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LIPIDS OF THE ROOT CROP Beta Vulgaris

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The composition and the amounts of various groups of neutral lipids and of glyco- and phospholipids in the root crop Beta vulgaris of the varieties bordeaux and Nosovskaya ploskaya have been investigated by a combination of chromatographic and chemical methods. About 30 groups of lipid compounds were identified, among which free sterols and their glycosides, di- and triacylglycerols, monogalactosyldiglycerides and their acyl derivatives, phosphatidylglycetols, phosphatidylcholides, and phosphatidic acids predominated. The fatty acid composition, determined by GLC, was represented by 11 components, of which about 90% consisted of linoleic, palmitic, and oleic acids.

Red table, or common, beet is a widely distributed vegetable crop possessing high nutritional value and medicinal properties [1]. At the present time, the food industry is faced with the task of substantially expanding the variety and improving the quality of products obtained from beets and achieving the complex utilization of beet wastes, the volume of which amounts to more than 20% of the weight of the initial raw material.

We have investigated the composition and amount of liposoluble substances of the root crop Beta vulgaris of two technically important varieties — Bordeaux (I) and Nosovskaya ploskaya (II) which are grown in the Odessa province of the UkrSSR.

The total liposoluble substances were extracted from the freshly gathered finely comminuted edible roots by extraction with mixtures of chloroform and methanol in volume ratios depending on the moisture content of the sample and determined from a ternary diagram [2].

According to the experimental results, the total amount of lipids in the roots was 1840 mg/kg for the variety Bordeaux and 1320 mg/kg for the variety Nosovskaya ploskaya.

The total lipids were separated into neutral lipids (NLs), glycolipids (GLs), and phospholipids (PLs) by column chromatography on silica gel [3]. The individual classes of lipid compounds were obtained by TLC.

The assignment of chromatographically individual zones of substances to definite groups of lipids was made on the basis of a comparison of the chromatographic mobilities of the substances under investigation with those of model substances, and also from qualitative reactions [3, 4] and spectral characteristics. For the identification of polar lipids of complex structure we used the results of chemical analysis of the water-soluble and liposoluble fragments of the molecules isolated after the performance of severe acid hydrolysis.

The quantitative determination of the lipids was made by the elution method. The ratio of the groups of NLs was estimated by universal method based on the oxidation of the lipid compounds with a dichromate reagent and subsequent spectrophotometric determination [5].

The neutral lipids were quantitatively the smallest fraction of the lipids of the beet roots, amounting to 20.7 and 15.4% for varieties I and II, respectively. On separation in system 1, the NLs were shown to contain more than 10 groups of different compounds (% on the total NLs):

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Neutral Lipids	Variety I	Variety II
Hydrocarbons	6.3	3.0
Sterol esters	7.9	11.3
Fatty acid esters	1.2	0.6
Triacylglycerols	17.4	20.4
Tocopherols	0.6	0.4
Lipoquinones	2.3	1.4
Free fatty acids	4.4	6.8
Fatty alcohols	2.0	2.5
Diacylglycerols	23.2	20.2
Free sterols	29.2	30.3
Pigments (carotenoids, chlorophylls)	2.3	2.0
Monoacylglycerols	3.2	1.1
Total amount, mg/kg of the weight of roots.	380.9	203.4

The group compositions of the NLs of varieties I and II were identical and their quantitative ratios were similar. The predominating components in the NLs were sterols and di- and triacylglycerols, making up 70% of the sum of the neutral lipids. The diacylglycerols were represented mainly (~90%) in the form of the 1,3-isomers.

The amount of glycolipids was substantially higher than of the NLs, and amounted to 49.3 and 35.2%, respectively, for varieties I and II. The quantitative determination of the GLs was based on the carbohydrate component [6], separation being effected in systems 2, 3, and 4.

The following components were detected in the glycolipids (% on the total GLs):

Glycolipids	Variety I	Variety II
Acylmonogalactosyldiglycerides	10.9	14.8
Esterified sterol glycosides	8.8	10.7
Monogalactosyldiglycerides	26.2	25.0
Sterol Glycosides	16.9	21.3
Cerebrosides	2.3	3.4
Ceramidooligosides	4.2	2.6
Digalactosyldiglycerides	4.7	6.5
Ceramidophosphatidylinositol oligosides	15.6	2.2
Sulfoquinovosyldiglycerides	10.4	13.5
Total amount, mg/kg weight of the roots.	644.0	650.8

The predominant types of GLs in Beta vulgaris roots of the varieties studied were monogalactosy-1-diglycerides, sterolglycosides, acylmonogalactosyldiglycerides, sufoquinovosyldiglycerides, and ceramidophosphatidylinositol oligosides (variety I). The glycolipids were found by PC to contain galactose, glucose, and arabinose (4:1:0.5). There were also small amounts (<10%) of uronic acids and aminosugars.

The phospholipids of Beta vulgaris roots amounted to 44 and 36% of the total lipids for varieties I and II, respectively.

The following types of compounds were found in the PLs of the beet (% on the total PLs):

Phospholipids	Variety I	Variety II
Diphosphatidylglycerols	10.6	14.1
Phosphatidic acids	21.6	19.1
Phosphatidylethanolamines	3.4	2.2
Phosphatidylglycerols	31.2	27.5
Phosphatidylcholines	19.5	24.1
Phosphatidylserines	4.9	5.4
Phosphatidylinositols	6.4	4.5
Lysophosphatidylethanolamines	0.9	1.2
Lysophosphatidylcholines	1.5	1.9
Total amount , mg/kg of the weight of the roots	809.6	466.0

TABLE 1. Fatty Acid Compositions (mole. %) of the Total Lipids of Beta vulgaris Roots

Variety	12:0	14:0	14:1	15:0	16:0	16:1	17:0	18:0	18:1	18:2	18:3	Σ_{sat}	Σ_{unsat}
I	Tr.	0,9	Tr.	3,5	31,4	0,8	0,8	0,6	18,4	38,[illegible]	4,7	37,2	62,8
II	Tr.	1,6	Tr.	3,0	23,3	0,8	0,6	1,1	16,2	47,0	6,4	29,6	70,4

The quantitative determinations of the PLs were made from their phosphorous content [7]. TLC separation being carried out in systems 2 and 5. A feature of the phospholipid composition was the high proportion of phosphatidylglycerols, phosphatidylcholines, and phosphatidic acids (~70%) and the comparatively low amount of phosphatidylethanolamines.

In the fatty acid composition, determined by the GLC method, three acids predominated — linoleic, palmitic, and oleic — making up about 90% of the weight of all the acids (Table 1).

The lipids of Beta vulgaris roots were characterized by a high degree of unsaturation (60-70%) of the fatty acid radicals, a large proportion of which were polyunsaturated, which may, to a certain extent, be responsible to the high susceptibility of beet roots to oxidative spoilage.

EXPERIMENTAL

Column chromatography was performed on silica gel L 100/160, and thin-layer chromatography on Silufol and on silica gel L 5/40 with gypsum in the following solvent systems: 1) heptane–methyl ethyl ketone–acetic acid (47.5:7.5:0.5), two runs; 2) chloroform–methanol–water (65:25:4); 3) acetone–toluene–acetic acid–water (60:60:2:1); 4) chloroform–acetone–methanol–acetic acid–water (6:8:2:2:1); 5) chloroform–methanol–7 N ammonia (65:30:4) in the first direction, and chloroform–methanol–acetic acid–water (170:25:25:6) in the second direction.

Methylation and the conditions for performing GLC have been described previously [8]. The water-soluble products obtained after severe acid hydrolysis of the GLs and PLs (2 N HCl, 125°C, 48 h) were separated and identified with the aid of paper chromatography according to Kates [3]. The paper chromatography of the carbohydrate components of the GLS was carried out by the descending method in the benzene–butan-1-ol–pyridine–water (1:5:3:3, upper phase) system. Detection was performed with aniline phthalate [9].

SUMMARY

The composition has been investigated and the amounts of various groups of neutral lipids and glyco-phospholipids in the root crop Beta vulgaris, varieties Bordeaux, and Nosovskaya ploskaya have been determined for the first time. About 30 groups of lipid compounds have been identified, of which the predominating types are free sterols and their glycosides, di- and triacylglycerols, monogalactosyldiglycerides and their acyl derivatives, phosphatidylglycerols, phosphatidylcholines, and phosphatidic acids. Among the fatty acids of the lipids 11 components have been detected of which about 90% is made up of linoleic, palmitic, and oleic acids.

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