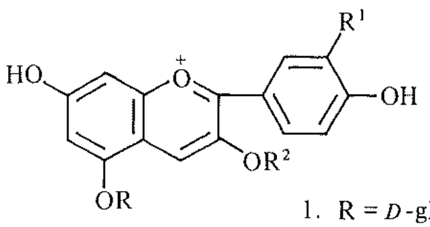
262 Setoclavine

Some alkaloids of the Convolvulaceae
(Seif El-Nasr and Rizk, 1985)

nine, penniclavine, ergosine, ergosinine and setoclavine (Chao and Der Marderosian, 1973b; Wilkinson *et al.*, 1986).

Morning glory flowers (due to their anthocyanin content) have been used as natural occurring colouring material for food and beverages (Asen *et al.*, 1978; Seiwa Kagaku, 1982). Kataoka (1936) isolated pelargonidin -3, 5-diglucoside from petals of *Ipomoea purpurea* without mentioning the occurrence of acylated anthocyanins in this species. Later the isolation of several acylated anthocyanins has been described from this genus. Imbert *et al.* (1966) characterized peonidin and cyanidin-3-dicaffeylsophoroside-5-glucoside from *I. batatas*. The lilac flowers of *I. cairica* contain four acylated anthocyan ins, the acyl groups of these pigments being caffeyl and *p*-coumaryl (Pomilio and Sproviero, 1972a).

The flowers of *I. indivisa* contain pelargonidin-3-(dicaffeoylrutinoside) 5-D-glucoside (263), -3-(caffeonylrutinoside)-5-D-glucoside (264), peonidin 3-(caffeoylrutinoside)-5-D-glucoside (265) and cyanidin 3-(dicaffeoylsophoroside)-5-D-glucoside (266) (Pomilio and Sproviero, 1972b). Ishikura (1981) reported the presence of fifteen anthocyanins

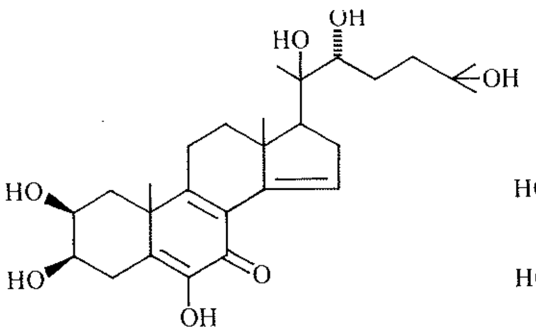


263 $R^1 = H$, R^2 = dicaffeoylrutinosyl
264 $R^1 = H$, R^2 = caffeoylrutinosyl
265 $R^1 = OCH_3$, R^2 = caffeoylrutinosyl
266 $R^1 = H$, R^2 = dicaffeoylsophorosyl

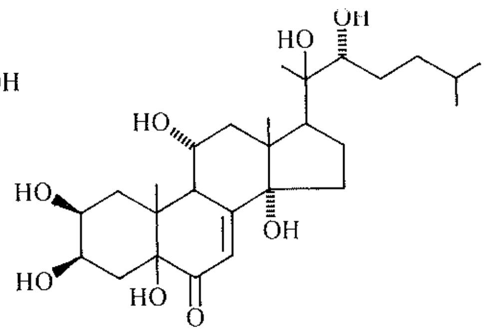
1. R = *D*-glucosyl
(Pomilio and Sproviero, 1972b)

(mainly acylated glucosides of peonidin and pelrgonidin) in the flower of morning-glory belonging to Higo line. Flavonoids occur in some *Ipomoea* species e.g. kaempferol and kaempferol 7-glucoside in flowers of *I. dissecta* (Malick and Nagarajan, 1980) and acacetin 7-*O*-β-D-glactoside in leaves of *I. fistulosa* (Dubey *et al.*, 1982).

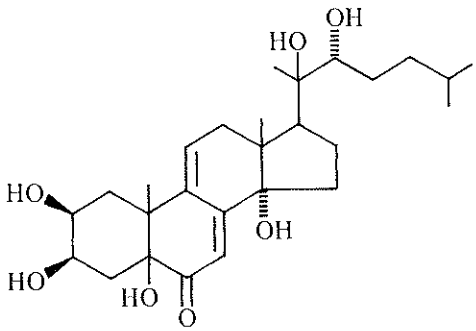
The genus *Ipomoea* is rich in fatty acid glycosides. Mono- and di-hydroxy C_{14}, C_{15}, and C_{16} fatty acids are present as aglycones, whereas glucose, fucose, rhamnose and quinovose constitute the sugar moiety. Occasionally, the sugar chain is esterified with lower fatty acids, and the glycosidic acids are esterified with each other to form a mixture of closely related polyesters (Harrison *et al.*, 1986). *I. leari* contains ipolearoside, with anticancer activity, which is a complex glucoside of 3, 11-dihydroxyhexadecanoic acid and glucose, rhamnose and fucose (Sarin *et al.*, 1973). Four fatty acid glycosides, designated dichrosides A, B, C and D have been recently isolated from *I. dichroa* (Harrison *et al.*, 1985). The structure of dichroside D is 11-{*O*-β-D-glucopyranosyl-(1 → 4)-*O*-[β-D-fucopyranosyl-(1 → 3)-*O*-α-L-rhamnopyranosyl-(1 → 4)-*O*-α-rhamnopyranosyl-(1 → 2)-α-L-rhamnopyranosyl)oxy} hexadecanoic acid. The leaves of *I. bahiensis* contain similar four antimicrobial fatty glycosides (Bieber *et al.*, 1986). other type of glycosides *viz.* eriodictyol-7-*O*-β-D-xylopyranosyl-*O*-β-D arabinopyranoside also occur in seeds of *I. purpurea* (Bhatt *et al.*, 1981).



267 Calonysterone



268 Muristerone A



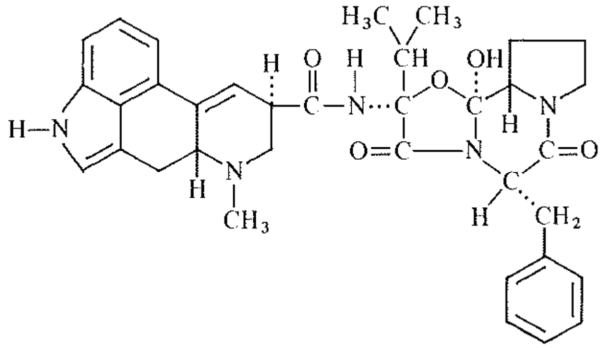
269 Kaladasterone

(Canonica *et al.*, 1977a)

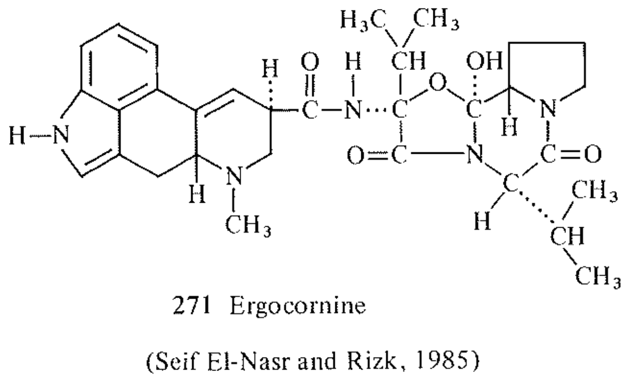
Phytoecdysones have been isolated from *Ipomoea* species e.g. calonysterone (267) (Canonica *et al.*, 1973, 1977b) and muristerone A (268) and kaladasterone (269) from *I. calonyction* (Canonica *et al.*, 1977a). Galactomannans were isolated from the seeds e.g. *I. fistulosa* (Gupta *et al.*, 1979a) and *I. muricata* (Khanna and Gupta, 1967).

1 *Ipomoea carnea*
Common name: *Ipomea*
Arabic name: *Ipomea*
The leaf contains a polysacchardie "pomose", an anthracene glucoside, a gum, jalapine and saponins. The plant contains two toxic principles. Oral administration of the toxins act as a mild purgative (Chopra *et al.*, 1969). A glycosidic component has been isolated from the leaves which caused an initial block of isolated frog heart followed by an increase in both the amplitude and rate (Argrawal and Uppadhyay, 1978).

2 *Ipomoea palmata*
Common name: —
Arabic name: *Sit el Hossn*
The leaves contain indole alkaloids (0·0202%) : ergosinine (255), ergocornine (271) and ergocristine (270) (or their isomers) (Sharda and Kokate, 1979). The seeds contain muricatin A and a glucoside which yields muricatin B on hydrolysis (Chaudhary *et al.*, 1957).



270 Ergocristine



271 Ergocornine

(Seif El-Nasr and Rizk, 1985)

3 *Ipomoea pandurata* G.F.W. Mey
Common name: *Wild sweet-potato vine*
Arabic name: *Ipomea*
The roots contain invert sugar, 0·36%; sucrose, 0·29%; starch, 10·10%; cellulose and ash, 12·47% and resins, 4·69% (Stevens and Wheeler, 1932). Phytochemical screening of the plant revealed the presence of alkaloids (Rizk *et al.*, 1988).

4 *Ipomoea paniculata* R.Br.
Common name: —
Arabic name: *Ipomea*
Phytochemical screening of the plant revealed the presence of alkaloids (Rizk *et al.*, 1988).

6 *Ipomoea pes-caprae*
Common name:
Arabic name: *Ipomoea khof el-gamal*
Earlier investigation of the plant revealed the presence of mucilage, a volatile oil, a phytosterol, bitter substances, a red colouring matter (Christensen and Reese, 1938), pentatriacontane, triacontane, behenic acid, melissic acid, butyric acid and myristic acid (Gustav and Jenkins, 1938). The leaves contain malic, citric, maleic, tartaric, succinic and fumaric acids (Joshi and Iyengar, 1978). Both leaves and seeds contain indole alkaloids (Jirawongse *et al.*, 1977).

8 *Ipomoea tricolor* Cav.
Common name: —
Arabic name: *Ipomea*
Phytochemical screening of the plant revealed the presence of alkaloids (Rizk *et al.*, 1988).

XVII CRASSULACEAE

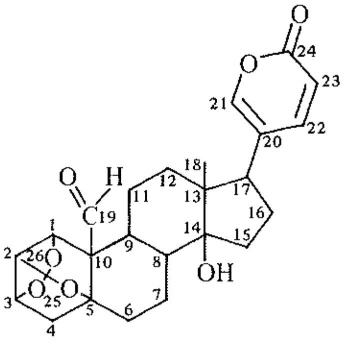
Plants of the family Crassulaceae contain several flavonoid *O*-acylglycosides. The acyl group is attached to 1 (2 or 3) of sugar hydroxyls and is not directly attached to the flavonoid skeleton (Zapesochnaya *et al.*, 1978). Though cyanogensis in the Crassulaceae has been known for many years (Hegnauer, 1964), yet only one cyanogenic compound (sarmentosin epoxide) was recently isolated from aerial parts of *Sedum capaea* (Nahrstedt *et al.*, 1982). Isocitric acid was found in 37 species of 38 species studied by Sonderstrom (1962).

1 *KALANCHOE*

Kalanchoe, a genus of approximately one hundred species, is native to tropical Africa, but has been naturalized throughout the tropics. Several *Kalanchoe* species have been used medicinally (Kirtikar and Basu 1984; Chopra *et al.*, 1956) and a number of species are toxic e.g. *K. integra* (Verma *et al.*, 1981) and *K. rotundifolia* (Van der Walt and Steyn, 1941). Examples of the substances identified in plants of this genus are:

— Flavonoids : e.g. kaempferol, quercetin, patuletin and their glycosides from *K. pinnata* (Maksyutina and Zub, 1969; Gaind and Gupta, 1971, 1973) and *K. spathulata* (Gaind *et al.*, 1981).

— Bufadienolides : e.g. bersaldegin 1, 3, 5-orthoacetate (272), bersaldegenin 1-acetate (273), daigredorigenin-3-acetate (274), daigremontianin (275) from *K. daigramontiana* (Wagner *et al.*, 1986) and lanceotoxins A (276) and B (277) from *K. lanceolata* (Anderson *et al.*, 1984b).



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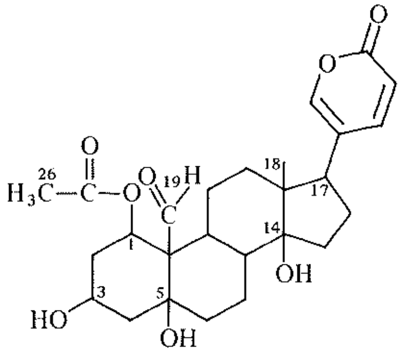

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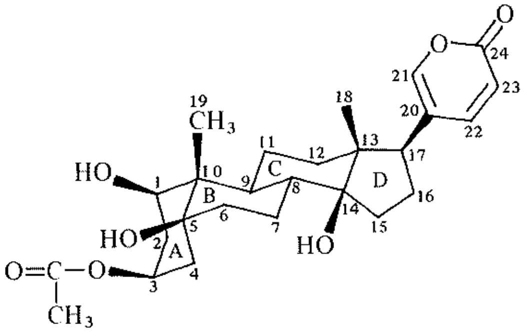

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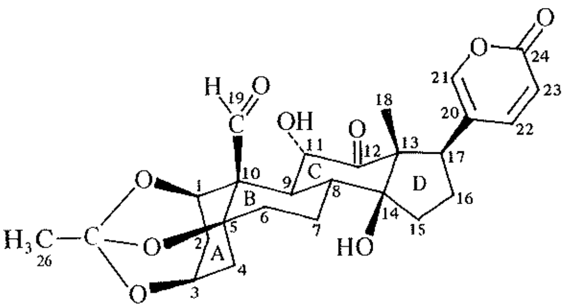
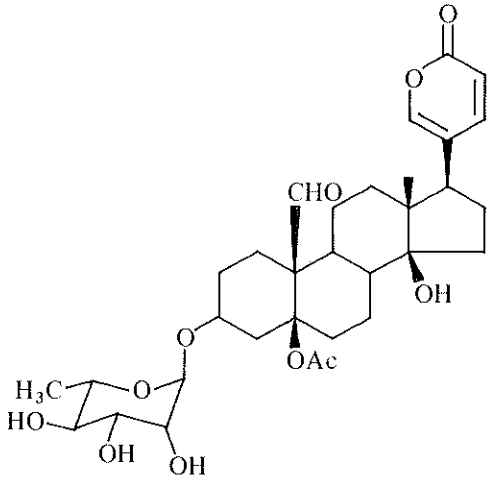
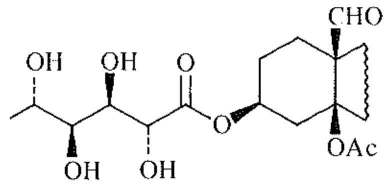


275 Daigremontianin
(Wagner *et al.*, 1986)



276 Lanceotoxin A



277 Lanceotoxin B

(Anderson *et al.*, 1964b)

— Triterpenoids : e.g. α-amyrin, β-amyrin, friedelin, taraxerol and glutinol and steroids from *K. pinnata* (Gaind and Gupta, 1972) and *K. spathulata* (Gaind *et al.*, 1974, 1976).

— Organic acids : e.g. *p*-coumaric, ferulic, syringic, caffeic and *p*-hydroxybenzoic acids from *K. pinnata* (Gaind and Gupta, 1973), fumaric, succinic, oxalic, malic, isocitric, shikimic and quinic acids from *K. daigremontiana* (Lesaint *et al.*, 1964).

1 *Kalonchoe blossfeldiana* V. Poellnitz
Common name: —
Arabic name: *Widnah*

The plant contains bound squalene, 4, 4-dimethylsterols (cycloartenol), 4α-methylsterols (cycloeucalenol) and sterols (β-sitosterol, campersterol, 28-isofucosterol, stigmasterol and cholesterol) (Pryce, 1971). The flowering plant contains prostaglandin $F_{2\alpha}$ (Janistyn, 1982). The major anthocyanin of the petals is cyanidin 3, 5-diglucoside, with minor amounts of cyanidin 3-monoglucoside and pelargonidin 3, 5-diglucoside. In the leaves the major pigment is cyanidin 3-monoglucoside and the minor is cyanidin 3, 5-diglucoside. Leucocyanidin occurs in leaves of non-flowering plants (Neyland *et al.*, 1963). The plant gives positive tests for flavonoids (Rizk *et al.*, 1988). It possesses a virucidal activity against enteroviruses (Shirobokov *et al.*, 1981).

XVIII CRUCIFERAE

The family Cruciferae is one of the families known to contain glucosinolates (sulphur glucosides). All the crucifer plants, so far investigated contain these substances. They seem responsible for the undesirable toxic manifestations occasionally observed as a result of the use of crucifer plants in animal, or human nutrition (e.g. rape, cabbage) (Kjaer, 1976). Erucic acid is also a characteristic constituent of crucifer oils occurring in almost all the species (Appelqvist, 1971). In addition, some crucifer plants contain alkaloids, cucurbitacins, cardenolides (Usher and Feeny, 1983) and flavonoids particularly acylated glycosides (Aguinagalde and Del Pero Martinez, 1982; Rizk, 1986).

1 *LOBULARIA*

1 *Lobularia maritima* Desv.
(= *Alyssum maritimum, A. odoratum*)
Common name: *Sweet Alyssum*
Arabic name: *Alyssum*

L. maritima contains glucosinolates; the aglycones of which are 2-phenylpropionitrile and 1-cyano, 3, 4-epithiobutane (Cole, 1976). The seeds contain a high proportion of *cis*-11-eicosenoic acid (42%) (Mikolajezak *et al.*, 1963). The plant gives positive tests for alkaloids (Rizk *et al.*, 1988).

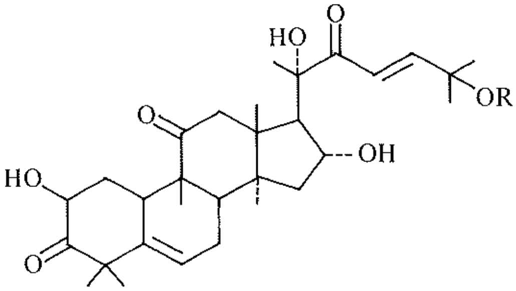
The infusion of the flowering plant is febrifuge (Boulos, 1983).

XIX CUCURBITACEAE

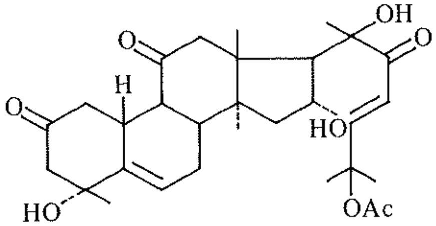
The characteristic constituents of the family Cucurbitaceae are cucurbitacins. These compounds are a group of highly oxygenated tetracyclic triterpenes having a unique 19(10 $\rightarrow$ 9β) abeo-10α-lanostane skeleton. This group of compounds possesses a wide range of biological activities (Rizk, 1986). The major sterols of the seeds of some Cucurbitaceae species are 24β-ethylsterols, 24β-ethylcholesta-7-25(27)- dienol, 25(27)-dehydrochondrillasterol and chondrillasterol, of which the last sterol is occasionally accompanied or replaced by its 24α-epimer, spinasterol (Itoh *et al.*, 1982).

1 *LUFFA*

Cucurbitacins and in particular cucurbitacin B have been identified from several *Luffa* species. Amarin (identical with cucurbitacin B) was isolated from the seeds of *L. amara* (Chaudhry *et al.*, 1951; Chaudhry and Halsall, 1959) and *L. aqgyptiaca* (Rangaswami and Sambumurthy, 1954). The seeds of *L. echinata* contain in addition to cucurbitacin B, 2-epicucurbitacin B and two triterpenes (echinatols A and B) (Bhakuni *et al.*, 1961c; Lavie *et al.*, 1962). Cucurbitacins B and E have been isolated from the mesocarp of the ripe fruits of both *L. echinata* var. *longistyla* (Bhakuni *et al.*, 1961b) and *L. graveolens* (Bhakuni *et al.*, 1961a). Cucurbitacins B, D (identical with elactericin B) and isocucurbitacin B have been identified as the bitter constituents of *L. operculata* (Kloss, 1966; Abreu Matos and Gottlieb, 1967). The seeds of *L. aegyptiaca* contain saponins which yield on hydrolysis oleanolic acid (Varshney and khan, 1960; Varshney and Beg, 1977) and gypsogenin (Varshney *et al.*, 1965b).



278 Cucurbitacin B : R = Ac
279 Cucurbitacin D : R = H
(Rizk, 1986)

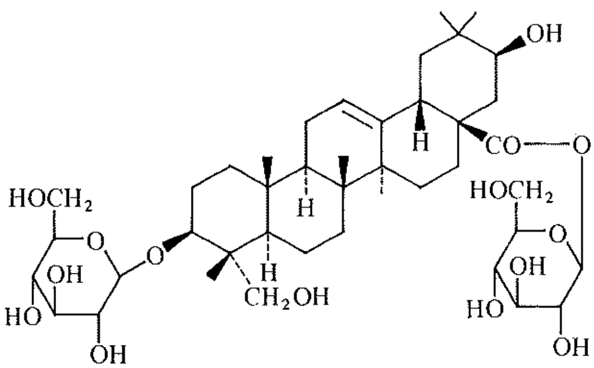


280 Isocucurbitacin B
(Abreu Matos and Gottlieb, 1967)

Apigenin, luteolin and chrysoeriol together with other flavonoids have been identified from several *Luffa* species (Seshadri and Vydeeswaran, 1971; Schilling and Heiser 1981). The nutritional and oil characteristics of the seeds of *Luffa* species e.g. *L. aegyptiaca* (Phadnis *et al.*, 1948) and *L. graveolens* and *L. echinata* (Nigam *et al.*, 1949) have been reported. The protein and fat contents of the kernels of *L. acutangula* amount to 39% and 44% respectively (Kamel and Blackman, 1982).

1 *Luffa cylindrica* L.
Common name: *Vegetable sponge, Hag gourd*
Arabic name: *Loof*

The seeds contain cucurbitacin B and saponins which yield on hydrolysis oleanolic acid (Barua and Bose, 1956–1958 Barua, 1957; Fayez and Osman, 1965) and α-spinasteryl-D-glucoside (Fayez and Osman, 1965) and luffamarin (Chopra *et al.*, 1969). Recently, Takemoto *et al.*, (1984) reported the isolation of eight saponins, named lucyosides A–H from the plant. Lucyosides A (281), B, C, E, G, and H yield on methanolysis methyl 21



281 Lucyoside
(Takemoto *et al.*, 1984)

β-hydroxyhederagenin, arjunolic acid, methyl machaerinate, hederagenin, maslinic acid and oleanolic acid respectively. The sterol fraction of the unsaponifiable lipid of the seeds contains the following compounds (Akihisa *et al.*, 1986a): cholesterol, 24-methylcholesterol, 24-methylenecholesterol, 24-methylcholesta-7, 22-dienol; 24-ethylcholesta, 5, 22-dienol, 24-ethylcholesta, 5, 22, 25-trienol; 24-ethylcholesta-8, 22-dienol; 24-methylcholest-7-enol, 24-methylenecholest-7-enol; 24-ethylcholesterol; 24-ethylcholesta, 8, 22 25-trienol; 24-ethylcholesta-5, 25-dienol; 24-ethylcholest-7, 22-dienol; 24-ethylcholesta-8, 25-dienol; 24-ethylcholesta-7, 22, 25-trienol, 28-isofucosterol, 24-ethylcholest-7-enol and 24-ethylcholesta-7, 25-dienol.

The composition of the seeds is: moisture, 6·4%; fixed oil, 43·3%; carbohydrates, 4·2%; proteins, 40·23%; ash, 4·2%; fibers, 1·2% and a caloric content of 655 cal/100 gm of seed kernel. Palmitic, stearic, oleic, linoleic, linolenic, margaric and arachidonic acids occur in the ratio of 3·17, 12·72, 44·83, 0·86, 8·08, 1·62 and 1·72% respectively. The seeds also contain rhamnose, fructose, at 5·75%, 64·25, 19·7, and 10·3% respectively (Joshi and Shrivastava, 1978). The oil seed cake is useful as animal feed-(Yuksekisk and Ozensoy, 1978). The free amino acids (e.g. citrulline) and the protein bound amino acids of the different parts of the plant have been determined by several workers (Inukai *et al.*, 1966; Jaiswal *et al.*, 1984a; Oritani, 1984). The amino acids identified in the protein fraction are alanine, arginine, aspartic acid, glutamic acid, histidine phenylalanine, proline, serine, tryptophan, tyrosine and valine (Gad *et al.*, 1964).

The plant is cultivated for its fruit which is used as a bath sponge. The fruit is purgative.

XX EUPHORBIACEAE

The plants of the family Euphorbiaceae contain acrid, milky or colourless juice. The diterpenoids and triterpenoids, followed by flavonoids and alkaloids are the main classes of compounds of this family. However, the presence of other substances e.g. coumarins, cyanogenic glucosides and tannins are also reported (Rizk and El-Missiry, 1986; Rizk, 1986, 1987). The family contains several species of considerable economic importance used as foodstuffs, as medicinal plants and in industry (Rizk, 1987).

1 *ACALYPHA*

Acalypha species are among the cyanogenic plants of the Euphorbiaceae. *A. indica* yields acalyphin (Rizk and El-Missiry, 1986; Rizk, 1987). Acalyphamide (an amide) along with the modified dipeptide aurantiamide and its acetate, succinimide, 2-methylanthraquinone, tri-*O*-methylellagic acid, β-sitosterol-β-D-glucoside occur also in *A. indica* (Talapatra *et al.*, 1981).

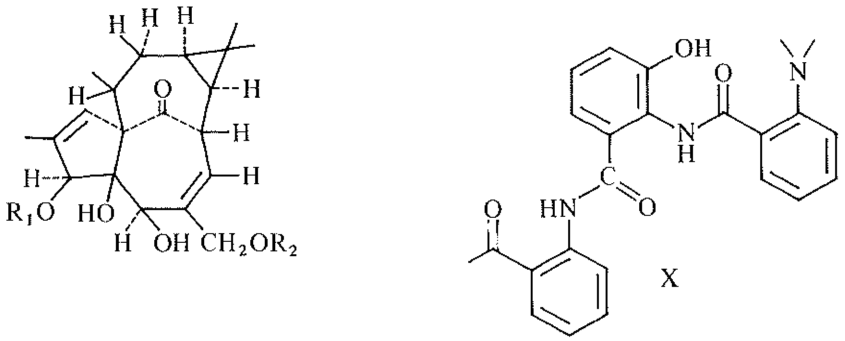
1 *Acalypha wilkesiana* Muell.
Common name: *Copper leaf*
Arabic name: *Acalyfa*
Phytochemical screening of the plant revealed the presence of terpenoids and/or steroids (Rizk *et al.*, 1988).

2 *EUPHORBIA*

Because of the medical interest in this group of plants, they have been studied by several investigators. They are characterized by the presence of irritant diterpenoids (Evans, 1986). *Euphorbia* species also contain several triterpenoids, flavonoids, lignans, coumarins and alkaloids (Rizk, 1987).

1 *Euphorbia millii* Ch.
(= *Euphorbia splendens* Hook.)
Common name: *Crown of thorns*
Arabic name: *Shouk El-Meseeh*
E. millii contains the following substances:

— Diterpenoids: The roots and stems contain several diterpenoids, mamed milliamines A–I. Milliamines A–C are ingenol esters and milliamines D–G are anthraniloyl peptides in various positions of ingenol (Uemara and Hirata, 1971, 1973, 1977; Marston and Hecker, 1983a). Milliamines H and I are 20 deoxy-5-hydroxy phorbol esters (Marston and Hecker, 1983b). Some of these diterpenoids *viz.* milliamines A–C are alkaloids. Baslas and Gupta (1984) identified 12-deoxy-4-β-hydroxy-phorbol-13-dodecanoata-20-acetate and 12-deoxyphorbol-13, 20-diacetate from the latex. Ingenol triacetate, tinyatoxin and 12-deoxyphorbol 13, 20-diacetate also occur in the stems (Baslas and Gupta, 1983).



282 Milliamine A: R_1 = X; R_2 = $COCH_3$
283 Milliamine B: R_1 = H; R_2 = X

(Rizk, 1987)

Fig. 1 *Adhatoda vasica* Nees

Fig. 2 *Adhatoda vasica* Nees

Fig. 3 *Carpobrotus edulis* N.E.Br.

Fig. 4 *Carpobrotus edulis* N.E.Br.

Fig. 5 *Dorotheanthus gramineus* Schwant

Fig. 6 *Dorotheanthus gramineus* Schwant


Fig. 7 *Lampranthus spectabilis* N.E.Br.


Fig. 8 *Lampranthus spectabilis* N.E.Br.


Fig. 9 *Alternanthera amoena* Voss


Fig. 10 *Alternanthera amoena* Voss


Fig. 11 *Amaranthus tricolor* L.


Fig. 12 *Celosia argentea* L.

Fig. 13 *Gomphrena globosa* L.

Fig. 14 *Gomphrena globosa* L.

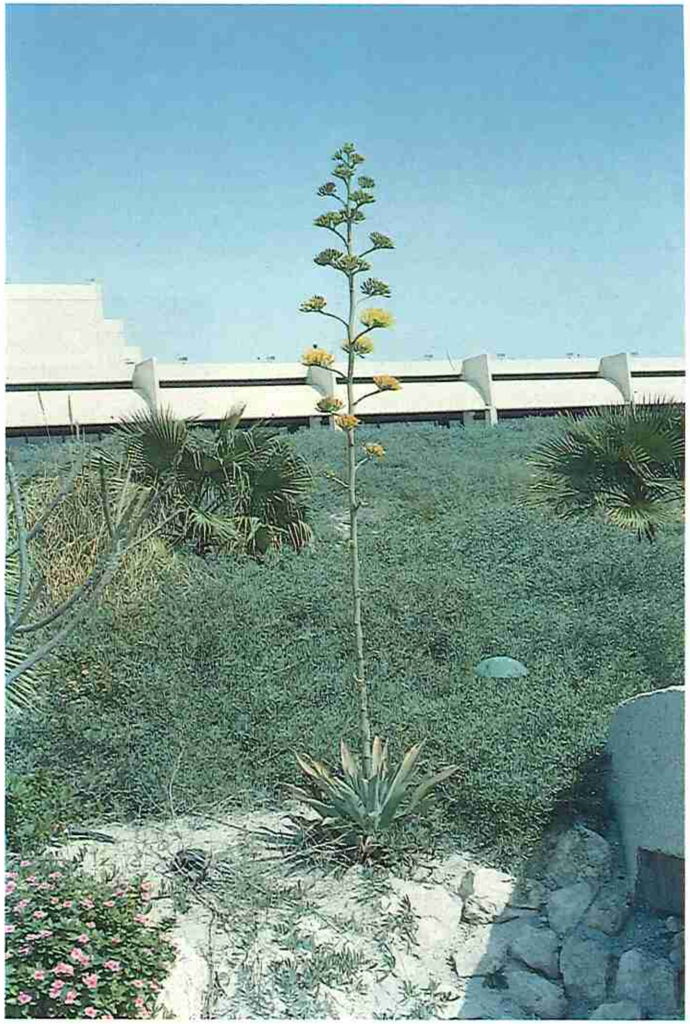


Fig. 15 *Agave americana* L.

Fig. 16 *Agave americana* L.

Fig. 17 *Schinus terebenthefolius* Radd.

Fig. 18 *Schinus terebenthefolius* Radd.

Fig. 19 *Carissa grandiflora* DC.

Fig. 20 *Carissa grandiflora* DC.

Fig. 21 *Nerium oleander* L.

Fig. 22 *Nerium oleander* L.

Fig. 23 *Plumeria alba* L.

Fig. 24 *Plumeria alba* L.

Fig. 25 *Thevetia peruviana* (Pers.) Merr.

Fig. 26 *Thevetia peruviana* (Pers.) Merr.

Fig. 27 *Vinca rosea* L.

Fig. 28 *Vinca rosea* L.

Fig. 29 *Stenolobium stans* Seem

Fig. 30 *Stenolobium stans* Seem

Fig. 31 *Bombax malabaricum* DC.

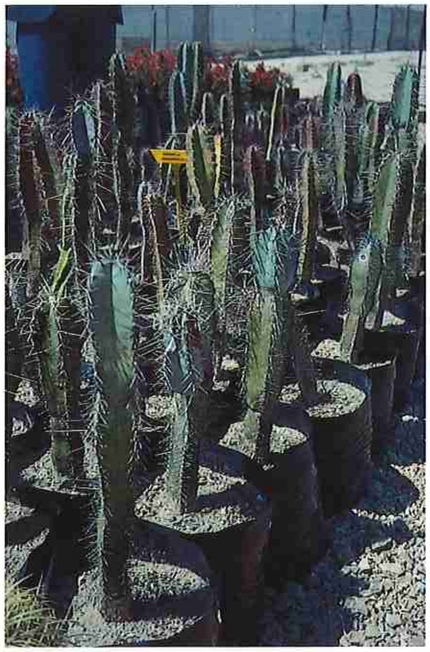


Fig. 32 *Cereus peruvianus* Mill.

Fig. 33 *Opuntia ficus-indica* Mill.

Fig. 34 *Opuntia ficus-indica* Mill.

Fig. 35 *Canna indica* L.

Fig. 36 *Canna indica* L.

Fig. 37 *Dianthus chinensis* L.

Fig. 38 *Dianthus chinensis* L.

Fig. 39 *Casuarina equisetifolia* L.

Fig. 40 *Casuarina equisetifolia* L.

Fig. 41 *Kochia scoparia* Schrad.

Fig. 42 *Terminalia catappa* L.

Fig. 43 *Terminalia catappa* L.

Fig. 44 *Ageratum conyzoides* L.

Fig. 45 *Ageratum conyzoides* L.

Fig. 46 *Calendula officinalis* L.

Fig. 47 *Calendula officinalis* L.

Fig. 48 *Centaurea babylonica* L.

Fig. 49 *Centaurea babylonica* L.

Fig. 50 *Centaurea cyanus* L.

Fig. 51 *Chrysanthemum carinatum* L.

Fig. 52 *Chrysanthemum frutescens* L.

Fig. 53 *Cosmos bipinnatus* Cav.

Fig. 54 *Cosmos bipinnatus* Cav.

Fig. 55 *Gazania longiscapa* DC.

Fig. 56 *Gazania longiscapa* DC.

Fig. 57 *Helianthus annuus* L.

Fig. 58 *Helianthus annuus* L.

Fig. 59 *Tagetes erecta* L.

Fig. 60 *Zinnia elegans* Jacq.

Fig. 61 *Zinnia elegans* Jacq.

Fig. 62 *Ipomoea carnea*

Fig. 63 *Ipomoea carnea*

Fig. 64 *Ipomoea pandurata* G.E.W. Mey

Fig. 65 *Ipomoea pandurata* G.E.W. Mey

Fig. 66 *Ipomoea paniculata* R.Br.

Fig. 67 *Kalanchoe blossfeldiana* V. Poellnitz.

Fig. 68 *Lobularia maritima* Desf.

Fig. 69 *Lobularia maritima* Desf.

Fig. 70 *Luffa cylindrica* L.

Fig. 71 *Luffa cylindrica* L.

Fig. 72 *Acalypha wilkesiana* Muell.

Fig. 73 *Euphorbia millii* Ch.

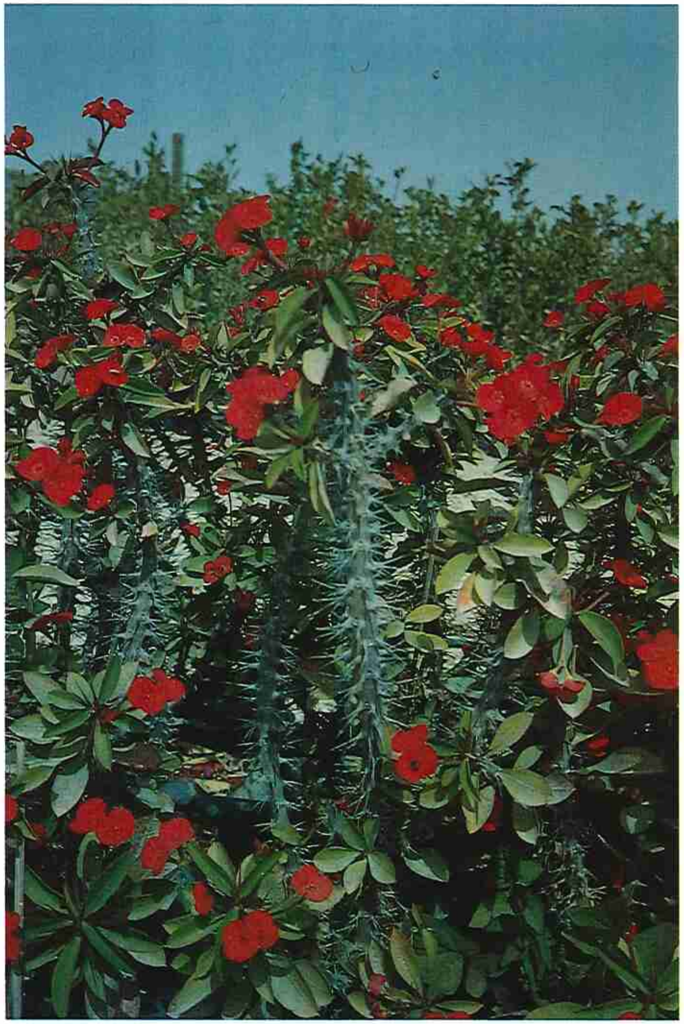
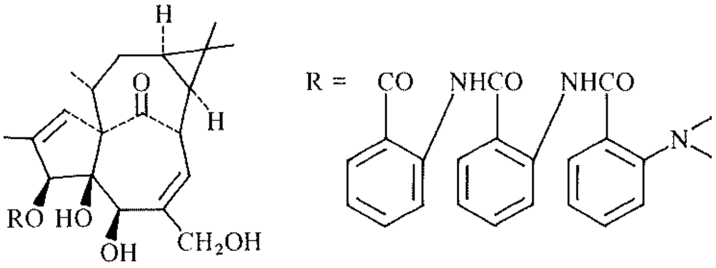


Fig. 74 *Euphorbia millii* Ch.

Fig. 75 *Ricinus communis* L.

Fig. 76 *Ricinus communis* L.

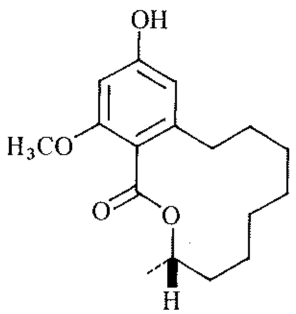


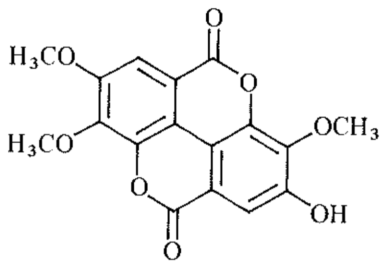
284 Milliamine C

(Uemura and Hirata, 1973)

— Triterpenoids and steroids: β-amyrin, β-amyrin acetate, cycloartenol, 24-methylenecycloartenol, euphorbol, and euphorbol hexacosanoate (Pancorbo and Hammer, 1972; Baslas and Gupta, 1983) and β-sitosterol from the herb (Baslas and Gupta, 1983).

E. splendens contains lasiodiplodin (285), a potent antileukemic macrolide (Lee *et al.*, 1982) and 3,3′-4-tri-*O*-methylellagic acid (286) (Lee, 1985).





285 Lasiodiplodin

286 3,3′,4-Tri-*O*-methylellagic acid

(Lee, 1985)

2 *Euphorbia pulcherrima* Willd.
Common name: *Poinsettia*
Arabic name: *Bint el Qonsol*

The plant contains several triterpenoids (Table 6) and the following sterols: β-sitosterol, campesterol, dihydrobrassicasterol and cholesterol (Rizk and El-Missiry, 1986). The leaves also contain β-sitosterol-D-glucoside (Khafagy *et al.*, 1980).

The anthocyanins of the poinsettia bracts are: cyanidin 3-glucoside and the 3-galactosides and 3-rutinosides of cyanidin and pelargonidin. Flavonoids of the bracts are identified as 3-rhamnosyl-galactosides, 3-rhamnosylglucosides, 3-galactosides, 3-glucosides and 3-rhamnosides of quercetin and kaempferol (Asen, 1979; Stewart *et al.*, 1979). The leaves contain kaempferol 3-*O*-rutinoside and rutin (Khafagy *et al.*, 1980).

Table 6: Triterpenoids of *E. pulcherrima*

Plant Part	Triterpenoids	References
Fruits and seeds	Germanicol, germanicyl acetate, epigermanicyl acetate, β-amyrin, pseudotaraxasterol	Gupta *et al.* (1983); Rizk and El-Missiry (1986).
Latex	Cycloartenol, α-amyrin, β-amyrin, germanicol, germanicyl acetate, pseudotaraxasterol	Baslas (1977); Rizk and El-Missiry (1986).
Herb	α-Amyrin, germanicol, germanicyl acetate, germanicyl behenate, germanicyl tetracosanoate, epigermanicol, epigermanicyl acetate, cycloartenol, brein	Khastgir and Pradhan (1967); Mahata *et al.*, (1977) Khafagy *et al.*, (1980); Biesboer *et al.*, (1982); Rizk and El-Missiry (1986).

The latex contains *N*-acetyldiaminobutyric acid (an amino acid) (Liss, 1962) and a conjugated trienoic fatty acid identified as deca-*trans*-2, *trans*-4-*cis*-6-trienoic acid (Warnaar, 1977).

3 *RICINUS*

1 *Ricinus communis* L.
Common name: *Castor bean*
Arabic name: *Kharwah*

The seeds of *R. communis,* are the source of castor oil, the yield being up to 54%. Castor oil contains 1% tocopherol, 21·6% non-sterol fraction of the unsaponifiable matter and 0·9% castor germ oil. The main constituents of the oil are glycerin esters of ricinoleic acid (80–90%) (Rizk, 1986).

The leaves contain rutin, quercetin, hyperoside (quercetin-3-galactoside), β-amyrin, β-sitosterol and stigmasterol; β-sistosterol and 1-tridecene 3,5,7,9,11-pentyne occur in roots of the plant.

The flowering heads contain, in addition to rutin and hyperoside, two coumarins *viz.* 6,7-dihydroxy-8-methoxy (or 6, 8-dihydroxy-7-methoxy) coumarin and 3, 4-dimethoxy-6, 8-dihydroxy coumarins. Chlorogenic acid, neochlorogenic acid, gallic acid, and a derivative of herbacetin also occur in the plant (Rizk, 1986).

All parts of the plant, especially the seeds, are poisonous to the human and animals. The main toxic principle is the phytotoxin ricin (a protein of globulin type) and the alkaloid ricinine (Rizk, 1986). Castor been seeds contain two types of lectins in equivalent amounts, ricin and hemaglutinin. They are homologous proteins and are composed of A-and B-chains which are glycosylated (Lord, 1985; Kimura and Funatsu, 1985). Ricin is the name now given to the toxic lectin which is only a weak agglutinin. In contrast, the other lectin, *R. communis* agglutinin, is a potent agglutinin but is relatively non-toxic. Ricin is a dimeric protein which consists of two dissimilar polypeptides, the A and B subunits, which are linked together via a disulphide bridge. The A chain (molecular weight, 32000) is responsible for the toxicity displayed by the whole lectin since it is an enzyme which irreversibly inactivates the 60 S subunits of 80 S ribosomes. As such the A chain alone is extremely toxic when given access to ribosomes in, for example, a cell-free extract. Isolated A chain is not toxic to intact cells, however, in marked contrast to the whole ricin molecule (Lord, 1985; and references therein). Mannose, xylose and fucose were found as neutral sugars in glycopeptides of ricin (Kimura and Funatsu, 1985).

Castor oil is used as a soothing local application and as a successful local application to get rid of warts. The oil is put to many industrial uses. It is useful as plasticizer in the lacquer industry, mixed with mineral oil derivatives as a lubricant and mixed with alcohol as a brake fluid. It is also used in the textile industry. The oil is mainly utilised in industry in manufacture of several different products. It is water resistant and so is used for coating fabrics and for protective coverings for aeroplanes, insulation, food containers, gums, etc. It is also used in paints, varnishes, soap, cosmetics, inks, surfactants, and plastics, for preserving leather; and as an illuminant (Pryde, 1983; Rizk, 1987).

Castor been has been used for various illnesses (e.g. as a purge, to promote childbirth and to stimulate milk production) in Africa and the Carribean as well as the surrounding areas (McClure, 1982). Ricin, is converted by acid hydrolysis into non-toxic compounds which are of nutritional value. The seed cake (after removal of the oil) is used almost exclusively as a fertelizer and in the manufacture of plastics. Treated castor cake (to remove the toxic constituents ricin and ricinin) is of high value for feeding of stock (Rizk, 1986).

The plant yields a fibre suitable for paper making of superior quality, if made with an admixture of bamboo pulp (Watt and Breyer-Brandwijk, 1962).

XXI GERANIACEAE

Plants of the family Geraniaceae are rich in tannins and volatile oils (Rizk, 1986).

1 *PELARGONIUM*

Several *Pelargonium* species are cultivated for the production of volatile oil (geranium oil) which is of commercial value. The essential oil obtained from the leaves of *P. radula* (1·1%) contains d-citronellic acid, 60·0%, l-menthone, 20·3%, d-isomenthone, 10·6% and l-citronellol, 5·2% (Hirose and Shibata, 1978). The oil of *P. capitatum* contains about 75% l-isomenthone (Goethals, 1942). The pink geranium, *P. roseum*, a hybrid form closely related to *P. graveolens* and *P. radula* yields 0·1–0·125% gernium oil

(Vorontsov, 1936), or 0·3–0·4% (Wollmann *et al.*, 1973) which contains citronellol and geraniol.

Flavonoids and coumarins have been isolated from *Pelargonium* species. *P. reniforme* contains several coumarins *viz.* umckalin, 7-hydroxy-5, 6-dimethoxycoumarin, its methyl ether, and 7-*O*-β-D-monoglucopyranoside, and scopoletin (Wagner *et al.*, 1974). These coumarins (except the methyl ether derivative) occur in the roots of eleven other South African *Pelargonium* species (Wagner and Bladt, 1975). Leaves and flowers *P. roseum* contain twelve flavonoids, out of which hyperin, quercetin and kaempferol were identified (Gumbaridze *et al.*, 1980). Cultivars Red Irene, Madam Salleron and Pink Barney of *P. hortorum* contain pelargonidin. In addition the Pink Barney contains cyanidin (Ahmedullah *et al.*, 1963). *P. endlicherianum* contains pelargonin, pelargonin pentose glycoside and cyanin; it also contains tannins (6·6%) (Gecgil, 1964). Several sterols and triterpenes were isolated from *Pelargonium* species e.g. *P. hortorum* which contains free and esterified cholesterol, campesterol and sitosterol, free stigmasterol, α-and β-amyrin, isomultifluorenol, cycloeucalenol, obtusifoliol, cycloartenol and 24-methylenecycloartenol (Aexel *et al.*, 1972).

1 *Pelargonium zonale* Ait.
(= *Geranium zonale* L.)
Common name: *Zonal*, or *Horseshoe Geranium*
Arabic name: *Garonia*

P. zonale contains gallic acid, traces of ellagic acid and Chinese gallotannin. The gallotannin content is 12% on dry matter basis, its structure is a petagalloyl glucose to which 1–2 galloyl groups are attached depsiode like (Bikbulatova and Peterson, 1981).

XXII IRIDACEAE

This ornamental family of about 1500 species and 85 genera is most richly represented in South Africa and tropical America, but has an almost worldwide distribution. The genus *Iris*, for example inhibits the northern hemisphere with a centre of origin in Asia. A few genera showed markedly disjunct distributions in different continents, notably *Libertia* and *Orthrosanthus* (Australia and S. America) and *Dietes* (Africa and Lord Howe Island). Taxonomically the family is related to the Liliaceae (*sensa stricto*) (Dahlgren and Clifford, 1982) and Colchicaceae but its exact affinities are presently obscure (Williams *et al.*, 1986). The family is recently divided into three subfamilies: the monotypic Isophysidoideae and the Iridoideae and Ixioideae which are further divided into five and two tribes respectively (Goldblatt, 1982; Goldblatt *et al.*, 1984). The position of the genera within the family however is still under active investigation (Williams *et al.*, 1986).

The chemistry of the family has been recently investigated. Flavones, xanthones, quinones (benzoquinones, naphthaquinones and anthraquinones), terpenes, aromatic amino acids and glutamyl peptides have been reported to occur in members of the

Iridaceae (e.g. Hegnauer, 1963; Bate-Smith, 1968; Thomson, 1971; Larsen *et al.*, 1981; Agarwal *et al.*, 1984a, b; Kumar *et al.*, 1985; Williams *et al.*, 1986).

A survey of 255 species from 57 genera representing all tribes in the Iridaceae has been recently carried out by Williams *et al.* (1986). The study has indicated considerable heterogenity in the distribution of flavonoids and other phenolics in the leaves. Thus the Iridoideae and Tigrideae can be distinguished from other tribes by the regular presence of mangiferin, whereas the Trimezieae and Sisyrincheae can be separated by the absence of flavonols. Again the Aristeae and Nivenieae are distinguished by the presence of plumbagin, although this quinone does occur in isolated instances in two other tribes. Members of the Wastonieae are separated by the fact that only flavonols are present, while Ixieae have a number of distinctive flavones, notably tricin, acacetin, 6-hydroxyluteolin and scutellarein derivatives. *Isophysis tasmanica*, the only taxon of the Isophysidoideae, is unusual in having the biflavonoids amentoflavone and dihydroamentoflavone, with only traces of glycosylflavones.

The flavone *C*-glycosides, present in the Iridaceae, were assumed to be generally of the normal type, i.e. derivatives of vitexin, isovitexin, orientin or isoorientin. Flavone *C*-glycosides and flavonols were found to be the most frequent leaf constituents in the Iridaceae, present in 66% and 32% of species respectively (Williams *et al.*, 1986). The distribution of some rare phenolics, namely mangiferin (*C*-glucosylxanthone) (in 17% of the sample), the quinone plumbagin (in 4%), the biflavonoid amentoflavone in *Patersonia glabrata* and 6-hydroxy-flavones in three *Crocus* species and others has been also reported (Williams *et al.*, 1986). Luteolin, apigenin and tricin *O*-glycosides occurred occasionally in all the tribes of Iridoideae except the Trimezieae and tricin was sometimes present in the free state.

Proanthocyanidins occur sporadically as leaf constituents through the Iridaceae, although they are most frequent in the Trimezieae (in 63% of species) and Aristeae (in 39% of taxa). Procyanidin was found most frequently. Apart from one exceptional, *Nivenia* species, prodelphinidin was only detected in those taxa that also synthesized myricetin. Propelargonidin was once detected in the family, in *Trimezia steyermarkii* (Williams *et al.*, 1986).

In most modern classification systems (e.g. Takhtajan, 1969; Cronquist, 1981; Dalgren *et al.*, 1985) the Iradaceae is placed in the same order as the Liliaceae and Amaryllidaceae, and a comparison of the data obtained by Williams *et al.* (1986) with that of these and some other monocot families previously screened indicates that there are some chemical links. The phenolic pattern of the family as a whole is heterogenous and shows only a few chemical links with any neighbouring families. It is also clear that the Iridaceae can be chemically distinguished from Liliaceae and Amaryllidaceae and other monocot families in the diversity of its phenolic profile and the presence of several otherwise rare constituents especially biflavonoids, quinones and mangiferin (Williams *et al.*, 1986).

1 *GLADIOLUS*

The petals of *Gladiolus* species contain six common anthocyanidins which occur in four types of glycosylation: 3-glucoside, 3-rhamnoglucoside, 3,5-diglucoside and 3-rhamnoglucoside-5-glucoside. The six monoglucosides appear in minute quantities, whereas any of the other eighteen anthocyanins can serve as the major contributor to the colouration of *Gladiolus* petals (Akavia *et al.*, 1981).

The petals contain anthocyanidins: pelargonidin > malvidin > peonidin > petunidin > cyanidin > delphinidin. The levels of anthocyanidins and anthocyanins are higher in apparent mutants with dark crimson and cardinal-red flowers than in the original cultivar. The darker the shade of red the higher is the pigment content. As the colour varies from magnolia purple to burnt orange, the pelargonidin level increases whereas that of malvidin decreases. The most abundantly present anthocyanins are A3, A4, A7, and A8, derivatives of malvidin, and A1, A6 and A10 derivatives of pelargonidin. The mutations cause disappearance of anthocyanidins delphinidin and petunidin and alter the levels and ratios of pelargonidin and malvidin and modify the number, content and ratios of anthocyanins. In general, the mutants form high quantities of heterosides A1 and A6 containing levels of heterosides (Seilleur 1977). The anthocyanins pof *Gladiolus* species have been studied by several investigators (e.g. Shibata and Nozaka, 1963; Arisumi and Kobayashi, 1971; Salehian, 1973; and references cited in Akavia *et al.*, 1981).

Luteolin and tricin 5-glucoside, quercetin 3-glucoside and two highly glycosylated isoorientin derivatives have been identified from *G. tristis* (Williams *et al.*, 1986). Apigenin and kaempferol were also detected in some species (Salehian, 1973, Williams *et al.*, 1986).

Fructose, glucose and sucrose are the only sugars present in the bulbs. Maximum sugar mobilization occur before death in old bulbs and blossoming in the newly developing bulbs (Bazan *et al.*, 1974).

The style of *Gladiolus* contains a mucilage, of which the major component (40%) is an arabinogalactan-protein. The arabinogalactan-protein contains 90% carbohydrates and 3% protein; the major monosaccharides of the carbohydrate component are galactose and arabinose in the proportion 6:1 (Glesson and Clarke, 1979). The structure of the arabinogalactan is based on 1,3-β-galactan backbone to which are attached side branches of 1,6-linked galactosyl residue linked through C(*O*)6, some of which terminate in arabinosyl residue. These arabinogalactans are covalently associated with protein (Glesson and Clarke, 1979, 1980a,b). The leaves, blossoms and stems of many varieties have been reported as a source of vitamin C (up to 12·3%) (Hilbert, 1957).

Gladiolus species are used in folk medicine in several countries e.g. to relieve rheumatic pain, to treat dysentry and as remedy for impotence (Watt and Breyer-Brandwijk, 1962).

1 *Gladiolus gandavensis* Van Houte
Common name: *Gladiolus*
Arabic name: *Gladiolus*

The floral tissue of *G. gandavensis* contains the following anthocyanin pigments: pelargonidin, cyanidin, delphinidin, petunidin and malvidin 3-rutinosides, 3-rutinoside-5-glucosides and 3, 5-diglucosides (Akavia *et al.*, 1981; Williams *et al.*, 1986).

XXIII LABIATAE

Labiatae species are commonly known as aromatic plants, because of their high content in essential oil. Most of the phytochemical studies carried out on species from this family were devoted to the terpene chemistry. Several diterpenoids (mostly of the clerodane, neroclerodane and quinone types) have been identified from several genera e.g. *Plectranthus*, *Salvia* and *Teucrium* (Rizk, 1986). Many species belonging to several genera contain iridoid glucosides (Kobayashi *et al.*, 1986; Rizk, 1986) with harpagide and harpagide 8-acetate prevailing (Gritsenko *et al.*, 1977). Ursolic acid has been reported in species representing numerous genera (e.g. Brieskorn *et al.*, 1952; Pourrat and Le Men, 1953). Several other pentacyclic triterpenes *viz.* α- and β-amyrins and oleanic acid also occur in the family.

Flavonoids have been identified from several genera. In the last twenty years a lot of new naturally occurring methoxylated flavones have been found from the Labiatae such as xanthomicrol from *Satureia douglasii*, salvigenin from *S. virgata*, sideritoflavone from *Sideritis leucantha*, thymonine from *Thymus vulgaris*, thymusin from *Thymus membranaceus*, 5, 6-dihydroxy-7-8, 3′, 4′-tetra-methoxyflavone form *Mentha piperita*, 8-methoxy-cirsilineol from *Sideritis mugronensis* etc. (Barberan, 1986). A review on the flavonoid compounds, as both free aglycones and glucosides, from Labiatae species has been recently carried out by Barberan (1986).

1 *COLEUS*

Coleus is a large genus of herbs and sub shrubs comprising nearly 200 species and innumerable hybrids. Many of the species are cultivated for ornamental purposes and some for the edible tubers. The root nodules of certain species are being consumed e.g. *C. edulis*, others are used as a spice or as salad e.g. *C. amboinicus*. Most of them are ornamental plants e.g. *C. blumei* and some are used in psychotropic drug mixtures (Baslas and Kumar, 1981).

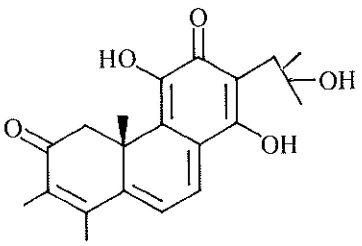
Coleus plants, contain diterpenoids which possess hypotensive and spasmolytic activities. Examples of the diterpenoids isolated from *Coleus* species are the following:

— *C. aquaticus* (leaves and infloroscences): coleon D, 11, 12, 14, 16-tetrahydroxy-5 α-abieta-8, 11, 13-trien-6, 7-dione (Ruedi and Eugster, 1972a).

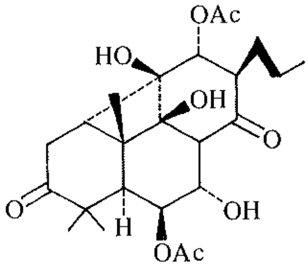
— *C. barbatus* (leaves and stems): coleon E (287; Ruedi and Eugster, 1972b), coleon F (Ruedi and Eugster, 1973), cyclobutatusin (288; Wang *et al.*, 1974), barbatusol (289; Kelecom, 1983), 20-deoxo-carnosol (290), 6β-hydroxy carnosol (291) and (+) ferruginol (292) (Kelecom, 1984).

— *C. forskohii* (roots): coleonol (293) and forskolin (294) (Tandon *et al.*, 1977; Singh and Tandon, 1982), coleosol (295; Jauhari *et al.*, 1978), coleonol D, coleol (296), coleonone (297) (Katti *et al.*, 1979), coleonol-E (298) and coleonol-F (299) (Painuly *et al.*, 1979).

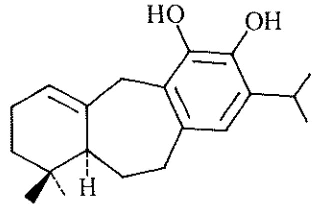
— *C. somaliensis* (leaves): coleans H (300), I (301), K (302) (Moir *et al.*, 1973a), coleons *G* (303), J (304) (Moir *et al.*, 1973b), coleon O (Arihara *et al.*, 1975), and coleon L (Ruedi and Eugster, 1977).



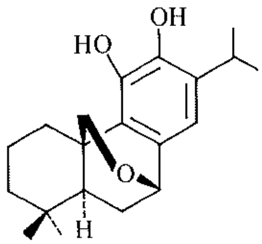
287 Coleon E
(Ruedi and Eugster, 1972b)



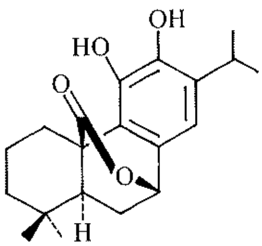
288 Cyclobutatusin
(Wang *et al.*, 1974)



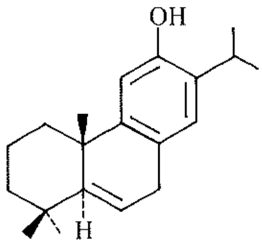
289 Barbatusol
(Kelcom, 1983)



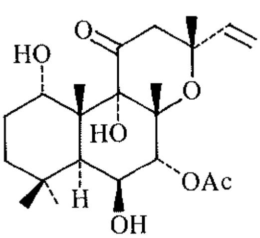
290 Deoxycarnosol



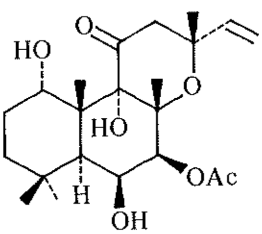
291 6 β-Hydroxycarnosl
(Kelcom, 1984)



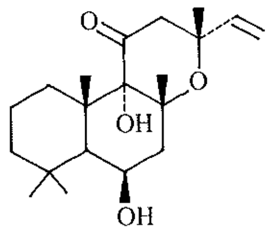
292 (t) Ferruginol



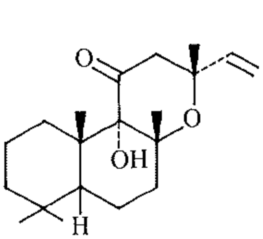
293 Coleonol



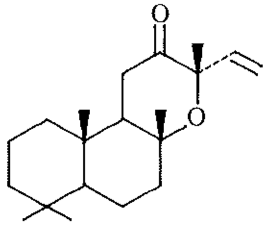
294 Forskolin
(Tandon *et al.*, 1977)



295 Coleosol
(Jauhari *et al.*, 1978)

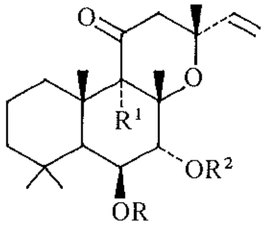


296 Coleol



297 Coleonone

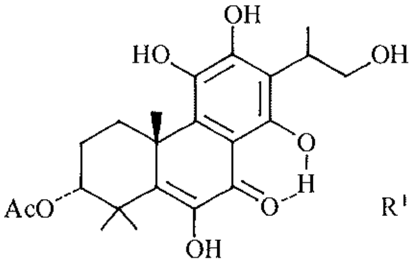
(Katti *et al.*, 1979)



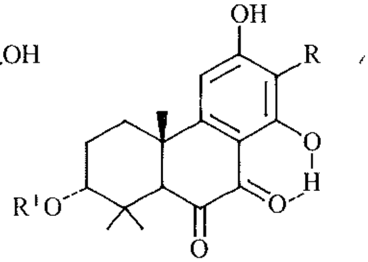
298 Coleonol E :
R = R^1 = H, R^2 = Ac

299 Coleonol F :
R = Ac, R^1 = OH, R^2 = H

(Painuly *et al.*, 1979)



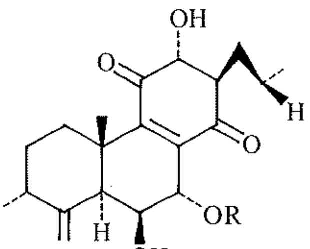
300 Colean H



301 Colean I :
R = $CHCH_3CH_2OH$, R^1 = OH

302 Colean K :
R = $CH(CH_2OAc)_2$, R^1 = H

(Moir *et al.*, 1973a)



303 Coleon G : R = H

304 Coleon J : R = Ac

(Moir *et al.*, 1973b)

Flavonoids occur in several *Coleus* species e.g. apigenin, cirsimaritin, luteolin, chrysoeriol, quercetin, eriodictyol, dihydrokaempferol, salvigenin and taxifolin from *C. amboinicus*, *C. aromaticus* and *C. blumei* (Brieskorn and Riedel, 1977; Barberan, 1986). Crocetin dialdehyde (8, 8′-diapocarotendial) has been identified from the roots of *C. forskohlii* (Tandon *et al.*, 1979). Royleanon and dehydroroyleanon occur in *C. igniarius* (Eugster, 1968).

1 *Coleus blumei* Benth.
(= *C. auctellarioides* L.et Miq.)
Common name: —
Arabic name: *Kolias*

C. blumei contains the following flavonoid and anthocyanin pigments:

— Flavonoids: baicalein (5, 6, 7-trihydroxyflavone) and scutellarein (5, 6, 7, 4′-tetrahydroxyflavone) (Palmieri and Landi, 1964–1965), apigenin and luteolin (Tronchet, 1975), and dihydrokaempferol (Lamprecht *et al.*, 1975).

— Anthocyanins: cyanidin, cyanidin 3-glucoside and cyanidin 3, 5-diglucoside acylated with *p*-coumaric acid (Lore and Malone, 1967; Lamprecht *et al.*, 1975, Barberan, 1986).

C. blumei also contains caffeic acid derivatives (Tronchet, 1975), a mixture of saturated hydrocarbons (nonacosane, hentriacontane, dotriacontane, tritriacontane, astetriacontane and pentatriacontane), *β*-sitosterol and stigmasterol (Garcia *et al.*, 1978) and unidentified triterpenoid compounds (Garcia *et al.*, 1973). Rosmarinic acid was detected in the vacuoles of suspension cultured cells of *C. blumei* (Chaprin and Ellis, 1984).

2 *OCIMUM*

Ocimum species are characterized by their content of volatile oil. *O. kilimandscharicum*, for example contains 2·5–7·6% volatile oil (Chakravarti *et al.*, 1961). Camphor has been identified from the volatile oils of several species e.g. *O. canum* (Runge 1948), *O. kilimandscharicum* (Ribeiro, 1950, Nair and Varier, 1952; Chowdhri and Haksar, 1962), and *O. kilimadjarum* (Baudrenghten and Jadot, 1949). It amounts to 70% and 65% of the essential oil of *O. kilimanjaricum* (Nayak and Guha, 1952), and *O. canum* (Thomssen, 1938) respectively. The composition of the oils of several species has been reported e.g.

— *O. gratissimum* : *α*-pinene, *β*-pinene, camphene, *α*-terpinene, Δ^3-carene, myrcene, 1,8-cineole, limonene, *p*-cymene, methyleugenol, methylisoeugenol, caryophyllene, humulene, *β*-seline, longfoline, camphor, linalool, *α*-terpineol, thymol and clovene (Sainsbury and Sofowora, 1971).

— *O. kilimadjarum* : camphor, cineole, chavibetol (Baudrenghten and Jadot, 1949).

— *O. kilimandscharicum* : camphor, limonene, terpeneoline, linalool, *α*-pinene, borneol, cineol, safrol, methyl cinnamate (de Toledo *et al.*, 1950; Dhingra *et al.*, 1951; Nair and Varier, 1952; Nayak and Guha, 1952).

— *O. micranthum*: eugenol, methyl eugenol and several sesquiterpenes (Khosla *et al.*, 1980)

— *O. sanctum*: eugenol, methyleugenol and caryophyllene (Dey and Choudhuri, 1984).

The presence of several other substances in *Ocimum* species has been reported e.g. gratissimene (a sesquiterpene) (Dembitskii *et al.*,1982), and ocimic acid (Ali and Shamsuzzaman, 1968) from *O. gratissimum* ; oleanolic and ursolic acids from *O. canum* (Xassan *et al.*, 1980), *O. kilimandscharicum* (Mookherjea, 1973); maslinic and epimaslinic acids from *O. spicatum* (Xassan *et al.*, 1983). Flavonoids were also identified from these plants e.g. nevadensin (5, 7-dihydroxy-6, 8, 4′-trimethoxyflavone) and salvigenin from *O. canum* (Xassan *et al.*, 1980). Ocimin (a neolignan) was isolated from the essential oil of *O. americanum* (Thappa *et al.*, 1979).

The seeds contain mucilage. The mucilagenous polysaccharide-complex found in the seeds of *O. adscendens* contains an acidic polysaccharide which is composed of D-galactose, (~20%), D-galacturonic acid (~35%) and L-rhamnose (~39%) (Anjaneyalu *et al.*, 1984). The mucilage of the seed of *O. canum* is composed of D-glucose, D-galactose, D-mannose, L-arabinose, D-xylose and L-rhamnose in the approximate ratio of 8:5:2:1:1:2 and uronic acids (8·15%) (Anjaneyalu and Tharanathan, 1971). The mucilage isolated from the seeds of *O. gratissimum* has a similar composition; it consists of D-glucose, D-galactose, D-mannose, D-xylose and L-arabinose in the molar ratio of 1·2:1·6:1:3·8:2·7, besides D-galacturonic and D-mannuronic acids in the ratio 1:0·42 (Tharanathan and Shamanna, 1975).

1 *Ocimum basilicum* L.
Common name: *Basil*
Arabic name: *Rihan*

The composition of the volatile oil from *O. basilicum* cultivated in different parts of the world has been reported. Camphor was early identified from the oil (Brodskiĭ, 1934). Linalyl acetate, linalool, methylchavicol, cineol, eugenol and sesquiterpenes have been identified from the plant cultivated in Virginia (Nelson and Lowman, 1935). The methylchavicol content of the true sweet basil (*O. basilicum*) grown in Germany, France, Spain and Northern Africa, is about 55% (Guenther, 1935). The oil of the plant of Calabria contains cineole (about 2·6%); l-linalool; estragole, 21–33% and eugenol, 0·3–2% (Bonaccorsi, 1936). The oil from *O. basilicum* of U.S.S.R contains thymol 32%, dipentene 48%, p-cymene 7%, aldehydes 1% and an unidentified alcohol 8% (Iskenderov, 1938). The oil from *O. basilicum* var. *purpurascens* produced in Tanganyika contains estragol (85·5%) and terpenes (especially d-α-pinene), cineole and linalool in small amount (Naves, 1950). The oil from flowering plant grown in Bombay contains methyl cinnamate (57·14–69·66%) and linalool (11·32–20·55%) (Khorana and Vangikar, 1950). French basil (*O. basilicum*) cultivated in India contains sesquiterpenes, eugenol, geraniol, linalool, methylchavicol, ocimene, eucalyptol, limonene, Δ^3-carene, α-pinene, 1,8-cineole and an unidentified compound (Gupta *et al.*, 1971). Among the other components identified from the volatile oil are: 1-epibicyclosesquiphellandrene (a sesquiterpene) (Terhune *et al.*, 1974), menthol, menthone, cyclohexanol, cyclohexanone, myrcenol and nerol (Chopra *et al.*, 1969; Huang *et al.*, 1981). The chemical composition of the oil has been reported by several other investigators (e.g. Anon, 1937; Rakshit, 1938; Chopra *et al.*, 1941; Dejoie, 1943; Singh *et al.*, 1970; Lawrence *et al.*, 1971; Jain and Jain, 1973). Several chemotypes of *O. basilicum* plants have been found which show variation in the major constituents of the essential oil (e.g. Pushpangadan *et al.*, 1975; Fleisher, 1981).

Acidic triterpenes *viz.* oleanolic and ursolic acids together with β-sitosterol have been identified from the plant (Nicholas, 1961). The fatty acids of the seed oil are: palmitic, stearic, oleic, linoleic and linolenic acids (Khan *et al.*, 1961; Minikeeva *et al.*, 1971).

Acid polysaccharides have been isolated from the seed mucilage of *O. basilicum*, and are composed of D-glucose, D-galactose, D-mannose L-arabinose, D-xylose and L-rhamnose together with D-galacturonic and D-mannuronic acids (Tharanathan and Anjaneyalu, 1972, 1974). Later, Anjaneyalu and Channe (1979) isolated an acidic polysaccharide which have an associated glucan impurity ($\sim 8\%$); the polysaccharide is composed of D-xylose, L-arabinose, L-rhamnose, D-galacturonic acid and traces of galactose and glucose. Partial hydrolysis of the mucilage gave an acid-stable core-polysaccharide composed of glucose and mannose (10:2). The core-polysaccharide was found to be a composite aggregate of degraded cellulose and glucomannan-type polymers (Tharanathan and Anjaneyalu, 1975). Planteose (a trisaccharide) occurs also in *O. basilicum* (French *et al.*, 1959).

Ocimum species are used in cosmetics, flavouring and pharmaceutical industries. Oil of *O. basilicum* possesses some insecticidal action against houseflies, blue butterflies and especially mosquitoes (Chopra *et al.*, 1941).

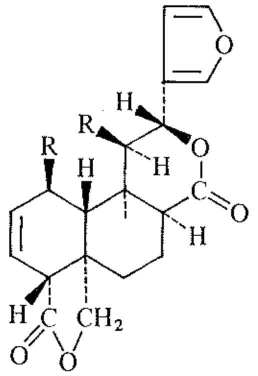
3 *SALVIA*

The genus *Salvia* has been widely studied and has yielded a great number of compounds. The diterpenoids are usually of the abietane type as in *S. tomentosa* (Ulubelen and Miski, 1981) or are quinones such as those found in *S. miltiorrhiza* (Kakisawa *et al.*, 1969), or have rearranged skeletons as in *S. aethiopis* (Boya and Valverde, 1981). Diterpenoids with a clerodane skeleton have been isolated from some species e.g. *S. melissodora* (Rodríguez *et al.*, 1973). The most common triterpenoids are of the oleanane or ursane type (e.g. Brieskorn and Grossekettler, 1964; Ulubelen and Brieskorn, 1975), although other types have been isolated e.g. lupanes from *S. phlomoides* (Garcia Alvarez *et al.*, 1981), friedelane from *S. glutinosa* (Taylor, 1967) and dammarane from *S. bicolor* (Valverde *et al.*, 1985). Flavonoids have been identified from several species (Barberan, 1986; Rizk, 1986).

Salvia species are regarded as a remedy for coughs, colds, chest inflammations, pulmonary tuberculosis and for abdominal troubles (Watt and Breyer-Brandwijk, 1962).

1 *Salvia splendens* Sello
Common name: *Scarlet sage*
Arabic name: *Salvia*

The aerial parts of the plant contain two diterpenoids of the clerodane type *viz.* salviarin



305 Salviarin : R = H
306 Splendidin : R = OAc
(Savona *et al.*, 1979)

(Savona *et al.*, 1978), splendidin (Savona *et al.*, 1979), and the roots contain diterpene quinones of the royleanone-type (Patudin *et al.*, 1974). The plant also contains ursolic acid, oleanolic acid (Savona *et al.*, 1978; Passannanti *et al.*, 1983), two alkaloids and coumarin derivatives (Albulescu *et al.*, 1978). Eicosanic acid occurs in the fixed oil of the plant (Mruk-Luckiewicz, 1981).

The anthocyanins of the flowers are identified as cyanidin 3, 5-diglucoside, cyanidin-3-*O*-(caffeoylglucoside)-5-*O*-*β*-D-glucoside, delphinidin-3, 5-diglucoside, delphinidin 3-*O*-(caffeoylglucoside)-5-glucoside, pelargonidin-3, 5-diglucoside, pelargonidin 3-*O* (*p*-coumaroyl-glucoside)-5-*O*-glucoside and pelargonidin 3-*O*-(caffeoylglucoside)-5-*O*-glucoside (Asen, 1961; Barberan, 1986). The flowers yield 6·7% (non-defatted) and 5·8% (defatted) total anthocyanins (Albulescu and Gavrila-Dinu, 1981).

XXIV LEGUMINOSEAE

Plants of the family Leguminoseae are known to contain a wide variety of compounds e.g. sesquiterpenes, diterpenes (both free and as saponins), tetraterpenoids and many phenolic compounds e.g. flavonoids (including isoflavonoids and neoflavonoids), and tannins. The family also contains alkaloids which belong to several classes (e.g. lupine, pyrrolizidine, phenylalanine, piperidine and many others) (Rizk, 1986).

1 *ACACIA*

The genus *Acacia* comprises about 1100–1200 species distributed in all countries, except Europe and Antarctica, principally in regions where the rainfall is markedly seasonal or low. A review of *Acacia* containing chapters on classification, phylogeny, ecology, uses and biological inter-relationships was published recently by New (1984).

Acacia species are known to exude gums. The chemical compositions of the gum exudates of many species have been studied and reviewed (e.g. Anderson and Dea, 1969, Anderson *et al.*, 1973, 1980, 1983). There are many works on *Acacia* gums; possibly because of the extensive traditional use of "gum arabic" as an article of commerce.

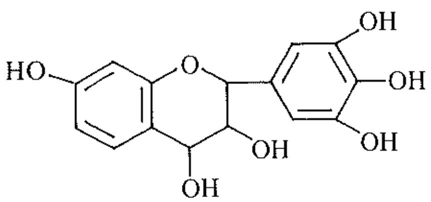
Diterpenoids, triterpenoids (free and as saponins), flavonoids (including biflavonoids and flaven derivatives), peltogynoids, alkaloids and cyanogenic compounds have been identified from several *Acacia* species (Rizk, 1986).

The seeds of a number of *Acacia* species contain non-protein amino acids e.g. *N*-acetyl-L-djenkolic acid, pipecolic and 4-hydroxy-pipecolic acids (Rizk, 1986), 2-amino-4-acetylaminobutyric and 2, 4-diaminobutyric acids (Evans *et al.*, 1985).

1 *Acacia arabica* Willd.
Common name: *Babul*
Arabic name: *Sant Arabi*

The gum exudate of *A. arabica* has been studied chemically (Anderson and Karamalla, 1966b; Anderson *et al.*, 1964, 1967; Anderson and Cree, 1968). The gum consists of D-galactose, 36%; L-Arabinose, 54%, L-rhamnose, 0·4% and uronic residues, 7·8% (Anderson and Karamalla, 1966b).

Polyphenols (including tannins) have been isolated from the bark, pods and leaves. Babul bark contains 15·7% tannin (Burton and Barat, 1954). Among the identified phenolic constituents from *A. arabica* bark are: (−)-epigallocatechin, gallic acid, (+)-catechin, (−)-epicatechin, (+)-dicatechin, (+)-leucocyanidin, quercetin and quercitrin (Sastry *et al.*, 1963; Bhanu *et al.*, 1964; Santhanam *et al.*, 1965). The leaves contain quercetin, epicatechol gallate, gallic acid, D-catechol, epicatechol and a dimer of D-catechol (Bhanu *et al.*, 1962) The pods are rich in tannins (30·4–41·7%) (Anon, 1930), and contain many (twenty four) phenols (Endres and Hilal, 1963), among which are: gallic acid, *m*-digallic acid, chlorogenic acid, robidandiol (flavan 3, 3′, 4, 4′, 5′, 7-hexiol, 307) (Endres and Hilal, 1963; Goodwin and Nursten, 1973. Tannins in the pods of *A.*



307 Robidandiol
(Endres and Hilal, 1963)

arabica are distributed as follows: inner coat 15·6, outer coat 18·0, layer of amorphous glossy substance between the inner and outer coats 58·9 weight % of the respective layers (Whitfeild, 1935). The polyphenolic fractions of *A. arabica* are fungitoxic (Baruah *et al.*, 1963) and have been reported to kill bacterial virus (*Escherichia coli* × P-host cells) (Fischer *et al.*, 1954).

The nutritive value of the pods has been reported. On dry basis the pods contain crude protein, 12·86; true protein, 11·62; amides, 1·24; ether extract "fats", 2·51; *N*-free extract, 63·82; crude fibre, 15·21; total ash, 5·6; calcium oxide, 0·72 and phosphorus pentoxide, 0·33% (French, 1934). The seeds contain 8·2% fatty oil (Gad *et al.*, 1965).

Gum of *Acacia arbica* has been early recommended for wider utilisation in pharmaceutical practice due to its emulsifying powers (Ganguly *et al.*, 1945). Some components of the seeds stimulate the secretion of insulin by the β-cells (Singh *et al.*, 1975).

2 *Acaia cyanophylla*
(= *A. saligna* Wendl.)
Common name: —
Arabic name: —

A. cyanophylla gum gives on hydrolysis L-rhamnose (5 mols.), L-arabinose (2 mols.), D-galactose (11 mols.), and D-glucuronic acid (5 mols.) (Charlson *et al.*, 1959; Kaplan and Stephen, 1967; Anderson and Bell, 1976). Smith degradation of the gum of *A. saligna* (average molecular weight 230,000), and a carboxyl-reduced sample, produced a mixture (average molecular weight 23,000) containing 3 polysaccharides having molecular weights 36,000, 12,000 and 6,000 (Churms *et al.*, 1979).

The leaves of *A. cyanophylla* contain quercetin 3-glucoside (Paris, 1953), apigenin 6, 8-bis-D-glycoside, rutin (Thieme and Khogali, 1974, 1975). The flowers contain two anthochlor pigments isosalipurposide (4, 2′, 4′, 6-tetrahydroxychalcone-2′-glucoside) and chalconaringenin 4-glucoside (Imperato, 1978).

The plant gives positive tests for coumarins, flavonoids, saponins and tannins (Rizk *et al.*, 1988).

3 *Acacia ehrenbergiana* Hayne
(= *A. flava* Schweinf.)
Common name: —
Arabic name: (local): *Salam*

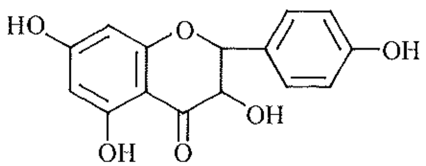
The gum exudate contains the following sugars: 4-*O*-methylglucuronic acid (3–5%) glucuronic acid (12–19%), galactose (51–56%), arabinose (13–17%) and rhamnose (10–11%) (Arderson *et al.*, 1984a).

The plant gives positive tests for coumarins, flavonoids, tannins and saponins (Rizk, 1986), and has an anti-inflammatory activity (Rizk *et al.*, 1985).

4 *Acacia farnesiana* Willd.
Common name: *Popinac*, *sweet Acacia*
Arabic name: *Fotnah*

A. farnesiana contains the following compounds:

1 —Flavonoids and other phenolic substances (from the leaves and or pods): kaempferol 7-glucoside, kaempferol 7-galloylglucose, apigenin 6, 8-bis-β-D-glucopyranoside, prunin *O*-6″-gallate (5-7,4′-trihydroxyflavanone″ naringenin″)-7-*O*-β-D[6″-*O*-galloyl]glucopyranoisde, gallic acid, ellagic acid, *m*-digallic acid, methyl gallate, kaempferol, aromadendrin (308; =dihydrokaemp-

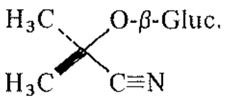


308 Aromadendrin
(Dihydrokaempferol)

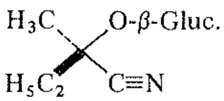
ferol), naringenin 7-glucoside and naringenin 7-rhamnoglucoside (naringin) (El-Sissi *et al.*, 1973; Thieme and Khogali, 1974; El-Negoumy and El-Ansary, 1981).

2 —The floral oil contains several monoterpenoids and other components among which are: *cis*-3-methyl-dec-3-en-1-ol, *trans*-3-methyl-dec-4-enoic acid, homoterpene lactone dihydroactinidiolide, eugenol, geraniol, α-ionone, β-ionone, anisaldehyde, benzyl alcohol, benzaldehyde, cuminic alcohol, farnesol, cuminic aldehyde, anisaldehyde, anisic acid, anisol, linalool, nerolidol, terpineol, and methyl salicylate (Demole *et al.*, 1969, El-Hamidi and Sidrak, 1970).

3 —Cyanogens: *A. farnesiana* has been reported to be both cyanogenic (Herbert 1922; Rehr *et al.*, 1973) and acyanogenic (Finnemore and Gledhill, 1928). Recent investigations showed that linamarin and lotaustralin are the major cyanogens of the plant; together with a third unidentified cyanogen (Secor *et al.*, 1976; Seigler *et al.*, 1979). The HCN content of dried *A. farnesiana* foliage varies from 0·0 to 5·495 umol/gm (Janzen *et al.*, 1980).



309 Linamarin

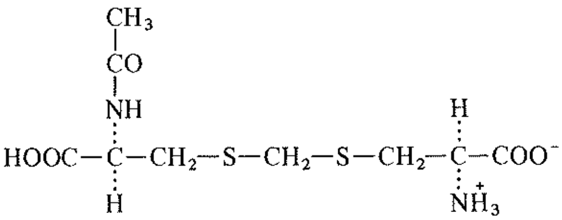


310 (*R*) Lotaustralin

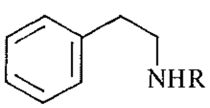
(Rizk, 1986)

4 —*N*-acetyl-L-djenkolic acid (a free sulphur amino acid first isolated from this plant), pipecolic acid and 4-hydroxy pipecolic acid (Gmelin *et al.*, 1962).

5 —Phenetheylamine alkaloids: *N*-methyl-β-phenethylamine, tyramine and *N*-methyltyaramine (Camp and Norvell, 1966).

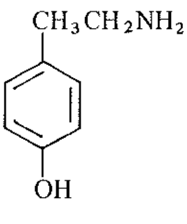


311 *N*-Acetyl-L-djenkolic acid



312 β-Phenylethylamine: R = H

313 *N*-Methyl-β-phenylethylamine: R = CH_3



314 Tyramine

(Rizk, 1986)

6 —A gum which consists of galactose as the main constituent (Andriaens, 1939).

7 —The leaves contain *n*-alkanes (C_{31}–C_{33}) with maximum occurrence of nonacosane (60%), triaconatanol and the phytosterols cholesterol (8·7%), campesterol (21·6%), stigmasterol (37·2%) and sitosterol (32·4%) (Andhiwal and Kishore, 1982). The flower wax consists of fatty acids (48·2%), alkanols (26·2%), alkanes (17·1%), steroids (3·2%) and alkanediols (3·1%) (Abd-El-Samad and Osman, 1980).

8 —Tannins: the fruits contain 11–16% of tannins and even as much as 32·2% (Watt and Breyer-Brandwijk, 1962).

The chemical composition of the seed is: moisture, 3·82%; ether extract (fat), 3·30%; protein, 25·15%; crude fiber, 18·28%; ash, 3·80% and carbohydrates 49·42%. The essential amino acid content of the seeds (g/100 gm of proteins) is as follows: methionine, 0·44; cystine, 1·79; lysine, 4·43; *iso*leucine, 2·69; leucine 9·27; phenylalanine 3·63; valine, 4·04; threonine, 2·67 and tryptophan, 1·10 (Giral *et al.*, 1978).

The gummy exudate from the tree is used as an emollient. Its blossom, known as cassie flower, is used in perfumery. The flowers yield an essential oil almost as valuable as otto of roses. The oil is removed from the petals by maceration with cocoa butter or coconut oil, or by extraction. It has an odour like violets, and is much used for pomades, sachets and powders (Hill, 1952). The flower is said to be antispasmodic, aphrodisiac and insecticidal. The fruit is used as a remedy for diarrhoeas and gynecological conditions.

The bark, leaf and root are all astringent and have been found useful as a lotion for wounds and injuries, skin diseases, inflammations of the mucous membranes of the eyes and throat. The plant is also said to be antidiarrhoeic and antirheumatic as well as poisonous (Watt and Breyer-Brandwijk, 1962).

Due to its tannin content the plant has been used in tanning. The wood is of value as timber.

5 *Acacia nilotica* L.

Common name: *Egyptian Acacia*

Arabic name: *Sant*

The different parts of the plant are rich in tannins (Lubrano, 1939; Endres *et al.*, 1959) and have been evaluated as a source of tanning material. The deseeded pods, seeds, bark and wood contain 34·95%, 6·61%, 27·11% and 6·35% tannins respectively (El-Sissi and El-Sissi, 1962; El-Sissi *et al.*, 1965). The pods contain both hydrolysable and condensed tannins (Adewoye and Rao, 1977a,b). El-Sayyad (1979) isolated from the pods two condensed tannins which are dimers derived from 3′, 4′, 5, 7-tetrahydroxyflavan-3-ol and the other is a mixture of oligomers (dimers and trimers) resulting from the condensation of 3′, 4′, 7-trihydroxyflavan-3, 4-diol with 3′, 4′, 5, 7-tetrahydroxy-flavan-3-ol (−)-epicatechol. Several phenolics have been identified from the different parts of the plant e.g. gallic acid, and protocatechuic acid from the pods (El-Sissi*et al.*, 1967; Adewoye and Rao, 1977b), ellagic acid and *m*-digallic acid (in addition to protocatechiuc and gallic acids) from the bark (El-Sissi *et al.*, 1965).

The distribution of other phenolic compounds *viz.* kaurenic, xanthurenic, hydroquinone, pyrogallol, phloroglucinol, *m*-aminophenyl glycoside, 3-quinolyl acid, 6-, 7- and

Table 7: The free and combined sugars present in *Acacia nilotica* (El-Sissi *et al.*, 1965)

Plant part	Free sugars	Combined sugars
Deseeded pods	Glucose	Galactose, glucose, arabinose, traces of xylose and rhamnose
Seeds	Sucrose and raffinose	Galactose, glucose, fructose and xylose
Bark	Sucrose	Glucose and arabinose

8-hydroxyquinolines and 7-coumarinyl acids, in pod flower, leaf and bark of *A. nilotica* has been reported by Begum *et al.*, (1977).

The gum which the tree exudes freely during March and April contains 50·43% pentosan and 21·85% galactan and yields arabinose and galactose and traces of rhamnose on hydrolysis (Watt and Breyer-Brandwijk, 1962; Anderson *et al.*, 1964; Anderson and Karamalla, 1966b; Anderson and Cree, 1968). Two arahinobioses identified as arabinofuranosyl-L-arabinose and 3-*O*- *β*-L-arabinopyranosyl-L-arabinose have been isolated from the gum (Chalk *et al.*, 1968).

The root bark contains octacosanol, *β*-amyrin (Prakash, and Garg, 1981). The fatty acids consist of palmitic, 15·2%; stearic, 8·4%; oleic, 26·3; linoleic, 48·7% and arachidic, 1·4% (Devi *et al.*, 1979).

The free and combined sugars present in the different parts are shown in table 7.

Most of the acids and salts present in the pods are in the form of weak acids and salts of weak acids (Adewoye and Rao, 1977a).

The nutritive value of babul (*A. nilotica*) seeds and their evaluation as livestock feed have been reported (Pande *et al.*, 1981; Kumaresan *et al.*, 1984). The proximate composition of the seeds is shown in Table 8. The nitrogen-free extract is slightly higher than that of cottonseed cake. The amino acids concentrations of kernels are similar to those of peanut protein. Calcium and sodium contents are low (Kumaresan *et al.*, 1984).

Table 8: (Kamaresan *et al.*, 1984)

	Kernels	Hulls	Whole seeds
Dry matter %	94·5	92·5	93·9
Crude protein* %	45·2	5·6	17·3
Oil content %	11·5	0·4	3·5
Crude fiber %	2·5	23·2	16·6
Ash content %	5·4	3·1	4·0

* Calculated on the basis of the dry matter

The seed of Indian babul (*A. nilotica* syn. *arabica* subsp. *indica*) contains 5.6% oil, 19.6% protein and 15.9% crude fibre.

The extracts of leaves, flowers, pods and bark of *A. nilotica* possess antifungal activities (Begum *et al.*, 1977). The aqueous extract of the fruits has algicidal activity against the species of *Rivularia, Spirogyra, Oscillatoria, Pediastrum, Coleastrum, Spirulina, Chrococcus, Microcystis, Cyclotella, Euglena, Cosmarium* and *Closterium*. The activity is probably due to the high content of tannins in the fruits (Ayoub, 1982a). TAN, a new molluscicide and algicide has been isolated from the fruits (Ayoub, 1982b).

The pods are widely used in the industry in both the rural and mechanized sectors of tannings in different countries. *A. nilotica* furnishes a valuable wood for house-beams, furniture and also in the construction of boats (Adewoye and Rao, 1977a). The wood is hard, heavy, durable, fine-textured and resistant to rot, the terminate and borer and is useful for fencing, local building and makes a good fuel. The paper making properties of pulps prepared from *A. nilotica* has been reported (Petroff *et al.*, 1968).

The gum, bark and leaf are used medicinally in colds, ophthalmia, diarrhoea and haemorrhage.

6 *Acacia tortilis* (Forssk.) Hayne
Common name: —
Arabic name: (local): *Samor*

The leaves contain condensed tannins and the following flavonoids: quercetin 3-glucoside, quercetin 3-rutinoside (the main component), quercetin 4′-glucoside, myricetin 4′-methylether 3-rhamnoside, isorhamnetin 3-rutionside, apigenin 6, 8-bis-*C*-glucoside and luteolin 7-glucoside (Thieme and Khogali, 1975).

The different subspecies of *A. tortilis* yield a proteinaceous gum exudate, the sugar components of which are 4-*O*-methylglucuronic acid, glucuronic acid, galactose, arabinose and rhamnose (Anderson *et al.*, 1964; Anderson and Cree, 1968; Anderson and Bell, 1974b).

N-Acetyldjenkolic, pipecolic and 4-hydroxypipecolic acids occur as free (non-protein) amino acids of the seeds (Evans *et al.*, 1977). The pod is rich in protein (18·83%) and contains fat (2·44%), carbohydrates (46·25%,) minerals (5·1%) and crude fibre (20·1%) (Rizk, 1986).

A. tortilis subsp. *heterocantha* is a cause of natural HCN poisoning; none the less, the dry mature seed coat gives negative tests for HCN and the mature seed with a coat yields a trace (Watt and Breyer-Brandwijk, 1962).

The gum of the plant is of economic importance. The plant is also valuable as a fodder tree. The wood is used for building cattle folds.

2 *AGATI*

1 *Agati grandiflora* Desv.
(= *Sesbania grandiflora* Pers.)
Common name: *Sesbania*
Arabic name: *Sasaban*

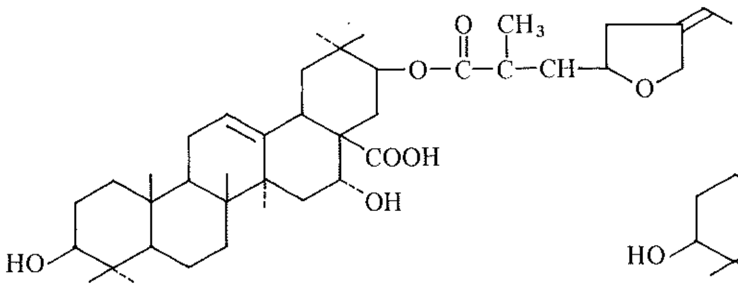
A galactomannan polysaccharide having a D-galactose and D-mannose ratio of 1:2 has been isolated from the seeds of *S. grandiflora* (Srivastava *et al.*, 1968). The tegmen of the seeds contain a complex mixture of gluco-and galactomannans (Rao and Rao, 1965a). The seeds contain ν-sitosterol (Bhattacharjee and Mullick, 1958). The seed oil (6·6%) contains oleic, linoleic, palmitic and stearic acids (Tiwari and Garg, 1960).

The leaves of *S. grandiflora* contain a tertiary alcohol "grandiflorol" (α-5-methyl-5-pentacosanol) (Tiwari *et al.*, 1964), and a saponin which yields on hydrolysis oleanolic acid, galactose, rhamnose and glucuronic acid (Tiwari and Bajpai, 1964). A homologous series of long chain hydrocarbons ($C_{23}H_{48}$ to $C_{31}H_{64}$) and *n*-nonacosanol also occur in the leaves (Khanna and Perkins, 1969).

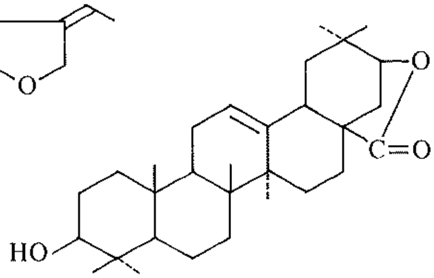
Phytochemical screening of the plant revealed the presence of coumarins and saponins (Rizk *et al.*, 1988).

3 *ALBIZZIA*

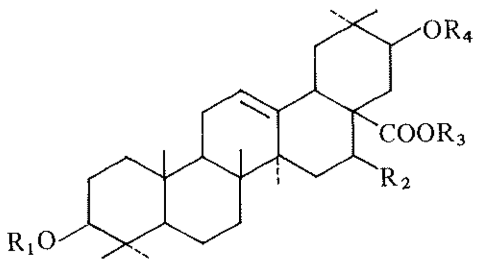
Albizzia species are characterized by the presence of triterpenoid glycosides (saponins) which occur in the different parts of the plants (e.g. seeds, leaves, fruits, bark, etc.). Examples of the sapogenins identified from *Albizzia* species are shown in Table 9. Free triterpenoids and steroids are also identified e.g. α-spinasterol and α-spinasterone from heartwood of *A. julibrissin* (Nakanno and Taskashima, 1975) and lupen-20(30)-en-3β-ol, stigmast-5-en-3β-ol and 5 α-stigmasta-7, 22-dien-3β-ol from the bark of *A. zygia* (Schoppa and Pachaly, 1981).



315 Acacigenin B



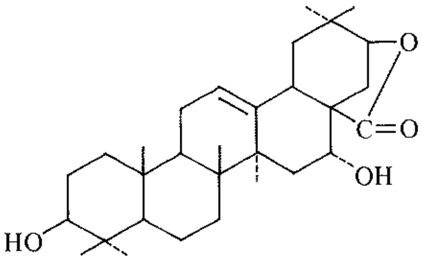
316 Machaerinic acid lactone



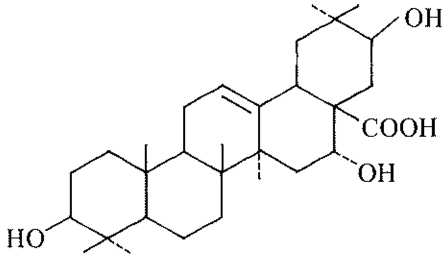
317 Machaerinic acid
$R_1 = R_3 = R_4 = H$, $R_2 = \alpha$-OH

318 Machaerinic acid methylester
$R_1 = R_2 = R_4 = H$, $R_3 = CH_3$

(Kang and Woo, 1983)



319 Acacic acid lactone

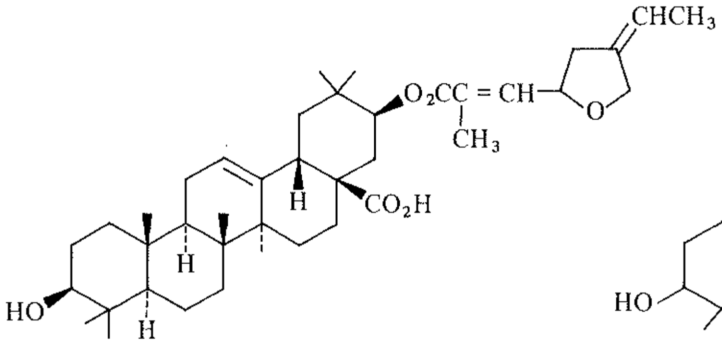


320 Acacic acid

(You *et al.*, 1982)

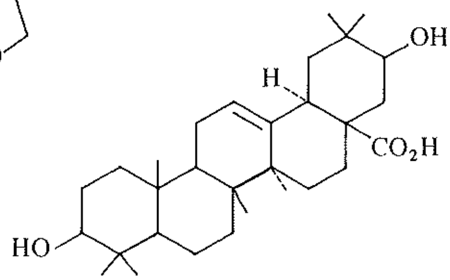
Table 9: The sapogenins of some *Albizzia* species

Species	Plant Part	Sapogenins	References
1-*A. adianthifolia*	roots	Triterpene carboxylic acid	Prista *et al.* (1962)
2-*A. amara*	seeds	Echinocystic acid	Varshney and Shamsuddin (1962)
3-*A. anthelmintica*		Echinocystic acid	Tschesche *et al.* (1966)
4-*A. julibrissin*	stem bark	Machaerinic acid methyl ester (318), acacigenin B, machaerinic acid lactone (319), 21-[4(ethylidene)-2-tetrahydrofuranmeth-acryloyl] machaerinic acid (321)	You *et al.*, (1982); Kang and Woo (1983); Woo and Kang (1984)
5-*A. lebbekoides*	fruit pericarp	Albizziagenin	Farooq and Varshney (1953)
6-*A. lucida*	seeds	Echinocystic acid, oleanolic acid	Chakraborti and Roy (1962); Chakraborti *et al.*, (1962).
7-*A. odoratissima*	seeds	Acacic acid, machaerinic acid (317)	Varshney and Khan (1961, 1965).
8-*A. procera*	seeds	Machaerinic acid, proceric acid (322)	Roy and Roy (1966); Roy and Rog (1967); Varshney (1968); Varshney and Badhwar(1972)



321

(Woo and Kang, 1984)



322 Proceric acid

(Varshney and Badhwar, 1972)

The composition of gum exudates from several *Albizzia* species has been reported. Galactose, mannose, arabinose, rhamnose, glucuronic acid and 4-methyl glucuronic acid are the components of the gum exudates of *A. galberrima* (Torto, 1961) and *A. procera* (Farooqi and Kaul, 1963; Farooqi, 1970). The gum of *A. zygia* consists of the same sugar components together with galacturonic acid (Drummond and Percival, 1981; Mital and Adotey, 1971).

Flavonoids have been detected in few *Albizzia* species. The leaves of *A. amara* contain 4′-*O*-methyl-quercetin 3-rutinoside (Sastry *et al.*, 1967), while the stem bark of *A. julibrissin* contains 3′, 4′7-trihydroxyflavone (Chamsuksai *et al.*, 1981). Isoflavanones *viz.* biochanin A, formononetin, genistein and daidzein occur in heartwoods and bark of *A. procera* (Deshpande and Shastri, 1977). The wood of *Albizzia* species is used in the production of pulps e.g. *A. falacta* (Chai, 1979) and *A. moluccana* (Guha and Karira, 1981).

1 *Albizzia lebbeck* (L.) Benth.
Common name: *Lebbeck tree*
Arabic name: *Labakh*

The different parts of *A. lebbeck* (seed, flower, leaf, bark) yield several triterpenoid saponins. The seeds (or pods) contain saponins which yield on hydrolysis echinocystic acid, albigenic acid (an isomer of echinocystic acid), oleanolic acid and albigenin (3β-hydroxy-16-oxo-28-norolean-13(18)-ene) (Varshney and Farrooq, 1952, Sannie *et al.*, 1957; Barua and Raman 1958, 1959, 1962; Varshney and Badhwar, 1970a,b; Varshney *et al.*, 1971, 1973a,b;). The saponins, isolated from the seeds and other parts of the plants are named lebbekanins A–H. Lebbekanins A,C,D,F,G, and H are glycosides of echinocystic acid with varying sugars; while lebbekanins B and E are glycosides of oleanolic acid and acacic acid respectively (Varshney, 1976; Varshney *et al.*, 1979, 1982b). The flowers contain lebbekanins D,F,G and H (Varshney and Jain, 1978; Varshney *et al.*, 1975, 1982). The bark contains saponins which yield acacic acid (Hassan *et al.*, 1962) and the wood yields lebbekanin E. The sugar moities of some lebbekanins are as follows:

Lebbekanin A: glucose, galactose, arabinose, xylose, fucose and rhamnose in the molar ratio of 5:1:1:1:1:2 (Varshney *et al.*, 1973b).

Lebbekanin C: glucose and rhamnose (Varshney *et al.*, 1973a).

Lebbekanin D: glucose, galactose, arabinose, xylose and rhamnose in the molar ratio of 2:2:5:3:3: (Varshney *et al.*, 1975; Varshney and Jain, 1978).

Lebbekanin E: glucose, arabinose, xylose and rhamnose in a molar ratio of 4:2:1:1 (Varshney *et al.*, 1979).

Lebbekanins F and G: glucose, arabinose, xylose, fucose and rhamnose in the molar ratios of 2:2:2:1:3 and 3:2:2:2:3 respectively (Varshney and Jain, 1978).

Lebbekanin H: galactose, glucose, arabinose, xylose and rhamnose in the molar ratio of 2:4:3:3:3 (Varshney and Jain, 1978).

The saponins of the plant possess antifertility properties (Vohora and Khan, 1974). Free triterpenes also occur in *A. lebbeck viz.* lupeol, α-and β-amyrins in the flowers (Jain and Mishra, 1963), echinocystic acid in the leaves (Varshney and Sharma, 1969a, b), and friedelan-3-one from the bark (Tripathi and Dasgupta, 1974).

The principle constituents of the unsaponifiable fraction (3·5%) of *A. lebbeck* oil are sterols (38%), methylsterols (3%), triterpenoid alcohols (18%), tocopherols (22%) and total hydrocarbons and carotenoids (19%); the following components have been also identified (Miralles, 1982):

— Sterols: cholesterol (traces), brassicasterol (traces), compesterol (2%), stigmasterol (10%), sitosterol (78%), Δ^5-avenasterol (3%), Δ^7-stigmasterol (6%) and Δ^7-avenasterol (1%).

— 4-Methylsterols: lophenol (traces), obtusifoliol (5%), cycloeucalenol (36%), gramisterol (15%), 24-ethyllophenol (41%), citrostadienol (2%) and an unidentified one (1%).

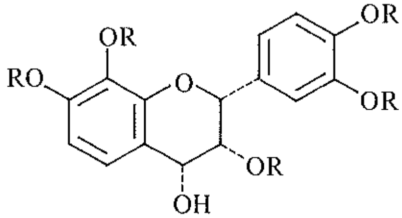
— Triterpenoid alcohols: cycloartanol (4%), β-amyrin (49%), cycloartenol (45%), α-amyrin (traces), 24-methylenecycloartanol (1%) and an unidentified one (1%).

— Tochopherols: δ-tocopherol (3%). β and α-tocopherols (36%) and α-tocopherol (61%).

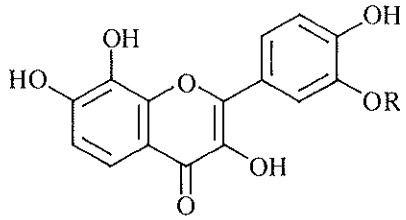
The seed yields 3·5 to 6·85 fixed oil (Kafuku and Hata, 1934, Farooq and Varshney, 1954; Watt and Breyer-Brandwijk, 1962). The oil contains palmitic acid (7·26%), stearic acid (9·63%), arachidic acid (10·89%), oleic acid (39·28%) and linoleic acid (32·94%) (Farooq and Varshney, 1954).

The heartwood contains melanoxetin (5-deoxygossypetin) (325), methyl ether of (−)-2, 3-*cis*-3,4-*cis*-3-*O*-methylmelacacidin (324), melacacidin (323), 3′-*O*-methylmelanoxetin (326) (Deshpande and Shastri, 1977), okanin (a chalcone) and leucopelargonidin (Gupta *et al.*, 1986). The bark contains 7 to 11% tannins. The leaf and bark of small branches yield 4% tannins.

The chemical composition of the fodder plant (*A. lebbeck*) is as follows: crude protein, 18·94%; fats, 2·85%; crude fibre, 29·54%; and total ash, 10·75%; calcium, 2·71 and



323 Melacacidin : R = H
324 : R = CH_3



325 Melanoxetin : R = H
326 3′-*O*-Methylmelanoxetin : R = CH_3

(Deshpande and Shastri, 1977)

phosphorus, 0·18% (Pal *et al.*, 1979). The average digestibility coefficients of crude protein, fat, fibre and total carbohydrates are 64·53, 44·61, 62·15 and 44·63 respectively (Khajuria and Singh, 1968).

The chemical composition of the seeds is as follows: moisture, 9·47%; ether extract (fats), 3·13%; protein, 33·69%; crude fibre 13·17%; ash 3·57% and carbohydrates 35·30%. The essential amino acid content in the seeds: (gm/100 gm of protein) is: methionine, 0·70; cystine, 0·72; lysine, 5·75; isoleucine, 2·98; leucine, 6·17; phenylalanine, 2·96; valine, 3·53; threonine 4·56 and tryptophan, 0·97 (Sotelo *et al.*, 1980).

A. lebbeck yields timber suitable for making furniture. The bark (due to its tannin content) is used in tanning. The oil is used as a leprosy remedy. The seeds, as well as the bark are used in eye diseases (Watt and Breyer-Brandwijk, 1962). Pulps for writing and printing paper were reported from the plant (Guha and Prasad, 1961).

4 *BAUHINIA*

Bauhinia species are characterized by the presence of several phenolic compounds in the different parts. Examples of the flavonoids identified are the following:

— *B. candicans* (leaves): kaempferol-3-*O*-*β*-rutinoside and kaempferol 3-*O*-rutinoside-7-*O*-α-rhamnopyranoside (Iribarren and Pomilio, 1983).

— *B. championii* (roots): 5, 6, 7, 5′-tetramethoxy-3′, 4′-methylenedioxyflavone, 5,6, 7, 3′, 4′, 5′,-hexamethoxyflavone, 5, 7, 5′-trimethoxy-3′4′-methylenedioxyflavone, 5, 6, 7, 3′, 4′-pentamethoxyflavone, 5, 7, 3′, 4′, 5′-pentamethoxyflavone and 5, 7, 3′, 4′-tetramethoxyflavone (Chen *et al.*, 1984).

— *B. reticulata* (leaves): quercitroside (rhamnoside of quercitol) (Rabaté, 1938).

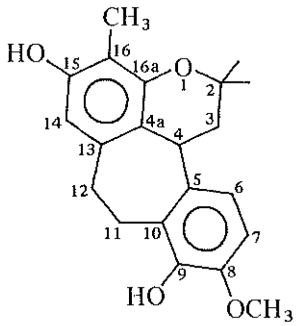
— *B. retusa* (bark): quercetin-3-*O*-*β*-D-glucoside, rutin (Tiwari *et al.*, 1978a).

— *B. splendens* (wood): bausplendin (7-methoxy-5, 6, 3′, 4′-dimethylenedioxyflavone) (Laux *et al.*, 1985).

— *B. tomentosa* (flowers): quercetin, rutin, isoquercitrin (quercetin *β*-glucoside) (Row and Viswonadham, 1954; Subramanian and Nair, 1963).

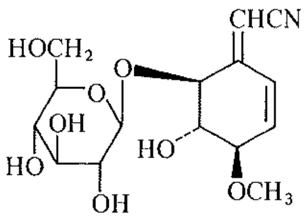
The seeds of *B. purpurea* contain two chalcones: butein 4′-*O*-*β*-L-arabinopyranosyl-*O*-*β*-D-galactoside and 3, 4-dihydroxychalcone-4-*Oβ*-L-arabinopyranosyl-*O*-*β*-D-galactopyranoside (Bhartiya *et al.*, 1979; Bhartiya and Gupta, 1981). The flowers of the same plant contain pelargonidin 3-glucoside and pelargonidin 3-triglucoside (Tiwari *et al.*, 1978a).

The stem of *B. manca* contains seventeen esters of ferulic acid and *p*-coumaric acid; the alcohol components range from $C_{22}H_{45}$ to $C_{28}H_{57}$ (Achenbach *et al.*, 1986). Racemosal (327), a tetracyclic phenol occurs in the heartwood of *B. racemosa* (Anjaneyulu *et al.*, 1986a).



327 Racemosol

(Anjaneyulu *et al.*, 1981a)



328 Bauhinin

(Chen *et al.*, 1986)

Octadecadienoic acid is the predominant fatty acid of the seeds of several *Bauhinia* species (Chowdhury *et al.*, 1984). A novel steroidal glucoside was identified as sitosterol-3-*O*-α-D-riburonofuranoside (Iribarren and Pomilio, 1985). The roots of *B. championii* contain bauhinin (328; a nitrile glucoside) (Chen *et al.*, 1985).

The isolation of lectins, from the seeds of *B. picta* (De Navarro and Perez, 1978) and *B. purpurea* (Allen *et al.*, 1980) has been reported. *B. purpurea* also produces pulp suitable for production of writing and printing paper (Kumar, 1980).

1 *Bauhinia variegata* L.

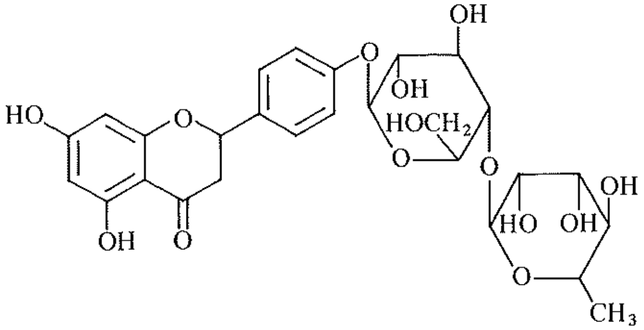
Common name: *Orchid-tree, mountain ebony*

Arabic name: *Khoff el-gamal*

Flavonoids have been identified from the stem and flower of the plant. The stem contains 5,7-dihydroxyflavanone-4′-*O*-α-L-rhamnopyranosyl-*β*-D-glucopyranoside (329) (Gupta *et al.*, 1979b), naringenin 5, 7-dimethylether 4′-rhamnoglucoside (Gupta *et al.*, 1980) and kaempferol-3-glucoside (Gupta and Chauhan, 1984). The flowers contain kaempferol 3-galactoside, kaempferol-3-rhamnoglucoside and at least four other unidentified flavonoids (Rahman and Begum, 1966).

The stems contain lupeol and *β*-sitosterol (Gupta *et al.*, 1980), and the seed yields anti-N-phytagglutinin (Fietcher, 1959).

The chemical composition of *B. variegata*, a fodder tree is as follows: crude protein,

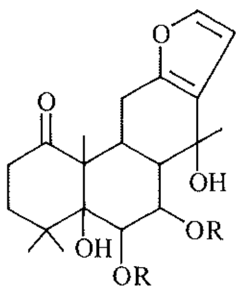


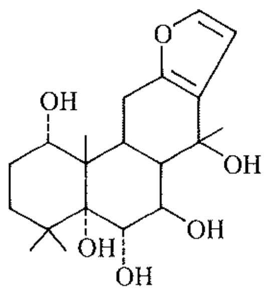
329 (Gupta *et al.*, 1979)

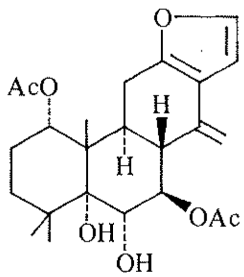
15·91%; fat, 1·33%; crude fibre, 27·04%; N-free extract, 48·32%; total ash, 7·40%; insoluble ash 0·82%; calcium, 1·76% and phosphorus, 0·22% (Pal *et al.*, 1979).

5 *CAESALPINIA*

Caesalpina species contain diterpenoids, several phenolic compounds and alkaloids. Caesalpines (α, β, υ, δ and ζ; 330–333, diteterpenoids containing a furan ring) occur in the seeds of *C. bonducella* (Qudrat-i-Khuda and Ali, 1963, 1964; Canonica *et al.*, 1966a, b; Balmain *et al.*, 1967; Pelizzoni, 1968; Purushothaman *et al.*, 1981). Triterpenoids e.g. ipuranol and lupeol also occur in the same species (Rao and Prasad, 1978; Langenheim, 1981), and β-amyrin in *C. sappan* (Nigam *et al.*, 1977).





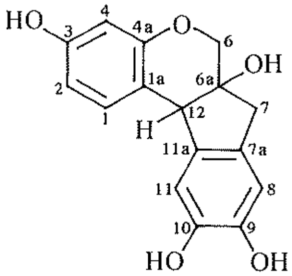


330 α-Caesalpin : R = Ac
331 β-Caesalpin : R = H
(Pelizzoni, 1968)

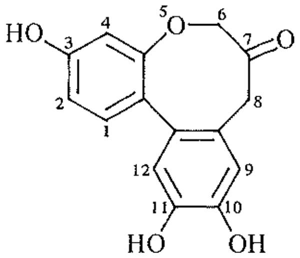
332 δ-Caesalpin
(Langenheim, 1981)

333 ζ-Caesalpin
(Purushothman *et al.*, 1981)

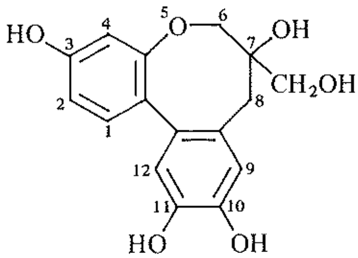
The heartwood of *C. sappan* contains several phenolic compounds e.g. brazilin (334) (Fuke *et al.*, 1985) which possesses antihypercholesteremic activity, protosappanin A (335) (Nagai *et al.*, 1986), protosappannin B (336) (Nagai and Nagumo, 1986) and caesalpins J (337) and P (338) (Shimokawa *et al.*, 1985). Brazilin a natural food colouring agent has been also isolated from *C. crista* and *C. brazililensis* (Ozeki, 1979).



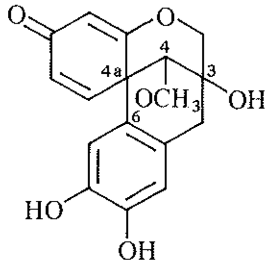
334 Brazilin
(Fuke *et al.*, 1985)



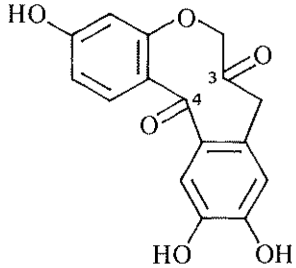
335 Protsappanin A
(Nagai *et al.*, 1986)



336 Protosappanin B
(Nagai and Nagumo, 1986)



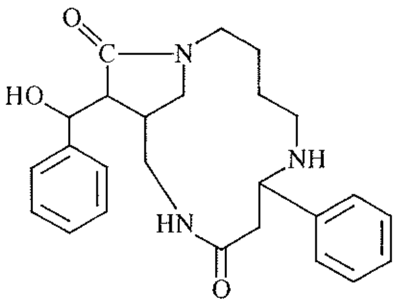
337 Caesalpin J



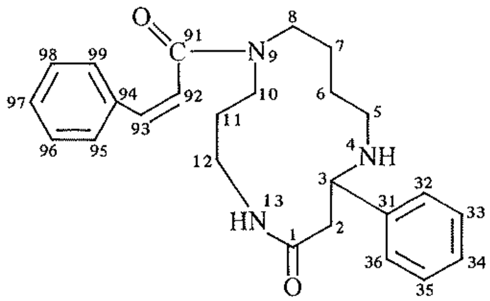
338 Caesalpin P

(Shimokawa *et al.*, 1985)

The leaves of *C. digyana* contain macrocyclic spermidine alkaloids *viz*. caesalpinine A (339), caesalpinine B (Mahato *et al.*, 1983) and caesalpinine C (celallocinnine, 340) (Mahato *et al.*, 1985).



339 Caesalpinine A



340 Caesalpinine C

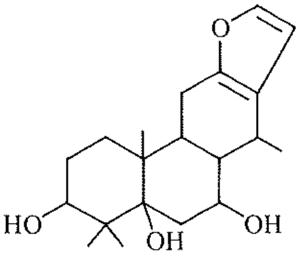
(Mahato *et al.*, 1985)

The pods of several *Caesalpinia* species are rich sources of tannins e.g. *C. brevifolia* (Schmidt *et al.*, 1967b), *C. digyna* (Biswas, 1943), *C. ferrea* and *C. tinctoria* (Vignolo-Lutati, 1938; Primo, 1945) and others (Rizk, 1986). The bark of *C. gardneriana* also produces tannins (Wasicky, 1944). *C. tinctoria* has tannins content up to 51% (Bravo, 1931). The stems and flowers of *C. japonica* yield the following flavonoids: apigenin, 4, 7-dihydroxyflavone and hyperin (Imamura *et al.*, 1980).

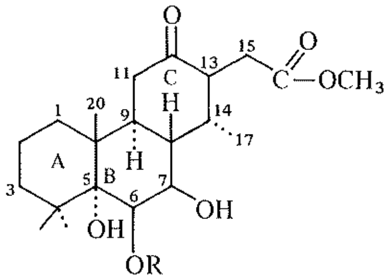
1 *Caesalpinia pulcherrima* Swartz.
(= *Poinciana pulcherrima*)
Common name: *Barbados pride*, *Dewarf Poinciana*.
Arabic name: *Caesalpina*

C. polcherrima contains the following substances:

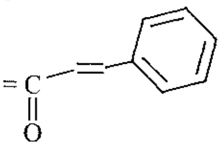
— Diterpenoids: The bark, and stem yield x-caesalpin (341) (Sengupta *et al.*, 1970) and pulcherralpin (342) a cassane-type diterpenoid (Che *et al.*, 1986) respective-

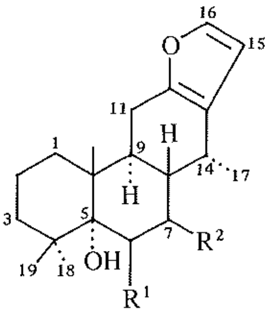


341 x-Caesalpin
(Sengupta *et al.*, 1970)

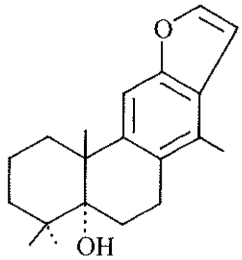


342 Pulcherralpin : R =
(Che *et al.*, 1986)



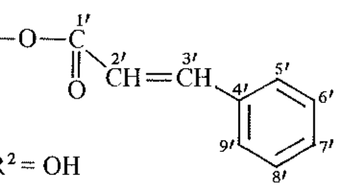


343 Vouacapen 5α-ol : $R^1 = R^2 = H$



345

344 : R^1 =



R^2 = OH

(McPherson *et al.*, 1986)

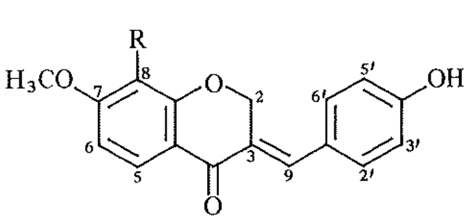
ly. The roots contain three furanoditerpenoids: vouacapen-5 α-ol (343), 6β-cinnamoyl-7-β-hydroxy-vouacapen-5 α-ol (344) and 8, 9, 11, 14-didehydrovouacapen-5 α-ol (345) (McPherson *et al.*, 1986).

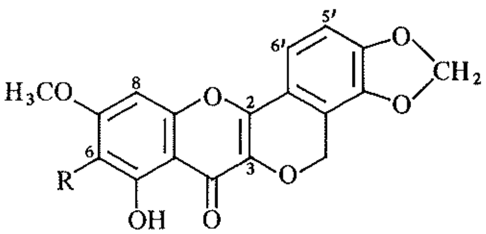
— Triterpenoids and steroids: The flowers contain β-sitosterol, lupeol and lupeol acetate (Rao and Prasad, 1978).

— Phenolic compounds:

1- Flavonoids: The leaves contain myricitrin 3-rhamnoside, myricitrin and myricetol (5,7,3′,4′,5′-pentahydroxyflavonol) (Paris and Delaveau, 1965, 1967). The flowers of the red-flowered variety contain quercetin and rutin, whereas the orange-yellow flowered variety contain quercetin and myricetin (Rao and Prasad, 1978). Two homoisoflavonoids: bonducellin (346) and 8-methoxybonducellin (347) occur in the stems (McPherson *et al.*, 1983).

2- Peltogynoids: The stems yield pulcherrimin (348) and 6-methoxypulcherrimin (349) (McPherson *et al.*, 1983).





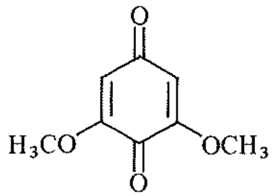
346 Bonducellin : R = H
347 8-Methoxy-bonducellin : R = OCH_3

348 Pulcherrimin : R = H
349 6-Methoxy-pulcherrimin : R = OCH_3

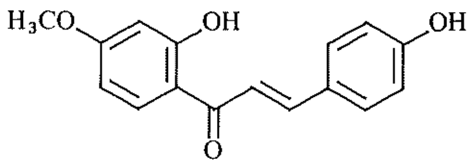
(McPherson *et al.*, 1983)

3- Tannins: Older plants (~ 1 year old) contain gallic acid, leucodelphinidin and a tannin B; young plants (3 months old) also contain gallic acid, leucodelphinidin, but a different tannin C. Tannins C and B have similar structures except that in the tannin B the reducing group of the glucose moiety is free, whereas in tannin C it is linked to a leucodelphinidin molecule. Tannin C is a novel type of ellagitannin incorporating in its structure both condensed as well as hydrolyzable tannin moieties (Awasthi and Misra, 1978; Awasthi *et al.*, 1980a). Both the two ellagitannins isolated from *C. pulcherrima* have a glucose esterified in one case with on hexahydroxydiphenoyl and 2 galloyl groups and in the other case with a galloyl, a hexahydroxydiphenoyl, and a *m*-digalloyl group (Awasthi *et al.*, 1980b). The bark also contains ellagic acid (Awasthi and Misra, 1976). Gallic acid also occurs in the flowers (Rao and Prasad, 1978).

4- The plant also contains 2, 6-dimethoxybenzoquinone (350) and 4′-methylisoliquiritigenin (351) (McPherson *et al.*, 1983).



350 2,6-Dimethoxybenzoquinone



351 4′-Methylisoliquiritigenin

(McPherson *et al.*, 1983)

— Galactomannan: The seeds of *C. pulcherrima* (*Poinciana pulcherrima*) contain a galactomannan which amounts to 34·4%. The gelling properties of which is similar to those of carob seed (Bains *et al.*, 1954; Morimoto *et al.*, 1962; Morimoto and Unrau, 1962; Unrau and Choy, 1970).

The green seed pods of *C. gilliesii* are severely irritant in the digestive tract, and cause nausea, vomiting and produce diarrhoea (Kingsbury, 1964). Poisoning after eating the pods has been reported (Watt and Breyer-Brandwijk, 1962).

In Libya the leaf is thought to be purgative. The thread of the stamen may be used as a saffron substitute. According to folklore, the stem has been used primarily as an abortifacient and emmenagogue (Quisimbing, 1951).

6 *DELONIX*

Other than *D. regia* (mentioned below in details), scanty information is available about the chemical constituents of this genus. The bark of *D. alata* contains β-amyrin, β-sitosterol glucoside, L-asparagine, aspartic acid and ν-methyleneglutamine (Subramanian *et al.*, 1966 Subramanian and Ramakrishnan, 1968; Hariharan, 1969). The flowers of the same species yield quercetin 3-*O*-rhamnoglucoside and quercetin 3-*O*-galactoside (Sethuraman *et al.*, 1984).

1 *Delonix regia* (Hook.) Raf.
(= *Poinciana regia* Bojor)
Common name: *Royal Poinciana*
Arabic name: *Poinciana*

The plant contains a galactomannan having a highly branched structure formed by a chain of mannose units linked β (1 → 4) to which single units of galactose are linked α (1 → 6) (Kapoor, 1972). The galactomannan acts as a nongelling thickening agent (Oliani and Bobbio, 1981).

The bark of *D. regia* contains leucocyanidin (Subramanian *et al.*, 1966), lupeol, β-sitosterol (Roy and Sengupta, 1968) and erythritol (Pant and Joshi, 1972).

The flowers contain anthoxanthin components (Pankajamani and Seshadri, 1955), hentriacontane, β-sitosterol and its β-glucoside, hentriacontanol, protocatechuic acid and quercetin (Gupta and Chandra, 1971). The petals contain twenty-nine carotenoids. The major pigments are phytoene, phytofluene, β-carotene, ν-carotene, lycopene isomers, rubixanthin, lutein, zeaxanthin and several epoxy carotenoids. The sepals contain eighteen carotenoids of which the major ones are phytoene, phytofluene, β-carotene, ν-carotene, lycopene isomers, lutein, zeaxanthin and carotenoid epoxides. Filaments contain twenty carotenoids: phytoene, β-carotene, ν-carotene, cryptoxanthin, lutein, zeaxanthin, antheraxanthin, violaxanthin, chrysanthemaxanthin, flavoxanthin and epoxy carotenoids. The highest concentrations of total carotenoids occur in anthers, 90% of which is zeaxanthin, the remainder β-carotene derivatives and traces of two unidentified compounds. Carotenoids identified in lesser quantities in the various segments of the plant include α-carotene, neo-β-carotene, a pigment X, ζ-carotene, δ-carotene, prolycopene, neolycopene, 5, 6-monoepoxy-β-carotene, mutatochrome, 5, 6-diepoxy-β-carotene, 5, 6-monoepoxylutein and six unidentified pigments (Jungalwala and Cama, 1962).

The red colour in *D. regia* flower is most probably due to copigmentation between anthocyanins and other flavonoids; the colour of the yellowish orange flowers is mostly attributed to an increase in the isosalipurposide concentration along with an increase in the background of the yellowish cytoplasmic carotenoids (Saleh and Ishak, 1976).

The fatty acids from the seed oil of *P. regia* are: palmitic, 0·42%; stearic, 16·63%; oleic, 31·42% and linoleic, 51·53% (Narayana- Murthy and Iyer, 1954). Patamapongse and Showler (1969) reported that the fatty acid composition of the oil seed of *D. regia* grown in Thailand differed from those grown in Egypt and India, probably owing to different mean ambient temperatures.

The seed of *D. regia* contains hydroxy-L-proline (Sung and Fowden, 1968). Floral parts and bud of the plant contain α-ketoglutaric acid, oxaloacetic acid, pyruvic acid and glyoxylic acid (Mukherjee, 1975).

The chemical composition of the seed is: moisture, 7·64%; ether extract (fat), 2·27%; protein, 17·87; crude fibre, 27·03; ash, 3·84 and carbohydrates, 50·00%. The essential amino acid content of the seed (g/100 gm protein) is: methionine, 0·65; cystine, 0·65; lysine, 5·55; isoleucine, 3·90; leucine, 7·56; phenylalanine, 4·84; valine, 5·10; threonine, 3·92 and tyrosine, 0·69 (Giral *et al.*, 1978).

Phytochemical screening of the plant revealed the presence of flavonoids and triterpenoids (and/or steroids) (Rizk *et al.*, 1988).

D. regia is a raw material for production of paper (Muliah, 1982). The bark has emetic and central nervous system depressant effect in cat and monkey (Pant and Joshi, 1972).

7 *LATHYRUS*

Several species of the genus *Lathyrus* are reported toxic to animals and/or man. Lathyrism, a disease which occurs in human beings results from the ingestion of *L. odoratus*. The main toxic principles are the osteolathyrogen β-amino-propionitrile (352) and its ν-glutamyl-β-aminopropionitrile identified from *L. odoratus* (Bell, 1971). The isolation and identification of other toxic factors form *Lathyrus* species have been reported. The neurotoxic compound α, γ-diaminobutyric acid was identified in seeds of twelve species of *Lathyrus* in concentrations of approximately 1% dry weight (Bell, 1962a). β(γ-Glutamylamino) propionitrile has been identified in seeds of *L. hirsutus* and *L. roseus* (Bell, 1962b). γ-L-Glutamyl-L-lathyrine occurs in the seeds of *L. japonicus* (Hatanaka and Kaneko, 1978). A natural occurring guanidino amino acid, homoarginine, has been detected in thirty-six species of *Lathyrus* (Bell, 1962b). This amino acid is sometimes associated with another new amino acids e.g. α-amino β-oxalylaminopropionic acid (Rao *et al.*, 1964) and the isomeric α-oxalylamino-β-aminopropionic acid (Bell, 1971). While the majority of *Lathyrus* species which have been analysed contain high concentrations of homoarginine or lathyrine in their seeds, a small number are characterized by the presence of α, γ-diaminobutyric acid. This lower homologue of ornithine was not known to occur naturally until it was isolated from seeds of *L. latifolius* by Ressler *et al.*, (1961) who showed it to be toxic to rats. Another uncommon amino acid found in *Lathyrus* is γ-methylglutamic acid which has been identified in *L. aphaca* and *L. maritimus* (Bell, 1971). γ-Hydroxyhomoarginine and its lactone occur in the seeds of *L. tingitanus* (Bell, 1963, 1964).

Lathyrus species also contain many phenolic constituents. Quercetin, kaempferol, caffeic acid and ferulic acid have been detected in the hydrolyzed extracts of leaves of twenty-eight *Lathyrus* species (Peckett 1959a, b). *L. pratensis* contains, in addition to these compounds 3′,4′,5,5′,7-pentahydroxyflavone monoglucoside (Malcher and Lamer, 1967), luteolin, luteolin 4′-β-monoglucoside, luteolin 7-monoglucoside, quercetin 3-monoglucoside and myricetin glycoside (Malcher and Bodalski, 1969). The leaves of *Lathyrus* species also contain sinapic acid, cyanidin and delphinidin (Brunsberg, 1965). Glycosides of delphinidin, petunidin and malvidin occur in the flowers (Pecket, 1959b).

Lathyrus species, though known to be poisonous (particularly the pea), yet the whole plant of certain species (e.g. *L. sativus*, *L. cicer*, *L. clymenus*) as well as the pea is used in several countries as fodder for cattle, horse and other stock. *L. sativus* even is edible by human beings and lathyrism has been observed in persons who had consumed 40% of lathyrus meal in their cereal intake (Watt and Breyer-Brandwijk, 1962).

1 *Lathyrus odoratus* L.
Common name: *Sweet pea*
Arabic name: *Bisillat zohoor*

The seeds contain the toxins β-aminopropionitrile (352) and its γ-glutamyl derivative (353) (Schilling and Strong, 1954, 1955). The seeds of *L. odoratus* are the first natural source of γ-hydroxynorvaline (354) (Fowden, 1966). Other uncommon amino acids isolated from *L. odoratus* are homoargine and lathyrine (355) from seeds (Bell, 1971), α-amino-γ-(isoxazolin-5-one-2-yl) butyric acid, 2-aminoethyl-isoxazolin-5-one and the γ-glutamyl derivative of the latter from the seedlings (Lambien and Van Parijs, 1974) and several isoxazolin-5-one derivatives, uracil, alanines, L-γ-glutamyl-D-alanine and α-aminoadipic acid from the root exudate (Kuo *et al.*, 1982).

Three kinds of lectin occur in the seeds. The amino acids of the three fractions are very similar. They contain large amounts of aspartic acid, threonine, serine and valine, but

$NC.CH_2.CH_2.NH_2$

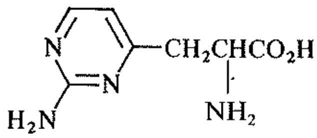
352 β-Aminopropionitrile

$NC.CH_2.CH_2.NH.OC.CH_2.CH_2.CH(NH_2).CO_2H$

353 γ-Glutamyl-β-aminopropionitrile

$CH_3.CH(OH).CH_2.CH(NH_2).CO_2H$

354 γ-Hydroxynorvaline



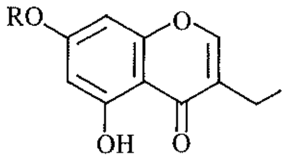
355 Lathyrine

(Bell, 1971)

no cysteine or methionine (Sakakibara *et al.*, 1979). The lectins of *L. odoratus* precipitate human normal serum glycoproteins (Pere *et al.*, 1978).

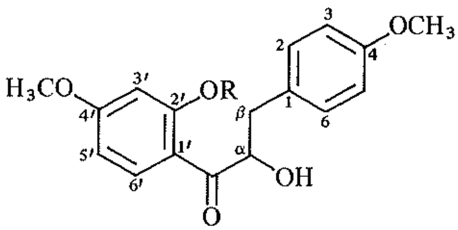
Ninteen anthocyanins and three flavonol glycosides have been identified from three varieties of *L. odoratus*: in Air Warden variety, pelargonidin 3-rhamnoside, -5-glucoside-3-rhamnoside, -3-glucoside, -3-xylosylglucoside, and -3,5-diglucoside and kaempferol 3-rhamnoside; in Harrow variety, cyanidin and peonidin3-rhamnoside, -5-glucoside-3-rhamnoside, -3-glucoside, and -3-xylosylglucoside, peonidin 3,5-diglucoside and kaempferol and quercetin 3-rhamnoside; and in Jupiter variety delphinidin and petunidin 3-rhamnoside, delphinidin, petunidin, and malvidin 5- glucoside-3-rhamnoside, and kaempferol, quercetin and myricetin 3-rhamnoside (Harborne 1960). The ratio of anthocyanins in the standard petals compared with the wing petals if 4; that of the flavonol glucoside is 1/6 (Pecket, 1966). The flowers contain 3,7-dirhamnoside and two other 3,7 glycosides of kaempferol (Harborne, 1962). The petals contain also kaempferol-7-rhamnoside-3-lathyroside (Harborne, 1965). *L. odoratus* also contains bornesitol (Plouvier, 1958), allantoin and arbutin (a phenolic glucoside) amounting to 1·74% in the aerial parts (Constantinescu *et al.*, 1965).

A major phytoalexin was isolated from the leaflets and pods of *L. odoratus* which had been inoculated with the fungus *Helminthosporium carbonum* and was identified as lathodoratin (356). Small amounts of 7-*O*-methyl ether of lathodoratin (357) was also



356 Lathodoratin : R = H
357 : R = CH_3

(Robeson *et al.*, 1980)



358 Odoratol : R = H
359 Methylodoratol : R = CH_3

(Fuchs *et al.*, 1984)

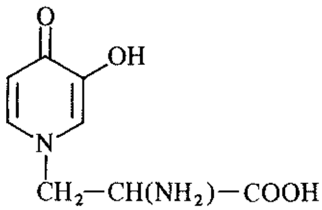
detected (Robeson *et al.*, 1980). A number of fungitoxic metabolities, among which are two α-hydroxychalcones (odoratol, 358) and methylodoratol, 359) have been isolated from cotyledons and pods treated with mercuric acetate or infected with *Phytophthora megasperma* (Fuch *et al.*, 1984).

The seeds are good source of vitamin A. Ingestion of the seeds, however, causes lathyrism (Geiger *et al.*, 1933; Vivanco and Diaz, 1951).

8 *LEUCAENA*

Of all tropical legumes leucaena (common name of *Leucaena leucocephala*) probably offers the widest assortment of uses. Through its many varieties, leucaena can produce nutritious forage, firewood, timber and rich organic fertilizer. Its diverse uses include revegetating tropical hillslops and providining windbreaks, firebreaks, shade and ornamentation (Leucaena, NAS, 1977).

L. leucocephala contains tannins (James *et al.*, 1977), galactomannan polysaccharide (McCleary *et al.*, 1982) and mimosine (360), an alpha amino acid which has injurious effects (Hathcock and Labadan, 1975). Mimoside, the major metabolic product of mimosine was also isolated from 4-or-5-days seedlings of *L. leucocephala* (Murakoshi *et al.*, 1971).



360 Mimosine
(NAS, 1977)

1 *Leucaena glauca* Benth.
Common name: *(Koa haole, ipil-ipil, lead) tree*
Arabic name: —

The plant possesses a high value as a source of forage protein for livestock (Henke, 1943; Henke *et al.*, 1942). The plant contains crude protein, 15·79–21·4%; fat, 2·09–2·28%; carbohydrates, 45%; crude fibre, 22–37·73% and ash, 6·64–8·26% (Arnold, 1934; Henke *et al.*, 1942; Damseaux, 1956). The seeds contain 30% protein (Liu *et al.*, 1956). However, the plant is also reported as poisonous plant (Kingsbury, 1964). The toxic principle is mimosine (Cheng *et al.*, 1959; Hegarty *et al.*, 1964), previously named leucenine and leucenol (Bickel and Wibaut, 1946, Bickel, 1947, 1948; Wibant and Schuhmacher, 1952). Swollen thyroids (goiters) are common among cattle feeding on leucaena. The cause is 3,4-dihydroxypyridine created in the animal rumens by bacteria that produce it by chemical transforming the amino acid mimosine. *L. glauca* contains approximately 2% leucenol (Mascré, 1937). Leaves of Phillippine varieties contain 4·4-7·5% mimosine; young leaves and pods contain as much as mature parts (Carañgal and Catindig, 1955). The seeds were reported to contain 1·2% mimosine (Lin and Lin, 1961).

The leaves and seeds of *L. glauca* contain 3·38% glutamic acid (Manzanilla and Carangal, Jr., 1961), and ferroxidin (a polypeptide, which contains 96 amino acid residues with sequence heterogenity occurring in positions 6, 12, 33 and 96) (Benson and Yasunobu, 1969a,b). The crude protein of *L. glauca* contains aspartic acid, 6·22%; arginine, 6·71; cysteine, 0·55; glycine, 7·19; histidine, 2·18; isoleucine, 5·83; leucine, 7·75; lysine, 5·18; methionine, 0·75; phenylalanine, 4·50; proline, 5·88, serine, 5·70; threonine, 4·65; tryptophan, 0·66; tyrosine, 3·56 and valine, 5·19 (Damseaux, 1956). The leaves also contain 5-hydroxy-2-piperidine carboxylic acid and a high concentration of pipecolic acid (Hegarty, 1957). The seeds contain 5-hydroxypipecolic acid (Lin and Lin, 1960).

The carotene content of leaves of *L. glauca* averaged 17,528 on 9-month old plant and 24,0·58 ν/100 gm in samples taken one month later (Ylagan and Sanchez, 1957).

The seeds have been early reported to contain mucilage which consists of mannans, galactans and xylans (Mascré and Ottenwaelder, 1941). Later, the polysaccharide of the seeds has been identified as galactomannoglycan (24–25%) (Unrau, 1961). The seeds also contain 5–6% oil, β-sitosterol (Mascré and Ottenwaelder, 1941; Farooq and Siddiqui, 1954, υ-sitosterol (Mitsuhashi *et al.*, 1972) and the tetrasaccharide stachyose (Hérissey and Mascré, 1941). The fatty acids of the seed oil are palmitic, 20·7%; palmitoleic, 0·1%; stearic, 11·8%; linoleic, 65·0%; linolenic, 1·4% and arachidic, 1·0% (Mitsuhashi *et al.*, 1972).

The leaves yield 0·08% quercitrin (Tominaga, 1949); while the flowers contain quercetagetin, patuletin, quercetin and quercetin 3-galactoside (Nair and Subramanian, 1962; Ranganthan and Nagarajan, 1980). The bark contains 16·31% tannins (Ch'in and Wang, 1947). D-Ononitol (a cyclitol) has been identified from the plant (Plouvier, 1962).

9 *PARKINSONIA*

1 *Parkinsonia aculeata* L.
Common name: *Jerusalem thorn*
Arabic name: *Parkinsonia*

The leaves and flowers contain several *C*-glycosylflavones. The flowers contain epi-orientin, parkinosin A (5-*O*-methylorientin) and parkinosin B (5, 7-di-*O*-methylorientin) (Bhatia *et al.*, 1965; Bhatia and Seshadri, 1967). The leaves contain orientin (early identified as epiorientin), isoorientin (previously named parkinosin-A), vitexin and isovitexin (previously named parkinosin-B) (Bhatia *et al.*, 1966; Besson *et al.*, 1980).

The aerial parts of the plant contain choline, β-amyrone, β-armyrin, β-amyrin acetate, β-sitosterol and β-sitosterol-β-D-glucoside (Rao *et al.*, 1979a). The seeds contain the unusual, non-protein amino acids 3-hydroxyproline and azetidine -2-carboxylic acid (Watson and Fowden, 1973) and are rich in the essential amino acids (Jaiswal *et al.*, 1984b). Hemicelluloses, celluloses and lignin constitute about 73% of the pods (Greene, 1932).

The seed contains 1·65–1·7% oil and 18·1% protein (Grindley, 1946; Hashmi *et al.*, 1985). The fatty acids of the seed oil are palmitic, 16·5; stearic, 2·3; oleic, 19·7; linoleic, 4·51 and linolenic, 12·9% (Hashmi *et al.* 1985).

The crude extract of *P. aculeata* possesses cholinomimetric activity (due to the choline content) and depressant activity of the central nervous system (due to the β-sitorterolβ-D-glucoside) (Rao *et al.*, 1979). The plant contains nitrates at a potentially toxic level (Kingsbury, 1964).

P. aculeata is used in paper industry. The leaf, flower and seed have been used as a remedy for fever and as an antiseptic (Watt and Breyer-Brandwijk, 1962).

10 *PITHECELLOBIUM*

Triterpenoids (free or as glycosides) occur in certain *Pithecllobium* species. The beans of *P. saman* contain samanin B, a sponin containing glucose, arabinose, xylose and rhamnose in a molar ratio of 4:2:1:1 attached to *C*-3, *C*-16 and *C*-21 of acacic acid (Varshney and Vyas, 1977). The roots of *P. multiflorum* yield lupeol and α-spinasterol (Gunasekera *et al.*, 1982). A triterpenoid containing an amino sugar moiety has been isolated from *P. cubense* and *P. arboreum* and identified as *O*(3)-(2-acetylamino-2-deoxy-β-D- glucopyranosyl)-oleanolic acid (Ripperger *et al.*, 1981). Glucopyranosyl-α-spinasterol occurs in *P. cubense* (Ripperger *et al.*, 1981). The bark of *P. pedicellare* contains 15·4% catechol tannins (Baslac *et al.*, 1931). The pods of *P. saman* are a good source of proteins, carbohydrates, and minerals and perhaps equal good-quality hay in nutritive value (Bhalerao and Dastur, 1946).

1 *Pithecellobium dulce* Benth.
Common name: *Gaumochil, huamuchil, opiuma*
Arabic name: —

The seeds contain mannans, 25·10%; crude fibre, 22·16%; protein, 17·12%; pentosans, 9·60%; fat, 8·12% and reducing sugars, 22·7%. Fresh seeds were reported to contain 29·89% protein, 17·69% fat and 28·40% carbohydrates (Padilla and Soliven, 1933). The plant has high phenylalanine + tyrosine and leucine contents (Perez-Gil *et al.*, 1983). The fresh pulp (of the pod) contains protein, 2·3%; fat, 0·5%; crude fibre, 1·1%; ash, 0·7% and carbohydrates, 19·6% (Gamo and Cruz, 1957). The component fatty acids of *P. dulce* seed fat are as follows: oleic, 47·3%; linoleic, 21·7%; palmitic, 7·2%; stearic, 7·1%; behenic, 6·9%; lignoceric, 6·2%, linolenic, 1·7% and arachidic, 1·4% (Nigam and Mitra, 1971). The seed saponin consists chiefly of 3β-xylose-arabinose glucosides of oleanolic acid and echinocystic acid with the sugar moiety in the sequence of xylose, arabinose and glucose (Nigam and Mitra, 1969). The presence of other sapogenins has been also reported *viz.* pithogenin (Nigam *et al.*, 1963) and proceric acid (Langenheim, 1981).

α-Spinasterol and/or its β-D-glucoside occur in the seed (Nigam and Mitra, 1971), leaves (Nigam *et al.*, 1969), trunk bark (Nigam and Mitra, 1967) and flowers (Nigam and Mitra, 1968). The heartwood and root bark contain β-sitosterol, campesterol, stigmasterol and α-spinasterol (Nigam and Mitra, 1968). The seeds contain 20% fat, similar to leguminous fats in general and containing 0·7% pure lecithin and the mesocarp yields hexacosanol (Nigam *et al.*, 1963). The trunk bark contains also xanthophyls, lupenone, lupeol and hexacosanol (Nigam and Mitra, 1967). Xanthophyls, hexacosanol and hexacosane occur in the flowers (Nigam and Mitra, 1968).

Flavonoids have been identified from the different plant parts. The seed contains kaempferol, quercetin and kaempferol 3-rhamnoside (Nigam and Mitra, 1969). The flowers and the heartwood contain kaempferol and quercetin glucosides (Nigam and Mitra, 1968).

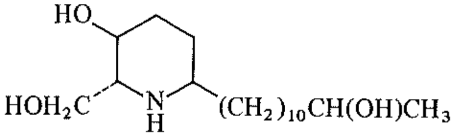
The trunk bark contains tannins (21–25·2%) (Varma *et al.*, 1956; Nigam and Mitra, 1967). A stereoisomeric leucofisetinidin, 3′, 4′, 7-trihydroxyflavan-3, 4-diol has been identified from the heartwood (Rajadurai, 1963; Rayudu and Rajadurai, 1965). Sole-leather tannage using *P. dulce* bark has been reported (Varma *et al.*, 1958).

Saponins from *P. dulce* have antiinflammatory activity (Bhargava *et al.*, 1970).

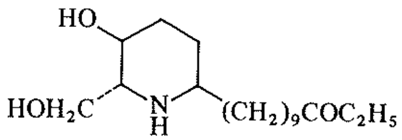
11 *PROSOPIS*

Prosopis species are characterized by the presence of alkaloids, gums and phenolic compounds. Alkaloids (mainly of the piperidine type) have been identified from the different parts of the plants; examples of identified alkaloids are shown below:

- *P. africana* (leaves): prosopine (361), prosopinine (362); prosophylline, prosafrine, prosafrinine; (roots and stems): isoprosopinine A and isoprosopinine B (Qui *et al.*, 1972a, b).
- *P. alba* (leaves): tyramine, β-phenethylamine and tryptamine (Graziano *et al.*, 1971).
- *P. alpataco* (bark): cassine, *N*-methylcassine and eleagnine (Chiale *et al.*, 1982).
- *P. glandulosa* (leaves): Julifloridine (Ahmad *et al.*, 1979) and julioprosopine (Usmanghani *et al.*, 1982).
- *P. nigra* (bark): *N*-methylcassine (Gianinetto *et al.*, 1980).
- *P. ruscifolia* (leaves): vinaline (Cercós, 1951); (bark): cassine, *N*-methylcassine and eleagnine (Gianinetto *et al.*, 1980; Chiale *et al.*, 1982).
- *P. sericantha* (bark): cassine, *N*-methylcassine and eleagnine (Chiale *et al.*, 1982).
- *P. spicigera*: spicigerine (363) (Jewers, 1974).
- *P. vinalillo* (bark): *N*-methylcassine (Gianinetto *et al.*, 1980).

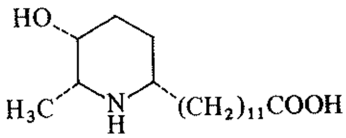


361 Prosopine



362 Prosopinine

(Qui *et al.*, 1972a)

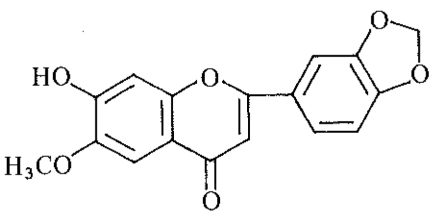


363 Spicigerine

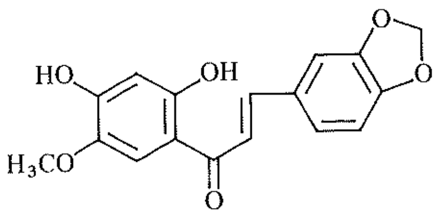
(Jewers *et al.*, 1974)

Several flavonoids (including both *O*-and *C*-glycosides) have been identified from *Prosopis* species. Examples of these are:

— *P. chilensis*: quercetin 3-methyl ether (Gitelli *et al.*, 1981).
— *P. flexuosa*: luteolin 7-glucoside and isorhamnetin 3-rutinoside (Gitelli *et al.*, 1981).
— *P. kuntzei*: vitexin, isovitexin and rutin (Gitelli *et al.*, 1981).
— *P. spicigera*: luteolin, patuletin, patulitrin, rutin, prosogerins A (364), B (365), D (366) and E (367) (Bhardwaj, 1979, 1980b, 1981).
— *P. stephaniana*: rutin (Shalaby *et al.*, 1976).
— *P. strombulifera*: luteolin, luteolin 7-glucoside, vitexin, isovitexin, rutin, quercitrin and rhamnosylvitexin (Gitelli *et al.*, 1981).

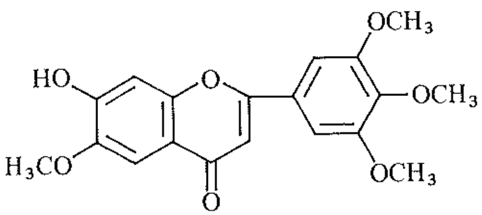


364 Prosogerin A



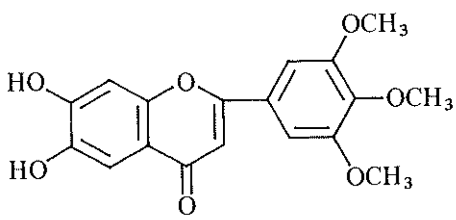
365 Prosogerin B

(Bhardwaj *et al.*, 1979)



366 Prosogerin D

(Bhardwaj *et al.*, 1980)

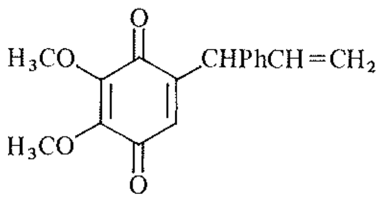


367 Prosogerin E

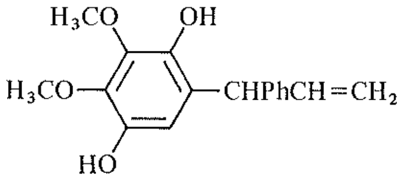
(Bhardwaj *et al.*, 1981)

— *P. torquata*: vitexin, isovitexin and rutin (Gitelli *et al.*, 1981).
— *P. vinalillo*: luteolin, vitexin and isovitexin (Gitelli *et al.*, 1981).

The heartwood of *P. kuntzei* contains 3, 4-dimethoxydalbergione (368) and its related quinol (369) (Yoshimoto *et al.*, 1975). *P. stephaniana* contains tannins of gallotannin nature with a percentage of 18·55 (Shalaby *et al.*, 1976).



368 3,4-Dimethoxydalbergione



369

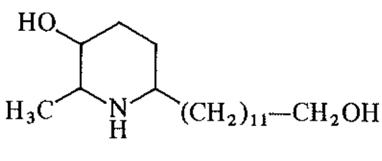
(Yoshimoto *et al.*, 1975)

The polysaccharide components of the gums from several *Prosopis* species have been studied. Mesquite gum consists of arabinose, galactose and methoxyglucruonic acid (e.g. Anderson and Otis, 1930; White, 1947). The chemical differences between the polysaccharide components of the gum from seven *Prosopis* species have been reported by Anderson and Fraquhar (1982). *Prosopis* species give gum exudates that contain amino acids. The exudates do not differ greatly in terms of their amino acid compositions; the largest variations occur in their proportions of alanine, glutamic acid, proline and hydroxyproline (Anderson *et al.*, 1985).

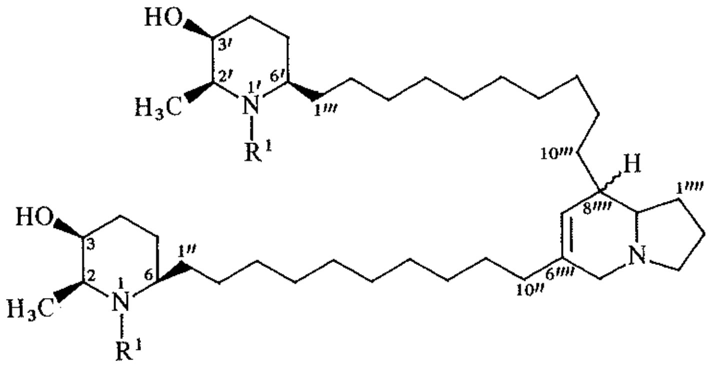
Oleanolic acid, ursolic acid, a series of the higher aliphatic alcohols, glycosides of campesterol, stigmasterol, and β-sitosterol, and D-(+)-pinitol have been identified from the stems of *P. glandulosa* (Zirvi *et al.*, 1977). Prosopol, isolated from the same species has been later identified as triacontanol (Abbas and Mison, 1983).

1 *Prosopis juliflora* DC.
Common name: *Mesquite tree*
Arabic name: *Ghaf*
The plant contains the following compounds:

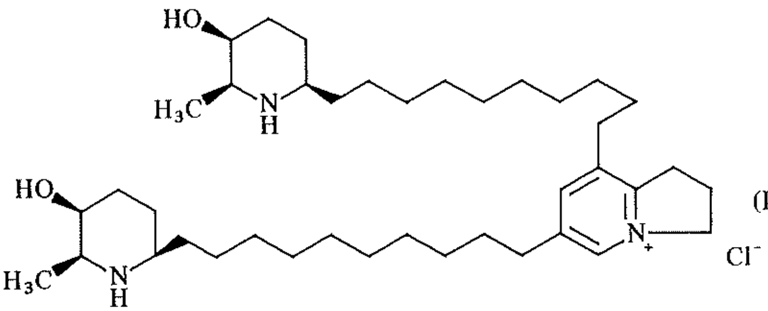
— Alkaloids: The leaves contain juliflorine, julifloricine, julifloridine (370) (Ahmed *et al.*, 1978), juliprospine (371) (Otto-Longoni *et al.*, 1980) and juliprosine (372) (Daetwyler *et al.*, 1981).



370 Julifloridine
(Ahmad *et al.*, 1978)

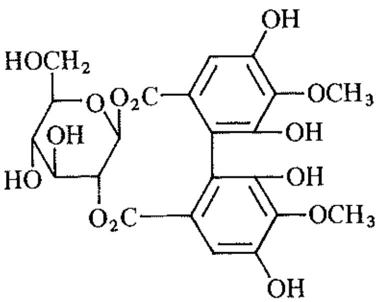


371 Juliprospine
(Otto-Longoni *et al.*, 1980)



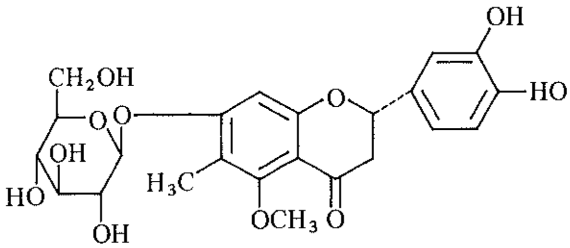
372 Juliprosine
(Daetwyler *et al.*, 1981)

— Tannins: The heartwood contains 5·1%, root wood, 1·74%; root bark, 1·04%; stem bark, 0·6%; sap wood, 0·28%; and leaves, 0·05% (Theresa *et al.*, 1977). The roots yield a novel tannin identified as glucose 1,3-diester of 3,3′, 5,5′-tetrahydroxy 4,4′, -dimethoxy diphenic acid (373) (Malhotra and Misra, 1981a, 1983a).

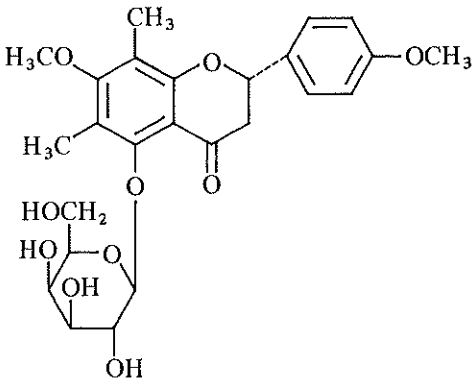


373 (Malhotra and Misra, 1981a)

— Flavonoids: Ombuin (5,3′-dihydroxy-7,4′-dimethoxyflavonol (Vajpeyi and Misra, 1981), kaempferol 4′-methyl ether 3-*O*-*β*-D-galactopyranoside and retusin 7-*O*-neohesperidoside (Vajpeyi *et al.*, 1981) from the stem bark and 3′,4-dihydroxy 5-methoxy-6-methylflavanone 7-*O*-*β*-D-glucopyranoside (374), 7,4′-dimethoxy-6,8-dimethylflavanone 5-*O*-*β*-D-galactopyranoside (375) (Malhotra and Misra, 1983b) from the roots and patulitrin from the pods (Wassel *et al.*, 1972).



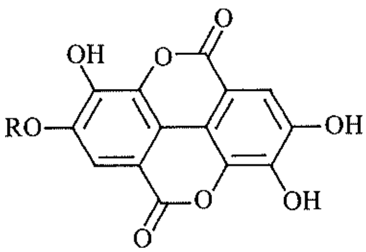
374

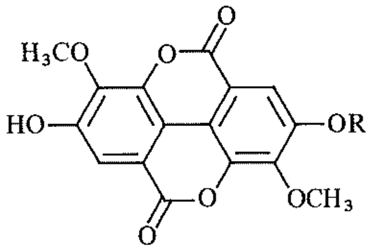


(Malhotra and Misra, 1983b)

375

— Ellagic acid glucosides: Ellagic acid 4-*O*-*α*-L-rhamnosylgentiobioside (376) (Malhotra and Misra, 1981b) and ellagic acid 4-*O*-rutinoside (Malhotra and Misra, 1981d) from the pods and 3, 3′-di-*O*-methylellagic acid 4-*O*-rhamnoside (377) form the roots (Malhotra and Misra, 1981c).





376 R = Rhamnosylgentiosyl
(Malhotra and Misra, 1981b)

377 R = *α*-L-Rhamnopyranosyl
(Malhotra and Misra, 1981c)

— Leucoanthocyanins: leucodelphinidin 3-*O*-*α*-L-rhamnopyranoside and leucodelphidin 3-*O*-*β*-D-glucopyranosyl-(1 → 4)-*O*-*α*-rhamnopyranoside (Shukla *et al.*, 1980).

— Polystyrenes: The seeds contain two polystyrenes with molecular weights 5725 (m.p. 155°C) and 12,580 (m.p. 209–210°C) (Pant and Bishnoi, 1982).

— Hexacosan-25-one-1-ol (keto alcohol), and a triterpenoid glycoside from the stem bark (Vajpeyi and Misra, 1981) and procyanidin from the root (Malhotra, and Misra, 1981c).

The plant is cyanogenetic (Hegnauer, 1958). It contains a gum which yields L-arabinose on hydrolysis (Belani, 1934). Glucose and sucrose occur as free sugars in the fruits (Wassel *et al.*, 1972).

The chemical composition of the seed is: moisture, 1·32%; ether extract (fat), 2·08%; protein, 13·45%; crude fibre, 27·50%; ash, 3·63% and carbohydrates, 53·34%. The essential amino acid content of the seed protein (g/100 gm of protein) is: methionine, 0·92; cystine, 0·69; lysine, 2·99; isoleucine, 2·03; leucine, 3·93; phenylalanine, 2·34; valine, 2·85; threonine 2·16 and tryptophan 1·2% (Giral *et al.*, 1978). Kernels contain 38% protein, 3% fat and 9% crude fibers (Del Valle *et al.*, 1983). The protein hydrolysate from leaves is rich in essential amino acids, but contains less amounts of tyrosine and histidine and lacks S-containing amino acids (Sankhla and Sankhla, 1979).

The ripe pods are used as a food in Brazil and Northern Nigeria (Wassel *et al.*, 1972). Though *P. julifolia* is a feed for cattle, yet ingestion of large amounts causes toxicity and even death of the stock. Indians of the Southwest America relied heavily upon the pods. The ripe pods are still used by famished desert travelers. The pulpy, sweet substance, contained in the pods (rich in grape sugar, 30%) is eaten fresh or dried, ground and pounded into bread and cakes which are backed in the intense sun. The seeds are highly valued, like the pods and are ground into a meal and prepared as such or porridge. To relieve thirst and to drew some immediate sustenance from their limited environment, the desert deweller chewe on the ripe pods, sweet pods in emergencies (Weiner, 1972).

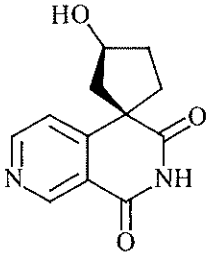
The tiny, pale yellow flowers are eaten and a delicious honey is still prepared from them. In Hawaii, up to two hundred tons of this honey were, until recently, produced and exported annually. The inner bark contains much tannins and has been successfully utilized as a medical tea to arrest diarrhoea (Weiner, 1972).

In the U.S.A., mesquite gum is obtained from *Prosopis juliflora*. The flowers are a source of honey, and the pods, and ground leaves as well, are an important stock feed. It has been estimated that one acre of the plant produces 1600 lb of beef, while one acre of corn or alfalfa produces only 450 lb (Hill, 1952).

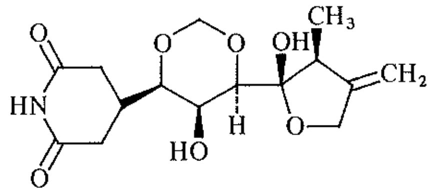
The tree grows very rapidly, is drought-resistant, and can utilize arid, barren ground, where no other crop will grow (Hill, 1952).

12 *SESBANIA*

Galactomannan polysaccharides have been isolated from the seeds of several species e.g. *S. aclueata* (Farooqi and Sharma, 1972), *S. aegyptiaca* (Bhattacharyya *et al.*, 1983), *S. cannabina* (Pecking Inst. Bot., 1978) and *S. speciosa* (Rao *et al.*, 1980. *S. drummondii* contains alkaloids which possess antitumour and antileukemic activities e.g. sesbanine (378) and sesbanimide (379) (Powell *et al.*, 1979, 1980; Powell, 1980; Powell and Smith, 1981). The seeds of *S. speciosa* contain saponins which yield on hydrolysis β-sitostanol and oleanolic acid (Varshney and Shamsuddin, 1964). Saponins which possess antitumour activity have been identified from seeds of several species e.g. *S. drummondii*, *S. punicea* and *S. vesicaria* (Powell *et al.*, 1976).



378 Sesbanine
(Powell *et al.*, 1979)



379 Sesbanimide
(Powell *et al.*, 1983)

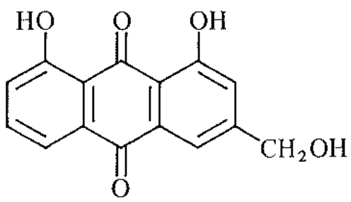
1 *Sesbania sesban*
Common name:—
Arabic name: *Sesaban*

Cyanidin, delphinidin and gallic acid have been identified from the flowers of *S. sesban* (Jain, 1964).

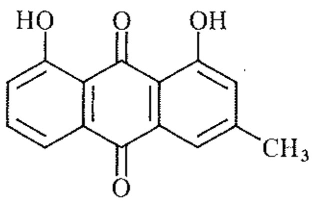
The production of pulp from several *Sesbania* species has been reported e.g. *S. aculeata* (Pai *et al.*, 1971), *S. paludosa* and *S. sesban* (Manavalan *et al.*, 1979).

XXV LILIACEAE

Plants of the family Liliaceae are widely used as medicines. Their medical value has been attributed to various constituents *viz.* alkaloids as colchicine in *Colchicum* species, anthraquinones in *Aloe* species. Anthraquinones (e.g. aloe-emodin, 380; chrysophanol, 381) and bianthraquinones have been isolated from several genera viz. *Aloe*, *Asphodeline*, *Asphodelus*, *Bulbine*, *Kniphofia* etc. (Rizk *et al.*, 1972; Hammouda *et al.*, 1977; Dagne and Steglich, 1984). Naphthaquinones were isolated from certain genera of the family and in particular *Dianella* (Thomson, 1971; Colgate *et al.*, 1986). Examples of the identified naphthaquinones in the family are dianellidin (382), dianallinone (2,2′-binaphtho-1,4 quinone, 383), stypandrone (384) and trianellinone (385, triquinone).

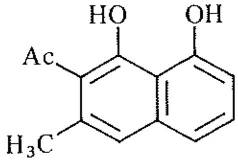


380 Aloe-emodin

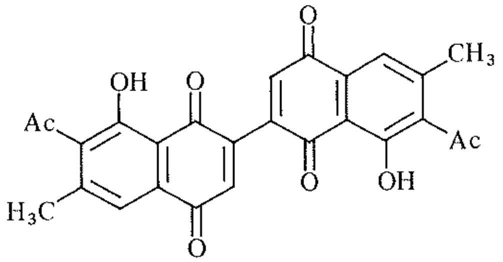


381 Chrysophanol

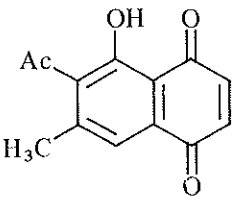
(Thomson, 1971)



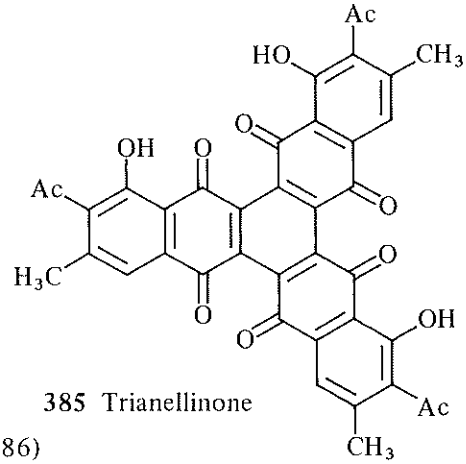
382 Dainellidin



383 Dianellinone



384 Stypandrone



385 Trianellinone

(Colgate *et al.*, 1986)

Tropolone alkaloids e.g. colchicine, 2-demthylcolchicine, 3-demethylcolchicine, demecoline, and cornigerine constitute the major secondary metabolites of many of the plants of this family e.g. *Androcymbium melanthoides* (Potesilova *et al.*, 1985), *Burchardia* species (Potesilova *et al.*, 1987), *Colchicum* species (Boit, 1961; Kaul *et al.*, 1964), *Schelhammera pedunculata* (Fitzgerald *et al.*, 1969; Jones *et al.*, 1969) and others (Kaul *et al.*, 1964). Solandine, solasodine, tomatidenol, hapepunine and other steroidal alkaloids were isolated from certain species e.g. *Fritilaria camtschatensis* (Kaneko *et al.*, 1981a,b) and *Veratrum* species (Gaffield *et al.*, 1982).

Flavonoids (e.g. quercetin, luteolin, kaempferol, tricin and isorhamnetin glycosides) were identified in several species (Skrzypczakowa, 1967; Elbanowska *et al.*, 1973; Williams, 1975). In a leaf survey of 168 species of the Liliaceae, most of the major flavonoid classes were represented in the family. Flavonols occured most frequently; quercetin and kaempferol were detected in 40% and 42% of the sample respectively, whereas the flavones luteolin and apigenin were present in only 24% and 20% of the sample. Methylated derivatives i.e. isorhamnetin, diosmetin and tricin were rare. Procyanidins were present in seventeen species, flavonoid sulphates in only one species and flavone *C*-glycosides in only three species. On the basis of the flavonoid survey, the subfamilies of the Liliaceae may be grouped into those containing flavonoids only, those with flavones only, or those having flavonols and flavones. A malonated anthocyanin (delphinidin 3-(6-*p*-coumarylglucoside)-5-(6-malonylglucoside)) has been recognized in members of the Liliaceae and in particular the bluebell, *Hyacinthoides non-scripta* (Takeda *et al.*, 1986), a plant previously reported as containing delphinidin-3-*p*-coumarylglucoside-5-glucoside (Harborne, 1967).

Hydroxy-, methoxy- and methylenedioxy derivatives of benzoic and cinnamic acids have been identified from several parts of the subfamily Wurmbaeoideae (Potesilova *et al.*, 1976).

Water-soluble polysaccharides were present in tubers, bulbs and roots of several species of the family Liliaceae, in amounts ranging from 0·6 to 10·7% (Rakhimov *et al.*, 1980).

1 *ALOE*

Aloesin (formerly aloeresin B), aloeresin A, aloeresin C and aloeresin D (*C*-glucosylated 5-methylated chromones) were isolated from several *Aloe* species (McCarthy and Haynes, 1967; Haynes *et al.*, 1970; Holdsorth, 1971; Speranza *et al.*, 1985, 1986). Aloesin was found in twenty-two (and probably twenty-three) of the fifty-five *Aloe* species studied by McCarthy and Haynes (1967). The very bitter, yellow latex which drains from the subepidermal, longitudinal cell of cut aloe leaves contains anthraquinone glycosides which are collectively termed "aloin".

Aloe species are known to contain anthraquinones. Aloe-emodin (380) as the name indicates is present in aloes where it occurs predominantly as aloin. In addition, a number of anthracene derivatives, either as free aglycones or in a glucosidal linkage were detected in *Aloe* species (e.g. chrysophanol, homonataloin, barbaloin, and asphodelin) (van Rheede van Oudtshoorn and Gerritsma, 1965; McCarthy and Price, 1966; Thomson, 1971; Hammouda *et al.*, 1977).

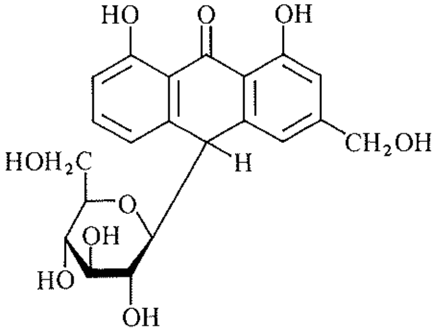
In a survey of slightly more than 100 *Aloe* species examined by McCarthy (1969), aloin and homonataloin appear in nearly half and in approximately equal proportions; and aloesin appears in 25%.

Of more than 300 Aloe species, only few have been of importance in pharmaceutical industry. The three leading species are *A. ferox* Mill., Cape aloe; *A. perryi* Baker, Secotrina or Zanzibar aloe (often confused with *A. succortina* Lam. of the Cape Peninsula and adjacent mainland of South Africa); and *A. barbadensis* Mill. (syn. *A. vera* Tourn. ex Linn.), Mediterranean, curacao or Barbados aloe (Morton, 1977).

The hemlock alkaloids ν-coniceine was identified in a number of *Aloe* species. The levels of ν-coniceine are higher than those found in *Conium maculatum* (Dring *et al.*, 1984). Some species also contain conhydrinone and pseudoconhydrine.

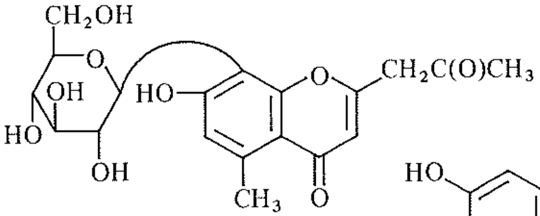
1 *Aloe barbandensis* Mill.
Common name: *Barbadose Aloe*
Arabic name: *Sabbar, Sabre, Sobbair*

The aloin content of Mediterranean *Aloe* (*A. barbadensis*) is around 30%. The amounts of reducing and non-reducing sugars, gums and resins in aloin of *A. barbadensis* growing in India have been reported by Mahabale and Kamble (1978). Aloin consists mainly of the pentosides barbaloin (386), isobarbaloin (in *A. barbadensis*), and *β*-barbaloin,resins, saponins and other substances. Barbaloin on hydrolysis yields a mixture in which aloe-emodin and D-arabinose have been identified (Morton, 1977). The plant also contains (in addition to aloin) aloe-emodin, chrysophanol, anthranol and aloesin (387) (Waller *et al.*, 1978). Aloesone (a 7-hydroxychromone, 388) also occurs in the plant (Holdsworth, 1972).

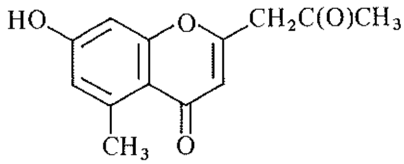


386 Barbaloin

(Thomson, 1971)



387 Aloesin



388 Aloesone

(Holdsworth, 1972)

The aloe-resins are composed of resinotannols with cinnamic or *p*-hydroxycinnamic acid (*p*-coumaric acid) and other aromatic acids (Morton, 1977). 7-Hydroxyaloin is the characteristic substance of *A. barbadensis* in the European Pharmacopeia III (Rauwald and Voetig, 1982).

The plant contains cholesterol, campesterol, *β*-sitosterol, lupeol, an unknown alkaloid and some 17 amino acids (Waller *et al.*, 1978). Arginine is the most abundant amino acid, being as high as 18% of the total amino acids (Khan, 1983). The leaves contain a mixture of polysaccharides containing mainly pectic acid, along with D-galactan, a glucomannan and an arabinan. The polysaccharide composition changes with the season of the year. The glucomannan fraction consists of glucose and mannose in the molar ratio of 1:22 (Mandal and Das, 1980a,b).

The medicinal evaluation and the pharmacotoxicological considerations on the use of aloes as a bitter principle have been reviewed by several authors (e.g. Cheney, 1970; Giachett, 1975). Since the earliest days of recorded history, man has made use of *Aloe* parts (Thorwald, 1963; Reynolds, 1966). They have long been recognized by pharmacopaeias over the world (e.g. Osol *et al.*, 1973) as a purgative drug; one variety called Curacao aloe, is the dried juice of *A. barbadensis* (Waller *et al.*, 1978). The plant is especially useful in correcting constipative action of iron medication (Duke and Ayensu, 1985b).

The Chinese were among the earliest people who used *A. barbadensis* for its medicinal qualities, but it was considered throughout the Middle Ages for a variety of ills (Cheney, 1970). Even today there is considerable use of *A. barbadensis* in folk medicine in other countries and some cosmetics and patent medicines generally found in U.S. markets are prepared from the gel in the leaves and from the juice (Waller *et al.*, 1978). A number of paramedical publications extol its ability to promote the healing of burns and other cutaneous injuries and of ulcers of mucous membranes; this literature has been reviewed by Gjerstad and Riner (1970). Some scientific reports attribute improved healings of burns due to their treatment with *A. barbadensis* products. These have been also effective against peptic ulcers, skin disorders and infections treated in veterinary medicine (Waller *et al.*, 1978).

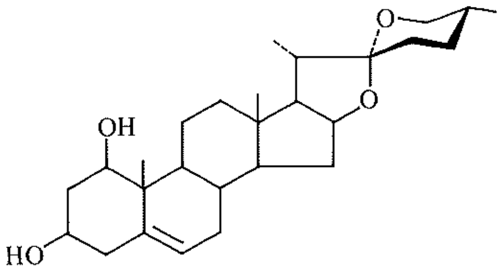
2 *SANSEVIERIA*

This genus is indicated as *Sanseverinia* Petagena, *Sansevera* Stokes, *Sansveria* Rafin, *Sansevieria* Thumb., *Sansevieroa* P. et K., and *Acyntha* (Choiv). It is sometimes classified as Agavaceae plants.

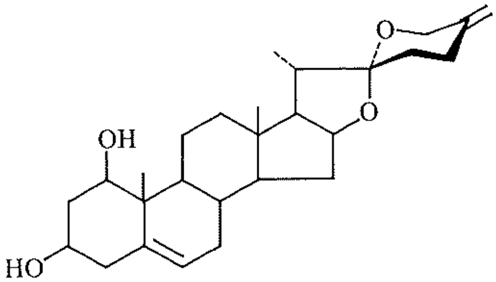
Steroid sapogenins have been identified from *Sansevieria trifasciata* (Gonzalez *et al.*, 1979) and *Sanseverinia rorida* (Passannanti *et al.*, 1985). The leaves and roots of *S. zeylanica* contain 9·87 and 4·67% saponins respectively (Wasicky and Hoehne, 1951). *S. zeylanica* contains 0·018% of an inter alkaloid, sansevierine (Chopra and Ghosh, 1935).

1 *Sansevieria triafasciata* Prain
Common name: *Bowstring-Hemb*
Arabic name: *Sabbar gild el-nimr*

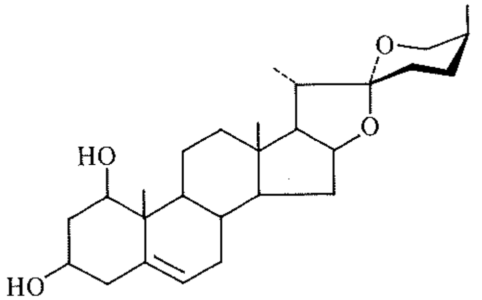
The leaves of *Sansevieria trifasciata* Prain contain β-sitosterol and five spirostan sapogenins, four of which were identified as ruscogenin (389), neoruscogenin (390), 25-*S*-ruscogenin (391) and sansevierigenin (392) (Gonzalez *et al.*, 1972). *n*-Butyl 4-ol-*n*-propyl phthalate (393) has been isolated from the leaves (Paré *et al.*, 1981).



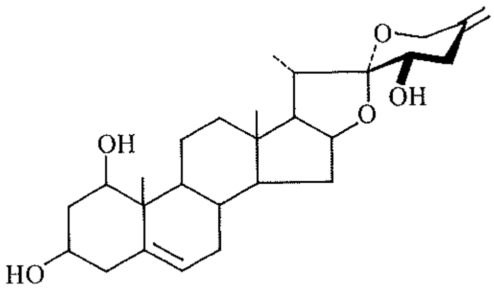
389 Ruscogenin



390 Neoruscogenin

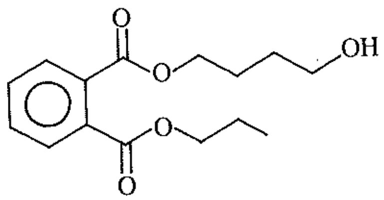


391 25-*S*-Ruscogenin



392 Sansevierigenin

(Gonzalez *et al.*, 1972)



393 (Paré *et al.*, 1981)

Phytochemical screening of the plant revealed the presence of flavonoids (Rizk *et al.*, 1988).

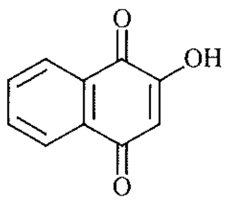
Hydrolysis of the purified hemicellulose, from extractive-free deliginigied fibre of *S. trifasciata* leaves, gives a product containing D-xylose and 4-*O*-methyl-D-glucuronic acid in a mole ratio 5:1 (Sharma and Mukherjee, 1981). Partial hydrolysis of the hemicellulose furnished additional evidence for its structure (Sharma and Mukherjee, 1982).

XXVI LYTHRACEAE

1 *LAWSONIA*

1 *Lawsonia inermis* L.
(= *L. alba* Lam.)
Common name: *Henna* (taken from Arabic name)
Arabic name: *Henna*

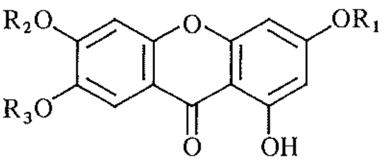
Lawsone (394; henna, naphthalenic acid, isojuglone) is the dyeing principle of the ancient colouring matter, henna, prepared from leaves of *L. alba* (Lam.) (= *L. inermis*) which is cultivated in Africa and Asia for medicinal and dyeing purposes. Henna can be found on the nails of Egyptian mummies and must be of the oldest cosmetics still in use (Thomson, 1971). Lawsone amounts to 1·02% in leaves of the plant growing in Iran (Khorrami, 1979).



394 Lawsone
(Thomson, 1971)

The leaves also contain the following compounds:

- 1,2-Dihdroxy-4-glucosylnaphthalene which is active against *Bacillus subtilis* and *Saccharomyces pastorianus* (Afzal *et al.*, 1984).
- Xanthones: laxanthones I (395), II (396) and III (397) (Bhardwaj *et al.*, 1977, 1978).
- Flavonoids: apigenin 7-glucoside, apigenin 4′-glucoside, luteolin 7-glucoside, luteolin 3′-glucoside and acacetin-7-glucoside (Afzal *et al.*, 1980; Mahmoud *et al.*, 1980).



395 Laxanthone I : R_1 = H, R_2 = R_3 = CH_3
396 Laxanthone II : R_1 = R_2 = Ac, R_3 = CH_3
397 Laxanthone III : R_1 = R_3 = CH_3, R_2 = Ac

(Bhardwaj *et al.*, 1978)

- Coumarins: lacoumarin (5-allyloxy-7-hydroxycoumarin) (Bhardwaj *et al.*, 1976), fraxetin, scopoletin and esculetin (Dzhuraev *et al.*, 1982). The percentage of the total coumarins is 1·27–2·14 (Dzhuraev *et al.*, 1982).
- Gallic acid and 1,4-naphthaquinone (Abd-el-Malek *et al.*, 1973).
- Sterols: *β*-sitosterol, stigmasterol and *β*-sitosterol glucoside (Mahmoud, 1980; Afzal *et al.*, 1984).

The bark contains two pentacyclic triterpenes: 3β-30-dihydroxylup-20(29)-ene(hen nadiol) and (20 *S*)-3β-30-dihydroxylupane (Chakrabartty *et al.*, 1977a; 1982). The plant also contains lupeol, 3-β-hydroxy-20-oxo-30-nor-lupane, betulin and betulinic acid (Chakrabartty *et al.*, 1977b).

Resedine, an albumin-inhibitable lectin which agglutinates erythrocytes of blood groups A, B and O, occurs in *L. inermis* var. *reseda* (Ochoa *et al.*, 1979). The flower yields a volatile oil with a pleasant odour (0·02%) (Antia and Kaushal, 1950). The seed contains 10–11% of fixed oil (Watt and Breyer-Brandwijk, 1962).

The pigment (lawsone) is used as a cosmetic in African and Eastern countries, not only for dyeing, but also for staining the hands and feet. Also, the leaf and root are used as an astringent. The leaf is used as leprosy remedy in Guinea and the powdered seed is said to produce stimulant effects on the cerebrum.

XXVII MALVACEAE

Within the Malvaceae worldwide, the most important genus is cotton (*Gossypium*), which supplies fibre, oil and meal. Stem fibers from other genera, including *Abutilon* and *Urena*, are used for cordage, sacks and paper. Marshmallow (*Althaea officinalis*) is used medicinally and as a confection. The pods of okra (*Abelmoschus esculentus*) are used as a vegetable. Wood of various arborescent species, such as *Hibiscus tiliaceus*, *Lagunaria patersonii* and *Thespesia populnea* is used locally as a timber. Many species are used as ornamentals, including the well-known hollyhock (*Alcea rosea*) and rose-of-China (*Hibiscus rosa-sinensis*) (Mitchell, 1982).

Plants of this family are generally rich in flavonoids, mucilages and anthocyanins. They also contain sterculic and malvalic acids (Rizk, 1986). Of six plants of the family Malvaceae studied by Chouhan and Shukla (1984), three contained cholesterol and ergosterol. Sitosterol and stigmasterol were found in all plants.

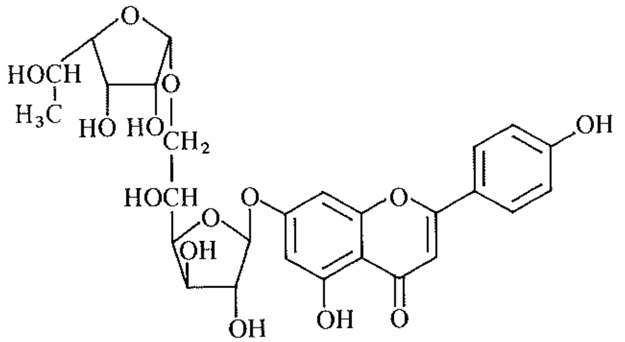
1 *ALTHAEA*

The roots of *Althaea* species (e.g. *A. armeniaca*, *A. officinalis*, and *A. rosea*) usually contain acidic mucilages which consist of pentoses, methylpentoses, hexoses and uronic acids (Shelud' ko, 1959). Mucilage also occur in the other different plant parts. *Althaea* species also contain flavonoids, coumarins, anthocyanins and several other polyphenolic compounds (Rizk, 1986).

1 *Althaea rosea* L.
Common name: *Marshmellow* ; *Hollyhock*
Arabic name: *Khatmia*

Both roots and leaves contain mucilage, named "Althaea-mucilage R and RL respectively. Althaea mucilage R is composed of partially acetylated acidic polysaccharide and protein in a ratio of approximately 10·3:1·0 and its molecular weights was estimated to be 41,700. The polysaccharide moeity consists of, D-galactose, D-glucose, L-rhamnose, D-galacturonic acid and D-glucuronic acid in the moler ratio of 2:1:6:4:6 (Tomoda *et al.*, 1983). The leaf mucilage (RL) is mainly composed of partially acetylated acidic polysaccharide, and its molecular weight was estimated to be about 1800000. The mucilage consists of L-rhamnose, D-galactose, D-galcturonic acid, D-glucuronic acid, *O*-acetyl groups and protein. The approximate molar ratio of L-rhamnose: D-galactose: D-galacturonic acid: D-glucuronic acid: *O*-acetyl groups is 20:1:16:10 (Tomoda *et al.*, 1985). Karawya and Afifi (1979) reported that mucilages from leaves, flowers, stems and roots of *A. rosea* contain D-xylose. Free sugars consist of sucrose and glucose in leaves, flowers, stems and roots; raffinose in roots and fructose in leaves, flowers and stems (Karawya and Afifi, 1979).

The flowers contain several flavonoids *viz.* aromadendrin 3-glucoside (Obara, 1964), nudiflorin (398; an apigenin 7-β-(6-β-L-rhamnofuranoside-D-glucofuranoside) (Pakudina, 1977), rutin, chrysin, kaempferol, robinetin, acacetin and phloretin (Srivastave and Jain, 1984). The flavonoids present in the yellow portions of *A. rosea* flowers are quercetin, kaempferol, isoquercitrin and kaempferol 3-glucoside. The purple portions of the petals contain 3-glucoside and 3-rhamnoglucoside of cyanidin (Nair *et al.*, 1964). The petals of *A. rosea* var. *nigra* contain malvidin 3-glucoside, malvidin 3,5-diglucoside, delphinidin 3-glucoside, delphinidin 3,5-diglucoside, petunidin 3-glucoside and petunidin 3, 5-diglucoside (Kohlmunzer *et al.*, 1983).



398 Nudiflorin
(Pakudina, 1977)

Palmitic, myristic, stearic, oleic, linoleic, linolenic and lauric acids occur in the lipid fraction of seeds, leaves and flowers (Karawya *et al.*, 1979). The lipid content of all tissues, (roots, stems, leaves, buds, and flowers), except the seeds decrease with age. Cyclopropene and cyclopropane fatty acids occur in all tissues. The major fatty acids in decreasing order are: palmitic, linoleic and linolenic in stems, buds and flowers; malvalic, palmitic, sterculic and linoleic in the roots; linolenic, palmitic and linoleic in the leaves; and linoleic, oleic and palmitic in the seeds. More malvalic than sterculic acid is present in all tissues except the stems and buds (Gopalakrishnan *et al.*, 1982). β-Sitosterol and stigmasterol have been identified from the different parts of the plant (Karawya *et al.*, 1979).

The dioxane lignin of *A. rosea* contains *p*-coumaric, guaiacylic and syringylic units (Geronikaki and Abduazimov, 1977).

2 *HIBISCUS*

The isolation and structural features of acidic mucilages from roots and leaves of *Hibiscus* species have been reported e.g. *H. ficulneus* (Bajpai and Mukherjee, 1969–1971), *H. manihot* (Inokawa *et al.*, 1964); *H. syriacus* (Shimizu *et al.*, 1986) and *H. trionum* (Mathe and Racz, 1975). The leaf mucilage of *H. syriacus*, for example, is mainly composed of acidic polysaccharide; which is composed of L-rhamnose: D-galactose: D-galacturonic acid: D-glucronic acid in the molar ratio of 8·0:1·1:8·0:4·0 (Shimizu *et al.*, 1986).

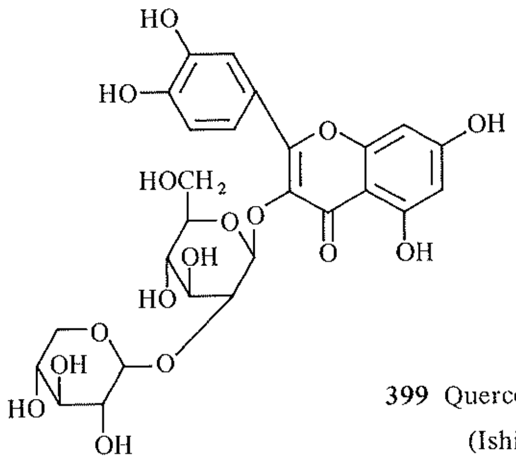
Several flavonoids have been identified from *Hibiscus* species particularly from the flowers. Examples of species, from which flavonoids have been identified are the following:

1 —*H. abelmoschus* (flowers): kaempferol, quercetin, kaempferol 3-glucoside, quercetin 3-glucoside, myrcicetin, myricetin 3′-glucoside (Nair *et al.*, 1964, Misra *et al.*, 1971).

2 —*H. cannabinus* (flowers): cannabiscetin (isomer of gossypetin), quercetagetin and myricetin (Neelakantam and Seshadri, 1938).

3 —*H. esculentus* (flowers): several quercetin and gossypetin glucosides (Hedin *et al.*, 1968).

4 —*H. L. mutabilis* (flowers): quercimeritrin (quercetin 7-glucoside), meratrin (quercetin 3-diglucoside) (Subramanian and Swamy, 1964), hyperin, isoquercitrin, guaijaverin, kaempferol glycoside and quercetin 3-sambubioside (399) (Ishikura, 1982); (stems): naringenin 5,7-dimethyl ether 4′-*O*-*β*-D-xylopyranosyl-*β*-D-arabinopyranoside (Chauhan *et al.*, 1979).



399 Quercetin 3-Sambubioside

(Ishikura, 1982)

5 —*H. sabdariffa* (flowers): gossypetin, gossypetin 3-glucoside, hibiscetin and sabdaretin (Seshadri and Thakur, 1961; Kerharo, 1971).

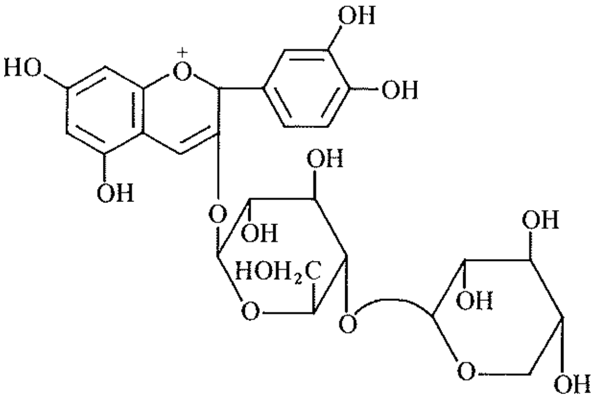
6 —*H. surattensis* (yellow parts of petals): gossypetin and gossypitrin (Nair *et al.*, 1962).

7 —*H. syriacus*: saponarin (Nakaoki, 1944).

8 —*H. tiliaceus* (flowers): gossypetin 3-glucoside, gossypetin 7-glucoside (Nair *et al.*, 1961); (fruits): quercetin 3-*O*-galactoside and kaempferol 3-*O*-galactoside (Subramanian and Nair, 1973a).

9 —*H. vitifolius* (flowers): gossypin (gossypetin-8-*O*-β-D-glucoside) and hibifolin (a glucosyluronate of gossypetin) (Nair and Subramanian, 1974).

The flowers of *Hibiscus* species are rich in anthocyanins. Various hybrids contain 4·8–10·6% anthocyanins (Rakhimkhanov *et al.*, 1970). In fourteen Malesian species of *Hibiscus* species studied by Lowry (1976), the most common floral anthocyanin is cyanidin 3-sambubioside. Gossypicyanin (400) has been isolated from *Hibiscus* hybrids (Rakhimkhanov *et al.*, 1973). The anthocyanins of certain *Hibiscus* species are:



400 Gossypicyanin
(Rakhimkhanov *et al.*, 1973)

— Cyanidin 3-glucoside and delphinidin 3-glucoside from *H. cisplatinus* (Pomilio and Sproviero, 1973).

— Cyanidin 4′-glucoside and cyanidin 3-glucoside 4′-glucoside from *H. esculentus* (Hedin *et al.*, 1968).

— Cyanin (cyanidin, 3,5-diglucoside) (Subramanin and Swamy, 1964), ilicicyanin (cyanidin 3-xylosylglucoside) and chrysanthemin (cyanidin 3-monoglucoside) (Ishikura, 1973) from *H. mutabilis*.

— Cyanidin, delphinidin and pelargonidin from the purple parts of the petals of *H. surattensis* (Nair *et al.*, 1962).

— Cyanidin 3-sophoroside in the large woody species (Lowry, 1976).

The seeds of *Hibiscus* species produce higher percentages of fixed oil e.g. *H. cannabinus* (17–19%), *H. trionum* (21·77–23·8%) (Vakulin; 1935) and *H. furcatus* (24·2%) (Rao and Nigam, 1979). Cyclopropenenoid fatty acids (malvalic and serculinic acids) occur in the seeds oil of various species e.g. *H. caesius* (Husain *et al.*, 1980) and *H. syriacus* (Chernenko *et al.*, 1973). The unsaponifiable substances in the oil consist of α-, β-, δ- and ν-tocopherol, β-sitosterol, campesterol, β-amyrin and 3,4-dihydroxycarotenes (Chernenko and Umarov, 1974; Rao and Nigam, 1979).

Various species in *Hibiscus* have been used as a fibre source to make such diverse products as fishing lines and nets, dilly bags and baskets. *H. cannabinus* is the best-known commercial cordage fibre plant. The tree species *H. heterophyllus* and *H. tiliaceus* produce beautifully marked woods which can be used as cabinet timbers, for musical instrument cases, walking sticks and similar wooden artifacts (Mitchell, 1982).

1 *Hibiscus rosa-sinensis* L.
Common name: *Chinese hibiscus*
Arabic name: *Hiboskos*

The flower petals of *H.rosa-sinensis* contain several flavonoids and anthocyanins. Deep yellow mutipetalled flowers contain quercetin 3-diglucoside, -3,7-diglucoside, cyanidin 3,5-diglucoside and cyanidin 3-sophoroside-5-glucoside. Ivory white, five petalled flowers contain the above compounds plus quercetin 3-sophorotrioside and kaempferol 3-xylosylglucoside (Subramanian and Nair, 1972). The flowers have been reported to contain also cyanidin diglucoside (Hayashi, 1944), florachrome B (Raman, 1969) and a small amount of hibiscetin (Watt and Breyer-Brandwijk, 1962).

The leaves and stems yield taraxeryl acetate and β-sitosterol (Agarwal and Rastogi, 1971). The plant contains citric, tartaric and oxalic acids and fructose, glucose and sucrose as the main sugar constituents (Lin, 1975).

The stem bark of Japanese *H. rosa-sinensis* has been found to yield two acetylenic straight-chain acids, 8-nonynoic acid ($HC{\equiv}C{-}(CH_2)_7{-}COOH$) and 9-decynoic acid ($HC{\equiv}C{-}(CH_2)_6{-}COOH$) and their methyl esters ($HC{\equiv}C{-}(CH_2)_7{-}COOCH_3$) and ($HC{\equiv}C{-}(CH_2)_6COOCH_3$). They are inhibitors of the germination of lettuce seeds (Nakatani *et al.*, 1985). Four novel aliphatic esters have been recently isolated from the stem bark *viz.* methyl-10-oxo-11-octadecynoate, methyl-8-oxo-9-octadecynoate, methyl 9-methylene-8-oxoheptadecanoate and methyl-10-methylene-9-oxooctadecanoate. The first two compounds also inhibited the germination of lettuce seeds (Nakatani *et al.*, 1986).

The flowers are eaten raw or pickled in China and Philippines. The leaf tip, bud and blossom are boiled as a spinach in some African countries (Watt and Breyer-Brandwijk, 1962; Chopra *et al.*, 1969). The flowers are used as demulcent, emollient, refrigerant, aphrodisiac, emmenagouge and in bronchial catarrh. The leaves are used as emollient, aperient, anodyne laxative and to stimulate expulsion after childbirth; and the root for gonorrhoea and menorrhagia (Chopra *et al.*, 1969).

XXVIII MELIACEAE

A number of limonoids and triterpenoids (tirucallane type, tetranortriterpenoids etc.) have been characterized from various plants in the family Meliaceae (Connolly *et al.*, 1979; Schulte *et al.*, 1979; Connolly, 1983; Banerji and Nigam, 1984; Kraus, 1984).

1 *MELIA*

Azadirachta indica (syn. *Melia azadirachta*) (neem) is a well known species. Several tetranortriterpenoids have been isolated from various parts of the neem tree. A number of these compounds *viz.* meliantriol, salannin and azadirachtin, occurring mainly in the seeds, act as antifeedants, disruptants of insect growth and development, or toxicants (Jacobson, 1985). Examples of triterpenoids isolated from certain *Melia* species are:

1 —*M. birmanica* (heartwood): nimbolin A (Rao *et al.*, 1979a).

2 —*M. dubia* (leaves and seeds): compositin and compositolide (Purushothaman *et al.*, 1984).

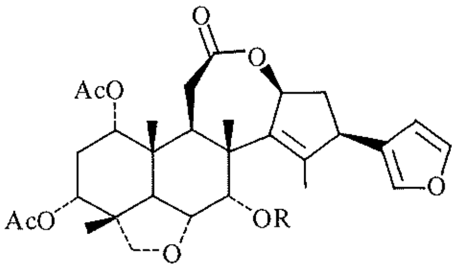
3 —*M. indica*: nimbidic acid and nimbidin (Mitra *et al.*, 1970).

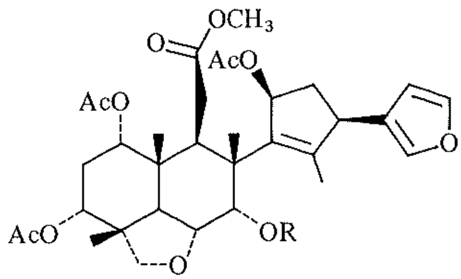
The leaves of *A. indica* contain the following flavonoids: hyperoside, quercitrin, rutin (Nakov *et al.*, 1982), and nimbaflavone (8, 3′-di-isoprenyl-5,7-dihydroxy-4′-methoxy-flavanone) (Garg and Bhakuni, 1984).

Neem leaves are used as a feed for livestock (Patel *et al.*, 1962; Juyal, 1963).

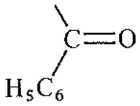
1 *Melia azedarach* L.
Common name: *China berry*
Arabic name: *Zanzalakht*

The fruits of *M. azedarach* L. var. *japonica* Makino contain several tetranortriterpenoids (bitter limonoids) *viz.* ochinolide A (401), ochinolide B (402) nimbolidin A (403), nimbolidin B (404), nimbolinin B (405) (Kraus *et al.*, 1980), ochinolal (406), ochinin (407), 17-epiazadiradione (408), the β-hydroxy compound (409), 1-α-methoxy-1,2-dihydroepoxyazadiradione (410), diepoxyazdiradione (411) and 7-acetylneotrichilenone (412) (Ochi *et al.*, 1978; Kraus *et al.*, 1980; Fukuyama *et al.*, 1983). The first five compounds exhibit antifeeding activity against the insect *Epilachna varivestis* (Kraus *et al.*, 1980).

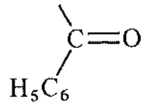




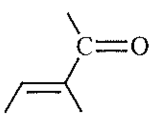
401 Ohchinolide A R =



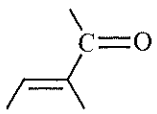
403 R = Nimbolidin A



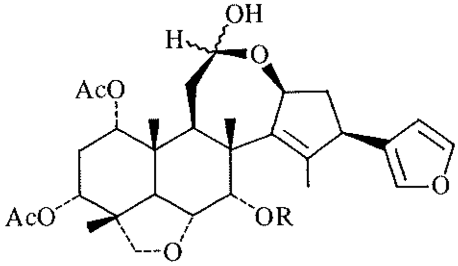
402 Ohchinolide B R =



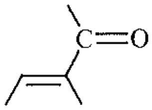
404 R = Nimbolidin B

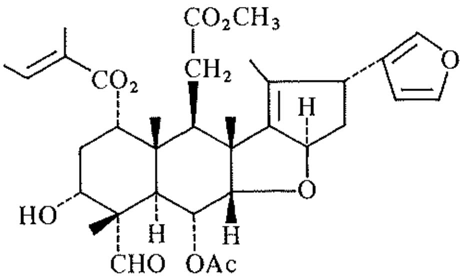


(Kraus *et al.*, 1980)

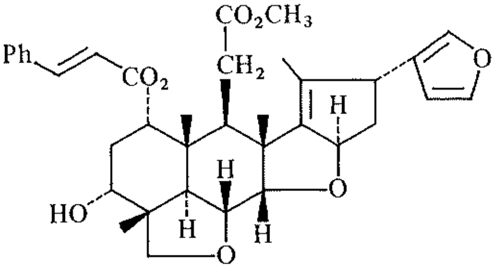


405 Nimbolinin B R:

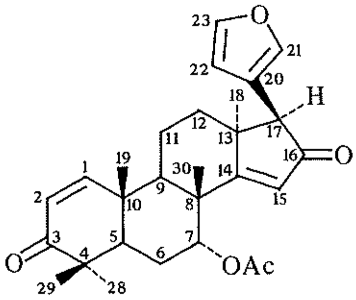




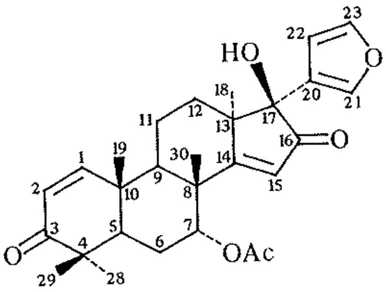
406 Ochinolal
(Fukuyama *et al.*, 1983)



407 Ochinin
(Fukuyama *et al.*, 1983)



408 17-Epiazadiradione



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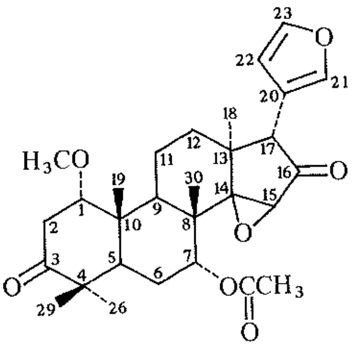

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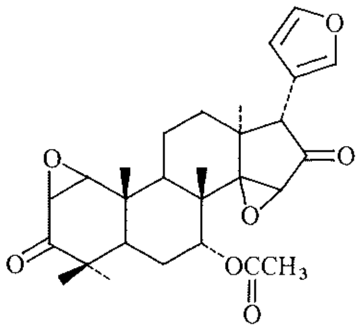
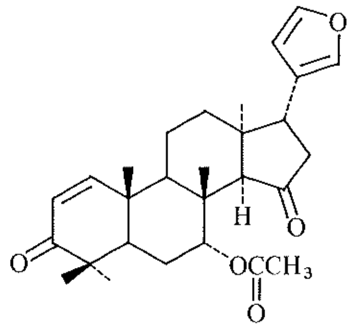
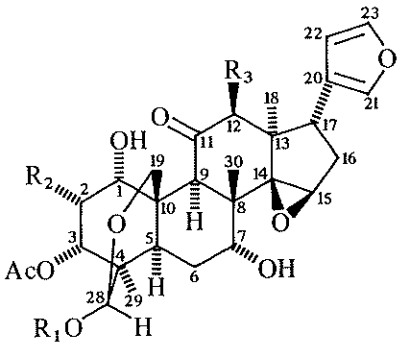


411 Diepoxyazidradione



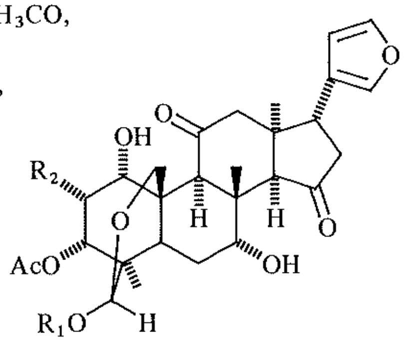
412 7-Acetylneotrichilenone

The fruits of *M. azedarach* var. *australica* contain four tetranortiterpenes, meliatoxins A_1, A_2, B_1 and B_2 (413–416) (Oelrichs *et al.*, 1983).



413 Meliatoxin A_1 : $R_1 = CH_3CH_2CHCH_3CO$, $R_2 = AcO$, $R_3 = H$

414 Meliatoxin A_2 : $R_1 = (CH_3)_2CHCO$, $R_2 = AcO$, $R_3 = H$



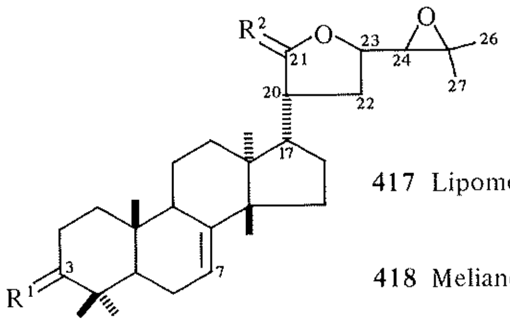
415 Meliatoxin B_1 : $R_1 = CH_3CH_2CHCH_3CO$, $R_2 = AcO$

416 Meliatoxin B_2 : $R_1 = (CH_3)_2CHCO$, $R_2 = AcO$

(Oelrichs *et al.*, 1983)

The root of *M. azedarach* yields 24-methylenecycloartanone, cycloeucalenone, 4-stigmasten-3-one, 4-campesten-3-one, 24-methylenecycloartanol, triacontanol, cycloeucalenol, β-sitosterol and β-sitosterol-β-D-glucoside. The fruits of the same plant contain 21, 23:24,5 diepoxytirucall 7-en-21-ol, 3-β-hydroxystigmast-5-en-7 one, 3 β-hydroxycampest-5-en-7-one, the same cyclolanostane derivatives as in the roots (Schulte *et al.*, 1979), and 7-tricosanol (Yelekci and Evliya, 1982).

The fruit of *M. tooseendan* (*M. azedarach* var. *toosendan*) contains tirucallene-type triterpenoid derivatives *viz.* lipomelianol (417), a mixture of the 3-*O*-stearate, palmitate, myristate and laurate of melianol (418), melianone (419) (Nakanishi *et al.*, 1986a) and 21-*O*-acetyl toosendantriol (420, an apotirucallane triterpene) (Nakanishi *et al.*, 1986b). The bark of the same species contains toosendanin (Zhong *et al.*, 1981). Meliatin (a carotenoid like substance) has been early identified from the leaves (Chauvin, 1946).

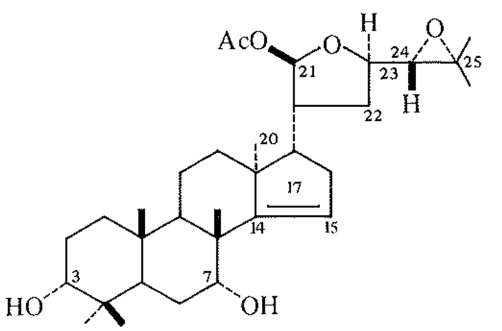


417 Lipomelianol : R^1 = α-H, β-OCO$(CH_2)_nCH_3$; n = 10, 12, 14, 16, R^2 = H, OH; C_{21} epimeric mixture

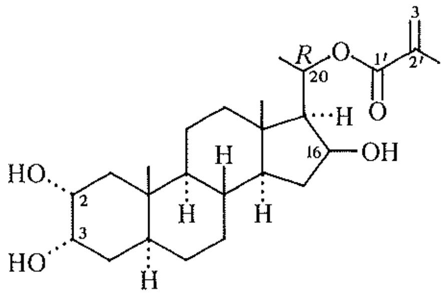
418 Melianol : R^1 = α-H, β-OH, R^2 = H, OH; C_{21} epimeric mixture

419 Melianone : R^1 = O, R^2 = H, OH; C_{21} epimeric mixture

(Nakanishi *et al.*, 1986a)



420 21-*O*-Acetyl-toosendantriol
(Nakanishi *et al.*, 1986b)



421 Azedarachol
(Nakatani *et al.*, 1985)

The root bark of *M. azedarach* var. *japonica* also contains azedarachol (421), a steroid ester, which possesses antifeedant activity against the larvae of the insect pest *Ajrotis sejetum* Denis (Nakatini *et al.*, 1985).

The volatile oil of the Sendan (*M. azedarach L.* var. *japonica*) heartwood contains the following compounds: *n*-hexanol, *cis*-3-hexen-1-ol, 3-octal, 1-octen-3-ol, *n*-heptanol, α-copaene, linalyl acetate, *cis*-*p*-menthen-1-ol, elemene, 1-terpinen-4-ol, *trans*-*p*-2-menthen-1-ol, furfuryl alcohol, β-caryophyllene, citronellyl acetate, aromadendrene, α-terpineol, benzyl acetate, ν-muurolene, α-muurolene, geranyl acetate, nerol, β-phenyl acetate, geraniol, benzyl alcohol, 3-phenylethyl alcohol, creosol, epicubenol, cubenol, T-cadinol, T-muurolol, eugenol, carvacrol and chavicol (Wang and Kameoka, 1978).

The plant also contains several phenolic compounds. The leaves contain quercetin 3-*O*-L-rhamnoside, rutin and kaempferol 3-rutinoside (Nair and Subramanian, 1975a; Marco *et al.*, 1986). The stem bark yields 4′, 5-dihydroxyflavone-7-*O*-β-L-rhamnopyranosyl-(1 → 4)-β-D-glycopyranoside (Mishra and Srivastava, 1984). The coumarins scopoletin, 6-hydroxy-7-methoxycoumarin and aesculetin have been identified from the leaves (Khalil *et al.*, 1979). The stem bark contains two anthraquinone glycosides: 1,8-dihydroxy-2-methylanthraquinone-3-O-β-D-galactopyranoside and 1,5-dihydroxy-8-methoxy-2-methylanthraquinone-3-*O*-α-L-rhamnopyranoside (Srivastava and Mishra, (1985). Cinnamic acid occurs in the leaves (Khalil *et al.*, 1979). Vanillic acid and vanillic aldehyde, have been identified from the different parts of *M. azedarach* (Okahara and Taniguchi, 1960; Schulte *et al.*, 1979). The heartwood contains bakalactone (Nath, 1954). The plant also contains tannins (18·26–26·04% in the bark) and the tree sometimes yields gum freely (Watt and Breyer-Brandwijk, 1962).

The fixed oil of the fruits consists chiefly of the glycerides of palmitic, oleic and stearic acids (Bost and Fore, 1935). Large fruits tend towards higher unsaturation of the oil, myristic and stearic acids, 2·6%; oleic acid, 32%; linoleic acid, 51% while small fruits yield oil with about 45% linoleic acid (Konovalov and Gol'dina, 1940). The volatile fatty acids (6·67%) contain acetic and caproic acids at the ratio of 1:2 (Murai, 1951). The oil contains 1·26% unsaponifiable substances (Kafuku and Hata, 1933), from which β-sitosterol has been identified (Khalil *et al.*, 1979).

The fruits of *M. azedarach* also contain an alkaloid, azaridine, tannin, meliotannic acid and benzoic acid (Carratala, 1939). The leaves have been reported to contain an alkaloid, paraisine (Volkonsky, 1937).

The tree is poisonous to animals. All parts (leaves, bark, flowers and fruits) are toxic, but the majority of cases occur from ingestion of fruits. These have a peculiar odour and intense taste which is not usually attractive to animals (Kingsbury, 1964). The pulp of the fruit is the poinsonous element.

M. azedarach is widely used in various countries as an emetic and cathartic (Nakabayashi, 1952; Taniguchi, 1960; Watt and Breyer-Brandwijk, 1962). A strong decoction of the root bark (or fruit) is used in Mauritius, China, Algeria as an anthelmintic. In Algeria the plant is also used as a tonic and antipyretic (Volkonsky, 1937). The drupe and the bark are used as vermifuge. A decoction of the bark is used as a lotion on ulcers, including syphilitic ulcers, and other skin diseases. A paste of the leaf, flower, bark and root bark is effective as a local application to the skin lesions of leprosy and scrofula (Watt and Breyer-Brandwijk, 1962).

Aqueous extract of the leaf, used as spray, has a repellent action and is effective in protecting kitchen gardens, orchards and the cultivation under the date palms of the desert oases. The fruit oil is suitable for making candles and has been used in painting (Watt and Breyer-Brandwijk, 1962).

XXIX MORACEAE

Corner's recent taxonomic treatment of the Moraceae has shown that the family constitutes a large taxa of over 50 genera and nearly 1400 species, including such important groups as *Artocarpus*, *Morus* and *Ficus* (Venkataraman, 1972). Members of this family have been reported to contain phenolic compounds of Diels-Alder-adducts, isoprenylated flavonoids, 2-arylbenzofuran derivatives, flavonoids, stilbenes, coumarins and xanthones. The first three classes of compounds have been isolated from various *Morus* species while coumarins were identified from *Ficus* species. Flavonoids with the common features of hydroxyls in the 5,7,2′,4′-positions and $C_{\gamma-\gamma}$-dimethylallyl substituents in the 3,6-or 3,6,8-positions, have been isolated from several genera e.g. *Artocarpus*, *Morus* (Venkataraman, 1972) and *Toxylon pomiferum* (Gerber, 1986). Leucocyanidin, leucopeonidin, leucodelphinidin were detected in some genera *viz*. *Ficus* and *Humulus* (Lebreton, 1964; Lebreton and Meneret, 1964). *Maclura pomifera*, for example, contains the following phenolics: isoflavones (osajin and pomiferin) from the fruits; xanthones (macluraxanthone, osajaxanthone, 8-prenyl-oxyxanthone C, alvaxanthone, 1,3,6,7-tetrahydroxyxanthone, 8-deoxygartanin, 6-deoxyjacarubin and toxyloxanthones A,B,C and D from the roots; flavonols, flavanols and oxyresveratrol from the heartwood, flavanones ((+)-euchrestaflavanones B and C) from the root bark and heartwood (Monache *et al*., 1984).

Alkaloids were also identified from the family e.g. 8-hydroxyquinoline-4-aldehyde and 3,4′-dihydroxy-2,3′-bipyridine from the timber of *Broussonetia zeylanica* (Gunatilaka *et al*., 1983).

1 *FICUS*

There are more than 800 *Ficus* species, varying greatly in habit. Some species are large trees e.g. *F. religiosa*, *F. benghalensis*, *F. indica*, *F. glomerata* etc., some are moderate sized trees which are often epiphyte e.g. *F. retusa*, *F. tomentosa*, *F. rumphii* etc. (Singhal and Baslas, 1972). Many plants of this genus are used in medicine for treatment of skin diseases, in enlargement of liver and spleen, dysentry, diarrhoea, diabetes, leprosy, etc. (Chopra *et al*., 1956).

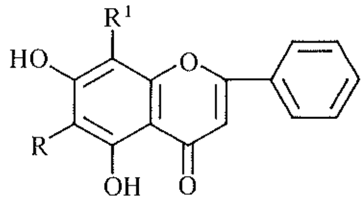
Ficus species contain coumarins and triterpenes as characteristic components. The coumarin bergapten has been identified from several species e.g. *F. asprima*, *F. benjamina*, *F. carica* and *F. hispida*. Other coumarins e.g. psoralen, herniarin, umbelliferone, scopoletin, xanthotoxin, isopimpinellin, xanthotoxol and marmesin also ocur in *Ficus* species (Ahmad *et al*., 1971; Abu-Mustafa *et al*., 1964, 1975; Yarosh and Nikonov, 1973; Ashy and El-Tawil, 1980; El-Khrisy *et al*., 1980; 1985).

Flavonoids have been identified from certain species e.g. rutin and quercetin 3-galactoside from the leaves of *F. benghalensis* (Subramanian and Nair, 1970) and 3-hydroxy-3′-methoxyflavone glucoside from the trunk bark of *F. rumphii* (Baslas, 1979).

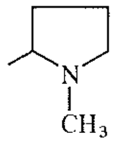
Triterpenoids have been isolated from the different parts of *Ficus* species e.g. β-amyrin from the leaves of *F. asprima*, *F. cunnghamii*, *F. eriobtryoides*, *F. hispida*, *F. sycomorus*

(El-Khrisy *et al.*, 1980, 1985) and *F. lacor* (Behari *et al.*, 1982); tiglic acid ester of taraxasterol and glunol acetate from the leaves (Sen and Chowdhury 1971) and fruits (Chandra *et al.*, 1979) of *F. glomerata*; lupeol and/or friedelin from the trunk bark of *F. glomerata* (Singhal and Saharia, 1980; Baslas and Agha, 1985) and *F. racemosa* (Shrivastava *et al.*, 1977); and cycloartenol, butyrospermol and moretenol form *F. macrophylla* (Galbraith *et al.*, 1965; Ritchie *et al.*, 1966).

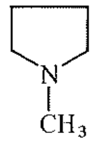
The first known flavonoidal alkaloids ficine (422) and the less abundant isoficine (423) were isolated from *F. pantoniana* (Johns *et al.*, 1965). Antofine and other minor bases of the phenanthroindolizidine type were detected in *F. septia* (Herbert and Moody, 1972). Hispidine (424, a biphenylhexahydroindolizine alkaloid and other phenanthraindolizidines (e.g. 425) occur in *F. hispida* (Venkatachalam and Mulchandani, 1982).



422 Ficine : R = H, R1 =

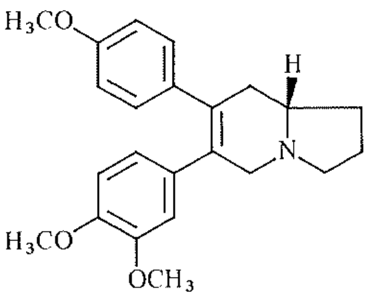


423 Isoficine : R =

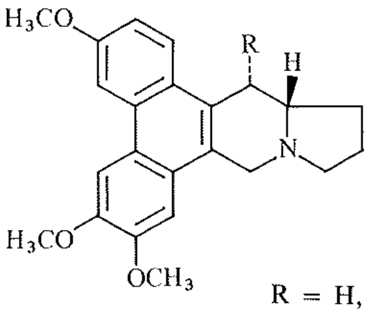


, R1 = H

(Johns *et al.*, 1965)



424 Hispidine



R = H, OH

425

(Venkatachalm and Mulchandani, 1982)

Ficaprenol-10 (C_{50}), ficaprenol-11 (C_{55}) and ficaprenol-12 (C_{60}), typical *cis-trans* polyprenols (a group of natural products whose carbon skeleton is made up of linear isoprene units linked head-to tail) were isolated from the leaves of *Ficus* species e.g. *F. elastica* (Tanaka *et al.*, 1982) and *F. elasticus* (Stone *et al.*, 1967). Natural rubbers occur in several *Ficus* species (Budhiraja and Beri, 1944; Dalma, 1945; Fernández, 1947).

1 *Ficus altissima* Blume.
Common name: —
Arabic name: —
Phytochemical screening of the plant revealed the presence of coumarins (Rizk *et al.*, 1988).

2 *Ficus benghalensis* L.
Common name: *Banyan*
Arabic name: *Teen Benghali*
The leaves contain two flavonoids: rutin and quercetin 3-galactoside and the heartwood yields tiglic acid ester of ψ-taraxasterol (0·4%), β-sitosterol and furocoumarins (Subramanian and Nair, 1970). The leaves and fruit contain petunidin-diglycoside and cyanidin-rhamnoglucoside respectively (Sharma and Seshadri, 1955). Surface hydrocarbons of the fresh leaves consist mainly of C_{14}, C_{16}, C_{18} and C_{20} alkanes (Bhar and Thakur, 1981).

The stem bark contains three ketones: 20-tetratriacontene-2-one, pentatriacontan-5-one and 6-henteriacontene-10-one, β-sitosterol α-D-glucoside, *meso*-inositol (Subramanian and Misra, 1978) and the glucoside bengaloside (Augusti, 1975). This glycoside has been found to respond against hypoglycemic action. Hypoglycemic principles from the bark have been reported by several workers (e.g. Deskmukh *et al.*, 1960; Shrotri and Aiman, 1960; Joglekar *et al.*, 1963; Brahmachari and Augusti, 1964).

The fresh latex contains 12% rubber; the coagulum (with ethanol) of which contains steroids, α-amyrin acetate and traces of wax containing stearic acid (Santhakumari and Pillay, 1959).

The dry bargad or banyan tree leaf (*F. bengalensis*) (used as cattle fodder) contains protein, 9·63%; fat, 2·64%; crude fibre, 26·84%; N-free extract, 51·59% and total ash, 9·3% (containing calcium oxide 2·53 and phosphorus pentoxide 0·08%, an unusually low ratio of phosphorus to calcium) (Mia *et al.*, 1960a). The composition and digestibility coefficient of various nutrients of *F. bengalensis* leaves were determined by Hossain (1960), who suggested that goats may be maintained on the leaves.

The pulp obtained from the banyan tree gives good writing paper (Dutt, 1941).

All parts of the plant are acrid, sweetish, astringent to the bowels; useful in biliousness, ulcers, erysipelas, vomiting, vaginal complaints, fever and inflammations. The leaves are good for ulcers. The milky juice is aphrodisiac, tonic, vulnerary, maturant and lessens inflammations. The aerial root is styptic, aphrodisiac, useful in gonorrhoea, and syphilis (Kirtikar and Basu, 1984c). The seeds are applied as tonic (Chopra *et al.*, 1956).

3 *Ficus carica* L.
Common name: *Common fig*
Arabic name: *Teen barshomi*

The leaves contain several furocoumarins and coumarins e.g. psoralen, bergapten, umbelliferone, 4′,5′-dihydropsoralen, marmesin, scopoletin, xanthotoxin and xanthotoxol (Obata and Fukushi, 1955; Fukushi and Saimen, 1957; Rodrighiero and Antonello, 1959; Athnasios *et al.*, 1962; Abu-Mustafa *et al.*, 1964; El-Khrisy *et al.*, 1980; Ashy and El-Tawil, 1981; Innocenti *et al.*, 1982). The ratio of psoralen to bergapten in the leaves of *F. carica* growing in Egypt remains at a constant level all through the season. The highest concentration of coumarins was found during the hottest and dry days in the summer. At this peak period, the leaves contain 0·8% of the total coumarins (0·41% proralen and 0·39% bergapten) (Abu Mustafa *et al.*, 1975). Leaves harvested after fruit maturation have a higher content than yellow and fallen leaves (Rakhmankulov *et al.*, 1974). Psoralen and bergapten, the only significant photoactive compounds also occur in the roots of *F. carica* (Fukushi, 1959a, 1960; Hatsuda *et al.*, 1960) but are not detected in the fruit (Zaynoun *et al.*, 1984).

The leaves contain rutin (0·1%) (Nakaoki *et al.*, 1957), a trihydroxy steroid sapogenin (fucusogenin), a ψ-taraxasteryl ester (El-Kholy and Shaban, 1966), β-sitosterol, β-amyrin and lupeol (Abu-Mustafa *et al.*, 1964). The essential oil of the green leaves contains guaiacol, *p*-cymene and cadalane (Fukushi, 1959b). The sesquiterpene guaiazulene occurs in the root oil (Fukushi and Tanaka, 1963). The leaf pectic substances consist of glucose, galactose, xylose, rhamnose and arabinose at trace:1:trace:1·8:2·6 and galacturonic acid (Arifkhodzhaev and Kondratenko, 1983).

Chlorophyll-a and-b, β-carotene, lutein, viloxanthin and neoxanthin have been isolated from the fruits. Provitamin A and anthocyanins were detected in ripe fruits

Table 10

	Leaves	Bark	Fruit
Total alkaloids	0·17	0·11	0·05
Total glycosides	0·26	0·08	0·05
Rutin	0·05	–	–
Derived furanocoumarin	0·06	–	–
Flavonoids	0·53	0·3	–
Tannins	3·63	0·48	–
Ketoses (before hydrolysis)	1·08	2·38	10·1
Ketoses (after hydrolysis)	1·28	2·49	11·6
Aldoses	0·88	0·72	2·5
Pectins	4·84	1·35	1·8
Resins	2·23	1·32	1·3
Essential oils	0·07	–	–
Fats	4·02	2·74	0·68
Acids (as malic)	2·34	1·4	3·02
Rubber	–	1·6	–
Hemicellulose	–	–	1·12
Vitamin C (mg. %)	105	–	201.3

(Singhal and Baslas, 1978). Cyanidin 3-monoglucoside is the only pigment detected in the fruit skin of *F. carica* var. *nigra* (Duro and Condorelli, 1977).

The analyses of the different parts of the plant are shown in Table 10 (Slawoj, 1964).

The ripe and unripe fruits contain fumaric, succinic, malonic, pyrrolidine-carboxylic, oxalic, malic, shikimic and quinic acids in small amounts (Vasudevan and Coic, 1960). The major acid in the unripe fruit is citric which decreases by about 50% in the ripe fruit. The fruit contains glucose, 3·105%; fructose, 2·295%; sucrose, 0·225% and arabinose (trace) (Vitle and Guichard, 1955). The bark contains 0·122% rubber (Fernández, 1947).

The fruits are consumed fresh, dried, preserved, candid or canned. Fresh figs are delicious with high nutritive value. The fruits contain (per 100 gm): 348–356 calories, 5·3–6·7% protein, 1·1–1·3% fat, 87·6–90·2% total carbohydrates, 5·3–9·0% fibre, 3·1–4·5% ash, 156–281 mg calcium, 98–168 mg phosphorus, 2·7–2·8 mg iron, 9 mg sodium, 862 mg potassium, 337–356 μg β-carotene equivalent, 0·22–0·27 mg thiamine, 0·22–0·28 mg riboflavine, 1·78–2·25 mg niacin and 9·22 mg ascorbic acid (Duke and Ayensu, 1985b).

The fruit is emollient, demulcent, laxative and is used in constipation. It is also antipyretic, tonic, aphrodisiac and useful in weakness, inflammations and paralysis. The root is tonic, useful in leucoderma and ringworm (Duke and Ayensu, 1985b). Wood ash is used as antipoison and leaves for treatment of eyes (Boulos, 1983).

4 *Ficus elastica* Roxb.

Common name: *Rubber plant*

Arabic name: *Fikus*

The leaves contain several isoprenoid alcohols *viz.* ficaprenol-10 (C_{50}), ficaprenol-11 (C_{55}), ficaprenol-12 (C_{60}) and ficaprenol-13(C_{65}) (Wellburn and Hemming, 1966a,b; Stone *et al.*, 1967). The aligment of the isoprene units of ficaprenol-11 is in order *w*-terminal unit, three *trans*-units, six *cis*-units and α-terminal *cis*-alcohol unit (Tanaka and Takagi, 1979).

The rubber content of the different parts of the plant is as follows: leaves without veins, 0·303%; veins of leaves, 0·107%; bark and wood 0·109% and roots 0·318% (Fernández, 1947). The latex of 8-years old *F. elastica* contains rubber hydrocarbons (10·6–21·1%), acetone-soluble substances (13·7–19·7%) and proteins (0·34–0·97%) (Kao and Yen, 1949). The rubber hydrocarbon content is highest in January (21·14%) and lowest in May (10·62%) (Kao and Yen, 1950). Latex of *F. elastica* is not readily coagulated and contains 20% total solids; the dry matter contains 48% rubber hydrocarbons and 38% resins (Kopaczewski, 1946). The unsaponifiable matter of the acetone extract (of the latex) contains chiefly α-amyrin with small amounts of β-amyrin and lupeol (Bie, 1946). The rubber has *cis*, 1,4-polyisoprene configuration (Hager *et al.*, 1979).

5 *Ficus lyrata* Warb.

Common name: *Fig.*

Arabic name: *Fikus*

Phytochemical screening of the plant growing in Qatar, revealed the presence of coumarins (Rizk *et al.*, 1988)

Fig. 77 *Pelargonium zonale* Ait.

Fig. 78 *Pelargonium zonale* Ait.

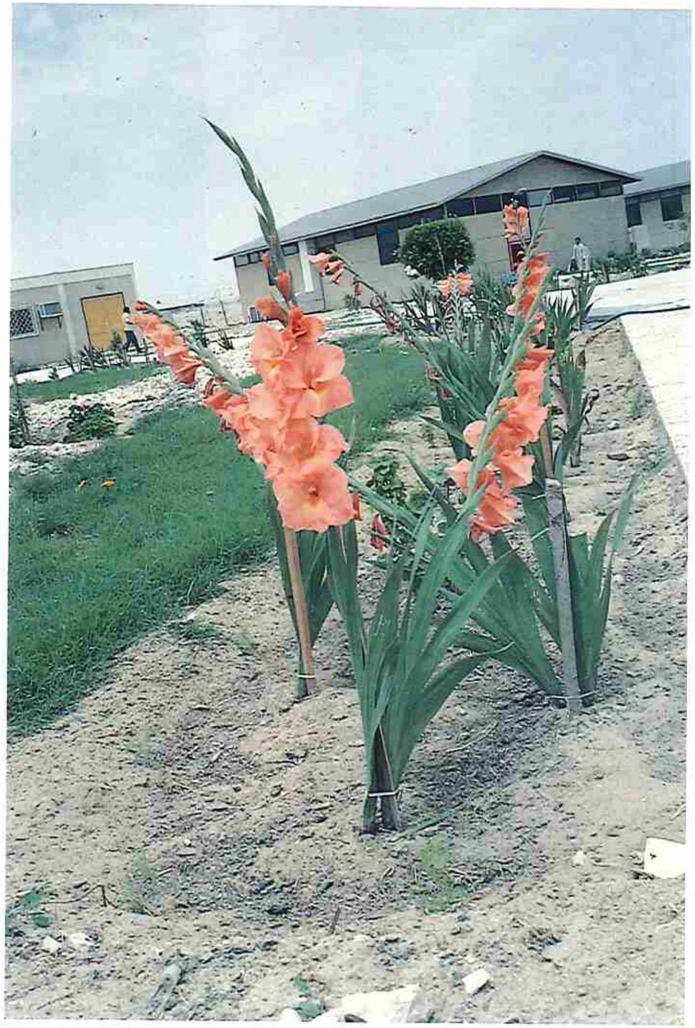


Fig. 79 *Gladiolus gandavensis* Van Houte

Fig. 80 *Gladiolus gandavensis* Van Houte

Fig. 81 *Coleus blumei* Benth.

Fig. 82 *Coleus blumei* Benth.

Fig. 83 *Ocimum basilicum* L.

Fig. 84 *Ocimum basilicum* L.

Fig. 85 *Salvia splendens* Sello

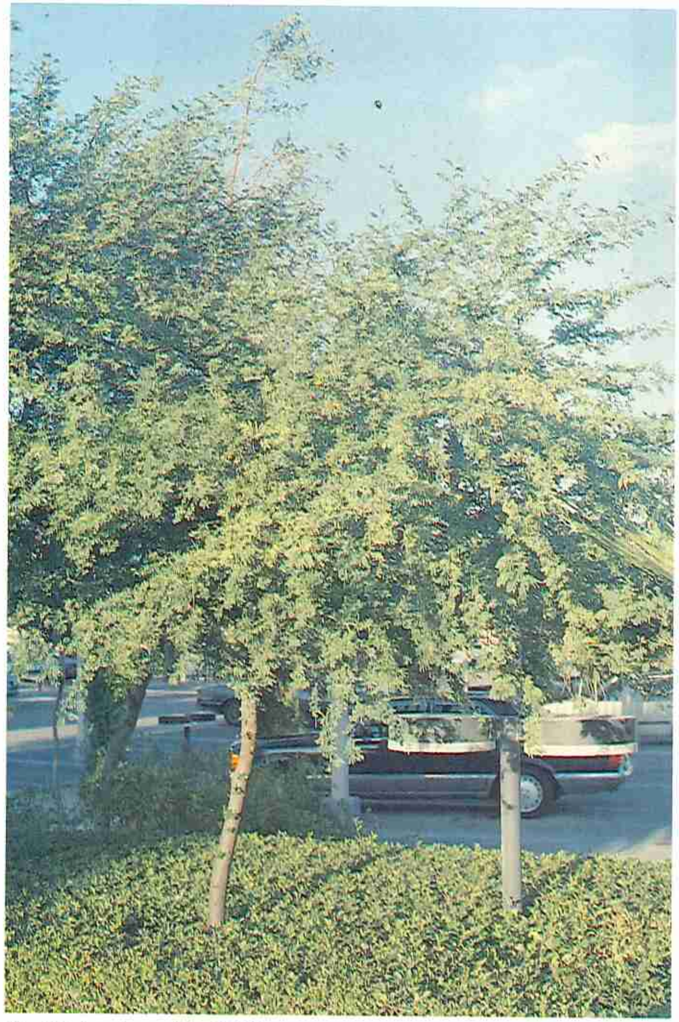


Fig. 86 *Acacia arabica* Willd.

Fig. 87 *Acacia cyanophylla*


Fig. 88 *Acacia cyanophylla*

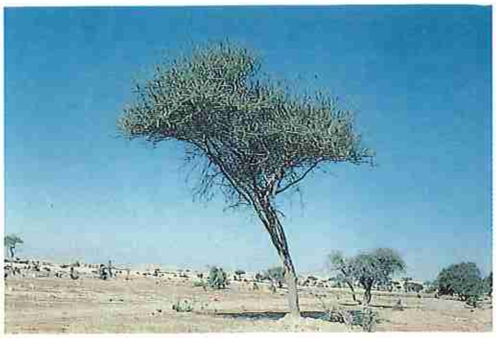


Fig. 89 *Acacia ehrenbergiana* Hayne


Fig. 90 *Acacia ehrenbergiana* Hayne


Fig. 91 *Acacia farnesiana* Willd.


Fig. 92 *Acacia farnesiana* Willd.


Fig. 93 *Acacia nilotica* L.

Fig. 94 *Acacia nilotica* L.

Fig. 95 *Acacia tortilis* (Forssk.) Hayne

Fig. 96 *Acacia tortilis* (Forssk.) Hayne

Fig. 97 *Agati grandiflora* Desf.

Fig. 98 *Agati grandiflora* Desf.

Fig. 99 *Albizzia lebbeck* (L.) Benth.

Fig. 100 *Albizzia lebbeck* (L.) Benth.

Fig. 101 *Bauhinia variegata* L.

Fig. 102 *Caesalpinia pulcherrima* Swartz.

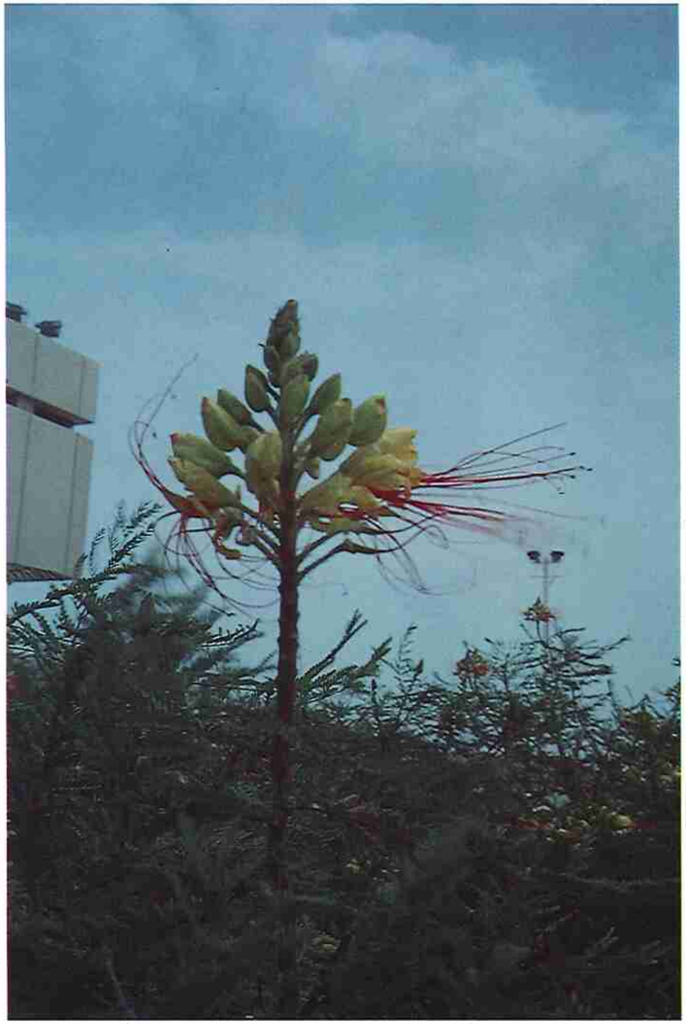


Fig. 103 *Caesalpinia pulcherrima* Swartz.

Fig. 104 *Delonix regia* (Hook.) Raf.

Fig. 105 *Delonix regia* (Hook.) Raf.

Fig. 106 *Lathyrus odoratus* L.

Fig. 107 *Lathyrus odoratus* L.

Fig. 108 *Parkinsonia aculeata* L.

Fig. 109 *Parkinsonia aculeata* L.

Fig. 110 *Pithecellobium dulce* Benth.

Fig. 111 *Pithecellobium dulce* Benth.

Fig. 112 *Prosopis juliflora* DC.

Fig. 113 *Prosopis juliflora* DC.

Fig. 114 *Aloe barbadensis* Mill

Fig. 115 *Aloe barbadensis* Mill

Fig. 116 *Sansevieria triafasciata* Prain

Fig. 117 *Lawsonia inermis* L.

Fig. 118 *Lawsonia inermis* L.

Fig. 119 *Althaea rosea* L.

Fig. 120 *Althaea rosea* L.

Fig. 121 *Hibiscus rosa-sinensis* L.

Fig. 122 *Hibiscus rosa-sinensis* L.

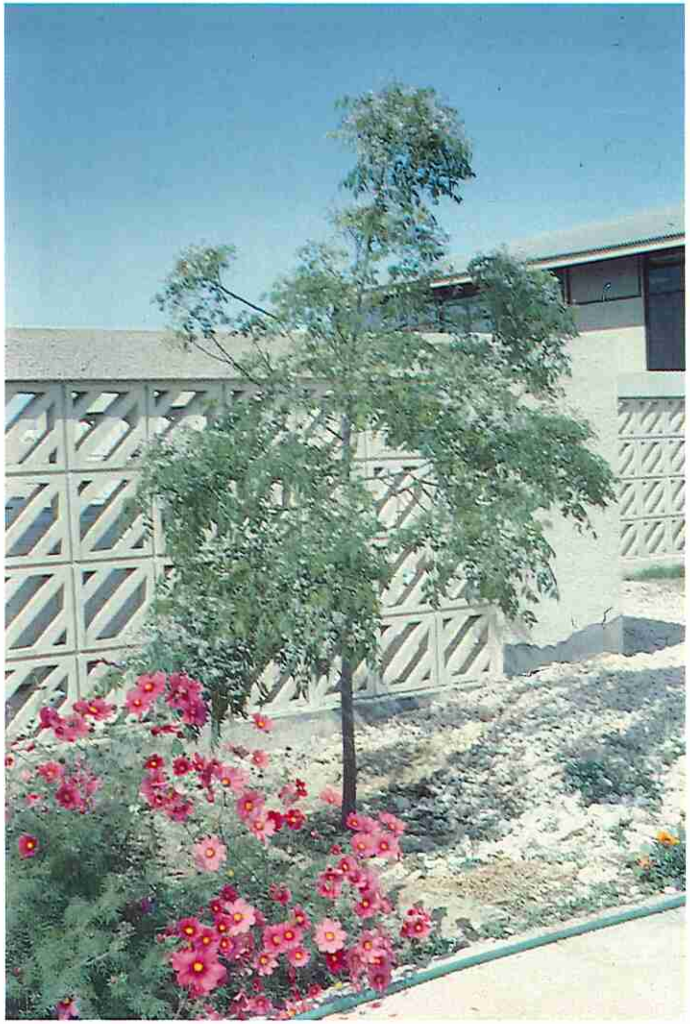


Fig. 123 *Melia azedarach* L.

Fig. 124 *Melia azedarach* L.

Fig. 125 *Ficus altissima* Blume.

Fig. 126 *Ficus altissima* Blume.

Fig. 127 *Ficus benghalensis* L.

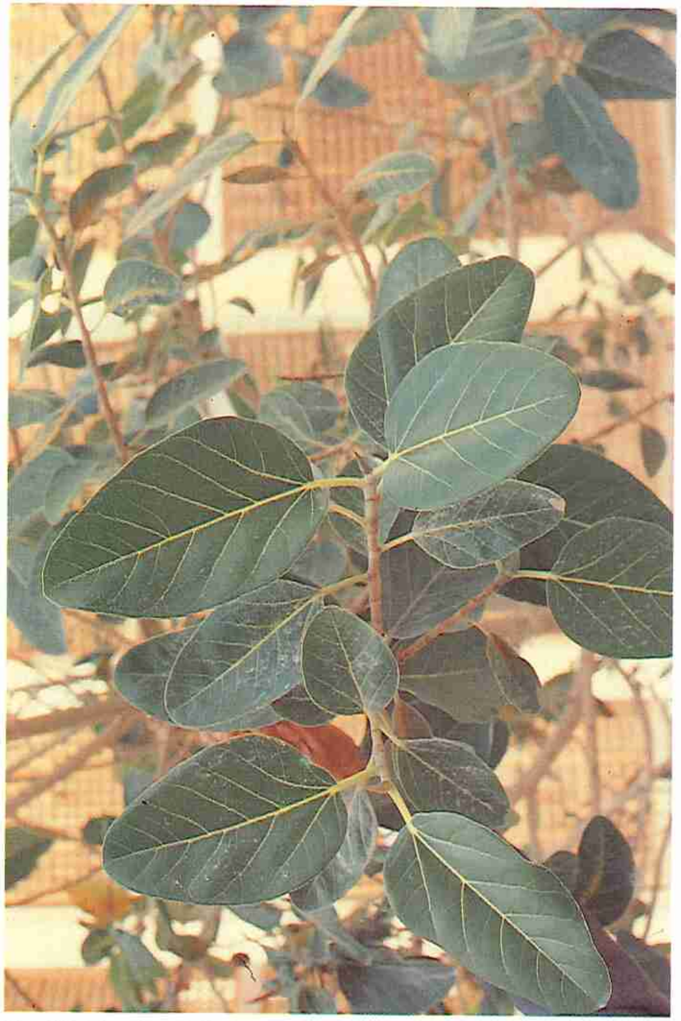


Fig. 128 *Ficus benghalensis* L.

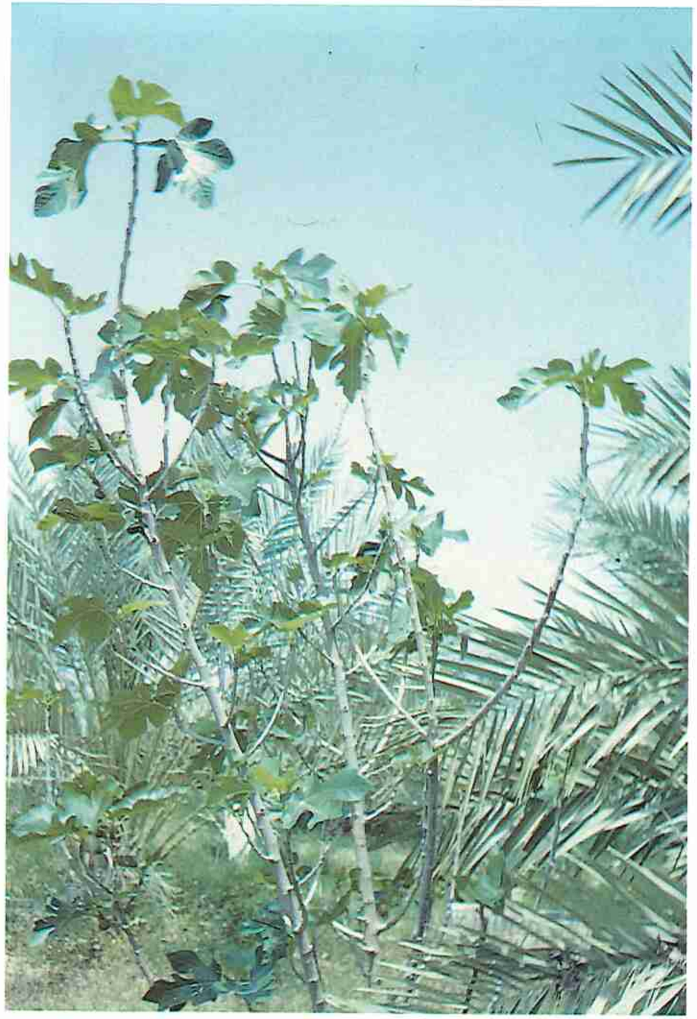


Fig. 129 *Ficus carica* L.

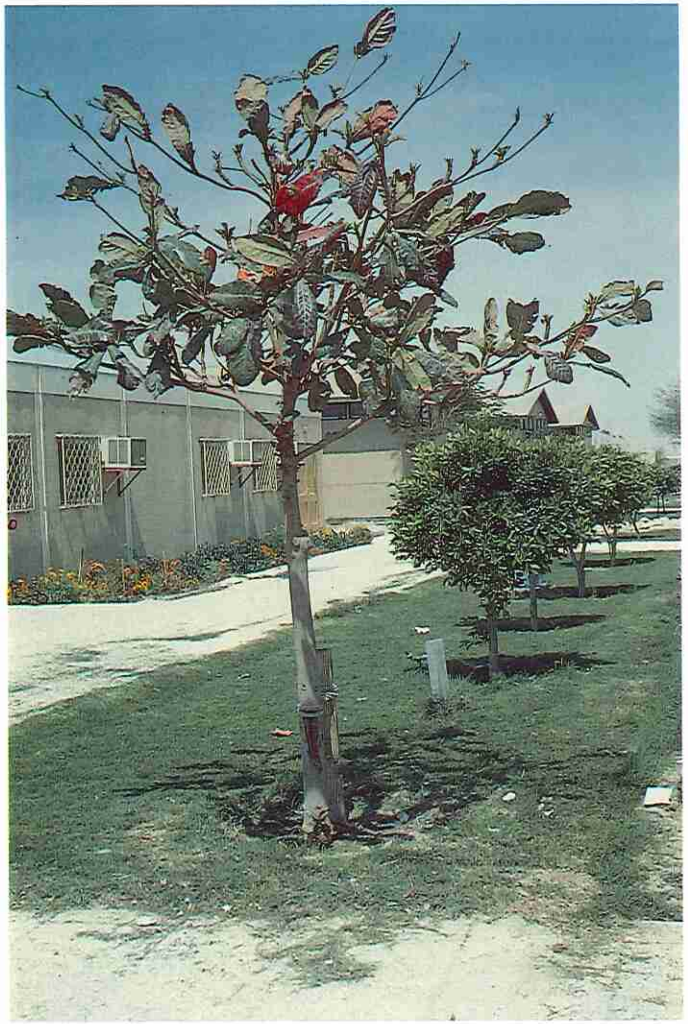


Fig. 130 *Ficus elastica* Roxb.

Fig. 131 *Ficus elastica* Roxb.

Fig. 132 *Ficus nitida* Thunb.

Fig. 133 *Ficus religiosa* L.

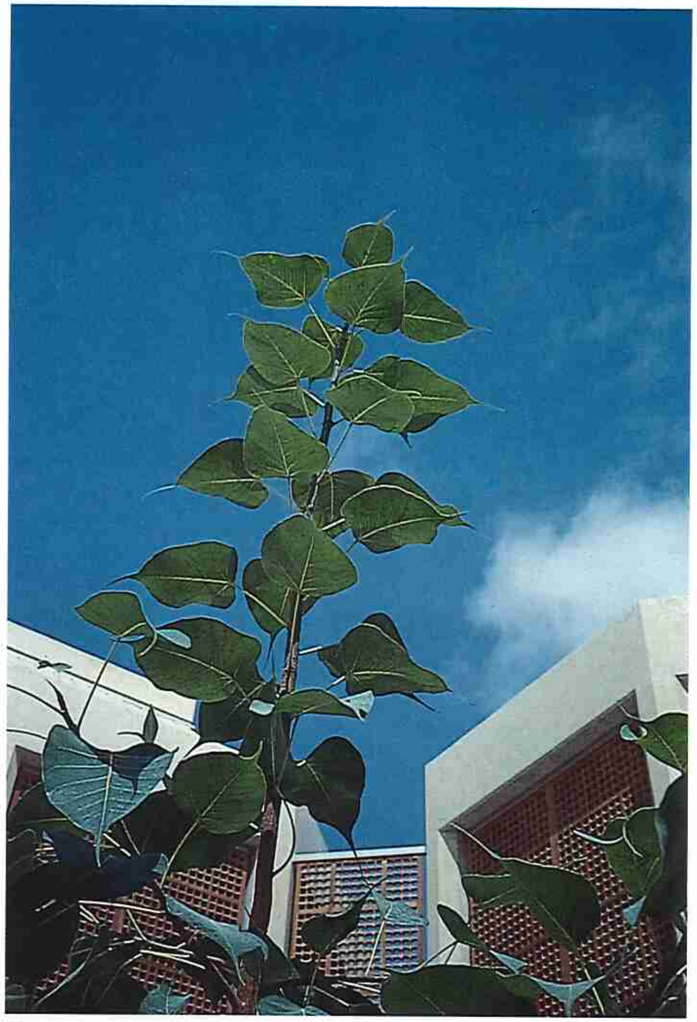


Fig. 134 *Ficus religiosa* L.

6 *Ficus nitida* Thumb.
Common name: *Fig*
Arabic name: *Fikus lameea*

The leaves contain angelicin, friedelin, epifriedelanol, nitidol (a triterpene, $C_{30}H_{50}O$, m.p. 250–253°C) and a mixture of two sterols (Elgamal *et al.*, 1975).

7 *Ficus religiosa* L.
Common name: *Fig, perpul, Bo-tree*
Arabic name: *Fikus, Lisan-el-asforr.*

The leaves contain n-alkanes (C_{25}-C_{33}), aliphatic alcohols (C_{25}-C_{30}), triterpene alcohols (α-amyrin, β-amyrin and lupeol) and sterols (campesterol, stigmasterol, β-sitosterol and traces of 28-isofucosterol) (Behari *et al.*, 1984).

The bark contains tannins (4%), phytosterols (β-sitosterol-D-glucoside), saponins and sapogenins (Varshney *et al.*, 1965; Ambike and Rao, 1967; Duke and Ayensu, 1985b). The latex contains 0·7–5·1% caoutchic (Duke and Ayensu, 1985b). The proximate and trace elements content of the leaves have been reported by Desai *et al.* (1980). The leaves are rich in calcium (2·91% dry matter basis). Both leaves and shoots are rich in protein and carbohydrates (Duke and Aynesu, 1985b).

The bark is astringent and is used in gonorrhoea. The fruits are laxative (Chopra *et al.*, 1956). The leaves possess estrogenic and anti-bacterial activities. The plant has also relaxant and spasmolytic effects (Ray and Bal, 1967; Singhal and Baslas, 1978). The bark is used as remedy for diabetes. The hypoglycemic activity of the plant has been reported by several authors (Brahmachari and Augusti, 1962; Rao *et al.*, 1966; Ambike and Rao, 1967).

The greyish wood is moderately hard and sometimes is used in India for making cases or burnt for charcoal (Singhal and Baslas, 1978).

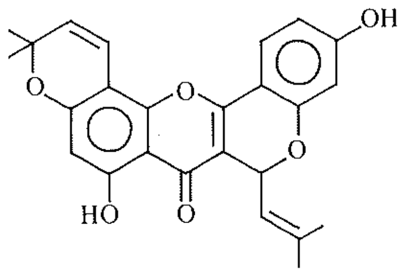
The leaves are used as cattle fodder (Hossain, 1959a,b; Mia *et al.*, 1960b). The dry leaf contains protein, 13·99%; fat, 2·71; crude fibre, 23·36 and N-free-extract, 46·04% (Mia *et al.*, 1960b).

2 *MORUS*

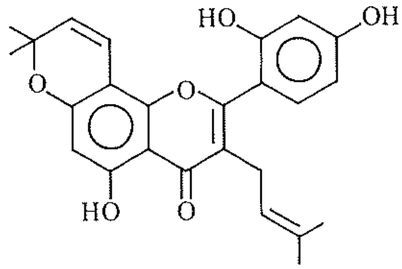
Several phenolic compounds have been isolated from both the heartwood and bark of *Morus* species. From the heartwood of five *Morus* species (*M. alba*, *M. indica*, *M. laevigata*, *M. rubra* and *M. serrata*), fifteen phenolics were identified *viz.* 3,4′-dihydroxydihydrostilbene, 3,2′,4′-trihydroxydihydrostilbene, 6,3′,5′-trihydroxy-2-phenylbenzofuran, norartocarpanone (5,7,2′,4′-tetrahydroflavanone), β-resorcylaldehyde, resorcinol, kaempferol, quercetin, resveratrol, piceatannol, dihydroxyresveratrol, morin, dihydromorin, dihydrokaempferol and oxyresveratrol (Deshpande *et al.*, 1975). A number of flavonoids have been identified from *M. mesozygia viz.* pinobanskin (dihydrogalangol, "5,7-dihydroxyflavonol"), morin (5,7,2′,2′-tetrahydroxyflavonol) and dihydromorin from the ground wood and moroside (morin rhamnoglucoside) from the leaves (Paris and Etchepare, 1966a).

A series of phenolic compounds *viz.* natural Diel's Alder type adducts, isprenylated flavonoids and 2-arylbenzofuran derivatives have been identified from the root bark of *Morus* species. Example of these phenolics are:

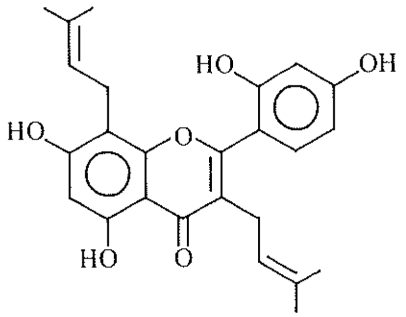
— Six flavonoid derivatives: cyclomorusin (= cyclomulberrochromene, 426), morusin (= mulberrochromene, 427), kuwanons C (= mulberrin, 428), E (429), G (430) and H (431); chalcomoracin (432) and mulberrofuran C (433, an 2-arylbenzofuran derivative) from the root bark of *M. alba*, *M. bomycis* and *M. lhou* (Nomura *et al.*, 1982; Zenyaku Kogyo Co., 1982).



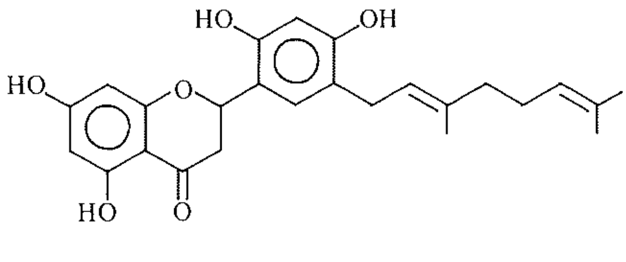
426 Cyclomorusin
(= Cyclomulberrochromene)



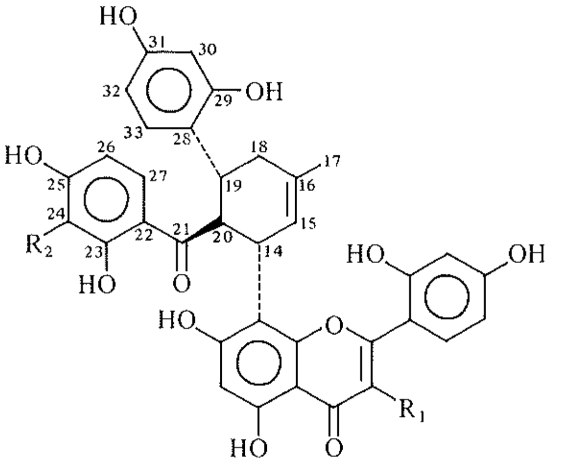
427 Morusin
(= Mulberrochromene)

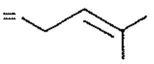


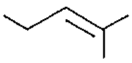
428 Kuwanon C
(= Mulberrin)

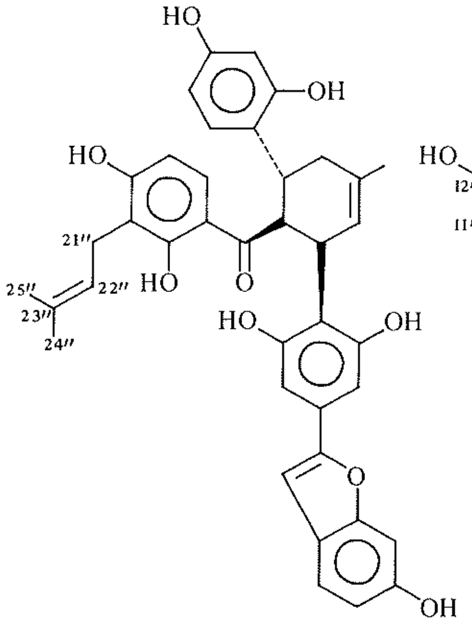


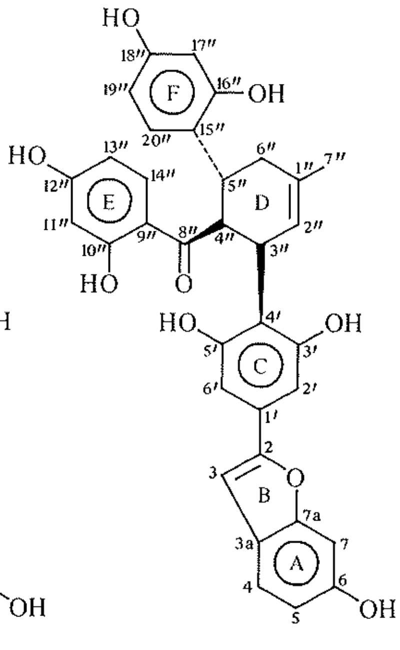
429 Kuwanon E
(Nomura *et al.*, 1982)



430 Kuwanon G
(= Albanin F; R_1 =  , R_2 = H
= Moracenin B)

431 Kuwanon H
(= Albanin G; R_1 = R_2 = 
= Moracenin A)



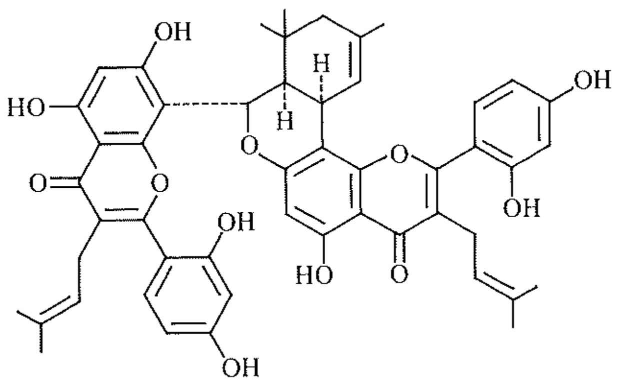


432 Chalcomoracin　　　433 Mulberrofuran C

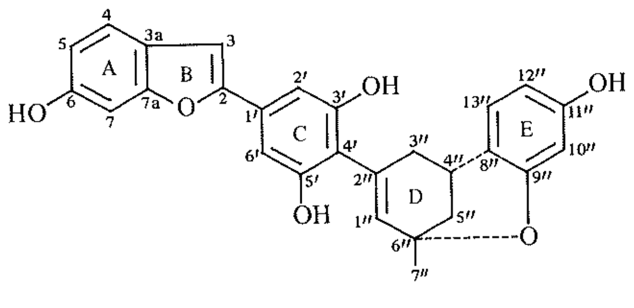
(Nomura *et al.*, 1982)

— Kuwanon M (434, a Diel's Alder adduct of two prenylflavone derivatives) (Nomura *et al.*, 1983a), mulberrofuran H (435, 2-arylbenzofuran derivative), Kuwanons S (436), T (437) (Fukai *et al.*, 1985), W (Hirakura *et al.*, 1985a), mulberroside B (439; 5,7-dihydroxycoumarin-6-*C*-*β*-glucopyranoside, (Hirakura *et al.*, 1985b) and mulberrosides A (oxyresveratrol-4,3′-di-*O*-*β*-D-glucopyranoside, 438) and C (moracin P-3′-*β*-D-xylopyranoside, 440) (Hirakura *et al.*, 1986) from the root bark of *M. lhou.*

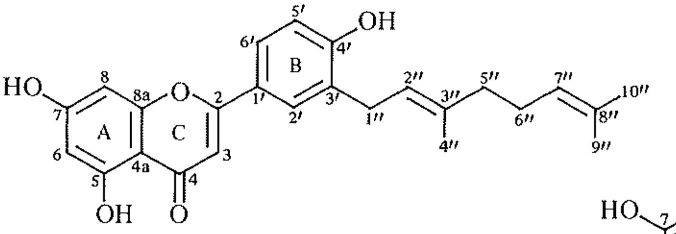
— Mulberrofurans K, N and O (2-arylbenzofuran derivatives) (Hano *et al.*, 1985) and sanggenons A, B (441), C, D (442) and E (443) (flavanone derivatives) from the root bark of *Morus* species (Nomura *et al.*, 1981a, 1982; Hano *et al.*, 1986b).



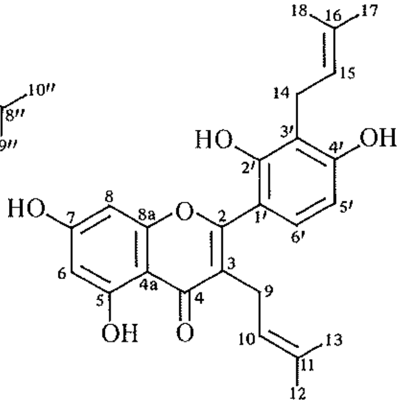
434 Kuwanon M
(Nomura *et al.*, 1983a)



435 Mulberrofuran H
(Fukai *et al.*, 1985)

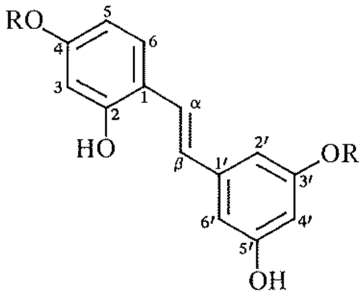


436 Kuwanon S

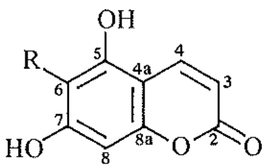


437 Kuwanon T

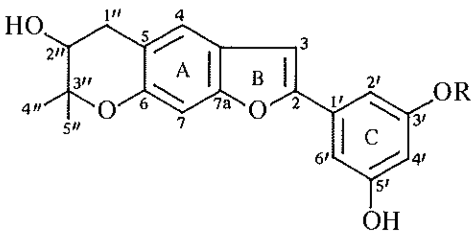
(Fukai *et al.*, 1985)



R = β-D-glucopyranosyl
438 Mulberroside A
(Hirakura *et al.*, 1986)



R = β-D-glucopyranosyl
439 Mulberroside B
(Hirakura *et al.*, 1985b)



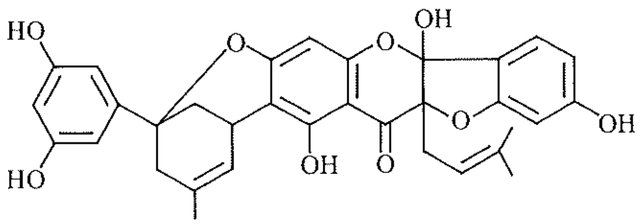
R = β-D-xylopyranosyl
440 Mulberroside C
(Hirakura *et al.*, 1986)

1 *Morus alba* L.
Common name: *White mulberry*
Arabic name: *Toot abiad*

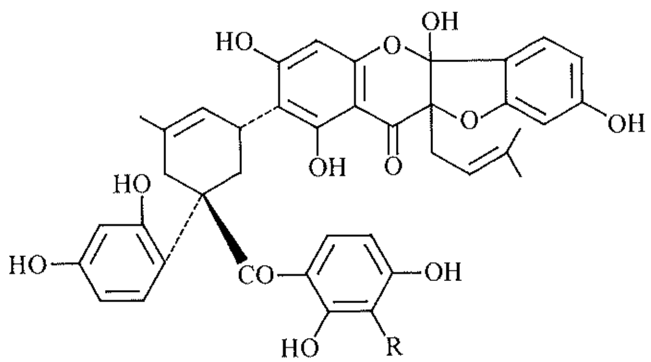
The bark of *M. alba* contains mulberrochromene (morusin, 427), mulberrin (kuwanon C, 428), mulberranol, albanol A (444) and albanol B (445) (Rao *et al.*, 1983), and α-amyrin (Oku, 1936).

The root bark contains the following compounds:

— Flavone derivatives: mulberrochromene (427), cyclomulberrochromene (426) (Deshpande *et al.*, 1968; Nomura *et al.*, 1978a), kuwanons A (446), B (447), C (428), D (448), E (429), F, G (430), H (431), K (449) and L (450) (Nomura *et al.*, 1977; 1978b, c, 1983b; Nomura and Fukai, 1978–1981; Zenyaku Kogyo Co., 1982), oxydihydromorusin (451) (Nomura *et al.*, 1977, 1978b) and moracenin D (452) (Nomura *et al.*, 1981b).

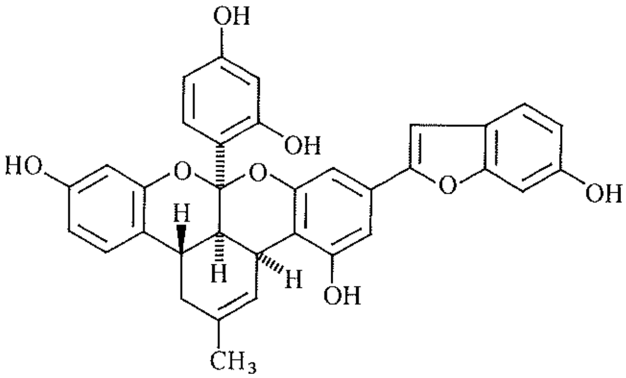


441 Sanggenon B

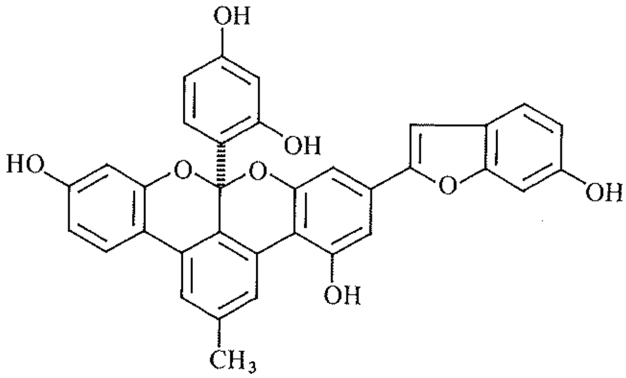


442 Sanggenon D : R = H
443 Sanggenon E : R = $CH_2CH{=}C(CH_3)_2$

(Nomura *et al.*,1981)

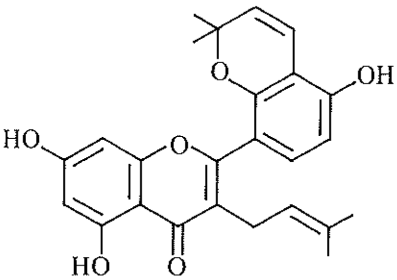


444 Albanol A

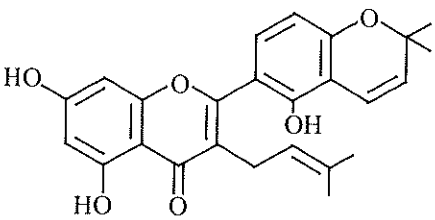


445 Albanol B

(Rao *et al.*,1983)

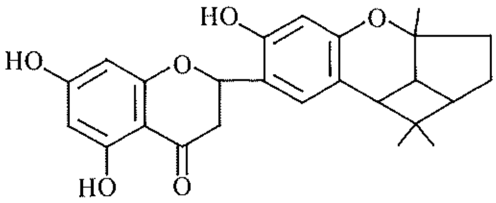


446 Kuwanon A

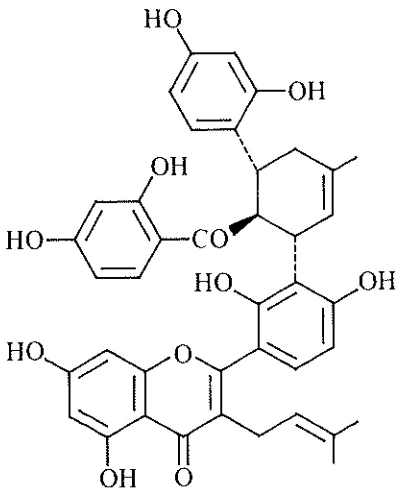


447 Kuwanon B

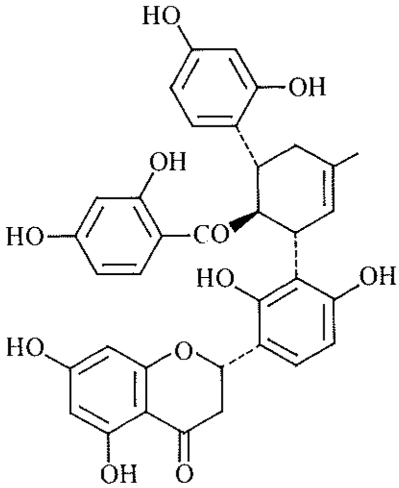
(Nomura *et al.*, 1977)



448 Kuwanon D
(Nomura *et al*., 1978c)

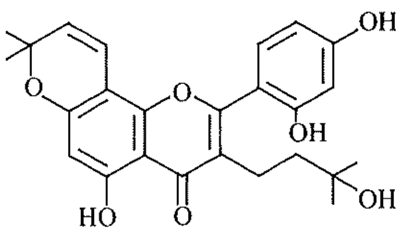


449 Kuwanon K



450 Kuwanon L

(Nomura *et al*., 1983b)



451 Oxydihydromorusin
(Nomura *et al*., 1977)

— 2-Arylbenzofuran derivatives: mulberrofurans A (453) (Nomura and Fukai, 1978), B (454) (Nomura *et al*., 1981b), M (455) (Hano *et al*., 1986a) and P (456) (Hano and Nomura, 1986).
— Stilbene derivatives: Kuwanons Y (457) and Z (458) (Hano *et al*., 1986c).

— Coumarins and chromones: umbelliferone and scopoletin (Uno, 1970) and 5,7-dihydroxychromone (Uno *et al.*, 1981).

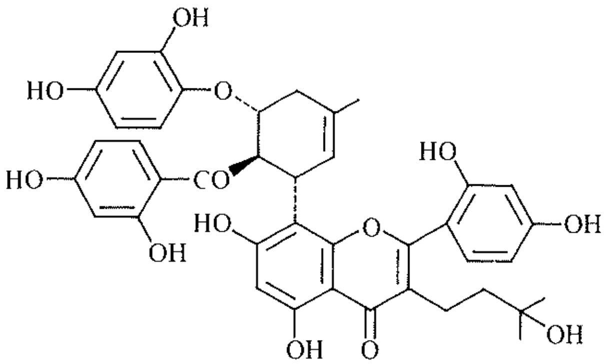
— A diglyceride, α, β-dimontany glycerol (Kondo and Takemoto, 1973) and ethyl 2,4-dihydroxybenzoate (Uno *et al.*, 1981). The latter compound exhibits antibacterial and antifungal activities.

The pigments of the wood are identified as morin (2′, 3, 4′, 5,7-pentahydroxyflavone), cudranin, maclurin (2,3′,4,4′-6-pentahydroxybenzophenone) and 2,4,4′,6-tetrahydroxybenzophenone (Suzushino, 1954a,b; Spada *et al.*, 1956, 1957).

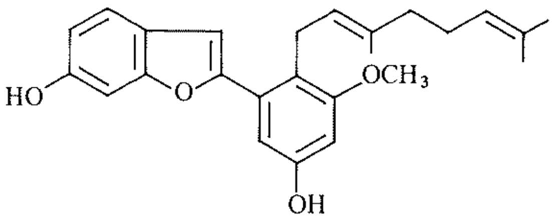
Mulberry leaves (which constitute the diet of the silk-worm *Bombyx mori*) have been thoroughly investigated. The leaves contain the following compounds:

— Flavonoids: rutin (Talyshinskii and Gasanov, 1965; Naito, 1968a), quercetin (Naito, 1968a), moracetin (quercetin 3-triglucoside) (Naito, 1968), quercitrin (Manunta, 1942) and astragalin (Naito, 1979).

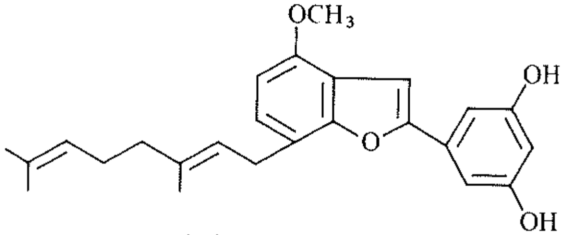
— Phenolic acids: chlorogenic acid (Nito and Hayashiya, 1965; Uno, 1972) and hydroxycinnamic acid (Cherno *et al.*, 1982).



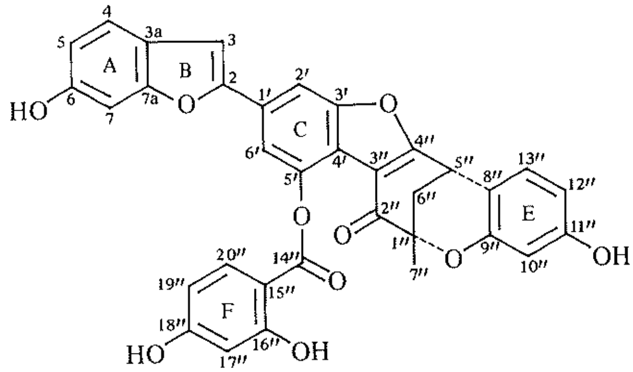
452 Moracenin D
(Nomura *et al.*, 1981b)



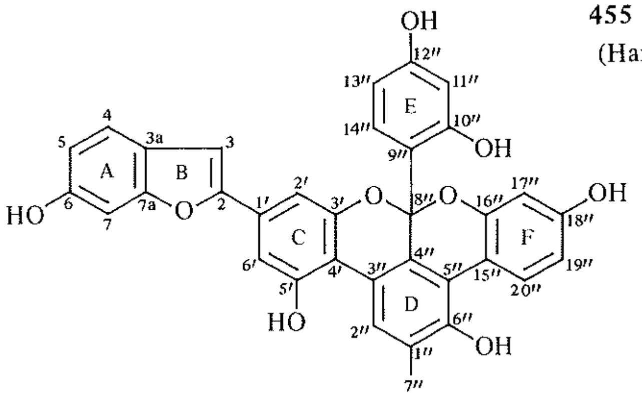
453 Mulberrofuran A
(Nomura and Fukai, 1978)



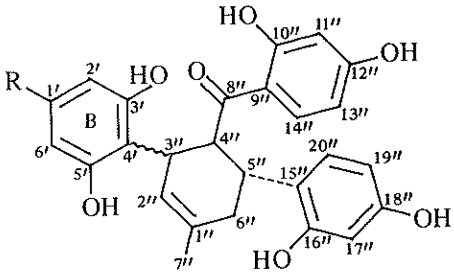
454 Mulberrofuran B
(Nomura and Fukia 1981)



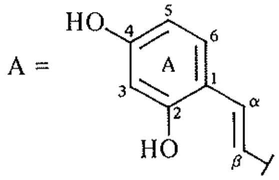
455 Mulberrofuran M
(Hano *et al.*, 1986a)

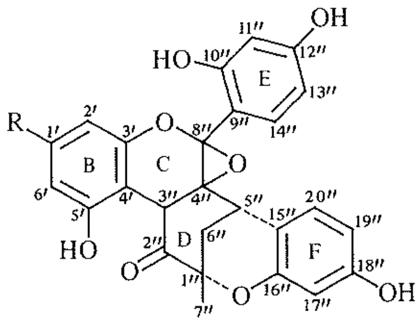


456 Mulberrofuran P
(Hano and Nomura, 1986)



457 Kuwanon Y
R = A, 3″ - H = α
(Nomura *et al.*, 1986c)





458 Kuwanon Z
(Nomura *et al.*, 1986c)

— Coumarins: scopolin, scopoletin and umbelliferone (Uno, 1972; Uno *et al.*, 1972). Umbelliferone and scopoletin (together with chlorogenic acid), occur in both autumn and spring leaves in almost the same amount; scopoletin apparently increases in autumn (Uno, 1972).

— Several volatile components (neutral, acidic, phenolic, carbonyl and basic fractions) e.g. acetic, propionic, isobutyric, valeric and caproic acids, methyl salicylate, guaicol, phenol, *o*-cresol, *m*-and (or) *p*-cresol, eugenol (Yamazaki, 1966), benzaldehyde (Yamazaki, 1967a), butyl alcohol, isoamyl alcohol, α-β-hexanal, *trans*-β-ν-hexanol, *cis*-β-ν-hexanol and linalool (Iwanari, 1973). Yields of neutral, acidic, phenolic, carbonyl and basic fractions from the crude essential oil of three varieties of mulberry leaves, as reported by Yamazaki (1967b), are 31·6, 25·5, 27·6, 10·8 and 4·4% respectively.

— β-Sitosterol, campesterol (Naito and Hammura, 1961; Moriya, 1977), β-sitosterol-β-D-glucoside, lupeol (Gato *et al.*, 1975) and straight chain alcohol ($C_{30}H_{62}O$), a biting stimulant to *Bombyx mori* (Frankel *et al.*, 1960).

— Pipecolic, *cis*- and *trans*-5-hydroxypipecolic acids (Kondo, 1957; Hatanaka and Kaneko, 1977).

The evaluation of the nutritive value of the leaves of mulberry has been reported by several workers. The polyploid forms, in most cases, have a higher content of phosphorus total soluble carbohydrates and trace elements, than diploid forms (Alieva *et al.*, 1971). The maximum content of crude protein in leaves is in July (26·7–22·7% of dry weight vs. 19·7–15·5% of dry weight in October). Cellulose content is high in the autumn (10·6–8·6% of dry weight in October) (Abdullaev *et al.*, 1967). Higher percentages of sugars also occur in July (Talyshinskii and Isaev, 1967). The highest content of fats and ash substances is in May (Talyshinskii, 1972). Proteins constitute about half of the nitrogenous substances (26·4% of dry matter) of the mulberry leaves. The leaves contain ~40% carbohydrates of which mono-and oligosaccharides constitute 31% (Cherno *et al.*, 1982). The average starch molecule contains one branch at 6 *th C* atom per each 18–20-D-glucopyranose units. Its main chain consists of D-glucopyranose residues linked by α-1-4 bonds (Cherno and Dudkin, 1984).

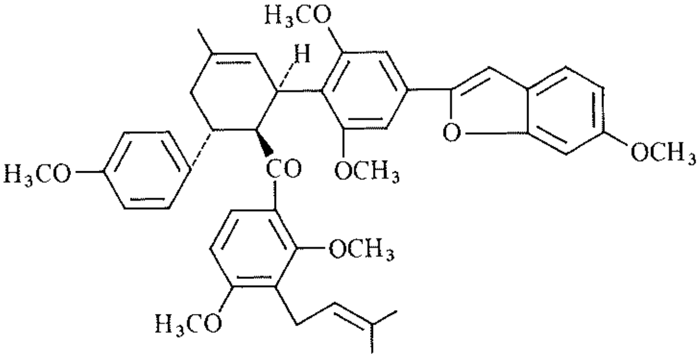
The leaves contain the following free amino acids: alanine leucine, isoleucine, tyrosine, valine, tryptophan, asparagine, proline threonine, arginine, glycine, methionine, aspartic acid, glutamic acid, serine and lysine (Ter-Karapetyan and Agadzhanyan, 1968; Vasuki and Basavanna, 1968). Tyrosine and threonine predominate in male leaves of *M. alba* (Dzhaparidze and Mikeladze, 1968). The leaves also contain vitamin B-complex (with the exception of vitamin B 12) (Jiro *et al.*, 1962), vitamin C and carotene (Badalov, 1971).

The fruits contain rutin, carotene, (Talyshinskii and Gasanov, 1965), chrysanthemin (cyanidin-3-glucoside) (Yamamoto, 1934; Ikuta *et al.*, 1985), pelargonidin 3-glucoside and petunidin 3-rutinoside (Maki and Inamoto, 1972), and succinic acid (Yamamoto, 1934). The fruits of *M. nigra* contain chrysanthemin (Toscano and Lamonica, 1972). The sterol composition of fruits and seed oil are identical and consists of β-sitosterol, stigmasterol, campesterol and cholesterol with β-sitosterol being the main component. The percentage ratios between the four sterols are 86·5:7·2:1·8:4·5 in unripe fruits; 87·5:4·2:2·2:6·1 in ripe fruits and 80·2:6·7:2·5:6·6 in seed oil (Zambakhidze and Durmishidze, 1981).

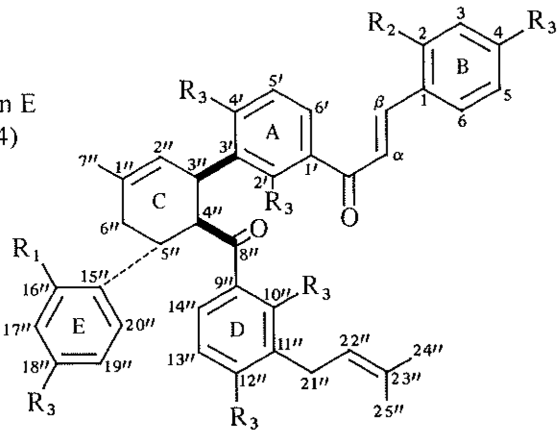
The fruits contain (per 100 gm) 87·5 gm water, 1·5 gm protein, 0·49 gm fat, 8·3 gm carbohydrates, 1·4 gm fibre, 0·9 gm ash, 80 mg calcium, 40 mg phosphorus, 1·9 mg iron, 174 IU vitamin A, 9 μg thiamine, 184 mg riboflavine, 0·8 mg nicotinic acid and 13 mg ascorbic acid (Duke and Ayensu, 1985b).

The seed-oil of *M. alba* is a rich source of linoleic acid, and palmitic acid is the major constituent of *M. nigra* seed oil. Myristic, palmitoleic and arachidic acids in traces and stearic and oleic acids in minor amounts occur in *M. alba* and *M. nigra* varieties (Salim *et al.*, 1966). The free sugars of the shoots are identified as sucrose, fructose, stachyose, glucose, maltose, raffinose, arabinose and xylose (Kashiwada, 1955).

From callus tissues of *M. alba* four Diel's-Alder type adducts have been identified: mulberrofuran E (459), Kuwanons Q,R and V (460–461). Mulberrofuran E is an adduct of a chalcone and a dehydroprenyl-2-arylbenzofurans, whereas kuwanons Q,R and V are adducts of 2-phenylchalcone derivatives (Ueda *et al.*, 1984). Chalcomoracin a natural Diels-Alder adduct (a phytoalexin) was isolated from disased mulberry leaves (Takasugi *et al.*, 1980a). Two other phytoalexins, albanins F (430) and G (431) have been identified from the shoot epidermis (Takasugi *et al.*, 1980b).



459 Mulberrofuran E
(Ueda *et al.*, 1984)



460 Kuwanon Q : $R_1 = H, R_2 = R_3 = OH$
461a Kuwanon R : $R_2 = H, R_1 = R_3 = OH$
461b Kuwanon V : $R_1 = R_2 = H, R_3 = H$
(Ueda *et al.*, 1984)

The fruit of white or red form, is nutritive, refrigerant and laxative. It is used as remedy for throat, dyspepsia and melancholia. The bark is considered purgative and anthelmintic (Kirtikar and Basu, 1984c). The leaves of *M. alba* possess growth-hormone like, androgen like and hypoglycemic activities (Sharaf, 1964; Sharaf and Mansour, 1964). The root bark possess cathartic, analgesic, diuretic, antitussive, antiedema, sedative, anticonvulsant and hypotensive activities (Tanemura, 1960; Yamataka *et al.*, 1976). Kuwanons G and H, isolated from *M. alba* and other *Morus* species, decrease the blood pressure (Nomura *et al.*, 1980; Zenyaku Kogya Co., 1982). Mulberry tree can be used for the production of various grades of strong and fine paper (Sansone, 1937).

XXX MUSACEAE

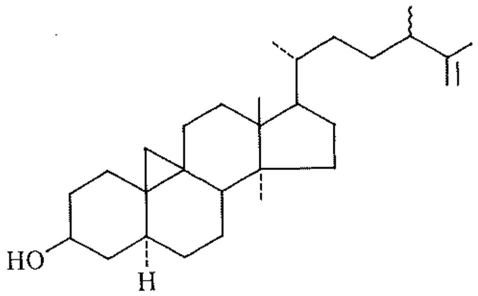
1 *MUSA*

1 *Musa paradisiaca* L. var. *sapientum* Kuntzl.
(= *M. sapientum*)
Common name: *Banana*
Arabic name: *Mooze*

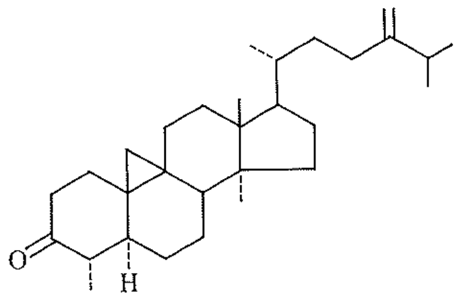
Fresh banana peel contains two physiologically important compounds, serotonin (5-hydroxytryamine) and norepinephrine (noradrealine), in addition to dopamine, dopa and indole 3-acetic acid (Krikorian, 1968). The fruit of *M. sapientum* var. *paradisiaca* contains noradrenaline, 5-hydroxytryptamine and dopamine (Foy and Parratt, 1960). Tyramine, β-phenylethylamines, propanolamine and histamine (non-volatile amines) and several volatile amines (e.g. methylamine, dimethylamine, ethylamine, isobutylamine, isoamylamine, spermidine, putrescine) also occur in the fruit (Askar *et al.*, 1972). The serotonin content increases proportionally with the degree of ripening, until reaching the maximum, then it decreases when the peel starts blackening (Poonpatan *et al.*, 1977). Dopamine accumulates in the peel prior to shooting (10–15%), most of the remaining dopamine accumulates during the first month after shooting with some accumulating during ripening (Buckley, 1964).

Studies on the sterol constituents of banana peel (*M. sapientum*) revealed the presence of unique sterols (e.g. cyloeucalenone, 24-methylenepollinastanol) besides several other usual sterols (4,4-dimethyl-,4α-methyl and 4-demethyl sterols) and 24-methylene-31-nor-5α-cycloartan-3-one (Knapp and Nicholas, 1969a, 1971; Knapp *et al.*, 1972). A recent detailed investigation of the sterol constituents of banana peel has been carried out by Akihisa *et al.*, (1986b) which led to the isolation and characterization of a new sterol (24*S*)-14α,24-dimethyl-9β,19-cyclo-5α-cholest-25-enβ-ol(=[24*S*]-24-methyl-25-dehydropollianastanol) (462). The sterols, so far identified from the peel (as reported by Akihisa *et al.*, 1986b) are: cycloeucalenone, 31-norcyclolaudenone, cycloartenol, 24-methylenecycloartenol, cyclolaudenol, cycloeucalenol, 31-norcyclolaudenol, obtusifoliol, 24-methylene-31-nor-5α-lanost-9(11)-en-3β-ol, 24-methylenepollinastanol, cholesterol, 24-methylcholesterol, 24-methylene cholesterol, (24*S*)-24-methyl-25-dehydrocholesterol, stigmasterol, sitosterol and isofucosterol.

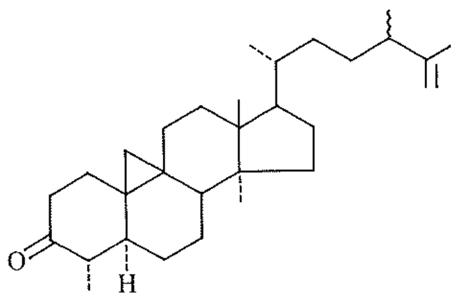
The fruits of *M. paradisiaca* contain two antiulcerogenic steryl glycosides sitoindoside I and sitoindoside II (467, 468) (Ghosal and Saini, 1984). The flowers contain two triterpenes (24*R*)-4α, 14α,24-trimethyl-5α-cholesta-8,25(27)-dien-3β-ol (469) (Dutta *et al.*, 1983) and 31-nor-24β-methyl-9,19-cycloalnost-25-en-3α-ol (Banerji and Das, 1984).



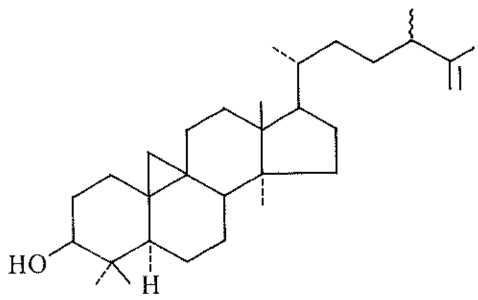
462



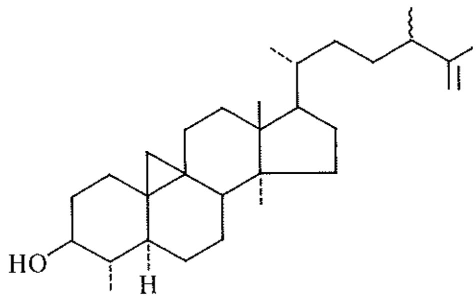
463 Cycloeucalenone



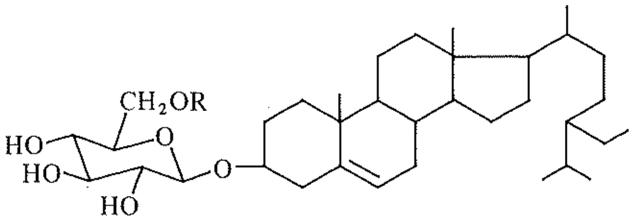
464 31-Norcycloiaudenone



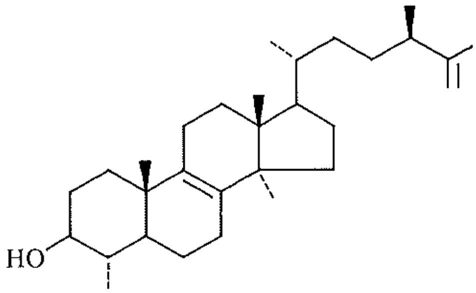
465 Cyclolaudenol



466 31-Norcyclolaudenol
(Akihisa *et al.*, 1986b)



467 Sitoindoside I : R = palmitoyl
468 Sitoindoside II : R = oleoyl
(Ghosal and Saini, 1984)



469 (Dutta *et al.*, 1983)

The sterol and steryl ester components of the stalk, leaves and rhizomes of the banana plant are very similar, although the relative amounts vary between tissues. Cycloeucalenol, cycloartenol, and 24-methylenecycloartenol are found in the free form and in the esterified form, primarily as esters of palmitic acid. Stigmasterol, campesterol and β-sitosterol are also present, primarily in the free form (Knapp and Nicholas, 1969b). Banana pulp contains the same sterol and triterpene components, with β-sitosterol accounting for more than 72% of the sterol fraction (1969c).

Eighteen fatty acids of even-numbered *C* chains between 6 and 22 carbon atoms occur in both the pulp and peel lipids. The unsaturated fatty acids in the lipid extract are of 16 and 18 *C* atoms. The composition of the fatty acid mixture is characterized by high levels of palmitic acid (57·8%) and lower levels of unsaturated acids (25·6% of oleic plus linoleic). During ripening the saturated acids in both the pulp and the peel increase and the unsaturated acids decrease (Groisbois and Mazliak, 1962). The total weight of lipid from pulp and peel does not change substantially during ripening. Goldstein and Wick (1969) reported a decrease in the linoleate from 12·58 to 4·88 mg/10 g dry weight as the pulp ripens. Palmitolate decreases from 2·21 to 0·84 mg/10 g dry weight, while stearate increases from 0·63 to 1·68 mg/gm. In general, the unsaturated acids decrease in both pulp and peel during ripening. The peel contains almost four times more lipid than the pulp. Banana peel wax contains 35% total fatty acids and 65% unsaponifiable matter. The latter consists of paraffins, 5%; polyene hydrocarbons, 6%; sterol esters, 11·5%; aliphatic alcohols, 30%;triterpenoid alcohols, 10%; sterols, 13% and unidentified substances, 25% (Rao and Rao, 1965b).

The contents of anhydrogalacturonic acid in the pectic substances from pulp and peel amount to 26·2% and 36·9% respectively. The amount of neutral sugars contained in the pectic substances varies, although the sugars are almost similar; arabinose and galactose are the largest followed by rhamnose and xylose, then mannose and ribose in trace amounts (Kawabata and Sawayama, 1975).

The fruit contains long-chain free fatty aldehydes (0·094 micromole/100 mg lipid) (Ferrell and Mark, 1970). Over 150 volatile compounds have been identified in bananas by various investigators. Most of the components are aliphatic esters, alcohols, and carbonyls (Issenberg and Wick, 1963; Wick *et al.*, 1966, 1969; Tressl and Drawert, 1973).

Malic, citric and phosphoric acids were identified from the dwarf Cavendish (Chinese) variety of bananas (Miller and Ross, 1963). Columbi and Ecuador bananas contain the above acids plus acetic and formic acids in small concentrations (Wolf, 1958). Malic and citric acids reach maximum values during the development stage and then decrease toward the end of ripening. The state of ripening and edibility can be characterized on the basis of the changes in the acid content (Wolf, 1958). The range of malic acid is 0·053–0·373% with a value of 0·314% at the usual eating stage (Harris and Poland, 1937). Tartaric and boric acids have been identified from two Brazilian varieties (Fonseca, 1941). Banana leaf contains oxalic, malic and citric acids and traces of glutamic, aspartic, glutaric, glyceric, glycolic, glyoxalic, shikimic, succinic, pyruvic, malonic and α-ketoglutaric acids (Palmer and Wyman, 1965).

The flavonols rutin and di- or triglucoside quercetin derivatives and their kaempferol homologs occur in the outermost layer of banana peel (Tronchet, 1970). Six anthocyanidins were identified from the bracts of eight species of banana plants *viz.* pelargonidin, cyanidin, peonidin, delphinidin, petunidin and malvidin: their specific occurrences are: *M. coccinea*: pelargonidin and cyanidin; *M. laterita*, *M. balbisiana* and *M. velutina*: cyanidin, peonidin and delphinidin; *M. acuminata*: partly methylated cyanidin, peonidin and delphinidin; *M. ornata*, *M. violascens* and an undescribed species: methylated cyanidin and delphinidin (Simmonds, 1954). Wild banana (*M. acuminata*) seeds, fruit pulp and flowers contain a mixture of proanthocyanidin glucosides based on leucopelargonidin (Mahey *et al.*, 1971).

The edible pulp of ripe bananas contains around 70% water, 20% carbohydrates, 1% proteins, 0·5% lipids and vitamins A,B group and C (Vickery and Vickery, 1975). A typical ripe banana has 3·5% fructose, 4·5% glucose, 11·9% sucrose, 0·6% fat and 0·8% ash. The ash contains Ca, Cu, Mg, Mn and Fe in available form. The unripe banana is high in starch, low in sugar and has an astringent taste due to tannin that becomes insoluble during ripening (Kar, 1938). Banana (from Taiwan) also contains 6^{G}-β-D-fructofuranosylsucrose (Su *et al.*, 1963; Su and Liao, 1964).

The amino acids (calculated to 16 gN) in Pacha bale (a variety of *M. cavandishii*), Kacla bale (a variety of *M. balbisiana*) and Rasa bale (a variety of *M. sapientum*) are as follows: cystine 1·7, 1·4, 2·3; lysine 5·8, 6·5, 6·6; histidine 8·3, 10·3, 7·1; arginine 6·1, 5·1, 5·3; serine, glycine and aspartic acid 12·9, 13·8 15·6; threonine and glutamic acid 15·4, 14·8, 17·4; alanine 5·6, 6·1, 6·8; γ-amino butyric acid 4·3, 5·2, 6·2; tyrosine 8·5, 5·3, 6·3; methionine and valine 6·8, 10·7, 10·6; phenylalanine 2·4, 3·7, 4·8. and leucine and isoleucine 6·7, 10·3, 9·0 (Bhagavan and Rajagopalan, 1956).

The evaluation of banana shoots as a human food has been reported by Gomez (1967).

The shoots have the following composition moisture, 92·604%; ash, 1·171%; protein, 1·893%; fat, 0·848%; fibers, 1·321%; carbohydrates, 3·897% and ash of fibers, 0·019%. The ash contains Fe, Mn, P, Ca, Na, and K. The amino acids of the protein fraction are: glutamic acid, aspartic acid, alanine, phenylalanine, glycine, proline, hydroxyproline, histidine, leucine, isoleucine, lysine, methionine, serine, threonine and tyrosine. The carbohydrate fraction contains glucose, fructose, xylose and sucrose. The shoots showed no toxicity to rats over a period of six months.

Although banana has high tannin content (which makes it not readily digestable; Agot, 1968), yet it is sufficiently digestible for humans (Maletto *et al.*, 1973). Several reports are available in literature about the nutritional values of bananas and their use in human nutrition (e.g. Carteni *et al.*, 1937; Parahym, 1945; Adriaens, 1953; Agot, 1968; Pande *et al.*, 1974).

Pulp has been prepared from banana stalks (Kane and Marathe, 1949; Moiseev *et al.*, 1972). Banana straw contains 20% water, 15% ash, 67% cellulose, 3·95% protein and 1·76% waxes and fats. The straw yields 28·2% pulp (Robinson-Gomez and Leonio, 1938). Fibre from banana plant stem closely resembles manila hemp in cellulose content (64·47% and 64·72%) (Biswas and Athawale, 1946). The fibers are smooth cylinderical cells, and yield pulp of moderate strength only (Laserna *et al.*, 1958).

The ripe fruit can be used as antiscorbutic, astringent, mild demulcent and in the treatment of cancerous ulcers, warts from skin, diabetes and dysentry (Ayensu, 1978). The flowers are used fro dysentry and menorrhagia and the leaves are used for blisters and burns, and were reported to contain hypoglycemic substance (Jain, 1969). The stems and twigs are used as tonic and in the treatment of venerael diseases, hysteria, epilepsy, dysentry, diarrhoea and urinary infections.

XXXI MYRTACEAE

Flavonoids and several other phenolic compounds occur in the different genera of the family Myrtaceae e.g. *Eucalyptus* species (mentioned below in details), aerial parts of *Eugenia kurzii* (Painuly and Tandon, 1983b), and bark of *Leptospermum scoparium* (Corbett *et al.*, 1964). Triterpenoids (e.g. cycloeucalenol, 24-methylenecycloartenol and arjunolic acid have been identified from many species e.g. the wood of *Tristania conferta* (Ritchie *et al.*, 1961) and *Angophora subvelutina* (Ritchie and Taylor, 1961) and the heartwood of *Metrosideros umbellata* (Corbett and Bailey, 1963).

1 *CALLISTEMON*

1 *Callistemon lanceolatus* D.C.
Common name: *Bottle brush*
Arabic name: *Forshat el-zogag*

The leaves of *C. lanceolatus* contain the following compounds:

— Triterpenoids: ursolic acid, oleanolic acid, uvaol, 2α-hydroxyursolic acid, 2α-hydroxyuvaol (the latter two occur as glycosides "saponins") (Younes, 1975a,b), betulin, betulinic acid erthyrodiol (Varma and Parthasarathy, 1975) and α-amyrin and β-sitosterol (Hashim *et al.*, 1980b).

— Essential oil (0·2%) (Purohit and Nigam, 1958) which contains about 60% 1,8-epoxy-*p*-menthane (Chuman *et al.*, 1972) and possesses fungitoxic activity (Pandey *et al.*, 1982). The essential oil stimulates vitellogenin formation when applied topically (200 μg) to allatectomized female bugs *Dysdercus koenigii* (*Katiyar et al.*, 1984).

— Flavonoids: 3′, 4′, 7-trihydroxyflavonol, 3′, 4′, 7-trihydoxyflavone, 3′, 4′, 7-trihydroxyflavonol-3-glucoside and 3′, 4′, 7-trihydroxyflavone-7-galactoside (Hashim *et al.*, 1980a).

The flower pigments are identified as pelargonidin 3,5-diglucoside, and kaempferol (Tandon *et al.*, 1970). The bark contains ellagic acid, 3,3′-di-*O*-methylellagic acid and 3,3′-tri-*O*-methylellgic acid (Bhatia *et al.*, 1972). Catechol tannins or pyrogallol tannins and flavonoids occur in leaves, flowers and fruits (Hashim *et al.*, 1980b).

The berries contain 51·49% water; fat, 5·39; nitrogenous matter, 2·97; crude fibre, 14·63; ash, 5·58; non nitrogenous extract, 19·94; reducing sugars, 0·84 and tannic substances, 13·47% (Sallusto, 1936–1937).

C. rigidus contains the same flavonoids detected in *C. lanceolutus* (Hashim *et al.*, 1980a), α-amyrin, β-sitosterol, betulinic acid, oleanolic acid, β-sitosterol (Hashim *et al.*, 1980b) and melaleucin (a triterpenoid) (Takemoto and Yahagi, 1955).

2 *EUCALYPTUS*

All species of *Eucalyptus* yield a volatile oil, known as oil of eucalyptus, most of which contain about 70% eucalyptol (1,8-cineole). The volatile oils contain a wide variety of compounds e.g. camphene, sabinene, myrcene, *p*-menthane, α-terpinene, ν-terpinene, fenchone, α-thujone, β-thujone, citral, citronellall, cryophyllene, piperitone, α-pinene, β-pinene, limonene, linalool, geraniol, borneol, α-terpineol, eucalyptol, α-and β-phellandrene (Penfold and Mourrison, 1932, 1944; Penfold *et al.*, 1953; Chkhaidze *et al*, 1973; Lastro Valdes and Rodriquez Galiano, 1981; Lassak and Southwell, 1982). Essential oil composition can be, at times, useful in the differentation of botanically close or superficially similar species of *Eucalyptus* species (Lassak and Southwell, 1982). *Eucalyptus* species (due to their oil content) have been evaluated recently as a renewable source of hydrocarbons (Nishimura and Calvin, 1979). *E. radiata* contains 8·7 weight % fuel ingredient and 27 weight % cellulose and various bioactive substances (Nishimura, 1979).

Polyphenolic compounds (flavonoids, anthocyanis, ellagic acids, tannins. . .etc.) occur in *Eucalyptus* species (Hillis and Hingston, 1964; Hillis, 1967a, b, d; Hillis and Morita, 1969). Forty-three of the fifty *Eucalyptus* species examined by Hillis (1967c) contain leucoanthocyanins. Methylellagic acids and their glycosides were detected in different tissues of *Eucalyptus* species (Hillis and Yazaki, 1973). From the young leaves and bark of twenty-three species of *Eucalyptus*, Sharma and Crowden (1974) isolated seventeen anthocyanins; among the identified anthocyanins are cyanidin 3-glucoside, cyanidin 3,5-diglucoside and delphinidin compounds. Tannins occur in relatively higher percentages in *Eucalyptus* species. *E. cornea* and *E. rudis* contain 25% and 15% respectively (Swamy *et al.*, 1981). Eucalyptin (4′, 7-dimethoxy-6,8-dimethyl-5-hydroxyflavone and 8-desmethyleucalyptin (two unusual *C*-methylflavones) occur in the leaf waxes of several species of *Eucalyptus* (Lamberton, 1964; Courtney *et al.*, 1983). Rutin occurs in several species (Humpreys, 1958, 1964) in a high percentage and thus allowing the use of certain species for industrial production. The presence of several other flavonoids has been reported e.g. myricetin, quercetin and kaempferol (Hillis and Hingston, 1963).

Ursolic acid has been identified from many *Eucalyptus* species: *E. microtheca* gives relatively high yields of it (2·5%) (Dayal, 1985). *Eucalyptus* waxes also contain 11,12-dehydroursolic lactone acetate (Horn and Lamberton, 1964). Oxalic acid (as calcium oxalate) occurs in the barks of several species (Metcalfe and Chalk, 1957; Bharadwaj and Chandra, 1985).

Oil of eucalyptus is used as a household remedy for colds and an ingredient in nasal drops. It is also used in soap prefumary and as a component of many insecticides and repellant preparations. *Eucalyptus* oil is used chiefly in the treatment of nose and throat disorders, malaria and other fevers (Hill, 1952).

1 *Eucalyptus camaldulensis* Dehne.
Common name: *Murray red gum*
Arabic name: *Kafour*

The wood of *E. camaldulensis* contains tannins including dimeric proanthocyanidins (one of which is a dimer of 3,5,7,3′,4′-pentahydroxyflavan) (Nisi, 1966, 1969; Nisi and Panizzi, 1966). Also, detected in the wood are *d*-catechol, ellagic acid, gallic acid, and a 2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxy-3,4-dihydro-2H-1-1,2-benzopyran octamer (Nisi, 1970). Methylellagic acids were identified in the plant (Hillis and Yazaki, 1973).

The leaves contain the following flavonoid glycosides: kaempferol 3-glucoside and 3-glucuronide, quercetin 3-glucoside, 3-glucuronide, 3-rhamnoside, 3-rutenoside (rutin), and 7-glucoside, apigenin 7-glucuronide, and luteolin 7-glucoside and 7-glucuronide (Abd-Alla *et al.*, 1980). Stilbenes also occur in the leaves (Hillis, 1966).

The leaves yield a volatile oil with a high cineole percentage (Abou-Dhab and Abouj-Zied, 1974). The volatile oil exhibits antibacterial activity (Suri and Thind, 1978). The bark is rich in calcium oxalate (3·32–8·68%) and has been recommended for use as a raw material for extraction of oxalic acid (Bharadwaj and Chandra, 1985). *E. camaldulensis* gives pulp (48–49%) suitable for handsheets (Kandeel *et al.*, 1982).

2 *Eucalyptus rostrata* Schlecht not Cav.
Common name: *Murray red gum*
Arabic name: *Kfour*

E. rostrata contains 12–16% tannin in 7–10 year old trees or 9% in 5–6 year old trees. The tannin is a mixture of the pyrogallol and catechol classes (Krakauer *et al.*, 1959). The plant contains the following sugars: xylose, mannose, arabinose, galactose and lyxose (Fumasoni, 1959).

XXXII NYCTAGINACEAE

Hydroxyrotenoids, alkaloids and polysaccharides have been isolated from *Boerhaavia* species (Nandi and Chatterjee, 1974; Gupta and Ahmed, 1984; Messana *et al.*, 1986). *C*-Glycosylflavonoids also occur in the family (Richardson, 1978).

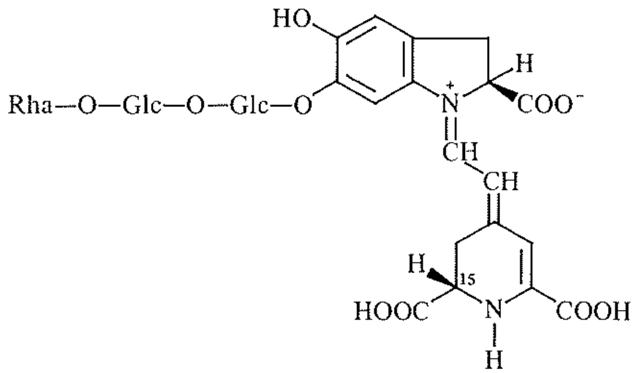
1 *BOUGAINVILLAEA*

The isolation and characterization of several betacyanins from a variety of *Bougainvillaea* ("Mrs. Butt") with purple bracts have been reported. Two of these red-violet pigments (bougainvillein-r's) have been shown to be 5-*O*-*β*-sophorosides of betanidin and isobetandin respectively. The remaining five bougainvillein-r's are hydroxycinnamoyl derivatives of bougainvillein-r-1 and isbougainvillein-r-1 (Piattelli and Imperato, 1970a).

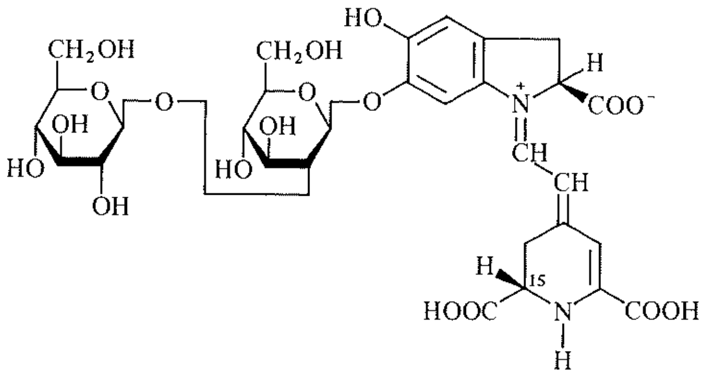
1 *Bougainvillaea glabra* Choise.
Common name: *Bougainvillea*
Arabic name: *Gohannamiah*

Early Price and Robinson (1937) reported the isolation of the pigments bougainvilleidin and quercetin from the bracts of *B. glabra*. Later, the violet-red pigments (bougainvillein-r's) isolated from *B. glabra* var. *sanderiana* have been identified as acylated betacyanins. Alkaline hydrolysis of the total betacyanin fraction gives four deacylated pigments. Two of these are the 6-*O*-rhamnosylsophoroside (470) and the 6-*O*-*β*-sophoroside (471), of betanidin, the other two being the corresponding isobetanidin derivatives (Piattelli and Imperato, 1970b). The sugar moiety of the betacyanin pigments is a branched trisaccharide, 2^G-glucosylrutinose (Imperato, 1975b).

Phytochemical screening of the plant revealed the presence of coumarins, saponins and alkaloids (Rizk *et al.*, 1988).



470 Betanidin 6-*O*-rhamnosylsophoroside

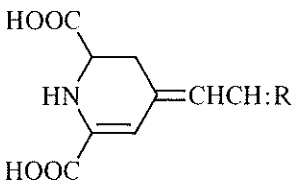


471 Betanidin 6-*O*-β-sophoroside
(Piatelli and Imperato, 1970b)

2 *MIRABILIS*

1 *Mirabilis jalapa* L.
Common name: *Four O'clock plant*
Arabic name: *Shabb Ellail*

The flowers of *M. jalapa* contain the following pigments: six betaxanthins (472), in which R is an amino acid or amine which is joined to the substituted dihydropyridine moiety by an = N^+H-link, indicaxanthin, vulgaxanthin I and four miraxanthins I,II,III and V in which the R moiety in (472) is methionine sulphoxide, aspartic acid, tyramine, and dopamine respectively (Piattelli *et al.*, 1965).



472 (Piatelli *et al.*, 1965)

The leaves of *M. jalapa* contain C_{23}-C_{35} straight alkanes, ketones (e.g. 12-tricosanone), alcohols (e.g. *n*-hexanol), sterols (e.g. β-sitosterol) and fatty acids (e.g. tetracosanoic acid), citric acid and tartaric acid (Behari *et al.*, 1976). The seed oil contains 8-hydroxy octadeca-*cis*-11,14-dienoic acid (Ahmed *et al.*, 1984).

The leaves contain the following amino acids: glycine, alanine, trytophan, valine and leucine (Behari and Andhiwal, 1976; Behari *et al.*, 1976). The amino acids of the seeds are arginine, glycine, histidine, threonine, tyrosine and aspartic and glutamic acids (Rastogi *et al.*, 1982).

The root of *M. jalapa* contains oxymethylanthraquinone. The alkaloid trigonelline occurs in the plant (Watt and Breyer-Brandwijk, 1962).

The cotyledons of the seed contain a D-glucan; both α-and β-D-glucosidic linkages are present in the polysaccharide, the former preponderating. For every 38 D-glucosyl residues therein, 34 and 3 are (1 → 3) linked; the D-glucosyl unit at the branch unit is linked through *O*-1, *O*-1 and *O*-4. In some places in the chain, there are ⩾ 3(1 → 3)-linked D-glucosyl residues in a sequence (Ghosh *et al.*, 1981). The isolation and characterization of starch from both fruits (Chaudhari, 1947) and seeds (Chang *et al.*, 1983) have been reported. The root contains 2·78% of total resins and is an irritant to the skin and mucous membrane (Youngken, 1940).

The root of *M. jalapa* is purgative. In India the fresh leaf juice is applied locally to relieve the heat and itching of urticaria and internally for gonorrhoea and uterine discharges. An infusion of the leaf is said to be diuretic and is used for dropsy (Watt and Breyer-Brandwijk, 1962). At night the flower exhales a strong odour which is said to stupefy and drive away the mosquito.

XXXIII OLEACEAE

Flavonoid and iridoid glucosides have been identified in many oleaceous plants. The chemotaxonomic survey of ninty-seven taxa representing all the genera of the family Oleaceae revealed that four flavonol glycosides are common: the 3-glucosides and 3-rutinosides of quercetin and kaempferol, as are four flavone glycosides namely the 7-glucosides and 7-rutinosides of luteolin and apigenin (Harborne and Green, 1980). Among rarer constituents detected were luteolin 4′-glucoside, eriodictyol 7-glucoside, chrysoeriol 7-glucoside, an apigenin-di-*C*-glycoside, and several higher glycosides of quercetin. Lignans e.g. phillygenin, (+) pinoresinol, phyllyrin, arctiin, olivil, (+) cyclo-olivil and (+) africanol have been identified from leaves (Kitagawa *et al.*, 1984) and fruits and bark (Tsukamoto *et al.*, 1983) of several *Forsythia* species.

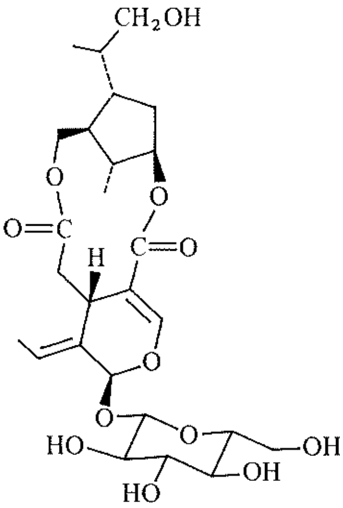
Iridoid and secoiridoid glucosides were isolated from several genera of the family Oleaceae (Inoue *et al.*, 1975) e.g. oleuropein, ligstroside, ligustalosides A and B from *Ligustrum japonicum* (Inoue *et al.*, 1982b) and several others from *Jasminum* and *Olea* species (mentioned later in details).

Of the fourteen species examined by Pourrat *et al.*, 1954), thirteen were found to contain ursolic acid in the leaves. The presence of other triterpenoids has been also reported e.g. β-amyrin and oleanolic acid (Dominguez *et al.*, 1980a). Mannitol is present in several genera e.g. *Syringa*, *Lingustrum*, *Jasminum* and *Fraxinus* (Plouvier, 1952). Phyllyrin (probably identical with chionanthin) occurs in certain species of *Phillyrea*, *Forsythia* and *Osmanthus* (Steinegger and Jacober, 1959). Fats of the Oleaceae contain acetylenic acids (Hatt *et al.*, 1960).

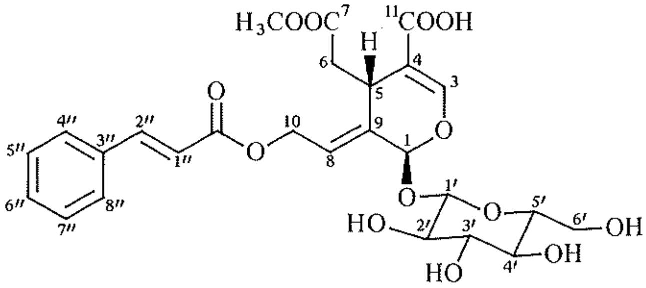
1 *JASMINUM*

Jasminum species (e.g. *J. auriculatum*, *J. grandiflorum*, *J. officinale*, *J. odoratissimum*), particularly the flowers contain volatile oils which consists of a variety of different components e.g. linalool, methyl benzoate, benzyl acetate, benzyl alcohol, *cis*-jasmone, eugenol, vanillin, nerolidol, isophytol, farnesol, phytol, nerol, cinnamyl benzoate (Deshpande and Upadhyay, 1970a; Cheng and Chao, 1977; Cheng, 1979; Jannin and Baron, 1980).

Secoiridoids have been identified from plants of this genus *viz.* jasminin (473) and Jasminoside (474) from *J. primulinum* Hemsl (= *J. mesnyi* Hance) (Kamikawa *et al.*, 1970) and *J. humile* var. *revolutum* (Inoue *et al.*, 1982a) respectively.



473 Jasminin



474 Jasminoside

(Inoue *et al.*, 1982)

Jasminium species also contain monoterpene alkaloids (e.g. jasminine) (Hart *et al.*, 1968, 1969). Also occur in these plants are flavonoids (e.g. rutin and quercetin) in *J. fruticans* (Mangaldzhiev, 1972) and *J. mesnyi* (El-Moghazy *et al.*, 1980); lignans (e.g. pinoresinol) in *J. simplicifolium* (Hart *et al.*, 1969), D-mannitol in *J. auriculatum* (Deshpande and Upadhyay, 1968), and several triterpenoids e.g. jasminol from *J. auriculatum* (Deshpande and Upadhyay, 1970b), ursolic acid from *J. fruticans* (Popov *et al.*, 1970b), friedelin, lupeol, betulin, betulinic acid and oleanolic acid from *J. flexile*, *J. humile*, *J. multiflorum* and *J. sambac* (Dan and Dan, 1985).

The volatile oil is used in perfumes. The primary alcohols, ketones, aldehydes and part of the wax esters are used as fixatives for the odour in soap perfume. The hydrocarbons and the free fatty acid fractions are used to replace carnauba wax in the production of an enriched cleansing cream (El-Wakeil *et al.*, 1982).

The bark and leaf of *J. glabrusculum* are used as antimalarials. The leaf of *Jasminum* is also used as an enema for biliousness (Watt and Breyer-Brandwijk, 1962).

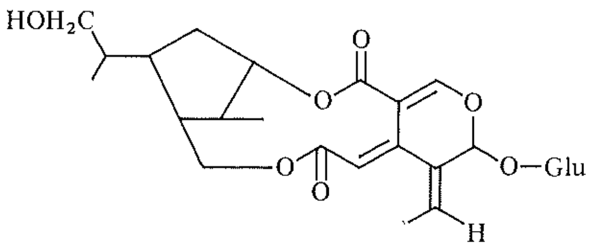
1 *Jasminum azoricum* L.
Common name: *Jasmine*
Arabic name: *Yasmine*

The leaves contain α-amyrin, β-amyrin, ceryl alcohol, β-sitosterol, linoleic acid, oleic acid, palmitic acid, myristic acid, lauric acid, quercetin, kaempferol-3-*O*-rhamnoside, kaempferol 3-*O*-rhamnoglucoside, rutin, mannitol, jasminin glucoside, sambacin glucoside and azoricin (Ross and Abdel-Hafiz, 1984).

2 *Jasminum sambac* Ait.
Common name: *Arabian Jasmine*
Arabic name: *Yasmin*

The top node oil preparation from *J. sambac* contains various fragrant components; at least thirty-four components are present, of which linalool and *cis*-3-hexen-1-yl acetate are the two major components. Benzyl acetate, methyl benzoate, methyl salicylate, myrcene, α-fenchene, limonene, ν-3-carene, *cis*-linalool oxide and *trans*-3-hexenyl butyrate are also present in quantifiable percentages (Ma *et al.*, 1983). Also detected in the oil are: methyl alcohol, isobutylalcohol, 1-penten-3-ol, 2-isopentenyl acetate, methyl-2-buten-1-ol, 1-pentanol, *trans* -3-pentene-1-ol, cyclopentanol, benzaldehyde, 1-methyl-6-isopropylidenebicyclo [3:1:0] hexane, α-terpineol, 2,6,6-trimethyl-2-vinyl-5-hydroxytetrahydropyran and benzyl alcohol (Ma *et al.*, 1984).

The leaves of the two varieties of *J. sambac* contain sambacin (475, an iridoid glycoside), jasminin (473), quercitrin, isoquercitrin, rutin, quercetin 3-dirhamnoglucoside, kaempferol 3-rhamnoglycoside, mannitol, α-amyrin, β-sitosterol, and sucrose (Ross *et al.*, 1982), friedelin, lupeol, betulin, betulinic acid, ursolic acid and oleanolic acid (Dan and Dan, 1985). The total terpenoids amount to 0·04% of dry weight leaves (Dan and Dan, 1985).



475 Sambacin
(Ross *et al.*, 1982)

2 *OLEA*

Olea species are characterized by the presence of secoiridoid glycosides and lignans. Coumarins occur in the barks of certain *Olea* species e.g. esculetin, scopoletin, esculin and scopolin form *O. africana* (*O. europea* var. *africana*) and *O. capensis* (Tsukamoto *et al.*, 1984a; 1985a). The leaf of *O. paniculata* contains the terpenoid jasminine (Hart *et al.*, 1971). D-Mannitol occurs in the exudation of *O. glandulifera* (Ram and Rao, 1949).

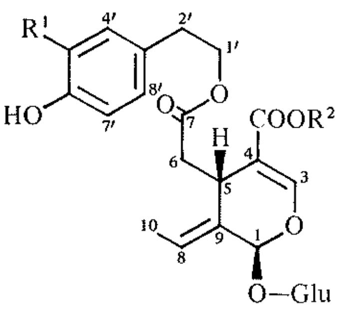
1 *Olea europea* L.
Common name: *Olive*
Arabic name: *Zaytoon*

The fruit of *O. europea* is the source of olive oil which is an important edible oil. The fruit, also contains two iridoid glucosides possessing molluscicidal activity, oleuropein (476, also called oleuropeoside) and ligstroside (479) (Kubo and Matsumoto, 1984a, b), and oleanolic and maslinic acids (Movsumov and Aliev, 1985). Verbascoside (a caffeic acid derivative) occurs in the fruit (Fleuriet *et al.*, 1984). The fruit pulp contains several phenolic compounds *viz.* 3,4-dihydroxyphenylethanol (4-monoglucoside and 4-diglucoside), an ester of caffeic acid (1-caffeyl glucose), *p*-coumaric acid, quercetin 3-rutinoside, luteolin7-glucoside, luteolin 5-glucoside, apigenin 7-glucoside, cyanidin 3-glucoside and cyanidin -3-rutinoside (Vazquez Roncero *et al.*, 1974). The epicarp contains cyanidin 3-monoglucoside, quercetin-3-*O*-rhamnoside, rutin, *p*-coumaric acid, caffeic acid and 1-caffeylglucose. The mesocarp contains flavonols with free OH in position 3 or free or esterified OH in position 5, as well as aurones. The endocarp contains luteolin 5-*O*-glucoside, apigenin glucoside, *p*-coumaric acid and caffeic acid (Camurati *et al.*, 1981).

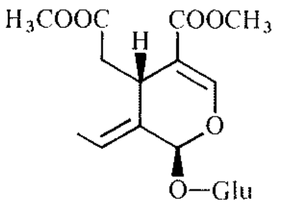
The epicarp contains higher concentration of triterpenic diols (uvaol and erythrodiol) as compared with the mesocarp, endocarp and seed of olives (Camurati *et al.*, 1988). Olive fruit protein contains all of the common amino acids present in other plant proteins. Arginine constitutes approximately 25% of all essential amino acids, followed by leucine and valine (Manoukas *et al.*, 1973). Estrone has been isolated from the oil (Amin and Bassiouny, 1979).

The leaves contain the following compounds:

1. Secoiridoids: oleuropein (476), demethyloleuropein (477), oleoside (478), ligstroside (479) and the two secoiridoids (480) and (481) (Panizzi *et al.*, 1960; Inouye *et al.*, 1970, 1974; Ragazzi *et al.*, 1973; Gariboldi *et al.*, 1980). Both oleuropein and its demethylderivative stimulate oviposition of *Dacus oleae*, an insect which infests Meditteranean olive crops (Ragazzi *et al.*, 1973). The degradation products form the hydrolysis of oleuropein inhibit oviposition of *D. oleae* and this fact is attrituable to the formation of 3,5-dihydroxy-β-phenylethanol which occurs in the leaves (Gariboldi *et al.*, 1986).

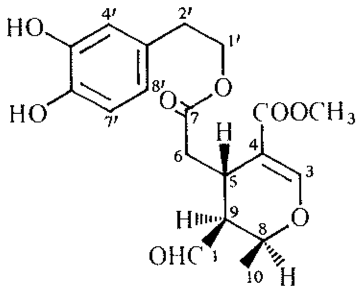


476 Oleuropein : $R^1 = OH, R^2 = CH_3$
477 Demethyloleuropein : $R^1 = OH, R^2 = H$
479 Ligstroside : $R^1 = H, R^2 = CH_3$

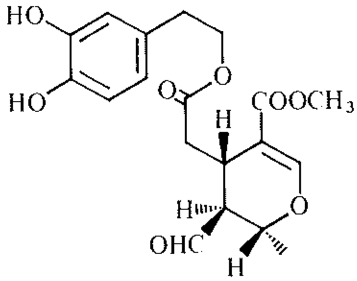


478 Oleoside

(Gariboldi *et al.*, 1986)



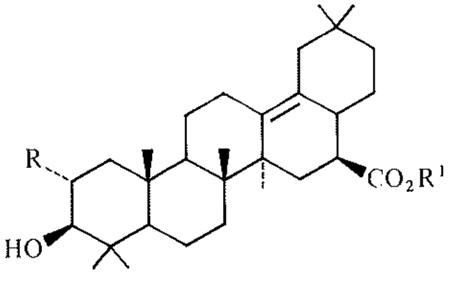
480



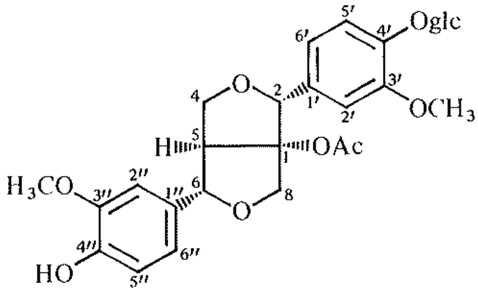
481

(Gariboldi *et al.*, 1986)

2. Flavonoids: luteolin, apigenin, luteolin-7-*O*-glucoside, chrysoeriol 7-*O*-glucoside, luteolin-4′-*O*-glucoside, apigenin-7-di-*O*-xyloside, apigenin7-glucoside (and probably 2′, 4, 4′, 6′-tetrahydroxy-2-methoxy*β*-methylchalcone (Bockova *et al.*, 1964; Kriventsov *et al.*, 1974; Tomas and Ferreres, 1980).
3. Triterpenoids: oleanolic acid, maslinic acid, *β*-amyrin and two oleanane hydroxy acids, (482) and (483) (Caputo *et al.*, 1974b; Mussini *et al.*, 1975; Hernandez Madrid, 1978). The leaf of bitter olive is heavily coated by almost pure oleanolic acid which form part of a multichemical defense against fungal attack (Kubo and Matsumoto, 1984).



482 : R = OH, $R^1 = CH_3$
483 : R = R^1 = H
(Cabuto *et al.*, 1974b)



484
(Tsukamoto *et al.*, 1984c)

4. Cinchona alkaloids: cinchonidine, cinchonine and dihydrocinchonine (Schneider and Kleinert, 1971, 1972).
5. Squalene (Vazquez-Roncero and Janer, 1962), tannins, mannit, choline and *β*-sitosterol glucoside (Watt and Breyer-Brandwijk, 1962).

The stems contain (+)-acetoxypinoresinol-4′*β*-D-glucoside (484, a lignan) (Chiba *et al.*, 1979), other nine lignan compounds (Tsukamoto *et al.*, 1980), kaempferol, quercetin, esculetin and esculin (Nishibe *et al.*, 1981).

The bark contains three secoiridoids: oleuropein, demethyloleuropein and oleoside 7-methyl ester (Tsukamoto *et al.*, 1985b) and the following lignans: (+)-1-acetoxypinoresinol, (+)-1-hydroxypinoresinol, (+)-1-acetoxypinoresinol-4″-*O*-methyl ether,

(+)-l-hydroxypinoresinol-4″-*O*-methy ether, (−)-olivil and (+)-cyclo-olivil (Tsukamoto *et al.*, 1984b). The bark and the heartwood of *O. europea* subsp. *africana* contains several secoiridoids, lignans and coumarins (Viviers *et al.*, 1979; Tsukamoto *et al.*, 1984a,c).

The study of distribution of various unsaponifiable components within olive drupes revealed that 4-methyl sterols, triterpene alcohols and phytol occur in the pulp, whereas most linear saturated alcohols and triterpene alcohols are located in the peel (Paganuzzi, 1980). Oleanolic acid is the major triterpene acid of the fresh olive husks (Caputo *et al.*, 1974a).

The isolation and structure of an acidic xylan (composed of xylose and 4-*O*-methyl glucuronic acid in the molar ratio 24:1) have been reported from the fruit pulp of *O. europea* var. *arolensis* (Gil-Serrano *et al.*, 1986). *O. europea* (fruit, bark and leaves) also contains elenolide (an unsaturated lactone) (Beyerman *et al.*, 1961). Oleuropeic acid (4-(1-hydroxyisopropyl)-1-cyclohexene-1-carboxylic acid) occurs in the root bark of *O. europea* as a sucrose ester linked to the *C*-6 of the D-glucose unit i.e. occurs as 6-*O*-oleuropeoylsucrose (Scarpati and Trogolo, 1966).

The anthocyanins of *O. europea* (Manzanillo olives) have been identified as peonidin 3-monoglucoside acylated with *p*-coumaric acid, cyanidin 3-monoglucoside, cyanidin 3-rhamnoglucoside acylated with caffeic acid and peonidin 3-rhamnosylglucoside (Luh and Mahecha, 1971).

The leaves have hypotensive action (due to the glucoside oleuropein) (Cavanna and Pirona, 1950; Samuelsson, 1951). The leaf and bark are employed as a remedy for scrofula and intermittent fever, as a tonic, and an antifebrile (Watt and Breyer-Brandwijk, 1962). Areview on production, chemical characteristics, nutritional value, methods of improvement of nutritional value and ruminant feeding of olive husks, has been recently reported (Nefzaoui and Vanbelle, 1984).

XXXIV ONAGARACEAE

Many species and genera of the family Ongaraceae have been surveyed for their flavonoid constituents. The flavonoid chemistry of the family appears to be relatively homogenous containing predominantly flavonols, particularly *O*-glycosides or methyl ethers of kaempferol, quercetin and myricetin (Hilsenbeck *et al.*, 1984). *C*-Glycosylflavones have, however been reported in the genera *Circaea* (Boufford *et al.*, 1978) and *Gaura* (Hilsenbeck *et al.*, 1984). Examples of the genera which contain *O*-glycosylflavonoids are: *Epilobium* (Averett *et al.*, 1978), *Heterogaura* (Averett *et al.*, 1982), *Oenothera* (Howard *et al.*, 1972), *Stenosiphon* (Averett and Raven, 1983b) and *Xylonagra* (Averett and Raven, 1983a).

1 *GODETIA*

Scanty information is available about the constituents and/or uses of this genus. The flowers of *G. whitneyi* contain the flavonoids hyperin and quercitrin (Zapesochnaya *et al.*, 1965).

1 *Godetia amoena* Don.
Common name: *Farwell to spring*
Arabic name: *Godetia*
Phytochemical screening revealed the presence of flavonoids (Rizk *et al.*, 1988).

XXXV PALMAE

The taxonomic patterns in the fat content, fatty acid composition of the triglycerides and the positional distribution of the fatty acids within the triglycerides of twelve species of Palmae seeds showed a direct correlation between the values of these parameters and the botanical sub-families within the families. Cocoideae species have a high fat content (44–72%), a high level of lauric acid (38–56 mole %), a low level of unsaturated acids (6–9 mole %), and appreciable esterification of lauric and myristic acids at the 2-position of the triglycerides. Coryphoideae and Phoenicoideae species exhibit a low fat content (3–14%), an intermediate level of lauric acid (15–29 mole %), a high level of unsaturated acids (45–61 mole %) and preferential esterification of lauric and myristic acids at the 1,3-positions of the triglycerides. Arecoideae species show a wide variation in the values of these parameters (Litchfield, 1970). Later, Opute (1978) studied the lipids and fatty acids from the fruit coat, pollens and seeds of a number of palm species belonging to seven subfamilies, and their use to evaluate the taxonomic position of the Palmae. Contrary to established belief, lauric and myristic acids were not the principal fatty acids in the palms (Opute, 1978, 1979a).

A survey of 125 species of the Palmae revealed a complex pattern of flavonoids in the leaf. *C*-glycosylflavones, leucoanthocyanins, and tricin, luteolin, and quercetin glycosides were common, being present in 84, 66, 51, 30 and 24% of the species respectively. Many of the *C*- and *O*-glycosides were present as their potassium bisulphate salts and negatively charged compounds were detected in 50% of the species. Of the thirty-one palm species investigated by Harborne and Williams (1971) seventeen were found to contain flavone bisulphate salts. In *Mascarena verschaffettii*, one of the flavones is the potassium salt of luteolin-3′-glucoside. The distribution patterns are correlated with the taxonomy of the family in several ways. Thus, the Phoenicoideae and Caryotoideae have distinctive flavonoid patterns, there is evidence to support the separation of the subfamilies Phytelephantoideae and Nypoideae, and tricin is a useful marker to the tribal level. A numerical analysis of the obtained data together with the morphological characters produces a new classification which suggests that the flavonoid data may have more systematic value than when they are applied to the traditional classification (Williams *et al.*, 1973).

Yields, physico-chemical characterization, acid composition values and sterol components of the seed and pulp oil and general composition values of the solvent-defatted meals from the ripe fruits of the plant has been reported by Rodenstein and Cattaneo (1974).

1 *ARECASTRUM*

1 *Arecastrum romanzoffianum* Becc.
(= *Cocos romanzoffiana* Cham.)
Common name: *Queen palm*
Arabic name: *Nakheel*

Full-grown dried nuts from a mature tree average 23% of fibrous husk, 69% shell and 8% kernel. The dried kernel contains 52% oil, somewhat similar to palm-kernel oil (Pulley and von Loesecke, 1941).

The leaves of *A. romanzoffianum* contain quercetin3-rutinoside sulphate and isorhamnetin 3-rutinoside sulphate (Williams *et al.*, 1973). The phenolic constituents of the flower of the same species are quercetin 7-glucoside, lucenin7-glucoside, orientin and caffeylshikimic acid (Harborne *et al.*, 1974). The flowers of palms are relatively rich in flavonoid pigments. They are also characterized by having charged flavones and large quantities of caffeylshikimic acid.

2 *PHOENIX*

Triterpenes, sterols, aliphatic hydrocarbons and alcohols, free-long-chain acids, flavonoids and polysaccharides have been identified from certain *Phoenix* species (Rizk, 1986). Friedelin and β-amyrone were detected in *P. paludosa* (Majumdar and Patra, 1979) and lupeol from *P. canariensis* (Garica *et al.*, 1981). Procyanidin polymers identified in *P. canariensis* were found to contain 2,3-*cis*-5,7,3′,4-tetrahydroxy-flavan-3-ol units (Foo and Porter, 1982).

The fatty acids profile of the seed oil of wild date (*P. sylvestris*) (8.2%), showed lauric, myristic, palmitic, stearic, behenic, lignoceric, oleic, and linoleic (Reddy *et al.*, 1980). Oleic and linoleic are the major fatty acids of the seeds of *P. canariensis* (Mitsuhashi *et al.*, 1980).

Quercetin and luteolin glycosides were detected in the flowers of *P. canariensis* and *P. roebolenii* (Harborne *et al.*, 1974). The cutin components of the leaves of *P. canariensis* were identified as *threo*-9, 10-18-trihydroxyoctadecanoic acid, *cis*-9,10-epoxy-18-hydroxyoctadecanoic acid, *p*-coumaric acid and ferulic acid (Fernandez *et al.*, 1979). Mannan polysaccharides were found in the seeds of both *P. canariensis* and *P. paludosa* (Courtois and Le Dizet, 1964; Moyna and Di Fabio, 1977).

1 *Phoenix dactylifera* L.
Common name: *Date palm*
Arabic name: *Nakheel balah*

The stems of *P. dactylifera* contain the following compounds:

- β-Sitosterol, stigmasterol and campesterol (Fernandez *et al.*, 1983a). and their glycosides (galactosides and glucosides (Luz Cardona *et al.*, 1985).
- Hydroxysterols: 6β-hydroxystigmast-4-en-3-one, 6β-hydroxystigmasta-4,22-dien-3-one and 6β-hydroxycampest-4-en-3-one (Fernandez *et al.*, 1983a).

— 3,6-Diketophytosterols: stigmast-4-en-3,6-dione, stigmasta-4,22-dien-3,6-dione and campest-4-en-3,6-dione, 5α-stigmastan-3,6-dione, 5α-stigmast-22-en-3,6-dione and 5α-campestan-3,6-dione (Fernandez *et al.*, 1983a).

— 3-Keto-6-hydroxyphytosterols: 6β-hydroxystigmast-4-en-3-one, 6β-hydroxystigmast-4-en-3-one, 6β-hydroxystigmasta-4,22-diene-3-one and 6-hydroxycampest-4-en-3-one (Fernandez *et al.*, 1983a).

— Stilbenes: *trans*-3,5,3′,5′-tetrahydroxy-4-methylstilbene, *cis*-3,5,3′,5′-tetrahydroxy-4-methylstilbene (resveratrol) (Rizk, 1986).

— Lupeol and a mixture of hydrocarbons (C_{26}-C_{31}) (Fernandez *et al.*, 1983a).

— *p*-Hydroxybenzaldehyde, 4-hydroxy-3-methoxybenzaldehyde, and 3,5-dihydroxy-4-methoxybenzaldehyde (Luz Cardona *et al.*, 1985).

— Benzoic acid, *p*-hydroxybenzoic acid, 4-hydroxy-3-methoxy-cinnamic acid and 3,5-dihydroxy-4-methoxybenzoic acid (Luz Cardona *et al.*, 1985).

— Apigenin and 7β-glucosyl chrysoeriol (Luz Cardona *et al.*, 1985).

The steroid hormone estrone has been identified from both the seeds and pollens of the date (Hassan and Abou El Wafa, 1947; Heftmann *et al.*, 1965; Amin, 1969). Moreover, the pollen contains cholesterol, the precursor of all the steroid hormones in animals (Bennett *et al.*, 1966). The fruits contain-3-caffeylshikimic acid (Harborne *et al.*, 1976). The pollen also contains rutin (El Ridi *et al.*, 1952), quercetin, β-amyrin, β-sitosterol, a steroidal saponin (having glucose, and rhamnose as sugar moiety) and a glucoprotein which has a gonadotrophic activity (Mahran *et al.*, 1976).

Traces of coumarin occur in the leaves and leaf stalk. Leaves contain luteolin 7-glucoside, luteolin-7-rutinoside and glycosylapigenin. The condensed tannins range 0·75–4·48% in different main parts of the data palm. Gallotannin ranges 0·43–2·78% and ellagitannin 0–0·99% (Nezam El-Din *et al.*, 1983).

Galactomannan polysacchardies have been isolated from *P. dactylifera* seeds (Jindal and Mukherjee, 1970, 1971; Jindal and Sharma, 1981). Polysaccharides which gave on hydrolysis xylose, arabinose and galactose were isolated from Iraq dates (Koro *et al.*, 1969) and Iran dates (Koro *et al.*, 1970). The possibility of date seed as a commercial source of mannonic lactones has been early reported by Goldner and Rogers (1939).

The sarocarp contains cholesterol, campesterol, stigmasterol, β-sitosterol and isofucosterol. The dry seed contains 7·9% moisture, 5·2% protein, 6·8% fat, 65% carbohydrates, 13·6% fibre and 0·89% ash. The fatty acid composition of the seed oil is lauric, 8%; myristic, 4%; palmitic, 25%; stearic, 10%; oleic, 45% and linoleic, 10% with some capric and caprylic acids as well. Acetaldehyde is the major volatile aldehyde in date (Duke and Ayensu, 1985a).

Dates are very nutritious, containing 60–70% sugars, 7% protein, pectins, gums and vitamins A,B_1,B_2 and nicotinic acid. Iraqi dates contain a high concentration of glucose (35·7% in Sayer variety) and fructose (30·8% in Zahdi variety) (Abu-Shakir and Hamdy, 1968). The total protein contents are 1·8% (Zahdi variety) and 2·1% (Sayer variety). The predominant amino acids identified in Sayer and Zahdi varieties were β-alanine, 29·30–40·80%, glutamine, 25·00–28·22%; aspartic acid, 24·1–27·4%, γ-aminobutyric acid, 24·85–25·16%, glycine, 10·20–12·98%; proline, 8·50–10·70%; and glutamic acid, 13·38–

16·74%. Per 100 gm, the fruit pulp (date) is reported to contain 317 calories, 15·3 gm water, 2·5 gm protein, 0·4 gm fat, 75·8 gm carbohydrates, 3·9 gm fibre, 2·1 gm ash, 120 mgm Ca, 50 mg P, 7·3 mg Fe, 26 μg β-carotene equivalent, 0·01 mg thiamine, 0·02 mg riboflavin, 0·9 mg niacin and 3 mg ascrobic acid. The fruit pulp also contains leucoanthocyanins, pipecolic acid, 5-oxypipecolic acid ($C_6H_{11}NO_3$) and the piperidine derivative baikiain ($C_6H_9NO_2$) and tannin (Duke and Ayensu, 1985b). A total of eighteen lactones were identified in the fruit aroma (Kikuchi and Miki, 1981).

The pigments responsible for the bright colours of the Egyptian dates (Samani and Zagloul) are a mixture of different carotenoids, anthocyanins, flavones and flavonols (Ashmawi *et al.*, 1955). Lycopene, α-carotene, dehydro-β-carotene (isocarotene) and violaxanthin are the pigments of Samani variety, while lycopene, α-carotene, semi-β-carotene, flavoxanthin and lutein occur in Zagloul variety.

The date palm wood is used as toothbrush; terminal bud 'djoummar' for intestinal hemorrhage, diarrhoea and jaundice. Dates were used internally in medication designed to purge, to clear enigmatic, or to regulate the urine; in vaginal pessaries, with other ingredients, they enhance fertility, and relieve cough. Green dates are reputed as aphrodisiac and tonic (Boulos, 1983). Date palm pollen grains have gonadotrophic activity. Extraction of 10 gm of pollen increases the weight of ovaries, uteri, testes and seminal vesicles (Chopre *et al.*, 1969).

3 *WASHINGTONIA*

Scanty information is available about the constituents of this genus.

1 *Washingtonia filifera* Wendl.

Common name: *Washington palm*
Arabic name: *Nakheel Washintonia*

Phytochemical screening of the plant revealed the presence of flavonoids (Rizk *et al.*, 1988).

2 *Washingtonia robusta*

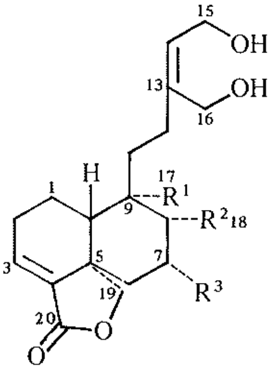
W. robusta contains luteolin 7-rutinoside disulphate (Williams *et al.*, 1973). A mannan polysaccharide consisting of β,1,4-mannan with traces of galactose has been isolated from the plant (Moyna and Difabio, 1984).

Although the black or brown fruits are hard and small, they are eaten for their sweetness; the leaf buds and seeds were ground into meal and made into bread gruel, etc. The leaves are used to some extent for roofs and baskets while the fibre was used for making cord (Weiner, 1972).

XXXVI PORTULACACEAE

1 *PORTULACA*

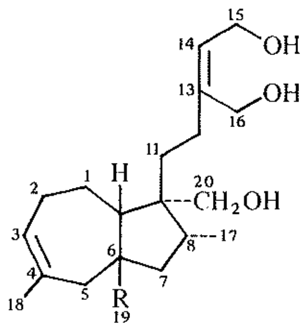
Several *trans*-clerodane diterpenes have been identified from *Portulaca* species e.g. portulide A (485, previously reported as protulide), portulide B (486), portulide C (487) and portulide D (488) from *Portulaca* CV Jewel, the flower of which is similar to that of *P. grandiflora* (Ohsaki *et al.*, 1986a). Betacyanins (including acylated ones) and betaxanthins have been identified from flowers of *Portulaca* species (Adachi and Katayama, 1968, 1969; Imperato, 1975a). High concentration of adrenaline occurs in *P. oleracea* (Feng *et al.*, 1961).



485 Portulide A : $R^1 = CH_3$, $R^2 = CH_2OH$, $R^3 = H$
486 Portulide B : $R^1 = CH_3$, $R^2 = CH_3$, $R^3 = H$
487 Portulide C : $R^1 = CH_3$, $R^2 = CH_3$, $R^3 = OH$
488 Portulide D : $R^1 = CH_3$, $R^2 = CHO$, $R^3 = H$
(Ohsaki *et al.*, 1986a)

1 *Portulaca grandiflora* Hook.
Common name: *Sun-plant, Rose-moss*
Arabic name: *Riglet zoohoor*

The plant contains several diterpenes, including the plant growth regulator portulal (489). Portulal has a unique structure, perhydroazulenoid skeleton with clerodane-type substitution (Mitsuhashi and Shibaoka, 1965; Yamazaki *et al.*, 1971; Ohsaki, 1986a, b). In addition to portulal, the aerial parts of *P. grandiflora* contain the following diterpenes: portulide (Ohsaki *et al.*, 1984), portulic lactone (492), 3-hydroxyportulol ether (493), portulol (490), 5-hydroxyportulal (494), portulic acid (491), 5-hydroxyportulic acid (495) (Ohsaki *et al.*, 1985), portulenone (496), portulenol (497) and portulene (498) (Ohsaki *et al.*, 1986b).



489 Portulal : $R = CHO$
490 Portulol : $R = CH_2OH$
491 Portulic acid : $R = CO_2H$
(Ohsaki *et al.*, 1985)

Fig. 135 *Musa paradisiaca* L. var. *sapientum* Kuntze

Fig. 136 *Callistemon lanceolatus* DC.

Fig. 137 *Callistemon lanceolatus* DC.

Fig. 138 *Eucalyptus camaldulensis* Dehne.

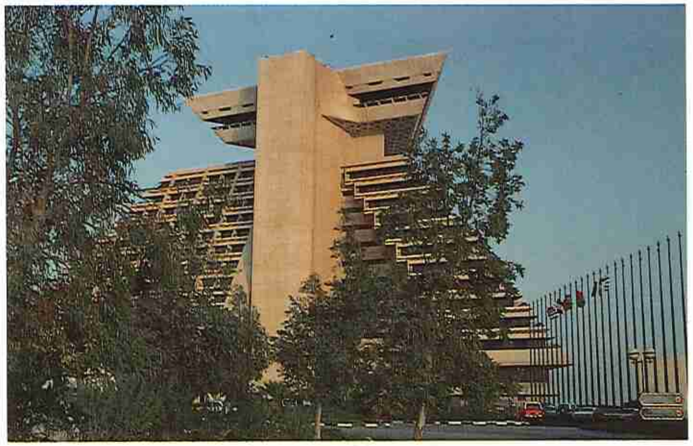


Fig. 139 *Eucalyptus rostrata* Schlecht not Cav.

Fig. 140 *Eucalyptus rostrata* Schlecht not Cav.

Fig. 141 *Bougainvillaea glabra* Chois.

Fig. 142 *Bougainvillaea glabra* Chois.

Fig. 143 *Mirabilis jalapa* L.

Fig. 144 *Mirabilis jalapa* L.

Fig. 145 *Jasminum azoricum* L.

Fig. 146 *Jasminum azoricum* L.

Fig. 147 *Jasminum sambac* Ait.

Fig. 148 *Jasminum sambac* Ait.

Fig. 149 *Olea europea* L.

Fig. 150 *Olea europea* L.

Fig. 151 *Godetia amoena* Don.

Fig. 152 *Godetia amoena* Don.

Fig. 153 *Arecastrum romanzoffianum* Becc.

Fig. 154 *Phoenix dactylifera* L.

Fig. 155 *Washingtonia filifera* Wendl.

Fig. 156 *Washingtonia robusta* Wendl.

Fig. 157 *Portulaca grandiflora* Hook.

Fig. 158 *Portulaca grandiflora* Hook.

Fig. 159 *Punica granatum* L.

Fig. 160 *Punica granatum* L.

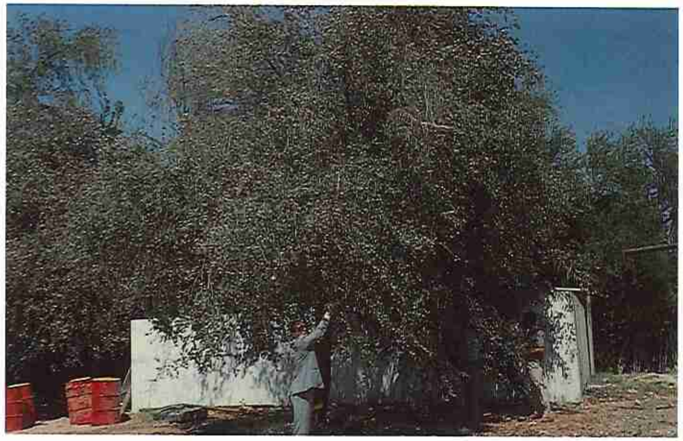


Fig. 161 *Ziziphus mauritiana* Lam.

Fig. 162 *Ziziphus nummularia* L.

Fig. 163 *Rosa gallica* L.

Fig. 164 *Rosa gallica* L.

Fig. 165 *Dodonaea viscosa*

Fig. 166 *Dodonaea viscosa*

Fig. 167 *Antirrhinum majus* L.

Fig. 168 *Antirrhinum majus* L.

Fig. 169 *Russelia equisetiformis* Schlecht. & Gham.

Fig. 170 *Russelia equisetiformis* Schlecht. & Gham.

Fig. 171 *Datura metel* L.

Fig. 172 *Datura metel* L.

Fig. 173 *Petunia hybrida* Vilm.

Fig. 174 *Petunia hybrida* Vilm.

Fig. 175 *Solanum muricatum* Ait.

Fig. 176 *Solanum muricatum* Ait.

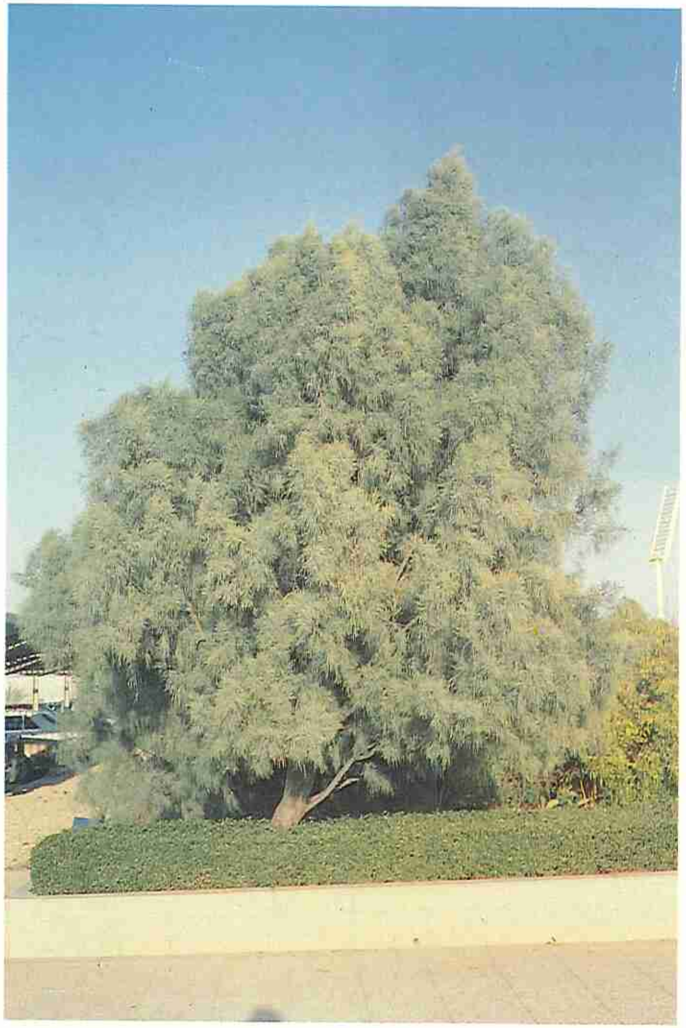


Fig. 177 *Tamarix aphylla* Karst.

Fig. 178 *Tamarix aphylla* Karst.

Fig. 179 *Tropaeolum majus* L.

Fig. 180 *Tropaeolum majus* L.

Fig. 181 *Clerodendrum glabrum* E. Mey.

Fig. 182 *Clerodendrum glabrum* E. Mey.

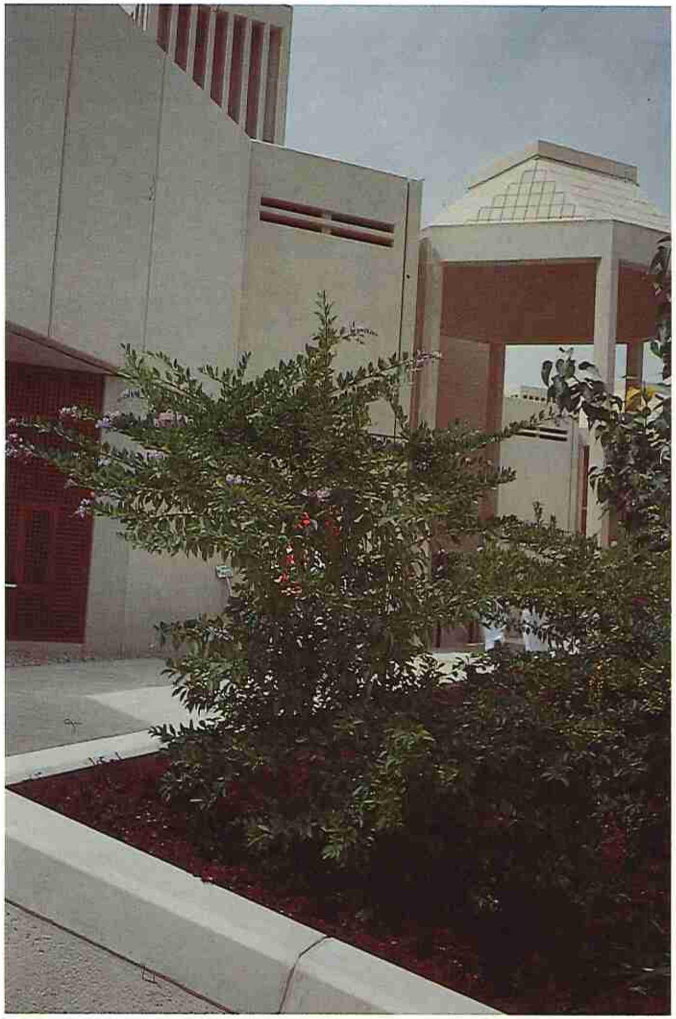


Fig. 183 *Duranta repens* L.

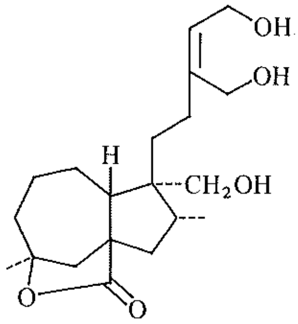
Fig. 184 *Duranta repens* L.

Fig. 185 *Lantana camara* L.

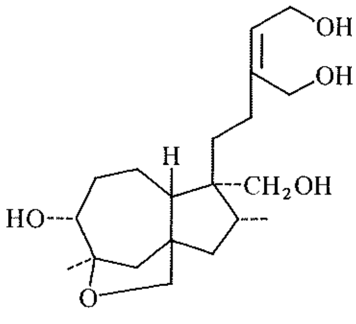
Fig. 186 *Lantana camara* L.

Fig. 187 *Verbena hybrida* Voss.

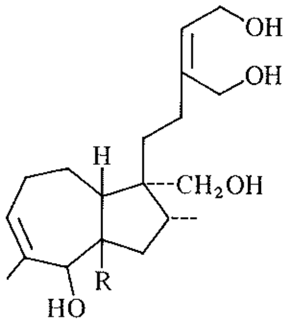
Fig. 188 *Verbena hybrida* Voss.



492 Portulic lactone

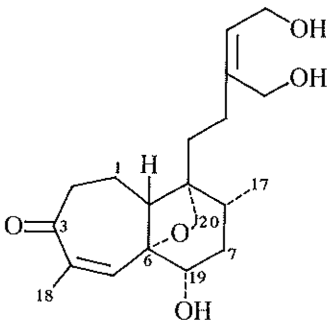


493 3-Hydroxyportulol ether

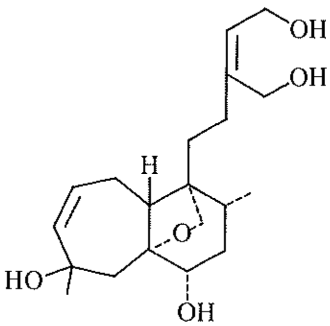


494 5-Hydroxyportulal : R = CHO
495 5-Hydroxyportulic acid : R = CO_2H

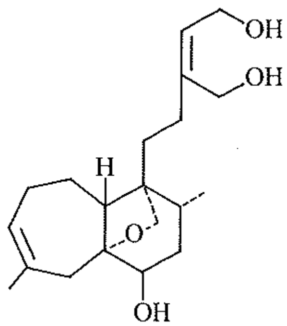
(Ohsaki *et al.*, 1985)



496 Portulenone



497 Portulenol



498 Portulene

(Ohsaki *et al.*, 1986b)

Four Betacyanins, namely betanin, isobetanin, betanidin and isobetanidin and several betaxanthins (e.g. indicaxanthin, vulgaxanthin I, vulgaxanthin II, miraxanthin and dopaxanthin) have been identified from the petals of *P. grandiflora* (Chiji, 1976; Adachi and Nakatsukasa, 1983).

XXXVII PUNICACEAE

1 *PUNICA*

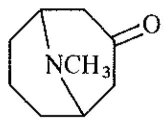
1 *Punica granatum* L.
Common name: *Pomegranate*
Arabic name: *Romman*

The plant contains alkaloids, tannins and several polyphenolic compounds.

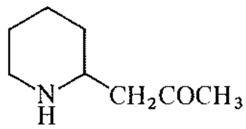
The plant, and in particular the bark contains the following compounds:

1. Alkaloids: Pelletierine (499), pseudopelletierine (500), isopelletierine (501) and methylisopelletierine (502) (Chilton and Partridge, 1950; Galinovsky and Vogl, 1952; Wibaut and Hollstein, 1956, 1957).

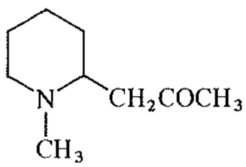
499 ψ-pelletierine



500 pseudopelletierine



501 isopelletierine



502 methylisopelletierine

(Finar, 1977)

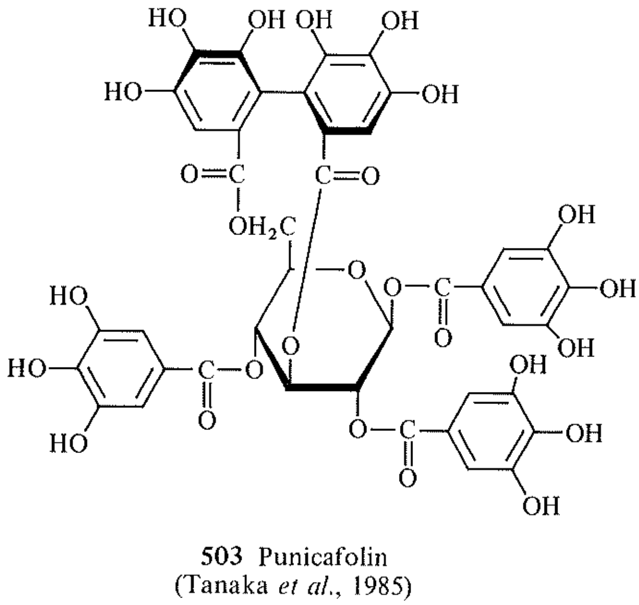
2. Tannins and related compounds: The bark and the rind (pericarp) contain large amount of tannins. The bark has been used since ancient times as a taeniacide and is regarded as a rich source of tannins. From the pericarp of the plant, four yellow-coloured ellagitannins, grantins A and B (Okuda *et al.*, 1981b), punicalagin and punicalin (Mayer *et al.*, 1977) have been isolated. The former two

tannins contain a dehydrohexahydroxydiphenoyl and hexahydrodxydiphenonyl ester group attached to D-glucose moiety, while the latters are unique in that they contain a galloyl (tetraphenyl) ester group in the molecule. The rind contains 21·3–33·6% tannins (Niketić and Gugušević, 1957; Kedlaya and Selvarangan, 1962; Nasacheva *et al.*, 1973b). Flavogallol (a sesquiellagic acid) has been isolated from the skin of pomegranate (Schmidt and Fickert, 1958).

The leaves contain seven tannins: punicafolin (503), granatins A (504) and B (505), corilagin (506), strictinin (138) 1,2,4,6-tetra-*O*-galloyl-β-D-glucose (507) and 1,2,3,4,6-penta-*O*-galloyl-β-D-glucose (508) (Tanaka *et al.*, 1985). Punicalin (509) and punicalagin (510) are almost entirely absent in the leaf, although these tannins predominate in the pericarp. The major components of the leaves are granatins A and B which comprise about 1·5% of fresh weight of the leaves (Tanaka *et al.*, 1985).

The bark contains punicalin (509), punicalagin (510), 2-*O*-galloylpunicalin (511, a hydrolyzable tannin) (Tanaka *et al.*, 1986a) and seven ellagitannins: punicacorteins A (512), B (513), C (514), D (515), punigluconin (516), casuariin (133) and casuarinin (132) (Tanaka *et al.*, 1986b).

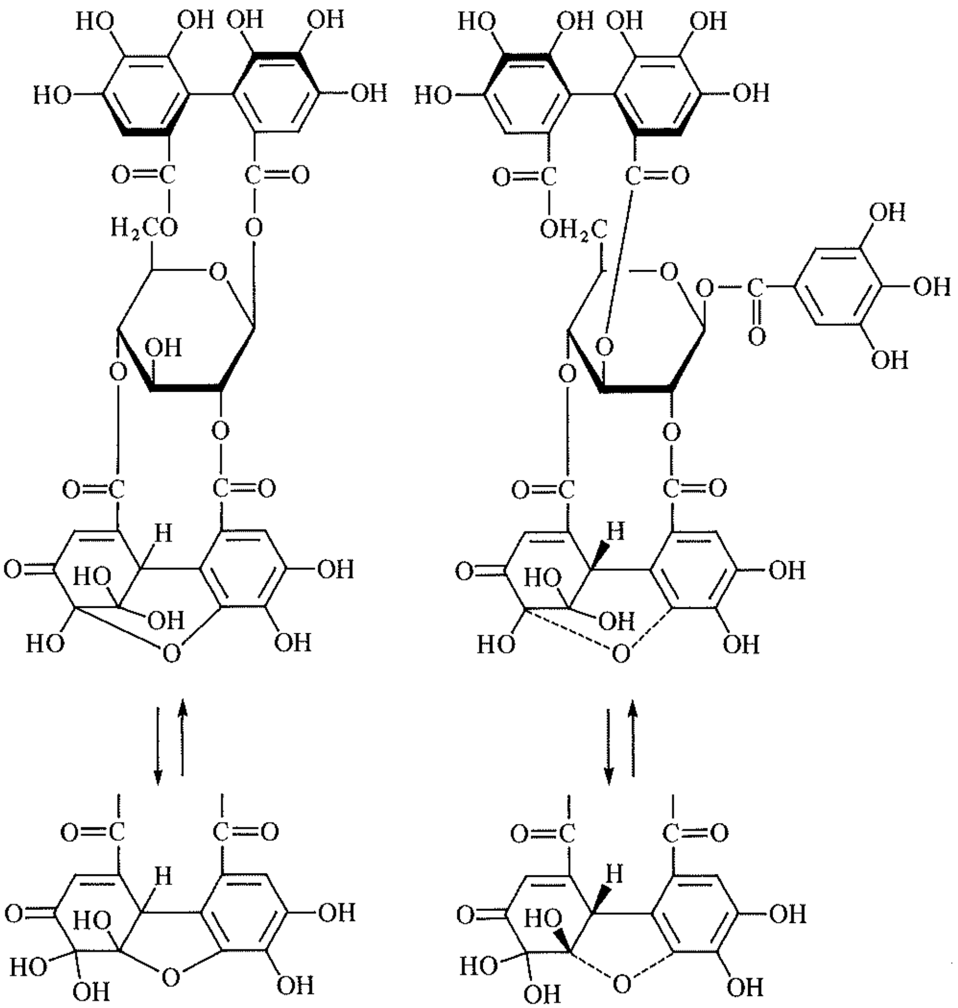
3. Polyphenolic compounds: The fruit contains 0·22–1·05% of water-soluble polyphenols mainly anthocyanins, including cyanidin 3-glucoside, cyanidin 3,5-diglucoside and delphinidin 3-glucoside; and the following carboxylic acids: chlorogenic acid, neochlorogenic acid, protocatecheuic acid and *p*-coumaric acid (Markh and Lysogor, 1973). The dark coloured pomegranates contain two derivatives of delphinidin, two of malvidin and one of cyanidin (Addurazakova and Gabbasova, 1972). The anthocyanins present in the seed coat are the 3,5-diglucoside and the 3-glucoside of cyanidin, delphinidin and pelargonidin (Du *et al.*, 1975; Santagati *et al.*, 1984). The peel contains only cyanidin and



503 Punicafolin
(Tanaka *et al.*, 1985)

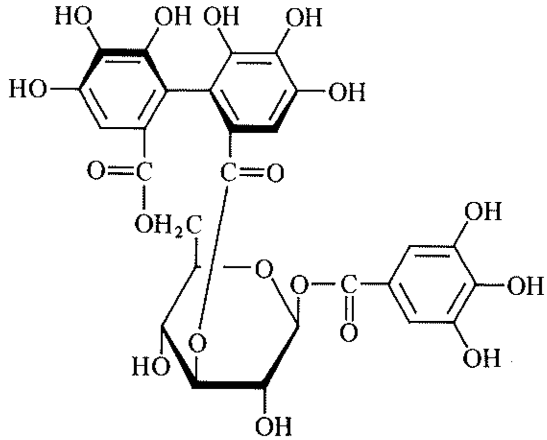
pelargonidin glucosides (Du *et al.*, 1975). The rind contains isoquercetrin (Rajadurai *et al.*, 1963). Gallic acid (0·09%), and elaidic acid (0·55%) occur in the fruit peel (Nosacheve *et al.*, 1973).

4. Triterpenoids, steroids and related substances: The bark contains betulic acid; peel, ursolic acid (Brieskorn and Keskin, 1954) and the leaves contain both triterpenes (Brieskorn and Keskin, 1954, 1955). The flowers contain ursolic acid and sitosterol as major components, and styptic, maslinic and asiatic acids and an unidentified compound as minor components (Batta and Rangaswami, 1973). Estrone and estradiol occur in the seeds (Heftmann *et al.*, 1966; Dean *et al.*, 1971) Punicic acid (a triene acid stereoisomer of eleostearic acid) has been

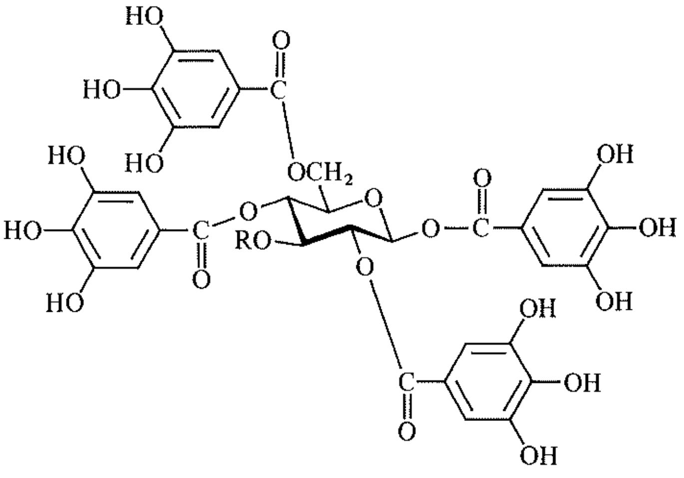


504 Granatin A **505** Granatin B

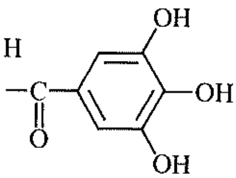
(Tanaka *et al.*, 1985)



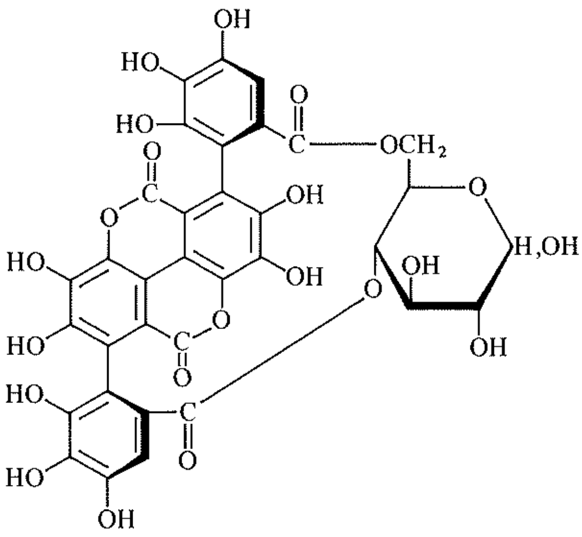
506 Corilagin



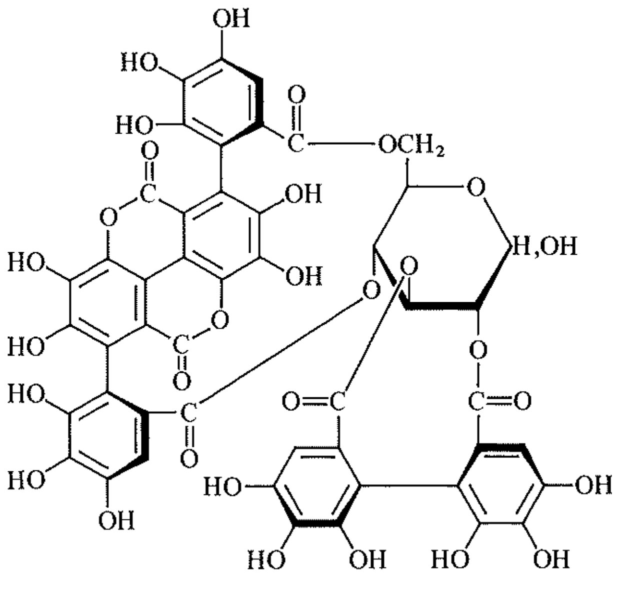
507 R = H

508 R = 

(Tanaka *et al.*, 1985)

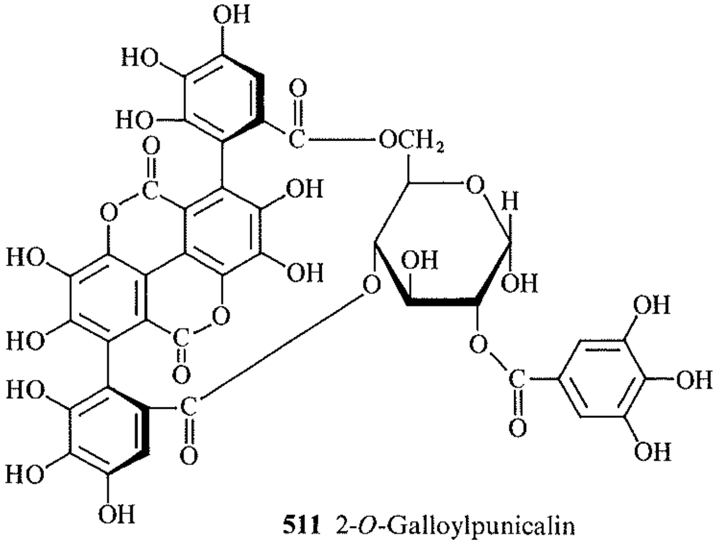


509 Punicalin

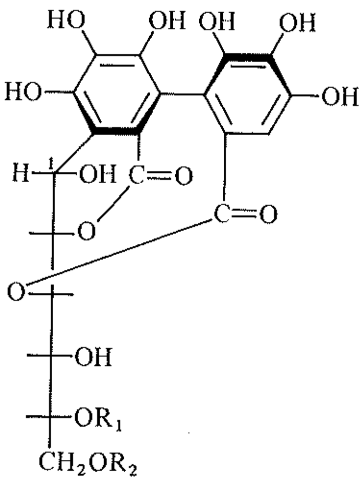


510 Punicalagin

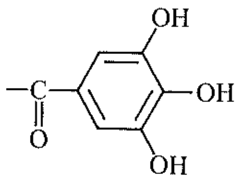
(Tanaka *et al.*, 1986b)

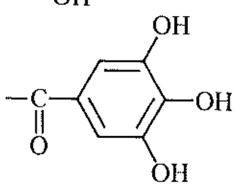


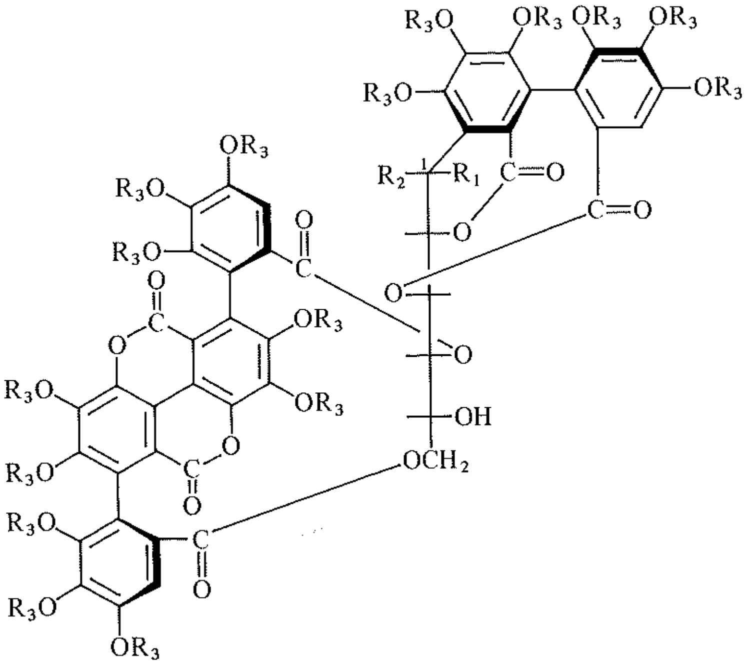
511 2-*O*-Galloylpunicalin
(Tanaka *et al.*, 1985a)



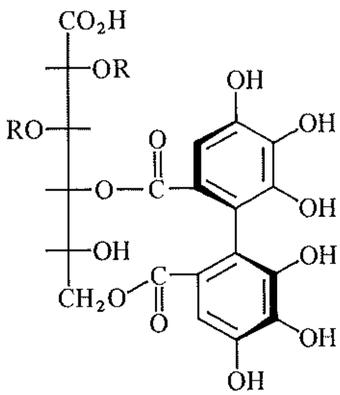
(Tanaka *et al.*, 1986b)

512 Punicacortein A : R_1 =  , R_2 = H

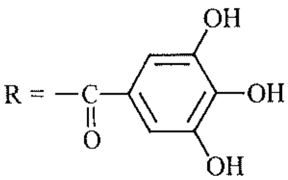
513 Punicacortein B: R_1 = H, R_2 = 



514 Punicacortein C : R_1 = OH, R_2 = R_3 = H
515 Punicacortein D : R_1 = R_3 = H, R_2 = OH



516 Punigluconin : R =



(Tanaka *et al.*, 1986b)

identified in the seed oil of pomegranate (Toyama and Tsuchiya, 1935; Farmer and Van den Heuvel, 1936). The pomegranate seed oil contains 60% punicic acid in its fatty acid pool (Isamukhamedov and Akramov, 1982).

The lipids of the seeds of *P. grantaum* var. *nana* are composed of triglycerides, 83·8%; 1,2-diglycerides, 3·3%; compound lipids, 2·9%; sterol esters, 2·8% free fatty acids, 2·5%; monoglycerides, 1·8%; sterols, 1·7%; and 1,3-diglycerides, 1·3%. The compound lipids consist of phosphatidylcholine, phosphatidylserine, phosphatidylinositol, cerebroside and an unidentified compound. In the sterol fraction β-sitosterol (as a major sterol) and stigmasterol are found (Tsuyuki *et al.*, 1981). The free amino acids in the juice of different kinds of pomegranates are: glutamic acid, aspartic acid, asparagine, tryptophan, methionine, alanine, ν-aminobutyric acid, arginine, cystine, glycine, leucine and isoleucine, lysine, phenyalanine, proline, threonine, tyrosine and valine (Gabbasova and Abdurazakova, 1968). Citric, malic and oxalic acids also occur in the juice (Abdurazakova and Gabbasova, 1968). The fruit juice contains 8·2–19·7% invert sugar, 4·8–10·6% glucose, 0·46–3·6% citric acid, 0·005% boric acid and up to 7 mg% of ascorbic acid (Rossiĭskiĭ, 1946). The peel contains 2–4% pectin (Niketic and Gungusěvić, 1957). The fresh rind contains wax, 0·8%; resins, 4·5%; mannitol, 1·8%; sugars, 2·7%; gums, 3·2%; inulin, 1·0%; mucilage, 0·6%; tannins, 10·4%; gallic acid, 4·0%; malic acid, pectin and calcium oxalate, 4% (Flaccomio, 1929).

The plant is grown for its fruit and is widely used medicinally. It is the well-known anthelmintic plant which has been used for years in orthodox medicine (Rossiĭkiĭ, 1946). The fruit (as well as the flower and seed) is used for the relief of stomachache and for the treatment of diarrhoeas and dysentries, and as an anthelmintic. In Mauritius the bark is an ingredient in dysentry remedies and is regarded as being contraindicated in the young infant, the aged and the pregnant. The bark is used as an abortifaciant. The bark of the twig is also used in tanning. The fruit and fruit rind are very effective as antibacterials (Watt and Breyer-Brandwijk 1962). The seed oil possesses estrogenic activity in the animal experiments (Sharaf and Nigm, 1964). A comparative determination of the rate, time and homogenity of settling *in vitro* and of the granular properties showed a pomegranate bark tincture admixture to be superior to an aqueous suspension of barium sulphate (100 gm/200 ml fluid) for possible use in the human large intestine (Il'yasov (1975).

XXXVIII RHAMNACEAE

Plants of this family generally contain cyclopeptide alkaloids, and/or anthraquinones and triterpenoids (Rizk, 1986).

1 *ZIZIPHUS*

Ziziphus species, and in particular the bark, contain several cyclopeptide alkaloids. They also contain pentacyclic triterpenoids of dammarane-type saponins and flavonoids (Rizk, 1986).

1 *Ziziphus mauritiana* Lam.
Common name: *Indian or cottony jujube*
Arabic name: *Kanar*

The bark of *Z. mauritiana* contains the following peptide alkaloids: mauritines A to H, frangufoline and amphibines B,D,E, and F (Tschesche *et al.*, 1974b, 1977).

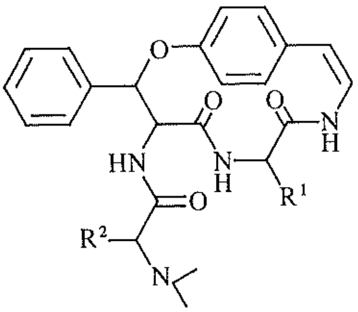
The stems contain zizogenin (a saponin) (Srivastava and Srivastava, 1979), betulonic acid, lupeol, betulin, β-sitosterol and β-sitosterol acetate (Chauhan and Srivastava, 1978).

2 *Ziziphus nummalaria* L.
Common name: *Jujube*
Arabic name: (local) *Sidr*

The root bark contains alkaloids of both the 13-membered and 14-membered cyclopeptide ring system *viz.* nummularines A,B,C,F,G,H,K, amphibine H and mucronine D (Tschesche *et al.*, 1974a, 1975, 1977b). The stem bark contains the following cyclopeptide alkaloids: nummularines-B, M (517), N (518), and O (520) Pandey *et al.* (1984, 1986).

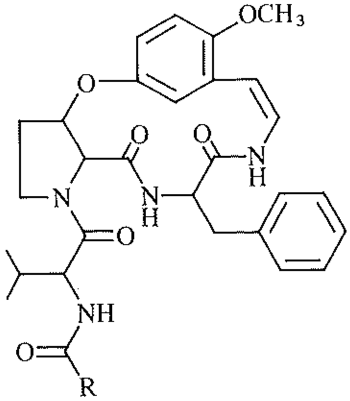
The leaves contain zizynummin (a dammarane saponin) (Charma and Kumar, 1983b), manogenin (a steroidal sapogenin) and the flavonols texifolin and its-3-glucoside (Srivastava and Chauhan, 1977).

The bark contains betulinic acid, oleanolic acid, ceanothic acid, sitosterol, stigmasterol and β-D-glucosides of sitosterol and stigmasterol (Sharma and Kumar, 1983a).



$R^1 = R^2 = H_3C-CH_2-CH(CH_3)-$

517 Nummularine M



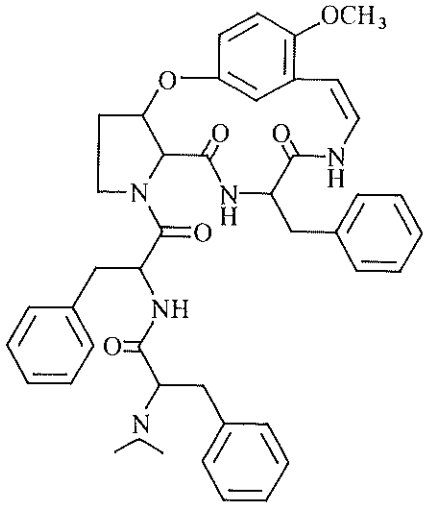
518 Nummularine B :

$R = (H)(H_3C)N-CH(CH_3)$

519 Nummularine N :

$R = (CH_3)_2N-CH_2-$

(Pandey *et al.*, 1984)



520 Nummularine
(Pandey *et al.*, 1986)

n-Octacosanol and quercetin 3-*O*-galactoside occur in the leaves (Sharma and Kumar, 1983a).

The leaves (a fodder for sheep and goat) contain 5·84% digestible crude protein and 47·51% total digestible nitrogen (Bhandari and Govil, 1978). The plant is reputed for its medicinal-importance (Chopra *et al.*, 1956).

3 *Ziziphus spina-christi* (L.) Willd.
Common name: *Jujube*
Arabic name: *Nabq*

The plant contains cyclopeptide alkaloids identified as amphibines A, E and F and mauritine C (Tschesche, 1974c), betulic acid, ceanothic acid, β-sitosterol, β-sitosterol β-D-glucoside, octacosanol, and *n*-nonacosane (Aynehci and Mahoodian, 1973; Ikram and Tomlinson, 1976). The bark contains 9·25% tannins which belong to the condensed class, and leucocyanidin. The free sugars are glucose, raffinose, and sucrose (Rizk, 1986).

The leaves contain the following flavonoids: rutin, hyperin, quercitrin and quercetin 3-xylosyl (1 → 2) rhamnoside-4′-rhamnoside (Nawwar *et al.*, 1984).

XXXIX ROSACEAE

Plants of the family Rosaceae contain several phenolic compounds *viz.* flavonoids, phenolic acids, tannins, etc. Investigation of the leaves of seventy-two species representing six subgenera of *Prunus*, fifty-six species of the genus *Potentilla*, and other related species revealed the presence of quercetin, cyanidin, kaempferol, myricetin, leucoanthocyanin, caffeic acid, *p*-coumaric acid, sinapic acid, ferulic acid and ellagic acid (Bate-

Smith, 1961). All the six species (belonging to six genera), investigated by Krzaczek (1984) contain homoprotocatechuic, protocatechuic, caffeic, gentisic, *p*-hydroxybenzoic, *p*-coumaric, vanillic, and salicylic acids. Some species also contain isoferulic, syringic, ellagic, gallic and *p*-hydroxyphenylacetic acids.

The occurrence of flavones, flavonols, flavanones, isoflavones and isoflavanones in the different parts (leaves, flowers, fruits, stem, stalks, roots and barks) of seventy-nine plants from the *Spiracoideae*, *Pomoideae*, *Rosoideae* and *Prunoideae* subfamilies of Rosaceae, have been reported by Bondyukova (1969). Both *O*-and *C*-glycoside flavonoids occur in the family e.g. 3-*O*-glycosides of kaempferol, quercetin and isorhamnetin from leaves of *Adenostoma* species (Proksh *et al.*, 1985), 7-*O*-glycosides of apigenin and luteolin and di-*O*-glycosides from several species (Kaneta *et al.*, 1979), and vicenins-1, -2 and -3, schaftoside and isoschaftoside from leaves of *Crataegus monogyna* (Nikolov *et al.*, 1981). Lignans have been identified from the family e.g. prinsepoil form *Prinsepia utilis* (Kilidhar *et al.*, 1982).

The phenolic constituents of Rosaceae fruits include catechins and proanthocyanidins as well as hydroxycinnamic acid derivatives. Moreover, small concentrations of flavonol glycosides and anthocyanins are also detected. The hydroxycinnamic acids exist partly as glucose esters but mainly as D-quinic acid esters (e.g. quinic acid ester of caffeic, *p*-coumaric and ferulic acids) (Moller and Hermann, 1983).

Several species of the family Rosaceae are well known as rich sources of tannins. *Potentilla tormentilla*, *Poterium sanguisorba*, *Rosa canina* and *Frageria vesca* roots contain catechuic tannins (19,16,12·5 and 12·5% respectively) and pyrogallic tannins (2,4,1·5 and 1·5% respectively) (Pourrat, 1966). Ellagitannins e.g. euginin and sanguins H-1, H-2, H-3 and H-6, gemins D,E and F were identified in rhizomes of *Sanguisorba officinalis* (Nonaka *et al.*, 1980, 1982a, b) and leaves of *Geum japonicum* (Yoshida *et al.*, 1985).

Cyanogenic compounds occur in several genera of the family Rosaceae (Hegnauer 1973, 1976). Within the Rosaceae the phenylalanine-based cyanogenic glucosides, amygdalin and prunasin are found mainly in the subfamilies Maloideae and Prunoideae (Fikenscher *et al.*, 1981) and hence have been considered to be the typical cyanogens of the family. However, other types of cyanogenic glycosides occur in the family e.g. leucine-derived cyanogenic glycosides heterodendrin in *Sorbaria arborea* (Nahrstedt and Scheid, 1981) and dhurrin (2-β-D-glucopyranosyloxyl-2-(4-hydroxy)-phenyl-2*S*-acetonitrile) in *Cerocarpus ledifolius* (Nahrstedt and Limmer, 1982). According to the latter findings Rosaceae are heterogenous in their synthesis of cyanogens.

The sugar alcohol sorbitol was isolated for the first time from the fruits of *Sorbus aucuparia* by Boussingault in 1872. Later, sorbitol was detected in many other members of the family (Barker, 1955, Wallaart, 1980).

Ursolic acid (in a percentage up to 1%) occurs in leaves of various Rosaceae (Le Men and Pourrat, 1955). The presence of other triterpenoids has been also reported e.g. 2α-hydroxyursolic acid and 2α-hydroxyoleanolic acid from *Geum japonicum* (Shigenaga *et al.*, 1985), triterpene glycosides e.g. tomentoside from species of the subfamilies Rosoideae and Maloideae (Steiegger and Peters, 1966) and nigaichigoside F 1 and suavissimoside F 1 from *Geum japonicum* (Shigenaga *et al.*, 1985). Diterpene glycosides (*ent*-labdane type) e.g. rubuoside and goshonosides F 1–5 have been isolated from the leaves of *Rubus chingii* (Tanaka *et al.*, 1984). Several carotenoids (e.g. β-carotene, β-carotene oxide, epoxycarotenoids, β-zeacarotene, lycopene, and rubixanthin) have been identifed in the Rosaceae flowers (e.g. Valadon and Mummery, 1968).

The characteristic wax constituents (of eleven Rosaceae plants studied by Wollrab, 1968) are straight-chain and branched paraffins, straight chain olefins, especially *ci*-5-alkenes, *cis*-7-alkenes, and *cis*-9-alkenes, and branched olefins e.g. 2-ethyl-1-nonacontene.

1 *ROSA*

Rose plants have been the object of many chemical investigators. The rose industry spread from Persia to surrounding countries, among them Arabia. The Arabs perfected the art of distillation and were therefore able to make new products, among them attar of rose, and to produce large quantities of good quality rose water. Especially the latter (because there was more of it) was extensively traded by the Arabs and was introduced to Europe as early as the second half of the tenth century (Touw, 1982).

The components of the volatile oil of *Rosa* species have been throughly investigated. The results on the contents of the concrete, wax and absolute in the different roses have been reported by several investigators. Among the identified components are citronellol, geraniol, 6-methyl-5-hepten-2-one, linalool, phenylethyl alcohol (Rollet *et al.*, 1969; Saakov *et al.*, 1982), from *R. rugosa* (Eto and Shiosaki, 1960) and/or several others from *R. damascene* (Miladenova *et al.*, 1983).

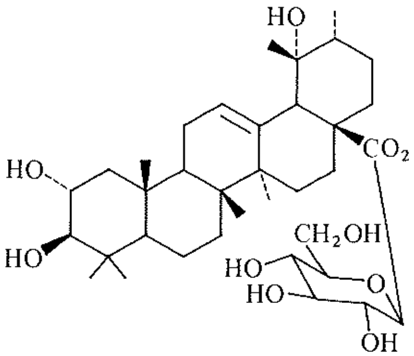
Flavonoids have been identified from the different parts of *Rose* species. Quercetin and kaempferol and/or their glycosides have been detected in flowers of *R. damascene* (Papanov *et al.*, 1984), leaves of *R. mollis* (Luczkiewicz 1967), petals (Aritomi, 1962), and fruits (Schuzo *et al.*, 1976) of *R. multiflora*, *R. sambucina* (Takagi *et al.*, 1982) and many others (Zemtsova *et al.*, 1972; Jennen 1973; Asen, 1982). Both quercetin and kaempferol occur in the different parts of *R. damascene viz.* petals, receptacles, green leaves, stalks, roots and fruits (Zolotovich and Decheva, 1967). The flavonoid content is much higher in the leaves of *R. rugosa* (0·62–1·42%) than in the fruit (Retezeanu *et al.*, 1972). The petals of *R. damascene* contain 1·86% of quercetin and kaempferol (Zolotovich and Decheva 1967).

The major anthocyanin pigments, identified form *Rosa* species (and in particular from the petals) are cyanidin 3-glucoside (chrysanthemin), cyanidin, 3,5-diglucoside and pelargonin (Ahuja *et al.*, 1963; Demina, 1966; Vega and Martin, 1967; Jain *et al.*, 1971; Jain, 1971; Chumbalov *et al.*, 1976). The rare peonin was found in *R. rugosa* and derived varieties (Harborne, 1961). Cyanidin 3,5-diglucoside amounts to 1% in the fresh weight of petals (Vega and Martin, 1967). The pigment of the pericarp of *R. polyantha* contains lycopene and a small amount of α-carotene (Ohta and Miyazaki, 1951).

Phenolic acids have been identified from several species. The analysis of twenty three species revealed the presence of protocatechuic, caffeic, gentisic, *p*-hydroxybenzoic, *p*-hydroxy-penylacetic, *p*-coumaric, syringic, vanillic, ferulic, isoferulic, homoprotocatechuic and salicylic acids (Krzaczek and Krzaczek, 1979).

The fruit of *R. platyacantha* contains two hydrolysable tannins. The first tannin yields on hydrolysis glucose and gallic, ellagic and dehydrodigallic acids (Bikbulatova and Beisekova, 1979). The second one is identified as platyacanthin (1-dehydrotrigalloyl-α-D-glucose) (Bikbulatova *et al.*, 1985). Catechins e.g. catechin, gallocatechin, epicatechin and epigallocatechin occur in several *Rosa* species (Glovkina and Novotel'nov, 1967; Kiselev *et al.*, 1971; Pankov and Safronova, 1975).

The roots of *R. multiflora* contain rosamultin (521, a triterpenoic acid sugar ester, 2α, 19α-dihydroxyursolic acid (28–1)-β-D-glucopyranosyl ester), 2α, 19α-dihyroxyursolic acid and β-sitosterol (Du *et al.*, 1983). Ursolic acid has been identified from the fruits of *R. nisami* (Kuliev and Gussarova, 1984). The roots of *R. amblyotis*, *R. davurica*, *R. rugosa* were reported as a source of vitamin P (Pankov and Safronova, 1975). The fruits of *R. rugosa*, *R. cinnamomea* (Inagaki and Saitô, 1948; Stepanova, 1959), *R. canina* (Stenzel and Feldheim, 1961) and several others (Makhamadzhanov, 1965; Gadzhieva, 1968: Rieksta and Ozola, 1980) have been considered as sources of vitamin C. The inner bark of young stems of *R. glauca* contains two arabinans: arabinan I consists of arabinose, 93; mannose, 3; glucose, 3 and galactose, 1% and arabinan II consists of 100% arabinose (Joseleau *et al.*, 1977).



521 Rosamultin
(Du *et al.*, 1983)

The use of the volatile oil of rose in perfumary and cosmetics is well known.

Rosa species are also used in folk medicine. Rose hips, with their high content of vitamin C, are of greatest value. Rose-hip syrup is a popular preventative of the common cold and is taken for kidney ailment, diarrhoea and dysentry, and to lighten menstrual pains (Gordon, 1980). The greatest importance of rose was in medicine. According to Kruessmann (1980) it was *R. gallica* and *R. canina* that were the medicinal species.

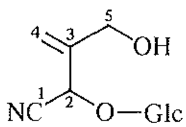
1 *Rosa gallica* L.
Common name: *French rose*
Arabic name: *Ward baladi*

The volatile oil of *R. gallica* contains citronellol, and geraniol as main components and several others (Staikov and Kalaidzhiv, 1980). The flowers of *R. gallica* yield gallicosides A, B and C. Gallicosides A and B have oleanolic acid as aglycone, with A containing glucose and B having both glucose and ribose. The aglycone of gallicoside C is β-sitosterol, and its sugar moiety contains glucose and galactose (Burgorskii and Mel'nikov, 1977). The blossoms of *R. gallica rubia* contains inositol (Dilthey *et al.*, 1937).

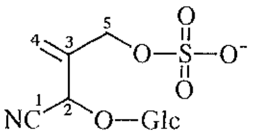
XL SAPINDACEAE

Plants of the Sapindaceae are characterized by the presence of saponins with hederagenin as the aglycone (Delaude and Welter 1975; Delaude *et al.*, 1976a; Encarnación *et al.*, 1981). Saponins have been identified from different parts e.g. fruits of *Blighia welwitschii* (Delaude and Welter 1975), root bark (Delaude *et al.*, 1976b) and stem bark (Encarnación *et al.*, 1981) of *Lecaniodiscus cupanioides.*

The seed lipids of sapindaceous plants contain cyanolipids. This interesting class of lipids has been characterized from the seeds of *Cardiospermum hirsutum* (Seigler, 1974), *Nephelium lappaceum* (Nishizawa *et al.*, 1983) and *Ungnadia speciosa* (Seigler *et al.*, 1971). Cardiospermin (522, 2-β-D-glucopyranosyloxy-3-hydroxymethylbutyronitril-3-en), a cyanogenic glucoside has been isolated from *Cardiospermum hirsutum* (Seigler *et al.*, 1974). This glucoside and cardiospermin-5-sulphate (523) (Huebel and Nahrstedt, 1979) have been identified from the leaves of *C. grandiflorum.* The latter is the first reported sulphur containing cyanogenic glycoside.



522 Cardiospermin



523 Cardiospermin-5-sulphate (Huebel and Nahrstedt, 1979)

1 *DODONAEA*

Dodonaea species are rich sources of bicarboxylic diterpenes with either the *ent*-labdane or *ent*-clerodane skeleton e.g. *D. attenuata* (Payne and Jefferies, 1973); *D. boroniaefolia* (Jefferies *et al.*, 1973), *D. lobulata* (Dawson *et al.*, 1966), *D. microzyga* (Jefferies *et al.*, 1974) and *D. petiolaris* (Jefferies *et al.*, 1981). Lupeol and a triterpene diol (lupene diol) have been identified from *D. attenuata* (Ghisalberti *et al.*, 1973). Oleanolic acid (as saponoside) has been isolated from *D. madagascariensis* (Trotin, 1972, 1973).

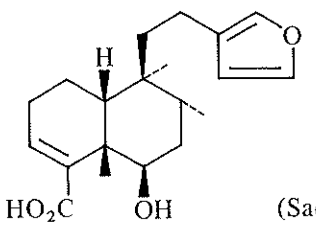
Flavonoids also occur in *Dodonaea* species e.g. 5,7-dihydroxy-3,4′,6-trimethoxyflavone from *D. attenuata* (Payne and Jefferies, 1973), 5-hydroxy-3,6,7,4′-tetramethoxyflavone from *D. lobulata* (Dawson *et al.*, 1966) and hyperoside from *D. madagascariensis* (Trotin *et al.*, 1970). The flavonoids of the leaves of the latter species amount to 3·25%.

1 *Dodonaea viscosa* L.
Common name: —
Arabic name: *Dodnia*

The plant contains the following substances:

1 —Terpenoids and related substances: The aerial parts afford haurtiwaic acid

(Kotake and Kuwata, 1936; Hsu *et al.*, 1971), a new diterpenoid, dodonic acid (524) (Sachadev and Kulshreshtha, 1984). The seeds also contain β-sitosterol and stigmasterol (Rao, 1962) and a saponin, dodonin which gives on hydrolysis dodogenin ($C_{23}H_{36}O_8$) (Parihar and Dutt, 1947).



524 Dodonic acid
(Sachdev and Kulshreshtha, 1984)

2 —Flavonoids: The aerial parts contain the following flavonoids: 5-hydroxy-3,6,7,4′,-tetramethoxyflavone, pinocembrin, santin, penduletin, 5,7,4′-trihydroxy-3,6-dimethoxyflavone, aliarin, isorhamnetin, isorhamnetin 3-rhamnosylgalactoside, 5,7-dihydroxy-3′-(3-hydroxy-methylbutyl)-3,6,4′,-trimethoxyflavone and 3,4′,6-trimethoxy-5,7-dihydroxyflavone, (Rao, 1962; Dominguez *et al.*, 1980b; Sachadev and Kulshreshtha, 1982, 1983). The leaves and pods contain isorhamnetin 3-*O*-rutinoside, quercetin 3-*O*-galactoside and quercetin 3-*O*-rutinoside (rutin) (Nair and Subramanian, 1975b). Kaempferol 3,7-dimethyl ether and kaempferol 3′,4′,7-trimethylether have been identified from the flowers (Dreyer, 1978). Kaempferol, quercetol and probably quercetol 3-arabinoside also occur in *D. viscosa* (Paris and Nothis, 1970). The flowers give positive colour reactions for a cyanidin-monoside (Dawson *et al.*, 1966).

3 —Tannins: The leaves and bark contain 5·98 and 5·8% tannins (Ghose, 1933).

The leaves also contain 0·02% of an alkaloid (Ghose, 1932). The composition of the fatty acids of the seed fat is: palmitic, 11·29; stearic, 9·86; arachidic, 3·75; oleic, 16·44; linoleic, 57·09; and linolenic, 1·57% (Kapur and Gupta, 1959).

D. viscosa is used as a remedy for many diseases, particularly for stomach disorders. The leaf is used as an antipruritic in skin rashes, antirheumatic, and taken internally as a febrifuge. The leaf is a remedy for fever, sore throat and haemorrhoids (Watt and Breyer-Brandwijk, 1962). Although the plant is generally regarded as harmless, it is used as a fish poison and has been suspected of causing deaths in calves. It has also been reported as being deleterious to the camel. The seed is, however, edible (Watt and Breyer-Brandwijk, 1962). The plant extracts possess anthelmintic activity and antibacterial properties (Sukkawala and Desai, 1962).

XLI SCROPHULARIACEAE

Plants of the family Scrophulariaceae are characterized by the presence of iridoid glucosides (Rizk, 1986). Cardiotonic glycosides as well as other triterpenoid glycosides also occur in several genera of the family (Delgado *et al.*, 1962; Breton and Gonzalez, 1963; Rizk, 1986).

1 *ANTIRRHINUM*

Antirrhinum species are chemically characterized by the presence of flavonoids, and tertiary alkaloidal bases (Rizk, 1986).

1 *Antirrhinum majus* L.
 Common name: *Snapdrogen*
 Arabic name: *Hanak el-Saba*

The flowers contain the following pigments:

- — Flavonols: quercetin 3-*O*-glucoside, quercetin 3-*O*-rutinoside, kaempferol 3-*O*-glucoside and kaempferol 3,7-*O*-diglucoside (Harborne, 1963a).
- — Flavones: apigenin, apigenin 7-*O*-glucuronide, apigenin 4′-*O*-glucuronide, apigenin 7,4′-*O*-di-glucuronide, luteolin, luteolin 7-*O*-glucuronide, and chrysoeriol 7-glucuronide (Jorgensen and Geissman, 1955; Seikel, 1955; Harborne, 1963; Scoggin, 1976; Tronchet, 1976).
- — Flavanones: naringenin 7-*O*-glucoside, and naringenin 7-*O*-rhamnosylglucoside (Seikel, 1955; Harborne, 1963a).
- — Chalcones (from yellow flowers): chalconaringenin 4′-glucoside and 3,4,2′,4′,6-pentahdroxychalcone 4′-glucoside (Gilbert, 1973).
- — Aurones (from yellow flowers): auresin (aureusidin-6-*O*-glucoside) and bracteatin 6-*O*-glucoside (Scoggin, 1976). These two aurones are restricted to the yellow region of the labium, whereas anthocyanis (cyanin derivatives) are found only in purple areas of the crolla (Tronchet, 1976).
- — Antocyanins: cyanidin 3-glucoside, cyanidin 3-rutionside (antirrhimin), pelargonidin 3-glucoside (Scott-Moncrieff, 1930; Jorgensen and Geissman, 1955b; Toki and Uemoto, 1977).
- — Phenolic acids: cinnamic acid esters of *p*-coumaric, caffeic and ferulic acids (Harborne and Corner, 1961).

The leaves contain a diphenolic 6-hydroxyflavone glycosides not found in corollas (Tronchet, 1976).

The plant contains the iridoids antirrhinoside and 5-*O*-*β*-D-glucosylantirrhinoside (Guiso and Scarpati, 1969) and *β*-sitosterol (Harkiss, 1971). The alkaloid 4-methyl-2,6-naphthyridine has been isolated from the aerial parts of the plant (Harkiss and Swift, 1970).

2 *RUSSELIA*

Nothing is known about the constituents and/or uses of this genus.

1 *Russelia equisetiformis* Schlecht. & Gham.
(= *R. juncea* Zucc.)
Common name: *Coral-blow*
Arabic name: *Rosolia*
Phytochemical screening of the plant revealed the presence of terpenoids and/or steroids (Rizk *et al.*, 1988).

XLII SOLANACEAE

Plants of the family solanceae generally contain alkaloids (e.g. tropane and steroidal types), steroidal sapogenins and sterols (Rizk, 1986).

1 *DATURA*

Datura species contain tropane alkaloids e.g. hysoscine, hyoscyamine, atropine, tropine, scopolamine and several others. The tropane alkaloid scopolamine is of considerable pharmaceutical interest because of its parasympatholytic, anti-cholinergic and anti-emetic as well as sedative action. This alkaloid is extracted on an industrial scale from plants of the genus *Datura* (Griffin, 1976). Littorine, various tropyl and trigloyl esters and cuscohygrine are components of the roots of all nine *Datura* species studied by Evans *et al.* (1972).

Withanolides (highly oxygenated C_{28} steroidal lactones) have been isolated from certain *Datura* species (Evans *et al.*, 1984).

1 *Datura metel* L.
Common name: —
Arabic name: *Datorah*
All parts of *D. metel* contain alkaloids. The total alkaloids (calculated as hyoscyamine) have been reported as: roots, 0·35; seeds, 0·33; leaves, 0·25; seedlings, 0·19 and stalks, 0·056% (Sova, 1946). Scopolamine and hyoscyamine are the two principal alkaloids of *D. metel* from Vietnam. In seeds, flowers, pericarp, leaves and stems, scopolamine is the main alkaloid ($\geqslant$ 70·5% of the total), whereas roots contain more hyoscyamine (66·5% of the total alkaloids) than scopolamine (Khuyen and Van Dan, 1977). The seeds contain 0·462% of alkaloids mainly hyoscyamine and the roots contain 0·356% of hyoscyamine (Libizov, 1939). The seeds have been reported to contain atropine, festunine (which resembles hyoscyamine and atropine) and festudine (which resembles norhyoscyamine) (Kahleque *et al.*, 1966). According to Somanabandhu and Suntorncharoenon (1980), *D. metel* may be considered as an attractive source for the production of medicinally useful tropane alkaloids.

Alkaloid content of roots, leaves, stems, flowers, fruits and seeds of *D. metel* show seasonal changes; the total content being maximum during the flowering stage for leaves

(0·55%), the flowering and fruiting stage for stems (0·41%) and roots (0·77%), the fruit ripening time for flowers (0·98%) and the time of fruit dehiscence for fruits (0·089%) and seeds (0·17%). Ploidy level affects total alkaloid content; thus for the seeds, haploid plants show 0.15%, diploid 0.33% and tertraploid 0.42% (Karnick and Saxena, 1970).

The roots of *D. metel* var. *fastucosa* growing in Bangladesh have been reported to contain the following tropane and related alkaloids: 3α, 6β-ditigloyloxytropane, 3α, 6β-ditigloyloxytropan-7 β-ol, tigloidine, apohyoscine, hyoscine, 3α-tigloyloxytropane, norhyoscine, meteloidine, hyoscyamine/atropine, norhyoscyamine/noratropine, 3α-acetoxytropane, cuscohygrine, tropine and ψ-tropine (Anwar and Ghani, 1973).

The seeds of *D. fastuosa* (*D. metel*) contain daturanolone and festusic acid (Khaleque *et al.*, 1967). The fatty acid compositions of the seed oil are: linoleic, 52·16; oleic, 31·84; palmitic, 13·05, and stearic, 2·95% (Grindley, 1954). Coumarins have been detected in the seeds (Zutsi and Atal, 1970).

2 *PETUNIA*

Other than *P. hybrida* which has been studied in details, little information is available about the constituents of other species. *P. petagonica* contains diterpenes of the bayerene type and flavonoids (Guerreiro *et al.*, 1984).

1 *Petunia hybrida* Vilm.
Common name: *Common garden Petunia*
Arabic name: *Betonia*

Several anthocyanin and flavonoid pigments have been identified from the flowers. All anthocyanins found in flowers of *P. hybrida* are glucosylated at the 3-position. Depending on the genetic background, they also possess a glucose group at the 5-position. Other substitutions of the anthocyanin molecule involve rhamnosylation, acylation by *p*-coumaric acid and methylation of the B-ring. In *P. hybrida*, anthocyanins are derived either from cyanidin or delphinidin (Wiering, 1974; Schram *et al.*, 1981; Jonsson *et al.*, 1984). Both mathylated as well as unmethylated anthocyanins are present in the flowers (Wiering, 1974). Out of twenty four cultivars of *P. hybrida* the flowers of twelve contain cyanidin, eleven peonidin, eleven petunidin, thirteen malvidin, two traces of delphinidin and two traces of rosinidin. Most varieties contain two pigments, and only two contain three (Muszynski, 1964). The red flowering variety contains mainly the nonacylated mono-and diglucosides and in blue or purple flowering varieties the acylated rhamnoglucosides prevail (Muszynski, 1968). *P. hybrida* mutants containing a mixture of 3-monoglucosides of pelargonidin, cyanidin and peonidin were obtained by selection of kaempferol producing lines (Cornu *et al.*, 1974). Sugar esters of cinnamic and hydroxycinnamic acids have been reported from *Petunia* hybrids (Brikofer *et al.*, 1960; Harborne and Corner, 1963).

The flowers contain several flavonoids. The petals contain an acylated flavonoid, petunoside (a kaempferol 3β-feruloylsophoroside) (Brikofer and Kaiser, 1962a). The fresh flowers yield five flavone glycosides: kaempferol 3β-sophoroside, quercetin 3-sophoroside, quercetin 3-sophoroside-7-glucoside, kaempferol 3-sophoroside-7-glucoside and 2,3-dihydroquercetin 4′-glucoside (Birkofer and Kaiser, 1962b). Other kaempferol glucosides (acylated with *p*-hydroxybenzoic acid and quercetin glycosides acylated with protocatechuic acid have been identified from a gene of *P. hybrida* (van Wyk, 1964).

The pollen of *P. hybrida* contains, 4,2′,4′,6′-tetrahydrochalcone (De Vlaming and Kho, 1976). The roots contain two coumarins scopoletin and fabiatrin (scopoletin 7-β-primveroside) (Birkofer *et al.*, 1967).

3 *SOLANUM*

Several *Solanum* species contain industrially important compounds (steroidal alkaloids and sapogenins). These substances are used for the preparation of certain hormonal steroids. Some of these plants also contain flavonoids, coumarins and triterpenoids (Rizk, 1986).

1 *Solanum muricatum* Ait.
Common name: *Pepino*
Arabic name: —

Phytochemical screening of the plant revealed the presence of alkaloids (Rizk *et al.*, 1988).

XLIII TAMARICACEAE

1 *TAMARIX*

The leaves, flowers and roots of *Tamarix* species contain several phenolic compounds *viz.* flavonoids, tannins, phenolic acids and phenolic lactones (Nawar and Souleman, 1984; Rizk, 1986). These plants bear galls which are usually rich in tannins (up to 50%) (Rizk, 1986).

1 *Tamarix aphylla* Karst.
Common name: *Athel tamarisk*
Arabic name: *Athl* or *Tarfa*

The galls of *T. aphylla* contain 47·94% tannins belonging mainly to the hydrolysable class. The galls contain the following phenolic compounds: gallic acid, ellagic acid, dehydrodigallic acid, dehydrojuglone 5-glucoside, isoferulic acid, juglanin (an ellagitannin), quercetin, isoquercitrin, tamarixetin and tamarixin (Ishak, *et al.*, 1972a,b).

The leaves contain tamarixin, isoquercitrin and rhamnetin 3-glucuronide 3,5,4′-trisulphate (Saleh *et al.*, 1975), quercetin and isoferulic acid (Chakrabarty *et al.*, 1965). The flowers contain quercetin, rhamnocitrin 3-glucoside and rhamnocitrin 3-

rhamnoside, sulphated and acylated flavonoids: kaempferol 7,4′-dimethyl ether 3-sulphate, rhamnetin 3-glucuronide 3,5,4′-trisulphate and quercetin *O*-isoferulyl-*β*-glucuronide (Nawwar *et al.*, 1975; El-Ansari *et al.*, 1976).

The wood of *T. aphylla* has been used in several countries as a remedy for syphilis and skin conditions (Watt and Breyer-Brandwijk, 1962).

XLIV TROPAEOLACEAE

Tropaeolaceae is one of the families which contain glucosinolates (isothiocyante glucosides) (Kjaer *et al.*, 1953).

1 *TROPAEOLUM*

The seeds of the nine *Tropaeolum* species investigated by Kjaer *et al.*(1978) have been found to contain glucosinolates. The studied species produce benzyl-2-propyl and 2-butyl-isothiocyanates upon enzymatic hydrolysis of the glucosinolates. Seeds, tubers, leaves and flowers of *T. tuberosum* subsp. *tuberosum* produce (upon enzymatic hydrolysis of the glucosenolate extract) *p*-methoxybenzyl isothiocyanate, while subsp. *silvestre* produce benzyl-,2-propyl and 2-butyl isothiocyanates (Johns and Towers, 1981). The occurrence of flavonoids in the genus has been also reported (Delaveau 1964).

1 *Tropaeolum majus* L.
Common name: *Garden nastrium*
Arabic name: *Abu Khangar*

The seeds of the plant contain the mustard oil glucoside, gluctropaeolin (Schultz and Gmelin, 1954; Kariyon *et al.*, 1956).

The leaves contain isoquercitroside, quercitol 3-triglucoside and an acid of the chlorogenic acid group, while the flowers contain a kaempferol glucoside (Deleaveu, 1967). The plant also contains sophorosides of cyanidin and pelargonidin (Harborne 1963b).

The leaf contains 200–465 mg/100 gm of ascorbic acid and the petiole 100–160 mg/100 gm. (Watt and Breyer-Brandwijk, 1962). The seed yields a fixed oil which contains 20% of 11-eicosenoic acid as well as the commoner fatty acids. The anthers of the pollen contain twelve carotenoids (Sykut, 1965).

The plant has been reported to yield a broad-spectrum antibiotic (Halbeisen, 1954; Stickl, 1954) which is preferentially excreted through the urinary and respiratory tract (Stickl, 1955; Winter, 1955). The antimicrobial principle of nasturtiums (*T. majus*) is identical with benzyl mustard oil (Dannenberg *et al.*, 1956). The essential oil of *T. majus* also possesses antifugal properties (Vichkanova *et al.*, 1969).

T. majus has been much used in household medicine, particularly for cystitis, infections of the urinary tract, for inflammation of the kidney and as an application of chronic sores. Other uses recorded are antipyretic, antiscorbutic, anticathartic, against meteorism and as a "blood purifying" agent (Watt and Breyer-Brandwijk, 1962). The fatty esters of the plant are more potent against dermatomycotic and protozoan organisms than against *Staphyloccal tuberculosis* and *Escherichia* (a genus of bacteria) (Vichkanova *et al.*, 1971).

XLV VERBENACEAE

Several members of the Verbenaceae are known to contain iridoids (Kooiman, 1975; Rizk, 1986). Plants of this family may also contain essential oils and flavonoids (Rizk, 1986).

1 *CLERODENDRUM*

Phytochemical investigations of this genus have led to the isolation of iridoids, flavones, neolignans, diterpenoids, triterpenoids and caffeic-acid glycosides. Of the twelve *Clerodendrum* species studied by Jacke and Rimpler (1983), eight contain iridoid glycosides. Examples of the iridoids isolated from certain *Clerodendrum* species are:

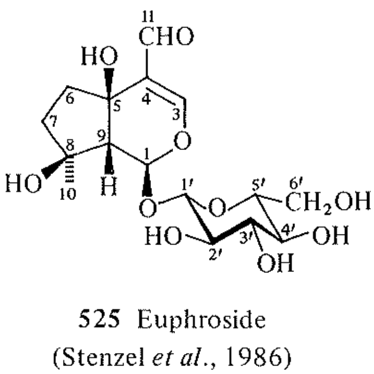
— *C. colebrokianum*: melittoside (leaves and fruits) and harpagide (fruits) (Jacke and Rimpler, 1983).

— *C. incisum*: euphroside (525) and its foliamenthic acid esters (leaves and twigs) and plantarenaloside (roots) (Stenzel *et al.*, 1986).

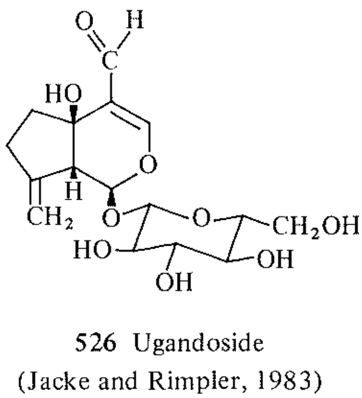
— *C. indicum*: harpagide (leaves) (Jacke and Rimpler, 1983).

— *C. inerme*: melittoside (leaves) (Jacke and Rimpler, 1983).

— *C. thomsonae*: melittoside, aucubin, 8-*O*-acetylharpagide, reptoside, ajugoside, 8-*O*-acetylmioporoside (Lammel and Rimpler, 1981; Jacke and Rimpler, 1983).



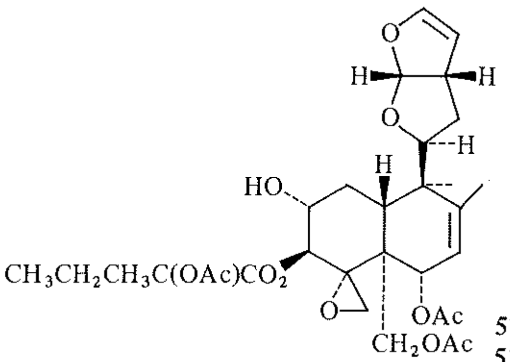
525 Euphroside
(Stenzel *et al.*, 1986)



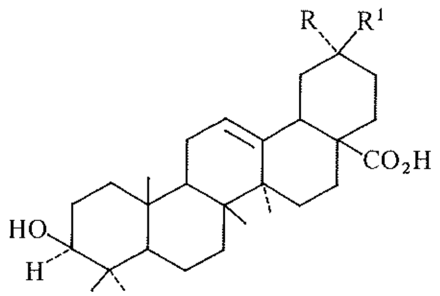
526 Ugandoside
(Jacke and Rimpler, 1983)

— *C. tomentosum*: harpagide (leaves) (Jacke and Rimpler, 1983).
— *C. trichotomum*: harpagide (leaves and fruits) and melittoside (fruits) (Jacke and Rimpler, 1983).
— *C. serratum* var. *dentatum*: plantarenaloside, euphroside and melittoside (leaves) (Jacke and Rimpler, 1983).
— *C. ugandense*: ugandoside (526) and euphroside (leaves) (Jacke and Rimpler, 1983).

Clerodendrum species contain diterpenoids e.g. clerodin from *C. infortunatum* (Banerjee, 1937; Joshi *et al.*, 1977) and roots of *C. colebrookianum* and *C. phlomoides* (Joshi *et al.*, 1979), clerodendrin A (527) and clerodendrin B from the leaves of *C. tricotomum* (Kato *et al.*, 1974) and 3-epicaryoptin from *C. calomitosum* (Hosozawa *et al.*, 1974) and *C. inerme* (Rogers *et al.*, 1979). Clerodendrins A and B as well as 3-epicaryoptin possess antifeeding activity against the larvae of *Spodoptera litura* (Kato *et al.*, 1971, 1972; Hosozawa *et al.*, 1974; Rogers *et al.*, 1979). The isolation of triterpenoids from the different parts of *Clerodendrum* species has been reported. Clerosterol (5,25-stigmastadien-3β-ol), clerodol (lupeol) and clerodolone (lup-20(30)-ene-19, 3β-diol-12-one) occur in the roots of *C. infortunatum* (Manzorr-I-Khuda and Sarela, 1965; Manzoor-I-Khuda, 1966). Clerodolone was also identified from the roots of *C. fragrans* (and its leaves) (Singh and Singhi, 1981) and *C. trichotomum* (Kawano *et al.*, 1967). The stem bark of *C. nerifolium* contains, in addition to β-sitosterol, α-amyrin acetate, lupeol acetate, ursolic acid and betulinic acid (Ganapaty and Rao, 1985). Epifriedelinol has been identified from the bark of *C. trichotomum* (Nonomura, 1955). The bark of *C. serratum* contains triterpenoid sapogenins *viz.* oleanolic acid, queretaroic acid (528) and serratagenic acid (529) (Rangaswami and Sarangan, 1969). A number of steroids have been also isolated from this genus. The leaves of *C. inerme* (Subramanian *et al.*, 1973a), *C. indicum, C. infortunatum, C. phlomoides, C. nerifolium* (Sabramanian *et al.*, 1973b). *C. fragrans* and *C. squamatum* (Nair *et al.*, 1974), the flowers of *C. infortunatum* (Joshi *et al.*, 1977) and the stems of *C. indicum* (Parakash and Garg, 1981) contain



527 Clerodendrin A
(Kato *et al.*, 1973)



528 Queretaroic acid : R = CH_3, R^1 = CH_2OH
529 Serratagenic acid : R = COOH, R^1 = CH_3
(Rangaswami and Sarangan, 1969)

(24*S*)-ethylcholesta-5,22,25-trien-3β-ol. This sterol may be considered a chemotaxonomic marker of this genus (Subramanian *et al.*, 1973b). β-Sitosterol and stigmasta-5,25-dien-3β-ol occur in several species e.g. the roots of *C. infortunatum* (Barua *et al.*, 1967b). The leaves of *C. serratum* contain stigmasterol (Nair *et al.*, 1976) and α-spinasterol (Nair *et al.*, 1979).

Flavonoids have been identified from several species of this genus. Examples of the species which contain flavonoids are:

- *C. indicum* (leaves): hispidulin, hispidulin 7-*O*-glucuronide and scutellarein 7-*O*-glucuronide (Subramanian and Nair, 1973b).
- *C. inerme* (leaves): apigenin and scutellarein (Subramanian *et al.*, 1973a)
- *C. infortunatum* (flowers): methyl ester of acacetin 7-*O*-glucuronide (Sinha *et al.*, 1981), (leaves): scutellarein-7-*O*-glucuronide and hispidulin 7-*O*-glucuronide (Subramanian and Nair, 1973).
- *C. nerifolium* (leaves): scutellarein 4′-L-arabinoside, acacetin 7-glucoside and acacetin glucuronide (Subramanian and Nair, 1972).
- *C. pholmidis* (flowers): pectolinarigenin, hispidulin and apigenin (Seth *et al.*, 1982).
- *C. serratum* (leaves): apigenin, luteolin, baicalin, scutellarein, 6-hydroxyluteolin (Nair *et al.*, 1979); (roots): luteolin and luteolin 7-*O*-glucuronide (Nair *et al.*, 1976).
- *C. trichotomum* (leaves): acecetin 7-glucuronide (1 → 2)-glucuronide (Okigawa *et al.*, 1970, 1971). Clerodendroside (5,6,7-trihydroxy-4-methoxyflavone-7-*O*-glucuronide) occurs in *C. trichotomum* var. *fargesii* (Morita *et al.*, 1977).

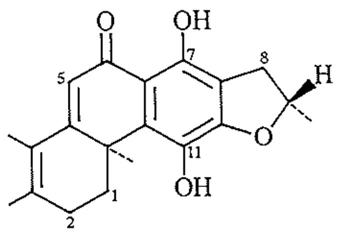
The seeds of *C. inermis* contain neoligenans; one of which (5,8-epoxy-6-7-dimethyl 2′,3′,2″,3″-dimethylenedioxy-4′-1″-dimethoxy-1,2:3,4-dibenzo-1,3-cyclooctadiene) makes up about 5% by weight of the seeds (Spencer and Flippen-Anderson, 1981). Uncinatone (530), a hydroquinone diterpenoid, which is strongly fungitoxic to spores of *Cladosporium cucumerinum* has been identified form *C. uncinatum* (Dorsaz *et al.*, 1985). The glycosides myricoside (531) and kusaginin (532) were isolated from *C. myricoides* (root bark) (Cooper *et al.*, 1980) and *C. trichotomum* (Sakurai and Kato, 1983) respectively. Myricsoide exhibits antifeedant activity against the African armyworm (*Spodoptera exempta*) (Cooper *et al.*, 1980).

The fruits of *C. trichotomum* contain trichotomine (533, a blue pigment which possesses hypotensive and sedative activities) and trichotomine G_1 (534) (Iwadare *et al.*, 1974a, b, 1976). D-Mannitol has been isolated form stems of *C. pholmidis* (Gupta *et al.*, 1967) and root bark of *C. serratum* (Garg and Verma, 1967; Banerjee *et al.*, 1969).

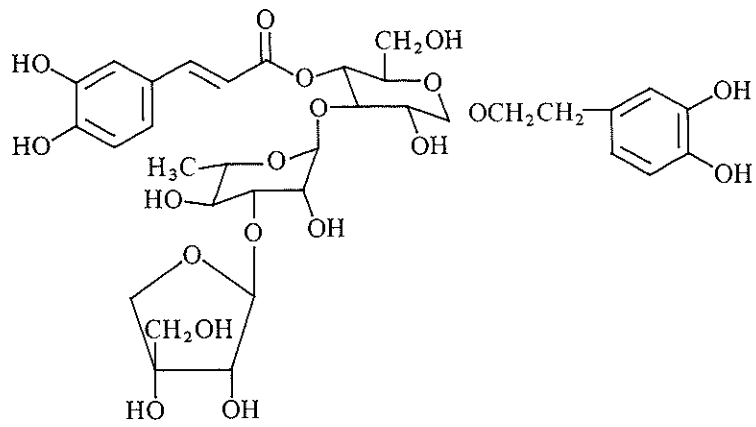
1 *Clerodendrum glabrum* E. Mey.
Common name: *Glorybower*
Arabic name: *Yasmin zifir*

Phytochemical screening of the plant revealed the presence of flavonoids (Rizk *et al.*, 1988).

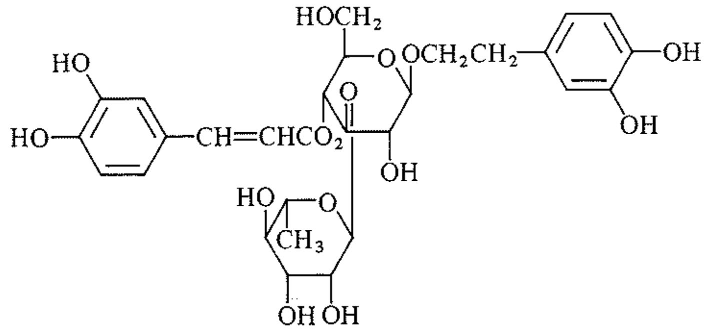
The leaf of *C. glabrum* is used as a remedy for colic, cough, fever, intestinal parasites and for convulsions in children. The plant is also used as a purgative for the calf (Watt and Breyer-Brandwijk, 1962).



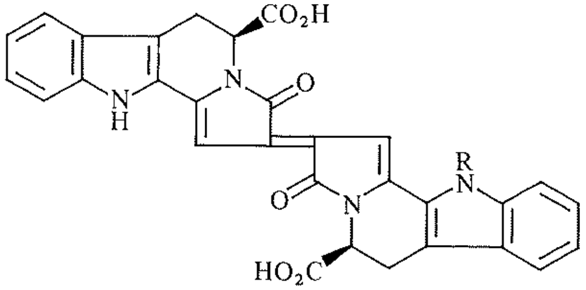
530 Unicantone
(Dorsaz *et al.*, 1985)



531 Myricoside
(Cooper *et al.*, 1980)

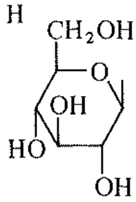


532 Kusasginin
(Sakurai and Kato, 1983)



533 Trichotomine : R = H

534 Trichotomine G_1 : R =



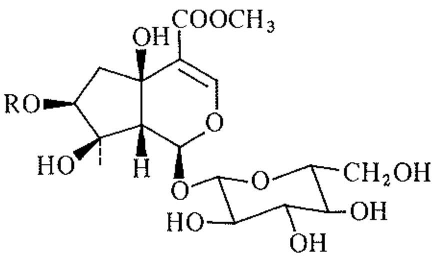
(Iwadare *et al.*, 1974b)

2 *DURANTA*

1 *Duranta pluimeri* Jacq.
(= *Duranta repens* L.)
Common name: *Golden dewdrop, pigeon-berry, sky-flower*
Arabic name: *Doranta*

The plant contains the following compounds:

— Iridoids: lamiide (535), durantosides I (536), II (537), III (538) (Rimpler and Timm, 1974), IV (539) (Rao *et al.*, 1978), durantoside I tetraacetate and pentaacetate, durantoside II tetraacetate and durantoside IV tetraacetate (Kuo and Kubota, 1976).



535 Lamiide : R = H
536 Durantoside I : R = —Cinnamoyl
537 Durantoside II : R = —*p*-Methoxycinnamoyl
538 Durantoside III : R = —3,4-Dimethoxycinnamoyl
539 Durantoside IV : R = —*p*-Hydroxycinnamoyl

(Rao *et al.*, 1983)

— Flavonoids: Scutellarein, 4′-methoxyscutellarein, scutellarein-7-*O* rhamnoside, pectolinaringenin, pectolinaringenin 7-*O*-rutinoside (Subramanian and Nair, 1972; Makboul and Abdel-Baky, 1981).

— Triterpenoids and steroids: *β*-sitosterol, *β*-amyrin, oleanolic acid and ursolic acid (Kapil, 1960; Rao *et al.*, 1978; Makboul and Abdel-Baki, 1981).

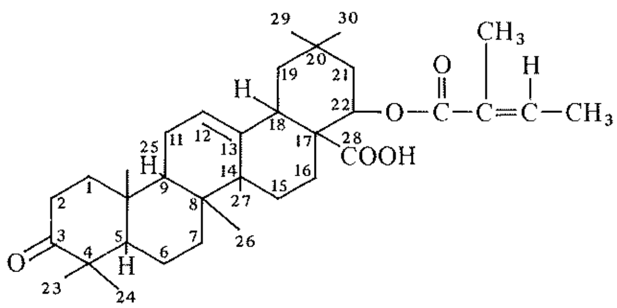
The fruits also contain alkaloids (Yousef *et al.*, 1973); methyl-*p*-methoxycinnamate and methyl *p*-hydroxycinnamate (Rao *et al.*, 1978).

The plant is used in folk medicine as a diuretic, febrifuge and stimulant leading even to convulsion and to toxic symptoms (Watt and Breyer-Brandwijk, 1962).

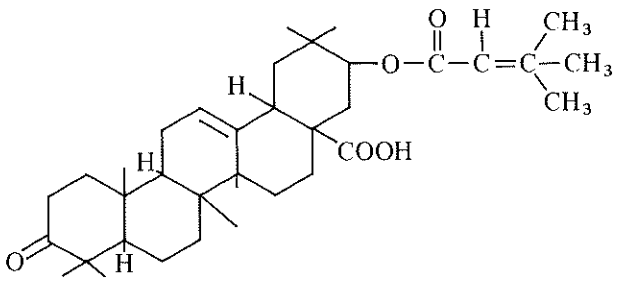
3 *LANTANA*

1 *Lantana camara* L.
Common name: *Lantana*
Arabic name: *Lantana*

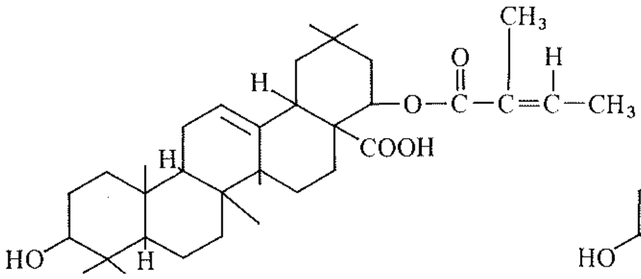
L. camara contains several triterpenoids, among which lantadene A represents the major toxin of the plant. The triterpenoids isolated form the different taxa of this species are: lantadene A (540, = rehmannic acid), lantadene B (541), reduced lantadene A (542, 22β-angeloyloxy-3-β-hydroxyolean-12-en-28-oic acid), reduced lantadene B (22 β-dimethylacryloxy-3β-hydroxolean-12-en-28-oic-acid), 22β-[(*S*)-2-methylbutanolyloxy]-3-oxoolean-12-en-28-oic acid, betulonic acid, icterogenin (544, 22β-angeloyloxy-24-hydroxy-3-oxoolean-12-en-28-oic acid), lantanolic acid (543), lantanic acid, lantic acid (545), lantoic acid (546), lantanilic acid (548), 3-ketoursolic acid, lantabetulic acid (547) and α-amyrin (Barua *et al.*, 1966, 1969, 1976; Ahmed *et al.*, 1972a; Hart *et al.*, 1976a, b; Sundaramaiah and Bai, 1973; Sharma *et al.*, 1981; Johns *et al.*, 1983; Roy and Barua, 1983, 1985).



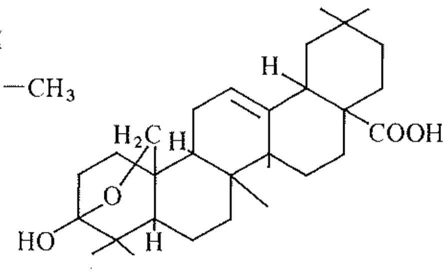
540 Lantadene A



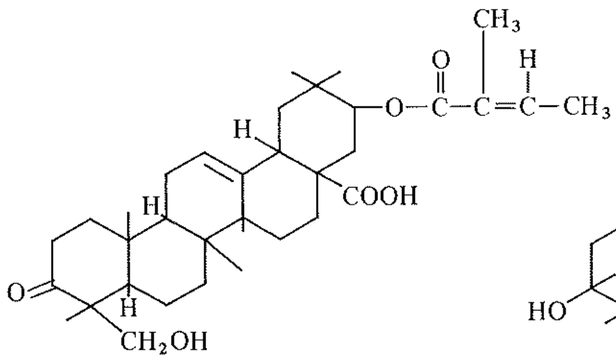
541 Lantadene B



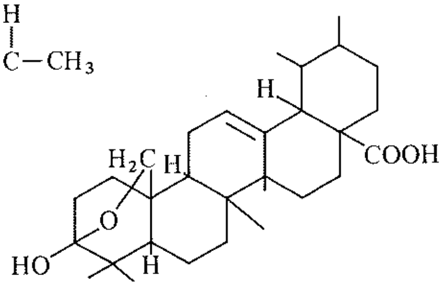
542 Reduced lantadene A



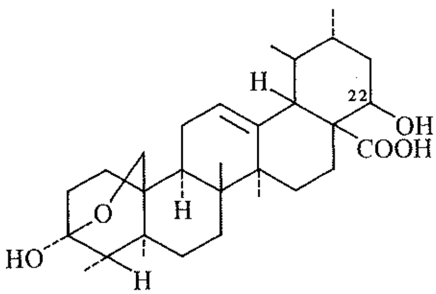
543 Lantanolic acid



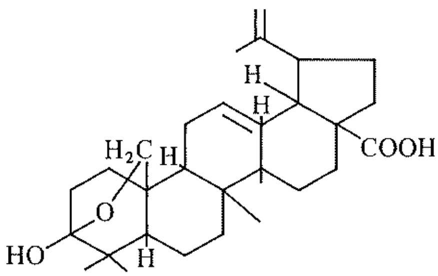
544 Icterogenin



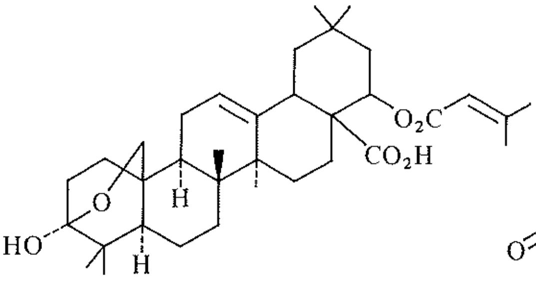
545 Lantic acid



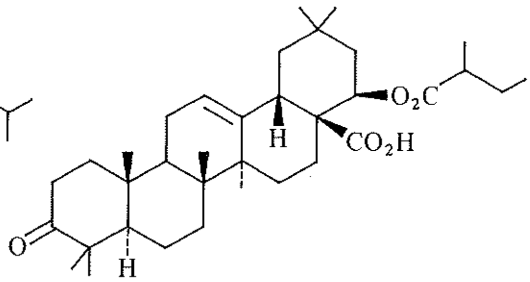
546 Lantoic acid



547 Lantabetulic acid

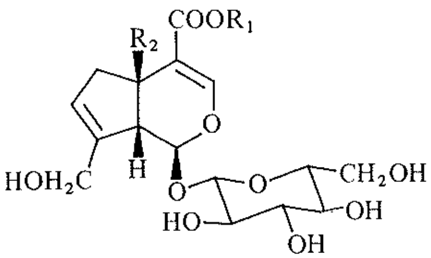


548 Lantanilic acid
(Barua *et al.*, 1976)



549
(Johns *et al.*, 1983)

The plant contains iridoid glucosides *viz.* theveside which occurs as the sodium salt (550) and theviridoside (551) (Rimpler and Sauerbier, 1986).



550 Theveside—Na :
R_1 = Na, R_2 = OH

551 Theviridoside :
R_1 = CH_3, R_2 = OH

(Rimpler and Sauerbier, 1986)

The leaf yields essential oil (0·23–0·32%) (Dutt, 1960) which consists of more than 35 compounds (Saleh, 1974); among which the following components have been identified: l-α-phellandrene, linalool, phellandral, geraniol, caryophyllene, *p*-cymene, α-pinene, cineole, dipentene, ν-terpinene, d-α-terpineol, citral, cadinene, cadinol, eugenol, furfural, phellandrone, camerene and isocamerene (Kafuku *et al.*, 1934, 1935; Dutt, 1960; Ahmed *et al.*, 1972b). Approximately half of the oil consists of sesquiterpenes (Dutt, 1960).

The seeds contain a fixed oil (containing four sterols, one being β-sitosterol (Avadhoot *et al.*, 1978). The lipids of the stems, leaves and flowers contain α-amyrin, β-sitosterol and 1-tricontanol (Ahmed *et al.*, 1972b). A keto steroid designated as "lancamarone" has been isolated from the plant (Sharma and Kaul, 1958, 1959). The bark of the root contains tannins and the stem bark contains a rubber-like substance and some resin (Watt and Breyer-Brandwijk, 1962).

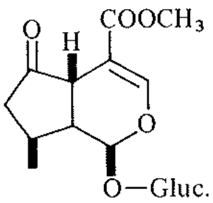
The chemical composition of the edible fruits is: dry matter, 24%; total water-soluble sugar, 18·0%; protein, 5·1%; ash, 3·7%; K_2O, 1·49%; Na, 0·820%; Ca, 0·11% and Mg, 0·146% in dry matter (Bajracharya, 1980).

The plant is toxic to sheep and cattle. The total lantadenes is 1·4–1·7% in July-September. Lantadene A content of the leaf is about 6–7 mg/gm dry weight during July-August; the compound being altogether absent in flowers, fruits and tender upper shoots. In taxa toxic to livestock lantadenes A and B are present as major constituents. Lantana poisoning in livestock causes obstructive jaundice, photosensitization, and rise in serum glutamic-oxaloacetic transaminase activity. Hepatic and renal xanthine oxidase activity is also elevated during lantana poisoning.

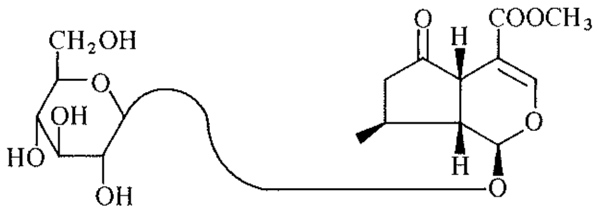
The leaf is used as a diaphoretic and stimulant for jaundice and chest diseases (Watt and Breyer-Brandwijk, 1962).

4 *VERBENA*

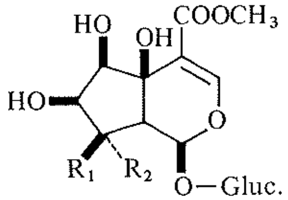
Iridoid glycosides are found in *Verbena* species. Verbenaloside (= verbenalin), first isolated as cornin (552) from a *Cornus* species occurs in some *Verbena* species (Reichert, 1935; Breitwieser, 1943; Kooiman, 1975; Damtoft *et al.*, 1979). A number of other iridoids have been identified from this genus *viz.* hastatoside (553) from *V. hastata* (Rimpler and Schaefer, 1979), pulchelloside I (554) (Milz and Rimpler, 1978a), pulchelloside II (555) (Milz and Rimpler, 1978b) from *V. pulchella*, griselinoside, lamiide, ipolamide, brasoside from several *Verbena* species (Milz and Rimpler, 1979) and aucubin from *V. officinalis* (Makboul, 1986).



552 Cornin
(Milz and Rimpler, 1979)



553 Hastatoside
(Rimpler and Schaefer, 1979)

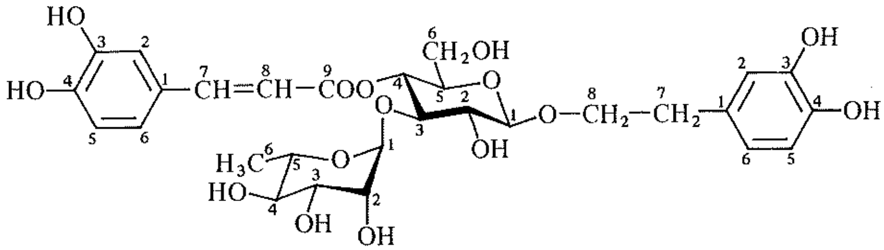


554 Pulchelloside I :
$R_1 = H, R_2 = CH_3$
555 Pulchelloside II :
$R_1 = CH_3, R_2 = H$

(Milz and Rimpler, 1979)

The types of pigments in garden hybrids of *Verbena* are anthocyanidins (pelargonidin, delphinidin or mixtures of these with each other or with cyanidin) and acylated or nonacylated anthocyanins (which are either 3-monoglucosides or 3,5-diglucosides). The anthocyanins can be partly or completely replaced by anthoxanthins (Beale *et al.*, 1940).

Flavonoids have been identified from certain *Verbena* species e.g. nodifloretin and penduletin from *V. bonariensis* (Pagani, 1984) and artemetin (5, hydroxy-3,6,7,3′,4′-pentamethoxyflavone) from *V. officinalis* (Makboul, 1986).



556 Verbascoside
(Haensel and Kallmann, 1986)

Verbascoside (β-(3′,4′,-dihydroxyphenyl) ethyl-*O*-α-L- rhamnopyranosyl (1 → 3)-β-D-(4-*O*-caffeoyl)-glucopyranoside has been recently isolated from *V. officinalis* (Haensel and Kallman, 1986).

1 *Verbena hybrida* Voss.
Common name: *Common garden Verbena*
Arabic name: *Verbena englizi*
The plant contains verbenaloside (Kooiman, 1975).

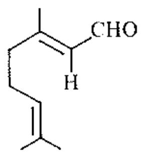
APPENDIX I

Molecular Structures of Some Terpenoids, Steroids, Flavonoids, Coumarins and Phenolic Acids

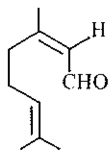
This part is intended as a centralised reference source for molecular structures of the compounds which are of common occurrence in many of the plants mentioned in this book.

I *TERPENOIDS*

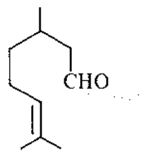
1. *Acyclic Monoterpenoids*



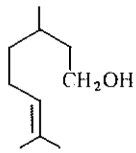
557 Geranial (citral "a")



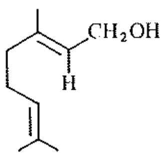
558 Neral (citral "b")



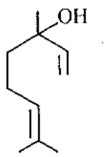
559 Citronellal



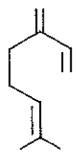
560 Citronellol



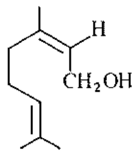
561 Geraniol



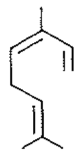
562 Linalool



563 Myrcene

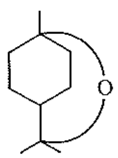


564 Nerol

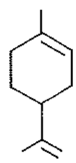


565 Ocimene

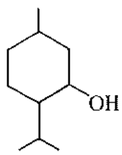
2. *Monocyclic Monoterpenoids*



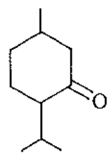
566 1,8-Cineole



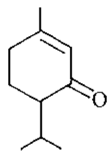
567 Limonene



568 Menthol

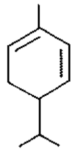


569 Menthone

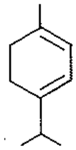


570 Piperitone

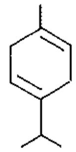
(Finar, 1977)



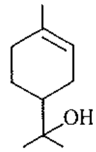
571 α-Phallandrene



572 α-Terpinene

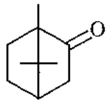


573 β-Terpinene

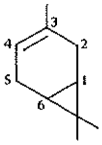


574 α-Terpineol

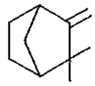
3. *Bicyclic Monoterpenoids*



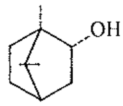
575 Camphor



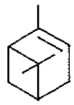
576 Car-3-ene



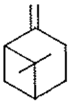
577 Camphene



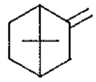
578 Borneol



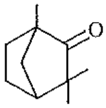
579 α-Pinene



580 β-Pinene

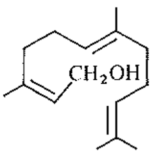


581 Fenchene

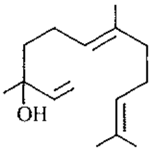


582 Fenchone

4. *Acyclic Sesquiterpenoids*

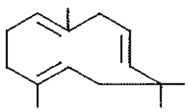


583 Farnesol



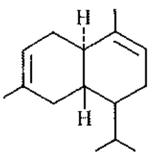
584 Nerolidol

5. *Monocyclic Sesquiterpenoids*

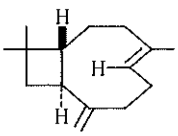


585 Humulene

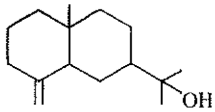
6. *Bicyclic Sesquiterpenoids*



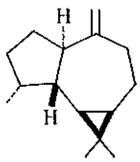
586 α-Cadinene



587 Caryophyllene



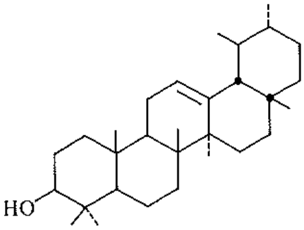
588 β-Eudesmol



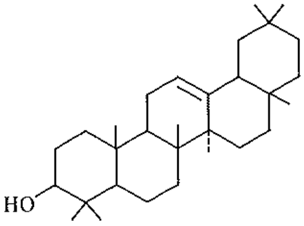
589 Aromadendrene

(Finar, 1977)

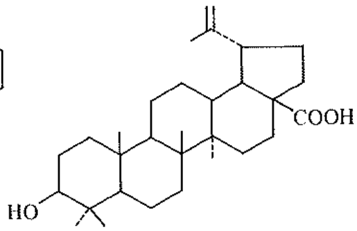
7. *Triterpenoids*



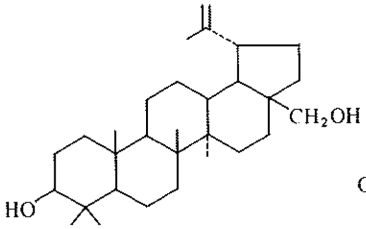
590 α-Amyrin



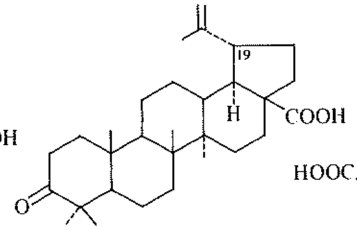
591 β-Amyrin



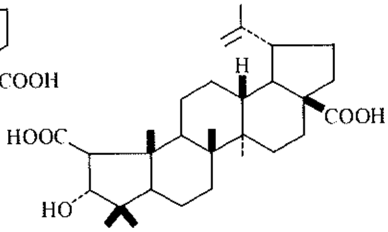
592 Betulic acid (= Betulinic acid)



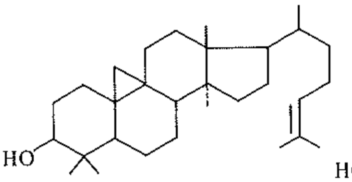
593 Betulin



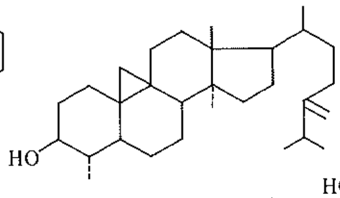
594 Betulonic acid



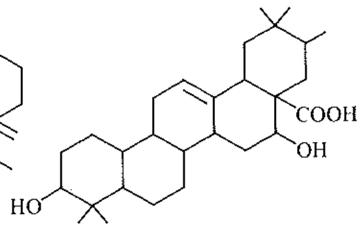
595 Ceanothic acid



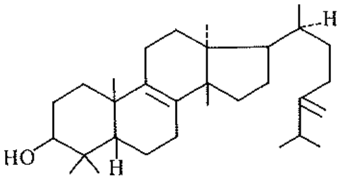
596 Cycloartenol



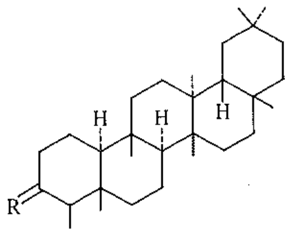
597 Cycloeucalenol



598 Echinocystic acid



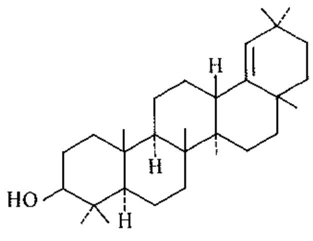
599 Euphorbol



600 : Friedelin : R = O

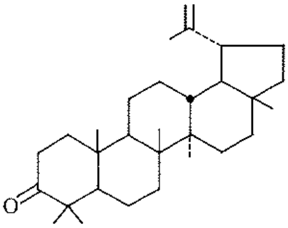
601 : Friedelinol : R

602 : EpiFriedelinol : R

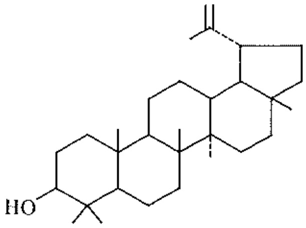


603 Germanicol

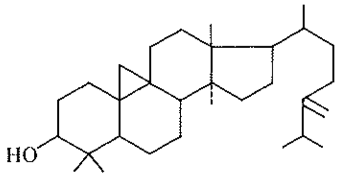
(Rizk, 1986)



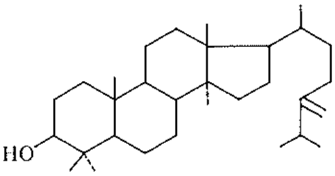
604 Lupenone



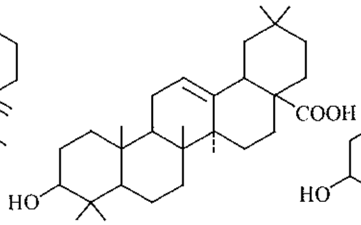
605 Lupeol



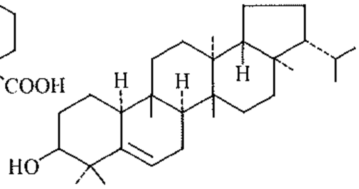
606 24-Methylene-cycloartenol



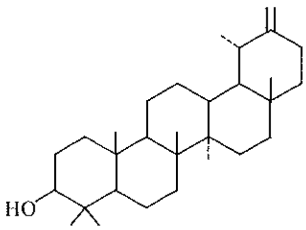
607 Obtusifoliol



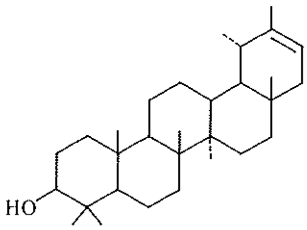
608 Oleanolic acid
(Rizk, 1986)



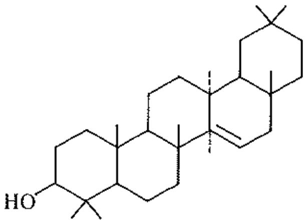
609 Simiarenol



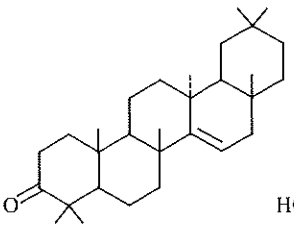
610 Taraxasterol



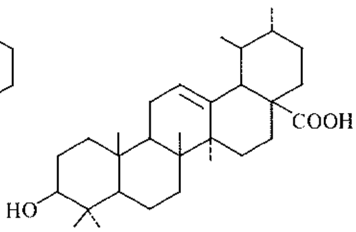
611 *pseudo*-Taraxasterol



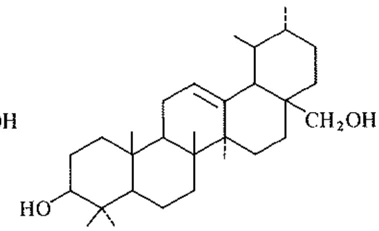
612 Taraxerol



613 Taraxerone

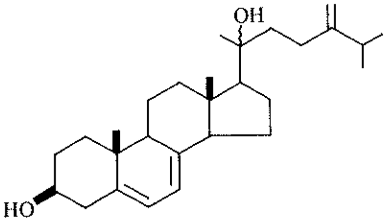


614 Ursolic acid
(Rizk and El-Missiry, 1986)

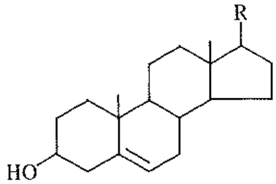


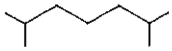
615 Uvaol

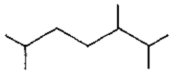
II *STEROIDS*

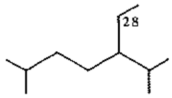


616 Amasterol

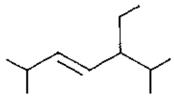


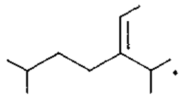
617 Cholesterol : R = 

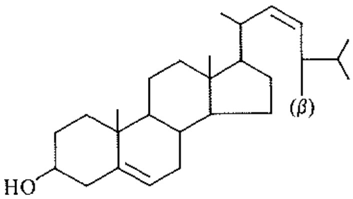
618 Campesterol : R = 

619 Sitosterol : R = 

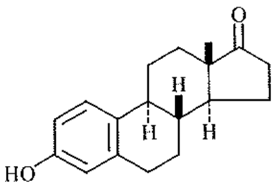
β-sitosterol (28α)
ν-sitosterol (28β)

620 Stigmasterol : R = 

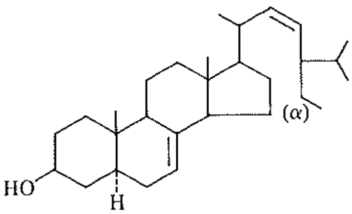
621 28-Isofucosterol : R = .



622 Brassicasterol



624 Oestrone (estrone)

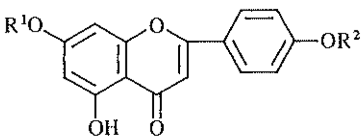


623 α-Spinasterol

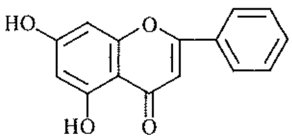
(Rizk, 1986)

III *FLAVONOIDS*

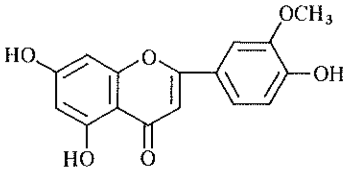
1. *Flovones*



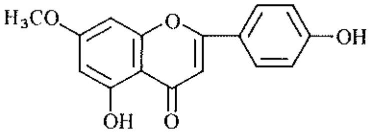
625 Acacetin : $R^1 = H, R^2 = CH_3$
626 Apigenin : $R^1 = R^2 = H$
627 Cosmosiin : R^1 = Glucosyl, $R^2 = H$



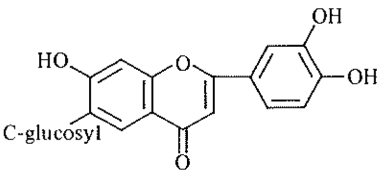
628 Chrysin



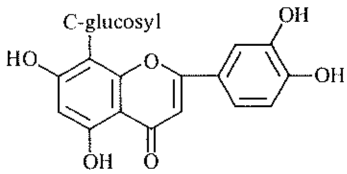
629 Chrysoeriol



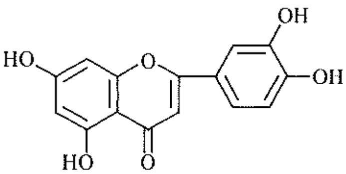
630 Genkwanin



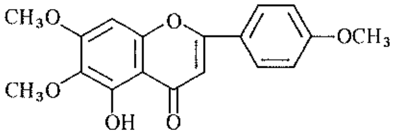
631 Isoorientin



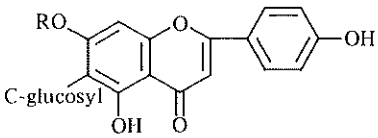
632 Orientin



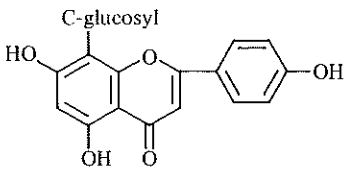
633 Luteolin



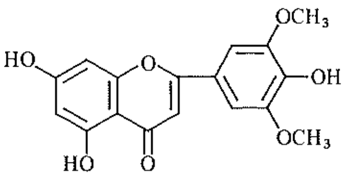
634 Salvigenin



635 Isovitexin : R = H (saponaretin)
636 Saponarin : R = Glucosyl



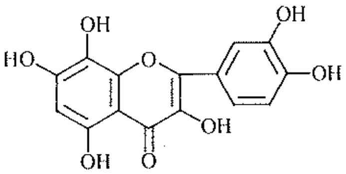
637 Vitexin



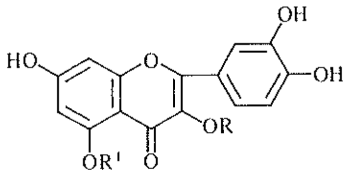
638 Tricin

(Rizk, 1986; Rizk and El-Missiry, 1986)

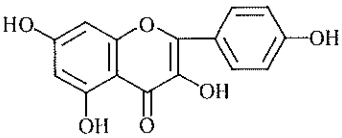
2. *Flavonols*



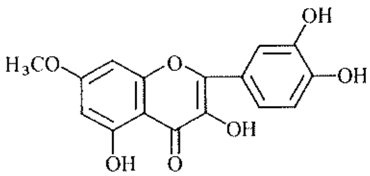
639 Gossypetin



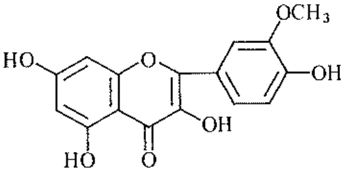
640 Quercetin : $R = R^1 = H$
641 Quercitrin: R = Rhamnosyl, $R^1 = H$
642 Hyperoside : R = Galactosyl, $R^1 = H$
643 Rutin : R = Rhamnoglucosyl, $R^1 = H$



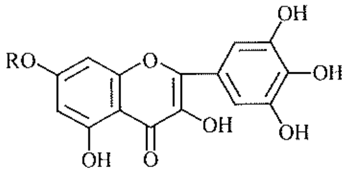
644 Kaempferol



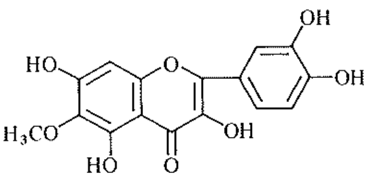
645 Rhamnetin



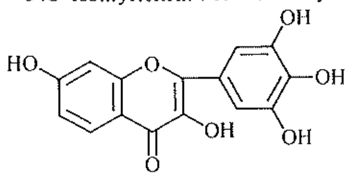
646 Isorhamnetin



647 Myricetin : R = H
648 Isomyricitrin : R = Glucosyl



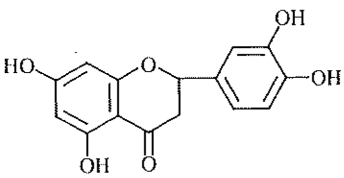
649 Patuletin



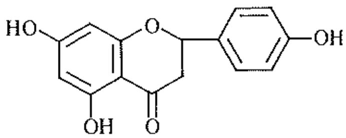
650 Robinetin

(Rizk, 1986; Mabry *et al.*, 1970)

3. *Flavanones*

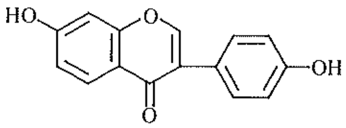


651 Eriodictyol



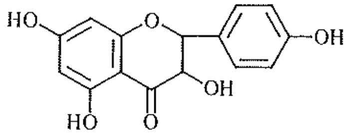
652 Naringenin

4. *Isoflavones*



653 Daidzein

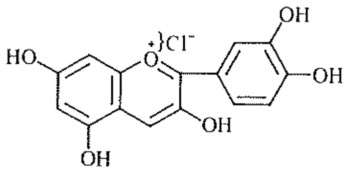
5. *Dihydroflavonols*



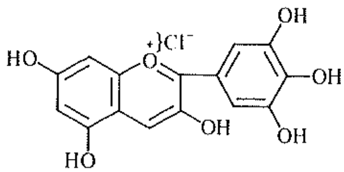
654 Dihydrokaempferol

(Mabry *et al.*, 1970)

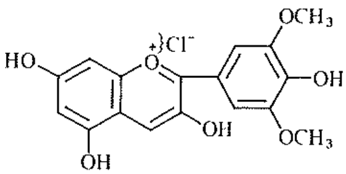
IV. *ANTHOCYANINS*



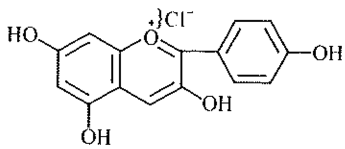
655 Cyanidin chloride



656 Delphinidin chloride



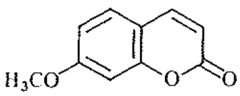
657 Malvidin chloride



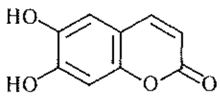
658 Pelargonidin chloride

(Finar, 1977)

V. *COUMARINS*

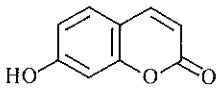


659 Herniarin



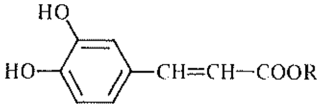
660 Esculetin

(Rizk, 1986)



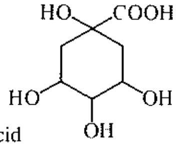
661 Umbelliferone

VI. *PHENOLIC ACIDS*

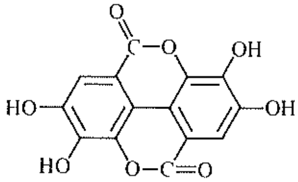


662 Caffeic acid : R = H

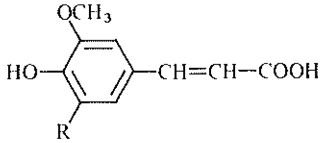
663 Chlorogenic acid : R = quinic acid



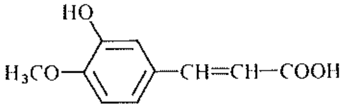
664



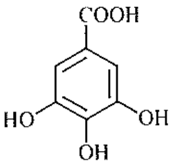
665 Ellagic acid



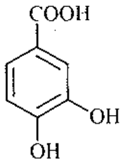
666 Ferulic acid : R = H
667 Sinapic acid : R = OCH_3



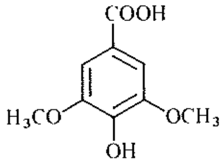
668 Isoferulic acid



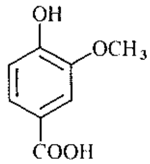
669 Gallic acid



670 Protocatechuic acid



671 Syringic acid



672 Vanillic acid

(Rizk, 1986)

APPENDIX II

GLOSSARY OF MEDICAL TERMS

Abortifacient: a drug or material that causes the expulsion of the fetus.
Alterative: agent presumed to correct a disordered bodily function.
Amenorrhea: abnormal suppression or absence of menstruation.
Analgesis: pain reliever.
Anodyne: a drug that relieve pain.
Anthelmintic: agent that expels worms from intestine.
Antibacterial: agent that exhibits or destroys bacteria.
Anticonvulsant: agent that prevents or stops convulsion.
Antifebrile:(= Antipyretic) a substance that reduces fever.
Antiinflammatory: against inflammation e.g. histamine.
Antineoplastic: a substance that works against cancer.
Antileukeumic: drug use in treatment of leukaemia.
Antirehumatic: agent that prevents or relieves the pain of rehumatism.
Antipyretic:(= Antifebrile)
Antiscorbutic: substance that corrects or cures scurvy.
Antiseptic: agent used for disinfection.
Antispasmodic: a drug or agent that prevents or relieves spasms occurring in muscles.
Antitumour: substance that destroys or inhibits the growth of the tumour and its spread e.g. cytotoxic or radioactive substances.
Antitussive: agent that prevents or relieves cough.
Aperient: a mild laxative.
Aphrodisiac: agent that stimulates sexual desire.
Astringent: agent or substance that produces diminution of discharges or bleeding from the surface of the body.
Bronchodilator: agent that dilates bronchi.
Bronchiectasis: following infection, dilation of bronchi associated with fetid breath, paroxysmal coughing and mucopurelent (pus-filled) discharge.
Biliousness: populat term used to describe conditions marked by general malaise, giddiness, vomiting, headache, indigestion, constipation, etc.
Blister: thin vesicle on the skin, filled with serum, and caused by rubbing, friction, burn, etc.
Cardiotonic: having a tonic effect on the heart.
Cathartic: (= Purgative)
Chronic: condition of gradual onset, long duration and usually with progressive course.
Colic: severe pain resulting from periodic spasm of abdominal organ, it may be biliary (related to gall bladder), intestinal (related to small intestine), renal (related to ureter), uterine (related to uterus), etc.

Constipation: chronic condition of infrequent and often difficult evacuation of faeces due to insufficient food or fluid intake or sluggish action of the bowel musculature or nerve supply.

Conjunctiva: the mucous membrane lining the inner eyelid and front of eyeball.

Conjunctivities: inflammation of the conjuctiva.

Convulsion: violent irregular motion of limb or body due to involuntary contraction of muscles.

Cutaneous: relating to the skin.

Cytotoxic: any substance which is toxic to the cell usually applied to drugs which are used for treatment of cancers.

Demulcent: substance used for its soothing and protective action; allaying irritation of surfaces, especially mucous membranes.

Depressant: agent that reduces functional activity.

Dermatitis: inflammation of the skin.

Diabetes: metabolic disorder affecting insulin production and resulting in faulty carbohydrate metabolism, giving rise to sugar in urine.

Diaphoretic: a substance causing an increase of perspiration as a result of the stimulation of the sweat glands.

Diarrhoea: (= Diarrhea): abnormal frequency and fluidity of stool discharge.

Diuretic: a substance that increases urine flow.

Dropsy: (= Edema)

Dysentry: inflammation of the bowel with evacuation of mucous and blood in the stool.

Dyspepsia: indigestion.

Eczema: an acute or chronic, noncontagious inflammation of the skin often accompanied by itching.

Edema: abnormal accumulation of fluid between cells.

Emetic: agent that induces vomiting.

Emmenagogue: a drug or agent that stimulates the menstrual flow.

Emollient: a substance applied externally to soften the skin, or internally, to soothe an irritated or inflammed surfaces.

Enema: a liquid preparation injected into the rectum resulting in complete emptying of the large bowel in minutes.

Epilepsy: disorder characterised by severe muscular spasms, loss of consciousness, and abnormally large discharges of electricity.

Erysipelas: an acute inflammation of the skin and subcutaneous tissues, characterised by serious toxic symptoms of high fever and great prostration.

Estrogenic effect: the effect of female steroidal in promoting ovulation and secondary sexual characteristics.

Expectorant: agent that ejects sputum from air passages.

Febrifuge: a fever-reducing drug.

Fever: elevation of body temperature above normal.

Gonorrhoea (*Gonorrhea*): a veneral disease that causes specific inflammation of the mucous membranes of the urethrum and adjacent cavities, due to *Gonococci* bacteria.

Haemorrhage (= Bleeding): the escape of blood from a vessel.

Hepatic: pertaining to or occurring in the liver.

Hypoglycemic: substance that decreases blood sugar, attended by anxiety, excitement, perspiration or coma.
Hysteria: a functional disturbance of the nervous system of psychoneurotic origin.
Impotence: inability to engage in sexual intercourse.
Inflammation: reaction of the living tissues to injury, infection, irritation characterised by pain, hotness, redness, tenderness and loss of function.
Itch: to feel irritating sensation on the skin, with the desire to scratch.
Jaundice: yellowness of the skin, mucous membranes and secretions, due to bile pigments in the blood.
Laxative: drug which stimulates evacuation of the bowel.
Leprosy: (Hansen's disease): chronic contagious characterised by defective whitish pigmentation, especially a congenital absence of pigments is spots or bands.
Menorrhagia (*hypermenorrhea*): excessive menstrual flow.
Nausea: a feeling of sickness at the stomach, with an urge to vomit.
Paroxysm: spasm or seizure; symptoms that suddenly intensify or recur.
Parasympatholytic: producing effects resembling those of interruption of the parasympathetic nerve supply to a part.
Pessary: a contraceptive device worn in the vagina.
Phytohemagglutinin: mitogenic lectin from plant agglutinates erythrocytes and stimulates thymus-derived lymphocytes.
Phytotoxic: proteinaceous toxin derived from a plant.
Pulmonary: pertaining to the lungs.
Purgative: (= cathartic, laxative)
Refrigerant: a cooling remedy, relieving fever and thirst or reducing heat.
Scrofula: tuberculosis of the lymphatic glands, especially of the neck, in which the glands become enlarged.
Scurvy: a nutritional disorder caused by deficiency of vitamin C, characterised by extreme weakness, spongy gums, and a tendency to develop hemorrhages under the skin, from the mucous membranes, and under the periosteum.
Sedative: agent used to relieve tension and anxiety.
Spasmolytic: (= Antispasmodic)
Stimulant: agent that excites or irritates.
Styptic: a drug or agent that checks hemorrhage by causing contraction of the blood vessels.
Sudorific: a drug or agent producing sweating.
Syphilis: a veneral disease, characterised by a variety of lesions, caused by *Treponema pallidum*.
Tonic: a drug or agent given to improve the normal tone of an organ or of the patient generally.
Tuberculosis: an infectious disease caused by the tubercle bacillus. It may affect any tissue of the body, but especially occurs in the lungs.
Ulcer: an interruption of continuity of a surface, with an inflamed base. Any open sore other than a wound.
Urticaria: hives or nettle rash, a transient skin eruption characterised by the appearance of intensely itching wheals or welts.

Veneral: pertaining to, or produced by, sexual intercourse.
Vermifuge: a drug or agent that kills or expels intestinal worms.
Vulnerary: a drug or agent that heals wounds.

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نباتات الزينة فى دولة قطر
مكوناتها الكيميائية وفوائدها

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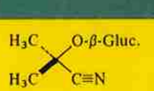

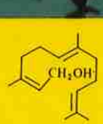

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