Diet Bread Based on Flaxseed Flour and a Plant Drink Made from Hazelnut Kernels and Hazelnut Oil Cake

E A Pchylina and M A Vikhrova
Yaroslav-the-Wise Novgorod State University, 41, ul. B. St. Petersburgskaya, Veliky Novgorod, Russian Federation
E-mail: katip@mail.ru

Abstract. The study analyzed the effect of diet on human metabolism. The authors propose the optimal recipe for dietary bread based on flaxseed flour and a plant drink made from hazelnut kernels and hazelnut oil cake. The analysis of the quality of the obtained product was carried out, its organoleptic properties, porosity, acidity, moisture content were determined, and the acidity and moisture content of flaxseed flour were also investigated. According to their characteristics the obtained results were correlated with an industrial sample of wheat bread with the addition of flaxseed flour and potato flakes. The nutritional value of both samples was also determined.

1. Introduction
Nutrition is one of the main external environmental factors affecting the health of an individual, his/her normal growth and development, as well as mental and physical performance. In addition, human nutrition determines life expectancy, the body's ability to resist infections and harmful environmental factors.

It must satisfy the needs of the human body in macro- and micronutrients, as well as correspond to the physiological characteristics of the body [1].

In the 20th and 21st centuries, the quality of food products is characterized by environmental problems. This is due to the use of various pesticides, mineral fertilizers, antibiotics and hormones in agriculture. Also, food additives affecting the quality of products are widely used in the food industry today. These factors led to a change in the nutritional value of products, a decrease in the content of many essential compounds.

Eating high-calorie foods with a low nutritional value, an excessive enthusiasm for saturated fats, a deficiency of micronutrients and dietary fiber leads to a decrease in the quality of life and the development of diseases [2]. In addition, the decrease in physical activity plays a huge role. Against this background, risk factors associated with diet are increasing.

According to the Food and Agriculture Organization of the United Nations (FAO), risk factors cause 10% of cases of illness and disability in population.

FAO is planning to discuss a new draft nutritional guidance to increase the nutritional value of foods. It is proposed to gradually change the recipes of finished products, as well as purposefully enrich food products with macro- and micronutrients.

By 2018, in Russia, 12.1 million people with diseases associated with the endocrine system, irrational nutrition and impaired metabolism were registered. Of these, 4.8 million suffer from diabetes mellitus, slightly more than 2 million are obese. For the same period, according to the Rosstat (Federal State
Statistics Service), 36.5 million Russians with cardiovascular diseases were recorded, including 16.1 million residents with diseases characterized by high blood pressure.

The rapid development of metabolic syndrome caused by malnutrition among the population is a widespread problem.

Metabolic syndrome is a group of metabolic disorders that include high blood pressure, obesity, insulin resistance, and atherogenic dyslipidemia.

The development of this syndrome can be associated with both genetic factors (hereditary predisposition) and acquired ones (overeating, decreased motor activity), which in turn leads to cardiovascular diseases.

There are two interrelated conditions in metabolic syndrome [3].

1. Insulin resistance, which is primarily associated with a lack of magnesium. Note that an insufficient response to insulin interferes with the binding of simple sugar (glucose) by the cell, as well as the penetration of magnesium into the cell. It is important that a lack of magnesium interferes with both the production of insulin and the normal effectiveness of the hormone. Both of these processes affect the utilization of fat in the body.

2. Deficiency of magnesium salts and (or) deficiency of antioxidant vitamins such as tocopherol, ascorbic acid, ubiquinone - coenzyme Q 10, contribute to the disruption of oxidative metabolism.

The main sign of a group of metabolic disorders is the visceral (abdominal) type of obesity, i.e. excessive fat deposition in the abdomen or upper body. At the same time, the waist circumference of European men is more than 94 cm, that of Asian men is more than 90 cm, and that of women of both races is more than 80 cm.

Let’s highlight the dominant signs of metabolic syndrome:

- insulin resistance;
- hyperinsulinemia (high levels of insulin in the blood);
- decreased glucose tolerance;
- increased concentration of low density lipoproteins in the blood;
- lowering the level of high density lipoproteins;
- increased triglycerides;
- high blood pressure (above 140/90 mm Hg) [4].

Abdominal obesity in patients and any two signs are the basis for the diagnosis of metabolic syndrome.

This problem continues to worsen among both children and adults of the entire population of the world.

Currently, there is no exact information on the incidence of metabolic syndrome, since targeted calculations by country have not been carried out [5].

Having reviewed the WHO data, we stated that in Russia the disease is diagnosed in both men and women in young and middle ages. In men, the incidence is about 20% at young age and almost 50% at middle age. In women, metabolic syndrome occurs a little less often: about 10% – at the age to 40 years and 21% – at the age of 40 to 55 years.

2. The experimental part
For a research in the development of the optimal formulation of dietary bread with a low glycemic index, an analysis of possible raw materials was carried out. It is worth noting that metabolic changes are often accompanied by intolerance to certain substances. For this reason, we have chosen a strategy of excluding gluten [7], milk [8], sugar [6, 9], yeast, and raw materials have been selected in such a way that the combination of ingredients meets the principles of nutrient balance with a minimum content of reactive compounds.

Many modern studies note the positive effect of fats on the correction of metabolic syndrome, as well as the danger of carbohydrates, including sugar, and trans fats [10].

Flaxseed flour is a gluten-free option [11,12].
In the course of the research, a bread recipe was developed and tested, which included flaxseed flour, a drink of plant origin based on hazelnut kernels, hazelnut cake, eggs, vegetable oil, soda, salt and natural apple cider vinegar (sample no. 1).

The choice of ingredients is based on the valuable properties of each of them.

Crushed flax seeds (flaxseed flour) are a source of a number of macro- and micronutrients valuable for the body. This flour contains fatty acids (palmitic, stearic, linoleic and linolenic), in particular, the content of alpha-linolenic acid ranges from 39.9 to 60.4%. The amount of protein in flaxseed varies from 20 to 30%, accounting for approximately 80% globulins and 20% gluten. Just 10 grams of flaxseed in one’s daily diet increases one’s daily fiber intake by 1 gram of soluble fiber and 3 grams of insoluble fiber. The pH analysis of mucus (a mixture of acidic and neutral heteropolysaccharides) indicates a value of 6-8, which corresponds to the acidity value normal for the human intestine.

According to the phytochemical analysis, different varieties of flax seeds contain from 8.1 to 12.9% fiber, 21.3 to 28% protein, and 30.8 to 49% fatty acids.

The protein composition of crushed flax seeds is characterized by a higher content of essential amino acids, compared to wheat and rye flour. The content of essential amino acids in flaxseed flour is more than 75%. The total amount of amino acids in flax seeds is 3.5–3.8 times higher than in premium wheat flour and peeled rye flour, respectively. Flaxseed flour protein is rich in valine, leucine, threonine and phenylalanine, and the amount of tryptophan in this product exceeds the content of a similar amino acid in premium wheat flour and peeled rye flour by 9 times.

Flax seeds also contain phenolic acids and flavonoids, which have antioxidant and antitumor properties.

Functional compounds of flax seeds and products of their processing have a fundamental effect on all organs and systems of the human body. Their positive effect on cardiovascular diseases, hypertension, metabolic syndrome is known [11].

Flaxseed flour is most often used as a component in making bread from wheat flour. In this case, it covers the human need for basic macro- and micronutrients, namely essential amino acids, unsaturated fatty acids, dietary fiber, flavonoids and vitamins.

Hazelnut kernels contain α-, β-, γ- and -tocopherols, and some varieties exceed walnut oil in α-tocopherol content by more than 20 times. It also contains saturated, mono- and polyunsaturated fatty acids, in particular oleic and linoleic ones, the content of which reaches 94% of the total fatty acid content.

Hazelnuts are also rich in tryptophan, valine, arginine, isoleucine, threonine and glutamic acid, and the total protein content per 100 grams of the product reaches 15%.

Water or whey is often added to industrial bread recipes. The addition of a plant drink to the created recipes was necessary to improve the organoleptic (improvement of taste) and nutritional properties of the final product (increase in the energy value and composition of macronutrients).

The plant hazelnut drink was made at home by grinding hazelnut kernels in a blender with the addition of water. Then the mixture was strained through cheesecloth, the drink itself was diluted with water, and the cake was dried in the oven for further use in one of the recipes. Thus, the principles of waste-free production were observed, which will allow saving money on raw materials for the final product.

Eggs are a source of protein, lecithin-rich fats, unsaturated fatty acids. Yolks also contain vitamins A, D, E, β-carotene, B vitamins, choline. Adding eggs to the bread recipe can increase the nutritional value and calorie content of the product. Also, beaten eggs act as a stabilizer and baking powder for the dough, thereby retaining the necessary crust and pores in the crumb during the baking process.

Soda slaked with apple cider vinegar also gives splendor and porosity to the dough.

The addition of sunflower oil also increases the final energy value of the bread, increases the plasticity of the dough and the volume of baked goods.
Metabolic disorders in the body are often accompanied by intolerances to certain foods, such as sugar, gluten, milk, or baker's yeast. In such conditions, people can develop irritable bowel syndrome, celiac disease, depressive disorders, etc. For this reason, the combination of ingredients in the bread recipe was created in such a way as to minimize the presence of these ingredients in the final product.

For comparison of nutritional value, a variant of industrial production was selected: wheat bread with the addition of flaxseed flour and potato flakes (sample no. 2). This is necessary in order to study the effect of flaxseed flour addition on a wheat flour mixture. Composition of a production sample of bread includes wheat flour (premium grade), water, potato flakes (fresh potatoes, curcumin dye (of natural origin)), sugar, rye flour (peeled), pressed baker's yeast, flaxseed flour, wheat gluten, sunflower oil, salt, apple food fibers, fermented glucose, complex food additive (wheat flour, enzymes), complex food additive – emulsifier (mixture of distilled mono- and diglycerides of fatty acids).

It should also be noted that this manufactured product contains natural wheat protein – gluten.

To determine the quality of bread, standard methods for determining the quality of bakery products were used: organoleptic assessment of the quality of bread, determination of moisture, porosity, acidity of bread, as well as determination of moisture and acidity of flour.

Calorie content and nutritional value were determined in the laboratory of the Rospotrebnadzor (Federal Service for Surveillance on Consumer Rights Protection and Human Welfare).

3. Results and discussion

The analysis of the quality of the prototypes of bread (table 1) showed that they differ in the color of the crust and crumb, as well as in taste and smell.

Sample no. 1 has a dark brown crust and crumb color, while sample no. 2 is light in color. Note that the prototype has an uneven surface with breaks, and the production one has a smooth surface. Both samples are medium-porous with elastic crumb.

It should be noted that sample no. 1 has a specific taste and smell characteristic of flaxseed flour.

According to the standards, the moisture content of the bread should not exceed 51%, the acidity should not exceed 12, and the porosity should not be less than 45%.

Both bread samples meet these requirements.

Determination of the moisture content of the bread samples showed the following results: 47.1% for sample no. 1 versus 38.0% in the second variant, the acidity was 1.0 and 0.3 in the first and second samples, respectively. Low acidity is due to the absence of yeast. The taste in comparison to the production bread sample seems a little peculiar.

The analysis of the nutritional value showed that the developed sample of bread has a lower calorie content, while the protein content in it is 7 g higher, the fat content is 13 times higher, and the amount of carbohydrates is less than 0.6 g.

Table 1. Comparison of the nutritional value of bread samples per 100 g.

| Parameter                | Research results |
|--------------------------|------------------|
|                          | Sample no. 1     | Sample no. 2 |
| Calorie content          | 270 kcal         | 338 kcal     |
| Protein content, g       | 18.3             | 11.0         |
| Fat content, g           | 32.4             | 2.5          |
| Carbohydrate content, g  | 4.5              | 5.1          |
| Number of bread units (BU)| 0.38             | 4.25         |

4. Conclusion

As a result of this research work, a recipe for dietary bread based on flax flour and a plant product from hazelnut kernels and hazelnut cake was developed.

The quality analysis showed that the resulting product meets the quality standards for bakery products.
The adjusted nutritional value will allow this product to be used in a low-carbohydrate diet, which is especially important for people suffering from metabolic syndrome and obesity. The number of bread units (BU) in the developed sample is significantly lower than in production analogs. This is an advantage for people with diabetes mellitus.

Note that the developed bread recipe is suitable for the nutrition of people who monitor their health and adhere to various low-carbohydrate diets. The absence of gluten, milk, sugar and yeast can significantly increase the target audience.

Note that this recipe for dietary bread will be further refined to make the product suitable to many categories of citizens.

References
[1] S Evstafieva 2011 Medicinskyi forum. Effektivnaya farmakoterapia Endocrinology 2011 4
[2] Shai I, Schwarzfuchs D, Henkin Y, Shahar D R, Witkow S, Greenberg I, Golan R, Fraser D, Bolotin A, Vardi H, Tangi-Rozental O, Zuk-Ramot R et al. 2008 Weight Loss with a Low-Carbohydrate, Mediterranean, or Low-Fat Diet New England Journal of Medicine 359 (3) 229–41
[3] Sackner-Bernstein J, Kanter D and Kaul S 2015 Dietary Intervention for Overweight and Obese Adults: Comparison of Low-Carbohydrate and Low-Fat Diets A Meta-Analysis. PLoS ONE 10 (10) 1–19
[4] Foster G D, Wyatt H R, Hill J O and McGuick B G 2003 A Randomized Analysis of a Low-Carbohydrate Diet for Obesity New England Journal of Medicine 348 (21) 2082–90
[5] Mansoor N, Vinknes K J, Veierod M B and Retterstol K 2015 Effects of low-carbohydrate diets v. low-fat diets on body weight and cardiovascular risk factors: a meta-analysis of randomised controlled trials British Journal Of Nutrition 1 (3) 1–14
[6] Stanton A 2018 Dietary carbohydrate intake and mortality: reflections and reactions The Lancet 3 (11) e508-e54
[7] Singh P, Arora A, Strand T A, Leffler D A, Catassi C, Green P H, Kelly C P, Ahuj V and Makharia G K 2018 Global Prevalence of Celiac Disease: Systematic Review and Meta-analysis Clinical Gastroenterology and Hepatology 16 823–36
[8] Varjú P et al. 2018 Lactose intolerance but not lactose maldigestion is more frequent in patients with irritable bowel syndrome than in healthy controls: A meta-analysis Neurogastroenterology and Motility 2018 13527
[9] Grummon A H and Hall M G 2020 Sugary drink warnings: A meta-analysis of experimental studies PLOS Medicine 17 (5) e1003120 DOI: 10.1371/journal.pmed.1003120
[10] Kearns C E, Schmidt L A and Glantz S A 2016 Sugar Industry and Coronary Heart Disease Research A Historical Analysis of Internal Industry Documents JAMA Internal Medicine 2016 229–36
[11] Yu P A, Demark-Wahnefried D, Franco W and Lin O H 2009 Meta-analysis of the effects of flaxseed interventions on blood lipids Am J Clin. Nutr. 90 288–97
[12] Sartang M M, Mazloom Z, Racisi-Dehkhordi H, Barati-Boldaji R, Bellissimo N and Tolosy de Zepetnek J O 2017 The effect of flaxseed supplementation on body weight and body composition: A systematic review and meta-analysis of 45 randomized placebo-controlled trials Obes. Rev. 18 9 1–12