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Abstract. The article presents the results of research on the enrichment of minced meat with animal and vegetable products in order to obtain a functional product that meets 10% of the body's needs for basic nutrients and energy. Milk of 3.2% fat, chicken eggs, rice, parsley, carrots, white cabbage, potatoes and onions were selected for the enrichment of meat products. When replacing 10% of meat with the listed components, the most optimal compositions are combinations with cockerel greens, carrots and white cabbage. Minced meat is enriched with β-carotene, ascorbic acid, as well as dietary fiber, potassium, calcium, magnesium and iron. An increase in the content of nutrients and vitamins in meat products increases the degree of satisfaction of the daily physiological needs of a person, which undoubtedly significantly improves the quality of life.

1. Introduction

In accordance with the "Strategy for improving the quality of food products in the Russian Federation until 2030", the regulation of relations in the field of ensuring the quality and safety of food products is carried out and is associated with the unification and harmonization of national food safety standards with international standards. The state policy of the Russian Federation in the field of healthy nutrition is a whole complex of documents that regulate its functionality and implementation mechanisms.

The increase in the number of noncommunicable diseases, including diabetes, heart disease, stroke, some types of cancer, an increase in the number of overweight and obese people around the world are increasingly associated with unhealthy diet, an imbalanced ratio of essential nutrients, vitamins and minerals that a person gets on a daily basis. According to the data published in June 2021 in the article [1], 1.9 billion adults and 41 million children under the age of 5 suffer from overweight or obesity. A paradoxical situation has developed in low-and middle-income countries. On the one hand, there is insufficient nutrition in children under 5 years of age, on the other hand, the proportion of overweight

and obese children is constantly growing.

Representatives of many countries of the world at various specialized platforms are increasingly raising issues related to healthy nutrition. The current and long-term consequences of malnutrition are negative and affect the socio-economic development of countries. According to the publication [2] on the website of the World Health Organization (WHO), by 2025, WHO member States have put forward global goals for the nutrition of the population in their countries, including goals to prevent an increase in the number of cases of diabetes and obesity in adults and adolescents, as well as overweight in children.

Currently, research by scientists of the Federal Research Center for Nutrition and Biotechnology has revealed a deficiency of vitamins, macro - and microelements in the diet of the country's population. Vitamins, as well as a number of macro- and microelements, such as potassium, calcium, magnesium and iron, are among the elements that are most often deficient in meat and meat products. Therefore, the enrichment of meat raw materials with vitamins and minerals is relevant.

Unfavorable environmental conditions and irrational nutrition provoke oxidative processes in the human body, causing cell dysfunction and an increase in the number of cardiovascular, oncological and other chronic diseases. To improve the health of the population, it is necessary to produce products that include natural ingredients with antioxidant properties [3].

The production of semi-finished meat products is the most dynamically developing branch of the meat industry. Most of the products produced are frozen semi-finished products due to their ease of use and long shelf life. However, the processes that occur during the storage of meat semi-finished products are accompanied by the accumulation of breakdown products of proteins and lipids and lead to a decrease in the nutritional value and organoleptic properties of products. The accumulation of lipid oxidation products limits the storage time of meat products and negatively affects their safety. Thus, it is possible to increase the storage time of meat semi-finished products and ensure the safety of their use in food several times by using antioxidants.

Natural carotenoids isolated from rosehip fruits also had anti-carcinogenic properties. They delayed spontaneous liver carcinogenesis of CBA mice by 6 months and increased the life expectancy of animals 3.6 times (more than 2 years in the experimental groups survived 36% of animals, in the control - 10%) [4, 5, 6]. A positive effect of taking an oil solution of beta-carotene on its serum level and the antioxidant status of patients with gastric ulcer and duodenal ulcer, as well as erosive gastritis was obtained. It has also been established that β-carotene has anticarcinogenic, antimutagenic, immunomodulatory, and antioxidant properties [7].

Many scientists and industry experts prefer natural supplements that can have a pronounced positive effect on the human body. A new scientific and practical direction is being actively formed — the development of recipes for food ingredients with therapeutic and preventive properties [8].

Of the vegetable raw materials, carrots and parsley have the most significant amount of β-carotene, so their introduction into minced meat is expedient.

2. Materials and methods

The review of the norms of the average daily physiological human need for basic nutrients and energy is carried out by the example of beef of the 2nd category. It was established that it is necessary to enrich meat products made from this raw material, since it contains an insufficient amount of necessary nutrients and energy from the average daily need.

The degree of satisfaction with the consumption of beef of the 2nd category of the daily human need for basic nutrients and energy is determined by the calculation method using reference literature [9] and is presented in Table 1.

For the enrichment of beef products of the 2nd category and for the production of functional products based on this raw material that meet 10% or more of a person's daily physiological need for nutrients and energy, the chemical compositions of cereals, legumes, vegetables, greens, as well as the result of adding chicken eggs and milk protein to the recipe, were studied.

Table 1. The degree of satisfaction of beef consumption of the 2nd category of the daily human need for basic nutrients and energy

Nutrient	Quantity	Norm*	% of the norm in 100 g		
			Russia	American Academy of Sciences	Codex Alimentarius
Energy	168 kcal	1684 kcal	10.0	11.9-14.9	13.7
Protein	20 g	76 g	26.3	40-31.7	40.0
Fat	9.8 g	56 g	17.5	15.07-11.8	-
Water	69.2 g	2273 g	3.0	-	-
Vitamin B1, thiamine	0.07 mg	1.5 mg	4.7	4.67	5.0
Vitamin B2, riboflavin	0.18 mg	1.8 mg	10	10.6	11.25
Vitamin PP, NE	8.8 mg	20 mg	44	-	-
Niacin	5 mg	~	25	25	27.8
Potassium, K	355 mg	2500 mg	14.2	10.14	-
Calcium, Ca	10 mg	1000 mg	1.0	1.0	1.25
Magnesium, Mg	25 mg	400 mg	6.3	6.3	8.3
Sodium, Na	73 mg	1300 mg	5.6	5.6	-
Phosphorus, P	200 mg	800 mg	25	-	-
Iron, Fe	2.9 mg	18 mg	16.1	16.1	20.7

Note: Norms for the population over 18 years and up to 65 years old.*

3. Results and their discussion

Based on exploratory experiments, we have identified the most significant factors that have the greatest impact on the quality indicators of minced beef of the 2nd category of fatness: the percentage of β-carotene, ascorbic acid, as well as dietary fiber, macro- and microelements: potassium, calcium, magnesium and iron.

To enrich the meat with the listed nutrients, eggs, milk of 3.2% fat content, parsley, carrots, onions, white cabbage, potatoes and rice were used.

Curly parsley is a promising plant, because it contains valuable biologically active substances that have a versatile effect on the human body. The phenolic complex of curly parsley raw material is represented in it by flavonoids, hydroxycinnamic acids, coumarins and vitamins. The quantitative content of the sum of flavonoids in terms of luteolin-7-glucoside is 1.6% [10]. Therefore, along with the enrichment of meat with carotenoids, the product is additionally saturated with flavonoids.

Carrots, white cabbage and potatoes were identified as promising raw materials. The total content of flavanoids in vegetables: carrots – 10-48 mg%, white cabbage – 29.9-108.5 mg% and potatoes – 15-77 mg% [11].

The analysis of the nutritional value of vegetable materials for the enrichment of category 2 beef per 100 g is given in table 2, and the chemical composition of minced meat with 10.0% meat replacement is in table 3.

Table 2. Comparative analysis of the nutritional value of vegetable raw materials, traditional and recommended for enriching beef of category 2 per 100 g.

Indicators	Beef category 2		Milk		Eggs		Rice		Parsley (greens)		White cabbage		Carrot		Onion		Potato	
	content	% of the total daily requirement	content	deviation	content	deviation	content	deviation	content	deviation	content	deviation	content	deviation	content	deviation	content	deviation
Water, g	69.2	3.0	88	18.8	74.1	4.9	14	-55.2	88	18.8	90.4	21.2	89.0	19.8	86.0	16.8	78.6	9.4
Protein, g	20	26.3	2.9	-17.1	12.7	-7.8	7.5	-12.5	4	-16	1.8	-18.2	1.3	-18.7	1.4	-18.6	2.0	-18
Fat, g	9.8	17.5	3.2	-6.6	11.5	1.7	2.6	-	1.2	-8.6	0.2	-9.6	0.1	-9.7	0.2	-9.6	0.4	-9.4
Carbohydrates (common), g	-	-	4.7	4.7	-	-	62.3	62.3	7.5	7.5	4.7	4.7	6.2	6.2	8.2	8.2	16.3	16.3
Starch, g	-	-	-	-	-	-	61.4	61.4	-	-	0.1	0.1	0.2	0.2	0.3	0.3	15.0	15.0
Alimentary fiber, g	-	-	-	-	-	-	9.7	9.7	4.5	4.5	2.0	2.0	0.8	0.8	3.0	3.0	1.4	1.4
Organic acids, g	-	-	-	-	-	-	-	-	-	-	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2
Ash, g	1.0	-	0.7	-0.3	-	-	3.9	2.9	2.2	1.2	0.7	-0.3	0.7	-0.3	1.0	-	1.1	0.1
Mineral substances, mg																		
Na	73	5.6	50	-23	134	61	30	-43	110	37	13.0	-60	30.0	-43	4.0	-69	5.0	-68
K	355	14.2	146	-209	140	-215	314	-40	610	255	300.0	-55	234.0	-121	175.0	-180	568.0	213
Ca	10	1.0	120	110	55	45	40	30	250	240	48.0	38	46.0	36	31.0	21	10.0	-
Mg	25	6.3	14	-11	12	-13	116	91	65	40	16.0	- 9	26.0	1.0	14.0	-11	23.0	- 2.0
P	200	25	90	-110	192	- 8	322	122	80	-120	31.0	-169	40.0	-160	58.0	-142	58.0	-142
Fe	2.9	16.1	0.1	-2.8	2.5	-0.4	2.1	-0.8	7	4.1	0.6	-2.3	0.6	-2.3	0.8	-2.1	0.9	- 2.0
Vitamins, mg																		
β-carotene	-	-	0.001	0.01	60	60	-	-	5.6	5.6	0.06	0.06	1.1	1.1	0.001	0.001	0.02	0.02
B_1	0.07	4.7	0.04	-0.03	0.07	-	0.34	0.27	0.1	0.03	0.03	-0.04	0.1	0.03	0.05	-0.02	0.12	0.05
B_2	0.18	10	0.15	-0.03	0.44	0.26	0.08	-0.1	0.35	0.17	0.07	-0.11	0.02	-0.16	0.02	-0.16	0.07	- 0.11
PP	8.8	44	0.8	- 8	0.2	-8.6	5.3	-3.5	2	-6.8	0.9	-7.9	1.0	-7.8	0.5	-8.5	1.8	- 7.0
C	-	-	1.3	1.3	-	-	-	-	300	300	60.0	60	5.0	5.0	10.0	10.0	20.0	20
Energy, kcal	168	10	60	-108	157	-11	303	135	36	-132	28.0	-140	30.0	-138	41.0	-127	77.0	- 91

Table 3. Chemical composition of minced meat compositions with 10.0% meat replacement, per 100 g

Indicators	Beef category 2	Milk		Eggs		Rice		Parsley (greens)		White cabbage		Carrot		Onion		Potato	
	in 90 g	in 10 g	in minced meat	in 10 g	in minced meat	in 10 g	in minced meat	in 10 g	in minced meat	in 10 g	in minced meat	in 10 g	in minced meat	in 10 g	in minced meat	in 10 g	in minced meat
Water, g	62.28	8.8	71.08	7.41	69.69	1.4	63.68	8.8	71.08	9.04	71.32	8.90	71.18	8.60	70.88	7.86	70.14
Protein, g	18	0.29	18.29	1.27	19.27	0.75	18.75	0.4	18.4	0.18	18.18	0.13	18.13	0.14	18.14	0.20	18.2
Fat, g	8.82	0.32	9.14	1.15	9.97	0.26	9.08	0.12	8.94	0.02	8.84	0.01	8.83	0.02	8.84	0.04	8.86
Carbohydrates (common), g	-	0.47	0.47	-	-	6.23	6.23	0.75	0.75	0.47	0.47	0.62	0.62	0.82	0.82	1.63	1.63
Starch, g	-	-	-	-	-	6.14	6.14	-	-	0.01	0.01	0.02	0.02	0.03	0.03	1.5	1.5
Alimentary fiber, g	-	-	-	-	-	0.97	0.97	0.45	0.45	0.20	0.20	0.08	0.08	0.30	0.30	0.14	0.14
Organic acids, g	-	-	-	-	-	-	-	-	-	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02
Ash, g	0.9	0.7	1.6	-	0.9	0.39	1.29	0.22	1.12	0.07	0.97	0.07	0.97	0.1	1.0	0.11	1.01
Mineral substances, mg																	
Na	65.7	5.0	70.7	13.4	79.1	3.0	68.7	11.0	76.7	1.30	67	3.0	68.7	0.4	66.1	0.5	66.2
K	319.5	14.6	334.1	14.0	333.5	31.4	350.9	61.0	380.5	30.0	349.5	23.4	342.9	17.5	337	56.8	376.3
Ca	9	12.0	21.0	5.5	14.5	4.0	13	25.0	34	4.80	13.8	4.6	13.6	3.1	12.1	1.0	10
Mg	22.5	1.4	23.9	1.2	23.7	11.6	34.1	6.5	29	1.60	24.1	2.6	25.1	1.4	23.9	2.3	24.8
P	180	9.0	189	19.2	199.2	32.2	212.2	8.0	188	3.10	183.1	4.0	184	5.8	185.8	5.8	185.8
Fe	2.61	0.01	2.62	0.25	2.86	0.21	2.82	0.7	3.31	0.06	2.67	0.06	2.67	0.08	2.69	0.09	2.7
Vitamins, mg																	
β-carotene	-	0.001	0.001	6.0	6.0	-	-	0.56	0.56	0.006	0.006	0.11	0.11	0.0001	0.0001	0.002	0.002
B_1	0.063	0.0047	0.067	0.007	0.07	0.034	0.097	0.01	0.073	0.003	0.066	0.01	0.073	0.005	0.068	0.012	0.075
B_2	0.16	0.015	0.175	0.044	0.204	0.008	0.168	0.035	0.195	0.007	0.167	0.002	0.162	0.002	0.162	0.007	0.167
PP	7.92	0.08	8.0	0.02	7.94	0.53	8.45	0.2	8.12	0.09	8.01	0.1	8.02	0.05	7.97	0.18	8.1
C	-	0.13	0.13	-	-	-	-	30.0	30	6.0	6.0	0.5	0.5	1.0	1.0	2.0	2.0
Energy, kcal	151.2	6.0	157.2	15.7	166.9	30.3	181.5	3.6	154.8	2.8	154.0	3.0	154.2	4.1	155.3	7.7	158.9

It was received that minced meat is enriched with dietary fibers, starch and organic acids due to the introduction of vegetable products, which, along with the listed factors, will allow forming the structure and taste range [12, 13].

When replacing 10% of meat with the listed components, the most optimal compositions are combinations with parsley, carrots and white cabbage. Minced meat is enriched with β-carotene, ascorbic acid, as well as dietary fiber, potassium, calcium, magnesium and iron. The maximum concentration of β-carotene was observed in samples with parsley and carrots.

The maximum content that meets the needs of the body in nutrients was noted in samples enriched with vegetables. Thus, the satisfaction of the daily requirement for vitamins was noted in the following minced meat: thiamine in the sample with carrots - 4.87%; potatoes - 5.0%; riboflavin in the sample with parsley - 10.83%, with white cabbage and potatoes - 9.28% each; vitamin PP in the sample with parsley - 40.6%, with potatoes - 40.5%. Additionally, all minced meat with vegetables is enriched with vitamin C, which is 33.3% in samples with parsley; with white cabbage – 6.67%.

The enrichment with vegetables is reflected in the increase in the concentration of minerals in the minced meat, which corresponds to the satisfaction of the daily requirement for potassium in the sample with potatoes - 15.05%; with white cabbage - 13.98%; sodium in the sample with carrots - 6.87%; with white cabbage - 6.7%; magnesium in the sample with parsley - 7.25%; with carrots - 6.28% and with potatoes - 6.2%; phosphorus in a sample with parsley - 23.5%; with onions and potatoes - 23.22% each; iron - in a sample with parsley - 18.39%; potatoes - 15%.

The introduction of rice into minced meat makes it possible to enrich it with K, Mg, Ca, P, vitamins B1, B2, PP, as well as carbohydrates (starch and dietary fiber).

The introduction of milk and eggs makes it possible to enrich minced meat with K, Mg, Ca, P and iron, as well as β-carotene and B vitamins.

Thus, when replacing 10% of meat with milk of 3.2% fat, eggs, rice, parsley, carrots, white cabbage, potatoes and onions, the most optimal compositions are combinations with parsley, carrots and white cabbage.

Minced meat is enriched with β-carotene, ascorbic acid, as well as dietary fiber, potassium, calcium, magnesium and iron.

4. Conclusion

The main results of the study of the composition of fortified meat semi-finished products are as follows:

1. The introduction of the proposed ingredients in certain quantities and combinations into the composition of meat semi-finished products allows us to satisfy the daily need of the human body for beta-carotene, ascorbic acid, potassium, calcium, magnesium, sodium, iron, phosphorus, vitamins B1, B2, PP, as well as carbohydrates.
2. Enrichment of minced meat from beef of the 2nd category with the listed vegetables can significantly increase its nutritional value, as well as increase the duration of storage and ensure the safety of its use in food.
3. The promising plants used for saturation of semi-finished meat products with flavonoids have been identified.
4. The enrichment of meat semi-finished products with the proposed ingredients improves their organoleptic properties, which increases their competitiveness in the market of similar raw materials.
5. The consumption of food products made from the proposed composition of fortified meat semi-finished products has a positive impact on the quality of life of consumers.

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