Proximate Composition and Amino Acids

The seeds of *Buchanania lanzan* contain 4.4% moisture, 3.2% ash and 28% proteins (Banerjee and Jain, 1988). The kernel of 13 varietis of mango (*Mangifera indica*) contained 6.8-12.6% fat, 5.2-6.3% proteins and 1.4-2.0% ash on dry weight basis. *Sclerocarya birrea* seed contains 11.0% crude oil, 17.2% carbohydrates, 36.7% crude protein, 3.4% fibre, and 0.9% crud saponins (Ogbobe, 1992).

The following amino acids were identified in seed protein of *Buchnania lanzan*: alanine, cystine, histidine, lysine, aspartic acid, methionine, serine, threonine, glutamic acid, glycine, arginine and valine (Banerjee and Jain, 1988). Glycine, cystine, serine, alanine and leucine were found in fruit of *Spondias mangifera* (Saxena and Singh, 1977).

Carbohydrates

Cashew apple (*Anacardium occidentale*) juice and the alcoholic extract of the residual pulp contain fructose, glucose, sucrose, maltose and acidic substances (Haq *et al*., 1975). The sugars of *Mangifera indica* flowers were identified as glucose, galactose and D-arabinose (Khan and Khan, 1988). Arabinose, xylose, glucose, fructose and galactose were identified as free sugars in different parts of *Pleiogynium solandri* Benth., cultivated in Egypt; while arabinose, xylose, rhamnose, glucose, galactose and galacturonic acid were identified in the pectic hydrolysate (El-Fiki and Ahmed, 1999). The free sugars of the pericarp of *Spondias lutea* L., cultivated in Egypt, are glucose, galactose, mannose, rhamnose, arabinose and fructose. Glucose, galactose, mannose, rhamnose, arabinose and galacturonic acid were identified in its pectic hydrolysate (El-Fiki, 2000). The leaves of *Schinus latifolius* yielded sophoricoside in 2.3% yield (Sepulveda and Cassels, 1979).

The gum exudates of *Anacardium occidentale*, *Spondias mombin* and *Spondias purpurea* are very soluble in water, The gums contain galactose, arabinose, mannose, xylose and rhamnose. Xylose was not present in *Spondias mombin* gum (De Pinto *et al*., 1995). Bose and

Soni (1971) stated that mild hydrolysis of water-soluble polysaccharides occurring in cashew nut (*Anacardium occidentale*) shells yielded 1 disaccharide, 1 trisaccharide and 2 tetrasaccharides, all of which are neutral in character. Anderson *et al.* (1974) reported that the composition and solution properties of Indian and Papuan specimens of the gum from *Anacardium occidentale*, are closely similar. Contrary to earlier reports by Indian workers, this gum does not contain galacturonic acid. It does, however contain glucose (Anderson *et al*., 1974). The study of the structure of the gum exudates from the Brazilian cashew nut (*Anacardium occidentale*) was also found to differ from that previously reported for the gum of a tree growing in India, lacking units of 4-*O*-methylglucuronic acid (Menestrina *et al*., 1998). The polysaccharide extracted from the pulp of *Anacardium occidentale* yielded on hydrolysis D-glucose, D-galactose, L-arabinose, and oligouronic acids together with traces of D-xylose and L-rhamnose (Haq *et al.*, 1975). *Lannea coromandelica* gum exudates has been found to contain small amounts of glucuronic and galacturonic acids. Its carbohydrate composition is 70% galactose, 11% arabinose, 2% rhamnose, and 17% uronic anhydride, of which 50% is 4-*O*-methylglucuronic acid (Anderson and Hendrie, 1970a). The composition and properties of the gum exudates from *Lannea coromandelica* (*Lannea grandis*) and *Lannea schimperi*, and of 2 specimens of the gum from *Lannea humilis* were studied. The results suggest that inter- and intraspecies differences in *Lannea* are unlikely to be large (Anderson *et al.*, 1970b). Earlier study of the properties of jeolic acid from gum jeol (*Lannea grandis*) showed that they are similar to arabic acid (Mukherjee, 1953; Mukherjee and Choudhury, 1953).

The gum resin exuded from the stems of *Mangifera indica* consisted of 16% gum and 81% resin. It contained 2.8% methoxyl, 22% pentoses, 38% hexoses, 24.1% uronic anhydride, glucurone and 4-*O*-methylglucuronic acid. Galactose and arabinose were present in the ratio of 3:2 (Farooqi, 1972). Soluble polysaccharides from four mango cultivars (~ 0.5-0.8% pulp fresh weight) were essentially highly esterified pectic substances (uronic acids content ~ 50-60%; degree of Me esterification ~ 89-97%) and their molecular weights were higher in the polyembryonic cultivars cell wall material, ~ 1% pulp fresh weight was mainly built of cellulose (~ 20%) and highly esterified pectic substances (uronic acids ~ 13-24%; degree of esterification ~ 63-73%). Hemicellulosic glucans were more abundant in the monoembryonic (~ 9%) than in the polyembryonic (~ 4%) cultivars (Olle *et al*., 1996).

Two water-soluble polysaccharides were isolated from the unripe fruits of *Spondias mangifera*. The polysaccharide, extracted with water at room temperature was rich in L-arabinose, together with minor proportions of D-glactose, traces of D-xylose and D-galacturonic acid. The polysaccharide extracted with hot water contained mainly D-glucose with smaller quantities of L-arabinose. A starch-type glucan was obtained from the hot-water polysaccharide by fractional precipitation with alcohol (Haq and Mollah, 1973; Hannan and Haq, 1979). A polysaccharide from gum of *Spondias dulcis* contains galactose (19.8), arabinose (48.5) and galacturonic acid (20%). The main chain of this polysaccharide contained 1,3-linked galactopyranosyl and galactosyluronic acid residues. The branches containing arabinosyl units are joined to *O*-6 of the galactopyranosyl residue and to *O*-2 of another (Basu, 1980). The purified gum from *Spondias dulcis* yielded on hydrolysis D-glactose, L-arabinose, and D-galacturonic acid in a molar proportion of 1.6:2:1.1. However, mild acid hydrolysis of the polysaccharide gave aldobiouronic and aldotriuronic acids, whose structures were established as galacturonic acid-$(1\rightarrow3)$-galactose and galacturonic acid-$(1\rightarrow3)$-galactose-$(1\rightarrow3)$-arabinose, respectively (Basu and Rao, 1982). A water-soluble polysaccharide was isolated from the edible part of *Spondias mombin* fruit, commonly known in Bangladesh as amra. The neutral sugar constituents of the neutral fraction of amra was found to be rhamnose (16.5%), arabinose (3.8%), mannose (45.0%), galactose (18.0%) and glucose (16.7%). The major acidic fraction of the fruit contained substantial amount of uronic acid (17.2%) in addition to neutral sugars arabinose (44.0%), galactose (18.2%), rhamnose (15.4%), glucose (3.6%) and mannose (1.6%), indicating that this acidic polysaccharide was a complex pectin like rhamnogalacturonan with side chains of arabinose residues (Rahman *et al*., 2007). The study of the amino acid composition of the gums from *Spondias mombin* and *Spondias purpurea* revealed some evidences which may indicate the presence of arabinogalactan-protein (AGP) in those gums. Amino acid composition of both gums showed that hydroxyproline, aspartic acid, glutamic acid, serine, proline, threonine and alanine are present (Leal *et al*., 2007).

Seed Oils and Fatty Acids

The ngongo (*Sclerocarya*) seeds contain a high percentage of edible oil. Twelve fatty acids were identified, 3 of which were detected in traces only (Ferrao, 1976). Dihdromalvalic acid (9,10-methylenehexadecanoic acid) has been reported to occur most frequently in seeds of Anacardiaceae (Vickery, 1981). The analysis of the seed oil of cashew nut (*Anacardium occidentale*) revealed that the oil should be among the top-ranking oils used for domestic and commercial purposes (Olayinka and Adebayo, 2006). The fatty acids of several species of the family

Anacardiaceae have been investigated; examples of these are as follows:

1. *Anacardium occidentale*: The cashew kernels had an oil content of 45.6% (Barroso *et al*., 1973) and 39.8% (Khotpal *et al*., 2001). The oil contained measurable amounts of palmitic (7.5%), stearic (4.5%), oleic (73.7%) and linoleic (14.3%) acids (Barroso *et al*., 1973). Myristic acid was also detected (Chowdhury and Mukherjea, 1963). The lipid classes had characterstic fatty acid distributions with phospholipids being higher in palmitic and oleic acids, and glycolipids being higher in linoleic acid (Maia *et al*., 1975).
2. *Buchanania lanzan*: The seed oil (33.5%) contained the following fatty acids: myristic, 4.9; palmitic, 44; stearic, 23.5; palmitoleic, 2.1; and linoleic, 20% acids (Banerjee and Jain, 1988).
3. *Crytocarpa procera* Kunth: Two fatty acid esters *viz.* 1,3-propyl dipentadecanoate and 3-hydroxypropyl-9-octadecanoate, have been identified (Rodriguez-Lopez *et al*., 2006).
4. *Mangifera indica* L.: The kernels of 13 varieties contained 6.8-12.6% fat (Van Pee *et al*., 1981). Stearic and oleic acids constituted 82-88% of the total fatty acids (Bandyopadhyay and Gholap, 1979; Van Pee *et al*., 1981; Hussain *et al*., 1983). The ratio of stearic to oleic acids, depending on variety was 0.56-0.97. The remaining fatty acids were, in decreasing order, palmitic, linoleic, arachidic, and linolenic acids. Oleic and linoleic acids represented ~ 88 and 10% respectively, of the fatty acids incorporated at the *sn*-2-position of the triglycerides (Van Pee *et al*., 1981). Palmitoleic acid, reported as a major constituent of mango pulp was not detected in the kernel (Bandyopadhyay and Gholap, 1979). Mangfarnasoic acid (2,6,10-trimethyl dodecanoic acid) was identified from the stem bark (Sharma and Ali, 1995).
5. *Pleiogynium solandri* (Benth.) Engl.: The major fatty acids of the leaves of the plant, cultivated in Egypt are myristic, palmitic and linolenic acids (El-Fiki and Ahmed, 1999).
6. *Schinus molle*: The twigs and leaves contained lignoceric acid (Dominguez *et al*., 1971).
7. *Sclerocarya birrea*: The seed oil (11.0%) contains 9 fatty acids of which palmitic, stearic and arachidonic acids are the most dominant (Ogbobe, 1992).
8. *Sclerocarya caffra* (Maroola): The kernel oil (53.8%) contains palmitic, 16.1; stearic, 5.1; C_{20} saturated, 0.1; C_{22} saturated, 1.0; hexadecanoic, 1.0; oleic, 66.7; linoleic 7.3 and linolenic, trace (Ligthelm *et al*., 1951).
9. *Semecarpus anacardium* Linn. (Marking nut): The fatty acids of the kernel oil are

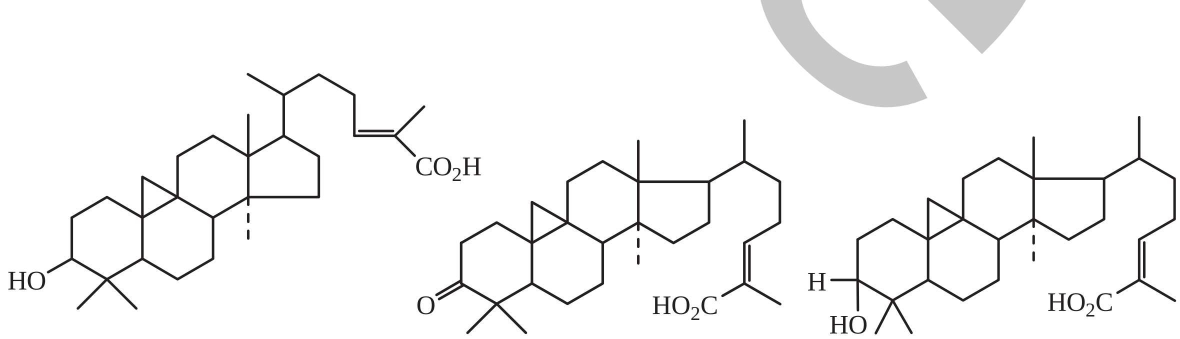
palmitic, 16; stearic, 3.8; oleic, 60.6; linoleic, 17.1 and arachidic, 1.4% acids (Agarwala and Absar, 1993). Mehta and Gokhale (1964) detected myristic acid in small amounts (0-0.17%) in the kernel oil (33.78%).

10. *Semecarpus kurzii*: The seed oil contains 10.5% of 9-hydroxy-*cis*-12-enoic (isoricinoleic) acid along with the usual fatty acids (Farooqi *et al.*, 1985).
11. *Spondias lutea* L.: Twelve fatty acids were identified in the lipid fraction of the leaves and fresh pericarp of the plant cultivated in Egypt. Palmitic, linoleic, oleic, linolenic and stearic acids are the major components (84%) (El-Fiki, 2000).

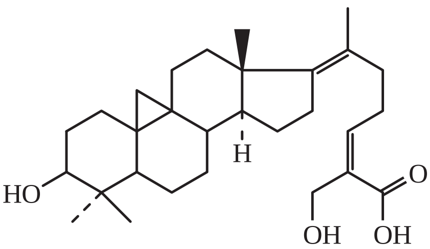
Triterpenes, Sterols, Hydrocarbons and Alcohols

Different types of triterpenes e.g. cycloartane, drammane, tricullane types and others have been identified from species of the family Anacardiaceae. The following are examples of the triterpenes, sterols as well as hydrocarbons and alcohols, isolated from some species of the family:

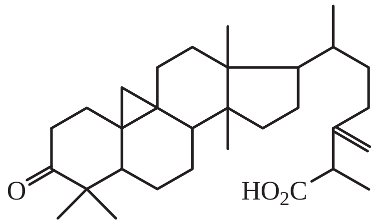
1. *Spondias lutea* L.: Twelve fatty acids were identified in the lipid fraction of the leaves and fresh pericarp of the plant cultivated in Egypt. Palmitic, linoleic, oleic, linolenic and stearic acids are the major components (84%) (El-Fiki, 2000).
2. *Buchanania lanzan*: The stems contain α-amyrin (Banerjee and Jain (1988).
3. *Holigarna arnottiana*: The leaves contain hentriacontane, hexacosanol, β-sitosterol and β-sitosterol β-D-glucoside (Prakash and Banerji, 1979).
4. *Lannea grandis*: Lanosterol was isolated from the heartwood (Sulochana *et al*., 1970).
5. *Mangifera indica*: Anjaneyulu and Radhika (2000) reviewed the triterpenoid and steroid constituents of this species. About 35 triterpenoids have been identified from the various parts of the plants; examples of these are:
   a- Leaves: Indicenol, traraxerol, taraxerone, fridelin and lupeol (Younes *et al.*, 1973; Anjaneyulu *et al*., 1982a).
   b- Resin: Mangiferolic acid (**1**), mangiferonic acid (**2**), isomangiferolic acid (**3**), hydroxymangiferolic acid (**4**), oleanolic aldehyde, Ambonic acid (**5**), ambolic acid (**6**) (Corsano and Mincione (1965, 1967a,b).
   c- Roots: Cycloartan-3β-,30-diol and cycloartan-30-ol (Khan *et al*., 1994).
   d- Root bark: α-Amyrin, β-amyrin, cycloartenol, fridelin, fridelan-3β-ol, mangniferonic acid, mangiferolic acid, mangiferin, isomangiferin, olean-11 one-13(18)-ene, urs-3-on-30-desmethylurs-3-on-20-o1 and β-sitosterol glycoside (Anjaneyulu *et al*., 1982b; Gupta and Ali, 1999).



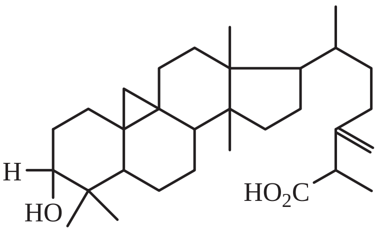
1 Mangiferolic acid **2 Mangiferonic acid** **3 Isomangiferolic acid**



4 Hydroxymangiferolic acid



5 Ambonic acid



6 Ambolic acid

e- Stem bark: α-Amyrin, β-amyrin, cycloartenol, 3β-hydoxycycloart-24-en-26-al, dammarenediol II, the C-24 epimers of cycloart-25-en-3β,24-diol, 24-methylenecycloartane-3β,26-diol, cycloart-24-ene-3β,26-diol, the C-24 epimers of cycloart-25-ene-3β,24,27-triol, the C-24 epimers of cycloartane-3β,24,25-triol, 3-ketodammar-24*E*-ene-20*S*,26-diol,ψ-taraxastane-3β-20-diol, ocotillol II, mangiferolic acid, isomangiferolic acid, sitosterol (Anjaneyulu *et al*., 1985); hopane-1β,3β,22-triol, 3α,22(*R* or *S*)-dihydroxycycloart-24*E*-en-26-oic acid, 3β,22 (*R* or *S*)-dihydroxycycloart-24*E*-en-26-oic acid, 3β-23(*R* or *S*)-dihydroxycycloart-24*E*-en-26-oic acid, 3α, 27-dihydroxycycloart-24*E*-en-26-oic acid (Anjaneyulu *et al*., 1989); 3-oxo-20*S*,24*R*-epoxy-dammarane-25ζ,26-diol (**7**) (Anjaneyulu *et al*., 1993); mangsterol, manglupenone, amngiferolic acid methyl ester, *n*-tetracosane, *n*-heneicosane, *n*-triacontante (Sharma and Ali, 1993a); taraxerol, friedelin, mangiferonic acid (Sharma and Ali, 1993b); 29-hydroxymangiferonic acid (3-oxo-29-hydroxycycloart-24*E*-en-36-oic acid) (Anjaneyulu *et al*., 1994a); manghopanal (hopan-28-al), mangoleanone (olean-3-one) (Sharma and Ali, 1994); mangdesisterol (Sharma and Ali, 1995); ocotillol (Anjaneyulu *et al*., 1994b); (25*R*)-3-oxo-24-methylenecycloartan-26-ol,ψ-taraxastanonol, 3-oxo-(23*R* or *S*)-hydroxycycloart-24-en-26-oic acid, and both C-23 epimers of 3β,23-dihydroxycycloart-24-en-26-oic acid, (Anjaneyulu *et al*., 1999).

f- Kernels of three varieties (Chaunsa, Sindhri and Desi) in Pakistan: Squalene (45.26-54.19%), hydrocarbons (8,6-9.8%) of carbon chain length C_{12}-C_{36}, and primary fatty alcohols (11.5-12.3%) of carbon chain C_{12}-C_{30}. Octacosanol is the predominant alcohol in each of the varities. The sterols are 4,4-di-Me sterols (15.1-16.0%), 4-Me-sterols (6.4-7.0%) and 4-desmethylsterols (53.5-54.0%) (Ali *et al*., 2007).

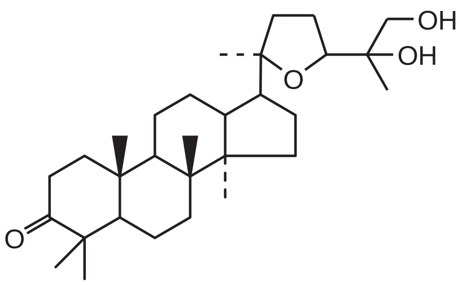
Corsano and Mincione (1966) isolated mangiferonic acid, ambonic acid (**5**), ambolic acid (**6**) and isomangiferolic acid from the plant. The following terpenoids and steroids have been isolated from the plant cycloartenone, cycloartenol, β-sitosterol, C-24 epimers of cycloart-25-en-3β,24-diol, dammar-24-en-3β,20 ζ-diol, ocotillol, 6β-hydroxystigmast- 4-en-3-one, 6β-hydroxy-campest-4-en-3-one, 6β-hydroxystigmast-4,22-dien-3-one, 3-oxodammar-24-en-20ζ,26-diol, mangiferonic acid, mangiferolic acid, hydroxyl manginferonic acid and hydroxyl mangiferolic acid have been identified from *Mangifera indica* (var./cv. Chittoor) (Anjaneyulu *et al*., 1992).

6. *Mangifera sylvatica* Roxb.: Friedelin, fridelan-3β-ol, cycloartenol, obtusifoldienol and β-sitosterol were identified from the stem bark (Anjaneyulu *et al*., 1991).

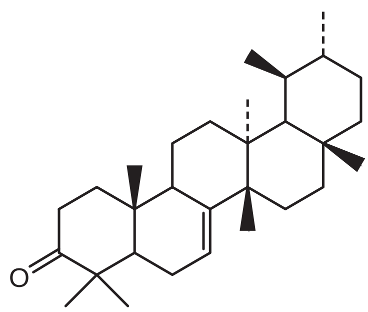
7. *Ozoroa insignis*: The following eight tricullane triterpenes were isolated from the roots: Me 3α,24*S*-dihydroxytriculla-8,25-dien-21-oate, Me 3α-hydroxy-24-oxo-triculla-8,25-dien-21-oate, Me 3α-hydroxy-25,26,27-trinor-24-oxotirucall-8-en-21-oate, 3α,25-dihydroxy-24-(2-hydroxyethyl)-tirucall-8-en-21-oic acid, 3α,24*S*,25-trihydroxytirucall-

8-en-21-oic acid, 3α,24*R*,25-trihydroxytirucall-8-en-21-oic acid, 3α,25-dihydroxytirucall-8-en-21-oic acid and Me 3α,25-dihydroxytirucall-8-en-21-oate, together with α-elemolic acid methyl ester (Liu and Abreu, 2006b). β-Amyrin, betulonic acid, betulinic acid, and others were identified from the root bark (Ng'ang'a *et al*., 2009).

8. *Ozoroa mucronata*: Moronic acid, a simple triterpenoid keto acid with antimicrobial activity was isolated from the root bark (Hostettmann-Kaldas and Nakanishi, 1979).
9. *Pleiogynium solandri*: The leaves and fruits contain α-amyrin and lupeol (El-Fiki and Ahmed, 1999).
10. *Schinopsis brasiliensis*: An unusual steroid 5α,8α-epidioxyergosta-6,22-dien-3 β-ol was isolated from the the trunk (Cardoso *et al*., 2005).
11. *Schinus molle* L.: Two triterpenoid keto acids, were isolated from the berries (Pozzo-Balbi *et al*., 1976). 3-*epi*-Isomasticadienolalic acid and masticadienonic acid were also identified from the plant (Pozzo-Balbi *et al*., 1978). α-Amyrin and β-sitosterol were identified from the plant cultivated in Egypt (Hashem *et al*., 1978). The seeds contain β-elemonic acid (Navarrete *et al.*, 1989). Mollinoic (13α,14β,20*R*,24*Z*)-3-oxo-26-hydroxylanosta-8,24-dien-21-oic acid) along with isomasticadienonalic acid, an nimeric aldehydes mixture of (13α,14β,17α, 20*R*,24*Z*)-3α-hydroxylanosta-8,24-dien-26-oic acid and its 20*S* epimer, 3-*epi*-masticadienolic and masticadienonic acids were isolated from the exudate of stem and stem branches of the plant cultivated in Saudi Arabia (Abdel-Sattar *et al.*, 2007).
12. *Schinus terebinthifolius*: The berries contain terebinthone (Kaistha and Kier, 1962), α-amyrin, α-amyrenone, simiarenol, simiarenone, masticadienoic acid, hydroxymasticadienoic acid and ursolic acid (Lloyd *et al.*, 1977). The leaves contain masticadienoic acid, 3α-hydroxymasticadienoic acid, sitosterol and triacontane (De Paivo Campello and Marsaioli, 1974). The bark contains simiarenol, α-amyrin, α-amyrenone, terebinthifolic acid, baurenone (**8**) and β-sitosterol (De Paivo Campello and Marsaioli, 1974, 1975).
13. *Spondias lutea* L.: β-Amyrin and lupeol were isolated from the leaves and pericarp from the plant cultivated in Egypt (El-Fiki, 2000).
14. *Spondias mangifera* Willd.: The fruits contain β-amyrin and oleanolic acid (Singh and Saxena, 1976).
15. *Tapirira guianensis*: β-Sitosterol, β-sitosterol 3β-D-glucoside, stigmastenone and stigmas-4-en-6β-ol-3 one were isolated from the bark (Correia *et al*, 2003). The leaves contain lupeol, 24-methylenecycloartan-3-ol, phytol, α-amyrin, β-amyrin, sitosterol, sitostenone, sitosterol glucoside, as well as sitosterol esterified with palmitic and stearic acids. Phytol, α-amyrin and β-amyrin esterified with fatty acids were also detected (Correia *et al*., 2008).



7



8 Bauerenone

Saponins

A triterpenoid saponin was isolated from the roots of *spondias mangifera* and identified as echinosystic acid 3-*O*-β-D-galactopyranasyl-(1→5)-β-D-xylofuranoside (Saxena and Mukharya, 1997). Oleanolic acid and ursolic acid were identified as the aglycones of saponins of *Pleiogynium solandri* (El-Fiki and Ahmed, 1999).

Essential Oils

The volatile constituents of several species of the family Anacardiaceae have been studied. The following are examples of these species and their main volatile constituents:

1. *Anacardium occidentale* (cashew): fresh cashew "apple": car-3-ene (24.3%) (MacLeod and De Troconis, 1982); leaves of red cashew: (*E*)-β-ocimene (28.8%), α-copaene (13.6%) and δ-cadinene (9.1%); flowers: β-caryophyllene (26.0%), methyl salicylate (12.8%) and benzyl tiglate (11.3%) (Maia *et al*, 2000); fresh leaves from the plant growing in Benin: 182 components were identified; the main components are β-phellandrene + limonene (17.5%), methyl chavicol (11.4%), germacrene B (8%), *trans*-bergamotene (7.9%), germacrene D (5.9%), β-copaene (5.9%), linalool (5.9%), α-cadinol (5.9%), β-caryophyllene (5%), 9-*epi*-(*E*)-caryophyllene (5%), β-phellandrene (4.9%), α-phellandrene (4.8%), hexadecanoic acid (4.7%), *epi*-α-cadinol (4.5%), β-bisabolene (4.4%) and *epi*-α-muurolol (4.1%) (Kossouch *et al*., 2008).
2. *Anacardium occidentale* L. var. *nanum* (Brazilian cashew apple): Several compounds including esters, terpenes, hydrocarbons, carboxylic acids, alcohols, ketones and norisoprenoids (Bicalho and Rezende, 2001).
3. *Astronium graveolens*: *trans*-β-ocimene (Chen *et al*., 1984).
4. *Comocladia dentata*: Cardol (Noble, 1947-1948).
5. *Cotinus coggyria*: The main constituents of the Bulgarian sumac (*Cotinus coggyria*) oil are α-pinene (44%), limonene (20%) and β-pinene (11.4%) (Tsankova *et al*., 1993). Thirty one compounds were identified in essential oils of young branches from 2 localities in Serbia; and among them monoterpene hydrocarbons were the dominant class (87.4 and 93.1 %). The dominant constituent in both oils was limonene (47.0 and 39.2%) (Novakovic *et al*., 2007). Monoterpenes were the dominating compounds in leaves, inflorescenes and infructescences from 3 localities in Greece. (Tzakou *et al*., 2005).
6. *Heeria insignis*.: The leaf and flower oil contain myrecene (30.6, 69.4%), β-pinene (27.9, 11.6%) and α-pinene (27.4, 11.5%) respectively (Ayedoun *et al*., 1998).
7. *Lithraea caustica*: Aerial parts: main constituents myrcene, α-pinene, *p*-cymene, limonene and caryophyllene (Garbarino *et al*., 2002).
8. *Lithraea molleoides:* Mature fruits: limonene 989.89%), α-pinene (3.48%), β-pinene (2.63%), α-terpineol (0.28%), camphene (0.22%) and Δ^3-carene (0.13) (Shimizu *et al*., 2006).
9. *Lithraea ternifolia* (Gillies) Barkley: Fruit: carvone (34.7%), limonene (21.6%), linalool (12.1%), elemol and spathulenol (Maestri *et al*., 2002).
10. *Mangifera foetida* Lour.: Among the 84 volatile components of the fruit, esters (55.7%) and oxygenated monoterpenes (20.3%) were dominant, with ethyl butanoate (33.4%) the most abundant (Wong and Ong, 1993).
11. *Mangifera indica*:
    a- Leaves: α-thujene, 3-carene, ocimene, α-terpinene (Nigam *et al*., 1962), α-pinene, β-pinene, camphene, myrcene, limonene, β-ocimene, γ-terpinene, α-terpinolene, linalool, estragole, δ-elemene, β-elemene, α-cubebene, methyl eugenol, *allo*

aromadendrene, α-guaien, β-bulnesene, α-farnesene, δ-cadinene, elemicin (Craveiro *et al*., 1980), α-gurjunene (23.6%), β-selinene (20.6%), β-caryophyllene (11.2%) and α-humulene (10.8%) (Ogunwande *et al.*, 2009). Forty-five compounds were identified from the skin; the major compounds are terpinolene (7.99%), 3-carene (2.60%), ocimene (2.85%), limonene (1.53%) and 2-caryophyllene (1.46%) (Gu and Shi, 1994).

b- Fruits: Terpenes are the major volatile compounds, monoterpene and sesquiterpene hydrocarbons comprising 50-63 and 14-19% of the total volatiles of Jaffna, Willard and Parrot cultivars. The major volatiles of Jaffna mango is cis-ocimene, whereas α-terpinolene is the major of the other 2 cultivars (MacLeod and Pieris, 1984). The oil of the fruits of cultivar Langra is characterized by δ-3-carene (61.7%) as major constituent. The oil of cultivar Bombay contains α-pinene (26.6%), caryophyllene oxide (14.5%) and humulene oxide (5.3%). The oil of cultivar Desi has considerable p-cymen-8-ol (28.6%) and moderate amounts of δ-3-carene (5.7%) (Ansari *et al*., 1999).

12. *Mangifera odorata* Griff.: Oxygenated monoterpenes (45.4%) and esters (33.0%) constitute the main classes of the seventy-three fruit volatiles, and α-terpineol (31.9%) was the major component (Wong and Ong, 1993).
13. *Schinopsis balansae* Engl.: *trans*-Caryophyllene (20.77%) was the major constituent of the leaves oil of the plant cultivated in Egypt, followed by α-farnesene (16.79%), longifoline (8.66%), β-bisabolene (6.58%), nerolidol (*E*) (5.56%) and γ-bisabolene (4.3%), while *cis*- and *trans*-ocimene constitute minor constituents. β-Sesquiphellandrene, α-muurolol, isophytol, phytol, *n*-tricosane, *n*-pentacosane and nerolidol were also detected in the leaves oil. In the oil of the fruits, caryophyllene oxide was the major constituent (18.27%), while *trans*-caryophyllene represents only 8.28%, followed by α-farnesene (*E,E*) (7.21%), longicamphenylone (4.05%) and sesquilavandulyl acetate (4.05%), 1,8-cineole (0.19) and 1-limonene (0.29%) represent the minor constituents of the oil (Azzam, 2004b). *cis*-Ocimene (81.73%) represents the predominant compound in the leaves essential oil from the same species growing in China (Na, 2008).
14. *Schinopsis lorentzii* Griseb.: 4-Epicubebol (12.79%) represents the major constituent of the leaves oil from the plant cultivated in Egypt, followed by nerolidol (*E*) (12.44%), Δ-cadinene (7.90%), *cis*-β-farnesene (6.64%), sesquilavendulyl acetate (5.83%), γ-muurolene (4.51%) while *n*-docosane (0.15%) was the minor constituent. β-Sesquiphellandrene, α-muurolol, isophytol, phytol, *n*-tricosane, *n*-pentacosane and nerolidol were also detected in the leaves oil (Azzam, 2004b).
15. *Schinus areira*: The major constituents of the aerial parts are limonene (28.6%), α-phellandrene (10.1%), sabinene (9.2%) and camphene (9.2%) (Murray *et al*., 2005).
16. *Schinus fasciculata*: The major constituents of the aerial parts are limonene (10.9%), β-phellandrene (6.16%) and α-phellandrene (5.6%) (Murray *et al.*, 2005).
17. *Schinus latifolius* Engl.: Forty-eight components, representing 96% of the oil were identified from the leaf. The major constituents are β-pinene (35%), sabinene(24%) and α-pinene (21%). Sesquiterpenes which were all found in a concentration lower than 1%, constituted 6.5% of the oil; the oxygen-containing components of these, all alcohols, amounted to 4.8% (Barroso *et al.*, 1991).
18. *Schinus longifolia*: The major constituents of the aerial parts are α-pinene (46.5%), β-pinene (15,1%) and α-phellandrene (10.1%) (Murray *et al.*, 2005).
19. *Schinus molle* L.: Forty six compounds were identified or partially identified in the fruit oil. Major components are myrcene, α-phellandrene, δ-cadinene, limonene, α-cadinol

and β-phellandrene (Bernhard *et al*., 1983). According to Human *et al*. (2004), the main components of essential oils of 3 samples of fruits collected between September and February are α-pinene (3.1-5.7%), myrcene (26.42.0%), α-phellandrene (4.0-25.0%), limonene (9.8-19.0%), β-phellandrene (7.7-9.7%), *p*-cymene (3.2-19.8%), methyl octanoate (0.7-1.9%) and (*Z*)-β-caryophyllene (0.5-).9%). Forty-two constituents, accounting for 97.2% of the leaf oil were identified; the major constituents were α-pinene and β-pinene (Diaz *et al.*, 2008). α-Phellandrene is the major component of the oil of the leaves (39.72%) and fruits (23.4%) of *Schinus molle* cultivated in Egypt (Ibrahim *et al*., 2004). Marongiu *et al*. (2004) stated that the main components of the oil of *Schinus molle* are α-phellandrene (26.5%), limonene + β-phellandrene (21.0%), elemol (10.8%) and α-eudesmol (6.1%). The sesquiterpene hydrocarbon β-spathulene has been identified from the oil of the tree (Terhune *et al*., 1974).

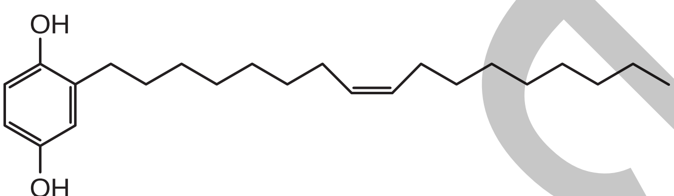
20. *Schinus terebenthifolius* Raddi: The essential oil of the plant, growing or cultivated in different countries has been investigated. The essential oil of *Schinus terebenthifolius* (Bourbon red berries) from Florida contains α-pinene (26.5%) and α-phellandrene (22.3%) as the main constituents (Pieribattesti *et al*., 1981). The identified terpenes (92.23%) in the essential oil of the plant, from Pakistan, are α-pinene (43.20%), camphene (0.42%), β-pinene (2.29%), sabinene (1.91%), α-phellandrene (18.85%), 3-carene (0.27%), *p*-cymene (0.84%), γ-terpinene (0.76%), terpinolene (1.07%) and β-caryophyllene (0.41%) (Malik *et al.*, 1994). The main component of the essential oil of the plant, grown in India is α-pinene (51.82%). The other identified constituents were *cis*-pinane, β-pinene, sabinene, *cis*-verbenol, caryophyllene, citral-b, terpenyl acetate, elemol, methyl farnesate, thymol and α-cadinol (Chowdhury and Tripathi, 2001). α-Phellandrene (24.2%) is the major component of the leaves, while elixene (15.18%), α-pinene (15.01%) and germacrene D (14.31%) were identified as the major components of fruits of *Schinus terebenthifolius*, cultivated in Egypt (Ibrahim *et al.*, 2004). Forty-one compounds were identified accounting for 86.4% of the oil from the leaves and inflorescences of the plant grown in India; the major components are α-pinene (24.4%), limonene (11.9%) and *p*-cymene (14.3%) (Singh *et al*., 1998). Sixty-one compounds were identified, representing over 82% of the oil from the aerial parts of the plant cultivated in Egypt. The major constituents were germacrene D (26.52%), δ-selinene (15.11%), β-amorphene (6.30%), isocaryophyllene (6.26%), (-)-spathulenol (5.64%), β-copaene (3.21%), hinesol (3.21%) and patchoulene (2.24%) (Moustafa, 2007). Oil content from either ripe or unripe fruits of the plant, growing in Brazil, were similar (4.65% and 3.98% respectively). Sesquiterpenes (78.0-90.4%) dominated the oil content of both leaves and unripe fruits (Barbosa *et al*., 2007).
21. *Schinus weinmanniaefolius*: Safrole (Fester *et al*., 1959)
22. *Sclerocarya birrea* subsp. *caffra*: The two major volatile components in the fruit pulp were β-caryophyllene (91.3%) and α-humulene (8.3%). Thirty volatiles representing 88.7% of the total composition were identified in the head-space of the whole fruits. Heptadecene (16.1%), benzyl 4-methylpentanoate (8.8%), benzyl butyrate (6.7%), (*Z*)-13-octadecenal (6.2%) and cyclopentadecane (5.7%) were present in levels higher than 5%. The major alcohol detected in the head-space of the whole intact fruits was (*Z*)-3-decen-1-ol (8.4%) (Viljoen *et al*., 2008).
23. *Spondias cytherea* Sonnerat.: The leaf oil is rich in 3-hexenol (12.03%), α-terpineol (14.02%), β-caryophyllene (27.69%), α-selinene (10.53%) and hexadecanoic acid (11.17%) (Lemos *et al*., 1995). (*E*)-Hex-2-enal and α-pinene constitute the major components of the fruit (Wong and Lai, 1995). The following six aroma compounds were identified from the Brazilian ambarella fruit (*Spondias cytherea*): Et (*S*)(+) 2-Me

butyrate (fruity), Et isovalerate (fruity and cheese-like), Et propionate (fruity), Et butyrate (fruity and refreshing), (*R*)(-)-linalool (floral) and *trans*-pinocarveol (herbaceous) (Fraga and Rezende, 2001).

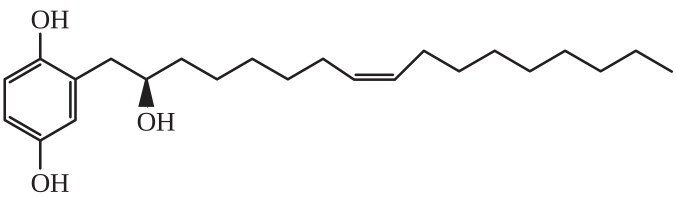
24. *Spondias mombin*.: The leaf oil of the plant, growing in Brazil, was rich in 3-hexenol (38.07%) and caryophyllene (13.73%) (Lemos *et al*., 1995). Later, Olufunke *et al*. (2003) reported that the leaf essential oil of *Spondias mombin*, from Nigeria, was a mixture of more than 54 components that constitute 82.9% of it. β-Caryophyllene (19.99%) was the most abundant compound. Other major compounds in the leaf essential oil were δ-cadinene (9.)7%), α-humulene (6.67%), *p*-muurolene (5.45%), α-gurjunene (4.27%), α-muurolene (3.38%), 5-isocedranol (3.03%), and *p*-cadinene (3.03%).
25. *Spondias purpurea*.: The leaf oil contains β-caryophyllene (11.16%), δ-cadinene (10.29%), torreyol (11.63%) and T-muurolol (10.09%) (Lemos *et al*., 1995).
26. *Spondias tuberosa* Arr.: The leaf oil contains 3-hexenol (13.56%), α-copaene (13.25%), β-caryophyllene (50.01%) and δ-cadine (Lemos *et al*., 1995).

Long-Chain Phenols

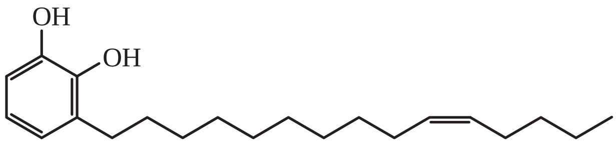
In 1922, Majima reported that 4-substituted catechols having an n-C_{17} alkyl side chain were the main constituents of the sap of *Melanorrhoea usitata*, and he named this compound thitsiol (isourushiol). Later, Du *et al.* (1986) reported that the sap consists not only of thitsiol but also a variety of homologues of urushiol, laccol, catechols substituted with an ω-phenylalkyl groups at positions 3 or 4 and resorcinols with the same substituents at positions 5, which are the first phenolic lipids having a phenyl group in the side chain, and further 3-substituted phenols with characteristic side chains. Twenty eight constituents of the sap of Burmese lac tree (*Melanorrhoea usitata*) have been identified. The sap consists of homologues of thitsiol (*ca* 20%), laccol (*ca* 10%), urushiol (4%), 3-substituted catechols with 12-phenyldodecyl (*ca* 30%) or 10-phenyldecyl groups (*ca* 8%), 4-substituted catechols (*ca* 3%) and 5-substituted resorcinols (*ca* 1%) with the same substituents. 3-Substituted phenols with characteristic side chain groups are also present in smaller amount (Du *et al.*, 1986). Examples of these compounds are (**9-19**).



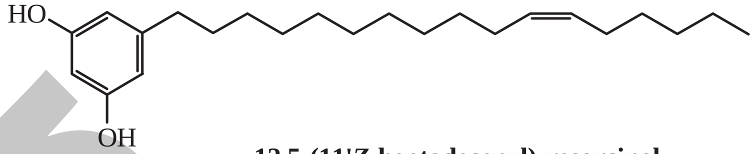
9 Lanneaquinol



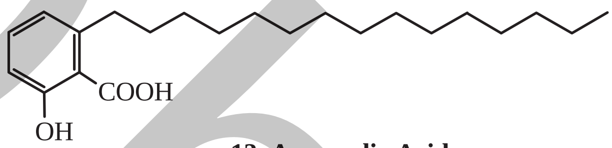
10 2'(R)-Hydroxylanneaquinol



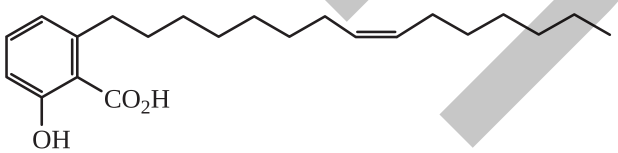
11 3-(Pentadec-10-enyl)-catechol



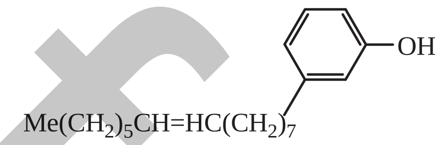
12 5-(11'Z-heptadecenyl)-resorcinol



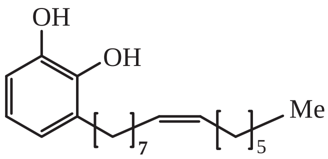
13 Anacardic Acid



14 Ginkgoic Acid

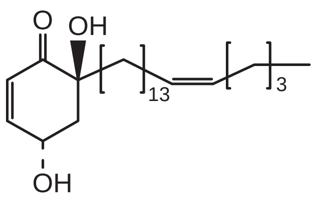


15 Cardanol

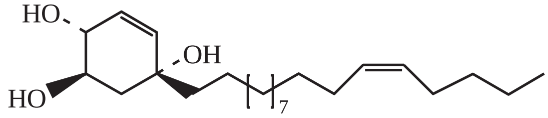


16 Urushiol

17



18



19 Lanneanol

Toxicodendron species have long been known to cause irritation, inflammation and blistering of the sensitive individuals. Active principles of these plants, collectively known as urushiol, are mixtures of homologus long-chain phenolic compounds (Evans and Schmidt, 1980). Long-chain phenols have been isolated from several species of the family Anacardiaceae. The following are examples of these species and the isolated compounds:

1. *Anacardium occidentale* (cashew): Anacardic acids, 2-hydroxy-6-(8,11-pentadecatrienyl) benzoic acid, 2-hydroxy-6-(8,11,14-pentadecatrienyl) benzoic acid, cardols and 2-methyl cardols (Kubo *et al.*, 1994; Angostine-Costa *et al.*, 2003; Ramakrishna *et al*., 2001).
2. *Lannea edulis*: Cardenol 7 and cardenol 13 (alkylphenols) were isolated from the root bark (Queiroz *et al*., 2003).
3. *Lannea welwitschii*: Lanneaquinol (**9**) and 2'(*R*)-hydroxylanneaquinol (**10**) (Groweiss *et al.*, 1997).
4. *Lithraea caustica*: 3-(Pentadec-10-enyl)-catechol (**11**), 3-pentadecylcatechol and 3-heptadec(en) catechols (mono and diolefins) (Gambaro *et al*., 1986).
5. *Lithraea molleoides*: Four alkylene resorcinols e.g. (*Z*,*Z*)-5-(trideca-4,7-dienylresorcinol (Valcic *et al.*, 2002), 1,3-dihydroxy-5-(tridec-4',7'- dienyl)benzene (Lopez *et al*, 2005).
6. *Mangifera caesia*: Alkylphenol with a $C_{23:1}$ side chain and alkenylsalicylic acids with $C_{23:2}$, $C_{25:2}$ and $C_{25:1}$ side chains from the bark (Masuda *et al*., 2002).
7. *Mangifera indica*: 5-[2(*Z*)-Heptadenyl] resorcinol from latex (Mamdapur, 1985); 5-(12-heptadecenyl) resorcinol (Cojocaru *et al*., 1986), 5-(11'Z-heptadecenyl) resorcinol (**12**) and 5-(8', *Z*,11'Z-heptadecadienyl) resorcinol (Knoedler *et al*., 2008) from the peel.
8. *Melanorrhoea usitata*: (8'Z,11'Z)-3-(heptadeca-8',11'-dienyl)catechol and (8'Z,ll'Z)-4-(heptadeca-8',11' dienyl) catechol (Jefferson and Wangchareontrakul, 1986; and 4 w-phenylkyl catechols (Jefferson *et al*., 1988).
9. *Metopium brownie*: 3-(10'Z,13'*E*-pentadecadienyl)catechol, 3-pentadecylcatechol and 3-(10'Z-pentadecenyl)catechol (Rivero-Cruz *et al*., 1997).
10. *Ozoroa insignis* Del.: Anacardic acid (**13**) (He *et al*., 2002), 6-pentadecylsalicylic acid (He *et al*., 2000) from twigs; ginkgoic acid (**14)** from bark (Rao *et al*., 2003); long-chain alkyl and alkenyl phenols from the roots (Liu *et al.*, 2006a).
11. *Protorhus thouvenotti*: Alkyl phloroglucinols from the fruits (Cao *et al*., 2004).
12. *Schinopsis brasiliensis*: Methyl-6-eicosanyl-2-hydroxy-4-methoxybenzoate from the trunk (Cardoso *et al.*, 2005).
13. *Schinus terebinthifolius* (pink pepper): Cardanol 15:1 ($\Delta^{8'}$-cardanol, **15**) from fruit (Stahl *et al*., 1983) and other *n*-alkyl phenols from the drupes (Skopp *et al*., 1987).
14. *Semecarpus anacardium*: 1,2-Dihydroxy-3-(pentadecenyl-8')-benzene and 1,2-dihydrox-3-(pentadecenyl-8',11')-benzene (Govindachari *et al*., 1971).
15. *Semecarpus australiensis* (cashew): A urushiol component (**16**) (Oelrichs *et al.*, 1997a,b).
16. *Smodingium argutum*: 1,2-Dihydroxy-3-heptadeca, 8',11'-dienylbenzene (**17**) from leaves and small branches (Gorst-Allman *et al*, 1987).
17. *Tapirira obtusa*: Six alkyl phenol derivatives from the bark (Correia *et al*., 2001).
18. *Toxicodendron diversilobum* (poison oak): Urushiols (ElSohly *et al.*, 1982).
19. *Toxicodendron radicans* (poison ivy): Urushiols (ElSohly *et al.*, 1982).
20. *Toxicodendron vernix* (poison sumac): Five urushiol components (e.g. 3*n* pentadec-8,11,13-trienylcatechol) (Adawadkar and ElSohly, 1983).

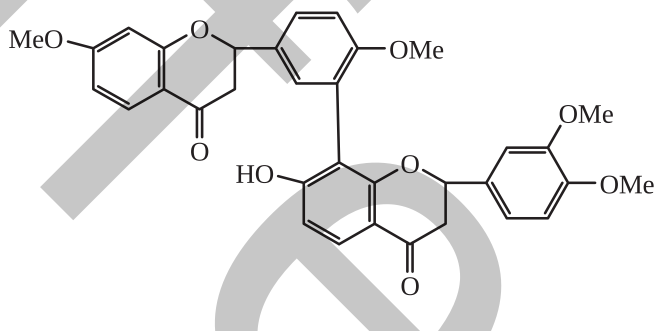
Correia *et al.* (2001) identified two cyclohexanone derivatives (e.g. (4*S*,6*S*)-dihydroxy-6-(14'Z-nonodecenyl)-2-cyclohexanone (**18**), the possible biogenetic precursors of alkyl phenols of *Tapirira obtusa*. Lanneanol (**19**) a dihdroalkyl cyclohexanol was isolated from the stem bark of *Lannea nigritana* (Kapche *et al.*, 2007).

Flavonoids

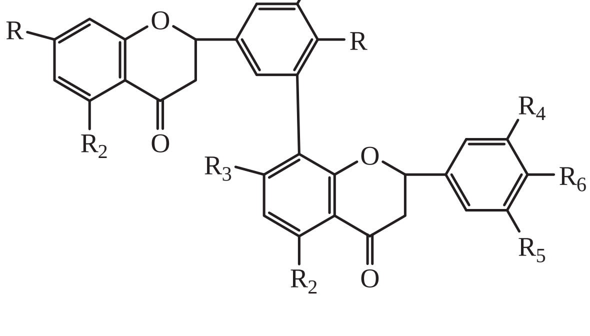
The flavonoid myricetin is of common occurrence in the Anacardiaceae (Reznik and Wgger, 1960). The nut shells of *Semecarpus anacardium* L., have been found to contain six biflavonoids (**20-25**) (Rao *et al*, 1973; Ishratullah *et al*., 1977; Murthy, 1983a-c,1984,1985a,b). Two other biflavonoids *viz.* semecarpetin (**26**) (Murthy 1988) and anacarduflavanone (**27**) (Murthy, 1992) have been isolated from the nut shells of the same species. A flavone glycoside (not a biflavonoid) was also given the same name semecarpetin (**26**) has been isolated from *Semecarpus kurzii* (Table 1) (Alam *et al*., 1987). Tetrahydroamentoflavone, was also identified from *Semecarpus prainii* King (Ahmad *et al*., 1981). Lanaroflavone (**28)**, (4''',5,5'',7,7''-pentahydroxy-4',8''-biflavonyl ether) was isolated from *Campnosperma panamense* (Weniger *et al*., 2004). Acuminatanol (**29**), reported as the first example of a bis-dihdroflavonol linked exclusively *via* the B-rings of *C*-2' and C-2''' positions was isolated from *Trichoscypha acuminata* (Hu *et al*., 2007). Occidentoside (**30**), claimed as the first biflavonoid to occur with 1 flavone and 1 chalcone unit, and also the first *C*-glycoside in the biflavonoid series was identified from chashew nut (*Anacardium occidentale*) shells (Murthy *et al*., 1981,1982). Disulfuretin (**31**) was isolated from *Cotinus coggygria* (Westenburg *et al*., 2000). Bandyukova and Avanesov (1975) reported that the probability of detection of kaempferol in species of the family is 0.54. Examples of the flavonoids isolated from some species of the family are shown in Table 1. Moreover, the identification of flavonoids from other species are reported *e.g.*

1- *Gluta* species (Imamura *et al*., 1979).

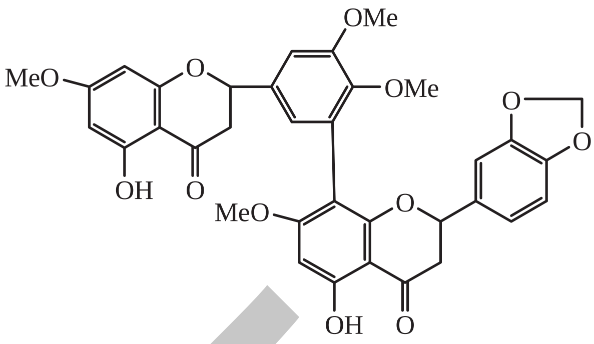
2- *Lannea grandis* (Sulochana *et al*., 1967).



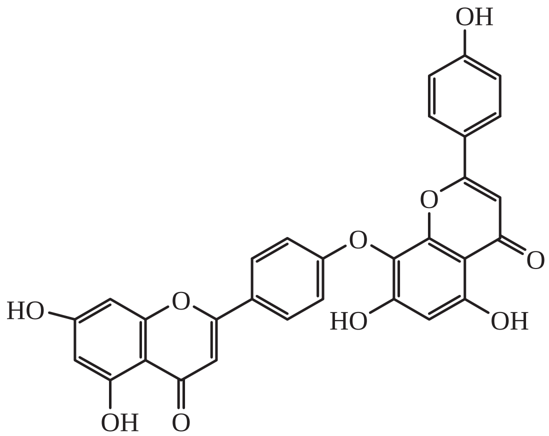
26 Semecarpetin



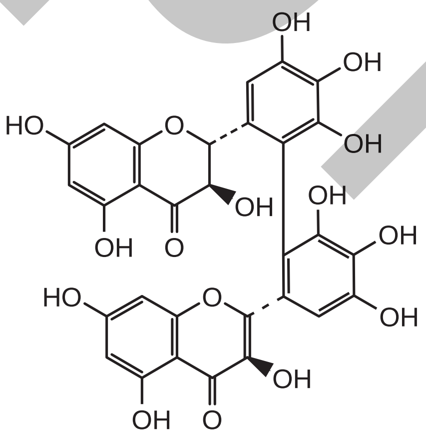
20 Biflavanone; $R=R_2=R_4=R_6=OH$; $R_1=R_3=R_5=H$
21 Tetrahydroamentoflavone; $R=R_2=R_3=R_6=OH$; $R_1=R_4=R_5=H$
22 Biflavanone; $R=R_3=R_6=OH$; $R_1=R_2=R_4=R_5=H$
23 Semecarpuflavanone; $R=R_3=R_4=R_5=R_6=OH$; $R_1=R_2=H$
24 Galluflavanone; $R=R_1=R_3=R_4=R_5=R_6=OH$; $R_2==H$
25 Jeediflavanone; $R=R_2=R_3=R_4=R_6=OH$; $R_1=R_5=H$



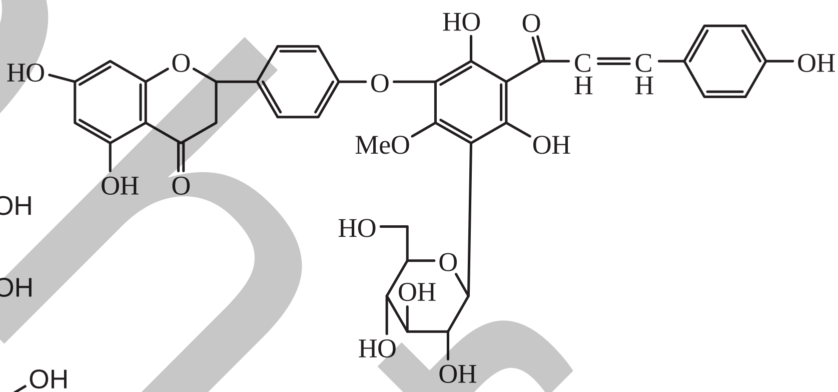
27 Anacarduflavanone



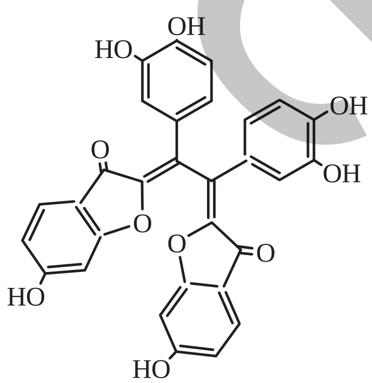
28 Lanaroflavone



29. Acuminatanol



30 Occidentoside



31 Disulfuretin

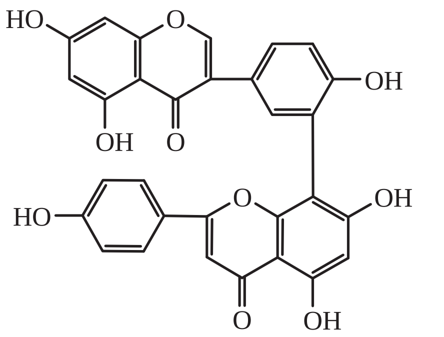
Table 1. The flavonoids of some species of the family Anacardiaceae

Species	Plant Part	Falvonoids	References
1. *Anacardium humile*	L	Rutin, quercetin 3-*O*-glucoside, amentoflavone(**32**) and catechin	Luiz Ferreira *et al*. (2008)
2. *Anacardium occidentale*	L	Myricetin, agathisflavone, robustaflavone, amentoflavone quercetin, kaempferol, apigenin, quercetin 3-*O*-rhamnoside and quercetin-3-*O*-glucoside	Arya *et al*. (1989a)
	Fr	Myricetin, quercetin and quercetin-3-galactoside	Satyanarayana *et al*. (1978); Arya *et al*. (1989a)
3. *Anacardium rhinocarpus*	L	Quercetin	Lopez (1982)
4. *Buchanania lanzan*	L	Myricetin 3'-rhamnoside-3-galactoside, kaempferol-7-glucoside, quercetin, kaempferol, quercetin 7-*O*-rhamnoside and quercetin 7-*O*-rhamnoglucoside	Arya *et al*. (1988, 1992)
5. *Choerospondias axillaris*	B	Choerospondin (5,7-dihydroflavanone 4'-β-glucopyranoside), naringenin	Lu (1982); Lu *et al*. (1983)
	Fr	Quercetin, kaempferol 7-*O*-glucoside and naringenin	Deng *et al*. (1989)
	L	Kaempferol 3-*O*-arabinoside, quercetin 3-*O*-rhamnoside, myricetin 3-*O*-rhamnoside, myricetin, kaempferol and querretin	Khabir *et al*. (1987)
6. *Cotinus coggygria*	L	Myricetin 3-*O*-β-D-galactopyranoside, myricetin 3-*O*-α-L-rhamnoside, quercetin, quercetin 3β-D- glucoside and kaempferol	Komissarenko *et al*.(1968); Kemertelidze *et al*. (2007)
	W	Fisetin (5-deoxyquercetin)	Du *et al*. (1983)
7. *Harpephyllum caffrum*	L	Kaempferol 3-rhamnoside, kaempferol 3-galactoside, apigenin 7-glucoside, quercetin 3-rhamnoside, quercetin 3-glucoside, quercetin 3-arabinoside, quercetin and kaempfereol	El-Sherbeiny and El Ansari (1976)
8. *Holigarna arnottiana*	L	Kaempferol, quercetin and quercimetrin (quercetin 7-*O*-glucoside)	Prakash and Banerji (1979)
9. *Lannea acida*	L	6,7,2,2-dimethylchromono-8-γ,γ-dimethylallylflavone (**33**), 7,2´-dimethoxy-4´,5´-methylenedioxyflavone and lanceolatin.	Sultana and Ilyas (1986a,b)

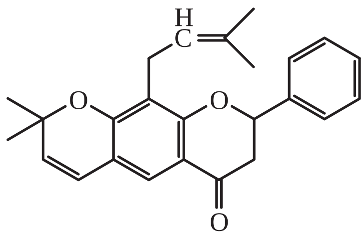
Table 1. The flavonoids of some species of the family Anacardiaceae (cont.)

Species	Plant Part	Falvonoids	References
10. *Lannea coromandelica*	F	Quercetin, isoquercitrin and morin	Nair *et al*. (1963)
	F,L	Quercetin 3-arabinoside	Subramanina and Nair (1971)
	B	3',5-dihydroxy-4',7-dimethoxydihydroflavonol (**34**), 4', 5, 7-trimethoxydihydroflavonol (**35**), 4',7-di-*O*-methyldihydro-quercetin, 4´, 7-di-*O*-methyldihydrokaempferol, 4'-*O*-methyldihydroquercetin and polyflavonoid tannins	Islam and Tahara (2000); Islam *et al*. (2002)
11. *Lannea microcarpa*		4'-*O*-Methoxymyricetin 3-*O*-α-L-rhamnopyranoside, myricetin 3-*O*-α-L-rhamnopyranoside, myricetin 3-*O*-β-D-gluco-pyranoside, vitexin and isovitexin.	Picerno *et al.* (2006)
12. *Mangjfera indica*	L	Kaempferol, astragalin, isoquercitrin	El-Sissi and Saleh (1970a)
	B	Amentoflavone (**32**)	Khan *et al*. (1992)
	L,T	Astragalin, fisetin, quercetin and isoquercitrin	Saleh and El-Ansari (1975)
13. *Myracrodruen urundeuva*	B	Urundeuvina A (chalcone dimer, **36**), and its unsaturated derivative (urundeuvina B)	Bandeira *et al.* (1994)
14. *Ozoroa insignis*	Rb	Ozoranone A (**37**)	Ng'ang'a *et al*. (2009)
15. *Pleiogynium solandri*	F,L	Quercitrin, quercetin 3-*O*-galactoside and rutin	El-Fiki and Ahmed (1999)
16. *Schinus lentiscifolius*	L	Rutin	Graziano *et al*. (1970)
17. *Semecarpus kurzii*	L	Apigenin 6-*C*-galactopyranoside, semecarpetin, apigenin 7-*O* neohesperidoside, kaempferol 3-*O*-β-D-glucopyranoside-4'-*O*-*α*-L-rhamnopyranoside, quercetin 3-*O*-rhamnoside and scutellarein 7-*O*-β-D-xylopyranosy (1→6)-β-D-galactopyranose	Alam *et al*. (1987); Jain *et al*., (1990, 1991); Alam and Jain (1993)
	N	2,2'',3,3''-Tetrahydroamentoflavone	Ahmad *et al*. (1982)
18. *Spondias lutea*	L,P	Quercetin, quercetrin, rutin and quercetin 7-*O*-glucoside	El-Fiki (2000)

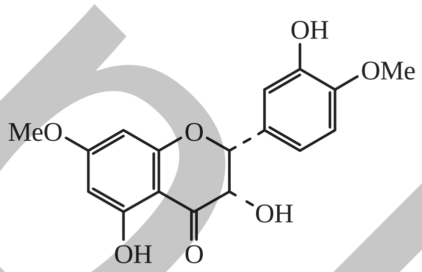
B: stem bark; F: flower; Fr: fruit; L: leaf; N: nut; Rb: root bark; T: Twigs; W: wood



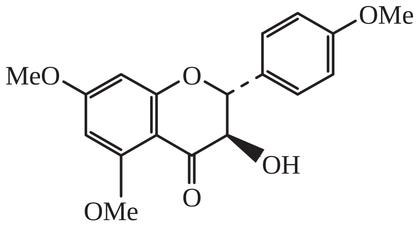
32 Amentoflavone



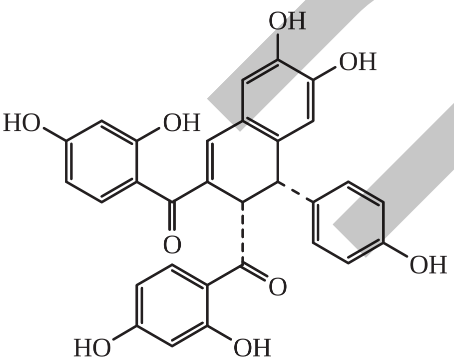
33



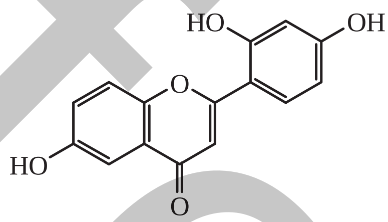
34



35



36 Urundeuvina A



37 Ozoranone A

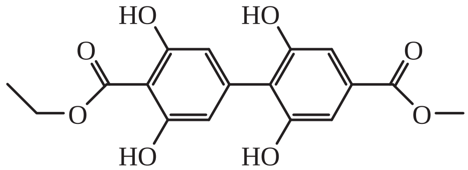
3- *Poupartia birrea* Aub (Laurens and Paris, 1977).
4- *Poupartia caffra* H. Perr. (Laurens and Paris, 1977)
5- *Schinus molle* (Marzouk *et al.*, 2006).
6- *Schinus terebenthifolius* Raddi (Skopp and Schwenker, 1986; Kassem *et al*, 2004; Ceruks *et al.*, 2007).
7- *Sclerocarya birrea* (Braca *et al*., 2003).
8- *Sclerocarya vitiensis* (Pramono *et al*., 1981,1985).
9- *Tapirira guianensis* (Compagone *et al*., 1997; Correia *et al.*, 2008).

The leaves of mango (*Mangifera indica*) contain cyanidin, delphinidin, peonidin and petunidin glycoside (Paris and Jacquemin, 1970). Peonidin 3-galactoside was isolated from the skin of mango fruit (Proctor and Creasy, 1969). *Schinus molle* var. *areira* contains cyanidin 3-galactoside, cyanidin 3-rutinoside and peonidin 3-glucoside (Aziz-ur-Rahman *et al.*, 1974). Leucocyanidin and leucodelphinidin were identified from leaves of *Anacardium occidentale* (Subramanian *et al.*, 1969) and *Lannea coromandelica* (Nair *et al*., 1963).

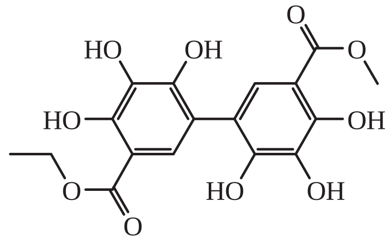
Tannins, Phenolic Acids and Other Phenolics

Several other phenolic compounds, including phenolic acids, tannins and others have been isolated from species of the family Anacardiaceae. Examples of these are:

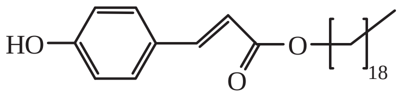
1. *Anacardium humile*: Gallic acid and methyl gallate from leaves (Luiz Ferreira *et al*., 2008).
2. *Anacardium occidentale* L.: Ethyl gallate from flowers, methyl gallate from leaves and condensed tannins from bark (Subramanian *et al*., 1969).
3. *Cotinus coggyria* Scop. (Smoke tree): Trimethylgalloyl glucose (Novokhatka and Lazur'evskiy,1958) gallic acid tetrasaccharide and *m*-digallic acid from leaves (Hoerhammer *et al*., 1958; Marzal *et al.*, 1982).
4. *Gluta* species (rengas): *d*-catechin and gallic acid from heartwood (Imamura *et al*., 1979).
5. *Harpephyllum caffrum*: Protocatechuic acid, gallic acid and methyl gallate from leaves (El-Sherbeiny and El Ansari, 1976).
6. *Holigarna arnottiana*: Ethyl gallate from leaves (Prakash and Banerji, 1979).
7. *Lannea coromandelica*: Phlobatannins from stem bark (Nair *et al*., 1963).
8. *Lannea grandis*: *dl-epi*-Catechins from bark (Sulochana *et al*., 1967).
9. *Lannea microcarpa*: Gallic acid and *epi*-catechin (Picerno *et al*., 2006).
10. *Mangifera indica* (mango): Gallotannin, β-glucogallin, ellagic acid, gallic acid, protocatechuic acid, catechin, epicatechin, ethyl gallate (and other alky gallates), six galloyl *p*-hydroxybenzoyl esters of benzophenone *C*-glycosides and others from different parts (El Sissi and El Ansary, 1966; El Ansari *et al*., 1968; El Sissi and Saleh, 1970b; Subramanian and Nair, 1971; Saleh and El Ansari, 1975; Saeed *et al.*, 1976; Tanaka *et al*., 1984; Khan and Khan, 1993).
11. *Mangifera quadrifida* J. (Assam): (4,6-Dihydroxy)-dihydrobenzofuran-3-yl-(3,4 dihydroxy) phenyl ketone from the wood (Takagi and Mitsunaga, 2002).
12. *Poupartia birrea* Aub.: *p*-Hydroxybenzoic , protocatechuic, gentisic and gallic acids (Laurens and Paris, 1977).
13. *Poupartia caffra* H. Perr.: *p*-Hydroxybenzoic, protocatechuic, gentisic and gallic acids (Laurens and Paris, 1977).
14. *Schinus molle*: Gallic acid, ethyl gallate and catechin (Marzouk *et al*., 2006).
15. *Schinus terebinthifolius*: Gallic acid, ethyl gallate, catechin (Skkopp and Schwenker, 1986; Ceruks *et al*., 2007); and biphenyl esters (**38**,**39**) from the fruits (Kassem *et al*., 2004).
16. *Sclerocarya birrea*: Epicatechin 3-galloyl ester from bark (Galves Peralta *et al*., 1992; Braca *et al*., 2003).
17. *Sclerocarya caffra*: 2-Hydroxy-4-methoxybenzaldehyde from bark (Kubo and Kinst-Hori, 1999).
18. *Semecarpus anacardium*: Anacardoside (1-*O*-β-D-glucopyranosyl-(1→6)-β-D gluco-pyranosyloxy-3-hydroxy-5-methylbenzene) from seeds (Gil *et al*., 1995).
19. *Semecarpus* species: 3-Alk(en)catechols and 5-methylmellein from wood of 3 species (Carpenter *et al*., 1980).
20. *Spondias mombin*: Two ellagitannins *viz.* geraniin and gallogeraniin and caffeoyl esters (Corthout *et al*., 1991,1992).
21. *Tapirira guianensis*: 2-[10(*Z*)-Heptadecenyl]-1,4-hydroquinone from seeds (David *et al.*, 1998) and six alkyl ferulates, including an unusual C-odd alkyl chain, nonadecyl coumarate (**40**) from bark (Correia *et al*., 2003).



38



39



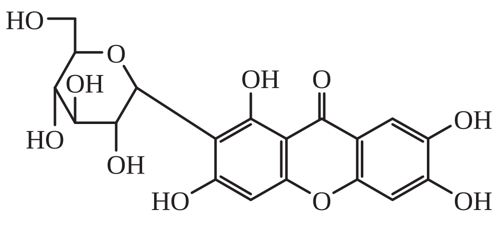
40 Nonadecyl coumarate

Xanthones, Chromones and Quinones

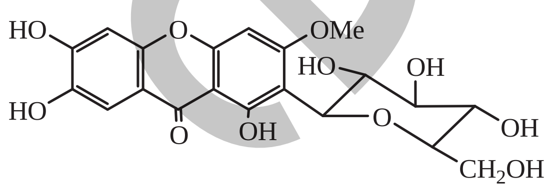
Several xanthones have been identified from *Mangifera indica*. Mangiferin (**41**) (also known as aphloiol) was isolated from the different parts of the plant (e.g. El Sissi and Saleh, 1964,1965,1970a; Mentzer and Ratsimamanga, 1968; Yang and Peng, 1981; Pham and Pham, 1991). Homomangiferin (xanthone *C*-glycoside) and mangiferin 3-methyl ether (**42**) were isolated from the bark (Aritomi and Kawasaki, 1968, 1970). The leaves contain isomangiferin (Tanaka *et al.*, 1984). Mangiferin, isomangiferin and homomangiferin were identified from leaves and twigs of *Mangifera indica* (Saleh and El-Ansari, 1975). Mangiferin was also isolated from the bark of *Mangifera zeylanica* (Herath *et al.*, 1970)

The following two chromones were isolated from the roots of *Mangifera indica*: 3-hydroxy-2-(4'-methylbenzoyl)-chromone (**43**) and 3-methoxy-2-(4'-methylbenzoyl)-chromone (**44**) (Khan *et al.*, 1995). Mangcoumarin (Sharma and Ali, 1993a) and scopoletin (a coumarin) was identified from the stem bark of *Mangifera indica* and *Pleiogynium solandri* (El-Fiki and Ahmed, 1999) respectively.

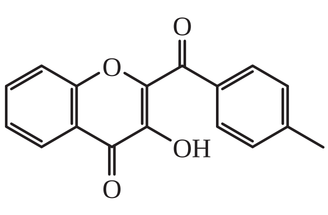
Physicon and physicon anthranol B were identified from *Lannea coromandelica* (Subramanian and Nair, 1971).



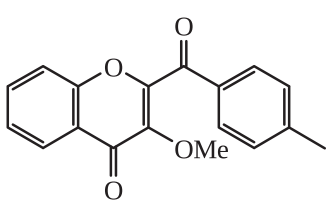
41 Mangiferin



42 Mangiferin-3-methyl ether



43



44

Nitrogenous Compounds

An indole alkaloid, (-)-octahydroindolo[2,3-*a*]quinolizine (**45**) was identified from the leaves of *Dracotomelon mangiferum* (Johns *et al*., 1966). Three other indole alkaloids, hydroxyl-Δ^1-aspidospermidine, (+) eburnamonine and (-) eburnamine were isolated from the leaves and stems of *Schinopsis lorentzii* Griseb., cultivated in Egypt (Azzam, 2004a). A deoxyuridine, 5-methyl-3',5'-di-*O*-(*p*-chlorobenzoyl)-2'deoxy-uridine was identified from the fruits of *Choerospondias axillaris* (Roxb.) Burtt *et* Hill (Fan *et al.*, 2005).

Other Constituents

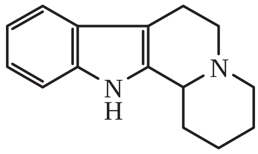
John *et al.* (1970) studied the carotenoids in 3 stages of ripening of mango (*Mangifera indica*), and 15, 14 and 16 different carotenoids were found in the unripe, partially ripe, and fully ripe fruit. The Badami varirty appeared to contain the same type of carotenoids as the Alfonso variety. During ripening there was a large increase of carotenoid in the Badami vaiety. Only the unripe fruit contained ζ-carotene. In partially ripe mangoes the carotene hydrocarbons (especially phytofluene, β-carotene and phytoene) constituted the major part of the carotenoids, *viz.* 85%. The level of epoxy carotenoids in unripe and fully ripe mangoes was very high compared to partially ripe mangoes.

Two acyclic sesquiterpenes, farnes-5,15-olide and farnes-(14)-en-9,12-diol were isolated from the stem bark of *Mangifera indica* (Sharma and Ali, 1983b). The leaves of *Schinus molle* contain preisocalamendiol (**46**, a sesquiterpene) (Delvalle, G. and Schwenker, 1987).

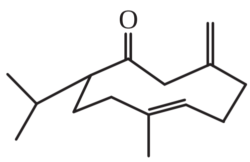
Mangeudesmenone (**47**) was isolated from the stem bark of *Mangifera indica* (Sharma and Ali, 1995).

Three dihydroalkylhexenones (**48-50**) were identified from the root bark of *Lannea edulis* (Queiroz *et al*., 2003). Lanneanol (**19**), a dihydroalkylcyclohexenol was isolated from the stem bark of *Lannea nigritana* (Kapche *et al*., 2007). A 2-cyclohexanone derivative (David *et al.*, 1998) and four cyclic alkyl polyol derivatives (Roumy *et al.*, 2009) were isolated from the seeds and bark of *Tapirira guianensis* respectively (David *et al*, 1998). 10-Nonylcyclohex-12-ene-11-glucoside have been identified from the root bark of *Mangifera indica* (Gupta and Ali, 1999).

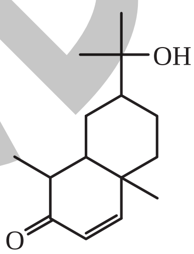
El-Fiki and Ahmed (1999) reported that *Pleiogynium solandri*, cultivated in Egypt, contains saponins which gave on hydrolysis oleanolic acid and ursolic acid.



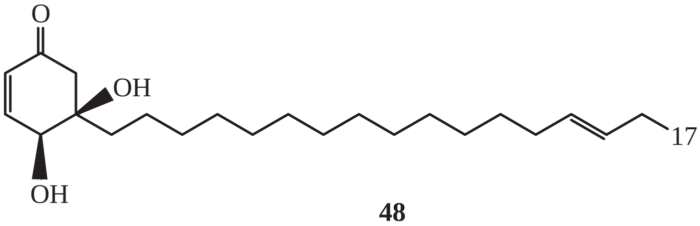
45



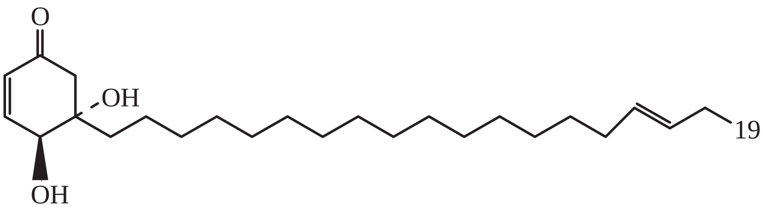
46 Preisocalamensdiol



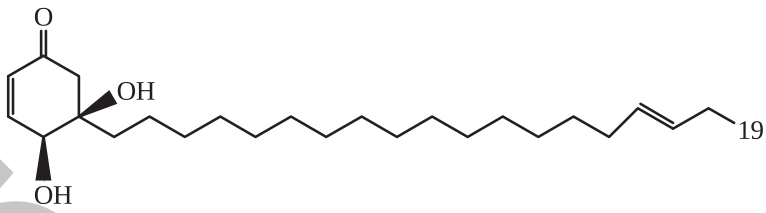
47 Mangeudesmenone



48



49



50