A POLAROGRAPHIC INVESTIGATION OF BENZYLISOQUINOLINE ALKALOIDS

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We have previously reported the use of the polarographic wave of thalsimine for the quantitative determination of this alkaloid in the epigeal part of Thalictrum simplex [1]. In the present paper we give the results of an investigation of the electrochemical properties of compounds related to it in order to determine the dependence between polarographic behavior and structure.

We have studied the benzylisoquinoline alkaloids thalfine, thalsimine, thalsimidine, hernandezine, armepavine [2], and tetrandrine [3], differing in the complexity of their structures (Table 1). The polarographic activities of these alkaloids are shown in the formation of diffusion and catalytic hydrogen waves in aqueous ethanolic media in the presence of tetraethylammonium hydroxide in Britton-Robinson buffer solutions [4].

Diffusion waves were shown only by compounds with C−N and C−C double bonds. By polarographic microcoulometry [5] we have determined the number of electrons participating in the reaction, which is four for thalfine, and two for thalsimine and thalsimidine. The products of the electrode reactions are the corresponding tetrahydro derivatives, as was confirmed by the absence of diffusion waves for synthetic (dihydrothalsimine) and natural (hernandezine) derivatives. The existence of a direct proportionality between the magnitude of the diffusion current and the concentrations of the alkaloids in the range from $1 \cdot 10^{-3}$ to $1 \cdot 10^{-4}$ M enables these waves to be used for analytical purposes. The polarographic characteristics of the bimolecular compounds (see Table 1) were compared with those of monomolecular compounds − papaverine and its derivatives [6, 7]. The isoquinoline rings of thalfine, papaverine, and papaveraldine are reduced only against a background of $(C_2H_5)_4NOH$, and the dihydroisoquinoline derivatives (thalsimine, thalsimidine, 3,4-dihyropapaverine, and 3,4-dihydropapaveraldine) are reduced both on a background of $(C_2H_5)_4NOH$ and in Britton−Robinson buffers.

The catalytic currents for equimolar concentrations of the alkaloids differ (see Table 1): in 0.1 N $(C_2H_5)_4NOH$ (pH 12) the current is greatest for thalsimine and there is no current for thalfine and papaverine. For the latter, catalytic hydrogen waves were observed in buffer solutions only at pH values < 8. There is information in the literature [8] showing a connection between the ionization constants of alkaloids and the size

TABLE 1. Polarographic Indices of Benzylisoquinoline Alkaloids (c 1.0 mM)

Alkaloid*	0.1 N $(C_2H_5)_4NOH$, 80% Ethanol				0.1 N $(C_2H_5)_4NOH$, 40% Ethanol		0.01 N $(C_2H_5)_4$ NOH, 40% Ethanol	
	i_d, μA	$E_{1/2}$, V	n	$D_2 \cdot 10^6$ cm²·sec⁻¹	i, μA	$E_{1/2}$, V	i, μA	$E_{1/2}$, V
Papaverine	6,72	1,75	4	2,08	—	—	—	—
Thalfine	6,56	1,70	4	2,58	—	—	—	—
Thalsimine	3,52	1,45	2	2,68	2,08	2,20	33,25	2,25
Thalsimidine	3,60	1,45	2	2,60	2,00	2,20	30,00	2,22
Tetrandrine	—	—	—	—	0,64	1,90	2,05	2,00
Hernandezine	—	—	—	—	0,45	1,85	1,92	1,90
Armepavine	—	—	—	—	0,45	1,85	1,28	1,90

*Isoquinole derivatives: 1) benzyl-; 2) bisbenzyl-; 3) bisbenzyldihydro-; 4) bisbenzyldihydro-; 5) bisbenzyltetrahydro-; 6) bisbenzyltetrahydro-; 7) benzyltetrahydro-.

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of the catalytic current: the higher the pK_a values the greater the catalytic current. Consequently, by arranging the alkaloids in order of increasing catalytic current we shall obtain information on the relative basicities of this series of compounds.

EXPERIMENTAL

The polarographic measurements were performed in an electrolyzer with an internal anode on a LP-55A polarograph; characteristics of the capillary at $h_{Hg} = 45$ cm: $m = 0.76$ mg · sec^{-1}, $t = 3.5$ sec in 1 N KCl. The temperature of the determinations was 25 ± 0.5°C.

SUMMARY

1. The polarographic behavior of six benzoisoquinoline alkaloids has been investigated. In the reduction of thalfine, thalsimine, and thalsimidine the products of the electrode reactions are the corresponding tetrahydro derivatives.

2. The size of the catalytic current can be used for a comparative evaluation of the basicities of this series of alkaloids.

LITERATURE CITED

1. D. A. Rakhimova, E. K. Dobronravova, and T. T. Shakirov, Khim. Prirodn. Soedin., 387 (1975).
2. S. Yu. Yunusov, Alkaloids [in Russian], Tashkent (1974), p. 100.
3. A. P. Orekhov, The Chemistry of the Alkaloids [in Russian], Moscow (1955), p. 524.
4. H. T. S. Britton, Hydrogen Ions, 2nd ed., Chapman and Hall, London (1932).
5. A. G. Stromberg and T. M. Markacheva, Zh. Fiz. Khim., 28, No. 4, 671 (1954).
6. V. D. Bezuglyi, Zh. Obshch. Khim., 24, 2190 (1954).
7. M. Maturová, Tschu Shun, F. Čtvrtnik, and F. Šantavý, Collection Czech. Chem. Commun., 25, 3321 (1960).
8. S. G. Mairanovskii, Usp, Khim., 33, No. 1, 75 (1964).

METHOD FOR THE QUANTITATIVE DETERMINATION OF PROTOPINE IN *Fumaria vaillantii*

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The alkaloid protopine [1] isolated from epigeal part of *Fumaria vaillantii* Loisel. (family Papaveraceae) is pharmacologically active [2, 3]. In the present paper we give the results of a polarographic investigation of protopine and propose a method for its quantitative determination in plant raw material.

Polarographic waves have been obtained previously [4] for protopine, but they were unsuitable for analytical purposes. We have detected distinct diffusion waves of this alkaloid with $E_{1/2} = -1.80$ to -1.85 V in 0.1 N $(C_2H_5)_4NOH$ in 70% dioxane. A linear relationship was found between the current and the concentration of protopine in the solution in the range from $2.9 \cdot 10^{-3}$ to $2.9 \cdot 10^{-4}$ M.

In the range of working concentrations, the polarographic behaviors of the alkaloid and of its hydrochloride are similar. This circumstance has been used for the quantitative determination of protopine by the method of standard solutions, with the introduction into the formula for calculation of a correction factor equal to the ratio of the molecular weights of the alkaloid and its salt. In order to determine the mechanism of the

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