

[CONTRIBUTION FROM FOOD RESEARCH DIVISION, BUREAU OF CHEMISTRY AND SOILS, U. S. DEPARTMENT OF AGRICULTURE]

The Occurrence of a Pentamethyl Flavonol in Tangerine Peel

By E. K. NELSON

Tangerine oil was expressed in the U. S. Citrus Products Laboratory in Winter Haven, Florida, by pressing the peel of Dancy tangerines (*Citrus nobilis deliciosa*) in a Pipkin oil machine and centrifuging the expressed liquid. On long standing in a refrigerator a yellow precipitate formed in the oil, and after the limonene had been removed by distillation at 10 mm. and the terpeneless oil had been cooled, more of the precipitate formed. Altogether 5 g. of precipitate was obtained from 1560 cc. of this oil.

This precipitate is partly crystalline. Recrystallized from alcohol and finally several times from ethyl acetate, the crystalline substance was obtained in the form of white needles, with a slight tinge of yellow. As investigation of this substance showed that it had not hitherto been found in a natural product, nor elsewhere described, the name *tangeretin* has been assigned to it.

Tangeretin melts at 154° (corr.). It is soluble in benzene, from which it is precipitated on the addition of petroleum ether. It is soluble in hot alcohol or hot ethyl acetate, crystallizing from these solvents at low temperatures. It is optically inactive and contains no nitrogen. With concentrated hydrochloric acid it forms an oxonium salt, which crystallizes from that solvent in yellow needles. On the addition of water these split off hydrochloric acid. Mixed with warm, concentrated nitric acid the crystals dissolve with a blood-red color.

Tangeretin is insoluble in a 10% solution of sodium hydroxide. When boiled with acetic anhydride and a little anhydrous sodium acetate, the substance is unchanged. Analysis shows that tangeretin is isomeric with pentamethylquercetin and that it contains five methoxyl groups.

Anal. Calcd. for $C_{20}H_{20}O_7$ ($C_{15}H_5O_2(OCH_3)_5$): C, 64.49; H, 5.42; OCH_3 , 41.67; mol. wt., 372. Found: C, 64.30, 64.64; H, 5.45, 5.43; OCH_3 (Clark's modification of the Vieböck-Schwappach method), 41.47, 41.92; mol. wt. (in benzene), 364, 362, 384.

Optical Crystallographic Properties.—Tangeretin consists of colorless rods and needles. In parallel polarized light (crossed nicols), the extinction is straight and inclined and the sign of elongation is negative. The double refraction is extremely strong. The refractive indices as determined statistically (immersion method) are: n_α 1.480

(common, and shown lengthwise on rods); n_β indeterminate; n_γ considerably higher than 1.737 (CH_2I_2); an intermediate index n_i 1.525 also frequently shown lengthwise on rods $n_\gamma - n_\alpha < 0.257$; all ± 0.003 .

One gram of tangeretin was hydrolyzed by heating for eight hours on the water-bath with 50 cc. of a 20% solution of potassium hydroxide in 50% alcohol.¹ Most of the alcohol was removed by evaporation, water was added and the solution was saturated with carbon dioxide. The separated material was then extracted by ether and an oil, tangeretol, was obtained. Tangeretol did not crystallize on keeping for some time in a refrigerator. An alcoholic solution of tangeretol gives an olive-green color with ferric chloride. A crystalline oxime was obtained by heating tangeretol with an alcoholic solution of hydroxylamine hydrochloride and anhydrous sodium acetate on the water-bath.² Tangeretol oxime, crystallized from a mixture of carbon disulfide and petroleum ether, melts at 89°. The oxime was used for analysis.

Anal. Calcd. for $C_{12}H_{17}O_6N$ ($C_8H_5O_2N(OCH_3)_4$): C, 53.11; H, 6.32; N, 5.17; OCH_3 , 45.76. Found: C, 53.14; H, 6.32; N, 4.82; OCH_3 , 45.6.

The alkaline solution from which the tangeretol had been removed was acidified with hydrochloric acid. A crystalline acid separated, which was recrystallized from its solution in boiling water in the form of white needles. It was very sparingly soluble in cold water; neut. eq., 154.4; m. p. 184°. A mixture with anisic acid gave no depression in melting point. Its identity with anisic acid was further shown by optical crystallographic examination in comparison with the known substance.

Tangeretin was demethylated by boiling with hydriodic acid and phenol. The demethylated tangeretin is a yellow microcrystalline substance with a high melting point. At 325° it becomes quite black but does not melt.

Reduction with magnesium ribbon in an acidified alcoholic solution develops a pinkish-red color (flavonol reaction).

Addition of an alcoholic solution of lead acetate to its alcoholic solution gives an orange colored precipitate which changes at once to greenish-brown. With ferric chloride the alcoholic solution gives a bluish-green color.

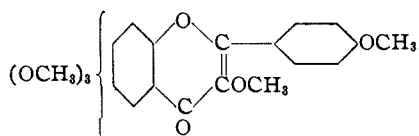
Tangeretin was also extracted by petroleum ether along with the volatile oil from dried and ground peel of Dancy tangerines. None could be obtained by a similar extraction of Sampson tangelo peel. The tangelo is a hybrid of the grapefruit and tangerine, but the skin is yellow like the grapefruit rather than orange like the tangerine, and tangeretin appears to be lacking in it.

Discussion

All the reactions and data thus far established

- (1) Herzig and Hoffman, *Ber.*, **42**, 155 (1909).
- (2) Lapworth and Steele, *J. Chem. Soc.*, **99**, 1884 (1911).

indicate that tangeretin is a substance of the flavonol type of the structure



It seems to be the first instance reported of a fully methylated flavonol occurring in nature.

Tangeretol, formed together with anisic acid by the hydrolysis of tangeretin, is isomeric with gossypitol tetramethyl ether.³

(3) Perkin, *J. Chem. Soc.*, **103**, 650 (1913).

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Summary

A pentamethylflavonol, tangeretin, has been isolated from tangerine peel. On alkaline hydrolysis anisic acid and a tetramethyl keto phenol (tangeretol) were obtained. Tangeretol is isomeric with gossypitol tetramethyl ether.

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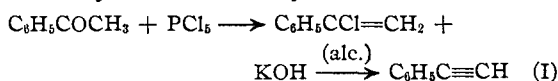
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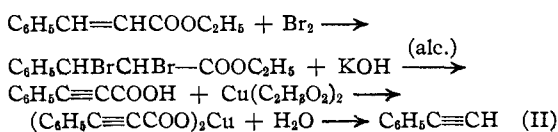
The Preparation and Properties of Substituted Phenylacetylenes and Di-phenylethyne Mercurys

By M. M. Orto

In some research work it was necessary to have samples of ortho-, meta- and para-halogen and para-alkyl substituted phenylacetylenes. The literature revealed that *p*-methylphenylacetylene,¹ *p*-ethyl- and *p*-isopropylphenylacetylenes,² *p*-bromophenylacetylene,³ and *o*-chlorophenylacetylene,⁴ had been prepared. The best methods of preparation were of two distinct types. The first may be illustrated by the reactions



The second type is illustrated by the set of reactions



By the use of either of these two general methods, *o*-, *m*- and *p*-bromo- and chlorophenylacetylene, *p*-methyl-, *p*-ethyl- and *p*-isopropylphenylacetylene were prepared. Their physical properties, together with those of the compounds in the literature, and type procedure are listed in Table I. As a step in making some of these acetylenes, three new phenylpropionic acids, namely, *m*-chloro-, *m*-bromo- and *o*-bromo-

phenylpropionic acids were prepared. These were purified and analyzed. The analyses for halogen⁶ and the physical properties are given in Table II.

As a means of identifying acetylenes, Johnson and McEwen⁶ have shown that the mercury derivative is very useful. All of the acetylenes of Table I were converted to these compounds, melting points determined, and analyses performed.⁷ The results are given in Table III.

TABLE I
PROPERTIES OF SUBSTITUTED PHENYLACETYLENES

Phenylacetylene	Procedure	B. p., °C.		n_D^{25}	d_4^{25}	MR _D
		m. p., °C.				
<i>p</i> -Methyl	I	65-67	18 mm.	1.5447	0.9159	39.14
<i>p</i> -Ethyl	I	72-74	16 mm.	1.5360	.9088	44.62
<i>p</i> -Isopropyl	I	79-81	12 mm.	1.5296	.9037	49.23
<i>p</i> -Chloro ^a	I	M. p. 43.5-44	
<i>m</i> -Chloro ^a	II	64-65	12 mm.	1.5610	1.1046	39.11
<i>o</i> -Chloro	II	71	18 mm.	1.5690	1.1249	39.76
<i>p</i> -Bromo	I	M. p. 63.5-63.7	
<i>m</i> -Bromo ^a	I	85-86	16 mm.	1.5896	1.4466	43.18
<i>o</i> -Bromo ^a	I	92-93	20 mm.	1.5962	1.4434	42.66

^a New compounds.

TABLE II
PROPERTIES OF SUBSTITUTED PHENYLPROPIOLIC ACIDS

Phenylpropionic acid	M. p., °C.	Halogen, %	
		Calcd.	Found
<i>o</i> -Chloro	131-132	19.09	19.19
<i>m</i> -Chloro ^a	140-141	19.09	18.93
<i>o</i> -Bromo ^a	118-119	35.52	35.09
<i>m</i> -Bromo ^a	135-136	35.52	35.29

^a New compounds.

(1) (a) Kunczell and Gotsch, *Ber.*, **33**, 2657 (1900); (b) Urbain and Delephine, *Ann. chim.*, **10**, 427 (1931).

(2) Kunczell and Koritzsky, *Ber.*, **33**, 3262 (1900).

(3) Dufraisse and Desquesnes, *Bull. soc. chim.*, **49**, 1880 (1931).

(4) Bergmann and Bondi, *Ber.*, **66**, 278 (1933).

(5) Vaughn and Nieuwland, *Ind. Eng. Chem., Anal. Ed.*, **3**, 274 (1931).

(6) Johnson and McEwen, *This Journal*, **48**, 471 (1926).

(7) Tabern and Shelberg, *Ind. Eng. Chem., Anal. Ed.*, **4**, 401 (1932).