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Article

Scientific Foundations Of Forming A Regulated Nutrient Profile Of Bakery Products Of Therapeutic And Dietary Purpose For Children's And Gerodietary Nutrition

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Annotation: The article examines modern scientific approaches to forming a regulated nutrient profile of bakery products of therapeutic and dietary purpose. Based on an analysis of literature data, information on the nutritional and biological value of traditional bakery products is summarised, the main nutrient limitations of mass-consumption products are identified, and promising directions for improving formulation composition are considered. It is shown that the use of functional food ingredients, wholegrain and legume raw materials, dietary fibre, vitamin–mineral complexes and biologically active plant components makes it possible to increase the nutritional value of products without impairing their consumer properties. The expediency of developing bakery products with a regulated nutrient profile for children's and gerodietary nutrition is substantiated.

Keywords: bakery products, therapeutic and dietary nutrition, gerodietary nutrition, functional foods, nutrient profile, nutritional value, biological value.

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1. Introduction

Education For many decades, bakery products have remained one of the most widely consumed products of the daily diet. Owing to their high availability and regular presence in the diet, they exert a substantial influence on the supply of essential nutrients to the human body. According to the recommendations of the Institute of Nutrition of the Russian Academy of Medical Sciences, the average daily consumption of bread should amount to 450–500 g, with approximately half of the total quantity recommended to be provided by products made from rye flour, which possess a higher physiological value [1].

Under modern conditions, nutrition is regarded not only as a means of supplying the body with energy, but also as a most important factor in the prevention of chronic non-communicable diseases. In this connection, interest has grown considerably in the creation of food products capable of exerting a targeted physiological effect. One of the most promising directions is the development of bakery products of therapeutic and dietary purpose with a regulated nutrient profile, intended for various age and physiological groups of the population [2].

This problem acquires particular relevance in the development of products for children and elderly persons. For the child's body, priority is given to the provision of complete protein, calcium, iron, zinc, B vitamins and dietary fibre, which are necessary for normal growth and development. In gerodietary nutrition, an important role is played by the prevention of sarcopenia, osteoporosis, cardiovascular diseases and disorders of carbohydrate metabolism, which requires the creation of products with

increased biological value and high nutrient bioavailability.
In this connection, the scientific substantiation of technologies for producing bakery products with a regulated nutrient profile represents one of the priority tasks of modern food science.

2. Methodology

Chemical composition and nutrient profile of traditional bakery products. The nutritional value of bakery products is determined by the content of proteins, fats, carbohydrates, dietary fibre, vitamins and minerals, as well as by the degree of their assimilation by the human body. An analysis of literature data indicates that the chemical composition of finished products depends substantially on the grade of flour used, the formulation and the technological parameters of production [3].

Table 1.
Chemical composition of the main types of bakery products
(per 100 g of product)

Product name	Protein, g	Fat, g	Carbohydrates, g	DF*, g	EV**, kcal
Premium-grade wheat bread	7.6	0.8	49.2	2.7	235
First-grade wheat bread	7.9	1.0	47.0	3.2	229
Wholemeal rye bread	6.6	1.2	41.3	5.6	197
"Darnitsky" bread	6.8	1.1	41.0	4.9	201
Sliced loaf (baton)	7.5	2.9	51.4	2.5	262

*Note: * – dietary fibre; ** – energy value.*

According to the data presented in Table 1, the protein content of traditional bakery products lies within the range of 6.0–8.0%, whereas the mass fraction of carbohydrates reaches 41–52%. At the same time, the main part of the carbohydrates is represented by starch, which is characterised by a high degree of assimilation and a comparatively high glycaemic index. The amount of dietary fibre in most products does not exceed 2.5–5.6 g per 100 g of product, which is substantially below modern requirements for products of preventive purpose [4].
The predominance of readily digestible carbohydrates together with a comparatively low content of protein and dietary fibre is one of the main factors limiting the physiological value of traditional bakery products. In addition, the use of premium-grade wheat flour is accompanied by the removal of the peripheral parts of the kernel and of the germ, which contain a significant amount of vitamins, minerals and biologically active compounds. As a result, the finished product is distinguished by good baking properties, yet its nutrient density is substantially reduced.
Biological value of proteins and nutrient limitations of traditional bakery products. The amino acid composition of the protein fraction is of particular importance. The biological value of proteins is determined by the content of essential amino acids and by the degree of correspondence of their composition to the FAO/WHO reference protein. An analysis of literature data shows that the first limiting amino acid of the proteins of bakery products is lysine, the content of which amounts to only 35–54% of the reference level, whereas the second limiting amino acid is threonine. At the same time, the proteins of rye bread are characterised by a higher biological value in comparison with products made from premium-grade wheat flour, which is associated with the features of the protein complex of various cereal crops (Fig. 1) [5].
It follows from the data of Figure 1 that the first limiting amino acid in the proteins of all types of bakery products is lysine (score 35–54%), and the second is threonine (score 68–85%). At the same time, the proteins of rye bread are more complete in amino acid composition than the proteins of wheat bread. As the grade of flour increases, the completeness of the proteins decreases owing to the removal of the peripheral parts of the kernel, which are rich in albumins and globulins.

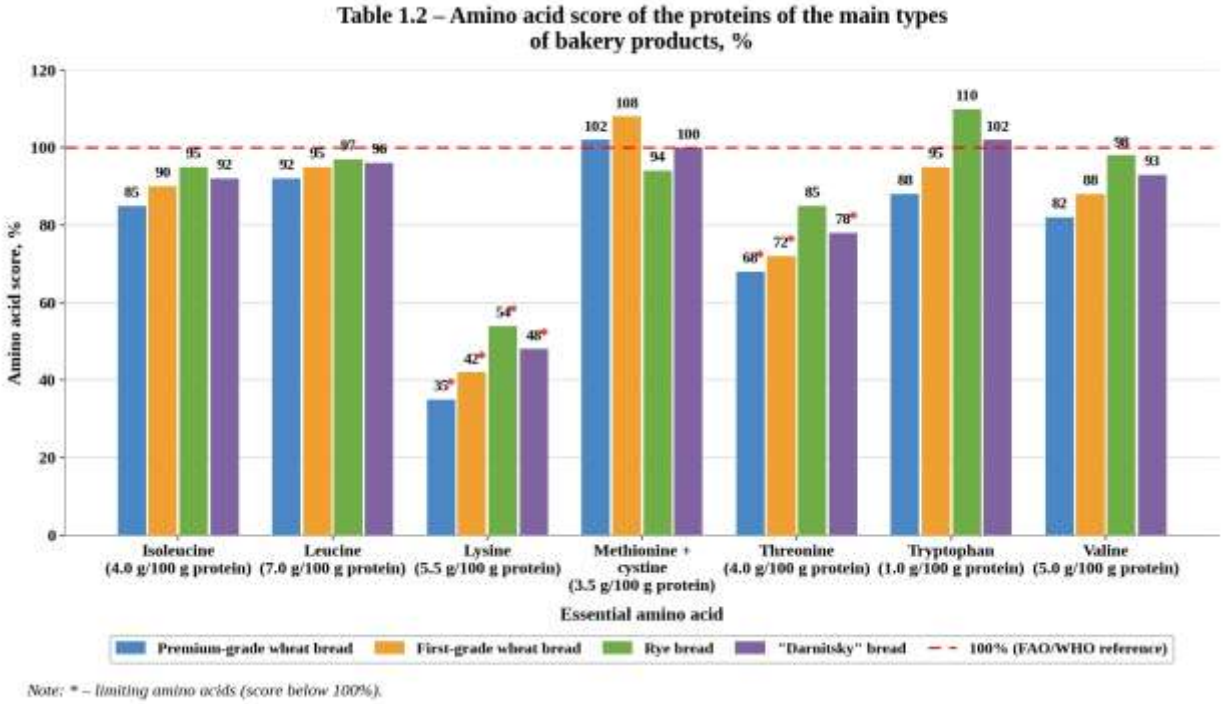


Figure 1. Amino acid score of the proteins of the main types of bakery products

3. Results

The data obtained indicate that an increase in the grade of flour is accompanied by a decrease in the content of albumins and globulins, which are rich in essential amino acids. As a result, the biological value of the finished product decreases, despite the retention of high baking properties. Consequently, the improvement of formulations should be directed not only towards increasing the total protein content, but also towards improving its amino acid composition through the use of raw materials of higher biological completeness.

An equally significant indicator is the provision of bakery products with vitamins and minerals.

Vitamin and mineral value of bakery products. The content of vitamins and minerals depends substantially on the grade of flour used and on the production technology. The most significant losses of B vitamins occur in the production of premium-grade flour, when the germ and the kernel coats are removed [6][7].

Bakery products have traditionally been an important source of B vitamins and niacin (Fig. 2). However, the vitamin content depends substantially on the grade of flour used and on the technology of product preparation [6, pp. 156–178].

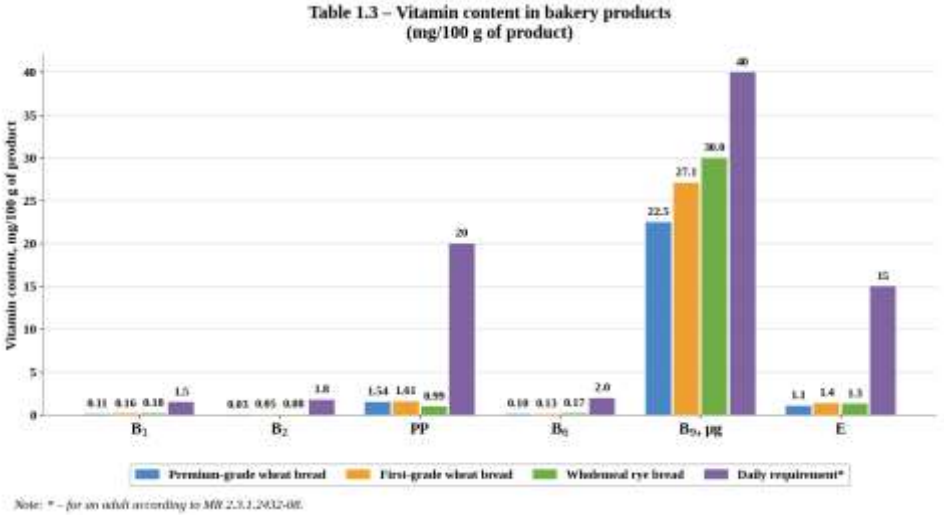


Figure 2. Vitamin content in bakery products (mg/100 g of product)

Nutrient limitations of traditional bakery products. A comprehensive assessment of the chemical composition makes it possible to identify several key nutrient limitations of traditional bakery products. These include an unbalanced ratio of proteins to carbohydrates (about 1:8, whereas the physiologically appropriate ratio is 1:4), a deficiency of lysine (35–54% of the reference) and threonine (68–85%), an insufficient content of dietary fibre (2.5–5.6 g/100 g against a norm of 20–25 g/day), of B vitamins (7–12% of the daily norm), of calcium, iron, iodine and zinc, as well as an unfavourable calcium-to-phosphorus ratio (1:8 instead of the optimal 1:1.5), which differs considerably from the recommended physiological values [8]

The limitations identified confirm the need for a scientifically substantiated correction of the formulation composition of bakery products. Modern research indicates that an increase in the physiological value of products should be carried out comprehensively, through the simultaneous improvement of the protein, vitamin, mineral and carbohydrate composition of the products, rather than through the introduction of a single separate functional component.[9]

Modern directions for optimising formulation composition. On the basis of the nutrient limitations identified, the main scientifically substantiated directions for optimising the formulation composition of bakery products have been determined. The results of an a priori analysis of specialised sources made it possible to determine the main directions for forming a regulated nutrient profile of bakery products of therapeutic and dietary purpose (Table 2).

Table 2.
Scientifically substantiated ways of optimising the formulation composition of bakery products

Direction of optimisation	Technological solution	Expected effect
Increasing protein value	Introduction of protein additives of plant and animal origin	Increase in protein content by 15–30%; increase in the lysine amino acid score to 70–85%
Enrichment with dietary fibre	Use of wholegrain flour, bran, prebiotics (inulin, FOS)	Increase in DF content to 8–12 g/100 g; improvement of gastrointestinal function
Vitaminisation	Introduction of vitamin premixes or natural vitamin sources	Coverage of 30–50% of the daily requirement for vitamins B_1, B_2, PP and folic acid
Mineralisation	Enrichment with iron, calcium and iodine preparations in bioavailable forms	Coverage of 20–40% of the daily requirement for Fe, Ca and I while maintaining product quality
Reduction of the glycaemic index	Use of flour from low-GI grain and resistant starch	Reduction of the GI from 70–85 to 45–55 units; prevention of type 2 diabetes mellitus

Thus, one of the most promising solutions is increasing the protein value of products by introducing protein ingredients of plant and animal origin. This approach provides an increase in protein content of 15–30% and contributes to raising the lysine amino acid score to 70–85%, which significantly improves the biological value of the finished products.[10][11]

The second most important direction is the enrichment of products with dietary fibre through the use of wholegrain flour, bran and prebiotic components, including inulin and fructo-oligosaccharides. Implementation of this approach makes it possible to increase the dietary fibre content to 8–12 g per 100 g of product, which contributes to improving the functional state of the gastrointestinal tract and to preventing metabolic disorders.[12]

An important direction for improving the technology is the vitaminisation of bakery products through the introduction of vitamin premixes or the use of natural vitamin sources. According to the data presented, such technological solutions are capable of providing coverage of up to 30–50% of the body's daily requirement for vitamins B_1, B_2, PP and folic acid without any substantial change in the organoleptic properties of the products.[13]

A promising direction is also the mineralisation of products through the application of bioavailable compounds of calcium, iron and iodine. The use of such ingredients makes it possible to compensate for the deficiency of vital microelements and to provide coverage of 20–40% of the body's physiological requirement while maintaining the high quality of the finished products.[14][15]

In recent years, the reduction of the glycaemic index of bakery products has acquired particular importance. To achieve this goal, it is recommended to use flour from cereal crops with a low glycaemic index, as well as to apply resistant starch and other slowly digestible carbohydrates. According to the material presented, such an approach makes it possible to reduce the glycaemic index of products from 70–85 to 45–55 units, which is of considerable importance for the prevention of type 2 diabetes mellitus and other disorders of carbohydrate metabolism.

Prospects for forming bakery products with a regulated nutrient profile for children's and gerodietary nutrition. The modern development of the technology of specialised food products indicates a transition from the traditional fortification of individual product types to the comprehensive regulation of their nutrient profile. Such an approach provides for the simultaneous optimisation of the content of macro- and micronutrients, an increase in the biological value of proteins, the correction of carbohydrate composition, an increase in the amount of dietary fibre and the provision of an optimal ratio of minerals. It is precisely the comprehensive correction of formulations that makes it possible to create bakery products meeting the modern principles of preventive and therapeutic-dietary nutrition .

This approach acquires particular significance in the development of products for children. During the period of intensive growth and formation of the organs and systems of the body, the requirement for complete protein, calcium, iron, zinc, B vitamins and dietary fibre increases considerably. At the same time, traditional bakery products are not able to fully meet the physiological requirement of the body for these nutrients owing to the limited content of essential amino acids, minerals and vitamins.

No less relevant is the development of specialised products for elderly persons. Age-related changes in metabolism are accompanied by a decrease in the intensity of protein synthesis, a reduction in the mineral density of bone tissue, a deterioration in the absorption of certain vitamins and microelements, and also an increased risk of developing cardiovascular diseases and type 2 diabetes mellitus. In this connection, gerodietary nutrition technologies should be directed towards creating products with high nutrient density, increased biological value and improved digestibility of the main nutrients. The use of functional ingredients makes it possible simultaneously to increase the physiological value of the products and to preserve the customary consumer properties of bakery products.

4. Discussion

The directions of formulation optimisation presented indicate that achieving the required nutrient profile is possible only through the comprehensive application of several technological solutions. Thus, the introduction of protein ingredients ensures an increase in the content of complete protein and an improvement of the amino acid composition; the use of wholegrain flour, bran and prebiotics contributes to increasing the amount of dietary fibre; vitaminisation and mineralisation make it possible to compensate for the deficiency of micronutrients; and the application of raw materials with a low glycaemic index ensures a reduction in the glycaemic load of the product. The comprehensive use of the approaches listed makes it possible to create a new generation of products possessing a preventive orientation and meeting the modern requirements of rational nutrition.

It should be noted that the effectiveness of formulation improvement is determined not only by the chemical composition of the raw materials used, but also by their technological properties. In developing specialised bakery products, it is necessary to take into account the influence of functional ingredients on the processes of dough formation, the gas-holding capacity of the dough, yeast activity, the structural and mechanical characteristics of the crumb and the preservation of the organoleptic indicators of the finished products. Therefore, the creation of products with a regulated nutrient profile requires a comprehensive approach combining the achievements of nutrition science, food chemistry, biotechnology and baking production technology.

Thus, the scientifically substantiated regulation of the formulation composition of bakery products is one of the most promising directions in the development of the modern food industry. Implementation of this approach makes it possible to create products possessing high nutritional and biological value, improved functional properties and a pronounced preventive orientation, which is especially important for the organisation of children's and gerodietary nutrition.

5. Conclusion

The analysis of literature data carried out has shown that traditional bakery products, despite their important role in the daily diet of the population, are characterised by a number of nutrient limitations, which include the insufficient biological value of proteins, a deficiency of dietary fibre, vitamins and minerals, as well as an unfavourable ratio of individual nutrients.

It has been established that the most promising direction for improving the technology is the formation of a regulated nutrient profile of the products through the comprehensive optimisation of the formulation composition. The use of protein ingredients, wholegrain raw materials, prebiotics, vitamin–mineral components and functional plant additives makes it possible to increase substantially the nutritional and biological value of bakery products without impairing their technological and organoleptic characteristics.

The results of the literature analysis obtained confirm the expediency of further research aimed at developing innovative technologies for bakery products of therapeutic and dietary purpose with a regulated nutrient profile.

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