ALKALOIDS OF CORYDALIS PSEUDOADUNCA AND C. GORTSCHAKOVII

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We have studied the alkaloids of the genus Corydalis [1,2] from various growth sites and in various phases of development. In this paper we give the results of a study of C. pseudoadunca collected in the fruit-bearing phase (Alai Valley—Basin of R. Nura) and in the budding and incipient flowering phase (Pamir), and C. gortschakovii collected in the flowering phase (western Tien-Shan, upper reaches of the R. Pskem).

The chloroform extraction of 2.5 kg of the air-dried plant (C. pseudoadunca, fruit-bearing phase) gave 33.15 g (1.34%) of ethereal and 0.61 g (0.04%) of chloroformic alkaloids. The ethereal alkaloids were separated into phenolic (4.46 g) and nonphenolic (27.69 g) fractions. The nonphenolic alkaloids, on treatment with a methanol–chloroform mixture, gave 5.51 g of a crystalline mixture of bases from which, by fractional crystallization from methanol–chloroform, 0.8 g of d-bicuculline and 0.7 g of d-β-hydrastine were isolated. The evaporated mother solution was triturated with acetone, giving 0.09 g of a base with mp 220–221° C (methanol–chloroform), $[\alpha]_D^{18}$ −100° (c 0.52, chloroform); hydrochloride mp 242° C. UV spectrum of the base: $\lambda_{max}^{ethanol}$, mμ: 225, 295, and 325 (log ε 4.36, 3.72, and 3.68). The IR spectrum has absorption bands at (cm^{-1}) 1505 and 1615 (aromatic ring), 1750 (ester group), and 935, 1030, and 1040 (CH_2O_2). The mass spectrum of this base lacks the molecular ion, and the main peak corresponds to an ion with m/e 190. In the NMR spectrum, there are signals in the form of a three-proton singlet at 2.45 ppm ($N—CH_3$), two two-proton singlets at 5.76 and 6.00 ppm (2 CH_2O_2), one-proton singlets at 6.31 and 6.58 ppm due to para-aromatic protons, and one-proton doublets at 6.84 and 7.06 ppm (J = 8 Hz), characteristic for ortho-aromatic protons. These properties are in complete agreement with those for *l*-adlumidine [3].

Subsequent treatment of the residual nonphenolic alkaloids with methanol yielded 0.39 g of protopine. Evaporation of the ethereal phenolic alkaloids yielded 1.1 g of coramine [2]. After the separation of the coramine, the remaining ethereal phenolic alkaloids were chromatographed on a column of alumina (1 : 30). The alkaloids were eluted with ether, ether–chloroform mixtures (50 : 1 and 10 : 1), chloroform, chloroform–methanol mixtures (50 : 1 and 10 : 1), and methanol. The ethereal fraction yielded 0.09 g of a base with mp 192–194° C (ethanol), $[\alpha]_D^{16}$ − 260° (c 0.5, ethanol); hydrochloride with mp 263° C (decomp), methiodide with mp 245-249°C (decomp). UV spectrum of the base: $\lambda_{max}^{ethanol}$ 287 mμ (log ε 3.80). The IR spectrum shows absorption bands at (cm^{-1}) 3455 (hydroxyl group) and 1590 and 1500 (aromatic ring). The mass spectrum has the peak of the molecular ion with m/e 327, and also strong peaks of ions with m/e 326, 178, 176, and 150. The NMR spectrum has a six-proton singlet at 3.75 ppm (2 OCH_3), and signals at 6.50 and 6.71 ppm due to four aromatic protons. A comparison of the properties given for this base with those of *l*-scoulerine [4] showed their identity.

From C. pseudoadunca (2.4 kg) collected in the budding and flowering phase we obtained 27.37 g (1.1%) of ethereal and 0.87 g (0.03%) of chloroformic alkaloids. The ethereal alkaloids were separated into phenolic (2.34 g) and nonphenolic (24.03 g) fractions. On being treated with methanol, the nonphenolic fraction crystallized (19.5 g). Fractional crystallization from a mixture of methanol and chloroform yielded 9.5 g of d-β-hydrastine, 0.66 g of protopine, and 0.47 g of d-bicuculline. After the separation of these alkaloids, chromatography of the mother liquor in a thin layer of silica gel [benzene–methanol–chloroform (5 : 1 : 1)] showed that the remaining crystalline bases contained the same alkaloids. The ethereal phenolic fraction yielded 0.15 g of coramine and 0.39 g of *l*-scoulerine.

The epigeal part of C. gortschakovii (1.7 kg) yielded 10.70 g (0.53%) of ethereal and 1.73 g (0.10%) of chloroformic alkaloids. The ethereal alkaloids were separated into phenolic (4.11 g) and nonphenolic (6.58 g) fractions.

By using acetone, the nonphenolic fraction yielded 0.48 g of isocorydine. On treatment with methanol, the evaporated mother solution yielded 0.66 g of a mixture of crystalline bases from which, by fractional crystallization, 0.21 g of a base with mp 179–180° C (methanol–chloroform), $[\alpha]_D^{20}$ − 51° (c 0.53), was isolated. This proved to be identical with an authentic sample of *l*-adlumine [5]. The mother liquor after the separation of the *l*-adlumine was chromatographed in a column of alumina. The alkaloids were eluted with ether, an ether–chloroform mixture (1 : 1), and chloroform. The chloroform fraction yielded 0.019 g of d-bicuculline. The mother liquor, after the separation of the crystalline mixture of bases, was evaporated and the residue was treated with ethanol, whereupon 0.052 g of protopine crystallized out. The residual ethereal nonphenolic alkaloids were separated into three fractions by means of buffer solutions (pH 7.0, 2.35, and 5% H_2SO_4). On treatment with acetone, the buffer fraction with pH 2.35 yielded 0.02 g of a base with mp 240–242° C (methanol–acetone). UV spectrum: $\lambda_{max}^{ethanol}$ 240 and 290 mμ (inflection; log ε 3.85). Mol wt 353 (mass spectrometry). The methanol treatment of the evaporated mother solution gave 0.025 g of a base $C_{18}H_{21}O_3N$ with mp 136–138° C (methanol); hydrochloride with mp 205–215° C. The UV spectrum of the base has two maxima: at 285 and 226 mμ (log ε 3.59 and 4.15). The IR spectrum shows absorption bands at (cm^{-1}) 3546 (hydroxyl group), and 2799 and 2849. In the mass spectrum of this base (M^+ 299) the strongest peak corresponds to the ion with m/e 121. In addition there are strong peaks of ions with m/e 192, 178, 163, 150, 135, and 107. In the NMR spectrum there is a six-proton singlet at 3.72 ppm (2 OCH_3). Signals at 6.39, 6.46, 6.78, and 7.20 ppm correspond to six aromatic protons. These properties of this base are in complete agreement with those for sendaverine [6].

The ethereal phenolic fraction was chromatographed on a column of alumina. The alkaloids were eluted with ether, ether-chloroform mixtures (10 : 1 and 1 : 1), chloroform, chloroform–methanol mixtures (50 : 1 and 10 : 1), and methanol, 15-ml fractions being collected. The ether–chloroform (1 : 1) fractions (1–10) were treated with methanol, giving 0.18 g of isocorydine. The chloroformic fractions (6–15) were treated with methanol, giving 0.1 g of sendaverine, and fractions 21–28 gave similarly 0.015 g of a base with Mp 214–217° C (decomp).

CONCLUSIONS

From two species of Corydalis with different growth sites 11 bases were obtained.

From C. pseudoadunca, collected in the Alai Valley, d-bicuculline, d-β-hydrastine, *l*-adlumidine, *l*-scoulerine, coramine, and protopine were isolated; from C. pseudoadunca, collected in the Pamir d-β-hydrastine, protopine, d-bicuculline, coramine, and *l*-scoulerine; and from C. gortschakovii, collected in the western Tien-Shan, isocorydine, protopine, sendaverine, d-bicuculline, *l*-adlumine, and a base with mp 240–242° C.

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