

STUDIES IN THE ENAMINE FIELD
REACTIONS BETWEEN ACETONE DIETHYLKETAL AND SECONDARY AMINES

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The reactions between 2,2-diethoxypropane (I) and secondary amines have been investigated.

By heating at reflux a mixture of equimolar quantities of I and morpholine in the presence of catalitical amounts of p-toluenesulphonic acid and by distilling the ethanol as it is formed (the theoretical amount of ethanol is produced in about 70 hours) and by fractionating the reaction mixture in vacuo, the following fractions were obtained:

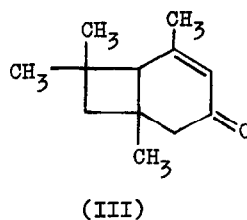
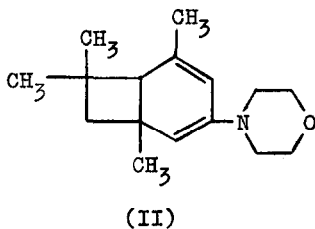
1. until 110°C / 0.1 torr,
2. 110 - 125°C / 0.1 torr,
3. 125 - 160°C / 0.1 torr,
4. residue (undistilled).

Fraction 1 consists of morpholine with minor amounts

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of unreacted ketal. Basic compounds were also detected and even though they couldn't be isolated in a pure condition, they afforded on hydrolysis with 10% hydrochloric acid a neutral fraction containing mainly mesityl oxide and isophorone (both identified by gaschromatographic analysis).

Fraction 2 (b.p. 120-125°C / 0.1 torr after rectification) is a yellow viscous oil (II), enaminic in character which analyses for $C_{16}H_{25}NO$ (found: C 77.62, H 10.29, N 5.92; calcd.: C 77.68, H 10.19, N 5.66). On acid hydrolysis (diluted hydrochloric acid) II yields a ketone (III), a colorless liquid with b.p. 119°C / 18 torr; $n_D^{20} = 1.4952$; UV spectrum: $\lambda_{\max}^{\text{MeOH}} = 245 \text{ m}\mu$; IR spectrum: $\nu = 1680 \text{ cm}^{-1}$; analysis: found: C 81.20, H 10.25; calcd. for $C_{12}H_{18}O$: C 80.85, H 10.18. The NMR spectrum of compound III is strongly in favour of the structure of 2.6.8.8-tetramethylbicyclo[4.2.0]oct-2-ene-4-one:

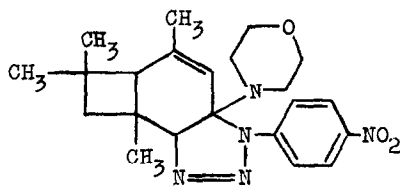


(NMR spectrum of compound III (in CCl_4)¹): 8.98 τ (singlet; 3H; methyl in 6), 8.82 and 8.68 τ (singlets; 6H;

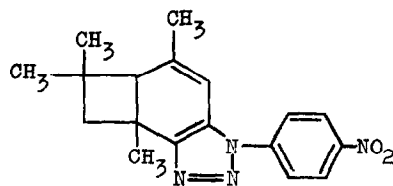
¹) This spectrum, along with the spectra of products VII and VIII, was taken on a Varian A-60 Spectrometer at 60 Mc/s with TMS as internal reference ($\tau = 10.00 \text{ ppm}$).

methyls in 8), 8.36 and 8.28 τ (doublets, $J = 11.5$ c/s; 2H; hydrogens in 7), 8.18 τ (doublet, $J \sim 1$ c/s; 3H; methyl in 2), 7.94 and 7.69 τ (doublets, $J = 16$ c/s; 2H; hydrogens in 5), 7.68 τ (singlet; 1H; hydrogen in 1), 4.21 τ (quartet, $J \sim 1$ c/s; 1H; hydrogen in 3)).

Structure III has been also confirmed by the data obtained with a derivative of the enamine II: as it is usual for enaminic substances compound II yields easily with 4-nitrophenylazide the corresponding triazolinic adduct (IV) (m.p. 139°C; found: C 64.24, H 7.34, N 17.09; calcd. for $C_{22}H_{29}N_5O_3$: C 64.21, H 7.10, N 17.02) which, after treatment with 25% acetic acid, yields the corresponding triazole (V) (m.p. 184°C; found: C 66.97, H 6.45, N 17.50; calcd. for $C_{18}H_{20}N_4O_2$: C 66.65; H 6.22, N 17.27). The NMR spectrum of this derivative confirms the structure V:



(IV)



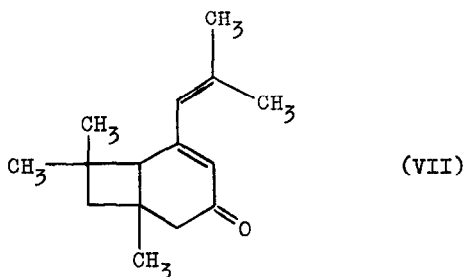
(V)

(NMR spectrum of V (in $CDCl_3$)¹): 9.02 τ (singlet; 3H; methyl in 6), 8.71 and 8.43 τ (singlets; 6H; methyls in 8),

¹) This spectrum was taken on a Perkin-Elmer R.10 Spectrometer at 60 Mc/s with TMS as internal reference ($\tau = 10.00$ ppm).

8.17 τ (doublet, $J \sim 1$ c/s; 3H; methyl in 2), 7.70 and 7.52 τ (doublets, $J = 12.5$ c/s; 2H; hydrogens in 7), 7.25 τ (singlet; 1H; hydrogen in 1), 3.76 τ (quartet, $J \sim 1$ c/s; 1H; hydrogen in 3), 2.19 and 1.68 τ (doublets, $J = 9$ c/s; 4H; aromatic hydrogens)).

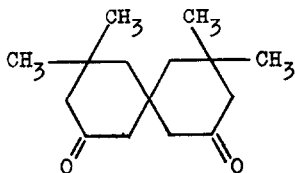
Fraction 3 is a complex mixture of enamines as it yields a mixture of ketonic bodies on acid hydrolysis. The following products have been separated from the preceding hydrolysed fraction: about 20% of III, a small quantity (about 12%) of a complex mixture (which, on gaschromatographic analysis, appears to be composed of at least four compounds), about 3% of another ketone (VI) (m.p. 105°C) and finally a substantial amount of a liquid product (VII) (b.p. 100-105 °C / 0.1 torr; $n_D^{18} = 1.5217$; UV spectrum: $\lambda_{\text{max}}^{\text{MeOH}} = 287 \text{ m}\mu$; IR spectrum: $\nu = 1670 \text{ cm}^{-1}$; found: C 82.26, H 10.18; calcd. for $\text{C}_{15}\text{H}_{22}\text{O}$: C 82.51, H 10.16). As far as now only VII could be identified. Its structure is clearly demonstrated by the NMR spectrum which is in agreement with the formulation of 2-(2-methyl-1-propenyl)-6,8,8-trimethyl-bicyclo[4.2.0]oct-2-ene-4-one:



(NMR spectrum of VII (in CCl_4): 9.01 τ (singlet; 3H; methyl in 6), 8.78 and 8.72 τ (singlets; 6H; methyls in 8), 8.28

τ (singlet; 2H; hydrogens in 7), 8.11 τ (doublet, $J \sim 1$ c/s; 6H; methyls in 10), 7.84 and 7.59 τ (doublets, $J = 16$ c/s; 2H; hydrogens in 5), 6.63 τ (singlet; 1H; hydrogen in 1), 4.45 τ (multiplet; 1H; hydrogen in 9), 4.12 τ (doublet, $J \sim 1$ c/s; 1H; hydrogen in 3).

Fraction 4 was hydrolyzed with diluted hydrochloric acid. The resulting mixture of neutral products, chromatographed with benzene on alumina, afforded a solid product (VIII) (m.p. 123°C; IR spectrum: $\nu = 1710 \text{ cm}^{-1}$ (nujol)) which analyzes correctly for $\text{C}_{15}\text{H}_{24}\text{O}_2$ (found: C 76.30, H 10.25; calcd.: C 76.22, H 10.25). The very simple NMR spectrum of VIII suggests the following structure:



(VIII)

(NMR spectrum of product VIII (in CDCl_3): 8.97 τ (singlets; 12H; methyls in 4 and 8), 8.30 τ (singlet; 4H; hydrogens in 5 and 7), 7.81 and 7.67 τ (singlets; 8H; hydrogens in 1, 3, 9, 11)).

The reaction between the ketal I and amines has been also performed using N-methylaniline as secondary amine. In this case the production of the expected amount of ethanol becomes complete in a very short time (about 30 minutes). From the reaction mixture it has been possible to

isolate by vacuum distillation a mixture of enaminic compounds. On hydrolysis with aqueous hydrochloric acid this mixture gave substantial amounts of the diketone VIII (about 20% of the theoretical on the basis of the starting quantity of I) and a minor amount (about 2%) of a solid derivative (IX), also ketonic in character, (m.p. 96°C; UV spectrum: $\lambda_{\text{max}}^{\text{MeOH}} = 247 \text{ m}\mu$; IR spectrum: $\nu = 1670 \text{ cm}^{-1}$ and 1720 cm^{-1}). IX analyzes correctly for $\text{C}_{18}\text{H}_{28}\text{O}_2$ (found: C 78.02, H 9.95; calcd; C 78.21, H 10.21). NMR spectrum of IX doesn't allow, as it happens for the other products here described, a sure structure assignment. The interesting point of the reaction with N-methylaniline is the absence, among the reaction products, of all the ketones which appear before the spiranic compound VIII in the reaction with morpholine.

All the new products can be formally derived from the condensation of several (4, 5 or 6) molecules of acetone, but are different from the known products of polycondensation of acetone; further work is in progress to establish the nature of the intermediates through which the preceding structures are formed and to confirm the above results by chemical evidence.

ACKNOWLEDGMENT

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