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SHORT COMMUNICATION

CUDRANIAXANTHONE AND BUTYROSPERMOL ACETATE FROM THE ROOTS OF *CUDRANIA JAVANENSIS*

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Abstract—A new xanthone, cudraniaxanthone has been isolated from *Cudrania javanensis* and its constitution established. Butyrospermol, its acetate (first isolation from a natural source), kaempferol, aromadendrin, populnin, quercetin and taxifolin have also been obtained.

INTRODUCTION

Cudrania javanensis, whose wood has been used as a dye source,[1] has not been chemically examined earlier. The air-dried root was separated into the 'periderm' or outer bark, inner bark and the woody 'stele'. Each was first soxhleted with acetone and later refluxed with boiling alcohol.

The acetone extract of the periderm contained the major extractives and yielded a pure compound (A) and a mixture of two compounds (B and C) described under 'inner bark'. Compound A, $C_{19}H_{18}O_6$ (M^+ 342), had one methoxyl and gave bright green ferric colouration. Its UV spectrum was comparable with those of 1,3,5,6-tetraoxygenated xanthones,[2,3] e.g. dihydrojacareubin. It was named cudraniaxanthone. The λ_{max} shifted considerably with $AlCl_3$ and NaOAc indicating free —OH groups at C_1 and/or C_8 and C_3 and/or C_6 positions respectively; ν_{max} showed —OH peaks at 3230 and 3030 cm^{-1}. The intense green ferric colouration, supported by its extractability with borax, suggested a catechol system in the molecule and this could be expected in positions 5 and 6. Further, the molecular formula indicated a C_5H_9, as isoprene residue.

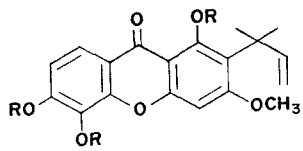
The NMR in $(CD_3)_2SO$ had signals for chelated 1-hydroxyl at δ 14·03 and a methoxyl at δ 3·81. Further, among three aromatic proton signals at δ 7·55 (1 H, d, $J = 10$ Hz), δ 6·90 (1 H, d, $J = 10$ Hz) and δ 6·60 (1 H, s), the first two were *ortho*-coupled corresponding to 7- and 8-positions and therefore the side-chain should be placed in position 2 or 4. Its nature, as $\alpha\alpha$-dimethylallyl, followed from NMR: a sharp singlet at δ 1·53 (6 H), two doublets at δ 4·62 and δ 4·85 (2 H) and a multiplet at δ 6·3 (1H). Since C_1-hydroxyl was highly resistant to acetylation or methylation, it could be hindered by C_5H_9 located in 2 position; the methoxyl group should therefore be placed at C_3 which is biogenetically favoured. Thus cudraniaxanthone is 1,5,6-trihydroxy-3-methoxy-2(1′,1′-dimethylallyl)-xanthone (I). This was supported by MS also.

[1] P. MAHESWARI and U. SINGH, in *Dictionary of Economic Plants of India*, p. 57, Indian Council of Agricultural Research, New Delhi (1965).
[2] B. JACKSON, H. D. LOCKSLEY and F. SCHEINMANN, *J. Chem. Soc.* C, 178 (1966).
[3] H. D. LOCKSLEY, I. MOORE and F. SCHEINMANN, *J. Chem. Soc.* C, 2265 (1966).

The complete methyl ether of cudraniaxanthone (m.p. 122–124°) had four methoxyl groups. Its NMR signals agreed with structure (II) and this was confirmed by comparison with a synthetic[4] sample from Dr. Scheinmann.

Cudraniaxanthone, apart from being the first xanthone of the *Cudrania* genus, is the first in the family Moraceae with one C_5 side-chain. Further, it represents the first stage of methylation of a tetrahydroxyxanthone in the plant, the 3-position being the most reactive.

The acetone extract of the inner bark was fractionated into petroleum soluble and insoluble (marked R) portions. The soluble fraction was a mixture of compounds B and C separated by chromatography.



(I) R = H
(II) R = CH_3

Compound B, $C_{32}H_{52}O_2$ (M^+ 468), m.p. 143–145°, was dextrorotatory. It gave Liebermann–Burchard and tetranitromethane tests. IR spectrum indicated the presence of —OAc (1744 and 1242 cm^{-1}). NMR spectrum (in $CDCl_3$) showed a peak at δ 2·06 (3H) for an acetoxyl and a broad multiplet at δ 4·61 for a proton attached to a secondary and equatorial acetoxyl group. Saponification of B gave compound C which on acetylation gave back compound B.

Compound C, $C_{30}H_{50}O$ (M^+ 426), melted at 108–110° and was laevorotatory. Its spectra and properties agreed with those of butyrospermol and the identity was confirmed by direct comparison with an authentic sample from Professor Ritchie. Oxidation of compound C with CrO_3–HOAc gave butyrospermone. Therefore, Compound B is butyrospermol acetate. The mass spectral fragmentations of B and C agree with these structures. This is the first record of butyrospermol acetate from a natural source.

The insoluble fraction (*R*) of the acetone extract yielded cudrainaxanthone and compounds E, F and G. Compound E, m.p. 273–275° was identified as kaempferol. Compound F, m.p. 245–247°, gave brown ferric colouration and positive Mg–HCl and Zn–HCl tests. Dehydrogenation with I_2–KOAc yielded kaempferol. Its properties and spectra showed it to be aromadendrin. Compound G, $C_{21}H_{20}O_{11}$, m.p. 275–278°, gave Mg–HCl and Molisch's tests. Results of hydrolysis and permethylation followed by hydrolysis showed it to be populnin (kaempferol-7-glucoside). The alcohol extract when analysed by preparative TLC yielded cudraniaxanthone, kaempferol, aromadendrin and populnin.

The acetone extract of the 'stele' contained, apart from cudraniaxanthone, butyrospermol, its acetate, kaempferol, aromadendrin and populnin and a mixture of two other compounds H and J which were identified as quercetin and taxifolin respectively and confirmed by comparison with authentic samples. The alcohol extract contained a small quantity of cudraniaxanthone, moderate amounts of kaempferol and quercetin along with their dihydrocompounds and larger quantity of populnin as compared with the alcohol extract of the inner bark. Xanthone and terpenoids have now been obtained for the first time from *Cudrania* genus. The co-occurrence of the flavanols with their dihydro-derivatives is of biogenetic interest.

[4] E. D. BURLING, A. JAFFERSON and F. SCHEINMANN, *Tetrahedron* **21**, 2653 (1965).

EXPERIMENTAL

'Periderm' (200 g). *Acetone extract* (cudraniaxanthone, butyrospermol and its acetate). The solid extract was macerated with Et_2O in which it almost completely dissolved. The ether solution was treated with light petroleum yielding a pale yellow solid. It crystallized from CH_2Cl_2 as microcubes (180 mg) (compound A). The mother liquor contained two compounds (B and C) (80 mg) and was worked up along with that from the inner bark.

Compound A (*cudraniaxanthone*) (I). M.p. 308°, gave the following colour tests: neutral $FeCl_3$-intense green, conc. H_2SO_4-bright yellow, aq. NaOH-bright yellow. (Found: C, 66·9; H, 5·5; —OCH_3, 8·5. $C_{18}H_{15}O_5$ (OCH_3) requires C, 66·7; H, 5·3; —OCH_3, 9·0%.) λ_{max}^{MeOH} 254 (4·53), 283 (4·89), 327 (4·23) nm; +$AlCl_3$ 242, 257, 343 nm; +NaOAc 256, 287, 345 nm. ν_{max}^{KBr} 3230, 3030, 1653, 1626, 1550, 890 cm^{-1}. Significant MS peaks: *m/e* 342 (M^+, 86%), 327 (100), 313 (78), 311 (46), 299 (46), 287 (60), 286 (51) and 274 (68).

The compound (100 mg) was refluxed with $(CH_3)_2SO_4$ (0·5 ml) and K_2CO_3 (5 g) in acetone (100 ml) for 100 hr, yielding pale yellow plates of the complete methyl ether (II) (60 mg), m.p. 122–124°. It showed bluish grey UV fluorescence. (Found: C, 68·9; H, 6·6; —OCH_3, 31·5. $C_{18}H_{22}O_2$ (OCH_3)$_4$ requires C, 68·7; H, 6·3, —OCH_3, 32·3%); λ_{max}^{MeOH} 246, 276, 312 nm; ν_{max}^{KBr} 1650, 1600, 1580, 874 cm^{-1}. NMR spectral data agreed with those reported by Burling *et al.*[4] This complete methyl ether was identical with 1,3,5,6-tetramethoxy-2(1′,1′-dimethylallyl)xanthone (m.m.p., co-TLC and IR).

Alcohol extract did not give test for flavonoids or triterpenes.

Inner bark (500 g). *Acetone extract* (cudraniaxanthone, butyrospermol and its acetate, kaempferol, aromadendrin and populnin): The solid extract was macerated with petroleum ether leaving behind a residue (*R*). The macerate contained two components (B and C). It (200 mg) was combined with a similar mixture from the periderm and chromatographed over alumina. Earlier fractions of light petroleum elution brought out compound B while the later ones, compound C.

Compound B (*butyrospermol acetate*). Colourless needles, m.p. 143–145°, $[\alpha]_D^{25}$ +15° (c, 1·6, $CHCl_3$), gave Liebermann–Burchard and tetranitromethane tests. (Found: C, 82·4; H, 11·2. $C_{32}H_{52}O_2$ requires C, 82·1; H, 11·1%.) Its UV spectrum had no characteristic absorption. ν_{max}^{KBr} 2924, 1744, 1462, 1361, 1242, 1031, 842, 835 cm^{-1}. NMR spectrum in $CDCl_3$: δ 5·42 to 4·95 (2H, broad), δ 4·61 (1H, m), δ 2·05 (3H, s), δ 1·7 and 1·63 (6H, two doublets of J = 4 Hz. each) and δ 1·0 to 0·75 (18H, m). Significant MS peaks: *m/e* 468 (M^+, 20%), 453 (55), 438·5 (M*), 393 (32), 341·0 (M*), 255 (6), 121 (20), 109 (35) and 69 (100). Hydrolysis of B with 5% methanolic KOH yielded C.

Compound C (*butyrospermol*). Colourless plates from MeOH, m.p. 108–110°, $[\alpha]_D^{25}$ −9·84 (c, 1·9, $CHCl_3$). Found: C, 84·7; H, 11·4. $C_{30}H_{50}O$ requires C, 84·5; H, 11·7%.) It had UV, IR and NMR agreeing with those of butyrospermol. Significant MS peaks: *m/e* 426 (M^+, 16%), 411 (39), 396·5 (M*), 393 (8), 378·5 (M*), 255 (3), 121 (12), 109 (25) and 69 (100). Compound B was in complete agreement with an authentic sample of butyrospermol (m.m.p., co-TLC and IR). Acetylation (C_5H_5N–Ac_2O) of C yielded B. Oxidation (CrO_3–HOAc)[5] of B yielded butyrospermone, m.p. 78°.

The solid residue (*R*) was subjected to dry column chromatography[6] over silica gel and eluted with $CHCl_3$–MeOH (9:1). Earlier fraction yielded cudraniaxanthone (80 mg); later fractions yielded a mixture of two compounds (E and F) and last fractions compound G. Compounds E and F were separated by using a column of polyamide and eluting with alcohol. Compound E, m.p. 273–275°, (tetramethyl ether, m.p. 150–151°) was identified as kaempferol.

Compound F (*aromadendrin*). Colourless plates, m.p. 245–247° (Found: C, 62·6, H, 4·6. $C_{15}H_{12}O_6$ requires C, 62·5; H, 4·2%). It had properties and spectra agreeing with those of aromadendrin (dihydrokaempferol). Acetate (Ac_2O–C_5H_5N), m.p. 79–81°; trimethyl ether-3-acetate, m.p. 126–128°. Dehydrogenation of F using I_2 and KOAc gave kaempferol.

Compound G (*populnin*). Pale yellow cubes from MeOH, m.p. 275–278°, gave Molisch's test, dark red Mg–HCl and brownish green $FeCl_3$ colourations. (Found: C, 56·6; H, 4·8. $C_{21}H_{20}O_{11}$ requires C, 56·3; H, 4·5%.) Absorption spectra and shifts produced by reagents showed C_7-OH to be blocked. Boiling with 5% H_2SO_4 (3 hr), yielded kaempferol and glucose. Exhaustive methylation[7] of compound G followed by hydrolysis with 5% H_2SO_4 yielded a pale yellow solid, m.p. above 300°, which gave deep red Zn–HCl colouration; consideration of its absorption spectra and shifts caused by reagents indicated only C_7–OH free. 2,3,4,6-Tetramethylglucose was identified in the aqueous solution. Compound G was thus populnin (kaempferol-7-glucoside).

Alcohol extract (*cudraniaxanthone, kaempferol, aromadendrin and populnin*). The extract was analysed by preparative TLC using HCOOEt–HCOOH–toluene, 4:1:5. It contained 4 compounds identified as cudraniaxanthone (R_f 0·65), kaempferol (R_f 0·35), aromadendrin (R_f 0·3) and populnin (R_f 0·15).

'Stele' (500 g). *Acetone extract* (butyrospermol and its acetate, cudraniaxanthone, kaempferol, aroma

[5] I. Heilbron, E. R. H. Jones and P. A. Robins, *J. Chem. Soc.* 444 (1949).
[6] S. Natarajan, V. V. S. Murti and T. R. Seshadri, *Phytochem.* **9**, 575 (1970).
[7] S. Hakomori, *J. Biochem.* **55**, 205 (1964).

dendrin, quercetin, taxifolin and populnin). The extract was subjected to dry column chromatography over silica gel. $CHCl_3$ elution brought out butyrospermol and its acetete (50 mg each). Cudraniaxanthone (25 mg) was eluted by earlier fractions of $CHCl_3$–MeOH (9:1) elution. Later fractions yielded, apart from kaempferol and aromadendrin (50 mg each), a mixture (150 mg) of two compounds (H and J). Last fractions contained populnin (50 mg). Compounds H and J which were separated by passing through a column of polyamide and eluting with alcohol, were identified as quercetin and taxifolin respectively and confirmed with authentic specimens.

Alcohol extract (*cudraniaxanthone, kaempferol, aromadendrin, quercetin, taxifolin and populnin*). This extract was worked up in the same way as the acetone extract of the 'stele'. Cudraniaxanthone (20 mg), the flavonols and dihydroflavonols (50 mg each) and populnin (100 mg) were isolated.

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Key Word Index—Cudrania javanensis; Moraceae; xanthone; cudraniaxanthone; butyrospermol; flavonoids.