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IDENTIFICATION OF NEW MAMMEA COUMARINS: FOUR 7,8-ANNULATED RELATIVES OF THE MAMMEA COUMARINS A/AA- A/AB, B/AA, B/AB, AND TWO OF THE 6-ACYL FAMILY, B/AA (ISOMAMMEIN) AND B/AB

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Nine new 4-alkyl coumarins having a 5,6-annulation pattern have been identified in the seeds of Mammea americana L.[2] These are additional to the eleven coumarins already isolated.[3-8] We now report six new relatives making a total of 26 allied coumarins in this remarkably rich source. Four, (VII)-(X), are tricyclic with a 7,8-five-membered annulation pattern. {Mammeigin[6] (A/A cyclo D)[4] also bears a six-membered 7,8-attached ring}. The other two are the missing mammeas B/AA (I) and B/AB (II).

Repeated chromatography of the light-petroleum extracts gave a yellow compound m.p. 109°, $C_{22}H_{28}O_5$, with ν_{max} (CCl_4) 3330, 1747, 1627 and 1595 cm^{-1}, agreeing with other 5,7-dioxygenated coumarins,[1,3,8] and λ_{max} (ethanol) 284 (log ε 4.38), 329 (3.95) nm., λ_{max} (0.01N-KOH), 232 (4.34), 300 (4.28), 380i (4.02), 415 (4.11) nm., supporting an 6-acylated-4-alkyl-5,7-dihydroxycoumarin.[3,4] N.m.r. data (double resonance) supported (I), designated[3,4] mammea B/AA. The mass-spectrum, very similar to that for mammea B/BA,[3] was in agreement with (I). A second yellow compound had m.p. 114°, isomeric with (I) and with similar spectral data. N.m.r. information showed this to be the 2-methylbutyryl isomer, mammea B/AB (II), containing a little of the 3-methylbutyryl isomer (I). Confirmation of these spectroscopic deductions was provided by isomerising the known[3] mammea B/BA (III) to mammea B/AA (I), and the known[3] mammea B/BB (IV) to mammea B/AB (I), using 5% methanolic potassium hydroxide.[8] The hydroxyl protons of the

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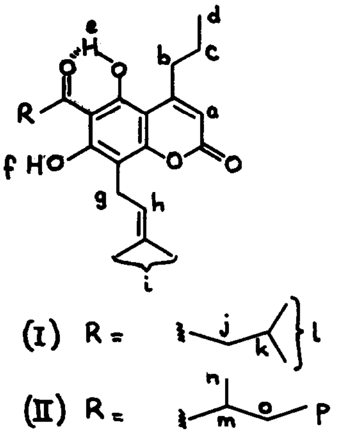
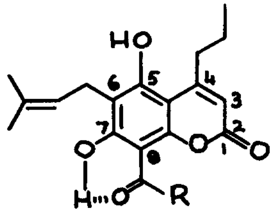


a) 4.17(1)s.
b) 7.05(2)t. J 7Hz
c) 8.2-8.4(2)m.
d) 8.98(3)t. J 7Hz
e) -5.19(1)s.
f) 2.46(1)s.
g) 6.49(2)d. J 7Hz
h) 4.82(1)m.
i) 8.15(3)s.
8.24(3)s.

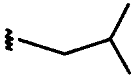
(I)
j) 7.00(2)d. J 7Hz
k) 7.8(1)m.
l) 9.02(6)d.

(II)
m) 6.2(1)m.
n) 8.82(3)d. J 7Hz
o) 8.2-8.4(2)m.
p) 9.08(3. J 7Hz

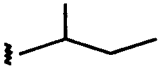
6-acylcoumarins (I) and (II) resonate at positions (τ-5.2 and 2.5) not markedly different from those of the 8-acyl isomers (III) and (IV) {contrast the 4-phenyl series}.[4,9]



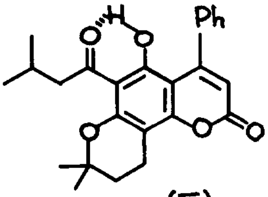
(III) R =



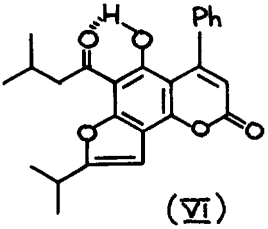
(IV) R =



A third yellow crystalline material, $C_{25}H_{26}O_6$, had m.p. 110-115°. It had ν_{max} (mull) 3460, 3420, 1715, 1610 cm^{-1}, λ_{max} (95% ethanol) 232 (log ε 4.11), 282 (4.39), 348 (4.01) nm., λ_{max} (0.01N-KOH) 249 (4.21) 280i (4.05), 316 (4.05), 428 (3.95) nm., indicative of a 4-phenyl-5,7-dihydroxycoumarin having a 6-acyl substituent.[4] {Similar to the acid cyclisation product (V) derived from mammea A/AA[6] which had ν_{max} (95% ethanol) 227 (4.16), 287 (4.45), 338 (4.05) nm., λ_{max} (0.01N-KOH) 248i (4.32), 293 (4.12), 318 (4.16), 420 (3.93) nm.}. N.m.r. examination,[2,4,6] with double resonance, showed it to be (VII), with a little of the isomeric (VIII). (Proportions of (VII) and (VIII) were variable, and another

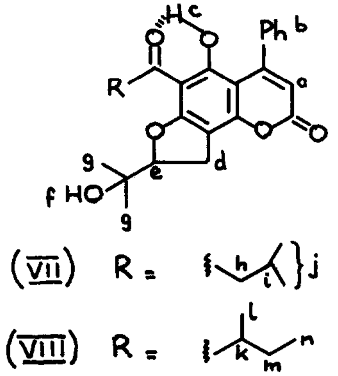


(V)



(VI)

specimen, m.p. 97-105°, was much richer in the latter.) The mass spectral fragmentation is consistent with both a C_5 acyl substituent[2,4] and a α-hydroxyisopropyldihydrofuran.[2,10]



a) 4.09(1)s.
b) 2.64(5)m.
c) -4.46(1)s.
d) 6.69(2)d. *J* 9Hz
e) 5.09(1)t. *J* 9Hz
f) 8.20(1)s.
g) 8.57(3)s.
8.69(3)s.

(VII)

h) 7.1(2)m.*
i) 7.8(1)m.
j) 9.04(6)d. *J* 7Hz

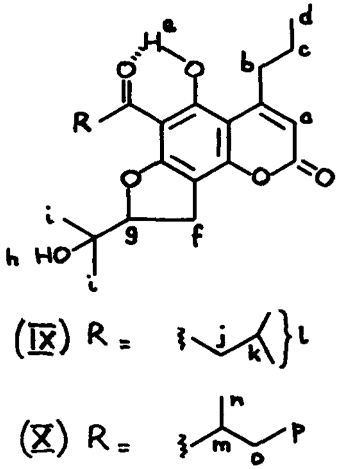
(VIII)

k) 6.35(1)m.
l) 8.85(3)d.d. *J* 7 and 2Hz*
m) 8.2-8.4(2)m.
n) 9.11(3)t. *J* 7Hz

* Not first order coupling.

To check these conclusions, coumarins (VII) and (VIII), m.p. 148-150° and 115-117° respectively, were synthesised by treating mammea A/AA and mammea A/AB respectively with *m*-chloroperbenzoic acid, and their admixtures were equated with the natural fractions. Acid catalysed dehydration of (VII) gave the benzofuran (VI),[11] and both (VII) and (VIII) gave monoacetates. On comparing (t.l.c.) these pure monoacetates with the monoacetates of the crystalline fractions m.p. 110-115° and 97-105°, the conclusions reached above were confirmed except that the presence of an acetate of a new minor component now became apparent.

A clue to the nature of the later came from mass spectral comparison of pure reference compounds with the natural mixtures. Spectra of the latter showed extra ions at m/e 388 (28), 331 (10) and 259 (6.5), consistent with replacement of a 4-phenyl by a 4-*n*-propyl.[1] Comparison (t.l.c.) with the known 5,6-annulated 4-*n*-propyl α-hydroxyisopropyl-dihydrofuranocoumarins showed non-identity and thus suggested that coumarins (IX) and (X), with 7,8-annulation, were likely.[12] These were synthesised by treatment of mammea B/AA (I) and B/AB (II) with *m*-chloroperbenzoic acid and spectral data were as expected. T.l.c. comparison, as the monoacetates, with the samples of natural origin, confirmed the identity of the latter.



a) 4.19(1)s.

b) 7.05(2)t. *J* 7Hz

c) 8.2-8.4(2)m.

d) 9.00(3)t. *J* 7Hz

e) -5.10(1)s.

f) 6.75(2)d. *J* 9Hz

g) 5.10(1)t. *J* 9Hz

h) 7.72(1)s.

i) 8.69(3)s.
8.55(3)s.

(IX)

j) 7.04(2)m.*
k) 7.8(1)m.
l) 8.96(6)d. *J* 7Hz

(X)

m) 6.80(1)m.
n) 8.92(3)d. *J* 7 and 2Hz*
o) 8.2-8.4(2)m.
p) 9.02(3)t. *J* 7Hz

* Not first order coupling.

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[1] Constituents of *Mammea americana* L., VII (R.A.F.); see ref. 1 of the preceeding communication. Aided (R.A.F.) by a grant (GM 11412) from the National Institutes of Health.

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[11] W. Bencze, J. Eisenbeiss and H. Schmidt, *Helv. Chim. Acta*, 1956, 39, 923.

[12] Dr. F. Scheinmann (Univ. of Salford) has kindly informed us that he and his colleagues have evidence of the presence of (II), (VIII) and (X) in *Mammea africana* bark.