

final, and it is necessary to subject the vinegar to further treatment before a conclusion regarding the presence of caramel can be reached.

BUREAU OF CHEMISTRY, U. S. DEPT. OF. AGR.

[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF HARVARD COLLEGE.]

HYDRAZONES OF AROMATIC HYDROXYKETONES. ALKALI-INSOLUBLE PHENOLS.

PRELIMINARY PAPER.

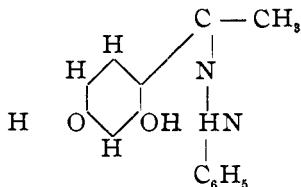
By HENRY A. TORREY AND H. B. KIPPER.

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The study of the action of phenylhydrazine upon aceto- and benzophenones carrying an hydroxyl group in the ortho position to the side chain seemed to us a reaction of some interest, since the possibility suggested itself that, under some conditions, in addition to the attack on the ketone group the hydroxyl of the ring might be made to react with the imide hydrogen thus forming a five-membered ring, calling to mind the action of phenylhydrazine on acetacetic ester.

Although thus far we have been unable to obtain such a secondary condensation, the hydroxyl group in the ortho position is affected in its properties by the formation of the hydrazones, since though these products supposably contain a free hydroxyl group they are insoluble in alkalis. Other examples of substances containing the hydroxyl group which are insoluble or difficultly soluble in alkalis are not entirely wanting. M. Rogow¹ has prepared some phenols which are insoluble in alkalis; he obtained for instance, a compound by the action of naphthylamine on vanillin which shows this property. In his paper he cites similar cases discovered by other observers, among them the case of chief interest to us is the observation by O. Anselmino² that the phenylhydrazone of homosalicylaldehyde is insoluble in aqueous alkalis.

The hydrazones which we have chiefly studied are those of dihydroxy-aceto- and benzophenones, such as resacetophenone, dibenzoresorcinol and dibenzohydroquinone. The hydrazone³ of resacetophenone⁴ made by the action of phenylhydrazine on resacetophenone, is, as would naturally be expected soluble in alkalis, while paeonol, the monomethyl ether of resacetophenone, in which the only free hydroxyl group is ortho to the keto side chain,

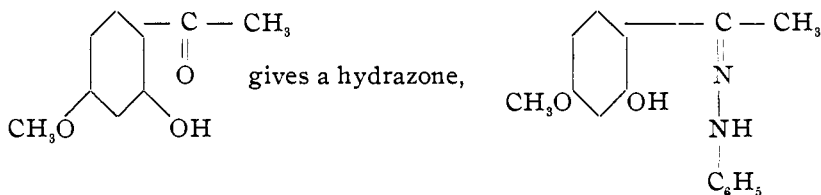


¹ J. pr. Chem. 2, 72, 315.

² Ber. 35, 4099.

³ Ann. chim. pharm. 7, 276. Bl. 36, 154.

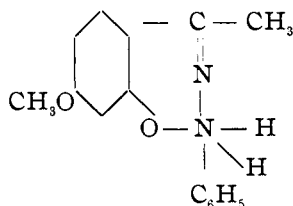
⁴ J. pr. Chem. 2, 23, 147, 537.



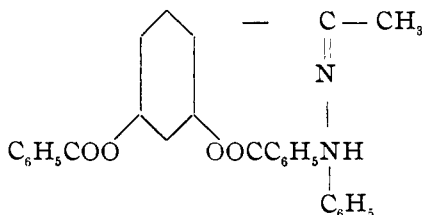
which is insoluble in alkalis, though from its method of formation it would appear to have a free hydroxyl group.

This same hydrazone was obtained by the action of dimethyl sulphate in alkaline solution on the hydrazone of resacetophenone, showing that only one hydroxyl group is methylated by this process, and that one which is farthest from the side chain.

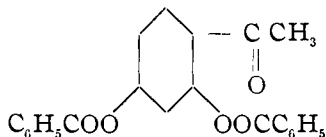
The insolubility in alkalis of the hydrazone of paeonol suggests to one that either the hydroxyl group has formed with the imide nitrogen of the hydrazone grouping a six-membered ring after the manner of an internal salt, or that the introduction of the basic phenylhydrazone group results in the formation of such a weak acid, that the salt, if formed at all is hydrolyzed by the water.



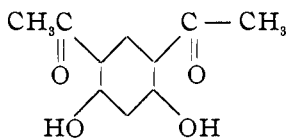
Regarding this question it may be said that the hydrazone of resacetophenone itself reacts with *two* molecules of benzoyl chloride giving a dibenzoate, which is a derivative in which the benzoyl groups have replaced the hydrogens of both hydroxyls as is made evident by the fact



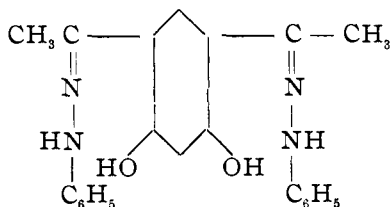
that the same hydrazone is formed by the action of phenylhydrazine on the dibenzoate of resacetophenone



From the monoacetate of resacetophenone a hydrazone is obtained which dissolves only slowly in alkalis with simultaneous saponification. Attempts to obtain the corresponding diacetate resulted in the formation of a thick viscous product, whether phenylhydrazine was allowed to react on the resacetophenone diacetate or acetic anhydride on the hydrazone of resacetophenone. From resodiacetophenone, in which each hy-



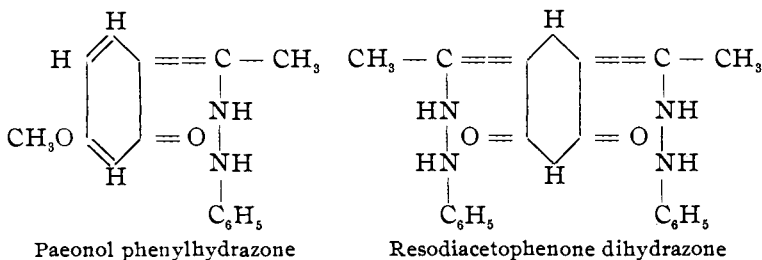
droxyl is ortho to a ketone side chain two molecules of phenylhydrazine give a dihydrazone which, as might be predicted from the action of the



hydrazone of paeonol, is also insoluble in aqueous alkalis. This hydrazone is insoluble in aqueous solutions of sodium or potassium hydroxide, even when as concentrated as 1 : 1. When it is allowed to stand for several weeks in this concentrated alkali or when gently heated for some time with the same, a white compound is formed which contains potassium, but which on simply treating with water goes over to the yellow hydrazone. These hydrazones, however, which show an insolubility in aqueous alkalis, are soluble in potassium alcoholate, but water in sufficient excess hydrolyzes the salt and the original compound is precipitated.

Another possible way of explaining the insolubility of these compounds is that they have a quinoid structure, and no hydroxyl group is actually present.

Thus the phenylhydrazone of paeonol and the dihydrazone of resodiacetophenone may be :



Preparation of the Phenylhydrazone of Paeonol by the action of dimethyl sulphate on the phenylhydrazone of resacetophenone.—One molecule of the phenylhydrazone of resacetophenone, obtained by the action of phenylhydrazine on resacetophenone, was treated with slightly more than one molecule of dimethyl sulphate in alkaline solution, with continued shaking. A colorless compound melting at 108° was obtained. This product was identical in properties with the body obtained from paeonol by the action of phenylhydrazine, according to the method of Tiemann.¹ It is *insoluble* in aqueous alkalis.

Analysis of the compound gave the following results: 0.1826 gram substance gave 0.4689 gram CO_2 and 0.1042 gram H_2O . Calculated for $\text{C}_6\text{H}_5(\text{OH})(\text{OCH}_3)\text{C}.\text{CH}_3\text{N}_2\text{HC}_6\text{H}_5$, C, 70.31; H, 6.25; found, C, 70.03; H, 6.34.

Dibenzoate of the phenylhydrazone of resacetophenone.—This compound could be obtained either by the action of phenylhydrazine on resacetophenone dibenzoate or by the action of benzoyl chloride on the hydrazone of resacetophenone dissolved in alkalis. The pure substance melted at 183° . It is soluble in hot alcohol and but slightly in cold alcohol, soluble in benzene and in acetic acid. It was purified by crystallization from alcohol. The two methods of preparation and the analytical results show the body to be the phenylhydrazone of resacetophenone dibenzoate.

Calculated for $\text{C}_6\text{H}_5(\text{OOC}\text{C}_6\text{H}_5)_2\text{C}.\text{CH}_3\text{N}_2\text{HC}_6\text{H}_5$, C, 74.67; H, 4.89; N, 6.22, found C, 74.81; H, 5.56; N, 6.98.

Resacetophenone dibenzoate.—One molecule of resacetophenone together with two molecules of benzoyl chloride was heated on the steam bath for about one hour and then for about fifteen minutes in an oil-bath at a temperature of 170° – 180° . The free benzoic acid and resacetophenone were removed with dilute ammonia water, and the dibenzoate was purified by crystallization from alcohol. During the crystallization the solution was kept out of contact with the moisture of the air to prevent the crystals deposited from becoming gummy. The dibenzoate of resacetophenone is insoluble in water, but soluble in alcohol, ether, benzene and acetic acid.

Calculated for $\text{C}_6\text{H}_5\text{COCH}_3(\text{OOC}\text{C}_6\text{H}_5)_2$, C, 73.33; H, 4.44; found C, 73.38; H, 5.28.

Action of Phenylhydrazone on Resodiacetophenone. 2,4-Dihydroxy-1-5-diacetophenone bisphenylhydrazone.—The resodiacetophenone was made from resacetophenone by treating it with zinc chloride dissolved in glacial acetic acid and phosphorus oxychloride. Eijkman² has recently made a dihydroxydiacetophenone by a slightly different method in which he shows the hydrogen groups are in the 2,4 position and the aceto in the 1,5

¹ Ber. 24, 2854.

² Chem. Centr. (1904), 1597, and (1905), 814.

position and we have found that the method used by us results in the formation of the same substance, leaving no doubt that the resodiacetophenone used by us is a 2,4-dihydroxy-1,5-diacetophenone. This substance was best obtained by the addition of slightly more than two molecules of phenylhydrazine to one of resodiacetophenone dissolved in hot alcohol. On cooling, an almost quantitative yield of the yellow needles of the hydrazone was given. P. Crespieux,¹ who also describes this substance, used a mixture of alcohol and acetic acid as a solvent and gives its melting point as 231°. We also carried out the reaction in a mixture of alcohol and acetic acid, but obtained the same compound as before, melting at 291°. It is possible that the figure 231° is a typographical error. The phenylhydrazone of resodiacetophenone is slightly soluble in hot alcohol and chloroform and readily soluble in hot aniline, quinoline, nitrobenzene, diethyl oxalate and acetic acid. It may be recrystallized from aniline or monobrombenzene. It is *insoluble* in concentrated aqueous solutions of sodium or potassium hydroxide.

Calculated for $C_6H_2(OH)_2(C_6H_5N_2HC_6H_5)_2$, C, 70.59; H, 5.88; N, 14.97; found C, 70.40; H, 6.05; N, 14.10.

Action of Phenylhydrazine on Dibenzohydroquinol. 1,4-Dihydroxydibenzophenone bisphenylhydrazone.—This substance was obtained by heating on the steam-bath one molecule of dibenzohydroquinol and about two molecules of phenylhydrazine dissolved in a mixture of dilute alcohol and acetic acid for a half hour. The reaction mixture was cooled and an excess of water added. After filtration any unchanged dibenzohydroquinol was dissolved out with alkali and the hydrazone was crystallized from dilute alcohol. It is a yellow crystalline body melting at 172°–4 with decomposition; it is *insoluble* in alkali, although decomposition takes place on boiling with strong potassium hydroxide. A nitrogen determination gave 10.90 per cent. N. Calculated for $C_6H_2(OH)_2(C_6H_5N_2HC_6H_5)_2$, 11.24 per cent.

Action of Phenylhydrazine on Dibenzoresorcinol. 1,3-dihydroxydibenzophenone bisphenylhydrazone.—The preparation of this substance was carried out under conditions entirely similar to those used in making the corresponding body from dibenzohydroquinol. Crystallized from benzene it gave white crystals melting at 292°–3°. It is soluble in alcohol, chloroform and glacial acetic acid, somewhat soluble in cold benzene and considerably more so in the hot solvent. It is *insoluble* in ammonia and the alkalis. A nitrogen determination gave 11.02 per cent. N; calculated for $C_6H_2(OH)_2C_6H_5N_2HC_6H_5)_2$, 11.24 per cent.

The study of these and similar compounds is being continued in this laboratory.

CAMBRIDGE, Nov. 6, 1906.

¹ Bull. [3], 6, 152.