CCII.—*A Synthesis of Pyrylium Salts of Anthocyanidin Type. Part XVII. The Synthesis of Peonidin Chloride by Means of* O-*Benzoylphloroglucinaldehyde.*

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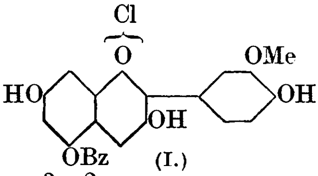
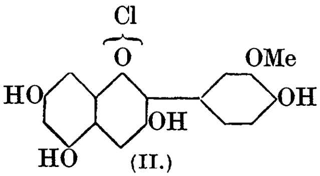
THE synthesis of peonidin chloride described by Nolan, Pratt, and Robinson (J., 1926, 1968) was a satisfactory proof of the constitution of the anthocyanidin, but the yield was poor and the purification of the salt was difficult to effect.

We have now found that a considerable improvement may be brought about by the substitution of *O*-benzoylphloroglucinaldehyde for the *O*-triacetylphloroglucinaldehyde previously employed.

5-O-*Benzoylpeonidin chloride* (I) is the product of the condensation of *O*-benzoylphloroglucinaldehyde and ω : 4-diacetoxy-3-methoxyacetophenone, $(AcO)(OMe)C_6H_3 \cdot CO \cdot CH_2 \cdot OAc$, by means of hydrogen chloride in ethyl acetate solution.



(I.)



(II.)

The hydrates $C_{23}H_{17}O_7Cl,0{\cdot}5H_2O$ and $C_{23}H_{17}O_7Cl,3H_2O$ were isolated and the alkali-colour-reaction of the salt closely resembles that of peonin chloride.

De-benzoylation by the usual method furnished peonidin chloride (II), of which three forms were analysed, namely, $C_{16}H_{13}O_6Cl,H_2O$ and two modifications of the hydrate $C_{16}H_{13}O_6Cl,1{\cdot}5H_2O$. We are very grateful to Professor R. Willstätter for kindly sending us a specimen of peonidin chloride of natural origin (Willstätter and Nolan, *Annalen*, 1915, **408**, 136). A comparison of the reactions of the natural and the synthetic specimen disclosed no differences, but the crystal habit and solubility relations could only be equated after drastic purification of the anthocyanidin from peonin. In the course of work in the flavylium salt group it has frequently been noticed that small traces of persistent impurities completely alter the behaviour of anthocyanidins, and Willstätter and his collaborators have directed attention to this on several occasions.

EXPERIMENTAL.

5-O-*Benzoylpeonidin Chloride* (I).—A solution of *O*-benzoylphloroglucinaldehyde (2·94 g.) and ω : 4-diacetoxy-3-methoxyacetophenone (2·58 g.) (Nolan, Pratt, and Robinson, *loc. cit.*) in ethyl acetate (75 c.c.) was cooled in running water and saturated with hydrogen chloride. Bright red crystals separated after 2 hours and after being kept over-night the salt was collected, washed with ethyl acetate and ether, and dried in the air (yield, 3·55 g., and 1·22 g. of darker crystalline material by the addition of ether to the mother-liquor) (Found : C, 61·1 ; H, 4·1 ; Cl, 7·3 ; loss at 110° in a vacuum over phosphoric oxide, 2·1. $C_{23}H_{17}O_7Cl,0{\cdot}5H_2O$ requires C, 61·4; H, 4·0; Cl, 8·0; H_2O, 2·0%). The scarlet needles are readily soluble in methyl and ethyl alcohols to crimson solutions that become violet on dilution with more alcohol and colourless on great dilution and warming. The pink colour is quickly and quantitatively regenerated on the addition of hydrochloric acid. Boiling distilled water is not coloured by this salt, which is also very sparingly soluble in hot 0·5% hydrochloric acid. The solution in aqueous sodium carbonate is pure blue, greenish-blue in thin layers and purplish-blue in thick layers. The dichroism is barely perceptible by daylight, but by artificial light (metal filament) it is marked and the colour of the solution appears reddish-violet. This contrast has been frequently noticed and it should be understood that all the colorations mentioned in this series of papers have been observed in daylight. Sodium acetate added to an acid alcoholic solution gives a violet coloration and on the addition of water the pseudo-base is quickly formed.

The red crystals (1 g.) were dissolved in methyl alcohol (about 80 c.c.) at 50—60° and warm 15% hydrochloric acid (about 10 c.c.) was added. On keeping short, stout, glistening beetle-green prisms separated; these were yellowish-brown by transmitted light and gave a violet-red smear on paper (Found : C, 56·5; H, 4·7; Cl, 7·3; loss at 160° in a vacuum over phosphoric oxide, 10·9. $C_{23}H_{17}O_7Cl,3H_2O$ requires C, 55·8; H, 4·7; Cl, 7·2; H_2O, 10·9%). The behaviour towards reagents was the same as that of the red crystals.

3 : 5 : 7 : *4'-Tetrahydroxy-3'-methoxyflavylium Chloride* (*Peonidin Chloride*) (II).—5-*O*-Benzoylpeonidin chloride (5 g.) was added to 8% aqueous alcoholic (50 c.c. of water and 75 c.c. of alcohol) sodium hydroxide with cooling, and the solution allowed to remain for 3 hours at room temperature; air was excluded by means of nitrogen and the mixture was occasionally shaken. After the addition of concentrated hydrochloric acid (100 c.c.), the whole was heated at 60° for some time and then cooled and kept in the ice-chest for 12 hours. The chocolate-brown precipitate was collected, washed with dilute hydrochloric acid and ether, and dried in the air.

(A). The crude product was dissolved in hot 1% hydrochloric acid, and concentrated hydrochloric acid added so as to bring the concentration of acid to 20%. Crystallisation was rapid and the dark violet product was seen under the microscope to consist of brown, prismatic needles (Found in air-dried material: C, 54·0; H, 4·6; loss at 110° in a vacuum, 4·8. $C_{16}H_{13}O_6Cl,H_2O$ requires C, 54·2; H, 4·2; H_2O, 5·1%). Willstätter and Nolan (*loc. cit.*) crystallised peonidin chloride from 20% hydrochloric acid and found that the product was a monohydrate.

(B). The chocolate-brown crystalline powder separating from 1% hydrochloric acid was dried in the air (Found: C, 52·3; H, 4·5; Cl, 9·9; loss at 110° in a vacuum, 7·4. $C_{16}H_{13}O_6Cl,1{\cdot}5H_2O$ requires C, 52·8; H, 4·4; Cl, 9·8; H_2O, 7·4%).

(C). The crude salt (1 g.) was dissolved in ethyl alcohol (70 c.c.) at 60—70°, and hot 10% hydrochloric acid (20 c.c.) added to the solution. After a few hours, glistening rhombohedra having a brilliant blue reflex separated; the crystals were yellowish-brown when viewed by transmitted light (Found: C, 52·4; H, 4·6; Cl, 9·2; loss at 110° in a vacuum, 7·5%. Theory as above).

The reactions of the three specimens analysed were identical and they were also found to be identical with those of the material of natural origin. The latter was dissolved in 0·5% hydrochloric acid, and the acid concentration brought to 3%. The crystals were collected and converted into the picrate, which was crystallised from a little methyl alcohol. The chloride recovered from the picrate was crystallised from hot dilute hydrochloric acid by bringing the concentration of hydrogen chloride to 20% and closely resembled our specimen (A) in appearance and crystalline form. A solution of either specimen of the salt (5·0 mg.) in 10 c.c. of alcohol had a bright eosin-red colour tinged with violet; after dilution to 50 c.c., the colour by transmitted light was yellower, duller, and deeper, but thin layers had a bluer cherry-red colour : dilution to 150 c.c. gave a cherry-red solution (S), and 20 c.c. of this diluted to 100 c.c. gave a violet solution the colour of which faded slowly on the addition of an equal volume of water. Addition of sodium acetate to (S) gave a dichroic solution, blue in thin layers, reddish-violet in thick layers, and apparently exhibiting a red fluorescence which is probably an effect of the dichroism. Quantitative colorimetric comparisons showed that at all stages the solutions were identical. Similarly, 5 mg. of each of the specimens were dissolved in 10 c.c. of saturated aqueous sodium carbonate; dilution to 100 c.c. gave a pure blue dichroic solution (violet in thick layers) (T) and dilution to 1000 c.c. gave a greenish-blue solution the dichroism of which was not evident. The two specimens behaved alike and were in this case also compared colorimetrically. The alcoholic solutions (S) gave no coloration on the addition of ferric chloride. A quantitative comparison of the rate of pseudo-base formation and the extent of recovery of pyrylium salt on acidification and heating was also carried out with the result that no differences could be detected. 10 C.c. of a dilute solution of hydrogen peroxide were added to 5 c.c. of the alkaline solutions (T); the colour faded, became green and then yellow, both specimens behaving alike. Many other comparisons were carried out and the only difference noted was that we could not crystallise the specimen of natural origin in the form noted above under (C). We therefore purified it once again through the picrate and the recovered chloride now crystallised from alcohol and 10% hydrochloric acid in more prismatic needles and exhibited a greenish-brown glance. After three more crystallisations a small amount of material of definitely prismatic habit and showing, although in a less well-defined manner, the crystalline form of the specimen (C) and having a green reflex was obtained. We are of the opinion that the anthocyanidins derived from natural sources are sometimes not quite pure and in the case of peonidin the impurity is probably malvidin.

By the addition of a trace of malvidin chloride (synthetic) to the specimen (C) (above) we found that we had obtained a material crystallising under the (C) conditions first indefinitely as a chocolate-brown powder and then in needles, exactly as *natural* peonidin chloride does. Under comparable conditions pure peonidin chloride is much more readily soluble in cold 0·1% hydrochloric acid than in

0·5% hydrochloric acid. The finally purified natural anthocyanidin and the specimen C behaved identically towards these reagents and this was confirmed colorimetrically with the solutions in 0·5% hydrochloric acid.

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