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NUTS-BASED NON-ALCOHOLIC DRINKS FOR A HEALTHY DIET

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Abstract

Given a prevalence in the world of people with a reduced ability to digest lactose, a new segment of the non-alcoholic drinks market is gaining more and more turnover – vegetable milk substitutes. Considering the existing demand for milk replacers, we have developed a series of non-alcoholic drinks, made up their recipes and evaluated their quality indicators. It was decided to take nuts as the basis for the drinks, and honey, lecithin, spirulina as the enriching raw materials. Walnut and Manchurian nut have an original chemical composition and useful properties, and there are no drinks based on them on the Russian market. To improve the organoleptic indicators, biological and physiological value, flower honey, sunflower lecithin and spirulina powder were introduced into the drinks recipes. Studies of the chemical composition and properties of drinks have shown a high nutritional and physiological value in terms of protein and mineral content. According to the results of the tasting, the developed drinks based on Manchurian walnut with honey and Manchurian walnut with honey and spirulina received the highest scoring, and drinks based on walnuts and Manchurian nuts with honey and spirulina turned out to be the richest in protein. The developed drinks are recommended as a source of protein to a wide range of consumers.

Keywords: Honey, manchurian nut, non-alcoholic drinks, spirulina, walnut

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1. Introduction

According to statistical data, there is a tendency for an increase in the incidence of the population of Russia. So, from 2004 to 2019, the number of people with diseases of the endocrine system, eating and metabolic disorders increased by 54.3%, with diseases of the circulatory system – by 63.3%, with diseases of the respiratory system – by 24.6% (Zabolevaniya naseleniya.., 2021).

About two-thirds of the world's people have a reduced ability to digest lactose after infancy. There is a tendency related to ethnicity: lactose intolerance is most often observed in populations that traditionally do not consume a lot of dairy products, and vice versa. Data from the US National Institutes of Health show that, for example, only about 5% of people in Northern Europe are lactose intolerant, while in some communities in East Asia, the disease can affect over 90% of adults (Lactose intolerance, 2020).

The active introduction of innovations in the food industry has significantly expanded the list of ingredients used and made it possible to give traditional food products original organoleptic properties, directed functional and technological characteristics and provide a therapeutic and prophylactic effect. Functional foods have proven properties that reduce the risk of developing nutritional diseases, prevent or compensate for nutritional deficiencies, maintain and improve health due to the presence of functional food ingredients in the composition

In the form of ordinary food, they are intended for a wide range of consumers and should be consumed regularly as part of the diet.

A variety of functional products are enriched products obtained by adding one or more functional food ingredients to traditional food products in an amount that ensures the replenishment of the nutrient deficiency present in the body and (or) its microflora.

The expansion of the raw material base for food production is an innovation that is closely related to the production of functional foods since often new raw material sources contain one or more functional food ingredients. Nuts are most appropriate to use as a new type of raw material for vegetable drinks as a source of proteins, unsaturated fatty acids and vitamins.

2. Problem Statement

As a result, a new segment of the non-alcoholic beverages market – herbal milk substitutes – has been gaining more and more turnover recently. The market for alternative dairy products was estimated at USD 5.4 billion in 2019, and at USD 22.6 billion in 2020 and is projected to reach USD 40.6 billion by 2026. The average annual growth rate will be 10.3% in value terms (Global Dairy Alternatives Market Report, 2021). As the analysis of the Russian market has shown, there are no drinks based on walnut (Zakusina, 2019).

3. Research Questions

When choosing raw materials among different types of nuts (walnuts, pine nuts, Brazilian nuts, pecans, macadamia), the decisive indicators were the easy separability of the kernel from the shell, the content of the kernel and its chemical composition.

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As a result, we chose the walnut due to its high kernel yield (47.6%), fat content (72.8%) and minerals (3.6%) compared to other nuts (Zhebo & Uvarova, 2020). In addition, walnut has a high physiological activity: it improves memory and brain function, relieves depression, normalizes blood pressure, strengthens the walls of blood vessels in cardiovascular diseases, has a low glycemic index and does not increase blood sugar, strengthens the immune system (Ob orekhah…, 2021).

Walnut is an important fruit among the nut species. It's cultivated throughout the world for its timber and nutritional values. In 2020 world production of walnuts was almost 3,323,964 tons and China, the United States, Iran and Turkey were the principal producers, with respectively 33.09, 21.29, 10.73 and 8.63% of total global production (Food Agriculture Organization.., 2020).

The walnut is characterized by large size (10.71-13.05 g), thin shell (5.50-6.36 mm) and a high kernel rate (Table 1) (Orman, et al., 2020). Kernel percentage in 107 out of 362 genotypes studied was more than 50% (Mirmahdi & Khadivi, 2021).

Table 1. Size characteristic of walnuts collected in different countries (Orman, et al., 2020)

	Nut weight, g			**Nut length, cm**			**Nut height, cm**			**Nut width, cm**		
	min	**max**	**mean**	**min**	**max**	**mean**	**min**	**max**	**mean**	**min**	**max**	**mean**
Turkey	5.72	25.98	13.05	3.17	8.72	4.04	2.56	5.29	3.51	2.80	5.57	3.48
USA	10.24	14.08	12.44	3.63	4.45	4.24	3.17	3.67	3.35	3.05	3.72	3.40
Portugal			12.16			4.15			3.07			3.23
France	11.44	13.09	12.50	3.80	4.18	4.06	2.93	3.65	3.23	3.12	3.64	3.38
Yugoslavia	9.16	12.26	10.71	3.84	4.25	4.04	3.10	3.42	3.26	3.15	3.55	3.35
Hungary			11.89			3.62			3.37			3.24
	Shell thickness, mm			**Kernel weight, g**			**Kernel ratio, %**					
	min	**max**	**mean**	**min**	**max**	**mean**	**min**	**max**	**mean**			
Turkey	3.48	11.37	6.36	0.40	2.32	1.46	32.35	73.23	49.33			
USA	5.11	7.10	6.17	1.36	1.99	1.55	41.38	51.76	48.60			
Portugal			5.66			1.49			51.12			
France	5.78	6.44	6.15	1.37	1.54	1.47	42.66	51.00	48.47			
Yugoslavia	4.76	6.23	5.50	1.38	1.42	1.40	50.06	50.06	50.06			
Hungary			5.64			1.57			48.84			

Walnut has a high calories level and rich nutrient composition. Walnut kernel contains about 60% of lipids and it is a good source of macronutrients and micronutrients and natural antioxidants like polyphenols, folate, tannins, and walnuts oil are rich in unsaturated fatty acids (Kabiri et al., 2019).

Saturated fatty acids are represented by myristic, palmitic, stearic, and arachidic acid; unsaturated acids are represented by linoleic, linolenic acid, oleic, and palmitoleic acid. Palmitic acid is the predominant saturated fatty acid compound and range from 5.74% to 9.49%; linoleic acid is the predominant unsaturated fatty acid compound and range from 58.96% to 66.07% (Table 2) (Kafkas et al., 2020).

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Table 2. Fatty acid composition of walnut oil (Kafkas et al., 2020)

	Polyunsaturated fatty acids (PUFA)			Monounsaturated fatty acids (MUFA)		
	Linoleic acid	Linolenic acid	Total PUFA	Oleic acid	Palmitoleic acid	Total MUFA
Max value	66.07	16.14	80.21	20.65	0.46	20.78
Min value	58.96	8.41	69.93	10.85	0.06	10.99
Avg Value	62.21	11.98	74.20	15.91	0.15	16.06

Walnut kernels are a good source of protein as well (an average value of ca. 21%) (Kafkas et al., 2020). Walnut protein contains a total of 17 amino acids, including all essential amino acids (29.31% of total amino acids) (Liu et al., 2020).

Walnuts can be considered a good source of natural compounds with antioxidant activity that can be used in the therapeutic as well as condiments in functional foods (Kabiri et al., 2019). The nutritional contents differ from one cultivar to another which can be influenced by genotype, cultivator, different ecology and different soil (Al-Snafi, 2018) (Table 3).

Table 3. Chemical composition of the walnut kernel (Al-Snafi, 2018; Kabiri et al., 2019; Kafkas et al., 2020; Liu et al., 2020)

Nutrients	Content, %	Minerals	Content, mg 100 g^{-1}	Vitamins	Content
Dry matter	96.75-98.56	Ca	98.00	Folates	98 mcg
Moisture	1.44-3.24	P	338.1-675.87	PP	1.125 mg
Protein	11.50-25.72	Cu	1.50-6.67	B5	0.570 mg
Total oil	53.17-70.30	Zn	3.09-18.63	Pyridoxine	0.537 mg
Total carbohydrates	8.17-19.25	Fe	1.17-2.90	B2	0.150 mg
Crude fibre	4.17-6.75	Cr	0.16-0.20	B1	0.541 mg
Starch	≤2.8	Ni	1.26-1.45	A	20 IU
Ash	1.67-2.53	B	0.07-1.49	C	1.3 mg
Total phenols	1017-3739 mg GAE 100 g^{-1} DM	K	210.10-441.00	E	20.83 mg
Flavonoids	12.59-62.11 mg RE 100 g^{-1} DM	Mg	79.15-374.54		
DPPH radical scavenging activity	75.02-85.96	Na	1.17-12.63	K	207 mcg
Energy value	648.91-713.83 Kcal	Mn	0.79-3.80		
		Al	0.58		

More, kernel walnut was revealed to be endowed with antimicrobial capacity against many different bacteria and fungi, in particular, *Staphylococcus aureus* and *Salmonella* spp (Kavuncuoglu et al., 2018; Pereira et al., 2008).

In European countries, walnut fruit has a great place in diet and customs and it is consumed, fresh or toasted, alone or in other edible products. The consumption of walnut is increasing due to the existence

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of a high concentration of natural antioxidants that have been reported as being protective against certain types of cancer and may also decrease the risk of cardiovascular disease (Kabiri et al., 2019).

In comparison with other kinds of nuts, most nuts are high in monounsaturated fatty acids, whereas walnut is composed largely of polyunsaturated fatty acids, and it is the richest one in α-linolenic acid content, which gives it additional anti-atherogenic properties. Such a unique property distinguishes walnut from most other nuts, making it an interesting target for investigation (Zibaeenezhad et al., 2017).

Dietary supplementation with walnut kernel and walnut septum extract can maintain liver and brain health and reduce the risk of age-related diseases, as well as delay the onset of ageing processes (Rusu et al., 2020).

It is now well documented that nuts can improve the blood lipid profile and reduce the risk of coronary artery disease (CAD). It has been shown that frequent nut consumption or intake of more than 4-5 servings per week (one serving is 1 oz. or 12-14 halves or 1/4 cup of a walnut) significantly reduces adjusted relative risk of CAD (Ashraf et al., 2021; Zibaeenezhad et al., 2017).

Showed that addition of 15 ml walnut oil to the previous diet of diabetics, for 90 days, significantly decreased the total cholesterol, low-density lipoprotein cholesterol, triglyceride and total cholesterol to high-density lipoprotein ratio, which is all-important in the management of diabetes. It can be hypothesized that these effects may have an impact on the reduction of CAD risk of and other disease-related complications in diabetic patients. Walnut oil may serve as a helpful natural remedy in hyperlipidemic patients with type 2 diabetes (Zibaeenezhad et al., 2017).

The Manchurian nut, an endemic to the Far East, was also considered as a basis for drinks.

As a historical herbal medicine, the Manchurian nut has been traditionally and popularly used in indigenous populations to treat cancer in China, Japan, Korea, and India for more than 2000 years. Recent investigations have focused primarily on evaluating the anticancer activities of the extracts or isolated compounds of this plant. Until now, more than 400 chemical constituents have been isolated and identified from the different parts of the Manchurian nut. Through a comprehensive analysis, it was found that the quinones, phenolics, triterpenoids, and diarylheptanoids are major and important active compounds of the Manchurian nut with numerous pharmacological activities shown *in vivo* and *in vitro* investigations (Luan et al., 2021).

The nuts are extensively used as food because of their considerable nutritional value (Mu et al., 2017; Wang et al., 2017). The kernels of the Manchurian nuts have high nutritional value, containing lipids (60-66%), proteins (15-20%), carbohydrates (1-15%), vitamins and minerals (Fang et al., 2018; Wang et al., 2017, 2020). The lipids are also considered to be the main source of bioactivities owing to their abundant polyunsaturated fatty acids (Carey et al., 2020).

Thus, the Manchurian nut is a source of nutritional and medical compounds and is worthy of further study owing to its health-promoting properties and its potential for further development in the food industry (Luan et al., 2021).

As our research has shown, the Manchurian nut kernel is characterized by a high content of fat (up to 63%), protein (up to 32%) and minerals (up to 3.3%) and can compete with other nuts in terms of nutritional value, including walnut. On the other hand, the kernel is difficult to remove from the shell and has a relatively low yield (up to 27%) (Zemlyak & Okara, 2011, 2015).

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To improve the organoleptic characteristics and physiological value, flower honey was included in the drink recipe. According to the literature, honey restores energy losses after heavy mental and physical exertion, stimulates the normal functioning of the immune and nervous systems, and relieves inflammation (15 samyh…, 2021).

Sunflower lecithin was used in the drinks recipes not only as a technological ingredient (emulsifier) but also as an enriching additive: it prevents and promotes the treatment of cardiovascular, gastroenterological and nervous system diseases (Yuviks-Farm, 2021).

Spirulina is a blue-green freshwater algae that grows in mineral-rich alkaline lakes and ponds around the world. It got its name from its shape that looks like a spiral. It contains about 68% protein, removes excess water from the body, strengthens the immune system. WHO has hailed spirulina as «the greatest food on Earth», FDA USA – «man's best source of protein», NASA – «food for Astronauts», FAO – «most ideal diet in 21st century».

4. Purpose of the Study

Considering the existing demand for milk replacers, we have developed a series of non-alcoholic drinks, made up their recipes and evaluated their quality indicators (Zhebo et al., 2019). It was decided to take nuts as the basis for the drinks, and honey, lecithin, spirulina as the enriching raw materials.

5. Research Methods

During the research, the methods of studying literature and documents, as well as measuring methods – organoleptic and physicochemical were used.

6. Findings

After the selection of the recipe components, we examined their quality indicators. As our research has shown, Manchurian nuts were almost as good as walnut in terms of fat and ash content in the kernel, exceeded it in protein content (by 1.3%) and contained fewer carbohydrates (by 3.5%) (Table 4).

Table 4. Physicochemical indicators of the walnut kernel and Manchurian nut kernel

Indicator name	Nut kernel	
	walnut	Manchurian nut
Moisture, %, no more	2.9	5.4
Dry matter, %	97.1± 0,2	94.6± 0,2
Fat, %,	68.0±0,1	67.6±0,1
Protein, %	12.2±0,1	13.5±0,1
Total ash, %	3.6±0,01	3.7±0,01
Carbohydrates, %	13.3	9.8

Organoleptic and physicochemical evaluation of spirulina powder purchased from a commercial network did not reveal any deviations from the manufacturer's marking data (Table 5).

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Table 5. Organoleptic and physicochemical indicators of spirulina powder

Indicator name	Characteristic	
	marking	in fact
Appearance	Homogeneous powdery	Homogeneous powdery
Taste, smell	Algae taste, herbaceous, without foreign tastes and odours	Algae taste, herbaceous, without foreign tastes and odours
Colour	Green	Green
Dry matter, %	97.83±0,20	97.82±0,20
Fat, %	5.17±0,10	5.17±0,10
Protein, %	68.06±0,10	68.05±0,10
Total ash, %	6.8±0,01	6.8±0,01
Carbohydrates, %	17.8	17.8
Acidity, cm^3 of a NaOH solution with a concentration of 0.1 mol/dm^3	No data	10.0±0,15
pH, units	No data	6.71±0,05

To determine the recipe for the product, a series of five non-alcoholic drinks was prepared: 1) based on walnut (control); 2) walnut with honey; 3) walnut with honey and spirulina; 4) Manchurian nut; 5) Manchurian nut with honey; 5) Manchurian nut with honey and spirulina. As tests have shown the organoleptic indicators of the drinks were benign and depended on the introduced raw materials (Table 6).

Table 6. Organoleptic indicators of non-alcoholic drinks based on walnut and Manchurian nut

Indicator	**Walnut (control)**	**Walnut with honey**	**Walnut with honey and spirulina**
Appearance	Opaque liquid with nut sediment on the bottom		
Colour	Cream	Cream	Green
Taste and aroma	Pleasant taste and odour of walnut	Pleasant taste and odour of walnut, sweet	Taste is sweet and sour, pleasant
Indicator	Manchurian nut	Manchurian nut with honey	Manchurian nut with honey and spirulina
Appearance	Opaque liquid with nut sediment on the bottom		
Colour	Cream	Cream	Cream
Taste and aroma	Pleasant taste and odour of nut	Pleasant taste and odour of nut	Pleasant taste and odour of nut

According to the results of tasting, the developed drinks based on Manchurian walnut with honey (19.3 scores) and Manchurian nut with honey and spirulina (19.4 scores) received the highest marks (Table 7).

Table 7. Scoring the organoleptic indicators of non-alcoholic drinks based on walnut and Manchurian nut

5	**Walnut (control)**	**Walnut with honey**	**Walnut with honey and spirulina**
Appearance	4.6	4.6	4.6
Colour	5.0	5.0	5.0
Taste and aroma	9.2	9.6	9.6
Total	18.8	19.2	19.2

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Indicator	Manchurian nut	Manchurian nut with honey	Manchurian nut with honey and spirulina
Appearance	4.7	4.9	4.9
Colour	5.0	5.0	5.0
Taste and aroma	9.2	9.4	9.5
Total	18.9	19.3	19.4

The physicochemical assessment showed that the developed drinks contained 19.5-30.0% dry matter, including 13.9-15.0% fat, 2.5-3.3% protein, up to 11% carbohydrates and 0,7-0.8% total ash. Drinks based on walnut with honey and spirulina and Manchu nut with honey and spirulina were the richest in protein – 3.1% and 3.3%, respectively (Table 8).

Table 8. Physicochemical indicators of non-alcoholic drinks based on walnut and Manchurian nut

Basis of drinks	**Dry matter, %**	**Fat, %**	**Protein, %**
Walnut (control)	20.85	14.94	2.5
Walnut with honey	29.08	14.94	2.5
Walnut with honey and spirulina	30.00	14.99	3.1
Manchurian nut	19.50	13.87	2.7
Manchurian nut with honey	27.16	14.23	2.7
Manchurian nut with honey and spirulina	28.50	14.78	3.3
Basis of drinks	**Total ash, %**	**Carbohydrates, %**	
Walnut (control)	0.72	2.70	
Walnut with honey	0.74	10.90	
Walnut with honey and spirulina	0.81	11.00	
Manchurian nut	0.70	2.23	
Manchurian nut with honey	0.75	9.48	
Manchurian nut with honey and spirulina	0.82	9.60	

7. Conclusion

Thus, we have developed a series of nut-based non-alcoholic drinks. According to the results of the tests, the drinks based on walnut and Manchurian nut with honey, lecithin and spirulina received the highest rating. The drinks are characterized by attractive organoleptic properties, high nutritional and physiological value due to their ingredients, including local origin. They can be categorized as functional and energy drinks and are recommended to a wide range of consumers. Their industrial production and sale will allow solving the problems of improving and strengthening the immunity of the population, as well as the rational use of raw materials of plant and animal origin.

We believe that the production of milk substitutes based on beans as a segment of lactose-free products is in line with the provisions of the NTI-2035 national technology initiative as an element of the FoodNet concept - a market for the production and sale of nutrients and final types of food products (personalized and general, on based on traditional raw materials and their substitutes) in the direction of personalized nutrition.

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