NEW AMINOALKYL AND VINYL DERIVATIVES OF PYRIDINE AND QUINOLINE

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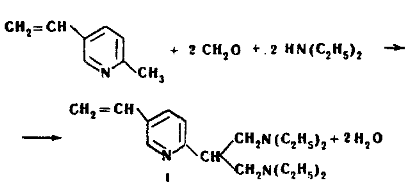
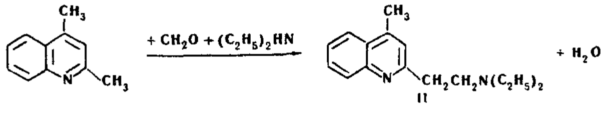
New bases have been obtained by the Mannich reaction from 2-methyl-5-vinylpyridine and from 2,4-dimethylquinoline. Decomposition of quaternary salts of these bases has yielded previously unknown vinyl derivatives of pyridine and quinoline.

It has been shown that the aminoalkylation of alkylpyridines and alkylquinolines with the subsequent decomposition of the quaternary salts of the Mannich bases formed is a convenient method for obtaining vinyl derivatives of these heterocycles [1, 2]. Continuing work in this direction, we have obtained 1,3-bis (diethylamino)-2-(5'-vinyl-2'-pyridyl) propane (I) from 2-methyl-5-vinylpyridine (MVP), diethylamine hydrochloride, and formaldehyde. The reaction takes place in accordance with Scheme 1.



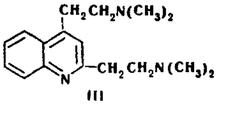
A competing reaction occurs simultaneously with the formation of 2-(β-diethylaminoethyl)-5-vinylpyridine, which we have described previously [1]. The quantity of products obtained at a constant pH of 7–8 depends on the ratio of the initial reactants and the order of their addition. The process takes place best at 70° C. Lower temperatures reduce the rate of the reaction, and at higher temperatures a large amount of resin is formed through the polymerization of the MVP.

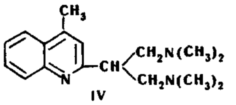
The reaction of 2,4-dimethylquinoline with formaldehyde and dimethylamine hydrochloride led to the monosubstituted base with a yield of 54%. The reaction takes place under mild conditions (55° C, pH 7–8) by Scheme 2.



According to the literature [3–7], in this case only the α-substituted compounds should be formed. This is confirmed by the fact that the corresponding vinyl derivative obtained from this base has no tendency to polymerize under the usual conditions. It is known that γ-vinylquinoline very readily polymerizes on standing in the air, while the α-isomer does not [2].

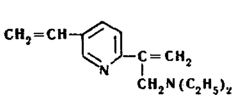
Attempts to synthesize the 2,4-bis-base from 2,4-dimethylquinoline, diethylamine hydrochloride, and formaldehyde by a method described in the literature [8] did not confirm the results obtained by the author concerned. However, when the diethylamine was replaced by the more active dimethylamine, the bis-base was obtained in good yield. It is probable that in this case a mixture of the isomeric products III and IV was formed

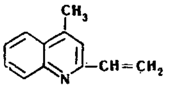

III


IV

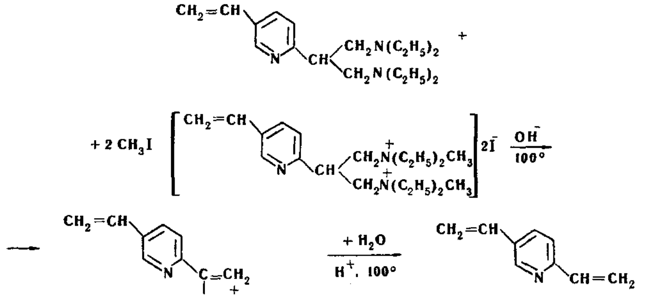
but this was not definitely proved. It was impossible to isolate the corresponding vinyl derivatives because the product of the decomposition of the quaternary salt of this base underwent polymerization on distillation. According to the literature, it may be concluded that Reactions (1) and (2) take place by a S_N2 mechanism and are catalyzed by hydroxyl ions [2].

The decomposition of the quaternary salts of bases I and II gave the unsaturated derivatives V and VI.


V


VI

Substances of type V have been described in the literature only for the quinoline series [9]. It is known that if the active hydrogen in the compound reacting with formaldehyde and a dialkylamine is located on a tertiary carbon atom, the decomposition of the reaction product with the formation of a double bond cannot take place [10,11]. Consequently, when conditions favoring hydrolysis exist, decomposition into dialkylamine, formaldehyde, and the initial compound takes place. We have succeeded in finding conditions for the hydrolysis of the base V in which 2,5-divinylpyridine is formed. This hydrolysis takes place at pH 2–3, but does not occur in an alkaline medium. To facilitate hydrolysis, it was not the base itself that was used but a quaternary salt of I, without being isolated from the reaction mixture. The whole process may be illustrated by the following equation



The degree of hydrolysis, determined from the yield of 2,5-divinylpyridine and calculated with respect to the 1-diethylamino-2-(5'-vinyl-2'-pyridyl)-2: propene (V) undergoing hydrolysis was 35%. The bases and vinyl derivatives obtained may find wide use as complex-forming agents and monomers for the synthesis of ion-exchange resins.

EXPERIMENTAL

1,3-Bis(diethylamino)-2-(5'-vinyl-2'-pyridyl)propane (I). With constant stirring, 107.1 g (0.9 mole) of freshly-distilled MVP (containing metol) in 20 ml of propyl alcohol was added dropwise at 70° C to a mixture of 154.2 g (1.8 mole) of 35% formalin and 195.3 g (1.8 mole) of diethylamine hydrochloride over 2 hr. The mixture was kept at the same temperature and at a pH of 7–8 for 5 hr and was then diluted with three volumes of water and was treated with ether (2 × 50 ml). In this way, 5–10 g of unchanged MVP was recovered. The aqueous solution was made alkaline with 156 g (3.9 mole) of sodium hydroxide. The oil that separated out was extracted with ether (3 × 100 ml), dried with anhydrous potassium carbonate, and, after the solvent had been driven off, distilled in vacuum. Another 30–40 g of MVP was recovered, and 65 g of an oil with bp 110–150° C (1–2 mm) was collected; the latter, on fractionation, yielded 20–25 g of 2-(β-diethylaminoethyl)-5-vinylpyridine with bp 115–120° C (1–2 mm) and 30–35 g (20–25%) of I, bp 140–143° C (1–2 mm); n_D^{20} 1.5140, a light yellow oil with a green opalescence polymerizing on being heated with phosphorus. Found, %: C 74.11; H 10.82%. Calculated for $C_{18}H_{31}N_3$, %: C 74.68; H 10.79%.

Bis(diethylaminoalkyl)quinolines (III) and (IV). With constant stirring, 31.4 g (0.2 mole) of 2,4-dimethylquinoline (DMQ) in 30 ml of ethanol and 1 ml of triethylamine to create a pH of 7–8 in the medium were added dropwise over 4 hr to a mixture of 35 g (0.44 mole) of 35% formalin and 37.8 g (0.44 mole) of dimethylamine hydrochloride in 30 ml of ethanol heated to 65° C. The reaction mixture was kept at the same temperature for another hour and was then treated in the same way as in the preceding experiment. Vacuum distillation was carried out in small portions from a short-necked Claisen flask. The yield of viscous light yellow oil was 35–40 g (66–75%), bp 180–185° C (2 mm); n_D^{20} 1.5550. Found, %: C 75.01; H 9.30%. Calculated for $C_{17}H_{25}N_3$, %: C 75.27; H 9.22%.

2-(β-Diethylaminoethyl)-4-methylquinoline (II). A two-necked flask fitted with a stirrer and dropping funnel was charged with 70.6 g (0.45 mole) of DMQ, 25.7 g (0.3 mole) of 35% formalin, 60 ml of propyl alcohol, and 1 ml of triethylamine. Then the mixture was heated to 55° C and, with stirring, 33 g (0.3 mole) of diethylamine hydrochloride in 20 ml of propyl alcohol and 15 ml of water was added dropwise over 3 hr. Heating was continued for another hour, and then the mixture was worked up in a similar manner to the preceeding experiment. This yielded 38–40 g of unchanged DMQ and 23–25 g (50–54%) of II, bp 170–175° C (1 mm), n_D^{20} 1.571. Found, %: C 79.20; H 9.17%. Calculated for $C_{16}H_{22}N_2$, %: C 79.29; H 9.15%.

1-Diethylamino-2-(5'-vinyl-2'-pyridyl)-2-propene (V). In small portions, 12.6 g (0.1 mole) of dimethyl sulfate was added to a solution of 28.9 g (0.1 mole) of I in 30 ml of propyl alcohol at a temperature not exceeding 40° C. The homogeneous mixture was left for 1 hr, after which 100 ml of water and 5 g of sodium hydroxide in 10 ml of water were added. The mixture was heated in the boiling water bath for 1.5 hr. After cooling, the reaction product was extracted and fractionally distilled in vacuum. The yield of colorless substance was 8 g (37%), bp 115–118° C (1–2 mm), n_D^{20} 1.537. Found, %: C 77.40; H 9.42%. Calculated for $C_{14}H_{20}N_2$, %: C 77.73; H 9.32%.

4-Methyl-2-vinylquinoline (VI). In a manner similar to the preceding experiment, 24.2 g (0.1 mole) of dimethyl sulfate yielded 6.6 g (39%) of VI, with bp 129–130° C (2 mm), n_D^{20} 1.635. Found, %: C 84.88; H 6.72%. Calculated for $C_{12}H_{11}N$, %: C 85.17; H 6.55%.

2,5-Divinylpyridine. In small portions, 14.2 g (0.1 mole) of methyl iodide in 15 ml of propyl alcohol was added through a reflux condenser to 14.5 g (0.05 mole) of I in 10 ml of propyl alcohol. The mixture was heated in the water bath at 50° C for 15 min and then 4 g of sodium hydroxide in 100 ml of water was added and it was boiled for 1 hr. After cooling, the reaction mixture was neutralized with 8.1 ml of concentrated HCl, the pH of the medium was brought to 2–3, another 5–6 ml of acid was added, and it was again heated in the boiling water bath for 1.5 hr. Then it was made alkaline and distilled with steam. The oil was extracted from the distillate with ether and distilled in vacuum from a water bath. This gave 0.9 g of divinylpyridine, bp 68–70° C (1 mm), n_D^{20} 1.5889. The degree of hydrolysis was 37.5%.

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