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A STUDY OF LEUCOANTHOCYANIDINS OF PLANTS—II[1]

(−)LEUCOCYANIDIN FROM THE GUM OF *BUTEA FRONDOSA*

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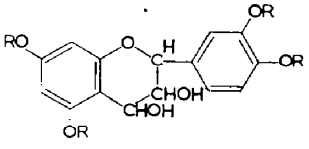
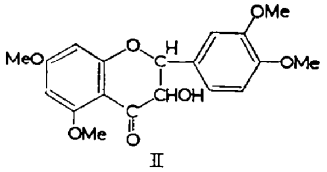
Abstract—A (+)leucocyanidin has been isolated from the gum of *Butea frondosa*, its acetate and methyl ether prepared and studied. The leucocyanidin is 5:7:3′:4′-tetrahydroxyflavan-3:4-diol. The methyl ether and the acetate have also been prepared by borohydride reduction of taxifolin tetramethyl ether and taxifolin respectively.

LEUCOCYANIDIN has now been extracted from the gum of *Butea frondosa* which was earlier used as a good source for the preparation of cyanidin chloride.[2] Leucocyanidin ($C_{15}H_{14}O_7$) is phenolic in character, dextrorotatory and gives all the reactions characteristic of a leucoanthocyanidin. With diazomethane it gives a tetramethyl ether which yields a diacetate showing the presence of two alcoholic groups. Oxidation of the tetramethyl ether with potassium permanganate yields veratric acd. Leucocyanidin reduces periodic acid indicating the presence of a diol grouping, and its infra-red spectrum has no C=O bond. Hence leucocyanidin of *Butea* gum should be represented as 5:7:3′:4′-tetrahydroxyflavan-3:4-diol (I).



I, R=H
III, R=Me



II

In the present investigation taxifolin tetramethyl ether (II) has been reduced by sodium borohydride (compare)[3] giving a mixture of two isomeric leucocyanidin tetramethyl ethers (III) m.p. 172° and 198° respectively. Both isomers give anthocyanidin chloride on boiling with alcoholic HCl, and do not give a coloration with ferric chloride. The higher melting isomer agrees with the tetramethyl ether of natural leucocyanidin and the infra-red spectra have similar bands in the region 2–12 μ. It is suggested that the higher melting isomer is the racemic form of the natural compound and the lower melting one is another of the possible racemic forms. It was not possible to obtain leucocyanidin in a pure condition by reduction of taxifolin; the product was converted into leucocyanidin hexa-acetate, which was also obtained from leucocyanidin by acetylation. Taxifolin penta-acetate has yielded a product which does not agree with the acetate of the natural compound.

[1] A. K. Ganguly, T. R. Seshadri and P. Subramanian, *Tetrahedron* **3**, 225 (1958).
[2] G. M. Robinson, *J. Chem. Soc.* 1157 (1937).
[3] T. Swain, *Chem. & Ind.* 1144 (1954).

EXPERIMENTAL

Isolation of leucocyanidin. The *Butea* gum was obtained from the Central Lac Research Institute, Ranchi. The powdered gum (600 g) was extracted successively with light petroleum and ether at room temp to remove wax. A small quantity of a pale yellow solid was obtained from the ether extract. It did not give any colour with magnesium or zinc and hydrochloric acid. In the Liebermann-Burchard reaction it gave a red colour changing to violet, green and finally to brown. The quantity of the substance was too small for further investigation.

The residual gum was extracted repeatedly with cold acetone, and the combined extracts were distilled under reduced pressure to remove the solvent almost completely. The viscous red liquid residue was repeatedly extracted with ethyl acetate, and the extract dried over anhydrous magnesium sulphate and then concentrated under reduced pressure. By gradual addition of light petroleum, coloured impurities were precipitated first and then with further addition of light petroleum, the leucocyanidin was obtained as a colourless solid. Repeated purification from a mixture of ethyl acetate and light petroleum yielded a crystalline powder (15 g). It darkened at 280° and did not melt at 355°. (Found: C, 55·2; H, 5·1; $C_{15}H_{14}O_7$, H_2O requires: C, 55·5; H, 4·9%). The product was insoluble in ether, chloroform and petroleum ether but was soluble in water, alcohol and acetone. With alcoholic HCl it developed a red colour in the cold which deepened on heating, and with alcoholic ferric chloride gave a green colour changing to blue on standing. In the ultra-violet region the alcoholic solution of the leucocyanidin had an absorption maximum at 285 mμ. The ethanolic solution was dextrorotatory, but definite values could not be obtained because the solution of the leucocyanidin developed colour rapidly.

Conversion into cyanidin chloride was effected following the procedure described for leucodelphinidin;[1] yield 10%. The anthocyanidin chloride gave a positive ferric reaction and a rose red colour when extracted with cyanidin reagent; R_f (circular) using phenol-water lower layer at 29°, 0·72. The ethanolic HCl solution had an absorption maximum at 544 mμ. Treatment of leucocyanidin (0·2 g) with acetic anhydride (4 cc) and dry pyridine (1 cc) in the cold for 48 hr yielded a colourless *acetate* (0·1 g) which crystallised from a mixture of ethyl acetate and light petroleum as colourless irregular prisms, m.p. 270° (d) sintering at 264°. (Found: C, 58·8; H, 5·0; $C_{27}H_{26}O_{13}$ requires: C, 58·1; H, 4·7%). It did not give any colour with alcoholic ferric chloride and with boiling alcoholic HCl it developed a red colour. The infra-red spectrum of the above *acetate* had the following main bands in microns: 5·70(s), 6·25(s), 6·68(m), 7·25(s), 8·25(w), 8·50(w). The leucoanthocyanidin (2 g) was methylated in methanol solution using diazomethane in the cold. The colourless *methyl ether* (1·5 g) crystallised from methanol as prisms, m.p. 198–200° sintering at 190°, $[\alpha]_D^{32}$ +125·2° (*c*, 0·2 in ethanol). (Found: C, 63·0; H, 6·1; $C_{19}H_{22}O_7$ requires: C, 63·0; H, 6·1%). It was insoluble in aqueous alkali and gave no ferric colour. The infra-red spectrum of leucocyanidin *tetramethyl ether* had the following main bands in microns: 2·95(s), 3·50(s), 6·27(s), 6·56(s), 7·90(m), 8·30(m), 8·70(w), 9·73(m). A colourless *acetate of the ether* was obtained using acetic anhydride and pyridine in the cold. It crystallised from a mixture of ethyl acetate and light petroleum as circular tablets m.p. 215–218°. (Found: C, 62·0; H, 5·5; $C_{23}H_{26}O_9$ requires: C, 61·9; H, 5·8%). Potassium permanganate was added to a boiling acetone solution of the *methyl ether* during the course of 4 hr. It was worked up as described previously.[1] The purified acid melted at 180–181°, alone or mixed with an authentic sample of veratric acid; R_f (circular) using butanol saturated with ammonia as solvent and bromophenol blue as developer at 30°C, 0·44; authentic sample of veratric acid under the same conditions gave R_f 0·44.

Periodic acid oxidation of leucocyanidin. An ethanolic solution of leucocyanidin (0·0066 M 1 cc) was allowed to react with periodic acid solution (0·0142 M 5 cc) for 24 hr at room temp. The reaction mixture was treated with excess potassium iodide solution and the liberated iodine titrated against standard arsenious oxide solution. For each mole of leucocyanidin 1·8 moles of periodic acid were consumed.

Reduction of taxifolin tetramethyl ether. To an ice cold solution of taxifolin tetramethyl ether (0·2 g) in methanol, sodium borohydride (60 mg) was added and after allowing the mixture to stand at room temp for 48 hr it was acidified with acetic acid and the solvent removed almost completely under reduced pressure and the residue kept in the vacuum desiccator over potassium hydroxide. The resulting colourless solid was washed with a little water, dried and crystallised from methanol; two fractions were obtained. The first (80 mg) on recrystallisation from ethanol yielded colourless needles, m.p. 171–172°. (Found: C, 62·8; H, 6·4; $C_{19}H_{22}O_7$ requires: C, 63·0; H, 6·1%); the

second (60 mg) gave colourless rectangular rods, m.p. 198° with previous sintering at 192°. (Found: C, 62·7; H, 5·9; $C_{19}H_{22}O_7$ requires: C, 63·0; H, 6·1%). The mixed m.ps. of both fractions with taxifolin tetramethyl ether were depressed. The second fraction did not depress the m.p. of the methyl ether of leucocyanidin obtained from butea gum.

Reduction of taxifolin. Taxifolin (0·15 g) was reduced in methanol solution using sodium borohydride (50 mg, excess) in the cold. It was worked up as above and the crude reduction product was acetylated using acetic anhydride and pyridine at room temp. The colourless acetate (0·1 g) crystallised from a mixture of ethyl acetate and light petroleum as clusters of small prisms m.p. 270° (d) with previous sintering at 263°, unaffected by admixture with natural leucocyanidin acetate (Found: C, 57·6; H, 4·7; $C_{27}H_{26}O_{13}$ requires: C, 58·1; H, 4·7%).

Reduction of taxifolin acetate. It was carried out using the acetate (0·2 g) in methanol solution and sodium borohydride (50 mg, excess). The product was acetylated using acetic anhydride and pyridine in the cold. The colourless hexa-acetate (0·1 g) was purified from a mixture of ethyl acetate and light petroleum, m.p. 204° with previous sintering at 190° (Found: C, 57·8; H, 5·0; $C_{27}H_{26}O_{13}$ requires: C, 58·1; H, 4·7%). It did not give a colour with alcoholic ferric chloride.