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LIPIDS OF THE ROOTS OF *Aconitum septentrionale* AND OF THEIR PROCESSING WASTES

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The compositions of the lipids and fatty acids of the roots of Aconitum septentrionale *and of their processing wastes have been investigated. A high level of the 18:2 and 18:3 acids has been found in the root lipids. A technological stage that concentrates in the wastes lipids that can be used as a complex of biologically active substances has been determined.*

Plants of the genus *Aconitum* (fam. Ranunculaceae) are typical alkaloid-bearers, in view of which they are widely used in the folk medicines of many countries. They are being studied systematically for the composition and structure of the alkaloids and their levels in individual organs [1, 2].

The roots of *A. septentrionale* Koelle (wolfbane monkshood) and the epigeal part of *A. leucostomum* Worosch. (aconite monkshood) are used as sources of lappaconitine hydrobromide – the basis of the antiarrhythmic drug allapinine [3].

We have previously investigated the composition of the lipids of the wastes from the processing of the epigeal part of *A. leucostomum* [4]. In the present paper we give the results of a comparative study of the compositions of the lipids of the roots of *A. septentrionale* and of the wastes formed in the process of extracting lappaconitine from them.

The lipids were extracted by Folch's method from roots with a moisture content of 6.7%.

The wastes consisted of the aqueous alkaline mother solution (pH 9.0) remaining after the precipitation of the alkaloids from a concentrated alcoholic extract with a saturated solution of Na_2CO_3 (sample 1) and a water-saturated chloroform eluate (pH 2.0) obtained after washing an acid precipitate of the alkaloids (sample 2) [5].

To investigate the presence of lipids, we carried out a preliminary analysis of the wastes. According to TLC, lipids with the same qualitative composition were present in a concentrated chloroform extract from the previously acidified aqueous alkaline mother solution and in the evaporated acidic water-saturated chloroform eluate.

The total amounts of extractive substances and of lipids proper in the roots and wastes are given in Table 1. The lipids were concentrated in the aqueous alkaline waste, but the level of alkaloids in it remained fairly high.

In view of the similarity of the two types of wastes, they were combined and were analyzed in detail without the separation of the alkaloids.

The lipids from the roots and from their processing wastes consisted of a dark brown resinous mass with a pleasant fruity odor. The lipids were separated by countercurrent extraction into fractions of neutral and polar lipids (NLs and PLs), mixed with pigments and alkaloids. The amounts of the main groups of lipids were (% on the total weight of the lipids and pigments):

Sample	NLs	PLs
Roots	24.9	75.1
Wastes	39.8	60.2

More than half the total lipids of the roots consisted of PLs. The ratio of NLs and PLs in the roots was 1:3, and in wastes 1:1.5. The decrease in the proportion of PLs in the total mass of lipids during the processing of the roots can be explained by their partial degradation under the severe conditions (pH 9.0) required for the extraction of the alkaloids.

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TABLE 1. Amounts of Extractive Substances in the Roots of *Aconitum septentrionale* and in the Wastes from Their Processing

Sample	Extractive substances, % on the weight of the air-dry roots	Lipids	Alkaloids
		% on the weight of the extractive substances (% on the weight of the air-dry roots)	
Roots	3.9	60.0 (2.34)	40.0 (1.56)
Wastes:			
sample 1	2.5	90.0 (2.25)	10.0 (0.25)
sample 2	0.53	94.4 (0.50)	5.6 (0.03)

TABLE 2. Compositions of the Neutral Lipids from the Roots of *Aconitum septentrionale* and from the Wastes of Their Processing

Class of lipids	Content, % of the weight of the lipids	
	roots	wastes
Hydrocarbons	2.9	3.1
Sterol esters	6.2	6.0
Wax esters	0.7	0.8
Esters of fatty acids and low-molecular-weight alcohols + X	3.0	1.0
Triacylglycerols	4.3	Tr.
Free fatty acids	6.3	26.6
Fatty alcohols	0.6	0.9
Sterols	0.9	1.2

TABLE 3. Fatty Acid Compositions of the Lipids of *Aconitum septentrionale* Roots and the Wastes from Their Processing

Acid	Roots	Wastes
8:0	Tr.	0.4
10:0	Tr.	0.3
11:0	Tr.	0.2
12:0	0.1	1.7
13:0	Tr.	0.5
14:0	0.4	0.9
15:0	0.4	2.1
x	Tr.	1.2
16:0	15.1	25.1
16:1	0.7	1.6
x	Tr.	6.3
16:2	0.6	2.2
16:3	0.3	Tr.
18:0	0.8	2.2
18:1	5.3	6.6
18:2	48.7	35.2
18:3	27.6	13.5
20:0–26:0	Tr.	Tr.

The qualitative compositions of the NLs and PLs were established by analytical TLC in the systems described in [4]. In all the samples we detected components of the NLs not listed in Table 2: glycolipids – steryl glycoside esters, mono- and diacylglycerols, steryl glycosides, and two unidentified components; and phospholipids – an N-acylphosphatidylethanolamine, phosphatidylethanolamine, phosphatidylcholine, phosphatidylinositol, phosphatidylserine, lysophosphatidylcholine, and phosphatidic acid. Visually, on the chromatography of aliquots of solution of the NLs and PLs, the predominating components of the NLs in the roots and wastes were FFAs, in the PLs of the roots they were monogalactosyldiacylglycerols (MGDGs) and phosphatidylcholine, and in the PLs of the processing wastes MGDGs and phosphatidic acid. Brown pigments appeared on chromatograms of the PLs in the form of individual spots not interfering with the detection and identification of the lipid classes.

A quantitative estimation of the composition of the NLs was made by preparative TLC with the subsequent rechromatography of the lipid classes in the system described in [4]. In the wastes from the processing of the roots, the FFA content was 4 times higher than in the initial raw material.

According to their mass spectra, the qualitative compositions of the free sterols and their esters from the roots and from the wastes were identical, consisting of seven components: cholesterol (M^+ 386, 7.2%), campesterol (M^+ 400, 19.7%), campestanol (M^+ 402, 5.2%), stigmasterol (M^+ 412, 14.4%), sitosterol (M^+ 414, 45.8%); 4α-methyl-24-ethylcholest-8(14)-en-3β-ol (M^+ 428, 15.8%), and 4α-methyl-24-ethylcholestan-3β-ol (M^+ 430, 10.0%) [6].

Apart from *A. septentrionale*, we have previously detected cholesterol in other plant tissues [7-9]. As a rule, it is a minor component of the intracellular sterols of higher plants, but it predominates in the surface lipids of the leaves and fruit of some species; there are only isolated reports of the presence of cholesterol in plant roots [10].

The composition of the FAs of the total lipids was determined by GLC and mass spectrometry. The results are given in Table 3. The lipids of the roots were enriched with unsaturated acids (more than 80% by weight), among which the 18:2 and 18:3 acids together made up more than 70%. During the industrial processing of the roots, the level of these acids fell by a factor of 1.6.

These results show the possibility of using the wastes from the processing of *A. septentrionale* roots for obtaining in fairly high yield a complex of biologically active lipids enriched with essential fatty acids.

EXPERIMENTAL

The conditions for mass spectrometry, GLC, and TLC, and the methods for isolating and identifying lipids and fatty acids have been described in [4, 8].

The *A. septentrionale* roots and the wastes from their processing after the extraction of lappaconitine were supplied by A. Z. Salikov of the Institute of the Chemistry of Plant Substances, Academy of Sciences of the Republic of Uzbekistan.

Before analysis, the extracts of the roots and of their processing wastes were washed with water to neutrality and were dried over Na_2SO_4; then the solvent was distilled off and the residue was dried in a vacuum desiccator.

The quantitative estimation of the total alkaloids was carried out by R. M. Galyautidinova of the Institute of the Chemistry of Plant Substances, Academy of Sciences of the Republic of Uzbekistan.

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