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MINOR AMIDES OF *PIPER* SPECIES

S. K. KOUL, S. C TANEJA, V. K. AGARWAL* and K L DHAR†

Natural Products Chemistry Division, Regional Research Laboratory Canal Road, Jammu Tawi 180001, India

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Key Word Index—*Piper brachystachyum*, *P longum*, Piperaceae; pyrrolidides, brachyamide A; brachyamide B, brachystine, longamide, retrofractamide A, isobutyl amides, lignans, cinnamic acid derivatives; sitosterol

Abstract—Three new pyrrolidides, brachyamide A, brachyamide B and brachystine, have been isolated from *Piper brachystachyum*. The known amides, pipercide, retrofractamide A and guineensine, the lignans pluviatilol, methyl pluviatilol (fargesin), sesamine, asarinine and the aromatic hydrocarbon pipataline, substituted cinnamic acids, methyl ester and sitosterol were also isolated and identified *Piper longum* furnished a new long chain isobutyl amide, longamide, besides guineensine and the same lignans as isolated from *P. brachystachyum*. All the new piperamides were characterized by spectral studies and chemical degradation

INTRODUCTION

Piper species are widely distributed in the tropical and sub-tropical regions of the world and used medicinally in various manners [1–3]. In view of the recent findings in our laboratory [4, 5] concerning Indian species of *Piper* greater attention is being paid to these plants [4, 5] *Piper brachystachyum* is rich in lignans and crotoepoxides [6]. On the other hand *Piper longum* is known for its content of piperamides [7–16]. However, we have found that fruits of *P brachystachyum* (procured from Sikkim) show the presence of several known and unknown pyrrolidides and isobutylamides. Three of the pyrrolidides are being reported for the first time in this plant and their structures assigned. Similarly fruits of *P. longum* of the same region showed considerable variation in the chemical constituents and piperine and piperlonguminine are conspicuously absent in this species Besides the known lignans, a new long chain piper amide has also been isolated from this plant

RESULTS AND DISCUSSION

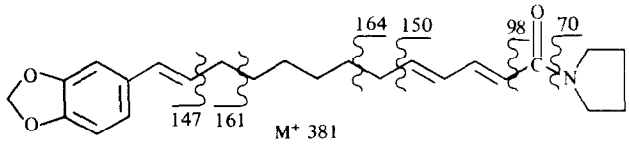
The petrol extract of fruits of *P. brachystachyum* was subjected to column chromatography and 15 pure compounds were separated and identified. The compounds **1–5** were aromatic amides and **6** was a long chain fatty acid pyrrolidide. The compounds **1**, **2** and **6** are now being reported for the first time from a natural source

Compound **6**, named as brachystine, was a semi-solid, which analysed as $C_{23}H_{41}NO$ (M^+ at *m/z* 347.5858). The IR spectrum displayed strong absorption at 1660 and 1610 cm^{-1}, specific of unsaturated amides and supported by the UV spectrum (λ_{max} at 216 nm) In the ^1H NMR spectrum, signals for the *trans*-olefinic protons of an α,β-unsaturated carbonyl system appeared at δ6 2 (*d*, *J* = 15 Hz) and 6.8 (*m*), respectively, and the isolated *cis*-olefinic proton signals appeared at δ5.32 as a triplet (*J* = 4 Hz) The signals for $N(CH_2)$ protons appeared at δ3.44 as a triplet (*J* = 6 Hz). In the ^{13}C NMR spectrum, α,β-unsaturated carbon signals were located at δ129 1 and 129.4, respectively [17, 18]. Hydrogenation of **6** gave a tetrahydro derivative (M^+ at *m/z* at 351), confirming the presence of two double bonds. The hydrogenated product on alkaline hydrolysis furnished a *n*-C_{19} acid besides pyrrolidine The position of a double bond in the chain was established from the mass spectral fragmentation studies which showed ions at *m/z* 113, 139, and 153. The fragments at *m/z* 70 and 98 also confirmed the basic moiety as pyrrolidine. All the ^{13}C NMR signals were in conformity with the proposed structure of brachystine as 2(*E*),9(*Z*)-nonadecadienoic acid pyrrolidide.

The minor pyrrolidide **1** (brachyamide A) was a semi-solid analysed as $C_{24}H_{31}NO_3$ (M^+ at *m/z* 381.5149). The UV spectrum displayed maxima at 262, 270 nm and an inflexion at 310 nm indicative of an extended conjugation to an unsaturated carbonyl system The IR spectrum showed strong bands at 1600 and 1655 cm^{-1} for an unsaturated amide carbonyl group In the ^1H NMR spectrum, a two proton singlet at δ5.86 was assigned to methylenedioxy protons. A doublet centred at δ5.90 (*J* = 15 Hz) was assigned to an α-proton of the *trans*-olefinic bond and a multiplet at 7 0–7.30 to the β-proton. The other olefinic protons signals were crowded into a multiplet centred at δ6 16 Aromatic proton signals were located at δ6.8 (*m*) and a $N(CH_2)_2$ protons signal was at 3.50 (*t*). Compound **1** was hydrogenated over Pd/C with the uptake of three mol of hydrogen (M^+ at *m/z* 387) and then hydrolysed with 15% methanolic potassium hydroxide to yield a semi-solid which was identified as 3,4-methylenedioxytridecanoic acid by gas chromatography and mass spectrometry of the methyl ester.

The position and stereochemistry of the olefinic bonds has been established with the help of the mass fragmentation pattern and the UV spectrum. The presence of two *trans*, *trans*-conjugated double bonds and another *trans*-double bond in conjugation with an aromatic ring was established by comparing the UV spectrum of **1** with the

*Alembic Laboratories, Baroda, India
†Author to whom correspondence should be addressed



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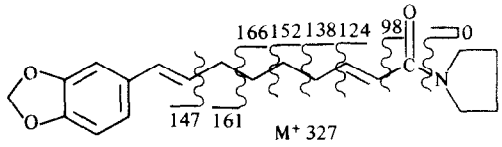

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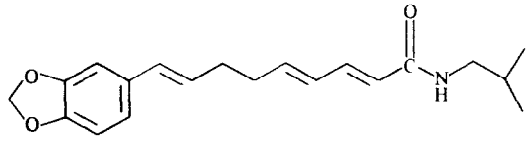

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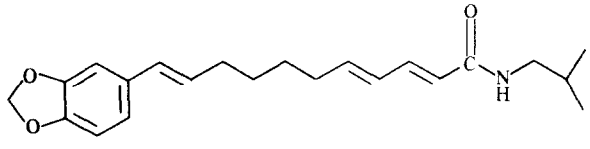

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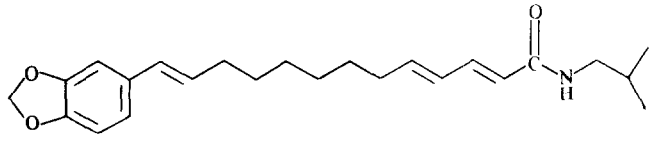

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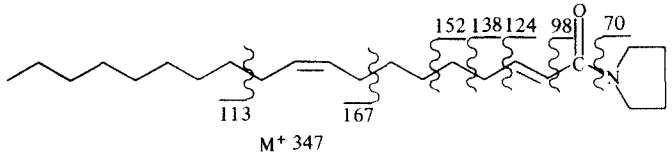

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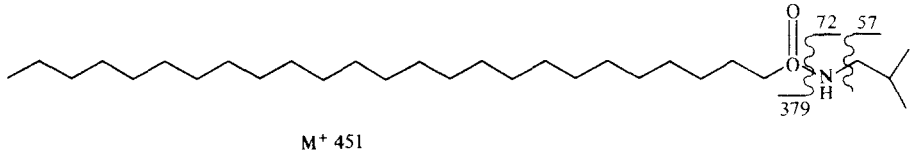

(7)

UV spectra of pipercide and (*E*)-isosafrole [5-(1-*E*-propenyl) 1,3-benzodioxol] which have λ_{max} at 259.5, 267, 305 and 261, 268 and 304 nm, respectively [17] The mass spectrum showed prominent fragments at *m/z* 351, 161, 135, 98 and 70. The ^{13}C NMR signals were completely in agreement with the proposed structure of **1** which was 2(*E*),4(*E*),12(*E*),13-(3,4-methylenedioxy)phenyltriadecatrienoic acid pyrrolidide

The pyrrolidide **2** (brachyamide B) a semi-solid, analysed for $C_{20}H_{25}NO_3$ (M^+ at *m/z* 327 4261) The diagnostic IR bands for an unsaturated amide carbonyl system appeared at 1660 and 1610 cm^{-1} The IR and UV spectra of **2** showed all the characteristics of **1** thus indicating the presence of an α,β-unsaturated carbonyl system alongwith a conjugated *trans*-olefinic bond with an aromatic ring In the ^1H NMR spectrum, α and β-

olefinic protons to the carbonyl appeared at δ6.06 (*d*, J = 15 Hz) and 7.1–7.3 (*m*) while an olefinic β-proton (conjugated with an aromatic ring) appeared at 6.15–6.23 (*m*) and the α-proton appeared, together with the aromatic proton signals, at δ6.60–7.0 (*m*). The signals for the $N(CH_2)_2$ protons were located at δ3.38 (*t*) and the methylenedioxy protons were at 5.88. Hydrogenation of **2** resulted in the absorption of two mol of hydrogen (M^+ at *m/z* 331). The hydrolysis of **2** with 15% alcoholic potassium hydroxide afforded an acid (M^+ at *m/z* 274). On the basis of the ^{1}H NMR spectrum and mass spectrum of the acid (see Experimental), compound **2** is assigned the structure as 2(*E*), 8(*E*), 9-(3,4-methylenedioxy)phenylnonadienoic acid. The structure of brachyamide B as the pyrrolidide of the above acid was further confirmed by the mass fragmentation pattern of **2** which showed fragments at *m/z* 227, 192, 135, 98 and 70 The ^{13}C NMR signals were also in agreement with the proposed structure.

Three other isobutyl amides **3**–**5** were characterized as 2(*E*),4(*E*),8(*E*),9-(3,4-methylenedioxy) phenylnonatrienoic acid isobutyl amide (retrofractamide A) [21]; 2(*E*),4(*E*),10(*E*),11-(3,4-methylenedioxy)phenylundecatrienoic acid isobutyl amide (piperciide) [19] and 2(*E*),4(*E*),12(*E*),13-(3,4-methylenedioxy)phenyltridecatrienoic acid isobutyl amide (guineensine) [20], respectively.

From the petrol ether extract of *Piper longum* another new long chain isobutyl amide **7** (longamide) was isolated and its structure assigned It was a whitish powder, mp 72°, and it was analysed for $C_{30}H_{61}NO$ (M^+ at *m/z* 451). The IR spectrum displayed a broad band at 1695 cm^{-1} for a saturated amide carbonyl. The ^{1}H NMR spectrum showed a triplet at δ3.64 (J = 6 Hz) for $N-(CH_2)_2$ protons and methylene protons α to a carbonyl appeared at 2.32 in the form of a diffuse triplet. The multiplet at δ0.92 which integrated for nine protons was assigned to one terminal methyl and two isobutyl methyls. Compound **7** was saponified by 15% alcoholic potassium hydroxide and the free acid was identified as hexacosanoic acid by mass spectral and elemental analysis. From the above data the compound **7** appeared to be a saturated isobutyl amide of hexacosanoic acid. This was further confirmed by its mass spectral fragmentation pattern which showed prominent fragments at *m/z* 451, 413 and 395. The structure of longamide **7** is thus assigned as hexacosanoic acid isobutyl amide. This is the first report of the presence of such an amide from *P. longum*.

EXPERIMENTAL

Mps uncorr IR (in KBr pellets) UV (MeOH) ^{1}H NMR recorded at 60 and 90 MHz, ^{13}C NMR at 22.5 MHz with TMS as internal standard. Mass spectra determined at 70 eV

Fruits of both *Piper brachystachyum* Wall (submitted at Kunjlal Herb botanical survey of India, Eastern circle, Shillong Herb. No PP905) and *Piper longum* (Herb No 895) were collected from the hilly forests of Sikkim (India) The dried powdered fruits of *P brachystachyum* (2 kg) and *P. longum* (400 g) were extracted with petrol (60–80°) and MeOH successively. Repeated CC of the petrol extract of *P brachystachyum* (45 g) on neutral alumina and elution with petrol–EtOAc in increasing proportions afforded 15 pure isolates Compounds **1** (0.6 g), **2** (0.42 g), **3** (0.38 g), **4** (0.36 g), **5** (0.7 g) and **6** (0.37 g) were isolated as minor amides The other compounds identified were lignans viz. sesamin, asarinin, pluviatilol and fargesin (*Z*) and (*E*) 2,4,5-trimethoxy cinnamic acids and the (*E*) Me-ester besides pipataline and sitosterol. Eight pure isolates were isolated from the petrol extract of *P longum* (18 g) after repeated CC on neutral alumina and elution with petrol–benzene–EtOAc in increasing proportions Compound **7** (0.6 g) was isolated as the minor amide and the other compounds identified were isobutyl amides (**4** and **5**) and lignans the same as isolated from *P brachystachyum*

Brachyamide A (**1**) Semi-solid, $C_{24}H_{31}NO_3$ $[M]^+$ at *m/z* 381.5149 (Found C 76.61, H 8.73, N 4.01 requires C 75.55; H 8.18, N 3.67%) λ_{max}^{MeOH} nm 262, 270 and 310 ν_{max}^{KBr} cm^{-1} 1655, 1615, 1600, 1490, 1440, 1245, 1040, 1000, 960, 910, 860, 815 ^{1}H NMR ($CDCl_3$) δ1.30–1.56 (8H, *m*, $-CH_2$), 1.72–2.00 (4H, *m*, 2×, $N-CH_2-CH_2$), 2.03–2.25 (4H, *m*, allylic protons), 3.50 [4H, *t*, J = 6 Hz, 2×$-N(CH_2)$], 5.86 (2H, *s*, $-OCH_2O$), 5.90 (1H, *d*, J = 15 Hz, $-CH=CH-CO-$), 6.04–6.20 (3H, *m*, olefinic H), 6.80 (1H, *m*, Ar-H) and 7.0–7.30 (1H, *m*, $-CH=CH-C=O$). MS *m/z* (rel int) 382 $[M+1]^+$ (20), 353 (4), 313 (6), 347 (8), 345 (6), 210 (30), 160 (24), 151 (51), 149 (24), 135 (53), 131 (33), 113 (50), 98 (40), 70 (58), 43 (100)

^{13}C NMR ($CDCl_3$): δ157.0 (*s*, C-1), 121.8 (*d*, C-2), 145.6 (*d*, C-3), 129.5 (*d*, C-4), 142.0 (*d*, C-5), 32.5 (*t*, C-6), 28.5 (*t*, C-7), 29.3 (*t*, C-8), 29.5 (*t*, C-9), 29.7 (*t*, C-10), 33.4 (*t*, C-11), 128.8 (*d*, C-12), 129.5 (*d*, C-13), 132.0 (*s*, C-1′), 105.5 (*d*, C-2′), 146.5 (*s*, C-3′), 148.0 (*s*, C-4′), 108.3 (*d*, C-5′), 120.0 (*d*, C-6′), 46.5 and 45.7 (*t*, C-1″ and 4″), 24.5 and 26.0 (*t*, C-2″ and C-3″) and 100.7 ($-OCH_2O$)

Catalytic hydrogenation of **1**. A soln of **1** (0.135 g) in EtOAc and 10% Pd/C (10 mg) on hydrogenation (room temp. for 3 hr) and purification afforded a semi-solid, $C_{24}H_{37}NO_3$ (Found C 75.03, H 9.93, N 3.77 requires C 74.37, H 9.62, N 3.61%). ^{1}H NMR (CCl_4) δ1.10–1.50 (20H, *m*, $-CH_2-$), 1.80–2.26 (8H, *m*, allylic H and 2×$-N-CH_2-CH_2$), 3.40 (4H, *t*, J = 6 Hz, 2×$-N-CH_2-$), 5.86 (2H, *s*, $-OCH_2O-$) and 6.60 (3H, *m*, Ar–H)

Saponification of **1** (H) Saponification of **1** (H) (0.1 g) with 15% methanolic KOH soln (sealed tube, heating 70 hr) after work-up afforded a semi-solid identified by MS as 13-(3,4-methylenedioxy)phenyltridecanoic acid.

Brachyamide B (**2**) Semi-solid, $C_{20}H_{25}NO_3$; M^+ at *m/z* 327.4261 (Found C 74.62, H 7.10, N 4.37 requires C 73.36, H 7.69; N 4.27%) λ_{max}^{MeOH} nm 217, 263 and 305 ν_{max}^{KBr} cm^{-1} 1660, 1610, 1500, 1488, 1446, 1250, 1190, 1090, 1040, 975, 905, 806 and 810 ^{1}H NMR (CCl_4) δ1.50 (4H, *m*, 2×$-CH_2$), 1.80–2.00 (4H, *m*, 2×NCH_2-CH_2), 2.10–2.40 (4H, *m*, allylic H), 3.48 (4H, *t*, J = 6 Hz, 2×$N-CH_2$), 5.88 (2H, *s*, $-OCH_2O-$), 6.06 (1H, *d*, J = 15 Hz, CH=CH–C=O), 6.15–6.23 (1H, *m*, Ar–CH=CH–), 6.60–7.00 (4H, *m*, 3–Ar–H and olefinic H) and 7.10–7.30 (1H, *m*, CH=CH–CO). MS at *m/z* (rel. int), 327 $[M]^+$ (30), 259 (10), 227 (19), 192 (41), 166 (8), 161 (50), 152 (100), 124 (38), 98 (53), 70 (66). ^{13}C NMR ($CDCl_3$) δ165.0 (*s*, C-1), 121.8 (*d*, C-2), 145.6 (*d*, C-3), 32.8 (*t*, C-4), 29.4 (*t*, C-5), 28.4 (*t*, C-6), 32.2 (*t*, C-7), 128.8 (*d*, C-8), 131.4 (*d*, C-9), 128.4 (*s*, C-1′), 105.4 (*d*, C-2′), 148.0 (*s*, C-3′), 147.8 (*s*, C-4′), 108.9 (*d*, C-5′), 120.2 (*d*, C-6′), 46.0 (*t*, C-1″ and C-4″), 24.6 and 26.0 (*t*, C-2″ and C-3″) and 100.8 ($-OCH_2O-$).

Catalytic hydrogenation of **2** Hydrogenation of **2** (0.1 g, 10% Pd/C, EtOAc) after work-up and purification afforded a semi-solid $C_{20}H_{29}NO_3$ (Found C 73.11; H 8.93; N 4.39 requires C 72.47; H 8.81 N 4.22%) ν_{max}^{KBr} cm^{-1} 1650 and 1600. ^{1}H NMR (CCl_4): δ1.36–1.42 (12 H, *m*, $-CH_2-$), 1.96–2.60 (8H, *m*, 2×$-CH_2$ and allylic protons), 3.40 (4H, *t*, J = 6 Hz, 2×$N-CH_2-CH_2$), 5.86 (2H, *s*, $-OCH_2O-$) and 6.60–6.76 (3H, *m*, Ar–H). MS *m/z* (rel. int.). 331 $[M]^+$ (20), 279 (18), 260 (8), 257 (10), 197 (30), 180 (78), 135 (21), 126 (6), 121 (80), 112 (100).

Saponification of **2** Compound **2** (0.1 g) on saponification (same as described for **1H**) afforded a semi-solid $C_{16}H_{18}O_4$. (Found C 71.05, H 7.6 requires C 70.05; H 6.61%) ^{1}H NMR ($CDCl_3$) δ1.56–1.70 (4H, *m*, $-CH_2-$), 2.10–2.70 (4H, *m*, allylic H),

5 83 (2H, s, $-OCH_2O-$), 6 10 (1H, *d*, $J = 15$ Hz, $-CH=HC-CO$), 6 18 (1H, *m*, olefinic H), 6 65–7 00 (4H, *m*, Ar-H and CH=CH) and 7 96 (1H, *br* s, exchangeable with D_2O, $-C(O)OH$ MS at *m/z* (rel int) 274 $[M]^+$ (60), 192 (100), 175 (20), 161 (18), 137 (13), 135 (50), 131 (60), 89 (24), 77 (20), 63 (86)

Retrofractamide A (**3**) Crystalline solid, mp 130° $C_{20}H_{25}NO_3$ (Found C 74 61, H 8 02 N 4 51 calc for C 73 36, H 7 69, N 4 27%) λ_{max}^{MeOH} nm 215 and 264 ν_{max}^{KBr} cm^{-1} 3200, 1655, 1622, 1540, 1490, 1440, 1260, 1040, 1000, 880, 810 ^1H NMR ($CDCl_3$) δ0 92 (6H, *d*, $J = 6$ Hz, C(H)Me_2), 1 76 (1H, *m* – C(H)Me_2), 2 30 (4H, *br* s, 4 × allylic H), 3 12 (2H, *t*, $J = 6$ Hz, $-CH_2-N$), 5 70 (1H, *d*, $J = 15$ Hz, $-CH=CH-CO$), 5 90 (2H, s, $-OCH_2O$), 6 08–6 46 (4H, *m*, olefinic H), 6 68–6 94 (4H, *m*, Ar-H) and 7 04–7 40 (1H, *m*, CH =CH CO) MS *m z* (rel int) 328 $[M+1]^+$ (28), 327 (58), 228 (6), 214 (4), 194 (4), 187 (16), 162 (100), 161 (98), 135 (20), 131 (93), 103 (94) and 77 (75) Compound **3** identified as retrofractamide-A (lit [21] mp 129°)

Piperolide (**4**) Crystalline solid, mp 113–115° $C_{22}H_{29}NO_3$ (Found C 75 13, H 8 44, N 4 14 calc for C 74 33, H 8 22, N 3 94%) λ_{max}^{MeOH} nm 208, 260, 267, 303 ν_{max}^{KBr} cm^{-1} 3256, 1612, 1600, 1240, 940, 906 ^1H NMR ($CDCl_3$) δ0 92 (6H, *d*, $J = 6$ Hz, C(H)Me_2), 1 16–1 60 (4H, *m*, $-CH_2-$), 1 64–1 96 (1H, *m*, $-CH_2$ C(H)Me) 2 04–2 38 (4H, *m*, allylic H), 3 12 (2H, *t*, $J = 6$ 5 Hz, $-CH_2-N-$) 5 76 (1H, $J = 15$ Hz. $-CH=CH-CO$), 5 92 (2H, *s*, OCH_2O), 5 94–6 28 (4H, *m*, olefinic H), 6 76 6 95 (3H, *m*, Ar-H), 7 03–7 32 (1H, *m*, CH=CH–CO) MS *m/z* (rel int) 356 $[M+1]^+$ (38), 283 (6), 255 (15), 248 (51), 220 (46), 194 (22), 187 (34), 180 (33), 161 (97), 152 (77), 135 (96), 115 (25), 103 (68), 91 (28), 77 (100), 72 (60) and 64 (33) Compound **4** was identified as piperolide by comparison with an authentic sample (lit [19] mp 113°)

Guineensine (**5**) Crystalline solid, mp 112–114° (M^+ at *m/z* 383) for $C_{24}H_{33}NO_3$ (Found C 75 92, H 8 98, N 3 77 calc for C 75 16, H 8 67, N 3 65%) λ_{max}^{MeOH} nm 359 ν_{max}^{KBr} cm^{-1} 3300, 1665, 1625, 1610, 1560, 1440, 1318, 1255, 1000, 945, 920 ^1H NMR ($CDCl_3$) δ0 92 (6H, *d*, $J = 6$ Hz, C(H)Me_2), 1 32 (8H, *br* s, 4 × CH_2-), 1 76 (1H, *m*, $-C(H)Me_2$), 1 92–2 32 (4H, *m*, allylic H), 3 12, (2H, *t*, $J = 6$ Hz, CH_2-N-), 5 76 (1H, *d*, $J = 15$ Hz, $-CH=CH-CO$), 5 92 (2H, *s*, $-OCH_2O-$) 6 72–6 92 (3H, *m*, Ar-H) and 7 0–7 4 (1H, *m*, CH=CH–CO) MS *m/z* (rel int) 383 $[M]^+$ (48), 311 (6), 283 (12), 268 (11), 248 (38), 203 (7), 180 (25), 161 (50), 152 (40), 135 (94), 131 (100), 103 (60), 71 (7) Compound **5** was identified as guineensine by comparison with an authentic sample (lit [20] mp 113–115°)

Brachystine (**6**) Semi-solid, $C_{23}H_{41}NO$, M^+ at *m/z* 347 5858 (Found C 80 80, H 12 08, N 4 22 requires C 79 47, H 11 88, N 4 02%) λ_{max}^{MeOH} nm 216 ν_{max}^{KBr} cm^{-1} 1660, 1615, 1550, 1470, 1140, 1340, 1260, 1040, 1000, 800, 730 ^1H NMR ($CDCl_3$): δ0 88 (3H, *t*, $J = 7$ Hz, $-CH_2-Me$), 1 1–1 68 (20H, *m*, 10 × CH_2), 1 76–2 35 (10 H, *m* allylic H and 2 × $-CH_2-CH_2-N$), 3 44 (4H, *t*, $J = 6$ Hz, 2 × $-CH_2-N$), 5 32 (2H *t*, $J = 4$ Hz, HC=CH), 6 20 (1H, *d*, $J = 15$ Hz, $-CH=CH-CO$) and 6 80 (1H, *m*, CH=CH–CO) MS *m/z* (rel int) 347 $[M]^+$ (6), 332 (20), 304 (14), 250 (11), 236 (9), 222 (33), 164 (8), 153 (72), 139 (30), 124 (40) 113 (85), 98 (68), 81 (55), 70 (86), 55 (86), and 41 (100). ^{13}C NMR ($CDCl_3$): δ167 0 (*s*, C-1), 119 8 (*d*, C-2) 144 1 (*d*, C-3), 32 6 (*t*, C-4), 27 3 (*t*, C-5), 29 4 (*t*, C-6), 32 2 (*t*, C-7), 28 6 (*t*, C-8), 129 4 (*d*, C-9), 129 1 (*d*, C-10), 27 5 (*t*, C-11), 30 8 (*t*, C-12), 29 6 (*t*, C-13), 29 4 (*t*, C-14), 29 2 (*t*, C-15), 28 6 (*t*, C-16), 32 6 (*t*, C-17), 22 6 (*t*, C-18), 14 1 (*q*, C-19), 46 0 and 46 6 (C-1′ and C-4′), 26 3 and 24 6 (C-2′ and C-3′)

Catalytic hydrogenation of **6**. Hydrogenation of **6** (0 16 g 10% Pd/C) after work-up and purification afforded a pale yellow semi-solid $C_{23}H_{45}NO$ (Found C 78 99, H 13 22, N 4 13 requires C 78 56, H 12 89, N 3 98%), ^1H NMR ($CDCl_3$): δ0 87 (3H, *t*, $J = 7$ Hz, Me–), 1 1–1 6 [*br* s, $(CH_2)_n$], 1 66–2 21 (6H, *m*, allylic and 2 × $-CH_2-CH_2-N$) and 3 36 (4H *t*, $J = 6$ Hz, 2 × CH_2-N-).

Saponification of **6H**. Compound **6H** (0 1 g) on saponification afforded a crystalline solid (from EtOH) mp 65° identified as nonadecanoic acid (lit [22] mp 68–69°)

Longamide (**7**) Amorphous powder, mp 72°, $C_{30}H_{61}NO$ (Found C 81 50, H 14 14; N 3 31 requires C 79 75, H 13 60, N 3 10%) ν_{max}^{KBr} cm^{-1}, 3380, 1695, 1485, 1480, 1300, 1020, 720, 735 ^1H NMR ($CDCl_3$) δ0 92 (9H, *m*, 3 × Me), 1 12–1 80 [*m*, $(CH_2)_n$], 2 32 (2H, *t*, $J = 6$ Hz, allylic H) and 3 64 (2H, *t*, $J = 6$ Hz, $-CH_2$ NH) MS *m/z* (rel int) 451 $[M]^+$ (50) 423 (77), 395 (60), 369 (12), 296 (7), 282 (6), 240 (11), 226 (10), 208 (12) 194 (15), 180 (25), 166 (40), 152 (65), 138 (79), 124 (80), 112 (70), 98 (88) and 61 (100)

Saponification of **7**. Compound 7 (0 4 g) on saponification and purification afforded crystalline solid mp 84° (lit [23] mp 88–89°) identified as hexacosanoic acid

E-2,4,5-*Trimethoxy cinnamic acid* (**8**) Crystalline solid, mp 166° $C_{12}H_{14}O_5$ (Found C 61 31, H 6 06 requires C 60 49, H 5 92%) λ_{max}^{MeOH} nm 216, 238, 284, 340 ν_{max}^{KBr} cm^{-1} 1690, 1495, 1510 ^1H NMR ($CDCl_3$) δ3 92 and 3 96 (9H, s, 3 × - OMe), 6 36 (1H, *d*, $J = 15$ Hz –CH=CH CO) 6 51 and 7 04 (1H each, s Ar-H), 8 08 (1H, *d*, $J = 15$ Hz, –CH=CH–CO) and 9 1 (1H, *br* s exchangeable with D_2O, COOH) The compound was identified as 2,4,5-trimethoxy-*E*-cinnamic acid [lit [24] mp 169°]

E-2,4,5-*Trimethoxy methyl cinnamate* (**9**) Crystalline solid, mp 108°, $C_{13}H_{16}O_5$ (Found C 62 91, H 6 97 calc for C 61 90, H 6 34%) λ_{max}^{MeOH} nm 225, 255, 265, 340 ν_{max}^{KBr} cm^{-1} 1690, 1500, 1515 ^1H NMR ($CDCl_3$) δ3 80, 3 88 and 3 92 (12 H, *s*, 4 × -OMe), 6 34 (1H, *d*, $J = 15$ Hz, –CH=CH–CO) 6 60 and 7 0 (1H each, s, Ar-H), 7 96 (1H, *d*, $J = 15$ Hz –CH=CH–CO) MS *m/z* (rel int) 253 $[M+1]^+$ (94), 237 (100), 221 (88), 207 (51), 191 (20), 178 (44), 163 (42), 149 (20) and 135 (26) This compound was identified as *E*-2,4,5-trimethoxy methyl cinnamate [lit [24] mp 109°] by comparsion with an authentic sample

Z-2,4,5-*Trimethoxy cinnamic acid* (**10**) Crystalline solid mp 124–5°, $C_{12}H_{14}O_5$ (Found C 61 31, H 6 18 requires C 60 49, H 5 92%) λ_{max}^{MeOH} nm 216, 235, 280, 335 ν_{max}^{KBr} cm^{-1} 1682, 1496, 1510 ^1H NMR ($CDCl_3$) δ3 83 (9H, s, 3 × OMe) 5 83 (1H, *d*, $J = 12$ Hz, CH=CH–CO), 6 61 (1H, s, Ar–H), 7 17 (1H, *d*, $J = 12$ Hz, –CH=CH–CO) and 7 27 (1H, s, Ar-H)

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REFERENCES

1. Kurtukar, R. K. and Basu, B. D. (1933) *Ind. Med. Plants*, 2nd. Edn. Vol. III (Basu, L. M., ed.), p. 2128. Allahabad, India.
2. Nadkarni, K. M. and Nadkarni, A. K. (1954) *Indian Materia Medica* Vol I, 3rd Edn, p 960 Popular & Dhootapapeshwar Prakashan Panvel-Bombay, India
3. Watt, G (1892) *Dictionary of the Economic Products of India* Vol 6, No 7 Part A, 264 W H Allan, London
4. Atal, C. K., Zutshi, U. and Rao, P. G. (1981) *J. Ethnopharmacol* **4**, 229
5. Atal, C. K., Dubey, R. K. and Singh, J. (1985) *J. Pharm. Exp. Therapeut.* **232**, 258
6. Oda, K., Ichichara, A. and Sakamura, S. (1975) *Tetrahedron Letters* **36**, 3187
7. Singh, J. and Atal, C. K. (1969) *Indian J. Pharm.* **31**, 129
8. Thappa, R. K., Vashist, V. N., Singh, J. and Sharma, R. K. (1970) *Curr. Sci.* **39**, 182
9. Atal, C. K. and Banga, S. S. (1962) *Indian J. Pharm.* **24**, 105
10. Atal, C. K. and Banga, S. S. (1963) *Curr. Sci.* **32**, 354
11. Atal, C. K., Dhar K. L. and Gurtra, R. N. (1966) *Indian J. Chem* **4**, 252

12. Chatterjee, A and Dutta, C. P. (1966) *Tetrahedron Letters* **16**, 1797.
13 Chatterjee, A. and Dutta, C P (1967) *Tetrahedron* **23**, 1769.
14. Dhar, K L. and Atal, C K (1967) *Indian J Chem.* **5**, 588
15. Dutta, C. P., Banerjee, N. and Roy, D. N (1975) *Phytochemistry* **14**, 2090.
16. Joshi, B. S., Kamat, V. N. and Saksena, A K. (1988) *Tetrahedron Letters* **20**, 2395
17. Gupta, O. P, Gupta, S C, Dhar, K. L and Atal, C. K (1976) *Indian J Chem* **14**, 912
18 Johnson, L F. and Jankawski, W C. (1978) Carbon-13 NMR spectra, Varian Associates Instrument Division Palo Alto, California, Robert E Krieger, Hutington, New York
19 Miyakado, M, Nayakayama, I, Yoshioka, H and Nakatani, N (1979) *Agric. Biol Chem* **43**, 1609.
20. Banerji, A, Bandyopadhyay, D., Siddhanta, A. K, Sudhir, C Pal, Gosh, S. C, Abraham, K and Shoolery, J N (1985) *Phytochemistry* **24**, 279.
21 Okogum J. I and Skong, E. U D (1974) *J Chem Soc Perkin Trans I* 2195
22 *Dictionary of Organic compounds* (1982) IV, p. 4304. Chapman & Hall, Mack Printing Company Easton Pennsylvania, New York.
23. *Dictionary of Organic Compounds* (1982) V, p. 5519 Chapman & Hall, Mack Printing Company Easton Pennsylvania, New York
24. *Dictionary of Organic Compounds* (1982) IV, p. 2891 Chapman & Hall, Mack Printing Company Easton Pennsylvania, New York.