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6.3 Scientific substantiation and development of technology of bechamel sauce of the increased nutritional value

The most important factor that negatively affects the health of people is an unbalanced diet, which against the background of environmental problems can cause quite serious disorders in the human body. According to the Concept of the National Target Program "Health - 2020: Ukrainian Dimension" [209] there is a further deterioration in public health and a decrease in life expectancy by 10 years compared to the European Union.

One of the priority areas for improving the nutrition of the population is the development of technologies for special purpose products aimed at the prevention of food-related diseases. When developing health products, it is necessary to take into account the interaction of individual nutrients with each other, their rational combination, which affects the phenomena of synergism and antagonism in the human body (Fig. 1) [210, 211].

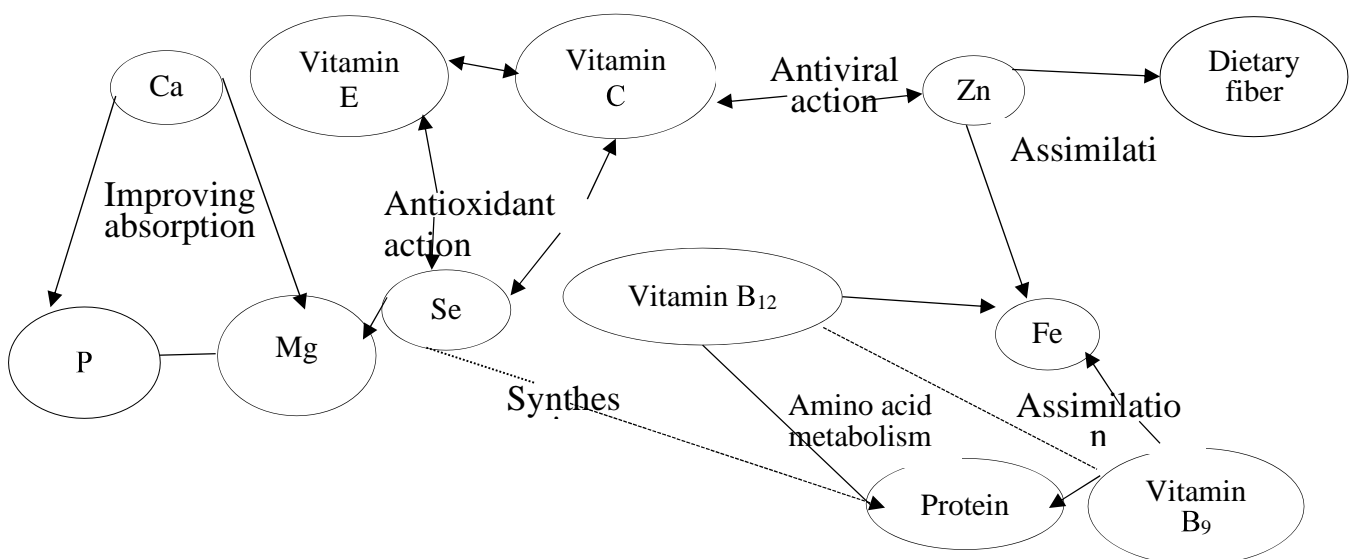


Figure 1. Interaction of nutrients

Among the products of the restaurant industry, a separate segment consists of sauces, which promote better absorption of nutrients by the human body, diversify the range and increase the biological value of dishes.

Sauce - an additional component of the dish, with a characteristic semi-liquid consistency, which is used in the cooking process or served with the finished dish to improve its taste and aroma [212]. In cooking, there are more than three thousand names of sauces, which can be reduced to a single classification (Fig. 2) [213].

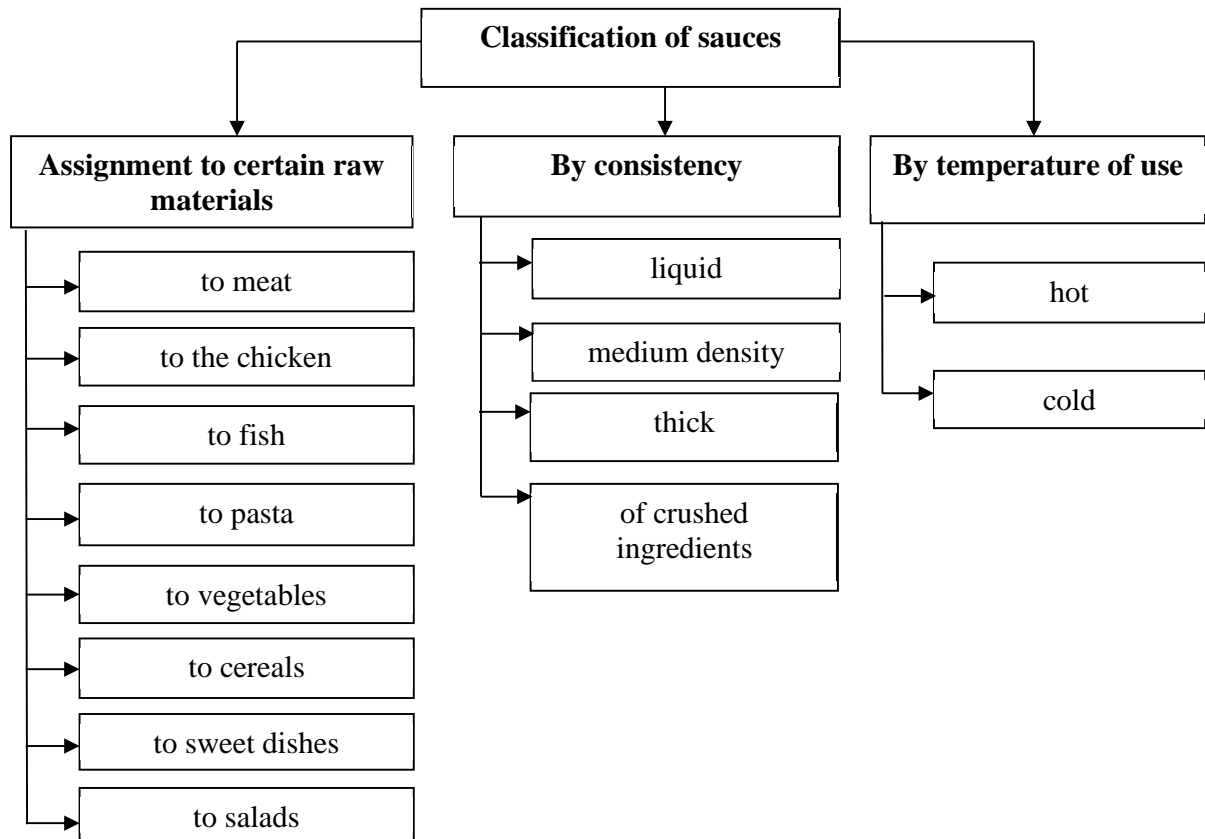


Figure 2. Classification of sauces

However, most of them have an unbalanced chemical composition, namely: increased amounts of saturated fatty acids and low vitamin and mineral content. A promising way to increase the nutritional value of sauces is to increase the deficit of essential substances, due to the combination of traditional raw materials with dietary supplements. This will allow you to get quality and safe products enriched with physiologically important nutrients for the human body.

«Béchamel» sauce is especially popular and is used in cooking: lasagna, pizza, cannelloni and other dishes.

The classic technology of «Béchamel» sauce includes three products: milk, flour and butter. The nutritional value of this sauce is not high.

Wheat flour is a source of proteins, carbohydrates, vitamins B1, B2, PP, organic acids, micro- and macronutrients. At the same time, the chemical composition of this product is characterized by an imbalance of essential nutrients. It is proved that one of the disadvantages of wheat flour is gluten protein.

Gluten is found in four cereals (wheat, rye, barley and oats) and their derivatives. Excessive consumption of gluten-rich foods increases the risk of a number of diseases, including cardiovascular disease, cancer, anemia, osteoporosis, rheumatoid arthritis, multiple sclerosis, autoimmune diseases, gastrointestinal disorders and many others. In addition, wheat flour has a high glycemic index, which increases insulin levels, and hence increases the risk of diabetes.

Recently, the number of people with genetically determined gluten intolerance (celiac disease), who should eat only gluten-free foods, is increasing.

Celiac disease (gluten disease) is an inherited autoimmune disease of children and adults caused by persistent intolerance to gluten.

The use of gluten by patients leads to the formation of antibodies, as a result of which the disease manifests itself in the form of impaired intestinal absorption and other diseases that occur as a result of inflammatory bowel damage.

Celiac disease is found in all countries of the world. Another name for this disease is gluten enteropathy. Celiac disease is the most common genetic disease in Europe. In Italy, about 1 in 250 people in Ireland - 1 in 300 suffer from celiac disease. Celiac disease is very rarely found in Africa, Japan, China, where the diet is preferred gluten-free products based on sorghum, millet, rice. According to estimates, there should be up to 450 thousand patients with celiac disease in Ukraine [214].

In order to expand the range and improve the nutritional value of dishes using Béchamel sauce for further research, it was chosen to replace wheat flour with amaranth.

Amaranth (from the Greek - eternal) - a new culture for our country, which is able to fill the deficiency of protein, vitamins and trace elements in the human diet. It has a high yield, high content of vitamins, minerals, proteins and their balance, a unique ability to adapt to different environmental conditions [215].

Evidence of the high biological significance of amaranth are also the results of determining the qualitative and quantitative composition of amino acids. Amino-acid score proteins have a high biological value. Amino acid score for amaranth flour protein on valine is 112.8%, leucine - 86.4%, isoleucine - 110.0%, lysine - 178.2% (for wheat flour this figure does not exceed 57%), methionine + cystine - 115.5%, threonine - 127.2%, phenylalanine + tyrosine - 146.9%, tryptophan - 287.2%. The amount of essential amino acids in amaranth flour protein is 17.6 g / 100 g of protein [215].

Amaranth seed processing products are amaranth flour and amaranth meal, which can be used as protein substitutes in the production of products with high biological value [216].

Data on the comparative characteristics of amaranth flour and wheat flour are given in table 1 [217, 218, 219].

Table 1

Comparative characteristics of amaranth flour and wheat flour

Index	Amaranth flour	Wheat flour
Proteins	16,0	10,3
Fats	6,5	1,1
Carbohydrates	54,5	69,0
Cellulose	0,85	0,1
Minerals, mg		
Sodium	22,0	3,0
Potassium	520,3	122,0
Calcium	215	18,0
Magnesium	16,0	16,0
Iron	21	1,2
Vitamins, mg		
Thiamine	1,5	0,2
Riboflavin	0,2	0,0
Nicotinic acid	0,5	1,2

Comparative characteristics of amaranth flour and wheat flour showed that the content of individual components of these products differ. The chemical composition of amaranth flour differs significantly in the content of proteins, fats, carbohydrates, minerals and vitamins.

In order to develop the technology of «Béchamel» sauce for health purposes, a series of technological studies was carried out, determining the rational ratio of raw

materials and technological parameters of sauce preparation. The substitution of wheat flour in the recipe of «Béchéamel» sauce for amaranth flour from 50%, 80% and 100% was investigated, the model compositions are shown in table 2.

Table 2

Model compositions (MK) of Béchéamel sauce with the addition of amaranth flour (per 100 g)

Raw materials	Control sample	Model compositions with the addition of amaranth flour		
		№1	№2	№3
Wheat flour	34	17	7	-
Amaranth flour	-	17	27	34
Butter	20	20	20	20
Milk	45	45	45	45
Salt	0,5	0,5	0,5	0,5
Sugar	0,4	0,4	0,4	0,4
Nutmeg	0,1	0,1	0,1	0,1
The output of the finished sauce	100	100	100	100

Based on technological developments, it is determined that 100% replacement of wheat flour with amaranth does not worsen the structural performance of the finished sauce «Béchéamel». Organoleptic characteristics of «Béchéamel» sauce with the addition of amaranth flour are shown in table 3.

Table 3

Organoleptic evaluation of «Béchéamel» sauce

Index	Control sample	Model composition №3
Appearance	The dense, homogeneous, without lumps	The dense, homogeneous, without lumps
Taste	Pleasant, corresponds to the ingredients	Pleasant, corresponds to the ingredients
Scent	Passer flour, milk and butter, without burnt smell	Passer flour, milk and butter, without burnt smell
Color	Creamy	Creamy
Consistence	Homogeneous, without foreign inclusions	Homogeneous, without foreign inclusions

Organoleptic characteristics of the developed «Béchéamel» sauce are shown in Figure 3.

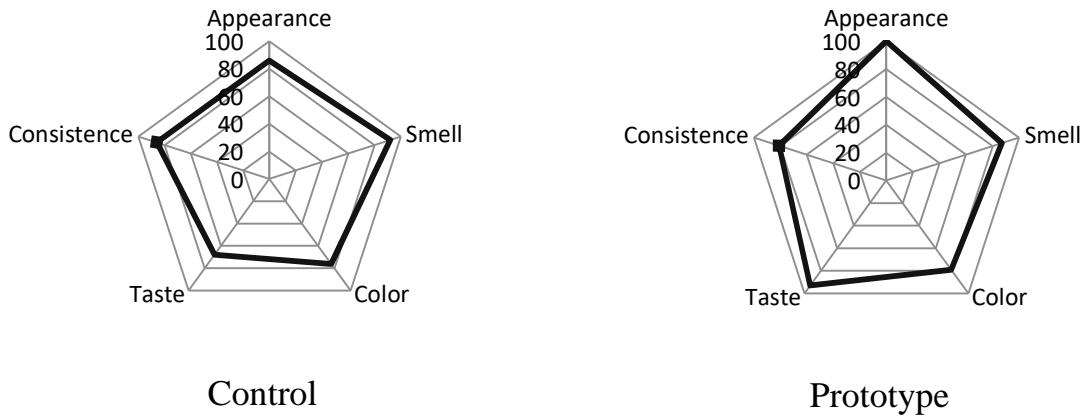


Figure 3. Organoleptic profiles of «Béchamel» sauce

The nutritional value of «Béchamel» sauce with the addition of amaranth flour was calculated (Table 4).

Table 4
Nutritional value of «Béchamel» sauce with the addition of amaranth flour
(g / mg per 100 g)

Index	Control	Prototype	Difference,%
Proteins	4,95	6,89	39,14
Fats	18,00	19,84	10,20
Carbohydrates	25,65	20,72	-19,22
Cellulose	0,03	0,29	750,00
Energy value, kcal	289,24	293,68	1,54
Minerals, mg			
Sodium	1,02	7,48	633,33
Potassium	44,48	179,90	304,46
Calcium	6,12	73,10	1094,44
Magnesium	5,44	6,65	22,24
Iron	0,41	7,14	1650,00
Vitamins, mg			
Thiamine	0,068	0,510	650,00
Riboflavin	0,010	0,068	580,00
Nicotinic acid	0,408	0,170	-58,33

Indicators of table 4 show that the replacement of wheat with amaranth flour has a positive effect on the nutritional value of the sauce. The protein content improved by 39%, the vitamin composition of the sauce significantly increased due to the introduction of carrot powder.

Taking into account the results of previous research on the recipe composition and rational technological parameters of Bechamel sauce production with the addition of amaranth flour, taking into account the data of the analysis of patent sources and scientific literature, the technological scheme of the sauce was developed. To prepare the béchamel sauce with amaranth flour, melt the butter and fry the flour on it for 1 minute. Add the milk gradually, stirring constantly. Boil the mixture until thickened. Add salt, nutmeg, boil the mixture for 1-2 minutes.

Based on the results of the research, a quality model of «Béchamel» sauce with amaranth flour was built, which takes into account organoleptic parameters and the content of dietary fiber, minerals, vitamins and energy value.

The energy value was defined as the inverse, the lower the value of the developed sauce, the better the data will be reflected in the quality model (Figure 4).

The results of the evaluation of the quality of the developed dish in comparison with the traditional one show that the quality indicators of the sauce exceeded the control ones due to the improvement of the nutritional value.

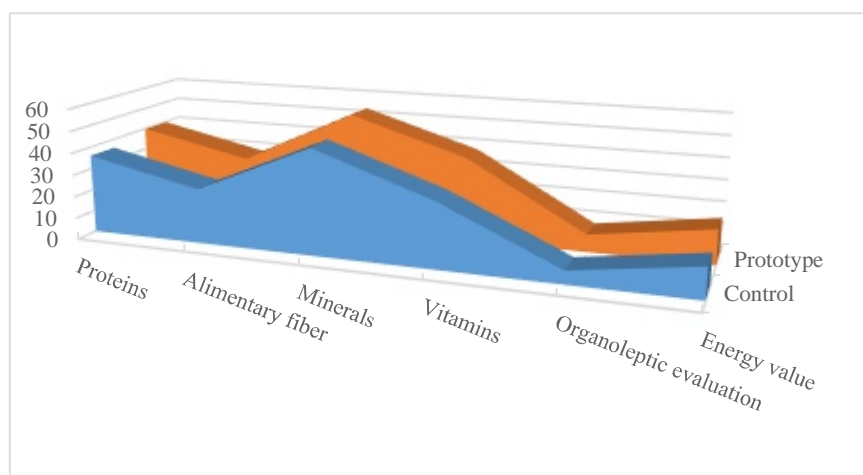


Figure 4. Model of quality of "Béchamel" sauce with the addition of amaranth flour

One of the promising areas of use of the developed sauce in lasagna technology. The classic lasagna recipe includes six layers of semi-finished dough, meat filling, «Béchamel» sauce and cheese. Forming lasagna, you need to grease the baking dish

with olive oil. Lay out the lasagna sheets on top. They have minced meat with bolognese sauce. Spread «Béchamel» sauce on top. Cover with lasagna sheets. Repeat the operation 6 times. Sprinkle with grated cheese on top. Bake in a preheated oven.

The calculated nutritional value of lasagna using amaranth flour and improved «Béchamel» sauce is given in table 5.

Table 5

The chemical composition of lasagna of high nutritional value

Substances of chemical composition	Lasagna classic	Lasagna with amaranth flour	Difference
Protein, g	13,25	21,50	8,25
Fats, g	12,24	11,82	-0,42
Carbohydrates	64,65	56,15	-8,50
Including dietary fiber	2,41	19,74	17,33
Energy value, kcal	360,62	312,51	-48,11

Comparing the chemical composition of the control and experimental samples, we can conclude that the amount of carbohydrates decreased by 8,5 %, and the content of dietary fiber increased by 17,33 %. The protein content in the test sample increased by 8,25%.

According to the results of the analysis of scientific and patent sources, the urgency of developing the technology of gluten-free sauces of high nutritional value, which are in demand in the preparation of culinary products of Italian cuisine, is substantiated and proved. The use of amaranth flour improves the organoleptic characteristics of the dish and the nutritional value of the dishes.

Thus, the developed sauce will expand the range of dishes of Italian cuisine of high nutritional value.