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Development of Meat-And-Cereal Semi-Finished Products Tailored to the Specificity of the Gerodietetic Nutrition.

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ABSTRACT

The article presents the results of studies on the use of sprouted oats in the formulations of meat chopped semi-finished product with a view to creating a product for gerodietetic nutrition. The article presents the chemical composition of the sprouted seed produced from hulless and hulled oats and provides a comparative analysis with meat stuffing. The choice of sprouted oats as an ingredient in meat-and-cereal semi-finished products designed for gerodietetic nutrition is proved, as well as the largest possible dosage of sprouted oats is determined to allow improving nutritional value of the semi-finished products preserving at the same time their acceptable consumer properties.

The inclusion of herbal supplement (sprouted seed of hulless or hulled oats) into stuffing helped to produce the meat-and-cereal semi-finished products, whose amino-acid composition corresponds to the specificity of the gerodietetic nutrition more than just a meat.

Keywords: gerodietetic nutrition, meat-and-cereal semi-finished products, sprouted grain, hulless oats, hulled oats, chemical composition, protein amino-acid composition, amino-acid compliance ratio, dietary fibers, calcium, magnesium.

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INTRODUCTION

Gerodietetic food products are intended for persons of elderly and old age group. In the elderly age, all body systems are subjected to a number of changes. The metabolic processes slow down and the adaptability of the organism reduces as well as its resistance and ability to regenerate. Human aging is a natural biological process, which however can be slowed thought the right lifestyle and particularly balanced diet. Proper nutrition contributes to the prevention of various diseases, extension of people's lives and improvement of their health [1-10].

Food products for this group of people should contain a sufficient amount of proteins, polyunsaturated fatty acids, vitamins and minerals, especially calcium, potassium, iron and dietary fibers [11-21]. The norms of physiological needs in these nutrients and energy for people over 59 years, adopted in the Russian Federation, are differentiated according to two age groups: elderly people group - from 60 to 74 years old and advanced age group – from 75 years and older.

The most important role among the listed nutrients for elderly group and advanced age group belongs to the proteins, which are of exceptional importance in the vital activity of the body, performing the basic function in metabolism.

The recommended daily protein intake for the elderly people is shown in Table 1.

Table 1 Recommended daily protein intake

Age groups	Daily protein intake, g	
	Total	including animal albumen
Males		
60-74 years old	85	44
75 years and older	75	38
Females		
60-74 years old	78	40
75 years and older	68	34

Daily intake of protein for the elderly group should be 13-14% of energy needs. It is known from literature that the individual amino-acids contained in dietary protein, influence life processes, in particular the prolongation of life. At that, the special role belongs to the methionine+cystine amino-acids. Therefore, when developing formulations of food products to ensure high efficiency of proteic substances consumed with food, it is necessary to consider the contents of methionine+cystine; at that, the mass fraction of these amino-acids must relate to the mass fraction of lysine as 1:1 [22]. The works of Yu.G. Grigorov dealing with the usefulness of diets deficient in tryptophan, are of particular interest, when developing technology for gerodietetic products [23-25].

Academician N.N. Lipatov and S.B. Yudina proposed a formal criterion of the amino-acid balance of proteins in gerodietetic products, which is calculated according to the formula:

$$K = 0{,}059 \times \frac{M_{met+cys}}{M_{lyz} \times C_{trp}} \times \sum_{j=1}^{4} A_{jn}$$

where K – is the amino-acid compliance ratio, unit fraction;

M – are mass fractions of methionine+cystine, lysine, and tryptophan, g/100 g of protein;

C – is the tryptophan score in the protein of the gerodietetic product relative to the standard FAO/WHO, unit fraction;

A_{jn} – are mass fractions of the j-th amino-acid in the protein of the product, g/100 g of protein.

The index j is identified to: 1 – isoleucine, 2 – leucine, 3 – phenylalanine, and 4 – tyrosine, consequently.

With the help of this criterion (ideally K=1) it is possible to make a quantitative assessment of adequacy of the amino-acid composition of the protein to specificity of gerodietetic requirements [26-27].

In addition to proteins, in the diet of older people no less is important dietary fibers.

Dietary fibers of plant origin are substances, diverse in composition and structure, including cellulose, hemicellulose, pectin, lignin, etc. Food fibers of animal origin consist of the connective tissue proteins, namely collagen and elastin.

The role of dietary fibers in the diet is quite diverse. It consists partly in the fact that dietary fibers promote the excretion of some food metabolites and pollutants, the regulation of physiological and biochemical processes in the digestive organs. Degradation of dietary fibers in the colon occurs under the influence of the intestinal microflora. Dietary fibers, modified by microflora, constitute food for certain groups of intestinal microorganisms, which produce vitamins and essential amino-acids. Water-soluble fibers are food substrate for microflora, increasing the number of lactic acid bacteria, bifidobacteria and lactobacilli, while reducing coliforms. They contribute to normalization of microbial association ratio in the intestine, and enhance local immunity [28-35].

Quality content of nutrients and their optimal balance in the diet is a key indicator of nutrition. The need of older people for essential nutrients is determined by the age peculiarities of metabolism and the nature of lifestyle in this age. In order to provide the organism with sufficient amount of essential and non-essential amino-acids, the diet should include both complete proteins (of animal origin) and vegetable proteins, which are less comprehensive. The most optimal ratio of animal and vegetable proteins in the diet is 1:1. For the normal functioning of the body, gerodietetic products should combine all essential amino-acids. The content of essential amino-acids in raw meat not fully complies with the general requirements adopted by the international FAO/WHO system. Therefore, the combination of meat-and-cereal raw materials allows completely balancing the composition of the new meat-and-cereal products in terms of amino-acid composition [14].

Taking the above into account, the main research line was directed to the development of meat-and-cereal semi-finished products containing protein, adequate to specificity of gerodietetic requirements, as well as development of dietary fibers.

METHODOLOGY

Research subject

The research subjects were the sprouted oats grain and meat-and-cereal semi-finished products containing this supplement. Herbal supplements were produced from the grain of hulless oats and grain of hulled oats provided by LLC Field Agroindustrial Firm (Russia). Oats was sprouted under specified conditions, dried and crushed to a powder.

For the production of meat-and-cereal stuffing, beef and pork were used in equal proportions as well as sprouted oats grain.

Research methods

Research was carried out according to standard methods: moisture content of sprouted oats was determined according to GOST 29143-91, that of semi-product – according to GOST 9793-74; protein content – by Kjeldahl method according to GOST 10846-91, GOST 25011-81; amino-acid composition was determined using amino-acid analyzer AAA 339, content of tryptophan – according to GOST 13496.21-87; fat content was determined by extraction method with prior hydrolysis of the sample according to GOST 13496.15-97; sugar content was measured by spectrophotometric method; starch – by acid hydrolysis method according to GOST 10845-98; ash – according to GOST 2749-87; content of mineral matters, particularly calcium and magnesium, were determined by chelatometry [36]; phosphorus – by photometric method according to GOST 26657-97; and iron – by colorimetric method according to GOST 26928-86. The stuffing quality was assessed based on the combination of organoleptic characteristics according to GOST 9959-91.

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RESULTS AND DISCUSSION

Characteristics of the raw materials used for the development of meat-and-cereal semi-finished products.

Sprouted oats grain is a natural product. All nutrients are contained in it in a natural balanced amount and combinations, these substances are embedded in the organic system of living tissue. Their absorption does not affect human health negatively. The enzymes produced in sprouted seeds, break down complex storage material into more simple components (amino-acids, fatty acids, and simple sugars). When sprouted grain is used in food, the human body consumes less energy for its digestion and absorption in comparison with any other products received from the dry grain [37-38]. Introduction of sprouted seeds in the diet stimulates metabolism and hematogenesis, improves the immune system, compensates for vitamin and mineral deficiency, normalizes the acid-alkaline balance, cleanses the body against toxins and ensures intense digestion, as well as slows the aging process [39].

Proteins of the sprouted oats seeds are easily digested by the human body. They are also a source of polysaccharides.

During the germination, oats accumulates phytohormones, in particular, gibberellin and auxin, which provoke chemical reactions that change the composition of the sprouted seeds. Also sprouted seeds contain essentially increased amount of antioxidants [37, 40].

In this study we used the meat-and-cereal stuffing with the addition of a sprouted seeds of hulless and hulled oats, obtained on the basis of the conducted research.

Sprouted hulless oats is a powder-like product of a light-beige color with a grayish tinge, with a specific smell of grain and a slightly sweet aftertaste. Sprouted hulled oats is a powder-like product of a gray-beige color with a specific smell of the oat grain. Chemical composition of the both raw materials is shown in Table 2.

Table 2 Chemical composition of raw materials

Indicator	Sprouted seeds of hulless oats	Sprouted seeds of hulled oats	Meat stuffing
Water, %	7.5	12.2	58.8
Protein, %	14.2	14.7	14.6
Fat, %	3.9	2.5	25.8
Mono- and disaccharides, %	3.9	1.2	-
Starch, %	64.2	51.7	-
Dietary fibers, %	4.6	15.1	-
Ash, %	1.7	2.6	0.8
Calcium, mg/100 g	155	168	9
Magnesium, mg/100 g	170	270	23
Phosphorus, mg/100 g	96	138	139

Sprouted seeds as a vegetable recourse is a source of primarily carbohydrates, the total content of which (starch, mono- and disaccharides) is 52.9-68.1%. At that, the sprouted oats grain of both types greatly exceeds the meat stuffing in terms of content of physiologically important functional ingredients such as minerals (calcium and magnesium). The sprouted seeds of hulless and hulled oats contain respectively 4.6% and 15.1% of dietary fibers, which are absent in raw meat.

The analysis of the chemical composition of the studied plant raw material (Table 2) showed that in terms of the protein content sprouted oats is slightly different from the meat stuffing, but it can be considered as a source of vegetable protein. Amino-acid composition of the protein is shown in Table 3.

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Table 3 Amino-acid composition of plant raw material, g/100 g protein

Amino-acid	Sprouted grain of hulless oats	Sprouted grain of hulled oats	Stuffing
Aspartic acid	4.05	10.51	9.10
Threonine	4.50	4.72	4.59
Serine	3.50	4.80	4.23
Glutamic acid	18.00	20.20	15.76
Proline	4.68	2.74	4.81
Glycine	4.11	5.43	4.96
Alanine	4.59	5.56	5.66
Valine	6.93	5.90	5.50
Cysteine	1.80	1.68	1.28
Methionine	5.40	3.90	2.42
Isoleucine	5.31	5.08	4.59
Leucine	12.50	10.92	8.03
Tyrosine	3.06	2.71	3.55
Phenylalanine	3.87	5.40	4.12
Lysine	4.11	3.91	8.38
Histidine	1.71	3.70	3.92
Arginine	6.93	2.50	5.87
Tryptophan	0.94	1.11	1.23

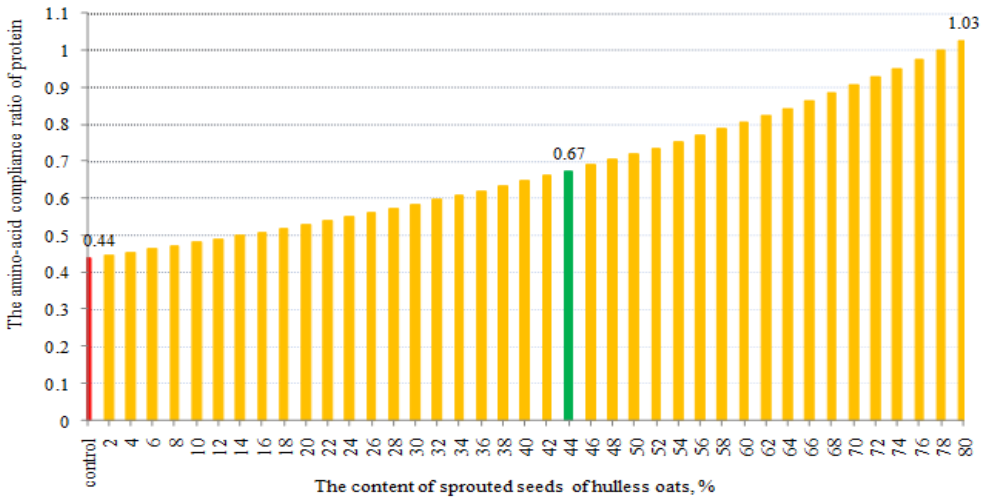
The content of essential amino-acids with regard to the total number of amino-acids amounts to 48.4% in protein of sprouted hulless oats, 45.3% – in sprouted hulled oats, and 43.7% – in meat stuffing . At that, the protein of sprouted oats differs from the protein of meat stuffing in terms of content of amino-acids such as cysteine, methionine, and leucine.

Development of meat-and-cereal semi-finished products

Approaches to the development of gerodietetic food products, namely, recipes of gerodietetic products based on raw materials of animal and vegetable origin, should maximally take into account the specifics of the organism of the elderly and old age people. The basic principle when creating a new kind of gerodietetic meat products with the supplement of herbal ingradients is to achieve the highest possible level of usefulness and amino-acid balance of proteins.

The results of computer simulation of the recipes of meat-and-cereal stuffing with sprouted seeds of hulless and hulled oats are shown in Figs. 1 and 2.

Figure 1. The amino-acid compliance ratio of protein in meat-and-cereal semi-finished products depending on the content of sprouted seeds of hulless oats.



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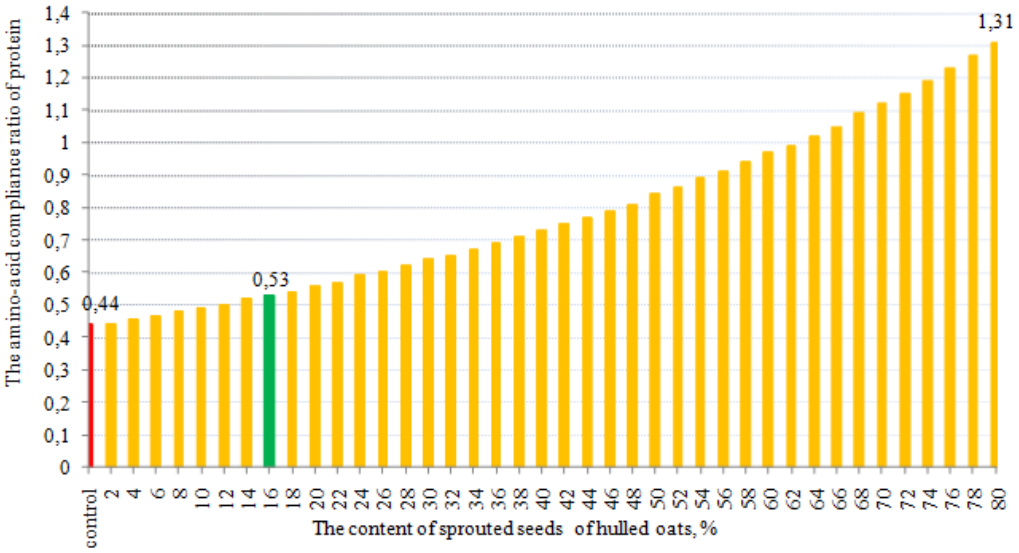

Figure 2. The amino-acid compliance ratio of protein in meat-and-cereal semi-finished products depending on the content of sprouted seeds of hulled oats.

With increasing dosage of sprouted oats seeds in the meat stuffing, the magnitude of the amino-acid compliance ratio of protein increases and approaches to its ideal value equal to 1.

The optimum formulation of meat-and-cereal stuffing was established based on the results of organoleptic analysis.

In the course of experiment, test samples of stuffing were prepared with the supplement of a sprouted seeds of hulless and hulled oats, as well as stuffing with no supplement for the comparative assessment. The composition of the stuffing additionally included 1.2% of salt and 0.1% of ground black pepper. In addition, water was added into the product to achieve moisture of the control meat stuffing at a level of 58%. The stuffing samples were subjected to thermal treatment to culinary readiness in the chamber of the thermal unit at a temperature of 190^0C for 35 minutes.

Quality assessment of the produced stuffing was performed first on the whole (uncut) piece of meat and then on slashed product according to the following organoleptic parameters: appearance, color, surface condition (visually by visual inspection); the smell on the product surface; chewy texture (by pressing); color, appearance and pattern of the cut product; the structure and distribution of ingredients, smell, taste and juiciness of finished products.

In consequence of organoleptic analysis of the stuffing we determined the highest possible dosage of sprouted oats seeds in meat-and-cereal semi-finished products not worsening their consumer properties. For sprouted seeds of hulless oats the highest possible dosage was 44% (Fig. 1), while for sprouted seeds of hulled oats – 16% (Fig. 2). The stuffing had organoleptic parameters appropriate to the description of a given product, including appearance and color when cut; odor and taste specific to meat products; and enough fine texture. Test samples of the products were inferior to the control samples in terms of juiciness, though at large the stuffing with the above mentioned dosages of sprouted oats had high consumer properties.

Further studies were carried out with the stuffing containing the above mentioned dosages of sprouted oats seeds. The chemical composition of the stuffing is shown in Table 4.

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Table 4 Chemical composition of the stuffing

Indicator	Stuffing		
	Meat-and-cereal stuffing with sprouted grain of hulless oats	Meat-and-cereal stuffing with sprouted grain of hulled oats	Meat stuffing
Water, %	36.2	53.4	58.8
Protein, %	14.4	14.5	14.6
Fat, %	16.2	20.3	25.8
Mono- and disaccharides, %	1.7	0.2	-
Starch, %	28.2	7.8	-
Dietary fibers, %	2.0	2.4	-
Ash, %	1.2	1.3	0.8
Calcium, mg/100 g	73.0	32.9	9.2
Magnesium, mg/100 g	87.2	62.5	23.4
Phosphorus, mg/100 g	120.0	130.7	139.0

It is shown (Table 4) that meat-and-cereal stuffing are not inferior to the meat stuffing in terms of protein containment, though they are combined products containing animal and vegetable protein. Besides, fat content in the test samples of the stuffing (16.2% and 20.3%, respectively) is lower than in the control sample (25.8%).

Amino-acid composition of the samples are presented in Table 5.

Table 5 The content of essential amino-acids in the protein of stuffing

Amino-acid	Content of amino-acid, g/100 of protein		
	Stuffing		
	Meat-and-cereal stuffing with sprouted grain of hulless oats	Meat-and-cereal stuffing with sprouted grain of hulled oats	Meat stuffing
Valine	6.11	5.62	5.50
Isoleucine	4.82	4.60	4.59
Leucine	9.97	8.47	8.03
Lysine	6.53	7.71	8.38
Methionine + Cysteine	5.21	4.18	3.7
Tryptophan	1.10	1.27	1.23
Threonine	4.55	4.61	4.59
Phenylalanine + Tyrosine	7.35	7.71	7.67
Total	45.64	44.17	43.92
Amino-acid compliance ratio K	0.67	0.52	0.44

The total content of essential amino-acids in the protein of meat-and-cereal stuffing is higher than in plain meat stuffing. At that, the amino-acid compliance ratio of the protein for stuffing with sprouted hulless oats and stuffing with sprouted hulled oats (0.67 and 0.52, respectively) is closer to the ideal value as compared to that for meat stuffing (0.44). The fact that meat-and-cereal semi-finished products contain more calcium and magnesium has also a positive value. At that, the ratio of calcium and phosphorus (1:1.6 – in semi-finished products with sprouted hulless oats and 1:4 in semi-finished products with sprouted hulled oats) facilitates to a greater extent the absorption of calcium in contrast to the control sample (1:15).

CONCLUSION

Research aimed at development of the products for gerodietetic nutrition is currently quite topical.

Foods for older people should be developed taking into account the physiological characteristics of the aging organism and in addition to protein, fat, and carbohydrates should contain also a number of micronutrients and dietary fibers, essential for the normal functioning of the body.

An important role in the diet of persons older than 59 years belongs to proteins. Gerodietetic products should combine all essential amino-acids with special emphasis made on the methionine + cystine amino-acids.

Dietary fibers are no less important than proteins in the diet of older people. The importance of dietary fibers cannot be overemphasized as their role in nutrition is quite diverse.

The aim of our research was to substantiate and develop formulations of meat-and-cereal semi-finished products – stuffing intended for gerodietetic nutrition. Sprouted seeds of hulless oats and hulled oats were selected as plant components. The choice was justified by the fact that the selected raw material is a natural product, in which substances are in a natural balanced amount and combination, being a source of vegetable protein and dietary fibers.

The selection of the proper dosage of sprouted oats supplemented in meat stuffing was based on computer simulation of the amino-acid balance of the protein using the method of N.N. Lipatov. Optimal formulations of meat-and-cereal stuffing were established based on the results of organoleptic assessment of finished products.

In consequence of organoleptic analysis of stuffing we determined the highest possible dosage of sprouted oats in meat-and-cereal semi-finished products, not worsening their consumer properties. For sprouted hulless oats it was 44%, while for sprouted hulled oats it was 16%. Semi-finished products with the above mentioned dosages of sprouted oats had quite acceptable consumer properties.

SUMMARY

Thus, findings of the conducted study on the chemical composition of the developed meat-and-cereal semi-finished products indicate that the investigated herbal supplements, i.e. the sprouted seeds of hulless and hulled oats included in the stuffing recipe, improve indicators characterizing the gerodietetic orientation of finished products, in particular, amino-acid composition of protein, as well as content of calcium, magnesium and dietary fibers.

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