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LIMONOIDS FROM THE SEED OF *ENTANDROPHRAGMA CAUDATUM*

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Key Word Index *Entandrophragma caudatum* Meliaceae, limonoid

Abstract—The seed of *Entandrophragma caudatum* has been shown to contain a mixture of limonoids, similar to those previously obtained from the trunk and bark of the tree

INTRODUCTION

Species of the genus *Entandrophragma* are characterized by containing fairly large quantities of limonoids in the timber, these range from the simple gedunin in *E. angolense* to the complex bussein in *E. bussei* and *E. spicatum* [1] Although the seeds are bitter, wehave not so far been able to find limonoids in them. *E. angolense*, *E. cylindricum* and *E. utile* yielded only protolimnoids [2] We now report that the seeds of *E. caudatum* are a rich source of limonoids, mainly esters of phragmalin similar to those obtained previously from the bark [3]

RESULTS AND DISCUSSION

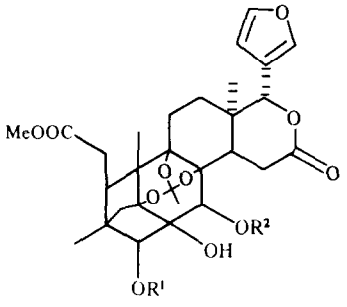
Seed collected by us in the Transvaal and in Zimbabwe was minced and extracted with petrol The extract contained melianone, 3-epimelianol acetate (≡3α-turreanthin, [4]) and a number of limonoids, of which six were isolated Extraction of the crushed seed capsule yielded no limonoids, but rather surprisingly gave large quantities of protolimonoids, of which melianone was the main constituent Of the six limonoids, the first was isolated as needles, mp 219–224 This was shown to be phragmalin 3,30-di-isobutyrate [5] (1) The second, which did not crystallize, was the corresponding isobutyrate-propionate, as shown by the very similar spectral properties In the di-isobutyrate the two acyl carbonyl resonances are at δ_C 176 3, 174 7 Earlier data on phragmalin ester [5] show that when two identical acyl groups are present, the carbonyl at C-3 resonates downfield of that at C-30, hence we assign the resonance at 176 3 to the C-3 carbonyl, the other to the C-30 carbonyl In the isobutyrate, propionate the two carbonyl resonances are at δ_C 176 7, 172 4 Therefore we deduce that the changed substituent is at C-30, so that the second compound is phragmalin 3-isobutyrate-30-propionate (2) This has been previously isolated from *Chukrasia tabularis* [5] and the recorded data agree with those of our sample

The third limonoid could not be obtained quite pure The spectrum showed a general similarity to phragmalin, but had two special features, the presence of an extra double doublet at δ4 66 (J = 12, 2 6 Hz), which together with a new singlet at δ1 6 suggested a 12α-acetate [5], and the presence of a number of bands in the aromatic region. Since phragmalin was originally isolated [3] as a nicotinate ester, these at once suggested that this compound was also a nicotinate, the remaining carbon atoms then would suggest an isobutyrate is also present The ^{13}C NMR spectrum is consistent with this proposal, unfortunately since we could not get the compound quite pure, it is not supported by analytical data There are five acyl carbonyl groups in the spectrum, these can be assigned to the acetate (169 2), the nicotinate (165), the carbomethoxy (172 4), the lactone (169 5), and the isobutyrate (174 6) Following our assignments of phragmalin di-isobutyrate, this suggests that the present compound is 12α-acetoxyphragmalin 3-nicotinate-30-isobutyrate (3) This assignment is supported by the large deshielding effect of the nicotinate on H-3, from δ4 59, 4 68 in the two known 12-acetoxy-3-isobutyrates [5] to δ4 94 in the present nicotinate, while H-30 is unchaged (δ6 02, 5 99, 6 06)

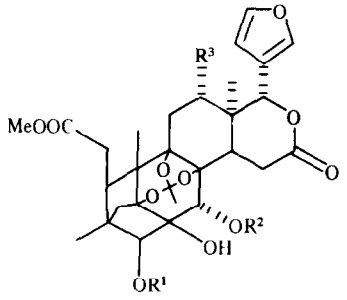
The fourth limonoid was obtained pure, but in limited quantity so that with our equipment it was difficult to obtain adequate ^{13}C NMR spectra Preliminary indications suggested similarity to the above compound, but lacking the 12α-acetoxy group We consider it is most probably phragmalin 3-nicotinate 30-isobutyrate, but some of the expected carbon resonances were not found

The fifth limonoid was also not obtained quite pure It appers to be a phragmalin 12α-isobutyrate, since there are a pair of doublet upfield methyl resonances (δ0 88, 0 78, each 3H, J = 6 Hz) consistent with this proposal [7]. However, the ^{1}H NMR spectrum shows an extra singlet (δ6 00, 5 86, 5 22, 5 03), which suggests a 14,15 unsaturated phragmalin nucleus, as in febrinin B and epoxy febrinin B [6] (δ_H H-15, 6 06) We therefore propose that this compound is $\Delta^{14,15}$ 12α-butyryloxyphragmalin 3-nicotinate 30-isobutyrate (4)

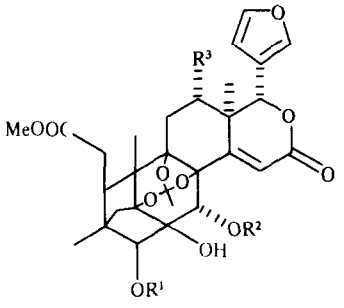
The final limonoid was not obtained pure enough for any structural diagnosis, but was characterized by a band at δ7 98, which may indicate a 17-carbonyl group in a ring-D-opened limonoid [8] We have obtained the same compound, or a very similar one, from other plants, but never in a pure enough state for identification Although impure, all our samples of this compound have appeared to be lacking in spectral details, thus the characteristic phragmalin singlets are not present, and it is possible that it may be a lower molecular mass degradation product An interesting possibility, raised by a recent paper on *Melia azedarach* [9] is that *Entandrophragma* seed may contain limonoid glycosides This is being investigated



1 $R^1 = R^2 = iso$PrCO
2 $R^1 = iso$PrCO $R^2 =$ EtCO



3 $R^1 = m$C$_5$H$_5$NCO
$R^2 = iso$PrCO
$R^3 =$ MeCO



4 R = mC$_5$H$_5$NCO
$R^2 = R^3 = iso$PrCO

EXPERIMENTAL

Two batches of seed were used, one of 108 g, from Zimbabwe, one of 240 g from the Transvaal The second batch included the capsules (850 g) which were examined separately Extraction of the seed with hexane gave an oil which was partitioned between hexane and 90% aqueous MeOH. The MeOH extract was diluted and returned to CH_2Cl_2 giving a gum (3%) which was chromatographed on a rapid column Extraction of the capsules with hexane gave on oil (15 g) which was chromatographed directly

Phragmalin 3,30 diisobutyrate (300 mg from the first batch of seed) had mp 219–224°, and spectral characteristics identical to those described earlier [6], the 30-propionate (150 mg from the first batch), did not crystallize, the spectral characteristics were as described [5] Melianone and 3-epimelianol acetate, isolated in small amount only, for identification, were identical with authentic samples The other limonoids were only obtained amorphous

12α-*Isobutyryloxyphragmalin* 3-*nicotinate*-30 *isobutyrate* was not obtained quite pure. Found ^{1}H NMR δ_H 9 52 (*br s*), 8 70 (*br s*), 8 60 (*t*), 7 40 (2H, *br s*), 6 38 (1H, *br s*), 6 06 (1H, *s*) 5 40 (1H, *s*), 4 94 (1H, *s*), 4 66 (1H, *dd J* = 12, 2 6), 3 72 (3H, *s*), 1 67 (3H, *s*), 1 59 (3H, *s*), 1 18 (6H, *s*), 0 96 (3H, *s*) ^{13}C NMR δ_c 174.6*s*, 172.4*s*, 169 5*s*, 169 2*s*, 165.0*s*, 153 1*d*, 151 5*d*, 143 0*d*, 141 1*d*, 137 7*s*, 130 3*d*, 123 0*d*, 120 7*s*, 119 3*s*, 109 7*d*, 86 1*s*, 85 7*s*, 85 4*s*, 84 8*d*, 80 4*s*, 76 3*d*, 70 2*d*, 69 0*d*, 51.8*q*, 45 5*s*, 45 0*s*, 43.9*d*, 39 8*t*, 38.9*s*, 36 1*d*, 34 3*d*, 33 4*t*, 31 7*t*, 26 6*t*, 21.0*q*, 20 0*q*, 18 9*q*, 17 8*q*, 16 2*q*, 13 9*q*, 13 9*q*

Phragmalin-3-*nicotinate*-30-*isobutyrate* (19 mg) was not obtained in sufficient quantity for identification of the weaker ^{13}C NMR bands Found ^{1}H NMR δ_H 9 40 (*br s*), 8 75 (*m*), 8.56 (*t*), 8 46 (*t*), 7 48 (1H, *br s*), 7 40 (2H, *br s*), 6 44 (1H, *br s*) 6 00 (1H, *s*), 5 40 (1H, *s*), 4 92 (1H, *s*), 3.68 (3H, *s*, 1 66 (3H, *s*), 1 18 (3*H*, *s*), 1 06 (3H, *s*), 0 96 (3H, *s*) ^{13}C NMR δ_c 174 9, 170 0, 143 1, 140 8, 138 4, 109 6, 84 8, 80 2, 78.2, 70 6, 52 3, 45 4, 45 2, 42.9, 39 5, 36 9, 34.7, 34.3, 33 5, 29 1, 26 6, 25 4, 21 1, 19 6, 19 0, 17 9, 16 5, 14 4 An ORD spectrum was not obtained

$\Delta^{14,15}$ 12α-*Isobutyryloxy phragmalin*-3-*nicotinate*-30-*isobutyrate* was also not obtained pure, and a ^{13}C NMR spectrum was not obtained Found ^{1}H NMR δ_H 9 32*s*, 8 76 (*br s*), 8 58 (*t*), 8 48*t*, 7 50 (1H, *s*), 7 40 (1H, *s*), 6 50 (1H, *br s*), 6 00 (1H, *s*), 5 86 (1H, *s*), 5 22 (1H, *s*), 5 03 (1H, *s*), 3 64 (3H, *s*), 1 66, 1 55, 1 16, 0 96 (all 3H, *s*), 0 88 (3H, *d*, *J* = 6 Hz), 0 78 (3H, *d*)

The final limonoid was not obtained pure, although the quantity available was considerable (*ca* 250 mg) It was charac-

terised by the following ^{1}H NMR bands, δ_H 7 98*s*, 7 38*s*, 6 72*s*, 4 64*s*, 3 64*m*, 3 52*s* and methyl groups

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PROTOLIMONOIDS FROM *TURRAEA NILOTICA*

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Key Word Index—*Turraea nilotica*, Meliaceae, protolimonoid

Abstract—*Turraea nilotica* has been found to yield a new protolimonoid, 24,25 epoxy-23-hydroxy-7-tirucallen-3-one, which we name niloticin, together with two closely related compounds No limonoids were found.

INTRODUCTION

Turraea (Meliaceae, tribe Turraeeae) is a rather variable genus, containing at the most recent delimitation [1] some 60–70 species of shrubs and small trees in the Indian Ocean area We have recently shown [2] that *T obtusifolia* (section Euturraea) contains the complex limonoid prieurianin, while *T floribunda* (section Rutaea) contains simpler limonoids of the havanensin type It would be interesting to know whether this difference is taxonomically significant or not; unfortunately although *Turraea* species are widespread they are nowhere common, or at least are inconspicuous, and correspondingly difficult to obtain We now report examination of *T nilotica* Kotschy et Peyr (also section Rutaea) collected and supplied by the scientific staff of the Kruger Park

RESULTS AND DISCUSSION

Extraction of pulverized stem of *T nilotica* (wood and bark) with petrol gave an extract which yielded one major crystalline protolimonoid niloticin, and two minor ones, one crystalline, one amorphous; but no limonoids The major product gave spectra suggesting that it was a stereoisomer of 24,25-epoxy-23-hydroxy-7-tirucallene-3-one **1** (=21 deoxy-melianone) The spectra were in general similar to those of melianone [3], showing the epoxide carbons δ_C 68 4*d* and 59 8*s* and the characteristic H-24 epoxide doublet (δ_H 2.67, J = 8 1 Hz). However the hemiacetal signals associated with C-21 in melianone were missing, and instead there was a secondary methyl resonance (δ_H 0 96, J = 6 Hz)

The presence of the epoxide was chemically confirmed by methanolysis, giving a 24-hydroxy-25-methoxy derivative **2**, the position of the hydroxy-epoxide was chemically confirmed by periodate oxidation, which gave a tetra-noraldehyde **3** This leaves the stereochemistry undetermined. The most commonly occurring arrangement is that of melianone, with the tirucallol 20αH and the 23*R*-24*R* configuration However, both 24*R* and 24*S* configurations have been identified [4, 5], we have no evidence to show which is present in niloticin

The second product, also crystalline but isolated in small yield, was a dihydroniloticin The spectra were similar to those of niloticin, but instead of a ketonic carbonyl, showed an extra secondary alcohol The ^{1}H NMR spectrum (δ 3 21, $W_{1/2}$ = 14 4 Hz) showed dihydroniloticin to be an equatorial alcohol; it is therefore the 3β alcohol **4** corresponding to the ketone niloticin It is interesting that protolimonoids, as for example turraean-