THE STRUCTURES OF ERVINIDINE AND ERVINIDININE

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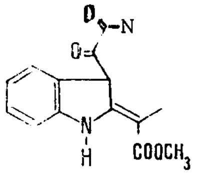
We isolated ervinidine $C_{21}H_{24}N_2O_4$ (mol. wt. 368) from the epigeal part of Vinca erecta Rgl. et Schmalh. [1]. The IR spectrum of the base has absorption bands of an NH group (3310 cm^{-1}) and of three carbonyl groups: a ketonic carbonyl (1720 cm^{-1}), a conjugated ester carbonyl (1690, 1232 cm^{-1}), and a lactam carbonyl (1660 cm^{-1}). The UV spectrum is characteristic for the α-methyleneindoline chromophore.

The NMR spectrum of ervinidine has the signal of the methyl of an ethyl group (δ 1.13 ppm), the methoxy group of an ester (δ 3.85 ppm, singlet), of four aromatic protons (δ 7.61 ppm, multiplet), and of an NH group (δ 9.21 ppm, singlet).

The mass spectrum (Fig. 1) shows the peak of the molecular ion (M^+ 368) and also the peaks of ions with m/e 340 $(M-28)^+$, 228, 214, 168, 154. The formation of the ion with m/e 340 is confirmed by a metastable peak with m/e 314 (the 368 → 340 transition). In addition, the appearance of a strong peak with m/e 340 $(M-CO)^+$ shows that in the base the ketonic carbonyl group is possibly connected directly with the lactam carbonyl group [2]; i.e., the base contains the grouping



This is also shown by the peaks with m/e 214 (d) and 228 (f). The results given show that ervinidine has the structure (I), very similar, on the one hand, to that of vincadine [3] and, on the other hand, to that of vincadifformine [4].

In the mass spectrography of (I), the $C_{11}-C_{12}$ bond is cleaved first, and then carbon monoxide is split off, which leads to the formation of a peak with m/e 340, and a strong peak with m/e 168 apparently arises from *a* as the result of the cleavage of the C_4-C_5 bond.

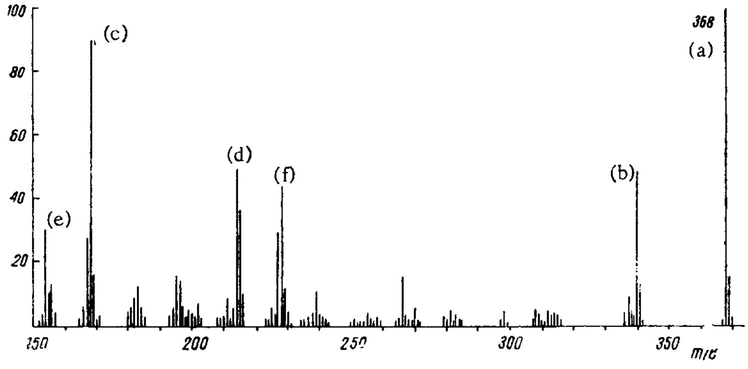


Fig. 1. Mass spectrum of ervinidine.

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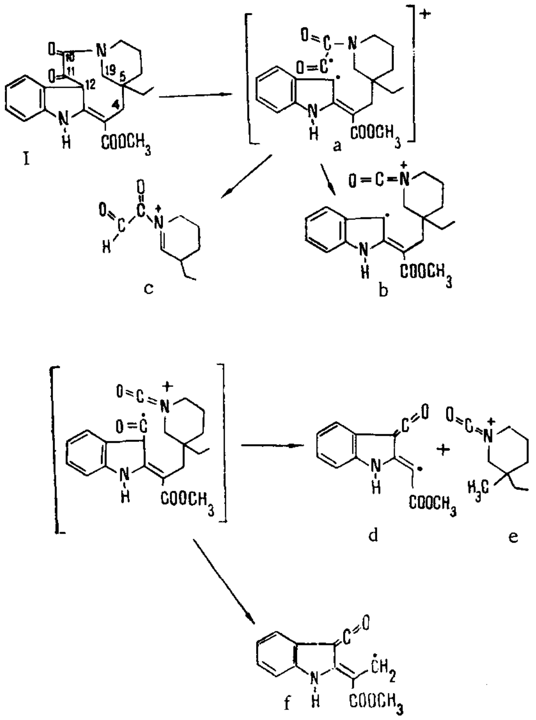
What has been said above permits the structure of 10,11-dioxo-2,3-dehydrovincadine (I) to be proposed for ervinidine.

In the structure of ervinidinine established previously [1], an epoxide bond was found on the basis of a certain analogy with other alkaloids [5]. In the IR spectrum of ervinidinine a weak band was observed at 1632 cm^{-1}. By reducing the base with zinc in a methanolic solution of sulfuric acid, 2,3-dihydroervinidinine (III) was obtained.

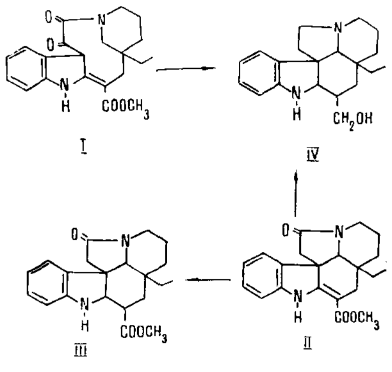


In the IR spectrum of the latter strong absorption bands appeared at 3290 cm^{-1} (NH), 1725 cm^{-1} (nonconjugated carbonyl group), 1675 cm^{-1} (N–CO), and 750 cm^{-1} (disubstituted benzene ring).

Consequently, the base (II) has two carbonyl groups: a conjugated ester carbonyl group and a lactam carbonyl group in a five-membered ring. Thus, ervinidinine possesses the structure of 11-oxovincadifformine (II). To confirm this, ervinidinine was reduced with lithium tetrahydroaluminate. The amorphous amino alcohol vincadifforminol (IV), which is an indoline derivative, was obtained.

The reduction of ervinidine with lithium tetrahydroaluminate formed a mixture of substances with mol. wts. 326, 324, and 312 (mass spectroscopy). One of the reaction products, with mol. wt. 312, was identical with (IV) according to its R_f value and mass spectrum.

In the reaction of ervinidine with lithium tetrahydroaluminate, in addition to the reduction of the carbonyl group, cyclization at the $C_{12}-C_{19}$ position takes place with the formation of more stable five- and six-membered rings. The second reduction product with mol. wt. 312 and the UV spectrum λ_{max} 224, 285, 292 nm (log ε 4.08, 3.40, 3.41) is an indole derivative.



EXPERIMENTAL

Isolation of Ervinidine and Ervinidinine. The nonphenolic fraction of the total alkaloids (300 g) was separated according to the strength of the bases into ten fractions. By treatment with benzene, fractions I-IV gave 6 g of a mixture of the bases ervinidine and ervinidinine.

Ervinidine, $C_{21}H_{24}N_2O_4$ (I), mp 282-283°C (from methanol, decomp.), $[\alpha]_D^{26} + 17° \pm 2°$ (c 0.05; chloroform), R_f 0.40 [TLC on SiO_2, benzene–methanol (9 : 1)]; mol. wt. 368. UV spectrum (ethanol), λ_{max}, nm: 232, 305, 342 (log ε 3.92; 3.93; 4.10).

Ervinidinine, $C_{21}H_{24}N_2O_3$ (II), mp 265-266°C (acetone, methanol, decomp.), $[\alpha]_D^{26} - 160.6°$ (c 0.60; methanol), R_f 0.22 [TLC on SiO_2, benzene–methanol (9 : 1)]. UV spectrum (ethanol), λ_{max}, nm: 228, 298, 332 (log ε 3.86; 3.84; 3.98); IR spectrum (KBr), cm^{-1}: 3250, 1680, 1632, 1600, 760; NMR spectrum (δ scale, ppm): 0.62 (CH_3), 3.69 (OCH_3), 8.91 (NH); mass spectrum: 352 M^+ (58), 320 (7), 241 (4), 214 (100), 182 (8), 154 (9%).

2,3-Dihydroervinidinine (III). A solution of 30 mg of the base in 30 ml of 10% methanolic sulfuric acid was treated with 1 g of zinc dust and boiled on the water bath for 30 min. The filtered solution was evaporated in vacuum to small volume, the residue was dissolved in water, and the solution was made alkaline and extracted with ether. The residue was crystallized from methanol, mp 215-216°C. UV spectrum (ethanol), λ_{max}, nm: 248, 308 (log ε 3.40, 3.62); mass spectrum: 354 (M^+); NMR spectrum, ppm: 0.50 (CH_3), 3.64 (OCH_3), 4.35 (NH).

Vincadifforminol (IV). A solution of 50 mg of the base in 200 ml of absolute ether was treated with 300 mg of lithium tetrahydroaluminate and boiled under reflux in the water bath for 8 h. From the reaction products, 30 mg of an amorphous base was obtained. IR spectrum, cm^{-1}: 3310-3380, 1610 UV spectrum (ethanol), λ_{max}, nm: 248, 303 (log ε 3.77, 3.34); mass spectrum: 312 M^+, 254, 182, 156, 144, 130, 124 (100%).

The mass spectra were taken on an MKh-1303 instrument, the NMR spectra on a JNM-4H-100/100 MHz instrument with HMDS as internal standard (δ scale) – the spectrum of ervinidine in trifluoroacetic acid and that of ervinidinine in $CDCl_3$.

SUMMARY

On the basis of a study of chemical properties, spectral results, and conversion into vincadifforminol, it has been established that ervinidine has the structure of 10,11-dioxo-2,3-dehydrovincadine, and ervinidinine is 10-oxovincadifformine.

LITERATURE CITED

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