

A POLAROGRAPHIC INVESTIGATION OF THE ALKALOIDS OF *Peganum harmala*

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UDC 547.944/945+543.253.422

The epigeal part of *Peganum harmala* L. family Ligophyllaceae contains a number of pharmacologically active alkaloids [1, 2]. There is information in the literature on the spontaneous oxidation of peganine to vasicinone [3] and of deoxypeganine to deoxyvasicinone [4]. In the process of isolating peganine and deoxypeganine from the plant raw material, the oxidation products are undesirable impurities the chromatographic detection of which is difficult in view of the low sensitivity of revelation (by the Dragendorff reagent and by iodine vapor—20 and 200 μg for deoxypeganine and deoxyvasicinone, respectively). To investigate the latter compounds, we have used a polarographic method the results of which are given in the present paper. We first studied the polarographic properties of the alkaloids of *Peganum harmala*: quinazoline alkaloids (peganine, deoxypeganine, vasicinone, deoxyvasicinone, and peganol) and indole alkaloids (harmine and harmaline) [5]. They all form catalytic hydrogen waves in aqueous ethanol in the presence of tetraalkylammonium salts and bases (Table 1). Vasicinone, deoxyvasicinone, and harmine showed clear diffusion waves in addition to catalytic waves (see Table 1). The difference in the values of the half-wave potentials of peganine and vasicinone, and of deoxypeganine and deoxyvasicinone, have been used for the detection of the oxidation products (down to 0.1%) in the main substance. Where the impurities are present, on a polarogram in 0.1 N $(\text{C}_2\text{H}_5)_4\text{NOH}$ in 80% ethanol before the peganine wave with $E_{1/2} = -1.95$ V (for deoxypeganine, with $E_{1/2} = -2.18$ V), a distinct wave of vasicinone appears with $E_{1/2} = -1.70$ V (for deoxyvasicinone, with $E_{1/2} = -1.85$ V). By using the method of standard solutions [6] we estimated the amount of oxidized form in peganine and deoxypeganine. It was found that the autooxidation of the bases takes place during their storage and during various chemical operations: evaporation, elution, etc. The timely conversion of the bases into their hydrochlorides stabilizes them [4]: no oxidation products were found in solutions of peganine and deoxypeganine hydrochlorides.

According to the literature, on the reduction of vasicinone and of deoxyvasicinone, depending on the reagent, either reduction of the carbonyl group of the quinazoline ring [7] or of the C—N double bond with the retention of the carbonyl group [8] takes place. To elucidate the mechanism of the polarographic reaction, we determined the number of electrons participating in the process and investigated the products of chemical reduction: dihydrovasicinone, dihydrodeoxyvasicinone, and the alkaloid peganol [9]. By polarographic microcoulometry [10] we found that the number of electrons for vasicinone and for deoxyvasicinone was two. The retention

TABLE 1. Polarographic Indices of the Alkaloids of *Peganum* and Their Derivatives; C = 1.0 mM

Name	0.1 N $(\text{C}_2\text{H}_5)_4\text{NI}$, 80% ethanol				0.1 N $(\text{C}_2\text{H}_5)_4\text{NOH}$, 80% ethanol			
	diffusion wave		catalytic hydrogen wave		diffusion wave		catalytic hydrogen wave	
	I_d , μA	$-E_{1/2}$, V	I_{lim} , μA	$-E_{1/2}$, V	I_d , μA	$-E_{1/2}$, V	I_{lim} , μA	$-E_{1/2}$, V
Peganine	—	—	3.41	1.88	—	—	2.23	1.95
Deoxypeganine	—	—	3.28	1.88	—	—	2.36	2.18
Vasicinone	3.87	1.60	22.01	2.02	3.80	1.70	12.84	2.32
Deoxyvasicinone	3.93	1.68	27.51	1.98	3.93	1.85	16.77	2.30
Dihydrodeoxyvasicinone	3.97	1.68	41.66	2.01	4.03	2.05	15.46	2.30
Peganol	—	—	6.03	2.06	—	—	—	—
Harmine	3.93	1.76	—	—	3.93	1.95	—	—
Harmaline	—	—	57.64	2.13	—	—	36.68	2.41
Tetrahydroharmine	—	—	56.33	2.12	—	—	35.37	2.42

Institute of the Chemistry of Plant Substances, Academy of Sciences of the Uzbek SSR, Tashkent. Translated from *Khimiya Prirodnikh Soedinenii*, No. 3, pp. 363–365, May–June, 1976. Original article submitted October 15, 1975.

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of the diffusion wave in the dihydro derivatives of the alkaloids and its absence in the case of peganol (see Table 1) show that the carbonyl group undergoes polarographic reduction and the reaction product is the corresponding carbinol. The reality of this scheme was confirmed by a study of the UV spectrum of the product of the electrolysis of deoxyvasicinone at a controlled potential: its spectrum had only one maximum, at 276 nm, which shows the absence of a quinazolinone structure from it [11].

For harmine the number of electrons found was two. In the case of harmaline (dihydroharmine) there is no diffusion wave (see Table 1). Consequently, in harmine the C-C double bond undergoes hydrolysis and the product of the electrode reaction is dihydroharmine.

EXPERIMENTAL

The investigation was performed on an LP-55A polarograph. The characteristics of the capillary at hHg 55 cm were: $m = 2.175 \text{ mg} \cdot \text{sec}^{-1}$, $t = 2 \text{ sec}$ in 1 N KCl. An electrolyzer with an internal anode was used, and the temperature of the determinations was $25 \pm 0.5^\circ\text{C}$.

SUMMARY

1. The polarographic behavior of seven alkaloids from *Peganum harmala* have been investigated. The products of the electrode reaction in the reduction of vasicinone and deoxyvasicinone are the corresponding carbinols, and in the reduction of harmine the product is dihydroharmine.

2. The possibility has been shown of using the polarographic method for studying the oxidation of peganine and deoxypeganine.

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