Features of technological approaches to the calf bull housing of different eco-geographical populations

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Abstract. The study of skeletal peculiarities was carried out on Simmental and Limousin bull calves and their cross breeds. The control slaughter of 3 bull calves of different genotypes was carried out at 20 months of age: I – Simmental, II – Limousin, III – 1/2 Limousin x 1/2 Simmental, IV – 3/4 Limousin x 1/4 Simmental, V – 7/8 Limousin x 1/8 Simmental. The fresh axial bones were weighed on a counter balance with the accuracy up to 1 g. The purebred Simmental bull calves (I g) were superior to Limousin herdmates (II g) both in weight of the whole skeleton and in its separate parts. This weight advantage of the entire skeleton made 0.49 kg, including the total axial skeleton weight – by 0.19 kg; in the weight of the whole peripheral skeleton – by 0.3 kg.

1. Introduction
In a number of European countries, the high share of beef production is based on dairy cattle breeding, including in Sweden – 60 %, in Russia – 75 %, etc. [1]. As a rule, the dairy breed cows are inseminated with the seed of bulls of the same breeds, but the proportion of the sperm doses of meat cattle is steadily increasing. In Russia this value has tripled over the last 5–7 years, in Sweden it has quadrupled [2]. The reason for this is relatively high profitability of growing meat and crossbred cattle due to lower production costs, low yield of dairy carcasses with a significant proportion of bones [3–5].

The superiority of dairy × meat crossbreds compared to purebred dairy cattle was found in the previous studies, but mainly in the conditions of intensive cultivation [6–8]. This effect is said to be more pronounced for late-maturing breeds than for early-maturing breeds [9].

Meanwhile, in terms of the body weight, external constitution forms, which largely depend on the fatness degree, which is quite difficult to judge objectively [10]. It is obvious that a detailed study of the skeleton is necessary to more accurately characterize and targeted exposure of forming the type of the animal constitution. There is no doubt that the knowledge of the patterns of bone growth and development and skeleton as a whole has great practical and theoretical significance. It promotes the targeted effect on forming the type of the animal constitution, knowledge of the patterns of bone tissue growth termination and periods of the highest and lowest intensity of this process in certain parts of the skeleton [11].

2. Problem statement
According to the majority of scientists, manufacturers and selectors, the animal viability and strength is mainly defined by the strength of its skeleton. In their opinion, the significance of the bone skeleton in the animal’s body should be considered not only as an organ performing support and mechanical functions, but...
also as a blood-forming organ taking part in the homeostatic function of the organism, a chemical repository, etc. [12–14]. Therefore, researchers are interested in the skeleton not only as a component of the motor apparatus, but also as a labile part in the ontogenesis of an animal with a pronounced character of systematicity. Since the patterns of skeleton change, which are directly expressed in the external forms of an animal and reflect the detectable history’s imprints of their individual development (breed, sex, constitution, etc.), this determines its economic and useful significance.

The purpose of the study is to analyze the peculiarities of the development of the bone system of purebred and crossbred bull calves.

3. Materials and methods

3.1. Object of study

Bull calves of Simmental, Limousin breeds and their cross breeds of different generations. All animal services and experimental studies were carried out in accordance with instructions and recommendations of the Russian Regulations, 1987 (Order No. 755 of 12.08.1977 the USSR Ministry of Health) and The Guide for Care and Use of Laboratory Animals (National Academy Press Washington, D.C. 1996).

3.2. Scheme of the experiment

The study was carried out at Novo-Raevsky farm of Alsheevsky district of the Republic of Bashkortostan. In total, 5 groups of bull calves of Simmental, Limousin breeds and their cross breeds of the I, II, III generations (15 heads each) were formed. The animals were kept under industrial complex conditions.

In order to study the development of the musculoskeletal system at the age of 20 months, a control slaughter was carried out with regard to 3 bull calves of different genotypes: I – Simmental, II – Limousin, III – 1/2 Limousin x 1/2 Simmental, IV – 3/4 Limousin x 1/4 Simmental, V – 7/8 Limousin x 1/8 Simmental. The fresh axial bones were weighed on a counter balance with the accuracy up to 1 g and measured with a caliper and a tape.

The skeleton is divided into axial and peripheral parts. The axial part includes a spine and appendages (ribs and breast bone), peripheral – thoracic and pelvic limbs.

We studied only the part of the skeleton that was directly in the carcass after treatment in a boning hall. The limb bones were taken from the right, and the spine was combined from two half-carcasses.

3.3. Equipment and technical means

The weighing of some skeleton bones was performed using Acom JW-1-300 electronic scales. A Wilkens caliper and a measuring tape were used to determine the linear dimensions of bones.

3.4. Statistical processing

The basic material obtained in the studies was processed using Statistica 10.0 software package (Star Soft Inc., USA), the reliability was determined using the Student criterion.

4. Results and discussion

The evaluation of the obtained results strongly becomes objective through the consideration of heterosis as a phenomenon that improves the stamina of descendants. In animal husbandry it is common to consider heterosis as a difference in the phenotype between the average value of cross breeds and their purebred parents [15]. This is usually expressed in the superiority of F1 crossing over the average of two parents [16] to increase fertility [17], milk production [18], meat qualities [19].

Our study has fundamentally confirmed the role of heterosis in the formation of the skeleton and its individual segments. Thus, the crossbreeds of the first generation have the largest skeleton weight – 55.71 kg that statistically exceeded a similar indicator of the Simmental breed by 4.7 % ($P \leq 0.05$) and the Limousins breed by 5.7 % ($P \leq 0.05$). The second and third generation animals were naturally characterized by smaller skeleton weight (Table 1).
Table 1. Weight of separate parts and the entire skeleton of bull calves at the age of 20 months, (kg)

| Skeletal parts                  | Group     |
|---------------------------------|-----------|
|                                 | I         | II        | III        | IV         | V          |
| Spine                           | 14.10±0.49| 14.00±0.52| 14.89±0.48| 14.30±0.50 | 14.04±0.49 |
| Ribs and breast bone            | 13.04±0.29| 12.95±0.32| 13.78±0.27| 13.24±0.28 | 12.99±0.32 |
| Entire axial skeleton           | 27.14±1.26| 26.95±1.31| 28.67±1.21| 27.54±1.26 | 27.03±1.27 |
| Shoulder blade                  | 1.33±0.12 | 1.31±0.11 | 1.14±0.16 | 1.35±0.10  | 1.32±0.15  |
| Arm bone                        | 2.07±1.21 | 2.06±1.23 | 2.19±1.08 | 2.11±1.15  | 2.07±1.22  |
| Brachium bones                  | 1.86±0.17 | 1.85±0.15 | 1.97±0.11 | 1.89±0.16  | 1.86±0.15  |
| Entire thoracic limb            | 5.26±0.26 | 5.22±0.28 | 5.30±0.25 | 5.35±0.23  | 5.25±0.27  |
| Hip bone                        | 2.11±0.18 | 2.04±0.19 | 2.23±0.10 | 2.08±0.16  | 2.05±0.19  |
| Thighbone and kneecap           | 2.72±0.16 | 2.70±0.18 | 2.87±0.14 | 2.76±0.17  | 2.71±0.17  |
| Lower-leg bones and heel hock joint | 2.95±0.19 | 2.93±0.20 | 3.12±0.14 | 3.00±0.16  | 2.94±0.18  |
| Entire pelvic limb              | 7.78±0.14 | 7.67±0.19 | 8.22±0.12 | 7.84±0.13  | 7.70±0.18  |
| Entire periperal skeleton       | 26.08±0.61| 25.78±0.63| 27.04±0.55| 26.38±0.61 | 25.90±0.60 |
| Entire carcass skeleton         | 53.22±0.70| 52.73±0.69| 55.71±0.65| 53.92±0.68 | 52.93±0.70 |

The purebred Simmental bull calves (I group) differed by smaller indicators than the herdmates of the Limousins (II group) in the preslaughter weight, carcass weight, they surpassed them both in the weight of the entire skeleton and its separate parts. Suffice it to note that this weight advantage of the entire skeleton was 0.49 kg (0.9 %), including the entire axial skeleton – by 0.19 kg (0.7 %), weight of ribs and a breast bone – by 0.09 kg (3.3 %); weight of the entire peripheral skeleton – by 0.3 kg (1.2 %), of which the entire thoracic limb – by 0.04 kg (0.8 %), shoulder blades – by 0.010 kg, arm bone – by 0.01 kg, brachium bones – by 0.02 kg, of which the entire pelvic limb – by 0.11 kg (1.4 %), hip bone – by 0.07 kg, thighbone and kneecap – by 0.02 kg, lower-leg bones and heel hock joint – by 0.02 kg.

It is obvious that in the animals of studied genotypes the different nature of bone and carcass development is caused by the specificity of their productivity formed during breeding and fully corresponding the production needs.

It should be noted that among the crossbred animals the half-breed bull calves (III group) had the highest weight of both separate parts and the entire carcass skeleton. Moreover, they had higher indicators in terms of the level of skeleton development not only compared to crossbred animals with the greater pedigree proportion of the Limousin breed, but also to purebred herdmates, which in turn indicates a relatively high heterosis effect at crossbreeding. Thus, the advantage of bull calves of the III group over the herdmates of the I and II groups was, respectively, in weight of the entire skeleton by 2.49 kg (4.7 %), including the entire axial skeleton – by 1.53 kg (5.6 %) and 1.72 kg (6.4 %), of which the spine – by 0.79 and 0.89 kg; ribs and a breast bone – by 0.74 and 0.83 kg; the entire peripheral skeleton – by 0.96 kg (3.7 %) and 1.26 kg (4.9 %), of which the entire thoracic limb – by 0.04 and 0.08 kg. At the same time in the structure of this group of bones the bull calves of the III group on the contrary lagged behind their herdmates of the I and II groups in the weight of a shoulder blade – by 0.19 (16.7 %) and 0.17 kg (14.9 %) respectively. However, they retained advantage in the weight of an arm bone – by 0.12 and 0.13 kg, brachium bones – by 0.11 and 0.12 kg. With regard to the level of development of pelvic limb bones of the peripheral skeleton, the main pattern in favor of the I generation crossbred bull calves remained the same and their advantage over the I and II groups of purebred herdmates made 0.44 kg (5.6 %) and 0.55 kg (7.2 %); of them hip bone – 0.12 and 0.19 kg, thighbone and kneecap – 0.15 and 0.17 kg, lower-leg bones and heel hock joint – 0.17 and 0.19 kg.

Comparing the level of development of the carcass skeleton among the I, II and III generations by the weight of separate parts and the entire skeleton, it should be noted that half-breed crossbred animals also differed from their herdmates with a greater proportion of Limousin pedigree relative to the higher level of the studied indicators. Thus, their advantage over the herdmates of the IV and...
V groups was by the weight of the entire skeleton: 1.79 kg (3.3 %) and 2.78 kg (5.2 %), including the weight of the axial skeleton – 1.13–1.64 kg; of them the weight of spine – 0.59–0.85 kg; ribs and a breast bone – 0.54–0.79 kg; peripheral skeleton – 0.66 kg (2.5 %) and 1.14 kg (4.4 %). At the same time the differences in the weight of bones of the entire thoracic limb were minimal. Besides, the bull calves of the IV group had the largest indicator. Their advantage over the herdmates of the III and V groups was 0.05 and 0.01 kg. A similar pattern was observed in the weight of the blade, when the bull calves of the III and V groups lagged behind the herdmates of the IV group by 0.21 and 0.03 kg. Nevertheless, the bull calves of the III group outnumbered their herdmates of the IV and V groups in weight mass: arm bone – by 0.08 and 0.12 kg; brachium bones – by 0.08 and 0.11 kg. In terms of the weight of the pelvic limb bones, both separately and entirely for this group the advantage was on the side of the half-breed animals. They outperformed their herdmates of the IV and V groups in the weight of the entire limb by 0.38 kg (4.8 %) and 0.52 kg (6.8 %), including the hip bone – by 0.15 and 0.18 kg; thighbone and kneecap – by 0.11 – 0.16; lower-leg bones and heel hock joint – by 0.12 and 0.18 kg.

5. Conclusion

The results of the analysis of the level of skeleton carcass development of the bull calves of different genotypes in terms of the weight of separate parts and the entire skeleton indicate that by the age of 20 months the bone system of animals acquire a complete form, while preserving the peculiarities of each genotype, which should necessarily be taken into account in the development of scientifically sound systems of young cattle breeding.

The obtained data confirm the earlier conclusions – in the conditions of intensive rearing and feeding the I generation crossbred animals exceeds their parental forms in the linear growth of the skeleton. Besides, the purebred Limousin bull calves were characterized by more moderate rate of skeleton development than the purebred Simmental and crossbred animals of the II and III generations, which should be taken into account when making decisions to use animals of the studied genotypes in industrial conditions.

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