Improving the quality of beef and its use in the production of enriched minced semi-finished products

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Abstract. The possibility of obtaining finished products with stable quality indicators primarily depends on the composition and properties of the main raw materials used in the production of meat products. The production of high-quality meat raw materials is possible provided that the causes causing the appearance of defective meat are eliminated. In this regard, it has been proposed to use an adaptogen of animal nature - drone homogenate - as part of the feed ration when feeding bulls raised for meat. For the bulls of the experimental groups, drone homogenate was added to the main diet in the form of a tincture at the rate of 0.005 - 0.015 ml per 1 kg of body weight. It was experimentally established that its use contributed to a more enhanced synthesis of feed nutrients, which had a positive effect on the quantity and quality of meat products obtained. By the end of fattening, the young animals of the experimental groups were superior to their peers from the control group in terms of pre-slaughter weight by 9.0-13.6 kg, and in terms of slaughter yield - by 0.1-0.6 kg. The meat of bulls from the experimental groups had a higher nutritional value. The greatest effect was achieved when an adaptogen was included in the diet at a dosage of 0.01 ml per 1 kg of live weight. Subject to the feeding conditions, the resulting beef was used as the main raw material for the production of enriched semi-finished products. To add functionality to the meat product, iodocasein was added to the cutlet recipes. The use of semi-finished products in the diet will satisfy the daily requirement for iodine for adults by 12.67%, for school-age children by 15.83% and for children of primary school age by 21.11%.

1 Introduction

In preserving and maintaining human health, performance, duration and quality of life, the leading role belongs to a healthy lifestyle and nutrition. Therefore, nutritional status, nutritional structure, and the provision of high-quality and safe food are of paramount importance throughout the world [1].

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Global challenges, characterized by an irrational ratio of essential nutrients, micronutrient deficiencies, an increase in the prevalence of overweight, obesity and other risk factors for non-communicable diseases, remain extremely relevant for most countries, which also requires further improvement of consumption patterns.

The meat industry is one of the most important sectors of the agro-industrial complex on the scale of each country, as it provides the population with basic food products of animal origin [2-3].

Meat and meat products are one of the main sources of nutrition. The presence in raw meat of biologically active substances with a wide range of physiological effects, such as bioactive peptides, minerals, vitamins, fatty acids and others, determines its functional properties: improving the general status of the body, stimulating the activity of enzymes of the detoxification system and antioxidant defense, increasing immune potential and resistance .

The main type of raw material in demand in many countries is cattle meat. In our country, beef consumption is associated with traditions and the national composition of the population, as well as natural and climatic conditions. Beef compares favorably in terms of quality and technological indicators.

Beef is an excellent source of high-quality protein, iron, zinc and vitamin B12. These nutrients are critical for normal growth and development and for maintaining a healthy human immune system. For example, the amino acids and proteins found in beef are especially important for stimulating muscle growth and facilitating muscle recovery. In beef, the share of essential amino acids from the total amount is 39.0%, and exceeds the same figure in other types of meat, such as lamb (37.2%), pork (38.3%) and chicken meat (33.5%) [4].

The quality of meat is influenced by various factors, such as: type of animal, breed, age, genetics, gender, stress resistance, etc. To increase the meat productivity of farm animals and improve the quality of meat, it is necessary to carry out a set of measures, the most important of which is proper feeding. Numerous studies confirm that enriching the diets of farm animals with various additives increases the potential for providing them with nutrients and has a positive effect on the quality of meat [5-7]. However, the intensification of raising and fattening young cattle on the basis of industrial technology is accompanied by numerous stress factors that cause endocrine and metabolic changes in the body. Stressful situations are caused by such environmental factors as: method of keeping, housing density, size of groups, indoor microclimate, type and level of feeding, biological usefulness of diets, methods of preparing and distributing feed, quality of drinking water, veterinary, preventive and zootechnical measures and many others.

The result of stress is a slowdown in the growth of young animals and a decrease in the productivity of adult animals, increased feed consumption per unit of production, increased disease and mortality of animals, as well as increased costs associated with the implementation of appropriate preventive measures.

Animal stress leads to deterioration in the quality characteristics of meat. Such raw materials are characterized by signs of abnormal development of autolysis and the presence of certain changes in the chemical composition of meat, leading to a deterioration in the technological properties of the raw material. Therefore, at the stage of raising animals, it is necessary to pay attention to the selection of stress-resistant individuals, including by monitoring feeding rations, living conditions and removing stress factors.

Currently, to eliminate the negative effects of stress on the body of animals, adaptogens are widely used - preparations consisting of natural components and not containing harmful substances for the body of animals and humans. They help accelerate the mobilization of the body’s defenses to counteract harmful environmental factors [8-11]. Correcting the health and productivity of farm animals in this way has a positive effect on the quality of

meat, which is especially important in the production of functional products, which are widespread in many countries.

Functional foods can be created by enriching food products with important functional ingredients (antioxidants, vitamins, minerals, microelements, polyunsaturated fatty acids, probiotics, prebiotics, dietary fiber), and also be represented by traditional products that contain significant amounts of physiologically active macronutrients. - and micronutrients in their native form. Increasing the value of such products is achieved, among other things, by plant selection and improving the food supply of animals [12-13]. The development and production of functional products is justified primarily by the unbalanced diet of the population. In particular, for many countries the problem of iodine deficiency remains relevant, which is an important element necessary for human health and metabolism and comes mainly from food [14-15].

In this regard, the goal of our research was to develop new technologies for the production of high-quality beef and its processing for the production of enriched meat semi-finished products.

2 Materials and methods

The scientific and economic experiment was carried out in the peasant farm of IP Gabdullin village. Podlubovo Karaidelsky district from 2020 to 2023, and studies of raw materials, semi-finished products and finished products were carried out on the basis of the Federal State Budgetary Educational Institution of Higher Education Bashkir State Agrarian University and the Federal Budgetary Institution "Center for Hygiene and Epidemiology in the Republic of Bashkortostan".

The objects of research were 40 six-month-old bulls of the Bestuzhev breed, which were divided into 4 groups (control and three experimental) of 10 individuals in each. When selecting, age (6 months) and live weight (within 175 kg) were taken into account. The beginning of the main stage of the study was preceded by a preparatory period in order to achieve homogeneity of the groups (formation using the method of analogous pairs).

Favorable conditions for keeping animals were created on the farm. For 10 days after birth, calves were kept in individual cages of the dispensary to obtain maternal colostrum, followed by transfer to a calf barn with group housing. Starting from 6 months of age, bull calves were kept indoors in groups without a leash, with feeding and the possibility of going out to the walking yard. For watering young animals, group automatic drinkers AGK-4 were organized. During the two weeks of the preparatory period, the animals got used to the feeding conditions.

To water the bulls, an adaptogen of animal nature was used – drone homogenate in the form of a tincture. The rate of administration was calculated according to Clark's rule, based on the weight of the animals, which was 0.005 ml for animals of experimental group II, 0.01 ml for experimental group III, and 0.015 ml per 1 kg of bull-calves weight for experimental group IV. The calculated volume was dissolved in 200 ml of water and added to the bulk of drinking water. The dissolved drug was given to the animals in the morning for two weeks with a break of similar duration.

Meat productivity was assessed after a control slaughter of three 18-month-old bulls from each group. After deboning, trimming was carried out according to the sausage classification, which is also used in the production of chopped semi-finished products.

The quality of meat products was assessed using standard methods: moisture content in the samples by drying the sample to constant weight at a temperature of 150 ± 2º C; protein content – by the Kjeldahl method with subsequent photometry of samples; mass fraction of fat in meat - by extracting a dry sample with ether in a Soxhlet apparatus; minerals in meat - by burning in a muffle furnace; The iodine content in the product was determined by the

stripping voltammetric method. The preparation of "Iodcasein" was carried out in accordance with the manufacturer's recommendations.

Study data are presented as means ± standard error of the mean (M ± m).

3 Results

Weight growth, expressed through live weight, is an important indicator of lifetime assessment of meat productivity of young animals and makes it possible to assess the feasibility of using new additives. We found that the introduction of drone homogenate into the diet had a positive effect on the digestibility of food nutrients, metabolic processes and, as a result, determined more intensive growth of the experimental groups of animals (Table 1).

Table 1. Dynamics of live weight of bull calves in the period from 6 to 18 months, kg.

Age, months	Group			
	I	II	III	IV
6	175.4±3.01	175.3±3.36	175.4±3.13	175.5±2.85
9	235.7±3.93	237.3±3.58	238.8±3.75	238.6±3.38
12	299.4±4.92	303.5±4.22	307.1±4.96	306.4±4.24
15	365.4±6.04	373.4±5.24	379.7±6.13	378.5±5.12
18	429.7±7.15	442.3±6.33	451.8±7.39	450.1±6.11

At the beginning of the experiment, the live weight of bulls of all groups practically did not differ, which proves the lack of manifestation of the effect of the additive due to the short duration of its use.

Starting from 9 months of age, animals in the experimental groups grew better. When using a minimum dosage of 0.005 ml per 1 kg of live weight of bull calves at the age of 9 months, the studied indicator was higher than that of analogues from the control group by 1.60 kg (0.67%), at 12 months - by 4.10 kg (1.36%), at 15 months – by 8.00 kg (2.18%) and at 18 months – by 12.60 kg (2.93%).

The best effect was observed when using a dose of drone homogenate tincture equal to 0.01 ml per 1 kg of animal weight. Thus, compared to control peers at 9 months of age, their advantage was 3.10 kg (1.31%), at 12 months - 7.70 kg (2.57%), at 15 months - 14.30 kg (3.91%) and at 18 months – 22.10 kg (5.14%).

It should be noted that the results of weighing bulls consuming the maximum dosage (0.015 ml per 1 kg of bull weight) were almost the same as when using the average dosage of the adaptogen. At 9 months the difference was 0.20 kg (0.08%), at 12 – 0.70 kg (0.22%), at 15 – 1.20 kg (0.31%) and at 18 – 1.70 kg (0.37%).

Thus, it can be assumed that the young animals of the experimental groups, in the process of growth and development, coped with stress manifestations more easily and better demonstrated their inherent genetic potential for productivity.

One of the most important indicators for the consumer is the quality and quantity of the products received. In this connection, the study of meat productivity indicators after the slaughter of young animals and the factors that have a direct impact are of particular interest.

The results of the control slaughter of Bestuzhev breed bulls consuming different dosages of the adaptogen are presented in Figure1.

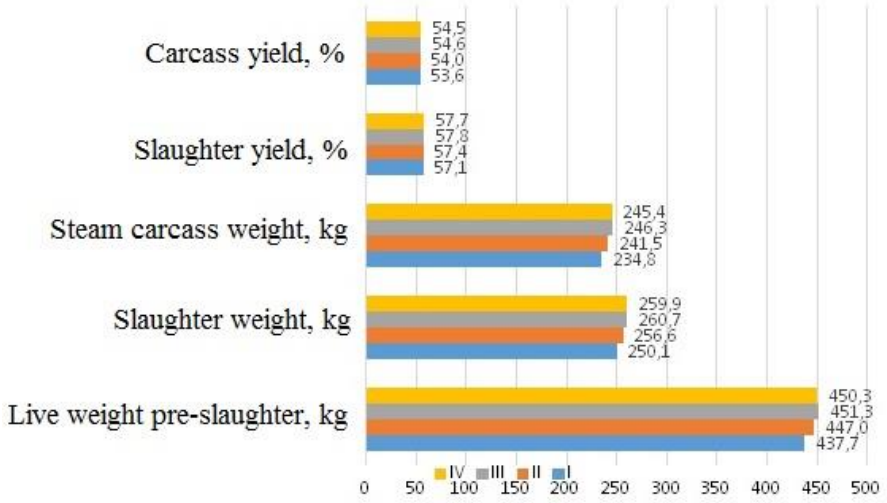

Fig. 1. Results of control slaughter of experimental bulls.

Analyzing the data from the results of the control slaughter of bulls, it should be noted that the pre-slaughter live weight of young animals of the III experimental group was 451.3 kg, and had an advantage over their peers in the control group by 13.6 kg (3.1%), of the II group - by 4. 3 kg (0.96%) and IV – by 1.0 kg (0.22%).

A similar trend remained in the weight of the fresh carcass. Thus, the maximum values were demonstrated by young animals of groups III and IV, amounting to 246.3 kg and 254.4 kg, the minimum values in group I (control) were 234.8 kg, an intermediate position was observed among peers of group II - 241.5 kg.

The advantage in the weight of the fresh carcass was also reflected in the carcass yield, which characterizes the ratio of the mass of the carcass without internal raw fat to the pre-slaughter live weight, expressed as a percentage.

It is known that the quality of carcass pulp differs in the content of connective and fatty tissue. To do this, it was subjected to trimming and subsequent distribution by variety (Figure 2).

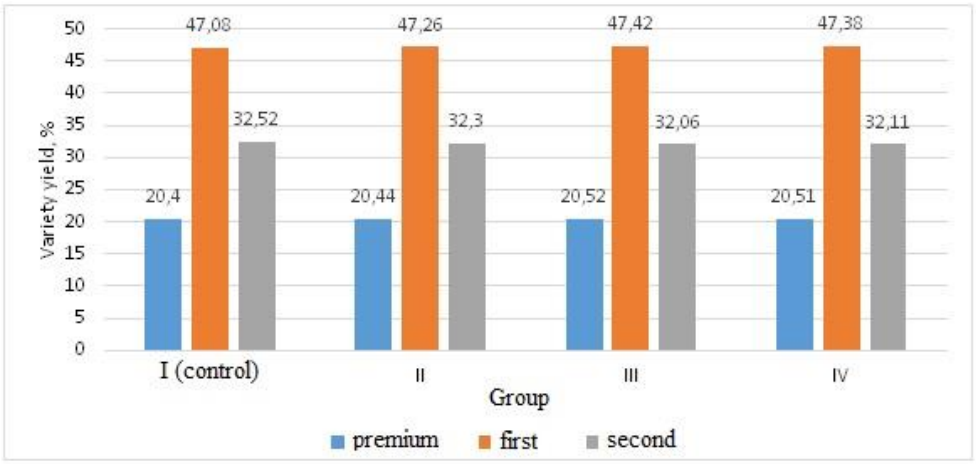

Fig. 2. Varietal composition of experimental bull carcass pulp.

The highest grade includes muscle tissue, where there are practically no inclusions of fat and connective tissue. In the structure of the pulp, its share accounted for about 20%. The highest yield of premium pulp is observed in the carcasses of bull calves in the experimental groups, with a difference relative to the control of 0.04-0.12%. The maximum pulp weight was assigned to the first grade from 47.08 to 47.42%, while the intergroup distribution was preserved.

The highest yield of premium and first grade meat is observed in the carcass of bulls of the III experimental group, amounting to 20.52 and 47.42%, respectively. This group was characterized by having the lowest yield of second-grade meat, 32.06% versus 32.52% in the control.

Determination of the chemical composition of an average sample of minced meat is included in a comprehensive assessment of the quality of meat products, which allows us to supplement information about the characteristics of meat. The chemical composition has a great influence on such important properties as the culinary, technological, and nutritional value of the product. The results of our studies of the chemical composition of an average sample of minced meat from young bulls of the Bestuzhev breed are presented in Table. 2.

Table 2. Chemical composition of an average sample of minced meat from experimental bulls, %.

Index		Group			
		I (control)	II	III	IV
Moisture	X	69.23	68.83	68.17	68.29
	±	0.42	0.50	0.41	0.27
Dry matter	X	30.77	31.17	31.83	31.71
	±	0.42	0.50	0.41	0.27
Protein	X	18.38	18.51	18.86	18.78
	±	0.21	0.32	0.57	0.22
Fat	X	11.48	11.74	12.04*	11.99*
	±	0.20	0.17	0.16	0.06
Ash	X	0.91	0.92	0.93	0.93
	±	0.01	0.01	0.02	0.02

Thus, bulls of group III had a leading position over their peers in terms of dry matter content in the average sample of minced meat. Their advantage over animals in the control group was 1.06%, experimental group II – 0.66% and animals in group IV – 0.12%. In terms of the mass fraction of moisture, the maximum values were observed in animals of the control group, the studied indicator was 69.23%, and the minimum in the third group was 68.17%. In terms of fat content, young animals of group III had the highest indicator of 12.04%, which is more than that of bulls of group I - by 0.56%, II - by 0.30% and IV - by 0.05%. As for the protein content in the average meat sample, intergroup differences were obtained in favor of the animals of the experimental groups. Their indicator was higher than that of group I bulls by 0.13-0.48%.

Taking into account the beneficial effect of the adaptogen on the studied set of indicators of raw meat, it was used for further deep processing. The raw materials of the III experimental group were used as the main raw material for the formulation of the produced chopped semi-finished products.

To enrich semi-finished products with iodine, Iodine casein was used in powder form, which is recommended for mass prevention of iodine deficiency and is used in the food industry in the production of bakery and dairy products [16]. "Iodocasein" is a compound, in the form of an organic form of iodine, which is an iodized milk protein. It is important to note that when using iodocasein to fortify foods, an overdose is practically impossible.

Studies have shown that enriching cutlets with the drug “Iodcasein” does not impair their consumer properties or affect their taste. And an assessment of the physicochemical

parameters of the cutlets showed that the introduced form of iodine was stable, which made it possible to increase the iodine content in the studied products (Table 3).

Table 3. Nutrition Facts for Beef Patties.

Index	Protein		Fat		Iodine	
meat cutlets						
Content	9.58±1.44	%	6.3±1.0	%	0.19±0.09	mg/kg
daily requirement						
Adults (men)	75-114 g	g	72-127 г	g	1.5	mg/kg
Adults (women)	60-90 g	g	57-100 г	g	1.5	mg/kg
school age children (7-12 years old)	77-90	g	79-92	g	1.2	mg/kg
young children (2-6 years old)	42	g	47	g	0.9	mg/kg
% satisfaction						
men	8.4-12.77	%	4.96-8.75	%	12.67	%
women	10.64-15.94	%	6.3-11.05	%	12.67	%
school age children (7-12 years old)	10.64-12.44	%	6.85-7.97	%	15.83	%
young children (2-6 years old)	22.81	%	13.40	%	21.11	%

The advantage in iodine content in cutlets compared to the natural iodine content in raw beef was 12 mcg per 100 g. Thus, the daily requirement for iodine will be satisfied for adults by 12.67%, for school-age children by 15.83% and for children of primary school age by 21.11%.

4 Discussion

The qualitative characteristics of meat products depend on many factors, among which the initial properties of raw meat are important. As a result of exposure to feed, climatic, technological and biological stress, an imbalance in the formation and detoxification of free radicals occurs; oxidative stress occurs in the body of poultry and monogastric animals, which negatively affects health, growth rates and product quality.

The inclusion of biologically active beekeeping products, such as drone homogenate, in the diet of experimental animals increases the potential of animals, which is confirmed by the results of our experiment and is consistent with the work of researchers [14]. Works of recent years also indicate the relationship between animal health and productivity and obtaining safe products from them [9, 17-19].

Summarizing information about the composition and properties of meat from Bestuzhev breed bulls when an adaptogen is included in the diet, we can conclude that it has a positive effect. This is confirmed by slaughter indicators: pre-slaughter live weight, slaughter weight, yield of premium pulp, and increased nutritional value of meat. The optimal effect was obtained when using the adaptogen at a dosage of 0.01 ml per 1 kg of live weight.

Along with solving the issues of obtaining safe and high-quality meat raw materials, it is important to consider the possibility of enriching mass-market products with micronutrients. For example, more than 50% of Russian regions belong to iodine-deficient areas. According to the literature, iodine-enriched products can be recommended for the prevention of iodine deficiency conditions [16]. And in order to avoid problems associated with the enrichment of products with inorganic iodine compounds, it is proposed to add iodine based on the milk protein casein. Our studies showed that iodine in the composition of iodocasein turned out to be chemically stable, did not change the organoleptic characteristics of the produced cutlets and contributed to an increase in the iodine content in the product, which is consistent with the studies of other authors on the use of iodocasein for food fortification [20].

5 Conclusion

Thus, to prevent the negative consequences of stress, and as a result of increasing meat productivity, the use of an adaptogen - drone homogenate in the diet of young animals raised for meat is effective. It has been established that the use of drone homogenate in a dosage of 0.01 ml per 1 kg of weight of bulls stabilizes the quality characteristics of meat raw materials, increases nutritional value and provides an advantage when choosing raw materials for the production of enriched minced meat semi-finished products. The use of beef in recipes as the main meat raw material and the addition of iodized protein iodine casein to the recipe increases the nutritional value of the cutlets, contributes to the enrichment of the organic form of iodine and can serve as a prevention of iodine deficiency.

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