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Nutritional Value of Beef from Steers Grown On Natural Pastures of Arid Territories

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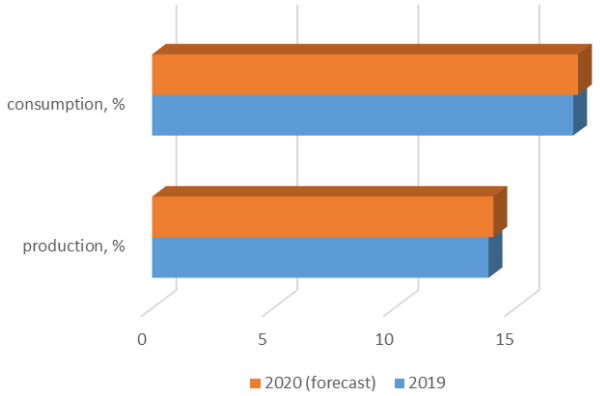
Abstract*: *Intensive development of beef cattle breeding is becoming a task of a national scale, which is reflected in all regulatory documents that determine the imperatives of the modern socio-economic development of our country. To solve this problem, of great necessity are scientifically based methods and mechanisms that will increase the intensity of meat production without reducing its biological value and nutritional qualities. This article substantiates the need to improve the forage base for the development of beef cattle breeding due to a more intensive grazing system on the arid territories in the South of Russia. The cattle feeding and keeping technology of that kind will contribute to the development of rural areas, employment and increase in the profitability of the beef production. Territory belongs to the zone of steppe and semi-desert landscapes and is noted for certain problems in terms of the grass and forage base. The conducted comparative analysis of meat obtained due to the technology of stable and grazing keeping of beef cattle bred on the arid territories has proved that pasturing cattle breeding enables the beef to exceed its analogues in biological value and in the composition of essential amino acids.

Keywords* : *beef, grass-fed, nutritional and biological value, pastures.

I. INTRODUCTION

The meat subcomplex in the agribusiness of Russia is an important agricultural sector for providing the country's population with meat products. At the state level, there has been developed and approved a “Strategy towards the development of beef cattle breeding in the Russian Federation until 2020” where the legislators clearly defined the criteria for the development of the beef cattle breeding industry and meat consumption by the population of Russia for the period until 2020 [2] (Fig. 1).



According to Fig. 1, the beef production and consumption standards projected by the Ministry of Agriculture indicate a deficit that is going to be compensated for the meat imports.

The domestic beef production is not enough to meet the population’s needs in this type of meat. Therefore, it is necessary to increase the production base of this sector of beef cattle breeding. The interest of the Government of the Russian Federation in this meat subcomplex has stimulated the growth of the number of beef cattle in recent years.

So, according to the Department of Livestock and Breeding of the Ministry of Agriculture of the Russian Federation for the period of 2013-2018, the number of beef cattle increased by 25% in farms, but the production still specializes in the dairy cattle breeds [3]. Therefore, the primary task of the industry is to increase the number of beef cattle in farms of all categories, which will cause the growth in high-quality beef production.

However, the state incentives at this stage were noted to be unstable, so, it is necessary to continue subsidizing the sub-sector at the expense of budgetary resources in such areas as keeping a cow with a calf, increasing the number of beef cattle and its proportion in the cattle population, building feedlots and developing beef cattle breeding base [4, p. 67].

In this matter, balanced feeding of cattle is crucial, since high-quality beef depends on the nutrition of animals. A sustainable fodder base is the basis for the essential services of livestock industries. A big problem of the feed production industry is the imbalance of protein, carbohydrates, micro and macro elements in the feed produced, which is the reason for the poor nutrition of cattle and, as a result, low quality of products. Restructuring the feed production technology with respect to increasing the production of legumes, meal and cake, as well as supplementing the feed with nitrogen-containing and other balanced additives can solve this problem in Russia.

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But such a comprehensive restructuring requires considerable investment and a certain amount of time. The main consumers of concentrated feeds of that kind are pig farms and poultry farms, while cattle breeding requires, first of all, green mass and roughage. In addition, in animal husbandry, the share of the feed cost in the net cost of meat produced can be about 75%, which leads to a notable increase in the cost of production.

Within this context, the most promising direction of the feed base development is the technology of low-cost intensive grazing cattle keeping.

In the framework of this research, we studied the geobotanical composition of the Trans-Volga natural pastures that belong to the farms of the Volgograd region [6, p. 39], in particular, the Paris Commune breeding factory, specializing in beef cattle. The location of the breeding farm is characterized by semi-desert steppes with a sharply continental climate, where about 81.5% of all land is covered with natural pastures [7, p. 23]. The keeping of cattle on the territory of the breeding farm involves grazing on natural pastures in the spring, summer and autumn period, when they are adequately provided with green mass (250-350 kg/ha). In fact, the cattle is grazed for about 240 days a year, which allows the farm to save enough on forage; in winter, the herds are kept on specialized enclosures or indoors. A feature of this keeping and raising technology is high meat production and high nutritional and biological value of beef.

II. MATERIALS AND METHODS

Domestic scientists and scholars abroad (Gorlov I.F., Gishlarkaev E.I., Garyaeva Kh.B., Zlobina E.Yu., Kokhanov M.A., Mosolov A.A., Makhonina V.N., Slozhenkina M.I., Tikhonov S.L., Fedotova G.V., Churzin V.N., Yuldashbaev Yu.A., etc.) showed the relevance of a comprehensive study of the raw meat production technology in conditions of natural grazing.

For the experimental studies, there were selected two groups of steers (10 heads each) grown according different feeding and keeping technologies. Group I was raised according to the technology of maximum stay on natural pastures. In Group II, livestock was raised according to the technology of stall keeping, feeding with harvested feed and grazing at specialized grounds.

The control slaughter of cattle was carried out at a slaughterhouse of the enterprise. Assessment of the biological value of beef was performed according to the Academician N. Lipatov's (Jr.) procedure, providing for the evaluation of the amino acid balance of various types of animal meat [9, p. 26]. The amino acid content in beef samples was determined using the Aracus amino acid analyzer in the laboratory of Volgograd State Technical University.

The content of macronutrients was determined according to GOST R 51429-99, GOST R 51430-99 and the recommendations.

The comparison with the amino acid composition of the reference protein was carried out according to the amino acid scale of the Food Committee of the World Health Organization (FAO / WHO).

The research material was processed by methods of graphical, trend and statistical analysis, as well as using the software package "Microsoft Office". The work used generally accepted methods standardized for the analysis of the objects under study.

III. RESULTS AND DISCUSSION

To increase production volumes and the profitability of livestock products, it is necessary to intensively use the natural renewable resources of hayfields and pastures, and to optimally combine arable and pasture land fodder cropping. In the Paris Commune breeding plant, the fodder conservation process is based on arable fodder cropping; its yield is sharply differentiated depending on the natural and climatic conditions.

As a task in our research, we provided for main directions of the development of the feed base, i.e., monitoring of existing feed resources in the regions, development of adaptive feeding systems for cattle, increasing the productive effect of feeds used and creating specialized crop rotation adapted to local climatic conditions.

The geobotanical analysis of the natural pastures of the Trans-Volga region showed that the composition of grasses in the area was not constant; their quantity and quality depended on the level of precipitation and the period of rains or drought. To preserve the grass stand in the Trans-Volga region, estuary irrigation of fields was used.

Fodder plants, growing on the natural pastures of the Trans-Volga region, are usually adapted to the harsh conditions of the steppes and semi-deserts, droughts and harsh winters. Accordingly, cattle for generations kept in these conditions are well adapted and resistant to abrupt climate changes. The Angus cattle of the Volgograd type bred in the farm possesses all of these qualities. It is also characterized by high meat quality and tolerates the harsh continental climate of the Volga region.

Assessing the forage base of the natural pastures of the area revealed that the natural pastures of the Trans-Volga region were covered mainly with fescue-wormwood and feather grass types; meadow grasses were found on the territories of inundative irrigation. The grass cover burns out during the period of drought and hot summer (in July and August) for the most part and does not actually represent sufficient feed value for herbivores [10, p. 32]. This is the hardest period for grazing, when cattle lost weight and lacked for food, therefore, it was necessary to additionally feed the herd or choose pastures with a juicy heat-resistant grass stand.

In spring herds was recommended to be grazed on pastures that had early green fodder. In May, there were goosefoot herbs, i.e., kochia prostrata and chenopodium album; medicago lupulina, lathyrus pratensis, lotus corniculatus and trigonetla of the legume family; stipa lessingiana of the family poaceae; striated fescue of the family fescue; and plantago lanceolata of the family plantain. The main herbs in the list formed a rather diverse and nutritious fodder base for the period of spring and early summer for grazing cattle.

In spring, the stock of fodder mass was in the range of 1.48-1.69 g/ha, dry weight was at the level of 0.2-0.4 t/ha. During this period, the main feeds were wormwood and cereal crops. In hot summer, the productivity of cereal crops decreased sharply,

and the productivity of wormwood rose. In autumn, grass stand contained wormwood herbs up to 87% of the total mass and shrubs (eurotia, vitex and camphorosma).

The most frost- and drought-resistant plant crops enrich the pastures of the dry-steppe and semi-desert regions of the South of Russia. Among them can be noted the following [5, p. 20]:

Kochia prostrate or *vitex* are shrubs with a straight branchy stem and small leaves, blooming in June. The ability to grow in conditions of lack of moisture on natural soil and even on salt marsh is considered a distinctive feature of the herb. Due to such exceptional unpretentiousness and a high protein content in the green mass, this plant is considered a valuable pasture crop that is used for producing hay that contains high-quality protein and leaves for more than 60%. The plant is able to vegetate for a long time in difficult climatic conditions, enduring not only drought, but also frosty snowless winters. In addition, numerous seeds are easily dispersed by the wind and germinate quickly, which allows the culture to be used for quick restoring of pasture lands, reclamation of lands affected by fires and wind erosion.

Eurotia (*Eurotia ceratoides* or *Eurotia lanata*) is a shrub with a good root system that enables getting moisture in any conditions. It possesses good adaptive abilities in conditions of drought, salt soils and frosts. Harvest makes from 2.0 to 2.8 t/ha.

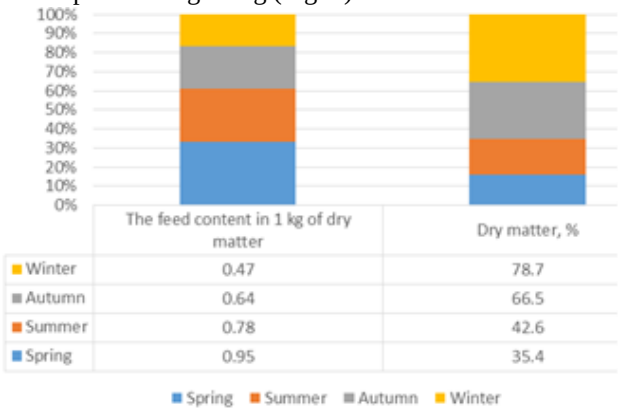
Artemisia diffusa or *artemisia halophila* is a shrub of the family compositae with a root system of up to 2.0 m. It is a good pasture in the autumn and winter period.

Lotus corniculatus is a perennial bean culture. Recently, grassland farmers have appreciated the potential of this grass that is resistant to trampling. It is distinguished by its winter hardiness and high growth rate. *Lotus corniculatus* is produced into very nutritious hay with a crude protein content of up to 22% of the dry weight. It is undemanding to soils, including acidic soils, and is generally resistant to adverse weather conditions. It tolerates prolonged flooding, which makes it the most desirable component for grass mixtures for flood meadows, and withstands flooding up to 35 days.

Astragalus feed species are annual and perennial plants of the legume family with a long creeping brachigerous rhizome with additional roots and aerial shoots. These are excellent fodder plants readily eaten by cattle both on pastures and in hay. Their herbal mass is very nutritious. The green grass of the plant contains ascorbic acid (up to 800 mg% in the leaves and up to 700 mg% in the flowers), carotene (10-22%), protein (17-28%), saponins, amara tonica and alkaloids. Many types of astragalus play an essential role in the medical-feed balance of pastures. The yield of green mass is 3.9-4.9 t/ha.

Medicago is a popular perennial forage crop. The feed value of this legume grass is very high, i.e., 1 kg of medicago hay contains 0.48 feed units and 103 g of digestible protein. By nutrition, 2 kg of medicago hay can be equated to 1 kg of oats. When mowing, the protein content of the medicago green mass phase is 21-22% at the stem-extension stage, 18-19% in budding and 15-17% in flowering; the fiber content is 25.34 and 39% of dry matter, respectively.

These are only some grasses and shrubs growing in the pastures of the southern Russia, but this rich grass stand is observed only in spring and early summer. In the middle of summer, many herbs burn out and stop vegetation, pastures become impoverished under the scorching sun and dry wind, so the nutritional value varies in different seasons [11]. Let us consider the nutritional value of the Trans-Volga pastures in different periods of grazing (Fig. 2).

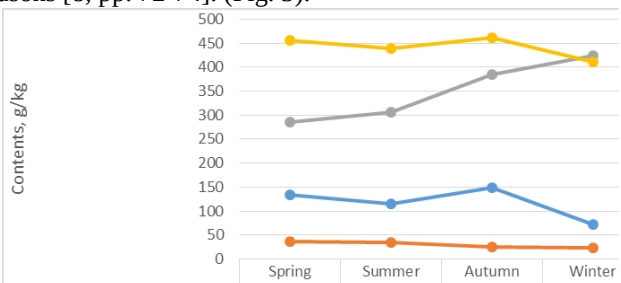


	The feed content in 1 kg of dry matter	Dry matter, %
Winter	0.47	78.7
Autumn	0.64	66.5
Summer	0.78	42.6
Spring	0.95	35.4

Figure 1: Nutritional value of the natural pastures of the Trans-Volga region in different seasons.

According to Fig. 2, there was an inversely proportional relationship between the fraction of dry matter content in the forage base of the pasture and feed units per 1 kilogram of dry matter. The highest dry matter content in the pasture grass in winter was 78.7%, while in spring in green fodder its share was reduced to 35.4%. The content of feed units in 1 kg of dry matter decreased in winter and vice versa was maximum in summer, which confirmed the assertion of a considerable depletion of natural pastures in winter and a decrease in their feed nutritional value by almost 2 times [5, p. 19].

The evaluated chemical composition of fodder crops growing on the pastures of the arid territories in the Trans-Volga Region reflected the change in their composition and the effect on the vital functions of the cattle fed with these crops. Let us consider the structure of feed in different seasons [8, pp. 72-74]. (Fig. 3).



	Spring	Summer	Autumn	Winter
Crude protein	133	116	148	72
Crude fat	37	34	26	24
Crude fiber	286	306	385	424
Nitrogen-free extractive substances	456	439	461	410

Figure 3: The chemical composition of the feed pasture of the Volga region in different seasons, g per 1 kg of dry feed.

The chemical composition of grass pastures was noted for a wide range of variations of protein content in feed from 72 g in spring to 133 g in winter. This was quite a difference showing that cattle received protein almost 2 times less on pastures, so the steers needed additional feeding with prepared feeds and various supplements in winter,

when the content of crude fiber was much lower in feeds. This indicated a high level of ballast substances that did not have nutritional value in the same amount of the feed consumed. The amount of fat and nitrogen-free extractive substances reduced in feeds; therefore, by winter cattle should have been well-fed and have gained a sufficient weight during the grazing period.

At the next stage of our study, we compared the biological value of the meat raw materials from the steers groups kept on pastures and in stall. To determine the biological value of meat, it was necessary to compare the composition of essential amino acids in samples of raw meat from cattle fed and raised according to different technologies. The assessment procedure was proposed by Academician N. N. Lipatov (Jr.) and included the following evaluation criteria:

- amino acid rate in terms of the ideal protein according to the FAO / WHO scale;
- coefficient of variation of the amino acid score, when the biological value of the protein was equal to the difference between 100 and this coefficient;
- utilitarian coefficient of the amino acid composition (U);
- coefficient of comparable redundancy of amino acids.

To make the study results clear, the data are presented graphically. Additional parameter for assessing the quality of meat can be the ratio between methionine and cystine levels in the diet or product. The greatest balance of the amino acids was at its high value. The comparative analysis of the biological values of domestic meat raw material and imported one is presented in Table.

Table 1. Comparison of the biological values of meat raw materials produced by various technologies.

Indicator*	**Beef (grass-fed)**	**Beef (stall)**	**Beef (Import)**
Biological value, %	85.83	59.62	74.67
U	0.867	0.691	0.788
AC, %	5.236	12.21	9.335
Methionine, %	2.42	1.64	1.85
Cystine, %	1.14	1.11	1.26

Note: calculated values

Comparison of domestic beef samples from cattle grown by grazing and stalling methods and assessing of their biological values proved that grazing (240 days a year) positively affected the quality of meat raw materials [12].

With respect to the biological value and balance of amino acids, domestic beef produced using pasture feeding technology took the first place, as its nutritional value was 85.83%; its methionine (2.42) and cystine (1.14) values were quite high; and the utilization coefficient of amino acids U was 0.873; and its coefficient of comparable redundancy of amino acids of 5.236 was minimal.

Imported beef with its biological value of 74.69% took the second place in terms of the quality composition. But in this case, we did not have evidence on how it had been produced.

Domestic beef produced by the stall method with the lowest indicators of biological value took the third place. Its biological value was only 59%, which was by 31.25% lower than the value of beef produced from grazed cattle and by 20.98% lower than in the meat imported. The amino acid composition of this meat sample contained methionine of 1.64, cystine of 1.11, U coefficient of 0.69 and of 12.211. These indicators testified to the low quality of beef produced by the stall method and in terms of its nutritional quality were lower than other varieties of domestic meat raw materials [11, p. 27].

Let us compare the domestic meat industry by the type of raw meat produced. (Fig. 5).

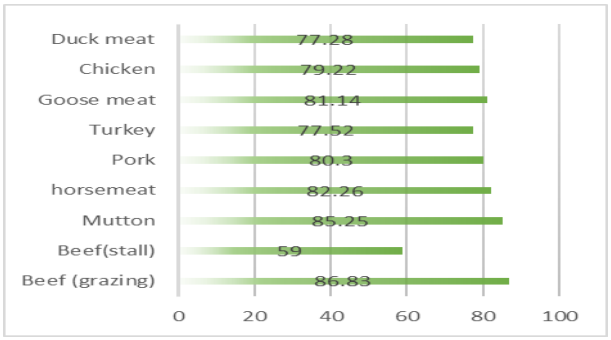


Figure 5: Comparison of the biological values of domestic meat raw materials, %.

The comparative analysis of the biological values of various types of meat raw materials showed that beef produced by the stall method was inferior not only to other varieties of red meat, but also to poultry [13]. Therefore, it is necessary to radically revise the technology of feeding and raising cattle, restore grazing and develop grazing in livestock farms producing beef.

A comprehensive solution to the problem lies in the qualitative restructuring of the entire technology of breeding and keeping cattle on farms. On the example of the economy of the Volgograd region, it was shown how the quality of the meat produced can differ considerably.

The assessment of the geobotanical composition of the grass stand of the natural pastures of the Volgograd Trans-Volga region showed a wide and diverse composition of forage crops that grow in sufficient quantities and are able to meet the needs of the herd in the spring-summer-autumn period; in the winter period the herd is provided by the feeds prepared in the farms. The grazing of cattle substantially reduces the cost of meat production, has a beneficial effect on the nutritional value of meat and can stimulate the development of the livestock industry.

In order to maintain grazing livestock, the state should stimulate this industry and finance the restoration of grazing land. So, for example, in the Volgograd region funding is allocated for the restoration of natural pastures undergone severe degradation in the steppe zone of southern Russia. These measures allow increasing the feed base of meat livestock and producing environmentally friendly high-quality meat products.

Only the joint efforts of the authorities, heads of agricultural enterprises and farmers allow for stable positive trends in the domestic beef cattle breeding industry.

IV. CONCLUSION

The scientific experiment showed that the quality of beef directly depends on the technology of growing beef cattle. The technology of stall keeping widely practiced today greatly reduces the biological value of beef, leads to an imbalance of amino acids and decreases the overall profitability of the beef cattle breeding. For this reason, there is fairly modest investment to beef cattle breeding, which is reflected in a decrease in the beef production and consumption by Russians. Partially, the needs of the domestic market are covered by imports of meat, but the deficit still persists. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

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