Cereals in clinical nutrition for type 2 diabetes mellitus from the standpoint of modern and traditional dietetics

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Traditional and modern view of dietetics on grains in nutrition for patients with diabetes type 2

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SUMMARY

The review is devoted to the peculiarities of the use of cereals in type 2 diabetes mellitus (DM) from the standpoint of theoretical concepts of various traditional medical systems and from the point of view of modern dietetics in a comparative aspect. It has been shown that in modern medical practice, the biological effect of cereals in diabetes is assessed mainly in accordance with the action of the macro and micronutrients they contain. At the same time, the causes of this disease are not taken into account, due to violations of the energy potential of the body, in particular, the depletion or decrease in the quality and / or quantity of the vital energy Qi. Modern dietetics also does not take into account the so-called "special properties" of cereals, known from traditional medicine: Character (usually "warm" or "neutral"), Taste (usually "sweet"), Action (usually "nourishing",

Taking into account the peculiarities of the use of cereals in modern and traditional dietetics, the expediency of using buckwheat has been substantiated, including its promise as the basis of food matrices for specialized food products for diet therapy of type 2 diabetes.

Key words: diabetes mellitus, diabetes mellitus 2 types, specialty foods, cereals, cereals, buckwheat, traditional medicine.

RESUME

The review is devoted to the use of cereals in type 2 diabetes from the standpoint of theoretical concepts of various traditional medical systems and from the point of view of modern dietetics in the comparative aspect. We found that in modern medical practice the biological effects of cereals in diabetes are evaluated mainly in accordance with the action of macro and micronutrients contained in them. This does not take into account the causes of this disease, due to violations of the energy potential of the body (in particular, depletion, or a decrease in the Quality and / or Quantity of life energy Qi). Modern dietetics also does not take into account the socalled "special properties" of cereals, known from Traditional medicine - Character (usually "warm" or "neutral"), Taste (usually "sweet"), Action (usually "nourishing", "Replenishing") and tropism to various organs and systems of the body. We have justified the use of buckwheat as the basis of food matrices in specialized food products for patients with type 2 diabetes.

Keywords: grains, cereals, diabetes, type 2 diabetes mellitus, specialized food products, buckwheat, Traditional Medicine.

Today, almost all over the world, the basis of human nutrition is made up of food products obtained from cereals, which include plants of the cereal family: wheat, rye, barley, oats, corn, rice, millet, sorghum, as well as buckwheat from the buckwheat family. According to a number of authors [8, 21], about 40% of the total caloric intake, almost 50% of the need for proteins, 60% of the need for carbohydrates are provided due to grain processing products. At the same time, there is often an outdated idea that the use of cereals and other cereal-based products as sources of carbohydrates should be limited in diabetes mellitus (DM).

In Russia, as in other countries of the world, there is a significant increase in the prevalence of diabetes. According to the Federal Register of Diabetes mellitus, in 2016, 4.35 million diabetic patients were registered in the dispensary, including 4 million people with type 2 diabetes. However, the real number of patients with diabetes is more than 2 times higher than the officially registered one and amounts to at least 8-9 million people (about 6% of the population) [2]. Therefore, expanding the range of food products for patients with diabetes mellitus 2 at the expense of domestic specialized food products (SPF) containing micronutrients that have a pronounced physiological effect on the body is an urgent task.

When developing a SPP for the prevention and treatment of type 2 diabetes (grant from the Russian Science Foundation No. 143600041), we faced the problem of choosing cereals to create food matrices for dry multicomponent mixtures with a modified carbohydrate profile, since the modern approach to the use of cereals and cereals comes down to a reasonable limitation of the amount of carbohydrates in the diet of such patients [15, 62]. The relevance of the development of SPP based on the combined use of polyphenols and cereals is due, on the one hand, to the rich macro and micronutrient composition and beneficial properties of cereals [22, 28–31, 34], on the other hand, the low bioavailability of antidiabetic polyphenols and the expediency of its increase in the SPP for plant protein counts [55].

The purpose of this information-analytical study was the search for a grain crop for its scientifically grounded use as the basis of food matrices for the development of specialized food products for diet therapy of type 2 diabetes. The review is devoted to the use of cereals in type 2 diabetes mellitus (DM) from the standpoint of theoretical concepts of various traditional medical systems and from the point of view of modern dietetics in a comparative aspect.

1. Cereals for diabetes mellitus from the perspective of traditional medical systems of the world

In the theoretical foundations of various traditional medical systems (Ayurveda, Unani, Siddhi, traditional Chinese, Korean (Korë), Japanese (Kampo), Tibetan medicine, etc.), based on their own theoretical concepts, harmonious nutrition implies such a choice and combination of food products, so that the energy balance of the body is promptly restored and / or maintained [1, 10, 17, 18, 25, 27, 36, 49, 53, 58–61].

Previously, we analyzed in detail the causes of diabetes from the standpoint of Ayurveda, traditional Chinese medicine and Tibetan medicine. [32]. We managed to summarize the experience of several traditional medical systems and show that the main reason for the occurrence of diabetes mellitus 2 and other metabolic diseases from the standpoint of oriental medicine is a violation of energy metabolism in the body, caused, among other things, by the untimely and unbalanced use of foods of unsuitable taste (sweet, bitter, sour, salty, spicy), the wrong balance of energetically "hot", "cold" and "neutral" foods, as well as constitutional and seasonal inadequacy of food and its excessive consumption [32].

From the standpoint of traditional dietetics, the thermal and gustatory classifications of products adopted in various traditional medical systems are based on their energetic effect on the body and must be taken into account in the process of drawing up a plan of therapeutic measures [7, 25, 26, 36–38, 45, 52, 60]. At the same time, the effect of many “neutral” and “sweet” foods, which include most cereals and cereals from them, restores Qi energy, manifests itself much sooner than long-term attempts to improve health without taking into account these properties of food [27, 36–38, 50, 58 , 59].

Analyzing the experience of using individual cereals to restore energy balance in the body for the prevention and treatment of diabetes in Ayurveda, traditional Chinese and Tibetan medicine, it was possible to identify that the preferred crops have historically been sources of cereals of a "neutral" and even "cooling" ("refreshing") character having a "sweet" or "bitter" (or both "sweet" and "bitter") taste [32]. From the standpoint of traditional Chinese medicine, such grains include whole wheat, spelled, buckwheat, corn [5, 6, 14, 17, 18, 53], in Tibetan medicine - buckwheat, millet, rye, barley [50, 58, 59] , in Ayurveda - with diabetes caused by exacerbation of Vata - wheat, spelled, buckwheat, millet, with diabetes caused by exacerbation of Pita - wheat, spelled, corn, millet, exacerbation of Kapha - buckwheat, corn, millet (wheat is strictly excluded) [49].

Also of great importance was the property of croup to "enter" the channels that are interested in diabetes mellitus - the Spleen, Liver, Stomach, Kidneys, Heart and Large intestine [32]. In accordance with the theory of traditional Chinese medicine, according to [5, 6], for example, buckwheat correlates with three channels at once - the Spleen, Stomach and Large intestine. According to [17, 18], in the case of whole cereals, wheat, rice, barley and buckwheat enter the Spleen canal, buckwheat into the Liver canal, buckwheat and wheat into the Kidney canal, wheat into the Heart canal, and buckwheat into the Large intestine canal. and corn.

2. Cereals and cereals in modern world dietetics

Among the food products obtained from grain, an important place is occupied by cereals, which are not only a good source of complex carbohydrates (from 55.4 to 68.5 g / 100 g), but also have a relatively high protein content (7.0–12.3 g / 100 g), dietary fiber, a number of vitamins (thiamine, niacin, to a lesser extent riboflavin) and minerals (magnesium, phosphorus, iron, potassium, copper, nickel, manganese, etc.) [54, 93].

From the standpoint of modern domestic dietetics, cereal protein has a low biological value due to a deficiency of essential amino acids. The lack of essential amino acids in cereals can be replenished by combining cereals with milk (for example, buckwheat or oatmeal with milk). Such mixtures of proteins of animal and plant origin in their amino acid composition are close to meat proteins and are better absorbed [15], which does not agree with the experience of traditional medicine in the combined use of products.

The amount of dietary fiber in some cereals ranges from 3.0 g to 12.5 g per 100 g of product, depending on the grinding of the cereal - a technological operation, as a result of which the core of cereal crops is freed from the remnants of the outer shells, partially or completely from the inner shells, aleurone layer and embryo. In the process of grinding, the anatomical parts of the grain with a high content of fiber, fat, and ash elements are removed, as a result of which the digestibility of the cereal, its digestibility, and its stability during storage increase [57].

The nutritional value of food products from cereals (cereals) is presented in table. one.

Table 1

Nutritional value of food products from cereals (cereals) [54]

Cereals	Nutrients												
	Proteins, G	Fats, G	Carbohydrates, G	Starch, G	Food fibers, G	Potassium, mg	Magnesium, mg	Calcium, mg	Phosphorus, mg	Iron, mg	Vitamin Vone, mg	Vitamin V_2, mg	PP, mg
Buckwheat groats	9.5	2,3	60.4	59	12.5	320	150	twenty	253	4.9	0.42	0.17	3.8
Buckwheat unground	12.6	3.3	57.1	55.4	11.3	380	200	twenty	298	6,7	0.43	0.2	4.2
Polished millet groats	11.5	3.3	66.5	64.6	3.6	211	83	27	233	2.7	0.42	0.04	1.6
Corn groats	8.3	1,2	71	69.6	4.8	147	thirty	twenty	109	2.7	0.13	0.07	1.1
Pearl barley	9.3	1.1	66.9	65.7	7.8	172	40	38	323	1.8	0.12	0.06	2
Barley groats	10	1,3	65.4	63.8	8.1	205	50	80	343	1.8	0.27	0.08	2.7
Rice groats	7	one	74	72.9	3	one hundred	50	eight	150	0,4	0.08	0.04	1.6
Oat groats	12.3	6.1	59.5	58.2	eight	362	116	64	349	3.9	0.49	0.11	1.1
Flakes "Hercules"	12.3	6.2	61.8	60.1	6	330	129	52	328	3.6	0.45	0.1	one
Oatmeal	12.5	6	64.9	62.9	4.8	351	111	58	325	3	0.22	0.06	0.7
Groats "Artek"	eleven	1,2	68.5	66.2	4.6	230	60	40	276	4.7	0.3	0.1	1.4
Semolina	10.3	one	70.6	68.5	3.6	130	eighteen	twenty	85	one	0.14	0.04	1,2
Groats "Poltavskaya"	11.5	1,3	67.9	66.5	4.4	230	60	40	261	4.4	0.3	0.1	1.4

Buckwheat groats are produced from buckwheat grain by separating the fruit shells. Three types of buckwheat are used: 1) unground, consisting of whole grains; 2) done - from crushed grains; 3) Smolensk groats (small buckwheat groats, rolled to the size of a poppy seed). In the 21st century, green buckwheat, or green buckwheat, also came into fashion [29]. Kernels and prodel are produced from steamed and dried buckwheat. Buckwheat is distinguished by a high content of dietary fiber, and in the core, consisting of grains without a shell, there are fewer of them than in the prodel (11.3 versus 12.5 g / 100 g of product), where part of the shell remains, since small grains, those that do not fall into the core are more difficult to clean. The smallest amount of casings contains Smolensk groats, which are obtained by sifting the casings and sifting out the flour after crushing the kernel. Buckwheat has a relatively high protein content (unground - 12.6 g / 100 g of product, spent - 9.5 g / 100 g of product), which, in contrast to proteins of other plant products, is relatively high in lysine [29, 63]. The digestibility of buckwheat proteins does not exceed 70%, fats - 92%, carbohydrates - 94% [63].

Oat groats, Hercules flakes (steamed and flattened oat grains) and oatmeal (oat flour) are characterized by a high protein content and the highest amount of vegetable fat compared to other types of cereals, which puts them in first place in terms of calorie content among the rest. croup. Oatmeal and Hercules flakes are distinguished by a significant content of dietary fiber, magnesium and phosphorus [11, 21–23, 27, 28, 48, 51].

Barley groats (barley and pearl barley) are produced from barley, which has a high fiber content (14.5 g / 100 g). Barley groats are crushed barley kernels, freed from flower films, pearl barley is whole barley grains, peeled and polished or unpolished. The advantage of barley is that, unlike pearl barley, it does not undergo grinding, so it contains slightly more dietary fiber. A feature of barley groats is a large amount of β-glucan polysaccharide, calcium, phosphorus, vitamin PP [11, 21–23, 27, 28, 48, 51].

Rice, in comparison with other cereals, contains relatively little protein and fat, while it contains a significant amount of starch, which has the ability to swell strongly when cooking cereals, with a low content of dietary fiber. Rice is easy to digest and well absorbed.

Semolina is obtained by varietal milling of wheat by selecting grains from the central part of the grain. Semolina is rich in protein, starch, and contains little dietary fiber.

Millet contains a significant amount of protein, which in its amino acid composition is inferior to buckwheat proteins. Millet contains relatively high amounts of nicotinic acid, copper, nickel, manganese and zinc [11, 21–23, 27, 28, 48, 51].

Cereals also contain a variety of combinations of biologically active substances (BAS), depending on the type of cereals, the location of the grains and the way they are processed. The external structures of grains, in particular the amniotic seed layer and the layer of aleurons, contain much higher amounts of biologically active substances, such as phenolic compounds, phytosterols, betaine, etc., than the embryo and endosperm [67, 77].

In particular, the main biologically active substances present in oats are tocopherolsitocotrienols, phenolic acids, sterols, selenium avenanthramides (a group of Ncinnamoylanthranil alkaloids, unique for oats) [67].), which were previously identified in the leaves of various grasses, in rye and corn [30, 103]. The richest raw materials in terms of the content of ferulic acid (natural phenylpropanoid of the class of hydroxycinnamic acids) are corn and wheat bran, flax, rye, spinach, broccoli, and red cabbage [30, 72, 105]. Barley contains various biologically active substances, including phenolic acids, flavonoids, lignans, tokols, phytosterols, folates [67, 87], buckwheat - D chiroinositol, flavonoids (mainly rutin and quercetin) [29, 79, 80].

There is now strong evidence that dietary patterns using whole grains are associated with a reduced risk of type 2 diabetes [67, 70, 78, 85, 95]. Systematic reviews and meta-analyzes of large prospective studies have consistently demonstrated that consumption of whole grains improves homeostasis and slows or prevents the development of type 2 diabetes and its complications [67]. It has been shown that daily consumption of two to three servings of whole grains is accompanied by a 20–30% reduction in the risk of developing type 2 diabetes compared with the predominant consumption of one serving of these products per week [92, 94, 97, 99, 106]. Results from a cross-sectional study by NM McKeown et al. [92], The purpose of which was to assess the relationship between the consumption of foods from whole or refined grains with several metabolic markers of the risk of cardiovascular diseases and type 2 diabetes, demonstrate that increased consumption of whole grains has a beneficial effect on the level of total cholesterol (CS), low density lipoprotein cholesterol (LDL) , insulin in the blood on an empty stomach. According to Y. Jang et al. [89], isocaloric substitution of refined rice for a whole grain product for 16 weeks was accompanied by a decrease in the content of glucose, insulin, malondialdehyde, and homocysteine in the blood in male patients with coronary heart disease against the background of a decrease in the concentration of 8epiprostaglandin F (2alpha) in urine in an average of 28%. In addition, in patients who have consumed a whole grain product,

In a randomized crossover study conducted by K. Rave et al. (2007) showed that consumption of a dietary product based on whole grains with a reduced starch content obtained from double-fermented wheat was accompanied by a decrease in blood glucose and insulin resistance index in obese patients with impaired fasting glucose [100]. According to Kh.Kh. Sharafetdinova (2001), the inclusion of a whole grain-based product in a hypocaloric diet favorably affects metabolic risk factors for type 2 diabetes, regardless of the amount of reduced body weight [63].

Understanding the mechanisms underlying the prevention or delay of the onset or progression of type 2 diabetes under the influence of whole grains is essential for the scientifically based development of specialized foods with the inclusion of food ingredients that can correct the main metabolic disorders in type 2 diabetes. These ingredients contained in various cereals include dietary fiber, mainly soluble, a number of vitamins and minerals, as well as a wide range of biologically active phytonutrients [67, 90]. It has been found that the consumption of whole grains with a high content of soluble dietary fiber from oats and barley leads to a decrease in the content of cholesterol, low density lipoproteins in serum and blood pressure levels, improvement of postprandial glycemic and insulinemic response [84]. A high intake of cereal fiber (more than 8 g / day) is associated with a lower risk of type 2 diabetes compared with a low intake of dietary fiber [107]. Along with this, soluble dietary fiber is involved in the removal of end metabolic products from the body and has a prebiotic effect due to their participation in the formation of a nutrient medium for the development of normal intestinal microflora [48, 63].

BAS contained in whole grains (phenolic and polyphenolic compounds, phytosterols, terpenes, etc.), according to numerous studies, reduce the risk of chronic non-infectious diseases [67, 90, 96], function as antioxidants that prevent the development and progression of metabolic syndrome and DM 2 type by reducing oxidative stress. It is known that oxidative stress is one of the main mechanisms leading to insulin resistance, β-cell dysfunction, impaired glucose tolerance and, ultimately, type 2 diabetes [73, 75, 101]. BAS with an antioxidant effect can prevent the development of effects caused by acute hyperglycemia, such as endothelial dysfunction, activation of coagulation, an increase in the amount of intracellular adhesive molecules1 (ICAM1) and interleukins in the plasma [3].

According to modern concepts, chronic sluggish inflammation, especially in adipose tissue, is fundamental in the development of many chronic diseases, including type 2 diabetes [3, 67]. According to a number of authors [65, 82], biologically active substances contained in whole grains have anti-inflammatory effects, thus allowing to modulate the risk of developing type 2 diabetes [83, 102].

From the point of view of nutrition, cereals are food products that can be used for most diseases, mainly for diseases of the digestive system [13, 27, 28]. So, using a different culinary, you can provide the most gentle regimen for the digestive organs (liquid and pureed cereals) or activate the motor function of the large intestine (crumbly cereals).

In the diet of type 2 diabetes patients, meals and cereal side dishes are of limited use, which is primarily due to the high carbohydrate content as the main factor determining the postprandial glycemic response, the need to limit the calorie intake and ensure weight loss in this contingent of patients through the use of foods with a lower energy value (mainly vegetables rich in water and dietary fiber) than cereals. Such cereals, first of all, include rice, wheat and semolina [56, 63].

At the same time, soluble dietary fiber and biologically active substances contained in cereals such as buckwheat, oat and barley, have hypoglycemic, hypolipidemic, antioxidant and anti-inflammatory effects. This determines the appropriateness of their use in personalized low-calorie diets for patients with type 2 diabetes [63].

Studies show that almost all cereal meals in the form of crumbly cereals cause less increase in postprandial glycemia in patients with type 2 diabetes compared to wheat bread. The lowest glycemic index values were noted in buckwheat and pearl barley (barley) porridges, which is probably due to the peculiarities of the amino acid composition of buckwheat protein (high content of arginine, which has a stimulating effect on insulin secretion), high content of soluble hemicelluloses (betaglucan) in pearl barley, reducing the level of postprandial glycemia and insulinemia in patients with type 2 diabetes and higher, in contrast to other croup, the content of chromium, a microelement that potentiates the effect of insulin [63].

3. The choice of the optimal grain crop for the creation of food matrices for specialized food products at diet therapy type 2 diabetes

Traditional medicine

An important property of cereals in the treatment of diabetes in traditional medical systems was considered to be the ability to strengthen the Spleen to “eliminate dampness and food blockages”, eliminate DampHeat, precipitate abnormally raised Qi, and promote the “elimination of waste” from the body (detoxification) [5-7, 32, 44, 52], to correct the work of the systems of the Liver, Gallbladder, Spleen, Pancreas, to help cleanse the Blood and Liver, as well as to reduce the internal "heat" [32, 58, 59].

The carried out information-analytical study made it possible to establish that, from the standpoint of traditional medical concepts, whole (not crushed) wheat and buckwheat meet all the requirements for cereals for the prevention and treatment of diabetes mellitus. In addition to the already listed properties of buckwheat (Section 1), it should be noted that this cereal corresponds to the Fire element and the direction of action
- down, has a refreshing character, and therefore, precipitates excessive Heat [32, 53], which is decisive for its use (and even appointment) with diabetes.

Modern dietetics

From the standpoint of modern scientific concepts, for the creation of food polyphenol-protein matrices in the development of SPP for patients with diabetes mellitus 2, the optimal grain culture containing a unique complex of macro and micronutrients (Section 2) is also buckwheat as a source of a rich protein and polyphenol complex [29].

Buckwheat occupies a somewhat separate place among cereal crops: proteins have a unique amino acid composition [40] and consist of well balanced amino acids [29, 41, 74]. On average, buckwheat contains from 8 to 20% (in the southern regions) of easily digestible protein substances with a high content of amino acids such as lysine, arginine, tryptophan [27, 29]; according to other data, 6–12% of proteins [29, 35]. In terms of the content of lysine and methionine, buckwheat proteins are superior to all cereal crops [28]: lysine is much higher than in wheat, and in the amount of arginine it surpasses rice groats [29].

Buckwheat protein has a biological value of more than 90% [76], which is explained by the high concentration of all essential amino acids [29, 71], especially lysine, threonine, tryptophan and sulfur-containing amino acids [68, 69]. In terms of the amount of valuable amino acids, proteins are close to animal products [12, 27, 29, 34].

The protein fraction of buckwheat is characterized by a high content (more than 50%) of water-soluble (albumin) and salt-soluble (globulins) fractions. These fractions are considered the most valuable, due to the fact that they are more susceptible to the action of enzymes of the stomach and intestines, therefore, more easily and fully absorbed by the human body [12, 29]. According to other data, readily soluble globulins and glutamine predominate in buckwheat, which is why buckwheat protein is better absorbed and more useful than cereal proteins [20]. According to foreign researchers (Japan, China, Czech Republic, Poland, Romania [68, 69]), the qualitative composition and quantitative content of proteins in buckwheat and flour depend on the buckwheat variety [16, 66], however, regardless of the variety, the protein content in flour significantly higher than in rice, wheat and corn [74].

The ratio of amino acids in relation to tryptophan indicates their good balance: tryptophan - 1; leucine - 3.8; isoleucine 2.9; valine - 3.3; threonine 2.8; lysine - 3.5; phenylalanine - 3; histidine - 1.7, and only methionine - 1.4 [19, 29].

Complex carbohydrates of buckwheat (Table 2) decompose slowly and, due to their resistance to amylase, buckwheat has a low glycemic index (GI = 62), while in hercules GI = 86 [24, 56]. Complex carbohydrates of buckwheat are absorbed by the body for a long time, therefore, after consuming it, a feeling of satiety usually occurs, which lasts for a relatively long time [19].

table 2

The content of carbohydrates and fats in buckwheat (according to [19])

Nutrients	Consumption rate, g / day	Content in 100 g product,%	Satisfaction daily requirement, %
Carbohydrates, g, total	400-500	66.7	14.8
Including: starch	400-500	58.2	13.7
alimentary fiber	thirty	8.0	26.7
Sahara	-	2.1	-
Fat, g, total	80-100	3.3	3.7
Including: - vegetable	30-40	3.3	9.4
- unsaturated fatty acids	eleven	2.28	20.7
- saturated fatty acids	25-30	0.59	2.1

Buckwheat contains 11.3% dietary fiber [43], which allows it to meet the daily human need by 37.7% (more than a third). According to the content of dietary fiber, buckwheat ranks first among all types of cereals [19].

The total fat content is up to 3.3% [19] (Table 2). It is important that 69% of the fat fraction are mono and polyunsaturated fatty acids: linoleic, linolenic, oleic [19]; a total of 9 aliphatic acids have been identified [74]. The content of the fat fraction is higher than in rice and wheat [74], however, buckwheat fat, unlike, for example, millet, is stable during storage [27, 29], which allows cereals and flour to retain their qualities (for 20 months for unground and 18 months for it spent in the northern and middle climatic zones of Russia, as well as for, respectively, 15 and 14 months in the southern regions) [19].

Fat stability is ensured by its high content of vitamin E, which protects unsaturated fatty acids from rapid oxidation and rancidity [19, 29]. According to other data, the protection of buckwheat grain from souring to a greater extent than in all other types of cereals is due to the high content of polyphenolic antioxidants [12, 29]. Of the polyphenols found in buckwheat, catechin 7O glucoside [98], flavonoids [79, 80] - the content of rutin is 10-200 ppm, tannins 0.1-2.0% [91].

When stored for a long time, buckwheat does not turn rancid and does not grow moldy at high humidity [12, 27, 29], its fats are not oxidized [20], and nutritional and taste qualities do not decrease [20, 27, 29]. Refers to strategic products that are included in the army reserves [27, 29].

A specific feature of the fat-soluble fraction of buckwheat is the presence of lecithin and miliacin (up to 4.5%) in it [29, 46]. The vitamin-mineral complex of buckwheat is considered valuable [19, 29] (Table 3). High in B vitamins$_{one}$, V$_2$, PP, B$_6$, pantothenic acid, folacin, choline, vitamin E; biotin, β-carotene, rutin are present [17, 27, 29, 35]; Inositol derivatives were found: Fagopyritol A1 and Fagopyritol B1 (monogalactosyl Dchiroinositol isomers), Fagopyritol A2, Fagopyritol B2 (digalactosyl Dhiro inositol isomers) and Fagopyritol B3 (trigalactosyl Dhiro] 86.

Of the minerals in buckwheat grain, a significant amount of calcium, phosphorus, magnesium, potassium, zinc, manganese, copper, silicon [19, 27, 35], iodine [27, 29, 35] has been established, contains a lot of iron [27, 29]; there is sulfur [19], fluorine, molybdenum, cobalt [27, 29]. According to foreign data, buckwheat is rich in iron (60–100 ppm), zinc (20–30 ppm) and selenium (20–50 ppb) [68, 69, 88].

Buckwheat minerals are in the form of well-assimilable salts of various organic and mineral acids, and are also included in the composition of high-molecular organic compounds in the form of chemical elements. Calcium plays a leading role in intracellular processes, protects membranes from destruction, thereby preventing tissue aging and other functional disorders. Phosphorus, in combination with calcium, participates in the formation of bone tissue; is necessary for the synthesis of complex proteins, phosphatides, as well as for the formation of complex organic compounds, which are accumulators of energy released during biochemical transformations of fat, sugars and other nutrients [64].

Table 3

The content of vitamins and minerals in buckwheat [19]

Nutrients	Consumption rate, g / day	Content in 100 g of product,%	Satisfaction daily requirement, %
Vitamins, mg:			
IN 1	1.5-2	0.53	30.3
IN 2	2-2.5	0.24	10.7
PP	15–20	4.3	24.6
Bcarotene	3-5	0.01	0.25
AT 6	2-3	0,4	sixteen
Pantothenic acid	5-10	1.5	twenty
Folacin	0.20.3	0.032	12.8
Choline	250-600	one hundred	23.5
E	twenty	6.65	33.2
Biotin	0.15-0.3	0.006	2.7
Mineral substances, mg:			
Calcium	1000	70	7
Phosphorus	1000	298	29.8
Magnesium	400	200	50
Potassium	3500	380	10.9
Silicon	thirty	81	270
Iron	14	eight	57.1
Zinc	10-15	2.1	16.8
Manganese	5-10	1.6	21.3
Copper	2	0.64	32
Sulfur	1000	48	4.8
Aluminum	one hundred	-	-

100 g of buckwheat groats can satisfy the daily human need: in protein by 14.2%; in amino acids - by 16.1%, including essential amino acids - by 15.3%; in carbohydrates - by 15.3%; in vegetable fat - by 9.4; in thiamine by 30.3%; in vitamin P - by 24.6%; in choline - by 23.5%, in vitamin E - by 33.2%, in phosphorus - by 29.8%, in copper - by 32%, in magnesium - by 50%, in iron - by 57%. Especially valuable is the high content of dietary fiber in buckwheat, unsaturated fatty acids (essential compounds that play an important role in metabolism, with extremely limited capacity of the human body to synthesize them), lecithin, essential vitamins and minerals [19].

On the territory of the Russian Federation, the food use of buckwheat grain has centuries-old traditions. Since the 15th century, buckwheat has been considered a national Russian dish [39], and A.V. Suvorov called her "heroic porridge" [9].

Currently, buckwheat is included in the diet of patients with diabetes mellitus (DM), including type 2 diabetes [56], as well as in depletion as a source of vitamin P (rutin) [47], obesity, iron deficiency anemia, disorders of the nervous system, diseases of the kidneys and gastrointestinal tract. Buckwheat is included in the fortifying diet at any age [28, 29, 34]. An important advantage of buckwheat is the complete absence of gluten (gluten) in its grains [42, 81]. Therefore, buckwheat can be included in the diet of patients with celiac disease or gluten allergy.

Immunological studies have made it possible to establish that buckwheat proteins, regardless of its variety, do not pose a danger to patients with celiac disease, since they do not have a protein homologous structure with wheat and do not contain toxic prolamins. Electropherograms reliably demonstrate the similarity of some protein bands of buckwheat proteins with legume proteins [66]. Buckwheat has been approved for dietary gluten-free diets in Canada, Europe and Australia [29, 104].

CONCLUSION

Thus, based on the analysis of the experience of using cereals for diabetes in traditional medical systems and in modern dietetics, buckwheat can be considered the optimal cereal crop for creating food matrices in order to develop a SPP for patients with diabetes mellitus. Despite the presence of traditional experience (Section 1), the use of wheat for this purpose is not advisable, since the use of whole grains, which has a “cooling” (“refreshing) effect on the body [5, 6], is technologically impossible to create food matrices with polyphenols. , and milled wheat has a "warming" effect [5, 6], not shown in diabetes. In addition, wheat has a relatively high glycemic index, as well as high potential allergic risks [31] and patient limitations associated with celiac disease.

We considered the following to be the main factors influencing the choice of a plant-based high-protein carrier for the creation of a food-grade polyphenol-protein matrix in the development of SPP for patients with diabetes mellitus 2:

1. Low glycemic index and traditions of food and medical use, including in type 2 diabetes.
2. High nutritional value.
3. High biological value of proteins (over 90%) and their unique amino acid composition.
4. Rich polyphenolic and vitamin-mineral complex.
5. Significant content of dietary fiber, as well as high water absorption capacity and swelling capacity.
6. Complete absence of gluten (gluten).
7. High content of unsaturated fatty acids and lecithin.
8. Stability during storage (does not go rancid and does not grow moldy at high humidity, fats do not oxidize, nutritional and taste qualities do not decrease).
9. Availability (large-tonnage domestic raw materials).

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CONCLUSIONS

1. In modern medical practice, the biological effect of croup in diabetes is assessed mainly in accordance with the action contained in them macro and micronutrients. At the same time, the causes of this disease are not taken into account, due to violations of the energy potential of the body (in particular, the depletion or decrease in the Quality and / or Quantity of the vital energy Qi).

2. Cereals and cereals in the world traditional medical practice are widely used for the prevention and treatment of diabetes (including constitutionally conditioned) due to their harmonizing properties, "character", "taste" and "entry into the channels" of the Liver and Spleen.

3.Taking into account the peculiarities of the use of cereals in modern and traditional dietetics, the expediency of using Buckwheat diabetes mellitus, including its promise as the basis of food matrices for specialized food products for diet therapy of type 2 diabetes.

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