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Study of Physical and Chemical Properties of Almond Milk

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Abstract:- Despite the fact that animal milk has a number of useful properties, the demand for plant-based milk is increasing due to reasons such as the inability to digest lactose in most consumers, allergies to the proteins contained in animal milk, and the popularization of a vegetarian lifestyle. Alternative to animal milks, plant-based milks are mainly made from nut-fruits, some seeds, grains and cereals. The important components of the above raw materials are extracted in water, enriched according to functional requirements, homogenized, aseptically processed and packaged. As a result of these technological processes, plant milk can be an alternative to animal milk in terms of appearance and composition. In the food industry, the plant based milk market is a rapidly developing area, and several famous brands are finding a lot of customers around the world. In this research, the physical and chemical characteristics of plant milk obtained from local almond varieties in laboratory conditions were compared with imported plant milk based on modern technological analysis.

Keywords:- *Almond Milk, Lactose Intolerance, Cholesterol, Amid Group, Fatty Acid, Scanning Elector Microscope, IR Spector, Scanning Electron Microscope.*

I. INTRODUCTION

Almonds are a valuable product with many useful properties. It contains riboflavin, manganese, magnesium, calcium, phosphorus, potassium, copper, iron, spirit and proteins, as well as α-tocopherol, a powerful antioxidant. Almonds contain unsaturated fatty acids, dietary fiber, and phytonutrients that help manage body weight, improve glucose levels, and reduce the risk of heart disease and diabetes by reducing inflammation and oxidative stress. In addition, almonds have a high fiber content, which provides a person with about 12% of the required daily dose, which helps to reduce blood cholesterol levels and stop gaining excess weight and prevent obesity [1].

Currently, there are many allergic reactions to milk protein. Allergy to cow's milk proteins and lactose intolerance can be distinguished by their symptoms. Allergy manifests itself immediately when consuming dairy products, even in small quantities, while lactose deficiency occurs several hours after consuming large amounts of animal milk products. However, some consumers may have both of these deficiencies, which presents its own set of problems [2; 3].

In today's globalized world, the number of people who do not consume animal products, including cow's milk, for ethical, religious, vegan or other reasons is increasing. In such cases, it is important to completely replace animal milks with plant-based milk alternatives. [4; 5; 6].

Almonds are a common fruit that has been cultivated in our republic since ancient times, and today various varieties have been created. However, almost no almond milk is produced from them. According to statistics, the number of diabetic patients who cannot consume cow's milk is very high in our country today. This requires the development of alternative sources of milk. One such alternative is almond milk. Almond milk is a nutritious drink that can be prepared both at home and at work. It is made from ground, unroasted almonds and water. The taste of almond milk is reminiscent of protein drinks [7,8].

The average yield of almonds is 0.7-1.2 t / ha, and in high-yield irrigated lands it is 2-2.5 t / ha. Almonds are harvested from 3–4 years of age and give good yields from 12–18 years of age to 35–40 years of age. The following varieties are included in the State Register for sowing in the territory of Uzbekistan: "Bostanliq kechpishari", "Konsoy", "Kilichnuskha" (Sablevidnyy), "Tunguch" (Pervenes), "Tyan-Shan", "Go ' hall ”(Krasivyy),“ Ertapishar ”(Ranniy),“ Ugom ”,“ Crimea ”,“ Nikita kechpishari ”,“ Primer ”,“ Nikita-62 ”,“ Yalta ”(Russia),“ Turkmen a "Losi" (Turkmenistan), "Nonparel" (France), "Drake" (USA) and others. [9]

It should be considered that almond milk has both positive and negative properties. Nuts can also contain substances that cause allergic reactions. Some commercial brands of almond milk contain the additive carrageenan, which is used for gelling, thickening, and stabilization. Recent studies have shown that it can cause inflammation of the gastrointestinal tract and even cancer. This substance has not been canceled as a food additive, but it is not recommended to use it in baby food [10].

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II. METHODOLOGY

The production of almond milk does not require complex equipment, but a step-by-step technological scheme is necessary on a production scale. To obtain this plant milk, it is necessary to separate, soak, grind, homogenize, sterilize and pasteurize almond kernels. Under laboratory conditions, almond milk was obtained from local almond varieties "Uzbekistan-20", and then a part of it was powdered in a lyophilization equipment to study comparative physical and chemical data. Infrared spectrometry Nicolet iS50 FT-IR model was used to study the IR regions of the object. The morphology of milk powders was analyzed using a JSM-IT200 scanning electron microscope. Fatty acids in almond milk were analyzed using Agilent Technologies 6890 N gas-liquid chromatography. Common components of milk were checked in liquid form on the Lactoscan S equipment, designed for milk processing enterprises, and comparative analyzes were carried out.

III. EXPERIMENTAL RESULTS

Part of the obtained almond milk was powdered by lyophilization. Preliminary analyzes began with the study of the spectral characteristics of the IR region (800-5000 cm^{-1}) recorded on an IR Nicolet iS50 FT-IR spectrophotometer at room temperature. Comparative absorption spectra of dairy products in the IR region are shown in Fig. 1.

In the results of the IR spectrum analysis (Fig. 1), it can be seen that the broad absorption band at 3281 cm^{-1} corresponds to the NH group. The absorption band at 2924 cm^{-1} is related to the bending vibrations of the CH group (ν_{CH}), and at 2853 cm^{-1} to the vibrations of the CH_3 groups (ν_{CH3}). In the 1648 cm^{-1} region, there is an absorption band associated with the stretching vibrations of the aminocarbonyl groups of the peptide bond. The spectrum also contains absorption bands at 1545 cm^{-1} associated with the band of the amide group, flat bending vibrations of the CH group at 1417 cm^{-1} and stretching vibrations of the C-N bond at 1219 and 1048 cm^{-1}.

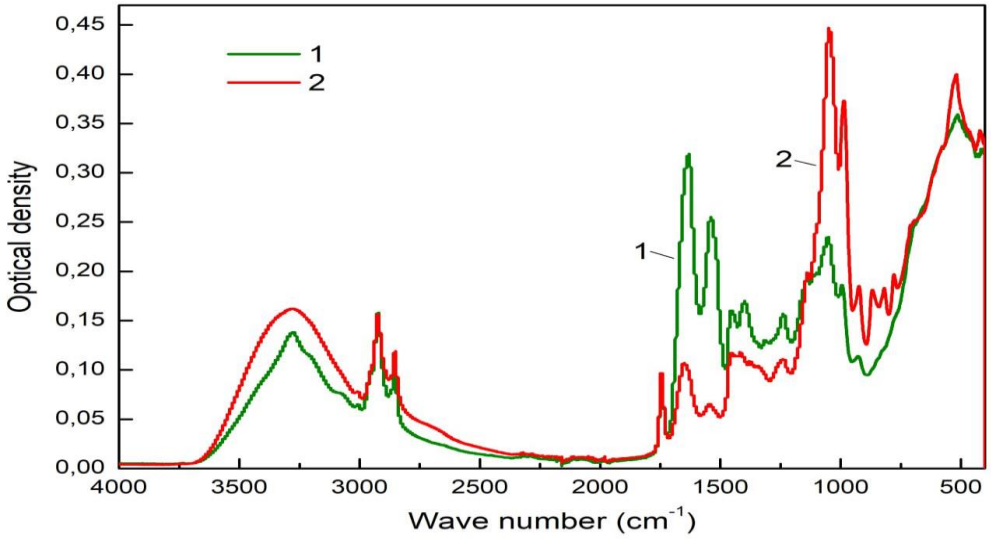
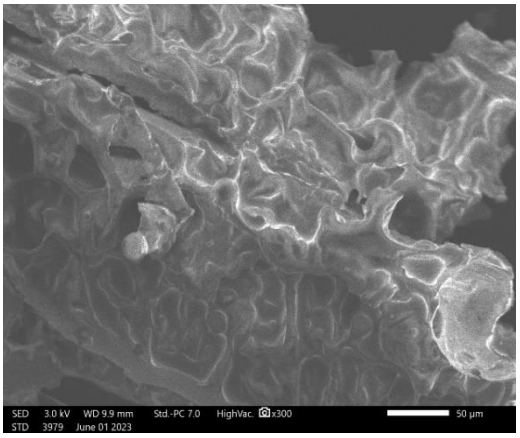


Fig 1. IR spectra of samples of milk derived from the local almond variety "NamMTI-Almond milk" and imported almond milk.

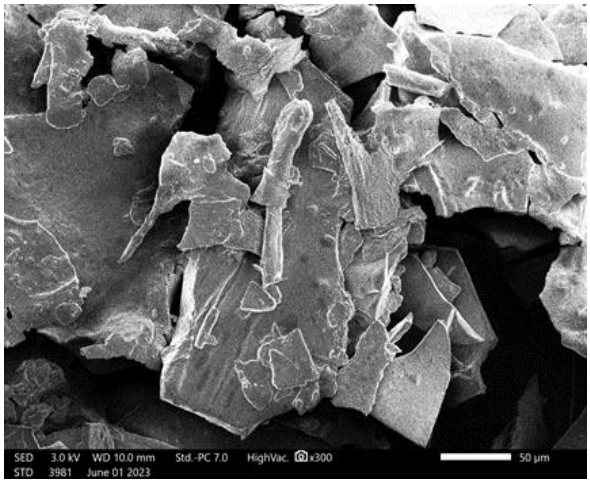
1- NamMTI-Almond milk from local almond variety, 2- sample of imported milk

Scanning electron microscopy analyzes were performed on a JSM-IT200 device to study the morphology of almond milk powders (Figure 2).



Elements	Mass, %
C	65.5
O	32.5
Mg	0.24
P	0.59
S	0.17
K	0.74
Ca	0.14
Total:	100

(*a*)



Elements	Mass, %
C	46.1
O	46.66
Na	0.78
Mg	0.13
Al	0.19
P	1.62
Cl	0.43
K	2.81
Ca	1.23
Total:	100

(***b***)

Fig 2. Results of Scanning Electron Microscope analyzes of almond milk powders
1- Almond milk obtained in the laboratory with the conditional name "NamMTI Almond Milk" (***a***), 2- imported almond milk (***b***)

As the results of the analysis presented in Figure 2 show, the elemental composition of the two samples differs from each other. It can be seen that the sample offered "NamMTI Almond Milk" has 1.4 times more C than imported almond milk. Also, the amount of Ca is 8-9 times less than imported for the proposed sample. It should be noted that the imported sample was fortified with Ca, but the sample obtained under laboratory conditions "NamMTI Almond Milk" was not fortified. Therefore, significant differences can be seen in this comparative analysis. In the key stages of the research work, the recommended variant of almond milk is enriched.

Fats are one of the main components of human nutrition, necessary for obtaining energy, assimilation of fat-soluble vitamins and obtaining phospholipids, sterols and polyunsaturated fatty acids [11]. The oil found in almond milk contains many useful substances that have a beneficial effect on the functioning of the nervous and cardiovascular systems, as well as increase the body's resistance to infectious diseases [12].

The liquid form of the samples was used to determine the components of fatty acids. The samples were mixed gently and placed in a 50 ml round dish. To this was added 20 ml of 2N methanolic KOH solution and the flask was placed in a water bath. This mixture is boiled for 1 hour to carry out the saponification process of lipids.

A 50% aqueous solution of H_2SO_4 was added to the aqueous soap solution to break down the soap and extract the fatty acids (FA). Addition of sulfuric acid was continued until the solution turned pink to methyl orange. The obtained acidic solution of fatty acids was extracted three times with diethyl ether in portions of 20-30 ml. The combined ether extracts were washed with distilled water until the medium became methyl orange neutral. The extracts were then dried over anhydrous sodium sulfate and the ether was removed in a rotary evaporator under vacuum of a water jet pump. Freshly prepared diazomethane was used to convert fatty acids into methyl esters.

For analysis, we use an Agilent Technologies 6890 N gas-liquid chromatograph equipped with a flame ionization detector and a capillary column 30 m long and 0.32 mm internal diameter coated with HP-5 phase. This analysis was performed at temperatures between 150 and 270° C using helium as the carrier gas agent. The table shows the composition of fatty acid methyl esters obtained from the samples and their proportions.

Table 1 Fatty acid composition (in the form of methyl esters) of samples, % by weight of acids

Fatty acids	Samples	
	№1 ("NamMTI Almond Milk")	№2 (Imported product)
Myristic 14:0	0,04	Weak
Palmitic 16:0	6,00	5,81
Palmitoleic 16:1	0,50	0,46
Margarine 17:0	0,05	0,05
Stearic 18:0	1,33	1,28
Oleic+linolenic ω-9 18:1 + ω-3 18:3*	77,39	78,12
Linoleic ω-6 18:2	14,54	14,12
Arachinova 20:0	0,06	0,06
Eicosene 20:1	0,09	0,10
∑ saturated fatty acids	7,48	7,20
∑unsaturated fatty acids	92,52	92,80

* This pair of fatty acids under the used GC conditions is not separated and comes out as a single peak.

Table 1 shows that the composition of fatty acids in both samples is practically the same. The ratio of linolenic ω-3 and linoleic ω-6 fatty acids, which are considered very rare in food supplements, is close to 5:1, which means that this composition is suitable for those who have a diet [13]. This indicates the biological value of the fatty acid content.

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Then, the composition of the two types of almond milk was studied on the Lactoscan S device, which is used in the analysis of the composition of milk received by milk processing plants. The obtained result is shown in Table 2.

Table 2 Composition of almond milk

Samples	Fat, %	Dry matter, %	Density,	Carbohydrate, %	Protein, %	Added water, %
"NamMTI Almond Milk"	6.60	03.50	05.40	01.88	01.21	-
Imported almond milk	2.60	05.50	06.40	02.55	04.21	-

As can be seen from Table 2, the fat content of the milk is 6.6% for the sample "NamMTI Almond Milk" and 2.6% for the imported almond milk. But the protein content of imported almond milk is 4 times higher than that of "NamMTI Almond Milk". Analyzing the obtained data, it can be said that the imported sample is enriched with protein.

IV. CONCLUSION

Thus, based on the conducted research, the following conclusions can be drawn:
- it is possible to take almond milk from local almond varieties and enrich its content according to functional purposes;
- IR spectra are almost the same, the amount of carbohydrates is much higher in almond milk obtained from local almond varieties, while the amount of protein is higher in imported and enriched almond milk;
-According to the SEM results, the amount of C in the proposed sample is 1.4 times higher than that of the imported one. Also, the amount of Ca in the proposed sample is 8.7 times less than the imported one.

Such noticeable differences are that imported almond milks are enriched with additives or reduced in the amount of some substances in accordance with the requirements of the selected consumer segment. The composition of the proposed almond milk obtained in laboratory conditions can also be enriched according to functional purposes.

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