J Biochem Tech (2020) 11 (4): 46-51
ISSN: 0974-2328

Particularities of Individual Muscles and Groups of Muscles Development over the Anatomical Areas of the Carcasses of the Bestuzhev Cattle and Their Crosses with Simmentals

Tursumbai Satymbaevich Kubatbekov, Vladimir Ivanovich Kosilov, Ivan Petrovich Prokhorov, Vladimir Alexandrovich Demin, Svetlana Vasilievna Savchuk, Salbak Olegovna Chylbak-ool, Fatkhullo Mirzosharipovich Radjabov

Received: 17 July 2020 / Received in revised form: 19 October 2020, Accepted: 24 October 2020, Published online: 24 November 2020

Abstract

The article presents the results of assessing the peculiarities of muscle development in purebred Bestuzhev bull-calves (group I), crossbred bull-calves (1/2 Simmental x 1/2 Bestuzhev – group II), purebred Bestuzhev steers (group III), and crossbred steers (1/2 Simmental x 1/2 Bestuzhev – IV group). It was found that due to the manifestations of the effect of crossing, the crossbred young bulls were superior to the purebred ones in terms of the development of the muscles in the spinal column, limb-girdle, and thoracic and pelvic limbs. With that, the degonalization of the calves reduced the growth rate in both the purebred and the crossbred calves. Therefore, the steers were inferior to the bull-calves in terms of the development of both individual muscles and their groups in all anatomical areas of the body. The results of the study showed that the differences between the groups in the development of the muscles are due to the uneven growth rate of the standard muscle groups under the influence of the genotype and the gender.

Keywords: cattle breeding, Bestuzhev breed, Simmental breed, bull-calves, steers, crossbreeds, muscle development, groups of muscles.

Tursumbai Satymbaevich Kubatbekov
Department of Morphology and Veterinary Sciences, Faculty of Animal Science and Biology, Russian State Agrarian University - Moscow Timiryazev Agricultural Academy, Moscow, Russia.

Vladimir Ivanovich Kosilov
Department of Production Technology and Processing of animal origin produce, Faculty of Biotechnology and Environmental Management, Orenburg State Agrarian University, Orenburg, Russia.

Ivan Petrovich Prokhorov
Department of Beef and Dairy Cattle Breeding, Faculty of Animal Science and Biology, Russian State Agrarian University - Moscow Timiryazev Agricultural Academy, Moscow, Russia.

Vladimir Alexandrovich Demin
Department of Horse Breeding, Faculty of Animal Science and Biology, Russian State Agrarian University - Moscow Timiryazev Agricultural Academy, Moscow, Russia.

Svetlana Vasilievna Savchuk
Ethology and Biotechnology, Faculty of Animal Science and Biology, Department of Animal Physiology, Russian State Agrarian University - Moscow Timiryazev Agricultural Academy, Moscow, Russia.

Salbak Olegovna Chylbak-ool
Institute of Amelioration, water management and construction named after A.N. Kostyakov, Russian State Agrarian University - Moscow Timiryazev Agricultural Academy, Moscow, Russia.

Fatkhullo Mirzosharipovich Radjabov
Department of Private Animal Husbandry, Faculty of Zooengineering, Tajik Agrarian University named after S. Shotemur, Dushanbe, Tajikistan.

Introduction

The main area in the development of the agroindustrial complex of the Russian Federation is providing high-quality food products, especially beef meat, for the population of the country (Kosilov et al., 2010; Nikonova et al., 2014; Kosilov and Mironenko, 2010; Kosilov et al., 2006; Kharlamov et al., 2015; Kosilov and Mironenko, 2005; Kubatbekov and Oganov, 2016; Anisimova et al., 2019). In this regard, it is necessary to develop and implement a set of measures for the rational use of the genetic resources of the cattle (Houhamdi, 2018). Therefore, the use of various kinds of crossbreeds is very promising.

The meat quality of the animals is mainly determined by the development of the muscle tissues (Rassolov et al., 2019), the weight of which in fattened animals exceeds 65% of the weight of the body. In this regard, studying the peculiarities of the growth and development of individual muscles in the anatomical parts of the animals of various genotype, gender, and physiological state is of great scientific and practical importance (Kubatbekov et al., 2016; Zadnepryansky et al., 2012; Kosilov et al., 2012; Bozymov et al., 2016; Kayumov et al., 2019; Mironova et al., 2018; Fatkullin et al., 2018; Sedykh et al., 2018; Tyulebaev et al., 2019).

It is known that individual muscles and groups of muscles perform different functions in the organism, have different structure and nutritional value, and are characterized by the different growth rate in various periods of the ontogenesis (Shalaby, 2018). In this regard, knowledge of these features will allow objectively

assessing the meat productivity of young animals of various genotype, gender, and physiological state.

Materials and Methods

To study the peculiarities of the development of groups of muscles and individual muscles in the anatomical parts, three animals from each group were check-slaughtered after intensive growth at the age of 19 months, following the methods of the Lenin All-Union Academy of Agricultural Sciences (VASKhNIL), the Federal Science Center for Animal Husbandry named after Academy Member L.K. Ernst (VIZh), the All-Russian Meat Research Institute (VNIIMP) (1977), and the All-Russian Scientific Research Institute for Metrological Service (VNIIMS) (1984):

Group I — the Bestuzhev breed (bull-calves), group II — crossbreeds (½ Simmental x ½ Bestuzhev – bull-calves), group III — the Bestuzhev breed (steers), and group IV – crossbreeds (½ Simmental x ½ Bestuzhev steers).

At the same time, the morphometric indicators of individual muscles and morphologically related muscle groups in various topographic areas of the body of the purebred and crossbred bull-calves and steers were determined. Left half carcasses were prepared. With that, 32 largest muscles were isolated and weighed, the doubled mass of which was about 80% of all muscle tissues of the carcass.

Results

The analysis of the development of individual muscles in the spinal column at the age of 19 months according to the results of the comparative assessment showed that the most developed were the crossbreed bull-calves in group II (Table 1). The weight of the muscles in this group was greater by 134 g (0.8 %), 1,135 g (7.7 %), and 1,017 g (6.8 %) than in groups I, III, and IV, respectively. A similar pattern was observed in the absolute mass of individual muscles in the spinal column with the corresponding parameters of difference. In terms of the absolute weight, the differences were the following: rib eye — 21 g (0.3 %), 368 g (6.4 %), and 350 g (6.1 %); the semispinalis capitis muscle — 25 g (1.3 %), 173 g (9.7 %), and 148 g (8.2 %); the spinal and semispinal muscles of the back and the neck — 19 g (1.0 %), 211 g (12.8 %), and 222 g (13 %); the longissimus muscle of the head and the neck – 17 g (1.3 %), 52 g (4.0 %), and 45 g (3.5 %); the splenius — 21 g (1.8 %), 65 g (5.7 %), and 49 g (4.2 %); the psoas minor muscle – 24 g (5.3 %), 53 g (12.5 %), and 50 g (11.8 %); the psoas major muscle — 14 g (1.1 %), 110 g (9.3 %), and 77 g (6.3 %); and the multifidus muscle — 31 g (1.8 %), 103 g (6.4 %), and 76 g (4.0 %).

Table 1. The development of individual muscles in the spinal column of the young animals at the age of 19 months, g (X ± Sx)

The names of individual muscles	Group			
	I	II	III	IV
Rib eye	6,089 ± 64.4	6,110 ± 66.2	5,742 ± 62.5	5,760 ± 88.9
Semispinalis capitis muscle	1,930 ± 22.1	1,955 ± 23.4	1,782 ± 30.2	1,807 ± 28.4
Spinal and semispinal muscles of the back and the neck	1,876 ± 26.4	1,857 ± 26.8	1,646 ± 31.1	1,635 ± 29.0
Longissimus muscle of head and neck	1,323 ± 42.1	1,340 ± 46.0	1,288 ± 43.4	1,295 ± 45.8
Splenius	1,188 ± 40.3	1,209 ± 41.8	1,144 ± 39.5	1,160 ± 38.7
Psoas minor muscle	451 ± 21.6	475 ± 18.7	422 ± 28.0	425 ± 24.5
Psoas major muscle	1,276 ± 37.0	1,290 ± 34.8	1,180 ± 36.9	1,213 ± 32.9
Multifidus muscle	1,683 ± 28.9	1,714 ± 36.4	1,611 ± 39.0	1,638 ± 35.5
Group total	15,816 ± 99.8	15,950±102.3	14,815±131.4	14,933± 128.7

In the comparative perspective, the general analysis by the absolute weight of the muscles in the spinal column shows that the major share is taken by the rib eye and the spinal and semispinal muscles of the head, the back, and the neck.

By the absolute weight, the next in this group of muscles is the multifidus muscle. The longissimus muscle of the head and neck was inferior to it. In this group, the psoas major muscle and the splenius had relatively lower weight. The smallest weight was noted in the psoas minor muscle, as evidenced by the very name of this muscle.

It is characteristic that, due to the manifestations of the crossing effect, the crossbred young animals in all cases exceeded the purebred peers in the absolute weight of both individual muscles of the spinal column and the total weight of the entire muscle group in this part of the body.

Moreover, the degonalization had a negative effect on the growth and development of the spinal muscles. As a result of this, both purebred and crossbred steers were inferior to the bull-calves in terms of the weight of the muscles in this part of the body. It is sufficient to note that the purebred Bestuzhev bull-calves in group I exceeded the purebred steers in group III by the total weight of the muscles in the spinal column by 1,001 g (6.7 %, $P < 0.01$). In the group of young crossbreeds, the superiority of the crossbred bull-calves in group II over the crossbred steers in group IV by the studied parameter was 1,017 g (6.8 %, $P < 0.001$).

The comparative analysis of the development of the muscles in the limb-girdle depending on the gender, the physiological state, and the genotype showed a pattern that was slightly different from the previously identified pattern: the superiority of crossbred steers (group IV), both in the final weight and in some individual muscles over their peers in the other groups (Table 2).

Table 2: The development of individual muscles in the limb-girdle of the young animals at the age of 19 months, g (X ± Sx)

The names of individual muscles	Group			
	I	II	III	IV
Musculus pectoralis profundus	3,925 ± 79.6	3,940 ± 74.3	3,815 ± 78.8	3,841 ± 77.9
Musculus pectoralis superficialis	1,410 ± 23.4	1,425 ± 26.2	1,418 ± 25.9	1,437 ± 30.1
Musculus serratus ventralis	5,385 ± 88.7	5,420 ± 94.5	5,433 ± 98.4	5,478 ± 90.9
Broadest muscle of the back	2,076 ± 41.3	2,108 ± 54.2	2,116 ± 48.3	2,139 ± 58.5
Rhomboid muscle	628 ± 21.8	641 ± 26.4	656 ± 23.5	673 ± 25.8
Trapezoid muscle	1,480 ± 28.7	1,515 ± 31.2	1,532 ± 34.9	1,544 ± 38.1
Brachycephalic muscle	1,673 ± 33.4	1,708 ± 30.5	1,717 ± 32.5	1,736 ± 36.9
Total for the group of muscles	16,577±108.8	16,757±105.7	16,687±112.3	16,848±107.4

For instance, their superiority by the final weight of the muscles in this part of the body over their peers in groups I, II, and III was 271 g (1.6 %), 91 g (0.5 %), and 161 g (1.0 %), respectively. With that, in terms of the absolute weight, this superiority for musculus pectoralis superficialis was 27 g (1.9 %), 12 g, and 19 g (1.3 %); for musculus serratus ventralis — 93 g (1.7 %), 58 g (1.1 %), and 45 g (0.8 %); for the broadest muscle of back — 63 g (3.0 %), 31 g (1.5 %), and 23 g (1.1 %); for the rhomboid muscle — 45 g (7.2 %), 32 g (5.0 %), and 17 g (2.6 %); for the trapezoid muscle — 64 g (4.3 %), 29 g (1.9 %), and 12 g (0.4 %); and for the brachycephalic muscle — 63 g (3.8 %), 28 g (1.6 %), and 19 g (1.1 %). At the same time, the crossbred bull-calves (group II) by the absolute weight of musculus pectoralis profundus were superior to their peers in groups I, II, and IV by 15 g (0.4 %), 125 g (3.3 %), and 99 g (2.6 %), respectively.

The structural analysis of the development of individual muscles in the limb-girdle, in general, showed that the greatest share belonged to musculus serratus ventralis. The second-largest absolute weight was noted in musculus pectoralis profundus. The next by the weight and functionality was the broadest muscle of the back. A somewhat lower weight was noted in the brachycephalic muscle. Relatively lower weights and relatively greater differences were noted between the trapezoid muscle and musculus pectoralis superficialis. The least absolute weight in this group was noted in the rhomboid muscle.

It is known that in the total weight of the muscles of the semi-carcass, the muscles of the thoracic limb take the smallest share, despite their functional importance in the life cycle of the animal organism, compared to the muscles of the vertebral column, which mainly perform the support function and are less prone to physical stress. Therefore, the muscles in this group are characterized by a high content of collagen and elastin, and poor nutritional properties.

The analysis of the obtained data showed that the greatest share in the total weight of the considered muscles was in the muscle groups in the area of the shoulder bone (51.4 – 53.2 %) (Table 3). With that, musculus infraspinatus had the greatest weight in the group (24.4 – 25.5%). The chuck tender muscle had a relatively lower weight (12.8 %). The subscapular muscle was intermediate by the weight (13.8 – 14.4 %).

Table 3. The development of individual muscles in the thoracic limbs of the young animals at the age of 19 months, g (X ± Sx)

The names of individual muscles	Group			
	I	II	III	IV
Chuck tender	1,310 ± 66.4	1,283 ± 70.2	1,385 ± 69.9	1,433 ± 71.0
Musculus infraspinatus	2,436 ± 102.3	2,495 ± 110.4	2,648 ± 99.8	2,752 ± 95.7
Subscapular muscle	1,414 ± 42.2	1,387 ± 40.8	1,476 ± 39.5	1,559 ± 43.0
Total for the scapular area	5,160 ± 150.4	5,165 ± 161.0	5,509 ± 148.5	5,744 ± 150.3
Triceps	3,522 ± 118.8	3,545 ± 174.5	3,774 ± 108.2	3,697 ± 117.8
Biceps	1,310 ± 48.4	1,328 ± 50.1	1,416 ± 49.8	1,357 ± 38.9
Total for the shoulder area	4,832 ± 144.1	4,873 ± 130.2	5,190 ± 140.8	5,054 ± 136.5
Total for the thoracic limb	9,992 ± 385.8	10,038 ± 394.3	10,699 ± 380.8	10,798 ± 390.5

The muscles in the shoulder area consisted mainly of two muscles, among which the largest was the triceps (34.2 – 35.3 %). The weight of the biceps was only a quarter of the total weight of this group. This pattern was manifested in the young animals of all studied genotypes without exception.

However, the comparative analysis of the development of certain muscles and in the whole of the thoracic limb in the context of the groups showed that the greatest weight was noted in the crossbred steers (group IV). For instance, their superiority in terms of the weight of the chest limb over their peers in groups I, II, and III was 876 g (8.8 %), 760 g (7.6 %), and 99 g (0.9 %), respectively. With that, in the group of muscles in the scapular area, they exceeded their peers in groups I, II, and III by 584 g (11.3 %), 579 g (11.0 %), and 235 g (4.3 %), respectively. In terms of the weight, for musculus infraspinatus, this superiority was 316 g (13.0 %), 257 g (10.3 %), and 104 g (3.9 %); for the chuck tender muscle — 123 g (9.4 %), 150 g (11.7 %), and 48 g (3.5 %); and for the subscapular muscle — 145 g (10.3 %), 172 g (12.4 %), and 83 g (5.6 %).

The greatest weight of the muscles in the group of the shoulder area was noted in the purebred steers (group III). Their peers in groups I, II, and IV were inferior in the total weight of this group of muscles by 358 g (7.4 %), 317 g (6.5 %), and 136 g (2.7 %), respectively. In terms of the absolute weight, the superiority of the triceps was 252 g (7.2 %), 229 g (6.5 %), and 77 g (2.1 %), respectively; the superiority of the biceps was 106 g (8.1 %), 88 g (6.6 %), and 59 g (4.3 %).

Undoubtedly, the steers developed a little longer than the bull-calves due to the absence of the gonadal hormone required for complete formation of the muscle tissues, especially the muscles of functional importance, which were triceps and biceps.

Studying the characteristic features of the muscles development in the pelvic limb was of great theoretical and practical importance because the most valuable cuts of high-quality junctures, such as butt, beef ham, and rump, the share of which was 30 % of the weight of the entire semi-carcass, were located in this area.

The pelvic limb included three main muscle groups: the pelvic girdle, the thigh, and the lower leg area. The main muscles in these groups amounted to about 95 % of the weight of the entire limb.

The results of assessing the development of the pelvic limb muscles separately by areas and in whole in this anatomical part of the carcass showed that the highest morphometric values were noted in the crossbred animals in groups II and IV (Table 4). With that, the highest total weight of the muscles of the pelvic limb was noted in the crossbred bull-calves in group II. Their superiority in terms of the weight of the studied indicator over their peers in groups I, II, and III was 311 g (0.9 %), 259 g (0.6 %), and 141 g (0.4 %), respectively. At the same time, by the final weight of the muscles of the pelvic girdle, the crossbred young cattle in group IV were superior over their peers in groups I, II, and III by 645 g (9.3 %), 586 g (8.4 %), and 101 g (1.6 %), respectively.

Table 4. The development of individual muscles in the pelvic limbs of the young animals at the age of 19 months, g (X ± Sx)

The names of individual muscles	Group			
	I	II	III	IV
Musculus glutaeus profundus	585 ± 38.1	570 ± 33.8	621 ± 39.2	633 ± 39.8
Lumboiliac muscle	776 ± 19.4	780 ± 18.5	867 ± 21.3	881 ± 20.2
Adductor muscle	2,331 ± 94.5	2,366 ± 90.2	2,493 ± 98.0	2,528 ± 92.5
Ventral gluteal muscle	3,221 ± 100.1	3,256 ± 103.4	3,476 ± 110.0	3,516 ± 111.8
Total for the pelvic girdle area	6,913 ± 204.4	6,972 ± 211.2	7,457 ± 215.3	7,558 ± 208.5
Musculus pectineus	543 ± 18.5	557 ± 22.4	528 ± 20.5	583 ± 20.9
Musculus quadriceps femoris	5,310 ± 108.8	5,340 ± 124.3	5,183 ± 150.1	5,122 ± 143.0
Musculus biceps femoris	6,261 ± 155.3	6,294 ± 150.8	6,178 ± 161.2	6,276 ± 158.1
Semimembranosus	6,487 ± 143.3	6,516 ± 138.5	6,433 ± 150.5	6,460 ± 161.0
Eye rib	2,790 ± 61.1	2,833 ± 62.8	2,658 ± 58.3	2,674 ± 60.6
Musculus gracilis	1,220 ± 30.2	1,237 ± 31.2	1,174 ± 33.4	1,152 ± 33.0
Tensor fasciae latae	1,287 ± 20.5	1,295 ± 21.3	1,251 ± 24.0	1,263 ± 23.6
Tailor's muscle	351 ± 13.8	365 ± 12.5	343 ± 15.1	351 ± 15.8
Musculus quadratus femoris	484 ± 28.2	506 ± 31.0	496 ± 30.5	484 ± 32.2
Total for the hip area,	24,733 ± 203.4	24,943 ± 211.8	24,244 ± 233.5	24,315 ± 240.4
including the gaskin area — the gastrocnemius muscle	2,187 ± 58.8	2,229 ± 60.3	2,184 ± 59.3	2,130 ± 61.8
Total for the pelvic limb	33,833 ± 680.8	34,144 ± 703.1	33,885 ± 691.5	34,003 ± 702.2

In terms of the weight of musculus glutaeus profundus, this superiority was 48 g (8.2 %), 63 g (11.0 %), and 12 g (1.9 %), respectively; that of the lumboiliac muscle — 105 g (13.5 %), 101 g (12.9 %), and 14 g (1.6 %), respectively; that of the adductor muscle — 197 g (8.5 %), 162 g (6.8 %), and 30 g (1.4 %), respectively; and that of the ventral gluteal muscle — 295 g (9.2 %), 260 g (8.0 %), and 40 g (1.3 %), respectively.

The greatest absolute weight of the group of muscles in the hip and the gaskin area was noted in the crossbred bull-calves in group II. The young animals in groups I, III, and IV were inferior to them in terms of the total muscle weight in the hip area by 210 g (0.8 %), 699 g (2.9 %), and 628 g (2.6 %), respectively. In terms of the weight of musculus pectineus — by 14 g (2.6 %), 29 g (5.5 %), and 24 g (4.5 %); of musculus quadriceps femoris – by 30 g (0.6 %), 157 g (3.0 %), and 218 g (4.0 %); of musculus biceps femoris — by 33 g (0.5 %), 116 g (1.9 %), and 18 g (0.3 %); of semimembranosus — by 2.9 g (0.5 %), 83 g (1.3 %), and 56 g (0.9 %); of eye round — by 43 g (1.5 %), 175 g (6.6 %), and 159 g (5.9 %); of musculus gracilis — by 17 g (1.4 %), 63 g (5.4 %), and 85 g (7.4 %); of tensor fasciae latae — by 8 g (0.6 %), 44 g (3.5 %), and 32 g (2.5 %); of the tailor's muscle — by 14 g (4.0 %), 22 g (6.4 %), and 14 g (4.0 %); of musculus quadratus femoris — by 22 g (4.5 %), 10 g (2.0 %), and 2 g (4.5 %); and of the gastrocnemius muscle of the hip — by 42 g (1.9 %), 45 g (2.1 %), and 99 g (4.6 %), respectively.

The largest muscles in the pelvic area were the ventral gluteal muscle and the adductor muscle the share of which was ¾ of the weight of the studied group of muscles. The lumboiliac muscle and musculus glutaeus profundus had relatively low weight.

The largest muscles of the hip area were biceps, quadriceps, semimembranosus, and the eye round. The largest size was noted in tensor fasciae latae and musculus gracilis. The smallest weight was noted in musculus pectineus, musculus quadratus femoris, and the tailor's muscle.

The differences found in the development of the muscles of the pelvic limb were determined by the unequal growth rate of the standard groups of muscles in the calves of different genotypes, gender, and physiological state. Apparently, with the beginning of the postnatal period of ontogenesis, the groups of muscles, like individual muscles, repeatedly pass the periods of varying growth rates, deviating in either direction under the influence of numerous factors that affect individual development. Responding to the changes, each organism tends to the most optimal actions, which subsequently have a direct effect on the formation of the tissues.

Conclusion

Thus, the standard muscle groups have various growth rates in the stages of animals' development, differing in the genotypic and gender traits.

References

Anisimova, T. Y., Naliukhin, A. N., Hamitowa, S. M., Avdeev, Y. M., & Belozerov, D. A. (2019). Responses of Soil Properties and Crop Productivity to Peat-Fertilizers in Russia. *International Journal of Pharmaceutical Research & Allied Sciences*, *8*(2), 180-189.

Bozymov, K.K., Nasambaev, E.G., & Kosilov, V.I. (2016). The technology of livestock breeding production. Uralsk: The West-Kazakhstan Agrarian and Technical University.

Fatkullin, R.R., Ermolova, E.M., Kosilov, V.I., Matrosova, Yu.V., & Chulichkova, S.A. (2018). Biochemical Status of Animal Organism Under Conditions of Technogenic Agroecosystem. *Advances in Engineering Research*, 151, 182 – 186.

Houhamdi, M. (2018). Diet Behavior of the Cattle Egret (Ardea Ibis) in the Tebessa Region (Eastern Algeria) Asma Selmane1, 2, Ali Chagra3, Nadjette Khelili1, 2, Linda Bouguessa4, Menouar Saheb1. *World Journal of Environmental Biosciences, 7*(3), 51-54.

Kayumov, F.G., Kosilov, V.I., Gerasimov, N.P., & Bykova, O.A. (2019). The effect of snp polymorphisms in growth hormone gene on weight and linear growth in cros-sbred red angus × kalmyk heifers. Digital agriculture – development strategy, in: Proceedings of the International Scientific and Practical Conference (ISPC 2019), *Advances in Intelligent Systems Research*, pp. 325 – 328.

Kharlamov, A.V., Nikonova, E.A., & Krylov, V.N. (2015). Vliyanie genotipa na vesovoi rost bychkov cherno-pestroi i simmentalskoi porod i ikh dvukh-trekhporodnykh pomesei [The effect of the genotype on the weight gain by black-motley and Simmental bull-calves and their two- and three-breed crosses]. *News of the Orenburg State Agrarian University, 1*(51), 96–99.

Kosilov, V.I., & Mironenko, S.I. (2005). Efficiency of two- and three-breed cattle crossing. *Dairy and beef cattle breeding*, 1, 11-12.

Kosilov, V.I., & Mironenko, S.I. (2010). Formation and implementation of the reproductive function of red steppe ewes and their crossbreeds. *Bulletin of the Russian Academy of Agricultural Sciences*, 3, 64 – 66.

Kosilov, V.I., Mironenko, S.I., & Nikonova, E.A. (2010). Intensification of beef production with the use of the genetic resources of red steppe cattle. *Vestnik Myasnogo Skotovodstva, 4*(63), 76-87.

Kosilov, V.I., Mironenko, S.I., & Nikonova, E.A. (2012). The weight gain by Simmental bull-calves and their two- and three-breed crosses with Holstein, German spotted and Limousine stud-bulls. *Bulletin of Meat Cattle Breeding, 2*(76), 44-49.

Kosilov, V.I., Zaikin, G.L., & Mufazalov, E.F. (2006). Meat quality of black-motley and Simmental cattle of various genotypes. Orenburg: Orenburg State Agrarian University.

Kubatbekov, T.S., & Oganov, E.O. (2016). Anatomy of productive animals. Workshop for specialists in veterinary-sanitary expertise. Moscow: Akvarium.

Kubatbekov, T.S., Kosilov, V.I., Mamaev, S.S., Yuldashbaev, J.A., & Nikonova, E.A. (2016). Growth, development and productive qualities of sheep. Moscow: Altyn Print.

Mironova, I.V., Kosilov, I.V., Nigmatyanov, A.A., Saifullin, R.R., Senchenko, O.V., Chalirachmanov, E.R., & Chernenkov, E.N. (2018). Nutrient and energy digestibility in cows fed the energy supplement "felucen". *Research Journal of Pharmaceutical, Biological and Chemical Sciences, 9*(6), 18-25.

Nikonova, E.A., Kosilov, V.I., & Bozymov, K.K. (2014). The reproductive function of breeding stock in creating herds of crossbred beef heifers. *Bulletin of beef cattle breeding, 2*(85), 49-57.

Rassolov, S. N., Kurbanova, M. G., Voroshilin, R. A., & Ulrikh, E. V. (2019). Effect of Phytobiotic fodder additives based on Water-Ethanol extract of Echinacea Purpurea on the qualitative characteristics of rabbit meat. *Journal of Advanced Pharmacy Education & Research| Jul-Sep*, *9*(3), 23-27.

Sedykh, T.A., Gizatullin, R.S., Kosilov, V.I., Chudov, I.V., Andreeva, A.V., Giniyatullin, M.G., Islamova, S.G., Tagirov, Kh.Kh., & Kalashnikova, L.A. (2018). Adapting australian hereford cattle to the conditions of the southern urals. *Research Journal of Pharmaceutical, Biological and Chemical Sciences, 9*(3), 885 – 898.

Shalaby, M. N. (2018). The Effect of Whey Protein (Natural Nanoparticle) on Muscle Strength, GH, IGF, T. Protein and body composition. *International Journal of Pharmaceutical Research & Allied Sciences*, *7*(1):126-132.

Tyulebaev, S.D., Kadysheva, M.D., Litovchenko, V.G., Kosilov, V.I., & Gabidulin, V.M. (2019). The use single-nucleotide polymophism in creating a crossline of meat Simmentals. Conference on Innovations in Agricultural and Rural Development (18-19 April 2019). IOP Conference Series: Earth And Environmental Science.

Zadnepryansky, I.P., Kosilov, V.I., & Zhaimysheva, S.S. (2012). Peculiarities of growth and development of calves of the beef, combined breeds and crossbreeds. *Bulletin of the Orenburg State Agrarian University, 6*(38), 105-107.