SYNTHESIS OF ALKENYLQUINOLINES AND CYCLIZATION OF (1-METHYL-2-BUTENYL)QUINALDINES IN POLYPHOSPHORIC ACID

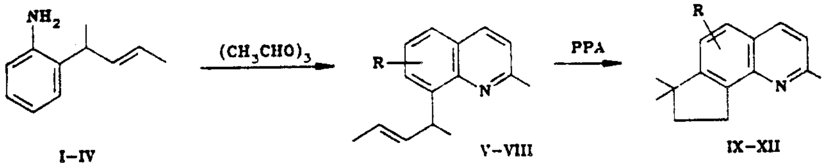
I. B. Abdrakhmanov, I. N. Khalilov, A. G. Mustafin, and G. A. Tolstikov

UDC 547.831.12.04

The reaction of 2- and 4-alkenylanilines with paraldehyde gave 6- and 8-alkenylquinaldines. Heating 8-(1'-methyl-2'-butenyl)quinaldines in polyphosphoric acid leads to the formation of tricyclic compounds with isomerization of the alkenyl group.

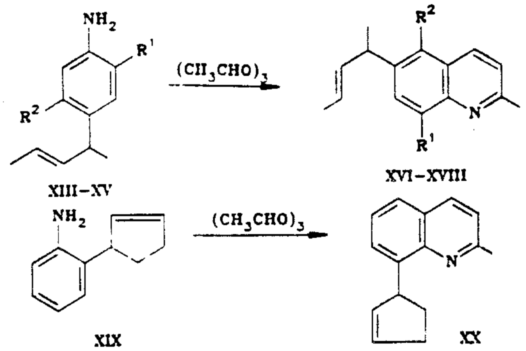
2-Alkenylanilines are convenient reagents for obtaining various heterocyclic compounds [1-4]. Their use for the synthesis of quinolines makes it possible to obtain unsaturated quinolines that can be cyclized to tricyclic compounds.

With this end in mind, a number of 2-alkenylanilines were subjected to reactions to synthesize quinolines. 8-Alkenylquinaldines V-VIII are formed in up to 87% yields in the reaction of 2-(1'-methyl-2'-butenyl)anilines I-IV with paraldehyde [5].



I, V, IX R=H; II, VI, X R=4-CH$_3$; III, VII, XI R=5-CH$_3$; IV\ VIII, XII R=4-OCH$_3$

Quinaldine derivatives were obtained on the basis of 4-(1'-methyl-2'-butenyl)anilines XIII-XV, as well as from 2-(2-cyclopentenyl)aniline (XIX).



XIII, XIV, XVI, XVII R^1=H; XV, XVIII R^1=CH$_3$; XIII, XVI R^2=H, XIV, XV, XVII, XVIII R^2=CH$_3$

It was established that cyclization under the influence of polyphosphoric acid proceeds only in the case of 8-alkenylquinaldines V-VIII and leads to the formation of tricyclic compounds IX-XII; isomerization of the 1-methyl-2-butenyl substituent, which is confirmed by the appearance in the PMR spectra of a six-proton singlet signal at 1.16-1.27 ppm [6], is observed. It should be noted that heating 6-alkenyl- and 8-cyclopentenylquinaldines XVI-XVIII and XX is accompanied by resinification and does not give cyclization products.

Institute of Chemistry, Bashkir Science Center, Ural Branch, Academy of Sciences of the USSR, Ufa 450054. Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 10, pp. 1364-1366, October, 1990. Original article submitted November 4, 1988.

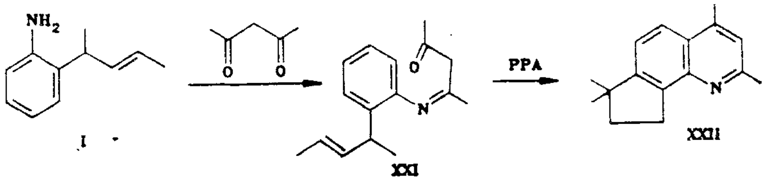
TABLE 1. Characteristics of V-XII and XVI-XXII

Compound	Empirical formula	bp,* °C	IR spectrum, cm^{-1}	PMR spectrum, δ, ppm	Yield, %
V	$C_{15}H_{17}N$	135	760, 970, 1600, 2970	1,41 (3H, d, CH_3); 1,65 (3H, d, CH_3); 2,70 (3H, s, CH_3); 4,88 (1H, m, CH); 5,46...5,86 (2H, m, HC=CH); 7,06...7,96 (5H, m, ArH)	87
VI	$C_{16}H_{19}N$	140	970, 1450, 1600, 2950	1,41 (3H, d, CH_3); 1,66 (3H, d, CH_3); 2,46 (3H, s, CH_3); 3,60 (3H, s, CH_3); 4,76...5,05 (1H, m, CH); 5,50...5,80 (2H, m, HC=CH); 6,70...7,85 (4H, m, ArH)	85
VII	$C_{16}H_{19}N$	138	800, 980, 1450, 1600	1,32 (3H, d, CH_3); 1,58 (3H, d, CH_3); 2,33 (3H, s, CH_3); 3,36 (3H, s, CH_3); 4,73...5,02 (1H, m, CH); 5,27...5,70 (2H, m, HC=CH); 6,76...7,86 (4H, m, ArH)	84
VIII	$C_{16}H_{19}N$	134	980, 1460, 1600, 2930, 2970	1,40 (3H, d, CH_3); 1,63 (3H, d, CH_3); 2,62 (3H, s, CH_3); 3,73 (3H, s, CH_3); 4,76...5,06 (1H, m, CH); 5,40...5,78 (2H, m, HC=CH); 6,66...7,82 (4H, m, ArH)	82
IX	$C_{15}H_{17}N$	—	840, 1450, 1600, 2850	1,27 (6H, s, $2CH_3$); 1,83...2,16 (4H, m, $2CH_2$); 2,53 (3H, s, CH_3); 6,9...7,9 (4H, m, ArH)	36
X	$C_{16}H_{19}N$	—	750, 970, 1450, 1600, 2920, 2970	1,24 (6H, s, $2CH_3$); 1,82...2,13 (4H, m, $2CH_2$); 2,55 (3H, s, CH_3); 2,60 (3H, s, CH_3); 6,8...7,16 (2H, m, ArH)	32
XI	$C_{16}H_{19}N$	—	800, 1450, 1600, 2950	1,23 (6H, s, $2CH_3$); 1,80...2,12 (4H, m, $2CH_2$); 2,53 (3H, s, CH_3); 2,6 (3H, s, CH_3); 6,9...7,15 (2H, m, ArH); 7,88 (1H, s, ArH)	34
XII	$C_{16}H_{19}ON$	—	815, 1120, 1600, 2930, 2970	1,16 (6H, s, $2CH_3$); 1,5...1,75 (4H, m, $2CH_2$); 2,56 (3H, CH_3); 3,73 (3H, s, OCH_3); 6,9...7,33 (3H, m, ArH)	29
XVI	$C_{15}H_{17}N$	140	830, 970, 1500, 1600, 2910	1,38 (3H, d, CH_3); 1,66 (3H, CH_3, 4 Hz); 2,70 (3H, s, CH_3); 3,42...3,67 (1H, m, CH); 5,48...5,65 (2H, m, HC=CH); 7,12...8,02 (5H, m, ArH)	84
XVII	$C_{16}H_{19}N$	141	980, 1450, 1600, 2920, 2950	1,30 (3H, d, CH_3); 1,58 (3H, d, CH_3); 2,42 (3H, s, CH_3); 2,55 (3H, s, CH_3); 3,5...3,83 (1H, m, CH); 5,13...5,55 (2H, m, HC=CH); 6,95...7,91 (4H, m, ArH)	80
XVIII	$C_{17}H_{21}N$	150	980, 1450, 1600, 2920, 2950	1,32 (3H, d, CH_3); 1,65 (3H, d, CH_3); 2,50 (3H, s, CH_3); 2,68 (3H, s, CH_3); 2,73 (3H, s, CH_3); 3,70...3,93 (1H, m, CH); 5,42...5,65 (2H, m, HC=CH); 7,37 (1H, s, ArH); 7,13 (1H, d, ArH); 8,13 (2H, d, ArH)	75
XX	$C_{15}H_{15}N$	134	750, 1500, 1600, 2920, 3040	0,83...2,22 (4H, m, $2CH_2$); 2,68 (3H, s, CH_3); 5,1...5,48 (1H, m, CH); 5,75...6,00 (2H, m, HC=CH); 7,02...7,96 (5H, m, ArH)	79
XXI	$C_{16}H_{21}NO$	132	750, 1280, 1580, 1610, 2960	1,26 (3H, d, CH_3); 1,60 (3H, d, CH_3); 1,73 (3H, s, CH_3); 2,06 (3H, s, CH_3); 3,40...3,83 (1H, m, CH); 5,16 (2H, s, CH_2); 5,36...5,53 (2H, m, HC=CH); 6,9...7,33 (4H, m, ArH)	96
XXII	$C_{16}H_{19}N$	153	750, 970, 1450, 1590, 2930, 2970	1,25 (6H, s, $2CH_3$); 1,81...2,10 (4H, m, $2CH_2$); 2,46 (3H, s, CH_3); 2,52 (3H, s, CH_3); 7,42...7,51 (2H, m, ArH); 7,80 (1H, s, ArH)	28

---

*At a pressure of 1 mm (2 mm for XXII).

The condensation of amine I with acetylacetone [7] leads to the formation of XXI in 96% yield, heating of which in polyphosphoric acid (PPA) leads to the formation of tricyclic quinoline XXI in 28% yield.



The structures of the compounds obtained were proved by spectral methods and by elementary analysis (Table 1).

Thus, 6- and 8-alkenylquinaldines were synthesized on the basis of 2- and 4-alkenylanilines. Heating 8-(1'-methyl-2'-butenyl)quinaldines in PPA leads to tricyclic quinoline compounds with isomerization of the alkenyl substituent.

EXPERIMENTAL

The IR spectra of films of the compounds were recorded with a UR-20 spectrometer. The PMR spectra of solutions in CCl_4 were obtained with a Tesla BS-487 spectrometer (60 MHz) with tetramethylsilane (TMS) as the internal standard. Analysis by GLC was carried out with an LKhM-8MD chromatograph with a column (2700 × 3 mm) packed with 5% SE-30 on Chromaton N-AW-DMC; the helium flow rate was 40 ml/min.

Starting compounds I-IV, VIII-XV, and XIX were obtained by the methods in [8, 9].

Synthesis of Alkenylquinaldines. A mixture of 80 mmoles of the alkenylaniline, 7 g (52 mmoles) of paraldehyde, 4.5 ml of concentrated HCl, and 0.05 g of $ZnCl_2$ was heated for 5 h at 180°C, after which the mixture was cooled and treated with 10 g of 40% KOH. The products were extracted with benzene and dried over KOH. The alkenylquinaldines were isolated by distillation at reduced pressure.

Cyclization of 8-(1'-Methyl-2'-butenyl)quinaldines in PPA. A 3.7 g (17 mmoles) sample of the 8-alkenylquinaldine was added to 20 g of PPA, prepared from 12.5 g of P_2O_5 and 7.5 g of H_3PO_4, and the reaction mixture was heated for 6 h at 140°C. The mixture was then treated with KOH solution, and the alkaline mixture was extracted with benzene. The extract was dried over KOH, the solvent was removed by distillation, and the product was isolated by chromatography with a column packed with Al_2O_3 with hexane–benzene (5:1) as the eluent. This procedure gave 1.33 g of IX, 1.18 g of X, 1.25 g of XI, and 1.07 g of XII.

Synthesis of XXII. A mixture of 20 g (124 mmoles) of 2-alkenylaniline I and 17 g (125 mmoles) of acetylacetone was heated for 3 h at 105°C. Vacuum distillation gave 29 g of XXI.

A 74 g sample of PPA (prepared from 20 g of P_2O_5 and 54 g of H_3PO_4) was added to 7.4 g of the XXI obtained above, and the mixture was heated for 12 h at 140°C. It was then treated with 40% KOH solution, and the alkaline mixture was extracted with benzene. Vacuum distillation gave 1.9 g of XXII.

LITERATURE CITED

1. L. S. Hegedus, G. F. Allen, J. J. Bozell, and E. L. Waterman, *J. Am. Chem. Soc.*, **100**, 5800 (1978).
2. R. R. Webb and S. Danishefsky, *Tetrahedron Lett.*, **24**, 1357 (1983).
3. B. Scholl and H.-J. Hansen, *Helv. Chim. Acta*, **63**, 1823 (1980).
4. I. B. Abdrakhmanov, A. G. Mustafin, G. A. Tolstikov, and U. M. Dzhemilev, *Khim. Geterotsikl. Soedin.*, No. 4, 505 (1987).
5. R. Elderfield (ed.), *Heterocyclic Compounds* [Russian translation], Vol. 4, IL, Moscow (1955).
6. I. B. Abdrakhmanov, A. G. Mustafin, V. M. Sharafutdinov, A. S. Taichinova, and G. A. Tolstikov, *Izv. Akad. Nauk SSSR, Ser. Khim.*, No. 4, 839 (1985).
7. G. Saint-Ruf, De Ashish, and J. C. Perche, *Bull. Soc. Chim. Fr.*, Nos. 7-8, 2514 (1973).
8. I. B. Abdrakhmanov, V. M. Sharafutdinov, N. G. Nigmatullin, I. A. Sagitdinov, and G. A. Tolstikov, *Zh. Org. Khim.*, **18**, 1466 (1982).
9. I. B. Abdrakhmanov, V. M. Sharafutdinov, and G. A. Tolstikov, *Izv. Akad. Nauk SSSR, Ser. Khim.*, No. 9, 2160 (1982).