LIPIDS OF *Zizyphus jujuba*

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The acyl-containing classes of neutral lipids have been studied and the amounts of phospholipids and their fatty acid composition have been determined in the pericarps and seeds of Zizyphus jujuba. *The fatty oil of the seeds contains oleic acid while in the neutral lipids of the pericarps the main acid is the biologically active palmitoleic. In the qualitative respect, the set of phospholipids in the seeds is more diverse, while the main classes quantitatively in both parts of the fruit are phosphatidylcholines and phosphatidylglycerols. The phospholipids of the pericarps are more saturated than those of the seeds.*

Zizyphus jujuba (common jujube) is a representative of the family Rhamnaceae. The plant is used in folk medicine, in the food and preserving industry, and in perfumery [1]. There is information on the presence of proteins, fats, carbohydrates, and vitamins in fresh jujube fruit [2-4]. So far as concerns the lipid composition, there is fragmentary and contradictory information on the fatty-acid (FA) composition of the total lipids [5, 6].

Using the variety ta-yan-tszao grown in Uzbekistan we have performed a determination of the FA composition of the fruit differentiated with respect to classes of lipids. The fruit was first divided into seeds (I) and pericarps (II), and the neutral lipids (NLs) and phospholipids (PLs) were isolated from each part. Their yields amounted to 0.50 and 0.17%, respectively, for (I) and 0.25 and 0.05% for (II) on the weight of the air-dry plant material.

The separation and identification of the lipids was carried out by the methods of column (CC), thin-layer (TLC), and gas-liquid (GLC) chromatographies.

TABLE 1. FA Composition of the Acyl-Containing Fractions of the Neutral Jujube Lipids

Fraction	Amounts of acid, %, GLC on the weight of FAs							
	10:0	12:0	13:0	14:0	15:0	16:0	16:1	18:0
Esters (I)	1,2	0,8	0,7	1,0	0,9	13,5	2,9	13,1
TAGs (I)	1,3	0,5	0,4	0,6	0,4	10,2	3,5	4,7
FFAs (I)	0,9	1,4	0,6	2,3	2,4	25,2	19,6	6,2
Esters (II)	0,9	1,4	—	1,7	2,3	15,5	12,8	5,0
FFAs (II)	0,6	2,6	—	2,2	7,2	16,1	54,9	1,6

Fraction	Amounts of acid, %, GLC on the weight of FAs							
	18:1	18:2	18:3	20:0	22:0	21:2	ΣS	ΣU
Esters (I)	18,4	15,2	19,0	7,3	6,0	—	44,5	55,5
TAGs (I)	33,4	24,0	21,0	—	—	—	18,1	81,9
FFAs (I)	24,9	14,1	2,4	—	—	—	39,0	61,0
Esters (II)	16,6	5,6	12,8	11,3	7,8	6,3	45,9	54,1
FFAs (II)	11,2	3,6	—	—	—	—	30,3	69,7

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TABLE 2. Total and Positional Composition of the PLs of the Jujube Seeds

Fractions of the PLs, % of total PLs	Amounts of acids, %, GLC on the weight of the FAs						
	16:0	16:1	18:0	18:1	18:2	ΣS	ΣU
PCs (42.3)							
sn-1 position	23,5	—	8.0	49.4	19,1	31,5	68,5
sn-2 position	0.6	0,6	—	68,7	30,1	0,6	99,4
total	12.0	0,3	4,0	59,1	24,6	16,0	84,0
PEs (8.4)							
sn-1 position	31,0	—	5,1	42,7	21,2	36,1	63,9
sn-2 position	3,1	1,2	-	57,6	38,1	3,1	96,9
total	17,1	0,6	2,6	50,1	29,6	19,7	80,3
PIs (11.1)							
sn-1 position	31,8	—	17,2	30.4	20,6	31,8	68,2
sn-2 position	1,4	1,0	—	41,6	56,0	1,4	98,6
total	16,6	0.5	8,6	36,0	38,4	25,2	74,8
N-PEs (7.4)	19.7	6,8	3.9	37,8	31.8	23,6	76,4
1-N-PEs (3.8)	17.2	5,2	3,0	25.3	49,3	20,2	79,8
FAs (7.2)	25,9	7,7	7,0	24,3	35,1	32,9	67,1
PGs (11.5)	27,2	3,1	7,2	34,3	28,2	34,4	65,6
1-PIs (2.3)	34,1	9,8	9,4	28,6	18,1	43,5	56.5
1-PCs (4.1)	22,7	2,1	7,7	45,1	22.4	30,4	69,6
1-PEs (1.9)	30,8	6,7	16,3	24,4	21,8	47,1	52,9

TABLE 3. Total and Positional Composition of the PLs of Jujube Pericarps

Fractions of the PLs, % on the total PLs	Amounts of acids, % GLC on the weight of the FAS								
	14:0	16:0	16:1	18:0	18:1	18:2	18:3	ΣS	ΣU
PCs (18.8)									
sn-1 position	0 2	39,3	4,8	13,7	26.5	15,5	—	53,2	46,8
sn-2 position	0,3	9,2	13,1	—	41,5	35 8	1.1	9,5	90,5
total	0,3	24,3	9,0	6,8	33,4	25.6	0,6	31,4	68,6
PEs (9.8)									
sn-1 position	2 5	36,6	9,2	19,3	21.4	9,2	1,8	58,4	41.6
sn-2 position	1,0	17,9	12 3	—	32,1	36,0	0,7	18,9	81,1
total	1.8	27.2	10,8	9,6	26,7	22,6	1,3	38,6	61 4
PIs (17.5)									
sn-1 position	Tr.	56.3	4 5	19,8	15,8	3,6	—	76,1	23,9
sn-2 position	Tr.	7,1	9,2	—	31,2	50,5	2,0	7,1	92,9
total	Tr.	31.7	6,8	9,9	23.5	27,1	1,0	41,6	58,4
FAs (7.1)	Tr.	47.4	8,8	8,8	13,6	19,7	1,7	56.2	43,8
N-PEs (8.6)	Tr.	43.0	6.0	9.1	11,7	27,6	2.6	52,1	47.9
1-PCs (3.7)	Tr.	70.3	5,5	11,0	9,9	3,3	—	81,3	18,7
1-PIs (6.4)	Tr.	66,7	12,1	8.1	9,1	3.0	1.0	74,8	25,2
PGs (28.1)	0.2	40,7	14,1	9,6	14,3	19.6	1,5	50,5	49,5

The main acyl-containing classes of NLs in (I) were triacylglycerols (TAGs) (90%), esters (2.3%), and free fatty acids (FFAs) (1.9%); in the NLs of (II) there were no TAGs and the FFAs formed quantitatively the main class of lipids (40%), the amount of esters being 15.5%.

In the TAGs of (I), unsaturated FAs made up 81.9% of the total, the acid present in the greatest amount being the 18:1 species, which is in harmony with information in the literature [5, 6] (Table 1). The ester fraction contained approximately the same amounts of saturated and unsaturated acids.

With respect to its saturated acid content, the FFA fraction occupied an intermediate position between the TAGs and the esters.

Practically the same characteristic was observed for the corresponding classes of lipids of sample (II). The composition of the FFA fraction is interesting: 55% of it consisted of the 16:1 acid which is known for its antitumoral and antimicrobial effects [7, 8].

The PLs of (I) were represented by ten, those of (II) by eight classes of compounds (Tables 2 and 3). The PLs (II) contained no lysophosphatidylethanolamines (*l*-PEs) and lyso-N-PEs (*l*-N-PEs). The main class for (I) was phosphatidylcholines (PCs), and for (II) phosphatidylglycerols (PGs). On the whole, a predominance of these classes of PLs is characteristic for fruits.

In the PCs, PEs, N-PEs, PGs, and *l*-PCs of sample (I), as in the NLs (I) the 18:1 acid occupied the leading position, being the main one quantitatively; in the phosphatidylinositols (PIs), the *l*-N-PEs and the phosphatidic acids (PAs), the 18:2 acid predominated, and in the *l*-PIs and *l*-PEs the 16:0 acid.

In the PLs of (II), the 18:1 acid remained the main one quantitatively only in the PCs, and the other seven classes of PLs were esterified predominantly with the 16:0 acid. It can be seen from Tables 2 and 3 that PLs of (I) were richer in unsaturated acids than those of (II). The same characteristic was observed in the positional distribution of the FAs in the PCs, PEs, and PIs: there was a higher degree of unsaturation in the sn-2 positions of sample (I) (99.4, 96.9, 98.6%, respectively) than in (II) (90.5, 81.1, and 92.9%, respectively). Furthermore, the PLs of (II), unlike those of (I), contained an 18:3 acid and an increased amount of the 16:1 acid in the sn-2 position.

The FA composition of the *l*-PCs of (I) practically corresponded to the sn-1 position of the PCs of the same sample; it is possible that the *l*-PCs of (I) had the structure of 1-sn-glycero-3-PCs, which was not observed in the *l*-PCs of sample (II).

EXPERIMENTAL

The neutral lipids were isolated by the repeated steeping of the air-dried comminuted seeds and pericarps with n-hexane.

The phospholipids were extracted by treating with a 2:1 mixture of chloroform and methanol the pulp of pericarps and seeds remaining after the extraction of the neutral lipids. The total material was purified and the individual PLs were isolated as in [9].

The alkaline hydrolysis of the neutral lipids was carried out by a known method [10], and the alkaline hydrolysis and enzymatic hydrolysis of the PLs as described in [9].

The FAs were esterified with diazomethane.

The CC of the neutral lipids was as described in [10] and of the PLs as in [9].

GLC was performed on a Chrom-41 chromatograph with a flame-ionization detector and a stainless steel column 2 m long filled with Chrom W (60-80 mesh) impregnated with 17% of poly(ethylene succinate); t_{evap} – 250°C, t_{therm} – 196-200°C.

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