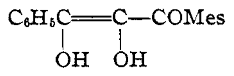
[Contribution from the Chemistry Department, Howard University]

The Properties of Benzoylmesitoylmethane

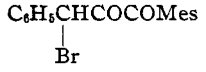
By R. P. Barnes, Charles I. Pierce[1] and Chappelle C. Cochrane[1]

In a previous paper[2] we reported the preparation and properties of an ene-diol (I), obtained from alpha-bromo benzylmesityl diketone (II). In this paper we are reporting the results of a similar investigation of the reactions of the isomeric bromobenzoylmesitoylmethane (III).



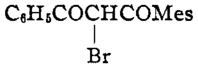
$$\begin{array}{l}\mathrm{C_6H_5C{=}C{-}COMes}\\ \quad\ \ \mathrm{OH\ \ OH}\end{array}$$

I



$$\begin{array}{l}\mathrm{C_6H_5CHCOCOMes}\\ \qquad\ \mathrm{Br}\end{array}$$

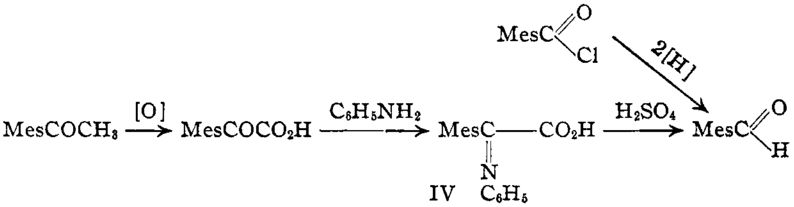
II



$$\begin{array}{l}\mathrm{C_6H_5COCHCOMes}\\ \qquad\qquad\ \mathrm{Br}\end{array}$$

III

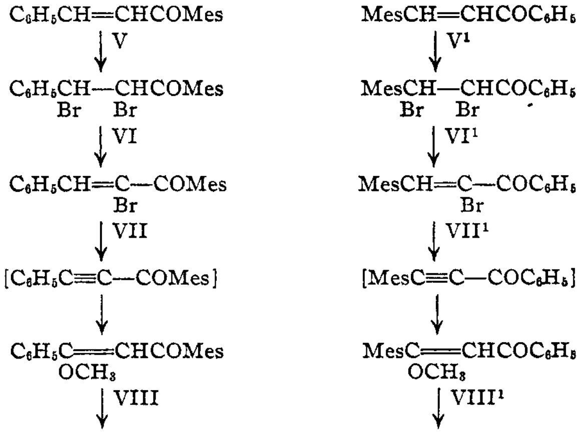
Benzoylmesitoylmethane is described by Kohler and co-workers as resulting from two series of reactions.[3,4] This substance is listed as a solid, melting at 79°, and being 100% enolic in alcoholic solution as indicated by Kurt Meyer titrations. Fuson and co-workers[5] describe mesitoylbenzoylmethane as a solid, melting at 74–77°.



In the light of the mechanism given for the formation of the enolic modification of *beta*-diketones,[6] it seemed likely that the two series of reactions as given by Kohler and his collaborators might lead to isomeric enols of benzoylmesitoylmethane. We have carried out these two series of reactions with slight modifications, exercising care to isolate the intermediates, and have found that there is only one stable enolic modification of benzoylmesitoylmethane, which is evidence that the mesityl group acts against enolization toward itself, which is in a sense hindrance to the existence of the 1,2-addition product resulting from the shift of hydrogen to the adjacent carbonyl.

Mesitylaldehyde (IV) was prepared by two methods: (1) the catalytic reduction[7] of mesitoyl chloride; and (2) the hydrolysis of the anil of mesitylglyoxylic acid obtained from the potassium permanganate oxidation of acetyl mesitylene.[8]

The preparation of the alpha-beta-unsaturated ketones (V) and (V^1) and their corresponding dibromides (VI) and (VI^1) was according to the methods of Kohler.[3,4] The dibromide (VI) was converted to the alpha-bromobenzalacetomesitylene (VII), by treatment with fused potassium acetate in glacial acetic acid solution. This compound was converted into the methyl ether of 1-phenyl-3-mesitylpropene-one-3-ol-1 (VIII), from which the enol, 1-phenyl-3-mesitylpropene-one-3-ol-1 (IX) was obtained by acid hydrolysis. The monobromo unsaturated compound (VII^1) was obtained in poor yield by the potassium acetate–glacial acetic acid treatment of the parent dibromide (VI^1). Both the mono-bromide (VII^1) and the dibromide (VI^1) were converted quantitatively into the methyl ether (VIII^1) of 1-mesityl-3-phenyl-propene-one-3-ol-1 by treatment with sodium methylate. Acid hydrolysis of this methyl ether resulted in the enol (IX), 1-phenyl-3-mesitylpropene-one-3-ol-1.



---

(1) In partial fulfillment of the requirements for the Master's degree.

(2) R. P. Barnes and Leila S. Green, This Journal, **60**, 1549 (1938).

(3) E. P. Kohler and Carl E. Barnes, *ibid.*, **55**, 690 (1933).

(4) E. P. Kohler and L. W. Blanchard, Jr., *ibid.*, **57**, 367 (1935).

(5) Reynold C. Fuson, G. E. Ullyot and J. L. Hickson, *ibid.*, **61**, 410 (1939).

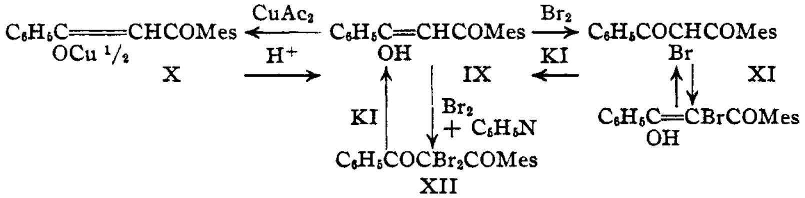
(6) E. P. Kohler and R. Johnstin, *Am. Chem. J.*, **33**, 35 (1905).

(7) Karl W. Rosenmund and F. Zetzsch, *Ber.*, **51**, 585 (1918); **54**, 425 (1921).

(8) Bouveault, *Compt. rend.*, **124**, 157 (1897).

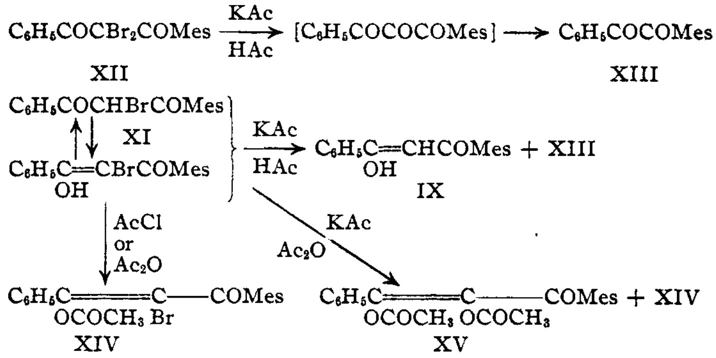
Enol (IX) gives a copper derivative (X) with copper acetate, from which the parent enol is regenerated.

This enol cannot be brominated completely to the monobromo compound by the direct addition of bromine to solutions of the enol, because the bromo compound is easily reduced by the hydrogen bromide formed. In solution in chloroform in the presence of a suspension of calcium carbonate, however, the enol is brominated quantitatively to the monobromo compound (XI), which is a colorless solid, enolic[9] to the extent of 24% in alcoholic solution. In acetic acid solution in the presence of pyridine, enol (IX) is brominated to the dibromo compound (XII).



The dibromo compound (XII) is converted to the diketone (XIII) on treatment with potassium acetate in glacial acetic acid. When the monobromo compound is treated similarly there results a mixture of the parent enol and the diketone (XIII). This is explained in terms of the equilibrium (KBr + HAc $\rightleftarrows$ KAc + HBr), the hydrogen bromide reducing the monobromo compound, and hydrolyzing any diacetate that might be formed, it being subsequently oxidized to the diketone.

The monobromo compound (XI) is acetylated[10] by both acetyl chloride and acetic anhydride to the acetate (XIV), which is not reduced by potassium iodide.



Since we could not obtain the carbinol acetate of benzoylmesitoylmethane by acetylation of the monobromo compound with potassium acetate and glacial acetic acid, we sought a solvent which would not furnish an active hydrogen. Thus the choice of acetic anhydride[10] which, in the presence of freshly fused potassium acetate, yields a mixture of the monobromo acetate (XIV) and the diacetate (XV) of mesitoylphenylacetyleneglycol.[2] The monobromo acetate (XIV), does not suffer further acetylation, since this reaction would necessarily involve a metathesis, and halogen atoms in the system, $>C{=}\overset{/}{C}Br$, which cannot relieve itself by rearrangement, do not take part in double decomposition reactions. Thus the acetylation process must involve two competitive reactions: first, direct esterification of the alpha-bromo ketone itself by splitting out potassium bromide resulting in the carbinol acetate which is subsequently esterified to the diacetate[10]; second, acetylation of the enolic modification of the alpha-bromo ketone, which is not further acetylated.

Further work is now in progress with 2,4,6-trimethylbenzyl phenyl diketone, the alpha diketone isomeric with mesitylbenzylglyoxal,[11] and with 2,4,6-trimethylbenzyl mesityl glyoxal.

Experimental

Preparation of Mesitylaldehyde.—(I) A solution of 90 g. of mesitoyl chloride in 270 g. of faultlessly dry xylene together with 20 g. of palladized barium sulfate was refluxed gently while a stream of dry oxygen-free hydrogen was passed through the solution. The process was continued until hydrogen chloride ceased to be evolved, about eighteen hours. The catalyst was filtered off and the filtrate distilled. The mesitylaldehyde came over at 96–98° (6 mm.). The yield was 60 g., which was 80%.

(II) A chilled mixture of 50 g. of acetylmesitylene and 200 cc. of water was treated dropwise with rapid stirring with a solution of 100 g. of potassium permanganate and 32 g. of potassium hydroxide in 3000 cc. of water. The manganese dioxide was filtered off and washed with water and the pale green solution was made strongly acid with concd. sulfuric acid and allowed to stand in the ice box overnight. A yellow oil consisting of a mixture of trimethylbenzoic, trimethylmandelic and mesitylglyoxylic acids separated out and crystallized. The mixed acids were filtered off and dried, weighing 31 g. The filtrate was extracted with ether, dried over anhydrous sodium sulfate and evaporated, yielding 19–20 g. Assuming the

---

[9] All titrations were done as by S. R. Cooper and R. P. Barnes, *Ind. Eng. Chem., Anal. Ed.*, **10**, 379 (1938).

[10] THIS JOURNAL, **62**, 894 (1940).

[11] R. P. Barnes, *ibid.*, **57**, 937 (1935).

total mixed acids to be mesitylglyoxylic acid, it was heated to boiling for thirty minutes with the calculated amount of aniline. The yellow solution was cooled, taken up in ether, and washed with dilute hydrochloric acid to remove the excess aniline. The ether was evaporated and the residual yellow oil warmed with 25 g. of concd. sulfuric acid. The dark red solution was allowed to cool and was taken up in the ether and washed with water to remove the excess sulfuric acid and aniline sulfate. Finally the trimethylbenzoic and trimethylmandelic acids were washed out with bicarbonate solution. The ethereal solution was dried over anhydrous sodium sulfate and distilled. The yield was 22.5–23.5 g. of mesitylaldehyde, boiling at 96–98° (6 mm.). This was 50% of the theoretical.

alpha-Bromobenzalacetomesitylene (VII).—To a solution of 234 g. of freshly fused potassium acetate in 500 cc. of hot glacial acetic acid was added 117 g. of dibromobenzalacetomesitylene. The mixture was refluxed for thirty minutes. The solution turned yellow and potassium bromide separated out. When cold the contents of the flask were poured into a large volume of water. A light brown oil separated out which upon stirring and cooling soon crystallized. The yield was 85–86 g. of crude material which was 91–92% of the theoretical. This solid was crystallized from the least amount of hot methyl alcohol, yielding 80–81 g. of lemon yellow solid, melting at 86°.

Anal. Calcd. for $C_{18}H_{17}OBr$: C, 65.6; H, 5.2. Found: C, 65.3; H, 5.1.

This monobromo compound reduces permanganate and decolorizes chloroform solutions of bromine. Phenylmagnesium bromide converts it into alpha-bromo-beta-phenylbenzylacetomesitylene.[12]

alpha-Bromo 2,4,6-Trimethylbenzalacetophenone (VII^1).—A solution of 100 g. of fused potassium acetate and 50 g. of the dibromide in 250 cc. of glacial acetic acid was treated as indicated in the preparation of alpha-bromobenzalacetomesitylene. A yellow oil resulted from the water treatment. Extraction with ether, washing, drying and concentrating yielded 3.1 g. of pale yellow solid melting at 98° and mix-melting with the parent alpha-beta-unsaturated ketone at 98°. Further concentration produced a crystalline solid which when recrystallized from methyl alcohol amounted to 7.1 g., melted sharply at 95°, and mix-melted with the parent alpha-beta-unsaturated ketone at 73–85°.

Anal. Calcd. for $C_{18}H_{17}OBr$: C, 65.6; H, 5.2. Found: C, 65.7; H, 5.5.

It decolorizes permanganate and bromine solutions.

The Methyl Ether of 1-Mesityl-3-phenyl-propene-one-3-ol-1 (VIII^1).—A solution of 1 g. of the monobromo unsaturated ketone in sodium methylate made from 0.1 g. of sodium in 1 g. of methyl alcohol was refluxed for one hour. On cooling, pale yellow needles separated. The mixture was poured into three times its volume of water. There was obtained 0.8 g. of material melting at 106–113°, which when recrystallized from methyl alcohol melted and mix-melted at 113° with a sample obtained by the treatment of the dibromo compound with sodium methylate.[4]

1-Phenyl-3-mesityl-propene-one-3-ol-1 (IX).—To the solution of 80.3 g. of alpha-bromobenzalacetomesitylene in the least amount of hot methyl alcohol was added slowly and carefully with shaking, a solution of 34 g. of potassium hydroxide in the least amount of hot methyl alcohol. The solution turned red and potassium bromide separated out. When cold it was poured into 300 cc. of cold water and acidified with dilute hydrochloric acid. The milky solution thus produced was extracted with ether, the ethereal extract washed with water and the ether distilled. The oily residue was dissolved in hot methyl alcohol from which, on cooling, a cream-colored solid separated. The yield was 53–55 g. of enol, melting at 76–77°. This crude yield was 79–81% of the theoretical. On recrystallizing from methyl alcohol, it melts sharply at 79°.

To a solution of 29.2 g. of the methyl ether of 1-mesityl-3-phenylpropene-one-3-ol-1 in 160 cc. of methyl alcohol was added 30 cc. of concd. hydrochloric acid, and the mixture refluxed for three hours. On cooling overnight, colorless plates separated out. This yield was 20.7 g. of crude product melting at 78°. Recrystallization from methyl alcohol gave beautiful plates, melting sharply at 79°, with no depression on mix-melting with the 79°-melting enol.

It is 100% enolic in methyl alcohol and less then 1% enolic in carbon tetrachloride.

Preparation of the Copper Derivative (X).—A saturated ether solution of 1 g. of the enol was shaken for several hours with an excess of saturated copper acetate solution. The resulting greenish-tan crystalline solid was filtered, washed and dried, and weighed 0.9 g. It melts with decomposition at 221°.

Anal. Calcd. for $C_{36}H_{34}O_4Cu$: Cu, 10.71. Found: Cu, 10.69.

When the copper derivative is shaken in chloroform solution with hydrochloric acid, the enol is regenerated.

Preparation of Bromo Benzoylmesitoylmethane (XI).—Fourteen grams of calcium carbonate was suspended in a solution of 10 g. of the enol in 30 cc. of chloroform. A solution of 6.1 g. of bromine in 10 cc. of chloroform was added slowly with rapid stirring. The bromine was absorbed rapidly without any evolution of hydrogen bromide. The mixture of calcium carbonate and calcium bromide was filtered off and the chloroform pumped off. A pale yellow viscous mass was left which crystallized upon standing in an evacuated desiccator over potassium hydroxide. Recrystallization from low-boiling petroleum ether yielded 6.2 g. of colorless prisms, melting at 64–66°.

Anal. Calcd. for $C_{18}H_{17}O_2Br$: C, 62.6; H, 4.9. Found: C, 62.9; H, 5.2.

Differential Kurt Meyer titrations show that this substance is 24% enolic. It gives a characteristic red color with alcoholic ferric chloride and is reduced to the parent enol by potassium iodide.

Five grams of the monobromo compound was dissolved in 25 cc. of glacial acetic acid and refluxed for one hour with 5 g. of freshly fused potassium acetate. It was poured into a large volume of cold water to distribute the acetic acid, whereupon a yellow oil separated out. This oil was crystallized from methyl alcohol, yielding 3 g. of the parent enol, and 0.5 g. of mesityl phenyl diketone, each identified by its melting point and mix-melting point.

---

(12) E. P. Kohler, *Am. Chem. J.*, **38**, 555 (1907).

Dibromo Benzoylmesitoylmethane (XII).—A solution of 20 g. of concd. sulfuric in 40 cc. of glacial acetic acid was added with cooling to a solution of 16 g. of pyridine in 40 cc. glacial acetic acid. To this mixture was added 26.8 g. of enol (IX) dissolved in 170 cc. of glacial acetic acid. Finally with cooling and vigorous shaking, 32 g. of bromine in 400 cc. of acetic acid was added. The bromine was taken up rapidly. The acetic acid was distilled under diminished pressure; the residual oil was poured into water and extracted with ether. The ethereal solution was washed with sodium bicarbonate solution and with water. The ether was evaporated and the resulting pale yellow oil crystallized from methyl alcohol yielding pale yellow crystals, melting at 101–106°. Recrystallization from low-boiling petroleum gave 16 g. of pale yellow crystals melting at 107–108°.

Anal. Calcd. for $C_{18}H_{16}O_2Br_2$: C, 50.9; H, 3.8; Br, 37.7. Found: C, 51.0; H, 3.9; Br, 37.8.

This dibromide upon treatment with glacial acetic acid and potassium acetate is converted into mesityl phenyl diketone, identified by comparison with an authentic sample.

The Acetate (XIV).—Five grams of the bromobenzoylmesitoylmethane was refluxed for one hour with an excess of acetyl chloride. The acetyl chloride was pumped off and the residue crystallized from methyl alcohol. A practically quantitative yield of colorless crystalline solid, melting at 96°, was obtained.

Anal. Calcd. for $C_{20}H_{19}O_3Br$: C, 62.0; H, 4.9. Found: C, 62.0; H, 5.2.

This substance is non-enolic and is hydrolyzed by acids to the parent bromo compound. It is not acetylated further by potassium acetate in acetic anhydride, nor is it reduced by potassium iodide in acid solution. The same compound is obtained when the bromobenzoylmesitoylmethane is treated with acetic anhydride.

The Action of Acetic Anhydride–Potassium Acetate on Bromobenzoylmesitoylmethane (XIV) and (XV).—To a hot mixture of 10 g. of freshly fused potassium acetate and 50 cc. of acetic anhydride were added 10 g. of the monobromo compound. This mixture was refluxed gently for forty-five minutes. The solution turned dark brown and potassium bromide separated out. When cold it was poured into a large volume of cold water and stirred vigorously until the acetic anhydride was decomposed. It was then taken up in ether, washed with sodium bicarbonate solution, and finally with water, dried and evaporated. The residue was dissolved in methyl alcohol, from which by fractional crystallization 5 g. of the bromo acetate, melting at 96°, and 1.0 g. of the diacetate, melting at 131°, were obtained. Both products were identified by their mixed-melting points with known samples.

Summary

In this paper we have reported the properties of the enolic modification of benzoylmesitoylmethane, which properties are influenced considerably by the presence of the mesityl nucleus, which seems not only to activate the *alpha* substituents but also to have a directing influence upon enolization.

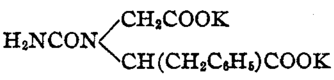
WASHINGTON, D. C. RECEIVED FEBRUARY 12, 1940

[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF MOUNT HOLYOKE COLLEGE]

Ring Closure of Acylic Ureides Resulting from the Elimination of Alcohol: A Study of the Esters of beta-Phenylalanine-N-acetic Acid and Related Compounds[1]

BY DOROTHY A. HAHN, MARGARET J. MCLEAN AND MARGARET M. ENDICOTT

Further study of the derivatives of β-phenylalanine-N-acetic acid has resulted in the synthesis of the isomer of C-5-benzylhydantoin-N-1-acetate, to which reference was made in an earlier report.[1a] It was then stated that although the formation of two isomeric hydantoin-acids was theoretically possible following the hydrolysis of the ureidic salt

(I)


$$H_2NCON\begin{cases}CH_2COOK\\ CH(CH_2C_6H_5)COOK\end{cases}$$

under the action of hydrochloric acid, ring closure actually had been observed to take place in one sense only.[2] Moreover, since the product[3]

$$\text{(II)}\quad HOOCCH_2NCONHCOCHCH_2C_6H_5$$

was precipitated instantly in yields averaging more than 90% of the theoretical, it seemed reasonable to conclude that the rates at which the two carboxyl groups were capable of reacting respectively with the hydrogen of the amide group in the ureide must differ greatly in magnitude. It appeared probable therefore that the formation of the isomer

$$\text{(III)}\quad HOOC(CH_2C_6H_5)CHNCONHCOCH_2$$

could not be expected under ordinary conditions. However, it was still possible that in the case of a compound having the configuration

---

[1] Original manuscript received November 7, 1939.

[1a] Hahn and Endicott, THIS JOURNAL, **60**, 1045 (1938).

[2] A similar observation has been reported by E. Ware, *ibid.*, **60**, 2653 (1938), who found that although two isomeric hydantoins were theoretically possible as a result of the cyclization of a hydantoic derivative of tyrosine-N-acetic acid, only one product could be isolated and identified, namely, $HOOCCH_2NCON(C_6H_5)COCHCH_2$-$C_6H_4OH$.

[3] The configuration of this compound has been definitely established, Hahn and Endicott, *loc. cit.*, p. 1042.