STUDY OF THE OILS OF SOME SPECIES OF AMYGDALUS

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In the mountain regions of central Asia, the wild species of almond Amygdalus bucharica, A. spinossisima, and A. Petounnicovii, family Rosaceae, are widely distributed.

Papers discussing the results of a study of almond fatty oil do not give sufficient information to characterize it completely [1]. The commonest component of the oils which have been studied is linoleic acid [2, 3], while in our oils oleic acid predominated.

We have determined the fatty acid composition of the oils of wild almonds and have compared it with the fatty acid composition of cultivated almonds, showing the possibility of using the oil extracted from wild almonds in medicine. The oil of the above mentioned species of wild almonds was extracted with ether. In order to compare the main indices of these oils and their fatty acid composition, the oil of A. communis (common almond) was obtained in the same way. The oil contents of the seeds of all four species of almond can be seen from the figures in Table 1.

Table 1. Characteristics of Almond Seeds

Species of almond	Oil content, %			Ratio of the weights of the kernel and the husk
	seed	kernel	husk	
A. communis	28.9	50.2	0.55	1.1
A. spinossisima	27.55	47.35	0.64	1.7
A. bucharica	27.72	48.90	0.51	1.8
A. Petounnicovii	24.84	45.35	0.4	1.5

The kernels of all the seeds were readily separated from their husk. The oil and the fatty acids isolated from them by a standard method [4] are characterized by the indices given in Table 2. The fatty-acid compositions of the oils (table 3) were determined by gas-liquid chromatography.

Table 2. Characteristics of Almond Oils and Their Fatty Acids

Index	Unit of measurement	A. communis		A. spinossisima		A. bucharica		A. Petounnicovii	
		oil	fatty acids	oil	fatty acids	oil	fatty acids	oil	fatty acids
Density	g/ml	0.9141	—	0.9153	—	0.9142	—	0.9120	—
Absolute viscosity	cP	—	—	74.91	—	74.73	—	75.01	—
Refractive index	—	1.4650	—	1.4723	—	1.4680	—	1.4675	—
Saponification number	mg KOH/g	190.05	—	194.49	—	193.00	—	191.01	—
Hehner number	%	—	—	95.47	—	95.13	—	95.17	—
Neutralization number	mg KOH/g	—	210.5	—	211.4	—	212.17	—	212.91
Mean mol wt of the acids	—	—	266.04	—	266.0	—	264.5	—	263.6
Iodine number	% I_2	101.79	105.03	97.6	100.0	99.5	103.85	95.9	101.01
Thiocyanogen number	% I_2	83.61	84.00	81.6	83.1	81.02	84.21	80.9	83.75
Content of unsaponifiables	%	—	—	0.25	—	0.13	—	0.51	—
unsaturated acids by Bertram's method	%	—	9.20	—	10.02	—	6.39	—	4.35
Neutralization number of the saturated acids	mg KOH/g	—	206.2	—	202.0	—	205.09	—	207.6
Mean mol wt of the saturated acids	—	—	272.1	—	278.6	—	273.6	—	275.0

We see from Table 3 that the almond oils are characterized by a high content of oleic acid, considerably less linoleic acid, and a very small amount of saturated acids.

Table 3. Fatty Acid Compositions of Almond Oils

Fatty Acids	A. communis	A. spinosissima	A. bucharica	A. Petounnicovii
Capric	—	—	0.3	0,1
Undecylic	1,41	1.0	—	—
Palmitic	6,5	6,9	5,5	3,6
Stearic	1,4	2,1	0,6	0,7
Oleic	64,7	66,3	67,9	66,4
Linoleic	23,7	21,6	24,3	27,3
Linolenic	2,3	2,1	1,4	1,9
Σ of the saturated acids	9,3	10,0	6,4	4,4
Σ of the unsaturated acids	90,7	90,0	93,6	95,6

The triglyceride composition of the oils was calculated from the rule of random distribution of fatty acid radicals without the introduction of Kartha's limitations [5] (Table 4).

Table 4. Glyceride Compositions of Almond Oils

Triglyceride	A. communis	A. spinosissima	A. bucharica	A. Petounnicovii
GlSSS	0,70	1,00	0,20	0,08
GlSSU	2,3	2,70	1,10	0,53
GlSUU	22,6	24,00	16,80	11,80
GlUUU	74,4	72,30	81,90	87,59

Note. Gl represents the glyceride radical, S the radical of a saturated acid, and U the radical of an unsaturated acid.

The figures given in Table 4 show the similarity in compositions of the oils of all four species of almond. The differences between the individual values are within the limits of fluctuation of the indices of the oil from the seeds of a single species growing in different regions. These divergencies are within the range given in the State Pharmacopeia Standards [6] (Table 5).

Table 5. Results of a comparison with the State Pharmacopeia Standards

Index	Units of measurement	State Pharmacopeial Standard	A. spinosissima	A. bucharica	A. Petounnicovii
Density	g/ml	0,913—0,918	0,9153	0,9142	0,9120
Acid number	mg KOH/g	not >2,5	0,80	0,70	0,78
Saponification number	mg KOH/g	190—195	194,49	193,00	195,01
Iodine number	$\%I_2$	93—102	97,6	99,5	95,9

Having determined the physical properties of the oils that we were studying and having tested them for purity and authenticity as laid down by the State Pharmacopeia of the USSR, we came to the conclusion that they satisfy the requirements set for medicinal almond oil in all respects.

An important reaction is the test for hydrocyanic acid, whose presence depends on the method used in isolating the oils, in particular on whether the almond kernels present were in contact with water, since the amygdalin present in the kernel hydrolyzes under the action of water with the formation of free hydrocyanic acid. In the oils obtained, the reaction for the presence of hydrocyanic acid was negative. Tests on the toxicity of the oils isolated from the three species of wild almond were carried out in the Pharmacology and Chemotherapy Laboratory of the Institute of the Chemistry of Plant Substances, AS UzSSR. Results of the tests involving single and repeated administration of the oil gave no indications of toxicity in animals; the oils of the wild almonds did not differ with respect to their pharmacological indices from the oil of cultivated almonds.

Since the fatty acid compositions of the oils of wild and cultivated almonds are identical, are not toxic, and satisfy the standards of the State Pharmacopeia of the USSR, we may recommed that these oils obtained by this extraction method be used in medicine.

EXPERIMENTAL

Production of the oil. Almonds were cracked open, and the kernel was separated from the husk and ground in

a mill. The mass obtained was extracted with petroleum ether having bp 70–100° C. The miscella was filtered, the solvent was distilled off in a current of inert gas, and the oil was dried under vacuum.

Reaction for hydrocyanic acid. About 5 g of the oil was heated in a porcelain dish with 5 ml of ammonium sulfide and a small amount of ammonia with stirring until the smell of ammonium sulfide had disappeared. The liquid was diluted with water and filtered into a test tube where it was acidified with HCl, and a few drops of ferric chloride were added. We did not observe any intense red coloration due to the formation of ammonium thiocyanate.

Determination of the ignition temperature of the oils. The ignition temperatures of the extracted oils were determined in a closed vessel according to GOST [State Standard] 6356-52; in all samples it was 236–239° C.

CONCLUSIONS

1. The oils of wild almonds are very similar in fatty acid composition and physical and chemical properties to the oil of cultivated almonds.

2. The oils of Amygdalus bucharica and A. Petounnicovii have a higher content of triunsaturated glycerides than the oil of cultivated almonds.

3. The replacement of cold pressing of almond kernels by low-temperature extraction does not adversely affect the quality of the oils. They do not contain any hydrocyanic acid and, according to pharmacological tests, can be recommended as medicinal oils.

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