chromatography. The following solvent systems were used for chromatography: 1) chloroform–methanol–water (65:35:5), and 2) chloroform–methanol–25% ammonia (65:35:5). The fatty acids of the oil and of the phospholipids were isolated by alkaline saponification (5% KOH in methanol, room temperature. 15-18 h). The mixtures of fatty acid methyl esters were separated on a UKh-2 chromatograph using a 2500 × 4 mm column containing 18% of polyethyleneglycol succinate on Celite-545 (60-80 mesh) at 197°C with helium as the carrier gas. The pressure of helium at the outlet was 2.5 atm. The IR spectrum was recorded on a UR-20 instrument with the substances in the form of films. The phosphorus was determined quantitatively by a known method. The acid, alkaline, and enzymatic hydrolyses of the PLs were performed by procedures described previously [2]. The N-acyl-PEs and N-acyllyso-PEs were also analyzed as described previously [3].

SUMMARY

The phospholipid complex of seeds of the plant Crambe amabilis has been studied for the first time. From the combined phospholipids freed from carbohydrates three main components (phosphatidylcholine, phosphatidylethanolamine, and phosphatidylinositol) and four minor components (lysophosphatidylcholine, N-acylphosphatidylethanolamine, phosphatidylserine, and N-acyllysophosphatidylethanolamine) have been isolated and characterized.

The position distributions of the fatty acids in the phosphatidylcholine, phosphatidylethanolamine, phosphatidylinositol, and phosphatidylserine molecules have been determined by enzymatic hydrolysis with phospholipase A_2. On the basis of these results, their possible molecular compositions have been calculated. The compositions of the fatty acids esterified in the glyceride moiety and acylating the nitrogen atom in the N-acylphosphatidylethanolamine molecule have been established.

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AMOUNTS OF PHOSPHOLIPIDS AND PHYTIN IN THE SEEDS OF VARIOUS PLANTS

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UDC 547.953:665.37

Over a number of years, we have systematically studied the phospholipid complexes of the seeds of a number of plants of the family Malvaceae: various types of cotton plant [1-5] and kenaf [6].

In order to determine the materials of the greatest interest in the theoretical or practical respect, we have begun to study the seeds of plants belonging to different families for their phospholipid and phytin contents.

The phospholipids were extracted by chloroform–methanol (2:1) from the comminuted and acetone-defatted seeds. For the preliminary purification of the combined phospholipids from accompanying substances (oil, pigments, carbohydrates, steriods, etc.), the dry extract was treated with acetone. The acetone-insoluble residue was dissolved in chloroform–methanol–water (90:10:1), and for final purification from carbohydrates this mixture was passed through a column with preswollen Molselekt G-25. As compared with the combined phospholipids from other sources, the combined phospholipids from the seeds of Onopordon acanthium L. and Rhaponticum integrifolium (family Compositae) possess some unusual properties: they do not precipitate from a concentrated chloroform solution on the addition of acetone, and when a dry residue is treated with acetone a

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Translated from Khimiya Prirodnykh Soedinenii, No. 4, pp. 505-507, July-August, 1977. Original article submitted March 29, 1977.

considerable proportion of the phospholipids pass into solution, which complicates the purification of the combined material. Consequently, in such cases the amount of combined phospholipids was determined in the acetone solution, as well.

For the qualitative characterization of the combined phospholipids freed from carbohydrates, for one-dimensional chromatography we used system 1 and for two-dimensional chromatography systems 1 (direction 1) and 2 (direction 2). The spots were identified on the chromatograms with the aid of "markers" and by qualitative color reactions for definite functional groups [7]. After the isolation of the phospholipids, the amount of phytin in the dried meal was determined by extraction with 1% nitric acid. In view of the high amounts of polysaccharides and mucilaginous substances in the seeds of some plants (Allium, Potentilla), the acid extract filtered with difficulty. In such cases, 20% [8] (sometimes even more) of ethanol was added to the acid. When this expedient was used, the amount of accompanying substances also increased through the inclusion of ethanol-soluble impurities.

As a result of the fact that when the acid solution was made alkaline (pH 7.5-8.0), the precipitated phytin was accompanied by other substances capable of being precipitated under these conditions, the purities of the samples of phytin obtained from different seeds were different. It must be observed that, to improve the filtration of the phytin extract, instead of ethanol it is possible to use methanol of various concentrations, acetone, and other water-miscible solvents.

The yield of technical phytin was determined on the weight of the meal. The results of determinations of the total phospholipids and of the amounts of phytin in the seeds of 22 plants are given below:

Plant	Total PLs. %	Number of components	Yield of phytin, %
Gramineae			
Lolium cuneatum Nevski	0,3	8	1,6
Oryza sativa L.	0,7	7	1,3
Compositae			
Onopordon acanthium L.	0,8	6	3,6
Onopordon olgae Bge. et Schmal.	0,2	7	1,0
Rhaponticum integrifolium C. Winkl.	1,9	6	1,0
Matricaria chamomilla L.	1,1	7	0,4
Calendula officinalis L.	1,0	5	2,6
Zygophyllaceae			
Peganum harmala L.	0,2	6	3,1
Nitraria komarovii Iljin et Lava	0,3	7	0,8
Nitraria schoberi L.	0,7	6	1,3
Rosaceae			
Rosa canina L.	0,2	7	2,5
Potentilla asiatica Juz.	0,4	7	2,3
Umbelliferae			
Ferula jaeschkeana Vatke	1,5	6	2,3
Ferula kelleri K.-Pol.	0,5	7	4,3
Ferula karataviensis (Rgl. et Schmalh) Korov.	0,8	7	1,2
Papaveraceae			
Glaucium fimbrilligerum Boiss.	0,6	7	8,0
Roemeria refracta DC.	0,5	8	4,3
Boraginaceae			
Trichodesma incanum (Bge.) DC.	0,1	6	1,2
Heliotropium lasiocarpum F. et M.	0,3	5	2,0
Lindelofia tschimganica (Lipsky) M. Pop. ex Pazij.	1,2	5	1,6
Lindelofia macrostyla (Bge.) M. Pop.	0,3	7	1,4
Liliaceae			
Allium turcomanicum Rgl.	1,1	8	3,4

The amounts of combined phospholipids and phytin vary fairly widely for the seeds of plants even of a given family. The seeds richest in phospholipids (more than 1%) are those of plants of the families Compositae, Umbelliferae, Liliaceae, and Boraginaceae. It was established by qualitative reactions in all samples the main component of the combined phospholipids were phosphatidylcholines, phosphatidylinositols, and phosphatidylethanolamines. The seeds of the families Lolium, Roemeria, Allium, and others attract attention because of the diversity of the qualitative composition of the combined phospholipids.

The seeds of some plants of the families Papaveraceae, Liliaceae, and Umbelliferae proved of interest in relation to their phytin content. The seeds of Glaucium, the amount of phytin in which amounts to 8%, deserve particular attention.

A phytin (substance C) content in the leaves of Anthyllis macrocephala of 6.7% has been reported [9]. Such a high phytin content is uncharacteristic for leaves. Furthermore, the method of isolating the phytin with water followed by precipitation ethanol cannot be considered acceptable, since in a test of the method in the isolation of phytin from rice flour we obtained a 0.2% yield instead of 6%.

EXPERIMENTAL

The solvents were purified by standard methods. For thin-layer chromatography we used type KSK silica gel and the following solvent systems 1) chloroform–methanol–25% ammonia (65:35:5) and 2) chloroform–methanol–water (65:35:5). The seeds were defatted and the total phospholipids were extracted from them at room temperature. The combined phospholipids were freed from carbohydrates by gel filtration on Molselekt as described previously [3].

The combined phospholipids freed from carbohydrates were calculated as percentages of the weights of the air-dried seeds.

SUMMARY

The amounts of combined phospholipids and phytin in the seeds of 22 plants belonging to various families have been determined. It has been established that the main components of the combined phospholipids of the seeds of the plants studied are phosphatidylcholines, phosphatidylinositols, and phosphatidylethanolamines. Some unusual properties of the combined phospholipids of the seeds of some plants of the family Compositae, and materials interesting in relation to their phospholipid and phytin contents have been found.

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