described above. When hot alcoholic solutions of the base and picric acid were mixed, a flocculent yellow precipitate consisting of fine needles of the picrate separated. This was washed with water and recrystallized from alcohol, from which it slowly separates as fine, light yellow, feathery needles, m. p. 210°.

*Anal.* Calcd. for $C_{15}H_{13}ON_3$: C, 71.68; H, 5.22. Found: C, 72.08; H, 5.15.

**Preparation of 2-Anilino-4-ethoxyquinazoline** (VI).—This compound was prepared in essentially the same way as the methoxy derivative just described. Ethyl alcohol was employed and the coagulation of the precipitate obtained on pouring the mixture into water was a matter of days rather than hours. One gram of 2-anilino-4-ethoxyquinazoline hydrochloride and 0.3 g. of sodium in 25 cc. of alcohol gave 0.85 g. of the crude precipitated base, which was recrystallized from 50% alcohol.

This compound separates as colorless glistening plates, m. p. 110–111°, somewhat larger than the crystals of 2-anilino-4-methoxyquinazoline. Its solubilities are the same as those given for the last-named substance. Addition of hydrochloric acid regenerated the hydrochloride but attempts to form an addition product with methyl iodide were unsuccessful. The picrate, prepared in the manner outlined above, crystallized from alcohol in rosets of coarse yellow needles, m. p. 183°; glossy needles were obtained on slow evaporation of the solvent.

*Anal.* Calcd. for $C_{16}H_{15}ON_3$: C, 72.41; H, 5.70. Found: C, 72.67; H, 5.81.

## Summary

Aniline has been found to react with 2-chloro-4-ketodihydroquinazoline and with 2-chloro-4-alkoxyquinazolines to yield 2-anilino-4-ketodihydroquinazoline and hydrochlorides of 2-anilino-4-alkoxyquinazolines, respectively. The constitutions of 2-chloro-4-alkoxyquinazolines and of 2-chloro-4-ketodihydroquinazoline are demonstrated by their conversion into the known 2-anilino-4-ketodihydroquinazoline. The following new compounds have been prepared: 2-anilino-4-methoxyquinazoline, 2-anilino-4-ethoxyquinazoline and their picrates and hydrochlorides.

CLEVELAND, OHIO

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[CONTRIBUTION FROM THE RESEARCH LABORATORIES OF THE BUREAU OF DAIRY INDUSTRY, UNITED STATES DEPARTMENT OF AGRICULTURE]

# BETA-SULFHYDRYL-BETA-PHENYLPROPIOPHENONE

BY BEN H. NICOLET

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The writer has recently[1] had occasion to examine certain β-mercapto ketones of the type $C_6H_5CH(SR)CH_2COR'$, particularly from the point of view of their instability toward alkaline reagents. These ketones were readily obtained by the addition of mercaptans to α,β-unsaturated ketones in the presence of alkalies. To use β-*p*-tolylmercapto-β-phenylpropiophenone as an example, two characteristic reactions are as follows: (a) with alkali, easy loss of tolyl mercaptan to form benzalacetophenone; (b) with phenylhydrazine, easy loss of the mercaptan to form 1,3,5-triphenylpyrazoline.

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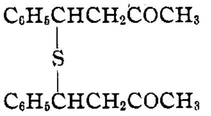
[1] Nicolet, THIS JOURNAL, **53**, 3066 (1931).

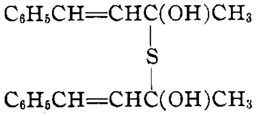
An examination of the literature failed to reveal any β-sulfhydryl ketone ($RCH(SH)CH_2COR'$) described as such, but some work by Fromm attracted attention. He described[2] the condensation with benzalacetone and benzalacetophenone, of sodium sulfide, disulfide and hydrosulfide, processes which should presumably be analogous to the addition of alkali mercaptides to these same ketones. The structures he assigned to the products obtained were, however, rather unusual and require discussion here.

For his "duplobenzylideneacetone monosulfide," for example, he considered and rejected Formula I, and chose instead Formula II.



$$\begin{array}{l} C_6H_5CHCH_2COCH_3 \\ \quad\;\; | \\ \quad\;\; S \\ \quad\;\; | \\ C_6H_5CHCH_2COCH_3 \end{array}$$

I



$$\begin{array}{l} C_6H_5CH{=}CHC(OH)CH_3 \\ \qquad\qquad\quad | \\ \qquad\qquad\quad S \\ \qquad\qquad\quad | \\ C_6H_5CH{=}CHC(OH)CH_3 \end{array}$$

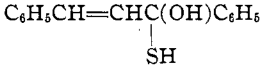
II

For this choice he gave two reasons: (a) the substance was readily decomposed by alkali, regenerating benzalacetone; (b) it reacted with phenylhydrazine, with loss of hydrogen sulfide, and yielded benzalacetonephenylhydrazone. One point against Formula II, he admitted, was that attempts at acylation gave no evidence of the presence of hydroxyl groups.

From what has been said of the β-mercapto ketones, all these properties are now seen to be entirely consistent with Formula I.

Fromm and Hubert[3] felt they had finally proved the correctness of a structure of type II, when they isolated the corresponding monosulfide of benzalacetophenone in three forms, each of which gave, on oxidation, a different sulfone. They interpreted these three sulfides as geometrical isomers of a substance analogous to that represented in Formula II. This result still requires investigation although Formula I presents the possibility of two geometrical isomers, with the possibility of additional enolized forms.

This discussion has been given to make clear the fact that Fromm's "benzalacetophenone hydrosulfide," to which he gave Formula III, is almost certainly β-sulfhydryl-β-phenylpropiophenone (IV), and, as such,



$$\begin{array}{l} C_6H_5CH{=}CHC(OH)C_6H_5 \\ \qquad\qquad\quad | \\ \qquad\qquad\quad SH \end{array}$$

III

$C_6H_5CH(SH)CH_2COC_6H_5$

IV

the first β-sulfhydryl ketone. As might be expected, it loses hydrogen sulfide with ease, especially in the presence of alkali.

In attempting to prove the structure of this compound, Fromm found that on benzoylation it would take up only a single benzoyl group, which

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[2] Fromm and Haas, *Ann.*, **394**, 290 (1912).

[3] Fromm and Hubert, *ibid.*, **394**, 301 (1912).

became attached to sulfur. No free hydroxyl group could be demonstrated. This same thiobenzoate has now been obtained by the direct addition of thiobenzoic acid to benzalacetophenone in alkaline solution. The thioacetate is similarly formed from thioacetic acid. Since these thio acids are even more similar than is hydrogen sulfide to the mercaptans whose addition has already been studied, the structures given by Fromm can scarcely be maintained.

## Experimental Part

**β-Sulfhydryl-β-phenylpropiophenone (IV).**—The directions of Fromm and Hubert[8] were followed. A solution of the substance in dilute alcohol gave with lead acetate a test for sulfide after standing for only a few minutes at room temperature. The rate of sulfide formation increased rapidly on heating, or on the addition of small amounts of alkali.

**β-Benzoylmercapto-β-phenylpropiophenone,** $C_6H_5CH(SCOC_6H_5)CH_2COC_6H_5$.—A solution of two moles of potassium hydroxide in 10 parts of alcohol was saturated with hydrogen sulfide, then shaken with one mole of benzoyl chloride. When this solution (A) was added to one mole of benzalacetophenone, and 2 *N* sodium ethylate then added (0.5 cc. more than required to give a pink color with phenolphthalein) there was immediate evidence of reaction. After an hour, acidification with acetic acid gave almost entirely a sulfide (formula analogous to I) which proved to be identical with Fromm's β-duplobenzylideneacetophenone sulfide. This product also resulted when the benzoyl chloride was omitted.

When, however, solution A was acidified, the thiobenzoic acid extracted with ether, and this extract (after removal of ether) dissolved in alcohol and condensed with benzalacetophenone as described above (reaction time, however, ten hours at room temperature), the main product obtained was the benzoylmercapto derivative. After purification it melted at 123° and proved to be identical with the product obtained by Fromm when he benzoylated the mercaptan.

*Anal.* (Parr bomb). Calcd. for $C_{22}H_{18}O_2S$: S, 9.25. Found: S, 8.91, 9.02.

**β-Acetylmercapto-β-phenylpropiophenone.**—This substance was prepared as described for the benzoyl derivative, but with the use of thioacetic acid. It separated as a yellow oil, which solidified on cooling, and after purification from somewhat diluted alcohol melted at 75–77°. The crystals were still slightly yellow.

*Anal.* (Parr bomb). Calcd. for $C_{17}H_{16}O_2S$: S, 11.27. Found: S, 11.15.

## Summary

Reasons have been given for the belief that Fromm's "benzalacetophenone hydrosulfide" is really β-sulfhydryl-β-phenylpropiophenone.

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