Effect of bull-calf management system on meat productivity

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Abstract. Traditional technologies for the production of beef in the conditions of industrial production of livestock products in the middle of the 20th century were schematically transferred from dairy cattle breeding and do not take into account the behavioral characteristics of animals. The traditional approach to the cultivation of young animals involves a stall-and-loose keeping system, mechanized distribution of feed and manure cleaning. Under such conditions the labor costs for the production of 1 kg of beef are within 15-30 man-hours, the total specific weight of feed, electricity, fuel and lubricants, depreciation costs of livestock buildings and technological equipment in the cost structure of this product reaches 50-55%. Beef production remains unprofitable regardless of animal breed – the cost of 1 kg of meat is 1.5-2 times higher than the sales price, which hinders further development of the industry. The paper shows the results of the assessment of meat productivity of bulls of various breeds when raised using traditional and low-cost technologies. Research results are relevant for beef production in steppe regions.

1. Introduction

In the production of beef, intensive and extensive livestock management systems are used, which are separated mainly depending on the level of animal feeding. Due to the physiological characteristics of cattle, due to the presence of a complex four-chamber stomach, it is able to eat coarse foods with high fiber content, therefore, in the diets of this livestock, regardless of the cultivation systems, hay, silage, green or pasture feed should be present. During intensification of breeding the diet is balanced by basic nutrients due to different protein and vitamin-mineral additives.

At the same time, in order to realize the genetic potential for development modern highly productive genotypes of meat livestock need an intensive breeding system, which ensures higher enrichment of the diet with energy and protein and levels stress factors. Therefore, the study on the efficiency of growing young animals on diets with an increased content of concentrates is particularly important. The studies of A.I. Korostelev [1] showed that with intensive fattening of black-and-white bull-calves and a high specific gravity of concentrated feed in the diet in the range of 62.5-64.0%, it was found that at the age of 16 months the animals reached the body weight of over 450 kg (one thousand English pounds), which is the EU standard for fattening young stock. It is also shown that the use of the so-called concentrate diets (over 55-57%) did not lead to the development of fodder stresses, i.e. undesirable transformation of internal organs (liver) was not observed. In other words,
these data suggest that given the free consumption of a large number of concentrated feeds by the fattening animals, they should not be expected to negatively affect the development of metabolic reactions in the liver, and accordingly, there will be no damage to animal health.

When studying the productive qualities of young animals and ways to reduce the cost of beef production V.P. Slavov et al. [2] showed that with a shortage of high-energy grain feed and the absence of waste from the processing industry (pulp, molasses, converter mash, brewing waste) it is possible to use cheap coarse and juicy feeds of their own production in winter and green pasture forage in summer. At the same time, about two-thirds of the increase in the body weight is obtained due to cheap pasture forage, the cost of concentrated feeds in the structure of the cost of growth does not exceed thirty percent, the average daily increases in the body weight for the entire growing period up to twenty months of age exceed 700 g, the costs of feeds for the growth of one kilogram of body weight are 8-15 feed units. To obtain cheap beef, the authors propose planning the calving of cows in February-March, at the end of the growing period young animals reach a body weight of 415 kg, and at the age of two years bull-calves have a body weight of 530 kg.

The studies in the opposite direction conducted by R. Khafizov and G. Minnekhanov [3] showed that a reduction of concentrated feed in the diet to 14-15% by nutritional value practically does not affect the growth energy of animals if they are additionally fed 75-80 kg of green feed or the corresponding amount of herbal flour.

Observing the behavior of calves at pasture management A.A. Shukanov [4] indicates that under the same conditions at pasture management the animals of dairy breeds with the “admixture of new blood” of bulls of specialized meat breeds show higher increases in the body weight. According to the author, this is caused by lower skin vulnerability, which is more characteristic of meat genotypes of livestock than for dairy. Such animals are much less vulnerable to stress from the bites of blood-sucking parasites, which are many in pastures near reservoirs. Characterizing the adaptive capabilities of adult livestock A.A. Maslov [5] notes that the industrial technology for the production of livestock products due to its inherent stress factors – group maintenance and feeding of animals, hypokinesia, increased bacterial and viral insemination of premises – weakens the immunity of animals, reduces their resistance, which in turn reduces the productive qualities of livestock. When studying the behavior of adult animals under different management systems, A. Tosev [6] concluded that in the conditions of industrial technologies cattle require increased attention to the environment, which should meet its biological capabilities and corresponding behavioral reactions in the system: animal – human – machine. As practice shows, individual technological solutions of industrial livestock complexes do not correspond to the biological characteristics of livestock. Through stresses, their reaction to behavior changes, resistance and productivity decrease. The animal’s braking reactions, including resting standing and lying, indicate that cattle spend an average of 10-12 hours daily for such reactions. The comfort of the rest conditions is very important, animals should be able to relax in a dry and clean place. Otherwise, cattle show discomfort, if there is no clean place, then the animal may not lie down at all. When resting in a polluted place, animals spend up to 500 kcal of energy on frequent getting up and down lying, which is 5-8% of the total daily energy costs. Besides, animals may suffer from pulmonary or other diseases, which significantly reduces the effectiveness of their breeding.

If the pasture is very polluted, then with a dirt thickness of up to 30 cm, the energy cost of changing the placement (movement) of legs of a 15-month-old bull-calf is calculated to be about 1472 kcal. If we add energy costs for frequent getting up and down lying at a polluted place for rest, then the total useless metabolic costs will be about 2 thousand kcal, which is 20-25% of the total energy costs. Moreover, if the depth of dirt on the pasture doubles, then the energy costs increase not by two, but by six times. This means that ensuring comfort in keeping livestock has, in addition to physiological, also economic importance, as shown in the studies of A.G. Timchenko et al. [7].

When organizing pasture management of animals, it is also important to ensure that they can rest, for example, on mounds of straw. The motor reactions of animals cover all possible movements, playful actions or struggles. For example, one of the genetically determined behaviors in cattle is to
maintain individual distance. The negligence of this in the planning the animal management technology leads to a state of “social stress” in livestock. In the wild, animals themselves determine the individual distance, while on farms with industrial technology, especially with loose housing, they find themselves in conditions of reduced individual distance, as a result of which there is excitement in the group, especially when feeding or drinking, which V.I. Velikzhanin drew attention to [8] in classical studies on animal ethology.

The purpose of our research was to study the morphological parameters of carcass in bull-calves of different breeds when growing them for meat according to low-cost and traditional technologies in agricultural farms of Dnipropetrovsk Region of Ukraine. Bull-calves-analogues by age and origin were kept according to traditional technology of growing for meat (control group) and according to innovative low-cost technology with free access to feed (experimental group) [9]. The study of animal ethological reactions was carried out according to the method of V.I. Velikzhanin [8], in the modification of M.V. Zubets [10], while all types of behavioral reactions were simplified to 3 main types: braking, motor and feeding. Meat productivity of bull-calves was determined by control slaughters using standard VNIIMP methodology [7].

2. Research results

The determination of the time spent on the main types of ethological reactions showed (Table 1) that when growing using low-cost technology, Ukrainian beef and Blond Aquitaine breeds spent 30-32 minutes more time on the braking actions of bull-calves than their peers of Gray Ukrainian breed (p<0.05).

At the same time, the bull-calves of group I spent 19 and 48 minutes less on motor actions than, respectively, the animals of groups II and III (p<0.05). The bull-calves of specialized meat breeds spent 59-80 minutes more time for feeding actions than the peers of Gray Ukrainian breed (p<0.05), which could be due to their genetic features. Since the bull-calves of the combined breed of the experimental group with free pasture management spent 29-48 minutes more time on motor reactions compared to peers of specialized breeds (Fig. 1).

Table 1. Time investments for basic elements of behavior in bull-calves of different breeds (X ± sx), min.

| Animal breed (group) | Ethological reactions | Braking reaction | Motor reaction | Feeding response |
|----------------------|-----------------------|------------------|----------------|-----------------|
|                      | Experimental groups   |                  |                |                 |
| Ukrainian beef (I)   | 762±4.12              | 73±1.89          | 605±4.03       |
| Blond Aquitaine (II) | 764±4.97              | 92±2.36          | 584±6.13       |
| Gray Ukrainian (III) | 794±3.01              | 121±2.27         | 525±5.12       |
|                      | Control groups        |                  |                |                 |
| Ukrainian beef (IV)  | 779±1.89              | 144±1.15         | 517±1.26       |
| +/- up to group I, % | + 2.2 **              | + 97.3**         | - 17.0**       |
| Blond Aquitaine (V)  | 790±1.44              | 180±2.72         | 470±2.17       |
| +/- up to group II, %| + 3.4**               | + 95.7**         | - 24.3**       |
| Gray Ukrainian (VI)  | 795±10.93             | 201±7.58         | 444±18.18      |
| +/- up to group III, %| + 0.1                 | + 66.1**         | - 18.2**       |

** – statistical reliability of differences at p<0.05

Compared to bull-calves of experimental groups I and II, the animals of their control analogues of groups IV and V spent 2.2-3.4% more time on braking actions (p<0.05). Between the peers of groups III and VI, the difference in this indicator was statistically remarkable.

Motor action costs for keeping animals according to traditional technology were 66.1-97.3% higher than for their respective breed analogues of experimental groups (p<0.05).
The time spent on feeding actions, on the contrary, in bull-calves of experimental groups of Ukrainian beef, Blond Aquitaine and Gray Ukrainian breeds was 17.0-24.3% more compared to their analogues of other groups (p<0.05).

Figure 1. Influence of bull-calf management technology on ethological reactions

The management of bull-calves of various breeds according to various technologies influenced their meat qualities, so according to the results of the control slaughter of animals, the weight advantage of the carcass of bull-calves of experimental groups was established on their control analogues by 17.26-34.67 kg (p<0.05) (Table 2). Moreover, the largest specific weight of carcass weight growth was observed in related genotypes of the Ukrainian beef breed and Gray Ukrainian breed, which is the mother breed in creating the Ukrainian beef breed, this indicator amounted to 13.45-15.8%. This means that in favorable conditions for feeding and keeping bull-calves of a combined Gray Ukrainian breed, even though they were inferior to specialized meat genotypes in terms of time spent on feeding reactions, they nevertheless effectively improved their meat qualities.

Table 2. Bone yield in the carcasses of experimental bull-calves (\(\bar{X} \pm S_x\)), %

| Indicator          | Breeds and groups of animals | Ukrainian beef breed | Blond Aquitaine | Gray Ukrainian breed |
|--------------------|------------------------------|----------------------|----------------|----------------------|
|                    | I                           | IV                   | II             | V                    | III               | VI                |
| Carcass weight, kg | 254.47±                      | 219.80±              | 226.63±        | 209.37±              | 186.67±          | 164.53±          |
| Bones in a carcass, kg | 8.35**                    | 2.07                 | 2.58**         | 4.98                 | 3.08**           | 2.72             |
| Bone yield, %      | 54.29±                      | 48.53±               | 49.05±         | 47.94±               | 46.65±           | 43.07±           |
|                    | 2.73                         | 2.08                 | 0.40           | 1.88                 | 0.51             | 0.55             |
|                    | 21.31±                       | 22.08±               | 21.65±         | 22.91±               | 24.99±           | 26.18±           |
|                    | 0.38                         | 0.86**               | 0.13           | 0.20**               | 0.17             | 0.10**           |

** – statistical reliability of differences at p<0.05

The analysis of the specific gravity of bones in carcasses shows that with a statistically remarkable difference in the number of bones in carcasses of bull-calves – breed analogues from different groups, there is a tendency to reduce the yield of bones in carcasses of young experimental groups by 3.61-5.82% (p<0.05), which indicates a high quality of beef obtained from young animals when grown using low-cost technology in conditions of free access to feed.
3. Discussion

Meat cattle breeding is a necessary branch of agricultural production, since its development, as indicated by Zubets M.M. [10], Timchenko A.G. [7], Erendzhenov I.B [11], allows growing significant volumes of beef of high quality and obtaining the necessary raw materials for leather processing with the lowest cost of capital and labor compared to dairy cattle breeding. Besides, raising livestock for meat allows organizing production with a shortage of labor in various conditions and natural and climatic regions. The main type of production in meat cattle breeding is a calf, which limits the stock recovery from the meat cow to its productive qualities over the year. The reduction of costs for the management of meat cows, as well as for the feeding system and the management of animals as a whole is the most important vector in the development of the industry.

The abundance of cheap pasture feeds significantly increases the efficiency of meat cattle breeding. In relation to the Stavropol Territory, these are the western and eastern regions of the region, as indicated by Trukhachev V.I., Zlydnev N.Z., Oleinik S.A. [12]. A characteristic feature of the management of meat cattle in the region is the minimization of all types of costs – this is the open housing in winter, the maximum use of natural and cultural pastures, which was made possible only due to the genetically determined natural endurance of meat animals. As a rule, during winter there is a slight decrease in the body weight and comfort of animals. However, the animal comfort is restored over the next one and a half to two months of fattening. Therefore, in order to feed livestock in winter, it is necessary to feed the most inexpensive feed – these are coarse feed, mainly, such as straw, hay and grain waste. To ensure rounded calving in the early spring period, it is possible in winter to manage only female droves with adult animals in order to get heavy young calves with a weight of about 200 kg. Displacement of the sucking period of calf breeding in the grazing season allows reducing the cost of labor and feed.

Among the breeds of meat cattle in the Stavropol Territory the most effective may be bred using innovative low-cost technology – this is Kalmyk and Kazakh white-headed, since these animals are most successfully bred in the arid regions – Apanasenkovsky, Arzgirsky and Ipatovsky, where 11 breeding farms are concentrated. The results of the estimate of the body weight beef production per 1 breeding cow per year for these breeds are 250-275 kg, which indicates an extensive breeding of animals in conditions of depleted pastures and arid conditions of Stavropol, where precipitation levels are within 300-400 mm per year.

Thus, in order to increase the efficiency of meat cattle breeding in the Stavropol Territory, it is necessary as a promising vector for the development of breeding and to develop directions for the consolidation of external-constitutional and productive parameters in animals in order to form a population of livestock consisting of individuals most adapted to the features of pasture management and with an improved conversion of feed to meat carcass.

4. Conclusion

Growing young meat breeds using low-cost technology contributed to an increase in time spent on feeding reactions by 17.0-24.3%, which led to an increase in carcass weight by 8.24-15.73% (p<0.05) and a decrease in bone specific gravity in the carcass by 3.61-5.82% (p<0.05).

The development of meat cattle breeding in the steppe zones of the Dnieper region and the Stavropol Territory is advisable in the direction of increasing the conversion of feed into edible parts of livestock carcasses.

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