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CHEMICAL CONSTITUENTS FROM THE SEEDS OF *PONGAMIA PINNATA* (L.) PIERRE

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ABSTRACT

Six compounds (two sterols, three sterol derivatives and one disaccharide) together with eight fatty acids (three saturated and five unsaturated) have been isolated from the seeds of *Pongamia pinnata.* Their structures were elucidated with the help of physico-chemical methods and spectroscopic techniques. The metabolities, β-sitosteryl acetate and ga!actoside, stigma sterol, its galactoside and sucrose are being reported for the first time from this plant. The saturated and unsaturated fatty acids (two monoenoic, one dienoic and two trienoic) were present in exactly the same amount. Oleic acid occurred in highest amount (44.24%), stearic (29.64%) and palmitic (18.58%) acids were the next in quantity. Hiragonic and octadecatrienoic acids were present in trace amounts (0.88%).

Introduction

Pongamia Vent. is a monotypic genus distributed in tropical Asia, Australia, Polynesia, Philippine Islands (Jayaweera, 1981), it belongs to the family Papilionaceae (Ali, 1977). Various parts of the medicinal plant, *Pongamia pinnata* (L.) Pierre [= *P. glabra* Vent.] such as seeds, leaves, bark, roots, flowers and stems are utilized in the traditional system of medicine. It is cultivated in all the four provinces of Pakistan under the loèal name karanja (Baquar, 1989). A furanoflavone, karanjin isolated from the seeds of this plant possesses insecticidal and antibacterial propeities and is highly toxic to fish, alcoholic extracts of oil showed activity against both Gram positive and Gram negative bacteria (Hooker, 1982). The oil has been applied in scabies, herpes, leucoderma and other cutaneous diseases. Internally, it has sometimes been used as a stomachic and cholagogue in~ cased of dyspcpsia with sluggish liver (Tanaka *et al.,* 1992).

The plant has a great phytochemical significance. On literature survey it was revealed that a variety of secondary metabolites have been reported from the seeds of *P. pinnata* such as furanofavones (Soliven, 1934; Chopra and Ghosh, 1935; Vidyarthi, 1951; Khanna and Seshadri, 1963; Roy *et al*., 19776; Pathak *et al*., 19836, c; Sharma *et al*, 1983), a furanodiketone viz. ovalitenone (Pathak *et al,* 1983b), two chromenochalcones designated as glabrachalcone and glabrachromene-1 & II (Pathak et al, 1983b, c), pongamol (Narayanaswami *et al,* 1954; Khanna and Seshadri, 1963; Pathak *et al*., 1983a), gamatin (Khanna and Seshadri,1963; Pathak *et al.,* 1983a), a furofiavone (An-Geja *et al*, 1963) and glabrin (Kumar *et al.,* 1971). Furthermore, several natural products have been isolated from this plant such as saponios (Gibbs, 1974), four chromenoflavones viz. karanjachromene (Naik and Bringi, 1973), isopongachromene (Pathak *et al*, 1983b), isopongaflavone (Roy *et al,* 1977a) and pongaflavone, a fldiketone (Sharma and Parthasarthy, 1977), alkaloids (Evans *et al.*, 1985), O-methylpongaglabol (Pathak *et al,* 1983a), pongachalcone (Pathak *et al,* 1983c), 3,3',4',7-tetramethoxyflavone (Pathak *et al.*, 1983b), b-sitosterol (Sinha, 1959) and some fatty acids (Beal and Katti, 1925; Margaillan, 1930; Belckar and Kane, 1973; Upadhya *et al*, 1974). No study was made on the specimens collected from the soil of Pakistan. Therefore, an attempt was made to investigate the natural products present in the seeds collected from the plants growing at Karachi.

Materials and Methods

Extraction:

The seeds of *Pongamia pinnate*; (33 kg) were collected from Male, Karachi and identified by Dr. Saood Omer, Department of Botany, University of Karachi. The shells were separated, and the seeds (endosperm) crushed in a homogenizer and finally soaked in Methanol (MeOH) for 1 month. The extract was filtered and then evaporated under reduced pressure, the gummy residue (80 g) so obtained was partitioned between *n*-hexane and distilled water. The aqueous fraction was partitioned again with ethyl acetate (EtOAc) and thereafter with n-butanol (BuOH). The EtOAc and BuOH extracts were loaded on to a column of SiO_2. The different solvents eluted were *n*-hexane, $CHCl_3$ and McOH in increasing order of polarity. The same fractions (on the basis of TLC) were mixed and further purified by different chromatographic techniques such as flash chromatography, low pressure pump, MPLC (medium pressure liquid chromatography) etc.

Instrumentation:

The melting points were determined in glass capillary on a Gallenkamp electrothermal melting point apparatus model 5A-6797. Optical rotations were recorded on Schmidt and Haensch Polartronic-D polarimeter. Infrared (IR) spectra were recorded with JASCO A-302 spectrophotometer. Electron impact (El) mass spectra were recorded

on Finnigan MAT-112 and 113 spectrometer coupled with PDP 11/34 computer system. High resolution-mass spectrometry (HR-MS) and field desorption- mass spectrometry (FD-MS) were also performed on MAT-312 mass spectrometer. The negative ion fast bombardment (FAB) mass spectra were recorded on Finnigan MAT-312 and hot JMS-Hx 110 spectrometer coupled with PDP 11/34 and 11173 computer system respectively.

Nuclear magnetic resonance (^{1}H- and ^{13}C-NMR) were recorded on Bruker AM-300 and Broker AM-400 spectrometers operating at 300 and 400 MHz for ^{1}H and 100 and 75 MHz for ^{13}C nuclei, respectively. Chemical shifts were reported in ppm relative to TMS (tetramethyl silane) as an internal standard. The two-dimensional COSY-45 experiments were acquired at 300 MHz with a sweep width of 4000 Hz (2k data points) in on and 2000 Hz (256 t_1 values zero-filled to 1k) in on. The heteronuclear 2D H, ^{13}C chemical shift correlation experiments were carried out at 300 MHz with a sweep width of 12820 Hz (2k data points) in wt and 1024 Hz (256 t_1 values zero-filled to 2k) in on. In both the 2D experiments a 2 second relaxation delay was used, and 16 transients were performed for each t_1 value.

Analysis of fatty acids:

The oily fractions obtained from the column were esterified with diazomethane. An aliquot of 0.5 mg of each fraction was dissolved in diethyl ether (Et_2O) and 0.5 mL of diazomethane. The reaction mixture was kept overnight at room temperature (28°C) and thereafter evaporated under reduced pressure. The methylated fatty acid fractions were analysed by GLC and finally by GC-MS. The details of the procedure and technique were the same as described previously (Shameel *et al.,* 1995).

Characterization of compounds [1-6]:

The isolated pure compounds were characterised and identified by using following values and spectral data:

β-**Sitosterol** ([1] Fig. 1): m.p.: 134.5°; [α]D: -40° (CHCI31; IR (CHCI3) ν_{max} cm^{-1}: 3450 (hydroxy group), 3050, 1650 and 815 (trisubstituted double bond); MS (El, FAB, FD & HR): m/z (rel. int. %): 414 [$C_{29}H_{50}O$, M^+] (30), 399 [M-Me]$^+$ (10), 396 [M-H_2O]$^+$ (15), 381 [M-Me-H_2O]$^+$ (75), 329 [M-H_2O-C_5H_7]$^+$ (26), 303 [M-$H_2OC_7H_9$]$^+$ (20, 275 ([M-H_2O-C_9H_{13}]$^+$ (14), 273 [M-side chain at C-17]$^+$ (35) and 255 [M-side chain-H_2O]$^+$ (35); ^{1}**H-NMR** ($CDCl_3$, 300 MHz, δ ppm): 5.23 (1H, m, H-6), 3.32 (1H, m, 14-3), 1.01 (3H, s, **Me**-19), 0.92 (3H, d,1=6.2 Hz, **Me**-21), 0.84 (3H, t, J=7.0 Hz, Me-29), 0.83 (**3H**, d, 1=6.5 Hz, Me-26), 0.81 (3H, d, J=6.5 Hz, Me-27) (3H, s, Me-18); ^{13}**C-NMR** ($CDCl_3$, 75 MHz, δ ppm): for these data please see Table 1

β-**Sitosteryl** acetate [2]: m.p.: 124-126°; $[\alpha]_D$: -39° ($CHCl_3$); **IR** ($CHCl_3$) ν_{max} cm^{-1}; 1730 (ester carbonyl), 3050, 1650 and 895 (trisubstituted double bond); **MS** (El, FFAB; FD & HR); *m/z* (rel. int. %): 456 [$C_{31}H_{52}O_2$, M^+] (15), 441 [M-Me]$^+$, (3), 396 [M-ACOH] (100),

381 [M-Me-ACOH]$^+$ (10), 329 [M-ACOH-C_5H_7]$^+$ (20), 315 [M- side chain at C-17]$^+$ (30), 303 [M-ACOH-C_7H_9]$^+$ (25), 275 (M-ACOH- C_9H_{13}]$^+$ (40) 273 [M-$C_{13}H_{27}$]$^+$ (38), 255 [M-ACOH-side chain]$^+$ (45) and 213 [(273-ACOH]$^+$ (16); ^{1}**H-NMR** ($CDCl_3$, 300 MHz, δ ppm): 5.23 (1H, m, H-6), 3.55 (1H, m, H-3), 2.05 (3H, s, CH_3-COO), 1.01 (3H, s, Me-19), 0.92 (3H, d, J= 6.2 Hz, Me 0.84 (3M, t, J =7.0 Hz, Me-29), 0.83 (3H, d, J =6.5 Hz, Me-26), 0.81 (3H, d, J=6.5 Hz, Me-27) and 0.68 (314, s, Me-18); ^{13}C-NMR ($CDCl_3$, 75 MHz, δ ppm): for these data please see Table 1.

Stigmasterol [3]: **m.p**.: 169.5°; $[\alpha]_D$: -50° ($CHCl_3$); **IR** ($CHCl_3$) ν_{max} cm^{-1}: 3440 (hydroxy group) and 3025, 1650, 1410, 1250, 690 and 820 (olefinic region); **MS** (El, FAB, FD & HR): *m/z* (rel. int. %): 412 [$C_{29}H_4SO$, M^{+1}] (15), 397 (M-Me]$^+$ (10), 394 [M-H_2O]$^+$ (38), 379 [M-Me-H_2O]$^+$ (20), 369 [M-C_3H_7]$^+$ (36), 351 [M-C_3H_7-H_2O]$^+$ (65), 327 [M-H_2O-C_5H_7]$^+$ (70), 301 [M-H_2O-C_7H_9]$^+$ (20), 300 [M-C_8H_{16}] (50), 273 [M-H_2O-C_7H_{13}]$^+$ (30) and 271 [M-side chain at C-17 2H]$^+$ (26); ^{1}**H-NMR** ($CDCl_3$ 300 MHz, δ ppm): 5.33 (1H, m, H-6), 5.15 (2H, m, H-22 and H-23), 3.21(1H, m, H-3) 0.90 (3H, d, J =6.5 Hz, Me-21), 0.84 (3H, t, J = 7.0 Hz, Me-29), 0.83 (3H, d, J= 6.6 Hz, Me-26), 0.81 (3H, d, J =6.5 Hz, Me-27), 0.80 (3H, s, Me-19) and 0.65 (3H, s, Me-18); ^{13}**C-NMR** ($CDCl_3$, 75 MHz, δ ppm): for these data please see Table 1.

Stigrnasteryl galactoslde [4]: m.p.: 245-247°; $[\alpha]_D$:-5° ($CHCl_3$); **IR** (KBr) ν_{max} cm^{-1} 3440-3410 (hydroxy groups), 3025, 1650, 880 (double bond region) and 1440 (gem-dimethly); **MS** (El, FAB, FD & HR): *m/z* (rel. int. %); 575 [M$^+$, (M+H), FAB-MS$^+$], aglycone: 412 [$C_{29}H_{48}O$]$^+$ (20), 394 [M-H_2O]$^+$ (15), 379 [M-Me-H_3O]$^+$ 369 [M-C_3H_7]$^+$ (35), 351 (M-C_3H_7-H_2O]$^+$ (75), 327 [M-H_2O-C_5H_7]$^+$ (55), 301 [M-C_7H_9-H_2O]^4 (20), 300 (M-C_8H_{16}]$^+$ (65) 273 (M-H_2O-C_9H_{13}]$^+$ (35) and 271 [M-side chain at C-17 + 2H]$^+$ (30); ^{1}**H-NMR** ($CDCl_3$, 300 MHz, δ ppm): **aglycone**: 5.30 (1H, dist. t, H-6), 5.16 (2H, m, H-22 and H-23), 3.71 (1H, m, H-3), 0.90 (3H, d, J=6.5 Hz, Me-21), 0.83 (3H, d, J = 6.6 Hz, Me-26), 0.81 (3H, d, J= 6.5 Hz, Me-27), 0.80 (3H, s, Me-19), 0.67 (3H, t, J=7.5 Hz, Me-29), and 0.65 (3H, s, Me-18). **Sugar**: 4.20 (1H=7.8 Hz, H-1), 3.65 (1H, dd, J=1.0 Hz, 3.0 Hz, H-4), 3.55 (1H, dd, J=8.0 Hz, 9.0 Hz, H-2), 3.52 (1H, dd, J=7.0 Hz, 11.0 Hz, H-6), 3.30 (1H, dd, J= 5.0 Hz, 11.0 Hz, H-6), 3.15 (1H, dd, J= 3.0 Hz, 9.0 Hz, H-3) and 3.03 (1H, dd, J= 1.0 Hz, 5.0 Hz, H-5); ^{13}**C-NMR** ($CDCl_3$, 75 MHz, δ ppm): for theses data please see Table 1.

β-Sitosteryl galactoside [5]: m.p,: 275-277°; $[\alpha]_D$: -63° (Py); **IR** (KBr) ν_{max} cm^{-1} 3440-3410 (hydroxy groups), 3025, 1650, 880 (double bond region) and 1440 (gem-dimethyls); **MS** (El, FAB, FD & HR): *m/z* (rel. int. %): 577 [M$^+$, (M + H), FAB-MS$^+$], **aglycone**: 414 [$C_{29}H_{50}O$]$^+$ (20), 396 [M-H_2O]$^+$ (15), 381 [M-Me-H_2O]$^+$ (26), 371 [M-C_3H_7]$^+$ (35), 353 [M-C_3H_7-H_2O]$^+$ (75), 329 [M-H_2O-C_5H_7]$^+$ (55), 303 [M-C_7H_9-H_2O]$^+$ (20), 302 [M-C_8H_{16}]$^+$ (65), 275 [M-H_2O-C_9H_{13}]$^+$ (35); ^{1}**H-NMR** ($CDCl_3$, 300 MHz, δ ppm): **aglycone**: 5.23 (1H, m, H-6), 3.72 (1H, m, H-3), 1.01 (3H, s, Me-19), 0.92 (3H, d, J = 6.2 Hz, Me-21), 0.84 (3H, t, J = 7.0 Hz, Me-29), 0.83 (3H, d, J=65 Hz, Me-26), 0.81

(3H, d, J=6.5 Hz, Me-27) and 0.68 (3H, s, Me-18). **Sugar:** 4.20 (1H, d, J=7.8 Hz, H-1), 3.65 (1H, dd, J=1.0 Hz, 3.0 Hz, H-4), 3.55 (1H, dd, J = 8.0 Hz, 9.0 Hz, H-2), 3.52 (1H, dd, J=7.0 Hz, 11.0 Hz, H-6), 3.30 (1H, dd, J = 5.0 Hz, 11.0 Hz, H-6), 3.15 (1H, dd, J=3.0 Hz, 9.0 Hz, H-3) and 3.03 (1H, dd, J = 1.0 Hz, 5.0 Hz, H-5); ^{13}**C-NMR** ($CDCl_3$, 75 MHz, δ ppm): for these data please see Table 1.

Sucrose [6]: m.p.: 185-187°; $[\alpha]_D$: + 66.5° (H_2O); **IR** (KBr) ν_{max} cm^{-1}: 3440-3410 (hydroxy group); HRMS *m/z* (rel. int. %): 342.299 ($C_{12}H_{22}O_{11}$); ^{13}**C-NMR** (D_2O, 75 MHz, δ ppm): 64.90 (C-1'), 106.20 (C-2'), 83.90 (C-3'), 79.15 (C-4'), 76.65 (C-5'), 64.06 (C-6'), 94.68 (C-1), 73.62 (C-2), 74.94 (C-3), 71.85 (C-4), 75.10 (C-5) and 62.80 (C-6).

Fatty Acids: The significant ions in the mass spectra of the isolated fatty acids as their methyl esters are given below:

Methyl-n-tridecanoate: GC-MS *m/z* (rel. int. %) 228 (M^+, $C_{14}H_{28}O_2$ 25%), 199 (10%), 185 (M^+-43, 5%), 171 (M^+ -57, 12%), 157 (10%), 143 (15%), 129 (5%), 115 (4%), 101 (2%), 87 (5%), 73 (100%).

6,10,14-Hexadecatrienoate: 264 (M^+, $C_{17}H_{28}O_2$, 40%), 221 (M^+ -43, 15%), 207 (M^+-57, 18%), 199 (5%), 180 (18%), 157 (4%), 87 (10%), 69 (100%).

***n*-Hexadecanoate**: 270 (M^+, $C_{17}H_{34}O_2$, 45%), 239 (M^+ -31, 23%), 227 (M^+ -43, 33%), 213 (M^+ -57, 5%), 199 (8%), 185 (10%), 171 (7%), 157 (4%), 143 (25%), 129 (15%), 115 (4%), 101 (5%), 87 (76%), 74 (100%).

Heptadecenoate: 282 (M^+, $C_{18}H_{34}O_2$, 20%), 250 (M^+-32, 30%), 239 (M^+-43, 15%), 225 (M^+ -57, 25%), 208 (M^+ -74, 15%), 194 (4%), 180 (15%), 166 (10%), 152 (12%), 138 (10%), 124 (18%), 110 (22%), 97 (60%), 71 (100%).

9,12,15-Octadecatriennate: 292 (M^+, $C_{19}H_{32}O_2$, 65%), 261 (M^+ -31, 5%), 249 (M^+ -43, 8%), 235 (M^+ -57, 10%), 218 (M^+- 74, 2%), 199 (5%), 185 (2%), 171 (4%), 157 (2%), 143 (5%), 129 (2%), 115 (4%), 101 (10%), 89 (5%), 69 (100%).

9,12-Octadecadienoate: 294 (M^+, $C_{19}H_{32}O_2$, 20%), 262 (M^+-32, 15%), 251 (M^+-43, 10%), 237 (M^+ -57, 12%), 220 (M^+ -74, 10%), 178 (2%), 164 (10%), 150 (35%), 136 (12%), 122 (5%), 108 (2%), 94 (12%), 80 (5%), 74 (100%).

9,Octadecenoate: 296 (M^+, $C_{19}H_{36}O_2$, 15%), 264 (M^+ -32, 66%), 253 (M^+ -43, 15%), 239 (M^+ -57, 10%), 222 (M^+ -74, 35%), 208 (10%), 194 (5%), 180 (20%) 166 (10%), 152 (12%), 138 (15%), 124 (18%), 110 (30%), 96 (50%), 82 (40%), 74 (95%), 69 (100%).

***n*-Octadecanoate**: 298 (M^+, $C_{19}H_{38}O_2$, 78%), 267 (M^+-31, 25%), 255 (M^+ -43 47%), 241 (M^+-57, 10%), 227 (5%), 213 (10%), 199 (15%), 185 (6%), 171 (2%), 15 (4%), 143 (30%), 129 (10%), 115 (5%), 101 (10%), 87 (80%), 74 (100%).

Results and Discussion

The phytochemical examination of the methanolic extract of the seeds of *Pongamia pinata* afforded different secondary metabolities such as β-sitosterol [1], β-sitosteryl acetate [2], β-sitosteryl galactoside [5], stigmasterol [3], stigmasteryl galactoside [4] and sucrose ([6], Fig. 1). They include two sterols, three sterol derivatives and one disaccharide. It appears that sterols occur in the seeds of *P. pinnata* in a variety of forms attached with other compounds. As seeds are the storage organs, they are rich in the variety of natural products. Similarly, the seeds of this plant possesses a large number of different types of flavones and other metabolites (Soliven, 1934; Vidyarthi, 1951; Khanna and Seshadri, 1963; Roy *et al*., 1977a, b; Sharma *et al*, 1983; Tanaka *et al*., 1992; etc.).

Among isolated compounds only β-sitosterol has already been reported from different parts of *P. pinata* including flowers (Talapatra *et al*., 1980, 1982), heart wood (Subrahmanyam *et al*, 1973), leaves (Malik *et al*, 1976; Talapatra *et al*., 1985) a seeds (Sinha, 1959), whereas its acetate and galactoside have never been detected far. Stigmasterol and its galactoside have also been isolated for the first time from plant. Similarly the disaccharide, sucrose has also not yet been reported from P. tuna. Apart from β-sitosterol all the other natural products are being reported for first time from this plant.

Eight fatty acids have been extracted from the seeds of *Pongamia pinnata* and being reported for the first time. Among them three were saturated and the remain five unsaturated (Table 2). They include tridecylate, palmitate, stearate, hiragon heptadecylenate, octadecatrienoate, linoleate and oleate, which have been detected methyl esters. The five unsaturated fatty acids contain two monoenoic, one die and two trienoie acids. Among them only oleic acid is reported in literature from plant (Beal and Matti, 1925). It is very interesting that the saturated (49.99%) and saturated fatty acids (49.98%) were present in exactly equal amount.

Out of all detected fatty acids oleate had the highest relative percentage of occurrence (44.24%). However, the percentage of oleic acid in the seed oil of *P. pinnata* reported in literature (Beal and Katti, 1925) was 8.36%. Therefore, it appears that a high percentage of oleic acid occurs in the seeds, which are the storage organs for the developing embryos. The unsaturated fatty acids are useful for humans and animals, as they are not synthesized by them but supplemented through vegetable food. They have an effect on hyperlipidemia by lowering the levels of triglycerides and cholesterol. The

hyperlipidemia is related to the development of atherosclerosis and coronary heart disease (Ross and Harker, 1976).

Among saturated fatty acids, stearic acid was detected in the highest percentage i.e., 29.64%, while palmic acid was present in the text highest amount i.e. 18.58% in the seeds of *P. pinnata*. Tridecylic acid was, however, present in very little quantity i.e. 1.77%. Apart from oleic acid, all the other unsaturated fatty acids occurred in small quantities such as heptadecylenic (2.21%) and linoleic acids (1.77%), while hiragonic and octadecatrienoic acids were present in trace amounts i.e. 0.88%. Except oleic all other fatty acids are being reported for the first time from this plant.

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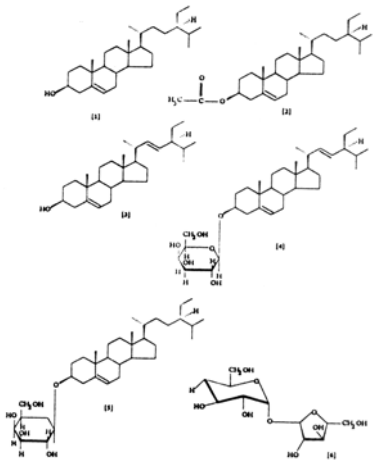

Fig. 1: Compounds isolated from the seeds of *Pongantia pinnata*: [1] = β-sitoterol, [2] = β-sitosteryl acetate, [3] = stigmasterol, [4] = stigmasleryl galactoside, [5] = β-sitoteryl galactoside, [6] = sucrose.

Table 1
^{13}C-NMR chemical shift of compounds [1-5] isolated from the seeds of *Pongamia pinnata*

Position of carbon	Compounds				
	[1]	[2]	[3]	[4]	[5]
1	37.31	37.12	37.42	37.06	37.31
2	31.81	31.81	31.81	31.64	31.81
3	71.90	77.24	71.92	78.85	78.85
4	42.40	42.40	42.40	41.50	42.40
5	140.90	139.83	140.92	140.23	140.90
6	121.87	122.63	121.78	121.69	121.87
7	32.07	32.07	31.91	31.72	32.07
8	32.00	32.00	31.89	31.95	32.00
9	50.81	50.10	50.37	50.16	50.81
10	36.61	36.61	36.61	36.72	36.61
11	21.12	21.12	21.01	20.80	21.12
12	40.00	40.01	39.78	39.59	40.00
13	42.61	42.61	42.40	42.50	42.61
14	56.78	56.78	36.61	56.67	56.78
15	24.32	24.32	24.41	24.01	24.32
16	28.24	28.24	28.90	28.55	28.24
17	56.20	56.20	56.00	55.85	56.20
18	11.90	11.90	12.43	11.61	11.90
19	19.44	19.44	19.40	19.23	19.44
20	36.26	36.26	40.50	40.13	36.26
21	19.10	19.10	21.12	20.48	19.10
22	34.00	34.00	138.40	138.04	34.00
23	29.31	29.31	129.48	129.15	29.31
24	45.80	45.89	51.31	51.06	45.80
25	26.21	26.21	32.00	32.00	26.21
26	18.80	18.80	19.00	19.00	18.80
27	19.80	19.80	21.21	21.21	19.80
28	23.10	23.10	25.41	25.41	23.10
29	11.92	11.99	12.00	12.00	11.92
$\underline{C}H_3$-COO	-	21.42	-	-	-
CH_3-$\underline{C}OO$	-	171.1	-	-	-
Sugar Units					
1	-	-	-	100.51	100.51

Table continued . . .

Position of carbon	Compounds				
	[1]	[2]	[3]	[4]	[5]
2	-	-	-	71.90	71.90
3	-	-	-	74.00	74.00
4	-	-	-	69.90	69.90
5	-	-	-	76.53	76.53
6	-	-	-	62.58	62.58

([1] = β-sitosterol, [2] = β-sitoteryl acetate, [3] = stigmasterol, [4] = stigmasteryl galactoside, [5] = β-sitosteryl galactoside)

Table 2
Fatty acids detected as methyl esters in the seeds of *Pongamia pinnata*

Systematic name	Common name	Molecular formula	Mol. wt.	R.R.T.	Relative % age
Saturated fatty acid methyl esters:					
n-Tridecanoate	Tridecylate	$C_{14}H_{28}O_2$	228	0.61	1.77
n-Hexadecanoate	Palmitate	$C_{17}H_{34}O_2$	270	1.00	18.58
n-Octadecanoate	Stearate	$C_{19}H_{38}O_2$	290	1.12	29.64
Unsaturated fatty acid methyl esters:					
6, 10, 14-Hexadecatrienoate	Hiragonate	$C_{17}H_{28}O_2$	264	1.24	0.88
Heptadecenoate	Heptadecylenate	$C_{18}H_{34}O_2$	282	1.25	2.21
9, 12, 15-Octadecatrienoate	Octadecatrienoate	$C_{19}H_{32}O_2$	292	1.47	0.88
9, 12-Octadecadienoate	Linoleate	$C_{19}H_{34}O_2$	294	1.48	1.77
9-Octadecenoate	Oleate	$C_{19}H_{36}O_2$	296	1.11	44.24

(R.R.T. = relative retention time, in relation with that of methyl palmitate)

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