CXXXII.—*The Action of Benzamidine on Olefinic β -Diketones.*

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THE olefinic β -diketones are formed from the aldehydes and β -diketones by the action of either hydrogen chloride or organic bases. The use of hydrogen chloride as a condensing agent will be found more convenient for the preparation of certain members of this group, just as it is for the formation of olefinic β -ketonic esters (this vol., p. 717); especially in those cases where the condensation is not accompanie

the union of the olefinic compound with hydrogen chloride. I have previously shown (*loc. cit.*) that such a union does not take place if, instead of benzaldehyde, *m*-nitrobenzaldehyde reacts with the β -ketonic ester in the presence of hydrogen chloride. Similarly, differences are observed in the behaviour of this condensing agent towards a mixture of aldehydes and β -diketones. Whilst benzaldehyde interacts with acetylacetone, forming benzylideneacetylacetone hydrochloride, $\text{CH}_3\cdot\text{CO}\cdot\text{CH}(\text{CO}\cdot\text{CH}_3)\cdot\text{CHCl}\cdot\text{C}_6\text{H}_5$ (Knoevenagel and Werner, *Annalen*, 1894, 281, 79), *m*-nitrobenzaldehyde and the diketone yield *m*-nitrobenzylideneacetylacetone, $\text{CH}_3\cdot\text{CO}\cdot\text{C}(\text{CO}\cdot\text{CH}_3):\text{CH}\cdot\text{C}_6\text{H}_4\cdot\text{NO}_2$. In a similar manner, hydrogen chloride acts on a benzene solution of *m*-nitrobenzaldehyde and benzoylacetone, although in this case the yield of *m*-nitrobenzylidenebenzoylacetone,

is very small on account of the ease with which benzoylacetone is decomposed by acids. By using alcohol as a solvent for the aldehyde and the diketone, instead of benzene, and saturating the solution with hydrogen chloride, I have been able to isolate from the product of the reaction, *m*-nitrobenzylideneacetophenone, $\text{C}_6\text{H}_5\cdot\text{CO}\cdot\text{CH}:\text{CH}\cdot\text{C}_6\text{H}_4\cdot\text{NO}_2$, which is formed owing to the elimination of the acetyl group from the diketone.

Whilst the mixture of β -diketones and *m*-nitrobenzaldehyde, on treatment with hydrogen chloride, forms olefinic diketones, the reaction of the aldehyde with the mono-ketone, deoxybenzoin, is analogous to that of benzaldehyde (Klages and Knoevenagel, *Ber.*, 1893, 26, 449), and furnishes *m*-nitrobenzylidenedeoxybenzoin hydrochloride, $\text{C}_6\text{H}_5\cdot\text{CH}(\text{CO}\cdot\text{C}_6\text{H}_5)\cdot\text{CHCl}\cdot\text{C}_6\text{H}_4\cdot\text{NO}_2$.

The condensation between *m*-nitrobenzaldehyde and β -diketones may also be effected by piperidine, but different compounds are formed according as the base acts on the dry mixture or on its alcoholic solution. In the first case, the olefinic β -diketone is produced; for instance, *m*-nitrobenzylideneacetylacetone from acetylacetone and *m*-nitrobenzaldehyde, whilst on using alcohol as a solvent, a saturated tetraketone is formed, such as *m*-nitrobenzylidenebisbenzoylacetone, $[\text{CH}(\text{CO}\cdot\text{C}_6\text{H}_5)\cdot\text{CO}\cdot\text{CH}_3]_2\text{CH}\cdot\text{C}_6\text{H}_4\cdot\text{NO}_2$, from *m*-nitrobenzaldehyde and benzoylacetone. The same influence of the solvent had been noticed in the course of the experiments on the condensation between *m*-nitrobenzaldehyde and β -ketonic esters (Ruhemann, *loc. cit.*)*

It has been shown lately (this vol., pp. 374, 717) that benzamidine

* I have stated, on p. 717, that ethyl benzylidenebisbenzoylacetate melts at 115–116°, and that after solidification, the melting point is raised to 129–130°. I now find that the ester melts at 131° without previous fusion, if the mixture of the reagents, dissolved in alcohol, is left for 1 to 2 weeks, and the solid, which has separated, is crystallised from alcohol.

condenses with olefinic β -ketonic esters to furnish derivatives of dihydropyrimidone. I have now studied the behaviour of the amidine towards olefinic β -diketones with the view of preparing dihydropyrimidines in accordance with the following equation :

An additive product of the diketone with the amidine is formed at first if the reaction proceeds at the ordinary temperature; the compound, obtained by using benzylidenebenzoylacetone, is, most probably to be represented by the formula

because this structure furnishes a ready explanation of the formation of dibenzamide, $(\text{C}_6\text{H}_5 \cdot \text{CO})_2\text{NH}$, which takes place when the substance is heated with hydrochloric acid.

The other olefinic β -diketones undoubtedly form similar additive compounds, but these are transformed if the reaction takes place at 100° . Thus, on boiling the alcoholic solution of the mixture of benzylideneacetylacetone and benzamidine, the additive product loses water and its acetyl group in the form of ethyl acetate, to produce a substance which does not seem to be an open chain compound, since it is not broken up by hydrochloric acid, as is the additive product of benzylidenebenzoylacetone and benzamidine. I am, therefore, inclined to regard it as diphenylmethyl dihydropyrimidine,

The behaviour of *m*-nitrobenzylideneacetylacetone towards benzamidine is of special interest, because the additive compound, which may be supposed to be first found, loses its acetyl group and yields *m*-nitrodiphenylmethylpyrimidine,

and not its dihydro-derivative, the hydrogen being probably used up in transforming a part of the product into a hydrogenised compound.

EXPERIMENTAL.

Action of Benzamidine on Benzylideneacetylacetone.

This reaction takes place when benzylideneacetylacetone, benzamidine hydrochloride, and sodium ethoxide in molecular proportions are dissolved in alcohol and the solution boiled for one hour. On

distillation from the water-bath, ethyl acetate and alcohol are removed, and the viscid residue, which becomes solid when freed from the adhering oil by washing with dilute alcohol, is crystallised from alcohol; it separates in colourless plates melting at 149—150°.

0.1772 gave 0.5330 CO₂ and 0.1060 H₂O. C = 82.03; H = 6.64.

0.2007 „ 0.6045 CO₂ „ 0.1205 H₂O. C = 82.15; H = 6.66.

0.2445 „ 24 c.c. moist nitrogen at 21° and 761 mm. N = 11.32.

C₁₇H₁₆N₂ requires C = 82.25; H = 6.45; N = 11.29 per cent.

This compound, which dissolves with difficulty in cold alcohol and more readily on warming, is freely soluble in glacial acetic acid. It has basic properties and dissolves in hydrochloric acid with the greatest ease, the solution giving a yellow platinichloride which melts under water.

0.2610 gave 0.0553 Pt. Pt = 21.18.

(C₁₇H₁₆N₂)₂, H₂PtCl₆ requires Pt = 21.47 per cent.

In the introduction to this paper, I have expressed the view that the compound C₁₇H₁₆N₂ is, most probably, diphenylmethyldihydropyrimidine. With the object of oxidising it to the corresponding derivative of pyrimidine, I have saturated its alcoholic solution with nitrogen peroxide, but I find that the transformation does not take place; almost the whole of the original substance is precipitated by caustic potash as a red oil, which gradually solidifies.

m-Nitrobenzylideneacetylacetone.

m-Nitrobenzaldehyde (7.5 grams) gradually dissolves in acetylacetone (5 grams) at the ordinary temperature; on adding 4 drops of piperidine, the solution becomes turbid after a short time and solidifies in the course of a day. The solid is only slightly soluble in cold alcohol, but readily dissolves in hot alcohol, and the solution, on cooling, deposits colourless prisms which melt at 101—102°.

0.2150 gave 0.4860 CO₂ and 0.0955 H₂O. C = 61.64; H = 4.93.

0.2170 „ 11.8 c.c. moist nitrogen at 22° and 758 mm. N = 6.11.

C₁₂H₁₁O₄N requires C = 61.80; H = 4.72; N = 6.0 per cent.

The yield of *m*-nitrobenzylideneacetylacetone is 85—90 per cent. This compound is also formed if the mixture of *m*-nitrobenzaldehyde and acetylacetone is dissolved in as little benzene as possible, and the solution saturated at 0° with dry hydrogen chloride. When left for 2—3 days, the whole sets to a mass of crystals, which, after recrystallisation from alcohol, melt at the same temperature as the foregoing preparation.

Action of Benzamidine on m-Nitrobenzylideneacetylacetone.

This reaction takes place on mixing molecular proportions of sodium ethoxide and the hydrochloride of the amidine, dissolved in absolute alcohol, then adding the olefinic diketone (1 mol.) and digesting the mixture for about an hour. On distillation from the water-bath, ethyl acetate and alcohol pass over; the yellow, resinous residue is agitated with dilute hydrochloric acid, when a portion is transformed into a white solid, whilst the other part dissolves. I have tried in vain to purify the solid by crystallisation, but the analyses which have been made with various specimens melting between 93° and 98° , although differing somewhat from each other, point to the formula $\text{CH}_3\cdot\text{CO}\cdot\text{CH}\cdot\text{CH}\cdot\text{C}_6\text{H}_4\cdot\text{NO}_2$ for *m*-nitrobenzylideneacetone. The formation of this substance is effected by the elimination of one acetyl group from the olefinic diketone. The acid filtrate from this compound, when treated with an excess of caustic potash, yields a viscid product which gradually hardens. It is washed with water and dissolved in alcohol, when the solution slowly deposits a white substance which readily dissolves in hot alcohol and crystallises from the solution in colourless needles melting at 137 — 138° .

0.2080 gave 0.5340 CO_2 and 0.0850 H_2O . $\text{C}=70.01$; $\text{H}=4.54$.

0.2055 „ 0.5270 CO_2 „ 0.0840 H_2O . $\text{C}=69.94$; $\text{H}=4.54$.

0.2133 „ 26.8 c.c. moist nitrogen at 22° and 762 mm. $\text{N}=14.26$.

0.2000 „ 26 c.c. „ „ 22° „ 750 mm. $\text{N}=14.53$.

$\text{C}_{17}\text{H}_{13}\text{O}_2\text{N}_3$ requires $\text{C}=70.10$; $\text{H}=4.46$; $\text{N}=14.43$ per cent.

This compound, as stated above, is to be regarded as *m*-nitrodiphenylmethylpyrimidine. It is insoluble in cold hydrochloric acid, and this circumstance, together with the fact that it results from the acid solution of the product of the reaction between benzamidine and the olefinic diketone, leads to the conclusion that it is formed by the gradual change of a substance which is first produced, and which is probably an open chain compound. The pyrimidine derivative, although insoluble in cold hydrochloric acid, dissolves on boiling for some time, and yields a hydrochloride, which crystallises from the acid solution in colourless plates; the salt, however, is unstable, and, on drying at 100° , loses hydrogen chloride. It dissolves also in cold concentrated sulphuric acid, and is precipitated unaltered by adding water to the solution.

m-Aminodiphenylmethylpyrimidine is obtained by reducing the foregoing compound with iron and hydrochloric acid, adding an excess of caustic potash to the solution, and extracting the precipitate with alcohol. The alcoholic filtrate, on concentration and dilution with

water, yields a white emulsion from which colourless needles gradually separate.

0.1738 gave 23.8 c.c. moist nitrogen at 19° and 772 mm. $N = 16.0$.
 $C_{17}H_{15}N_3$ requires $N = 16.09$ per cent.

This compound, which melts at 104–105°, is readily soluble in alcohol or hydrochloric acid, and the acid solution gives, with platinic chloride, an insoluble platinichloride.

Action of Benzamidine on Benzylidenbenzoylacetone.

The mixture of benzamidine hydrochloride and sodium ethoxide, dissolved in absolute alcohol, turns yellow on treatment with benzylidenbenzoylacetone. After leaving the product for a day at the ordinary temperature, water is added, when a semi-solid product separates, which slowly becomes hard, and this readily dissolves in alcohol or benzene, the concentrated solutions depositing colourless needles which melt at 132°.

0.2142 gave 0.6083 CO_2 and 0.1173 H_2O . $C = 77.45$; $H = 6.08$.
 0.3020 „ 20 c.c. moist nitrogen at 16° and 747 mm. $N = 7.57$
 $C_{24}H_{22}O_2N_2$ requires $C = 77.57$; $H = 5.94$; $N = 7.57$ per cent.

This compound is the additive product of benzamidine with benzylidenbenzoylacetone; it dissolves in cold dilute hydrochloric acid, and, on boiling the solution, an oil separates which quickly solidifies. The solid, which crystallises from alcohol in colourless needles melting at 148–149°, is identified as dibenzamide.

0.18579 gave 0.5065 CO_2 and 0.0838 H_2O . $C = 74.38$; $H = 5.01$.
 0.2068 „ 11.4 c.c. moist nitrogen at 190° and 753 mm. $N = 6.27$.
 $C_{14}H_{11}O_2N$ requires $C = 74.66$; $H = 4.88$; $N = 6.22$ per cent.

Action of m-Nitrobenzaldehyde on Benzoylacetone.

m-Nitrobenzylidenbisbenzoylacetone is formed when the mixture of *m*-nitrobenzaldehyde (7.5 grams) and benzoylacetone (8 grams), dissolved in as little alcohol as possible, is cooled down by ice, and piperidine (5–6 drops) added to the solution. After 2 days, the whole sets to a mass of crystals, which are washed with alcohol and recrystallised from hot glacial acetic acid, in which they dissolve with great difficulty. The substance gradually separates from this solution in colourless needles which melt and decompose at 229–230°.

0.1815 gave 0.4720 CO_2 and 0.0845 H_2O . $C = 70.92$; $H = 5.17$.
 0.2162 „ 6 c.c. moist nitrogen at 22° and 757 mm. $N = 3.16$.
 $C_{27}H_{23}O_6N$ requires $C = 70.90$; $H = 5.03$; $N = 3.06$ per cent.

m-Nitrobenzylidenebenzoylacetone is formed by dissolving the mixture of benzoylacetone and *m*-nitrobenzaldehyde in benzene, saturating the ice-cold solution with dry hydrogen chloride, and allowing the solution to remain for about 2 weeks at the ordinary temperature until the benzene has evaporated. The yellow residue is then boiled with light petroleum, which extracts the olefinic diketone, but does not dissolve the resinous by-product. The filtrate, on cooling, deposits light yellow needles which melt at 111—112°.

0.2197 gave 0.5568 CO₂ and 0.0910 H₂O. C = 69.12; H = 4.60.

0.3078 „ 12.8 c.c. moist nitrogen at 16° and 758 mm. N = 4.83.

C₁₇H₁₃O₄N requires C = 69.15; H = 4.41; N = 4.74 per cent.

The compound dissolves in alcohol or benzene with the greatest ease; its alcoholic solution is not coloured by ferric chloride in the cold, but turns red on warming. Owing to the small yield, I have been unable to study the action of benzamidine on this olefinic diketone.

m-Nitrobenzylideneacetophenone.—With the view of improving the yield of *m*-nitrobenzylidenebenzoylacetone, I have repeated the former experiment, using alcohol as the solvent instead of benzene. As the alcoholic solution of the reagents, after saturation with dry hydrogen chloride at 0°, rapidly turns red and decomposes, I have only left it for 5—6 hours, subsequently removing the hydrogen chloride and most of the alcohol by evaporation *in vacuo* at 25°, when a solid separates and the odour of acetophenone is perceptible. The solid is freely soluble in benzene, less so in alcohol, and crystallises from the alcoholic solution in light yellow needles which melt at 145°.

0.2027 gave 0.5268 CO₂ and 0.0845 H₂O. C = 70.88; H = 4.63.

0.3005 „ 14.6 c.c. moist nitrogen at 20° and 761 mm. N = 5.56

C₁₅H₁₁O₃N requires C = 71.14; H = 4.34; N = 5.53 per cent.

The yield of this compound is very small, since the greater part of the *m*-nitrobenzylidenebenzoylacetone, which undoubtedly is first formed, undergoes complete decomposition.

Action of m-Nitrobenzaldehyde on Deoxybenzoin.

This reaction takes place on dissolving, in molecular proportions, the mixture of the aldehyde and the ketone in absolute alcohol, and saturating the ice-cold solution with dry hydrogen chloride. When left overnight, the whole sets to a semi-solid mass, which dissolves in boiling alcohol and separates again in fine needles melting at 166—167°.

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0.2620 gave 0.6623 CO_2 and 0.1078 H_2O . $\text{C} = 68.94$; $\text{H} = 4.57$.

0.3079 „ 10.8 c.c. moist nitrogen at 21° and 750 mm. $\text{N} = 3.93$.

0.1240 gave 0.1240 AgCl ; $\text{Cl} = 9.56$.

$\text{C}_{21}\text{H}_{16}\text{O}_3\text{NCl}$ requires $\text{C} = 68.94$; $\text{H} = 4.38$; $\text{N} = 3.83$; $\text{Cl} = 9.71$
per cent.

This compound, therefore, is *m*-nitrobenzylidenedeoxybenzoin hydrochloride. In conclusion, I may state that benzamidine does not react with benzylidenedeoxybenzoin.

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