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COMPARISON OF THE QUALITY MICRONUTRIENT COMPOUND OF RECOMMENDED DAILY INTAKES AND THE SECOND TYPE DIABETES PATIENTS' DIET

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Annotation The comparative analysis of the micronutrient diet compositions of the patients with type II diabetes and healthy people were held. It was found that in a diet it is necessary to enrich the following micronutrients: B vitamins, biotin, vitamin A, E, D, C, minerals magnesium, zinc, calcium, selenium, manganese, chromium, sulfur. At the same time, it is necessary to reduce the content of sodium, iron and fluoride. You can find the recommendations for the creation of software for the development of individual diets for the prevention and treatment of diabetes type II. In addition to these selected criteria (Micronutrient) it is recommended to enter the following: the total number of proteins, fats, carbohydrates, as well as the minimum content of omega-3 fatty acids, and the maximum content of simple carbohydrates and starch. The analysis of the chia seeds chemical composition on the content of diabet essential micronutrients were held. It is shown that the use of chia seeds in products for the prevention and treatment of diabetes is extremely important.

Keywords: diabetes type II, insulin resistance, metabolic syndrome, minerals, chia seeds, food rations.

ПОРІВНЯННЯ ЯКІСНОГО МІКРОНУТРІЄНТНОГО СКЛАДУ РАЦІОНІВ ХАРЧУВАННЯ ХВОРИХ НА ЦУКРОВИЙ ДІАБЕТ ІІ ТИПУ ТА ЗДОРОВИХ ОСІБ

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Анотація Проведено порівняльний аналіз мікронутрієнтного складу раціонів харчування хворих на цукровий діабет ІІ типу та здорових осіб. Встановлено, що раціони харчування необхідно збагачувати наступними мікронутрієнтами: вітамінами групи В, біотином, вітамінами А, Е, D, С, мінеральними речовинами магнієм, цинком, кальцієм, селеном, марганцем, хромом, сіркою. Водночас, потрібно знижувати вміст натрію, заліза та фтору. Наведено рекомендації щодо створення програмного забезпечення для розробки індивідуальних раціонів харчування з профілактики та лікування цукрового діабету ІІ типу. Окрім перелічених критеріїв вибору (за мікронутрієнтами), рекомендовано ввести наступні: загальну кількість білків, жирів, вуглеводів, а також мінімальний вміст омега-3-жирних кислот та максимальний вміст простих вуглеводів та крохмалю Проведено аналіз хімічного складу насіння чіа щодо вмісту есенційних, з точки зору діабету ІІ типу, мікронутрієнтів. Показано, що використання насіння чіа у продуктах для профілактики та лікування цукрового діабету є актуальним.

Ключові слова: цукровий діабет другого типу, інсулінорезистентність, метаболічний синдром, мінеральні речовини; насіння чіа, раціони харчування.

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Introduction. Problem statement

20 years ago there were only 30 million people with diagnosis "diabetes". Nowadays, according to the WHO, their amount increased up to 347 million. Experts predict that in 2030 diabetes will be the seventh leading cause of death in the world. Over the next 10 years the number of deaths from diabetes will increase by the half. The second type diabetes is 85 – 90 % of all types of diabetes.

The second type diabetes is also called insulin-dependent diabetes, or elderly person's diabetes. Now, however, every year the disease damages people in more young age, so the scope of the disease were developed from 35 years [1].

The second type diabetes is the metabolic disease, which characterized by chronic hyperglycemia that occurs by a lack of insulin action in tissues. This is called insulin resistance. It's a state when in the blood there is a normal or increased amount of insulin, but the cells are insensitive to it. In this case, as in the case of insulin lack, the glucose flow into the cell is reduces, and, accordingly, blood glucose increases [2,3].

Analysis of recent research and publications

There are number of symptoms that occur in most patients for diabetes type II signs. These symptoms were first described in 1960 – 1970 and included several risk

factors for cardiovascular disease, lipid metabolism, hypertension, etc. Later symptoms related diseases called metabolic syndrome (MS). According to some researchers, one of the causes of these disorders can be insulin resistance that develops with increasing body weight [4]. The following are factors that increase insulin resistance:

- Abdominal obesity;
- Diet high in saturated and trans fats;
- Physical inactivity;
- Low intake of fruit and vegetables;
- Bad habits (alcohol and smoking), etc. [5].

In 50 – 97 % of patients with diabetes type II there were observed the lipid metabolism disbalance, including obesity, it is in 3,8 times higher than in people with normal body weight. Increased body weight and obesity are considered as major risk factors for diabetes type II. Thus, insulin resistance and obesity are related.

The first thing that triggering the mechanism of appearance, and in the future and progression of MS and diabetes type II as its component, are defections of a basic homeostasis regulation systems, which are responsible for providing nutritional cells and human tissue with numerous physiologically active functional ingredients. These disorders are caused by a chronic deficiency of water, numerous macro- and micronutrients, vitamins, glycosides, dietary fiber and many other physiologically active functional ingredients that are precursors of structural and / or regulatory substances (neurotransmitters, hormones, etc.) or cofactors of their metabolic activity. Different stress effects that exceed the strength and duration of the compensatory man possibilities even more accelerate and deepen the deficit. The absence in the human body of the extremely necessary amounts of hundreds of micronutrients and functional active ingredients that come from food or formed endogenously by cells of the intestine and representatives of symbiotic microorganisms, underlying the origin and progression of the metabolic syndrome and diabetes type II as its component [6,7].

The purpose of the article

Metabolic syndrome and diabetes type II, as an integral component of it, are widespread today. According to the opinion of Enfeldt and others [8], the global increase in the body weight and the MS spreading in the world are particularly active since the majority of scientific community proclaimed the need to reduce the fat amount in the diet, simultaneously called them as the main factor for cardiovascular disease. This, consequently, increases the number of carbohydrates in a diet as a result of daily calorie content compensation. Food industry quickly adaptes to current dietary recommendations: to provide new lowfat products with the pleasant taste in their recipes they add sugars, flavors enhancers and other artificial ingredients. So now we are seeing a significant imbalance in diet towards increasing mass fraction of sugar and flour, which correspondingly increase the level of glucose in the blood. As a result, insulin level increases and contributes to the high rate of appetite and increasing of the body fat. The diet with a big amount of carbohydrates is a risk area for people who genetically predisposed to diabetes. At first scientists do not correlate clinical signs with the diet, then, recently, more researchers say that diabetes (as a part of the MS) is the result of the nutrient imbalance [9].

The **purposes of the article are:**

- Determining the role of certain vitamins and mineral compounds in the people diet, including people with diabetes type II;
- Determination of food various micronutrients' daily intakes for diabetes type II patient;
- Setting criteria (by micronutrient composition) for the scientific approved diets preparation for patients with diabetes type II;
- To study the natural mineral compounds and vitamins' sourses for the presence of the most essential components in the diets of patients with diabetes type II (search for raw materials with the required chemical composition);
- To identify ways for diets regulation by micronutrient composition.

The analysis of micronutrient deficient factors in the second type diabetes' prevention and treatment

Elaboration of the scientifically based diet for the treatment and prevention of the second type diabetes is the important task, because the disease prevalence in the world has a constant tendency to increase, and also it has complex flow. It is recommended for the patients to take meal according to the ninth regime. In the regime describing there is a list of permitted and prohibited products, methods of thermal processing of it and day menu examples divided on partitive meal. Diabetes is a disease that requires periodic sanatorium visits. In sanatorium they make a generalized diet, according to the ninth regime, which deferens by the mass fraction of main makronutrien from the RDA of healthy persons. This diet usually is general and does not take into account individual physiological characteristics of the patient.

In contradistinction to regulation rations by macronutrient composition (which requires certain components correlation and can be adjusted using various raw materials), regulation by micronutrients is even more challenging. This is because of the great number of certain minor substances that should be increased in food and rations and the number of others – on the contrary be decreased, which requires a detailed study of the role of each foods' micronutrient. The assimilation of minerals typically depends on having a complex support. For example, calcium is absorbed in the body in the presence of at least 15 related substances. For the calcium absorption the presence of magnesium, phosphorus, organic citric acid, etc is necessary. If this balance is disturbed, calcium is not absorbed and can form mineral deposits in

various organs, which complicates the already disrupted body, whish suffers from diabetes.

Micronutrients despite of small daily intakes are irreplaceable components of the diet. The lack of certain micronutrients can lead to many physiological disorders. We are going to look at the role of specific micronutrients in the prevention and treatment of diabetes type II.

Vitamins. Numerous studies show that vitamins deficiency is a risk factor for diabetes type II progressing. Almost 70 % of diabetes patients revealed a lack of listed bellow vitamins in tissues and biological fluids. Table 1 shows the data of the daily intakes for vitamins, the number of which should be increased in the diet for the prevention and treatment diabetes type II [10].

Table 1 – The daily intakes of vitamins for healthy persons and diabetes type II patients

Name of the vitamin	The daily intakes for diabetes type II patients	The daily intakes for healthy persons
Vitamin A (retinol), mg	1,5	1
Vitamin D, mkg	25	2,5
Vitamin E (tocopherol), mg	15	10
Vitamin C (ascorbic acid), mg	100	75
Vitamin B_1 (thiamine), mg	2,5	2
Vitamin B_2, mg	2,5	2
Vitamin B_6 (pyridoxine), mg	2,5	2,0
Vitamin B_{12} (tsiankobalamin), mkg	3	2,4
Vitamin PP (nicotinamide), mg	25	20
Vitamin H (biotin), mkg	1000	50

The leading value for diabetes prevention owned by B vitamins. Vitamin B_1 increases the glucose digestion efficiency, restores the cells sensitivity to insulin, prevents the toxic lactic acid accumulation in the cells, thereby weakening the toxic effect of hyperglycemia [11]. B_2 and B_6 increase thiamin efficiency, restorate fat oxidation, reduce the load on the insulin-dependent processes of glucose utilization. In addition, it is known that B_6 deficiency disturbed tryptophan metabolism and this state is accompanied by ksanturen acid accumulation, which forms a complex with insulin and accordingly reduces the activity of the hormone. Deficiency of B_6, B_{12} vitamins and folic acid violates metionin metabolism and leads to the accumulation of homocysteine in the plasma, which damages the epithelium of blood vessels, leading to faster development of vascular complications. The lack of C, E and A vitamins also make contribution in the development of these complications. To increase the content of B vitamins it is recommended to carry in the diet the following products: whole grain legumes and cereals, bread of coarse flour, bran, any seeds, nuts, asparagus, dairy products and so on.

To diet for the diabetes type II prevention and treatment it is necessary to add biotin, which has hipoglikemic action, restores the sensitivity of peripherals tissues to insulin and reduces the risk of diabetes. The sources of biotin in the diet are: meat, eggs, bran, flour, mushrooms, nuts, etc.

Vitamin E reduces the quickness of diabetes developing by increasing the insulin sensitivity of cells. To enrich the diet with vitamin E it is necessary to include the following products: cereals, vegetable oil, eggs, lettuce, liver.

Side by side with vitamins C and E, vitamin A provides antioxidant defense. Vitamin A neutralizes toxic form of oxygen that is continuously formed during the normal life of any cell. During the vast number of diseases, including diabetes, toxic oxygen species increases dramatically. It should be noted that vitamin A is selfoxidated to form peroxide compounds, and its medication should be combined with other antioxidant compounds (vitamins C and E, selenium, etc.) to increase its biological activity. Sources of vitamin A in the diet are: fatty dairy products, egg yolk, liver, carrots, broccoli and so on.

Vitamin C takes part in almost all metabolic types and, first of all, carbohydrate metabolism, and has expressed anti-stress and universal antioxidant activities. By providing body with physiologically normal amounts of this vitamin it is possible to prevent the obesity development, cardiovascular complications, to normalize serum glucose level in the blood. It is more effective for the normalization of carbohydrate metabolism to have the simultaneous use of E and C vitamins, as well as the inclusion to diet products that have enough calcium, magnesium, cobalt, copper, sodium, which increases the effects of both vitamins and manganese, potassium, selenium and zinc which increases the effect of vitamin E. Sources of vitamin C in the diet may be the wild rose, currants, pepper, broccoli, apples, kiwis, citrus and so on [12].

Daily intake of calcium (at least 1200 mg) in combination with vitamin D reduces the risk of diabetes type II developing up to 33 %. Vitamin D and calcium are also using to reduce insulin resistance [9]. Sources of vitamin D in the diet are: eggs, milk, cream butter, liver, fish etc.

Minerals. In the mechanism of diabetes type II developing the mineral metabolism plays definite role [13]. There is always a deficiency of magnesium, zinc, calcium, chromium and selenium in patients' blood serum. Table 2 shows the recommendations for the reduction or increasing of certain minerals in the diet (compared to a healthy person) for the prevention and treatment of diabetes type II [10]. For a better visual perception data presented in Figure 1. Thus, it is shown the con-

tent of which minerals should be raised in the diet, or which minerals accordingly should be reduced.

Table 2 – The daily intakes of minerals for healthy persons and diabetes type II patients

Name of the mineral	The daily intakes for diabetes type II patients	The daily intakes for healthy persons
Na, mg	500	1000
Mg, mg	600 – 800	350 – 400
Ca, mg	1200 – 1500	800 – 1000
S, mg	700 – 800	500
Mn, mg	600 – 700	2 – 5
Fe, mg	3 – 5	10 – 18
Zn, mg	17 – 19	15
F, mg	200 – 300	600 – 1000
Cr, mkg	100 – 200	50
Se, mkg	100 – 150	40 – 70

Magnesium stimulates insulin secretion and increases sensitivity of the receptors to it. Sources of magnesium in the diet: bran, cocoa, nuts, spinach, buckwheat and etc. Zinc is involved in insulin stabilizing of sector tissues that's because its deficiency in the body is the limiting factor in the formation of this hormone by the pancreas. With a lack of zinc in biological fluids it was observed the decrease in the cells sensitivity to insulin. This lack also can lead to the real insulin resistance. Zinc bioassimilation increases with the presence of vitamin B_6 and beta-carotene. Zinc can be add to the diet by following products: corn and bean products, nuts, bran, oysters. Antioxidant properties of selenium reasoning its use during diabetes in combination with zinc, chromium, magnesium and calcium. Sources of selenium in the diet are: oats and buckwheat, mushrooms, corn, meat, garlic etc. The insulin cells sensitivity also depends on the chromium and vanadium trivalent ions. These two micronutrients' presence in food helps to maintain required blood sugar level, accelerates the transport of glucose into cells. At the same time it was marked also that there is a reduce of cholesterol level in blood serum and blood pressure lowering. The sources of chromium in the diet are: various kinds of fish (especially tuna) etc. It is known that sulfur is a required component of sulfur-containing amino acids that makes the insulin. The inclusion of sulfur in the diet are also one of the dietary tips for reducing the diabetes risk. Sulfur is in the solid cheese, eggs, meat etc. Manganese ions are part of many enzymes that are involved in the control of blood sugar, also they helps glucose to be used by nervous system cells. Manganese sources are meat, offal, flour, cranberries, tea etc [9].

There are data that confirm the important role of iron ions in the development of diabetes type II. Thus, increased iron delays in the pancreas and liver cell damage these organs and increases the insulin sensitivity [14]. Excessive food sodium ammount (as salt) has negative impact on pressor hormones level and carbohydrate metabolism. There are also data about the ability of fluoride ions to violate carbohydrate metabolism and hold down oxidation of fatty acids.

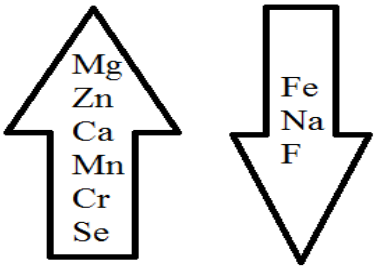

Fig.1. The diagram of the diet minerals that influence on the condition of patients with diabetes type II (in the context of the increase-decrease)

To cover the lack of vitamins and minerals listed above there were designed special vitamin complexes. These artificial drugs help to strengthen the body, regulate energy metabolism at the cellular level, thereby reducing both the risk of diabetes type II and progression of chronic complications of the disease. But, today, we do not have full information about the assimilation degree of artificial nutrients in the human body. On the contrary, more and more scientists state that nutrients are better absorbed in the form of the native complexes, namely as a part of food products. Therefore, in addition to medical treatment, based on medical data, it is necessary to include to the everyday diet the foods with high level of these micronutrients. In view of this, it is important to select a «universal» raw material that can be used as a supplement to the regular diet for the prevention of diabetes type II. To ensure the process of ion exchange in the body it is necessary to use numerous natural sources of minerals. Such as spices and condiments, dried fruits, seeds, nuts, mineral water, bishofit etc.

One example of a minor essential compounds natural source is chia seeds, which are widely known in America, but Europe began to put them in a diet only from 2005. Now the main suppliers of chia seeds are Australia, Peru and Bolivia. Scientists compared chia seeds with flax seeds because of the high content of unsaturated fatty acids and other essential nutrients.

Table 3 shows the chemical composition of chia seeds with the main macro- and micronutrients that are essential for the prevention and treatment of diabetes type II. There were analyzed the fixed percentage of essential substances for the diabetes prevention in the daily diet. These data correlate with the recommendations of medical researchers, therefore, chia seeds can be added to diets for the prevention and treatment of diabetes type II.

Table 3 – The chemical composition of chia seeds with nutrients indication that have a decisive impact in the prevention and treatment of diabetes type II [15,16]

Name of nutrient	Amount in 100 g	Rate of daily intakes, %
Water, g	4,9	
Proteins, g	15,62	26
Fat, g	30, 75	46
- including polyunsaturated fatty acids	23,34	106
Carbohydrates, g	43,85	191
- including dietary fiber	37,7	189
Ash, g	4,87	
Vitamins		
Vitamin C, mg	10	13
Vitamin B_1, mg	0,62	31
Vitamin B_2, mg	0,2	10
Vitamin PP, mg	8,8	44
Vitamin E, mg	1,2	
Minerals		
Calcium, mg	631	63
Potassium, mg	407	17
Sodium, mg	16	1,6
Magnesium, mg	335	83
Zinc, mg	4,58	31
Iron, mg	6,3	42
Manganese, mg	2,7	110
Selenium, mg	55	110
Chromium, mg	30	60
Sulfur, mg	290	58

Conclusions

Diabetes together with other diseases form the "metabolic syndrome, which is also called "deadly quartet" or Western disease. Symptoms develop for a long time, gradually and in the early stages there are usually difficulties in diagnosis. Diabetes (and MS in general) is widespread and connected, in our opinion, with incorrect dietary recommendations which were given by the top nutriologists over the past decades. Therefore, it is necessary to analyze the patients diets and create recommendations for its revision in view in accordance to the latest achievements in the nutrition science. To summarize the scientific evidence, we believe it is necessary, firstly, to create a database of the chemical composition of foods recommended for patients with diabetes type II, and secondly, to develop technological approaches for enriching food products with necessary components, thirdly, to develop software and determine the criteria which will form sick person's individual diet. It is offered, for the start, to establish such selection criteria as the total number of proteins, fats, carbohydrates, and minimal content of omega-3 fatty acids and maximum content of simple carbohydrates and starch [17-20]. Also enter the minimum diet presence value of the vitamins B, biotin, vitamin A, E, D, C, minerals such as magnesium, zinc, calcium, selenium, manganese, chromium, sulfur and maximum values for sodium, iron and fluoride. It is also necessary to search for raw materials that would meet the above requirements. With this in mind, the inclusion of chia seeds in the diet is promising.

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СОПОСТАВЛЕНИЕ КАЧЕСТВЕННОГО МИКРОНУТРИЕНТНОГО СОСТАВА РАЦИОНА ПИТАНИЯ БОЛЬНЫХ САХАРНЫМ ДИАБЕТОМ II ТИПА И ЗДОРОВЫХ ЛЮДЕЙ

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Аннотация Проведен сравнительный анализ микронутриентного состав рационов питания больных сахарным диабетом II типа и здоровых лиц. Установлено, что рационы питания необходимо обогащать следующими микронутриентами: витаминами группы В, биотином, витаминами А, Е, D, С, минеральными веществами магнием, цинком, кальцием, селеном, марганцем, хромом, серой. В то же время, необходимо снижать содержание натрия, железа и фтора. Приведены рекомендации по созданию програмного обеспечения для разработки индивидуальных рационов питания по профилактике и лечению сахарного диабета II типа. Кроме перечисленных критериев выбора (по микронутриентам) рекомендуют ввести следующие: общее количество белков, жиров, углеводов, а также минимальное содержание омега-3 жирных кислот и максимальное содержание простых углеводов и крахмала Проведен анализ химического состава семян чиа по содержанию эссенциальных с точки зрения диабета II типа микронутриентов. Показано, что использование семян чиа в продуктах для профилактики и лечения сахарного диабета является актуальным.

Ключевые слова: сахарный диабет второго типа, инсулинорезистентность, метаболический синдром, минеральные вещества; семена чиа, рационы питания.

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