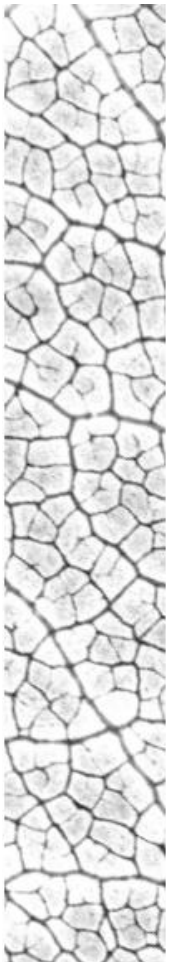

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# Efficiency of utilization of genetic resources of imported and domestic servicing bulls of beef breeds

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**Abstract**
The article presents the results of comparative studies of qualitative and quantitative indicators of sperm of beef breed servicing bull and the influence of factors such as appearance, live weight, breed characteristics and growth on the sperm productivity indicators. Based on the results obtained, it can be concluded that in all of bull use periods the influence of live weight on sperm production indices has a different degree of connection.

**Keywords:** servicing bulls, beef breed, live weight, sperm production

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## INTRODUCTION

Providing the population of Kazakhstan with high-quality meat products is an important national economic task. To solve this problem all genetic resources of both domestic and imported origin are involved.

The use of highly productive breeds is expanding everywhere, animal feeding and keeping systems, the forms of organization and beef production technology, which occupies the leading position in the meat balance, are being improved.

However, the successful development of the industry and its profitability largely depend on the correct scientifically sound choice of breeds and genotypes for breeding in a particular area, as well as the timely implementation of measures for the reproduction of the herd.

An increase in production is possible not only by improving of the existing gene pools and increasing of the number of livestock, but also by increasing of the productivity of animals.

In the field of breeding, a special place is given to the problem of effective selection and assessment of farm animals by productive and breeding abilities.

The reproductive function of bulls is largely determined by the significant genetic diversity of animals according to the main selection characteristics and the degree of inheritance of the economically useful properties. Therefore, the most reliable way to determine the breeding value of animals is to evaluate them by the quality of the offspring.

In beef cattle breeding, a two-stage assessment of producers was adopted, which provides for breeding according to the main selection characteristics: the bull's own productivity and the assessment of the offspring received from it.

The possibility of obtaining several thousand offspring from one bull has led many scientists to develop the problem of increasing the quantity and improving the quality of sperm production of servicing bulls and the effective use of this potential in large-scale selection (Ivanov 2000, Kostomakhin and Badmazhapova 2004, Satygul 2008, Shamshidin et al. 2014, Soldatov et al. 2003).

Selection of bulls by fertility and quality of sperm production based on quantitative and qualitative characters allows achieving success in accelerating the selection process in cattle breeding. However, the interest to this problem has faded unreasonably in recent years. This affected especially the new genotypes of beef breed cattle (Farnam et al. 2016).

An incorrect assessment of a servicing bull, whose sperm is inseminated in thousands of cows, can cause

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significant loss of the gene pool not only in a separate herd, but also in the population as a whole.

Sperm quality is not constant and depends on many factors: genotype, feeding conditions, the managing and use of producers of different breeds and directions of productivity. However, the types of activation and inhibition of sexual reflexes are poorly studied, the factors affecting the sperm production of servicing bull of beef breeds that are in the same conditions of use are identified insufficiently (Boyko et al. 2007, Kazhgaliyev et al. 2016, 2017).

In this regard, increasing of the reproductive ability of bull of beef breeds used in Kazakhstan is relevant.

The researches of the scientific and technical program are devoted to the solution of this problem: 217 "Improving the effectiveness of selection methods in cattle breeding", by event: "The study of reproduction problems in breeding herds selection and the use of modern methods to increase the calf crop" for 2018-2020.

## RESEARCH METHODOLOGY

The research work was carried out on the basis of the "Republican Center for Breeding work in Cattle Breeding of "Asyl Tulik" JSC, in breed livestock and commercial farms of the Republic of Kazakhstan.

Materials: servicing bulls, IMV-technologies breeding material cryopreservation laboratory equipment, semen collection machine, artificial vagina, sperm receiver, thermostats, autoclaves, water bath, microscope, trinocular microscope with CEROS software, freezer, photometer, sperm production registers, monthly, annual reports, measuring instruments, etc.

The live weight was determined by individual weighing. The measurements were taken using compass instruments, a measuring stick and tape measure. The main body measurements were taken from the entire livestock and body indices were calculated according to generally accepted methods.

Sperm production of bulls was collected twice a week with a double cage, weekends were excluded (Saturday and Sunday). Also, bulls had made up to 3 single rises aimed at hormonal stimulation of the sperm output process before resultant mounting. In each of the days of semen collection, it was possible to obtain only two resultant mountings.

The obtained sperm was studied in a specialized laboratory for color, odour, body, volume (in a volumetric flask), concentration by photometer, and motility by microscope.(Izah and Srivastav 2015)

The research materials were processed using Microsoft Office Excel programs.

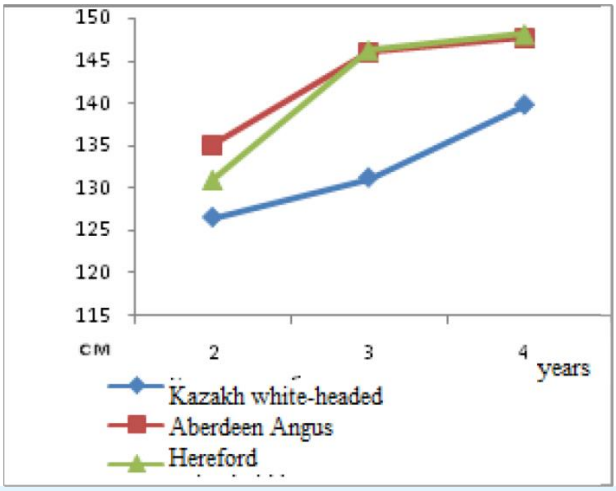


**Fig. 1.** Height at the withers

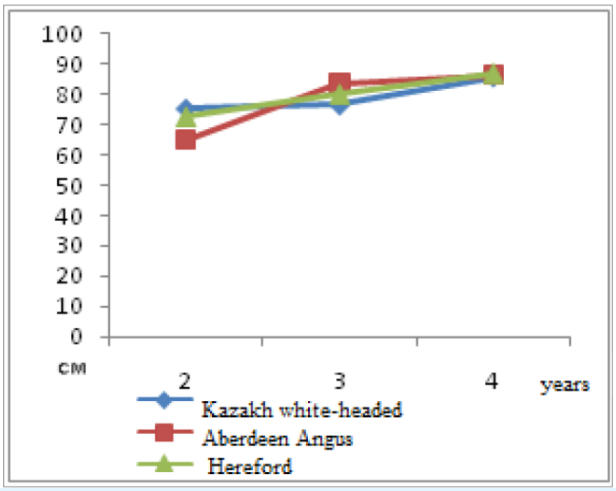


**Fig. 2.** Depth of the chest

## RESEARCH RESULTS

Among the most important individual qualities of breeding animals are the distinct manifestation of the breed, physique and type of constitution.

Breeding bulls intended for selection and reproduction of the herd must meet with their qualities the appropriate type of breed and productivity direction (Boyko et al. 2007, Ivanov 2000, Kazhgaliyev et al. 2016, 2017).

The main point in the breeding work is the evaluation of servicing bulls by the performance, appearance (exterior) and constitution.

In the process of bulls selection in the center the great attention has been paid to the exterior indicators. As a result of studies, interbreed differences have been found in terms of the bulls main measurements indicators (**Figs. 1-6**).

Age has an impact on the vital functions of the organism, and many functions have a progressive development in the process of life up to a certain point,

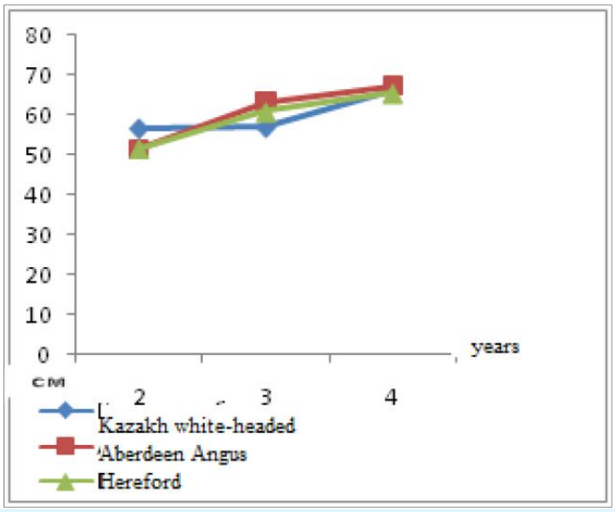


**Fig. 3.** Width of chest

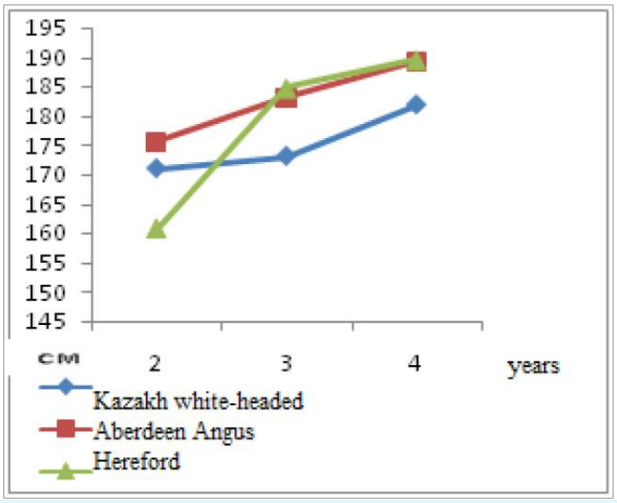


**Fig. 4.** Oblique length of body

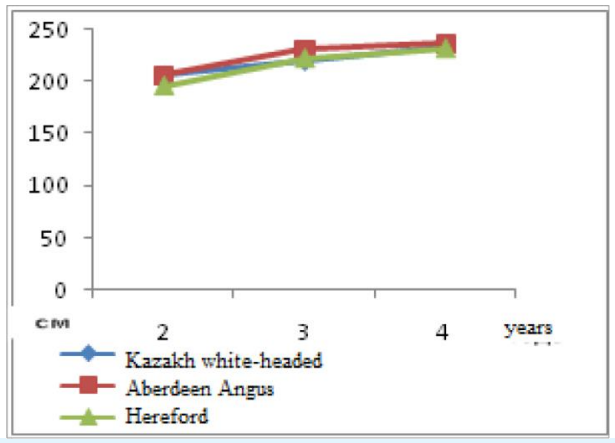


**Fig. 5.** Heart girth

and then fade away with the aging of the body (Afanasyeva 2014, Soldatov et al. 2003).

These figures show that altitude measurements of animals change with age. So, for example, the active growth is noticeable in bulls from 2 to 3 years with an increase in growth of 10-15 cm. The bulls of Aberdeen

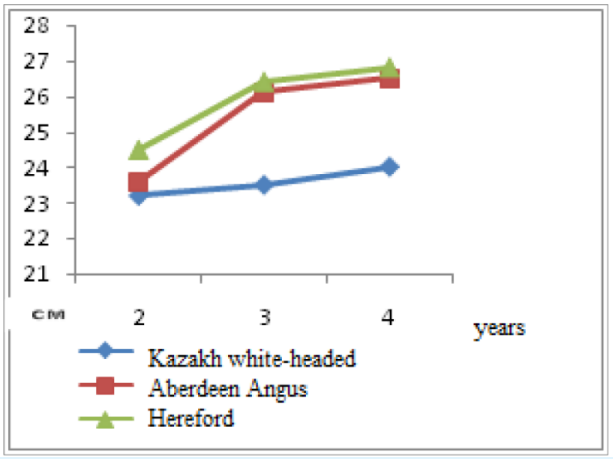


**Fig. 6.** Metacarpus girth

and Hereford breeds, aged 4 years and older, exceeded 3 years-old servicing bulls by 1-2 cm. Such an increasing trend is observed in all measuring indicators and interbreed differences are displayed. So, the Aberdeen bulls at the age of 2 years exceeded the Kazakh white-headed and Hereford ones by 8.7 cm (6.8%) and 4.1 cm (3%).

The increase in the measurement of chest depth was different in 3 bull breeds, the most noticeable in the Aberdeen and Herefords from 2 to 3 years old, and in Kazakh white-headed from 3 to 4 years and older. There was a sharp increase in growth for Aberdeen Angus at the age of 2 to 3 years by 18.7 cm (22%).

Starting from 2 to 3 years, the most variable value is the width of the chest of the Aberdeen Angus and Hereford. The increase is 11.8 cm (18%) and 9.2 cm (15%). In the Kazakh whiteheaded, this measurement has increased significantly from 3 years old by 9.1 cm (14%), in Aberdeen Angus and Herefords, only by 4.1 cm (6%) and by 4.7 cm (7.1%).

An active increase in the oblique length of the body was observed in 3 breeds in all periods of age. The chest girth has changed in bulls from 2 to 4 years old. The metacarpus girth also changes and increases depending on the age of the animal. the Aberdeen Angus and Hereford bulls turned out to be with the largest metacarpus at the age of 4years exceeding 2.5 cm (9.4%) and 2.8 cm (10.4%) the Kazakh white-headed ones.

In order to obtain a broader picture of the dynamics of the development of breeding bulls, the main body indices were calculated: leg height, elongation, blockiness, boniness and chest.

It was noted that the servicing bulls had differences in the age dynamics of body indices (**Table 1**).

Aberdeen-Angus bulls turned out to be the most high-legged in comparison with their peers of other breeds, the difference is noticed between the bulls from 2 to 4 years old. The least high-legged are the Kazakh white-headed. Due to the increase in the depth of the

**Table 1.** The main body indices, depending on age

| Indices | Beef breed Index Benchmark | breed | Age, years | | |
|---|---|---|---|---|---|
| | | | 2 | 3 | 4 |
| High Legged | 41-43 | Kazakh whiteheaded | 41.0±0.9 | 42.0±0.6 | 39.0±0.6 |
| | | Aberdeen | 52.0±1 | 43.0±0.5 | 42.0±0.6 |
| | | Hereford | 43.0±0.9 | 45.1±1 | 41.4±0.8 |
| Elong Ation | 122-123 | Kazakh whiteheaded | 135.0±0.9 | 132.0±1.5 | 130.0±1.5 |
| | | Aberdeen | 129.9±1.4 | 125.3±1.9 | 127.9±0.8 |
| | | Hereford | 122.5±2.4 | 126.3±1.2 | 127.9±0.81 |
| Chest | 73-74 | Kazakh whiteheaded | 75.4±1 | 74.6±0.7 | 77.0±0.9 |
| | | Aberdeen | 75.0±1.4 | 75.7±1 | 78.0±1.8 |
| | | Hereford | 70.8±1.2 | 75.9±0.9 | 73.6±1.7 |
| Blockiness. | 132-133 | Kazakh whiteheaded | 121.0±1.7 | 127.6±2.2 | 129.0±2.4 |
| | | Aberdeen | 117.3±0.9 | 126±2.1 | 125.3±0.5 |
| | | Hereford | 122.1±1.8 | 120.4±0.8 | 122.3±1.8 |
| Boniness | 16-17 | Kazakh whiteheaded | 18.3±0.1 | 17.9±0.1 | 17.1±0.1 |
| | | Aberdeen | 17.4±0.1 | 17.8±0.1 | 17.9±0.28 |
| | | Hereford | 18.6±0.2 | 18.0±0.1 | 18.1±0.2 |

**Table 2.** The Dynamics of live weight of breeding bulls depending on their age

| breed | Age, years | n | Breed standard, kg | Actual weight, kg | Difference, ± kg |
|---|---|---|---|---|---|
| Kazakh whiteheaded | 2 | 16 | 600 | 605±6.9 | + 5 |
| | 3 | 10 | 740 | 796±6.4 | + 56 |
| | 4 | 8 | 840 | 917±7.8 | + 77 |
| Aberdeen | 2 | 5 | 560 | 618±9.1 | + 58 |
| | 3 | 8 | 715 | 825±11 | + 110 |
| | 4 | 6 | 780 | 960±7.3 | + 180 |
| Hereford | 2 | 11 | 600 | 609±5.4 | + 9 |
| | 3 | 11 | 740 | 818±9.6 | + 78 |
| | 4 | 5 | 840 | 952±14 | + 112 |

chest of animals over the years, the high-legged index of servicing bulls is gradually decreasing.

The index of elongation had different variability in all age periods. In the Kazakh white-headed bulls, it decreased by 5.2% with age, in the Aberdeen-Angus bulls by 2%, and in the Hereford bulls it increased by 5.4%.

The different change in the chest index was observed in all bulls in all periods. There is a decrease in Kazakh whiteheads on the 3rd year, an increase on the 4th year, on the contrary, an increase in the Hereford bulls was by the 3rd year, and a decrease was noticed by the 4th year. This is due to an increase in the measurement of the depth and width of the chest.

The blockiness index increased uniformly with advancing ageing, depending on the measurement of heart girth. There are interbreed differences, and as shown in the table, the blockiest ones are the bulls of the Kazakh whiteheaded breed.

The Hereford bulls exceeded other bulls in index of boniness the change in boniness index in all bulls was insignificant with advancing ageing.

From the above data, it can be concluded that in bulls of 3 breeds, the difference in age dynamics in the values of chest and boniness indices was insignificant, but there were changes in the indices of leg height, elongation and blockiness in all bulls with advancing ageing.

The live weight of farm animals is one of the most important indicators taken into account in breeding work. It is the phenotype indicator, which reflects the intensity of growth and development of the animal. **Table 2** presents data on live weight.

The results of the data studied indicate that the live weight of bulls is increasing from a young age and older. So, bulls of the Kazakh white-headed breed at the age of 4 years exceeded the 2-year-olds by 312.6 kg, or 34%; Aberdeen Angus by 368.1 kg, or 37%; Herefords by 342 kg, or 36%. An increase in live weight of breeding bulls was observed in 3 breeds, while the annual live weight gain was characterized by actual values.

The study of age variability of quantitative and qualitative indicators of bull sperm productivity is necessary to justify the parameters of their use in operation (Shamshidin et al. 2014).

The total volume of sperm output over the entire period of use of the bulls is considered as one of the important indicators of reproductive ability. The different amounts of sperm were accumulated from the bulls of meat breeds under the same conditions of feeding, housing and sperm harvest technology (**Figs. 7**-**9**).

Research data shows that sperm production indicators are different with advancing ageing. Moreover, an increase in the average ejaculate volume indicator is observed in the period from 2-year to 4-year-old age of using bulls of meat breeds, and the amount of ejaculate decreases with advancing ageing (**Figs. 8** and **9**).

In the first year of operation of young calves, it is difficult to make statements about effective use from them, due to the fact that they begin to produce sperm at different periods and time, as well as seasons. Nevertheless, the size of the ejaculate volume at the age of 2 years is gradually increasing and the difference with the next year is noted in Kazakh white-headed - by 0.41 ml (11%), at the age of 4 years by 0.35 ml (9%),

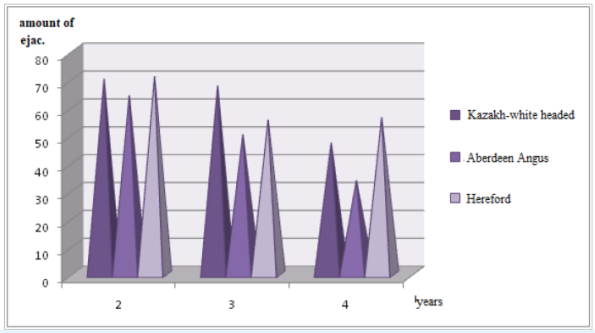


**Fig. 7.** Change in the number of ejaculates with advancing ageing

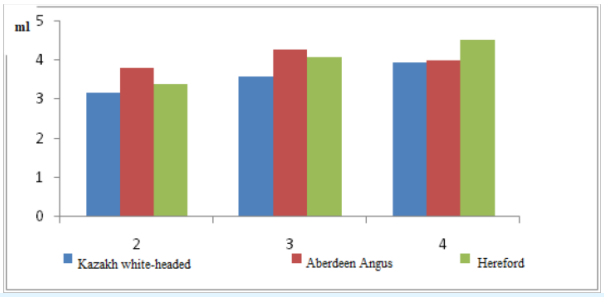


**Fig. 8.** Volume of ejaculates depending on age

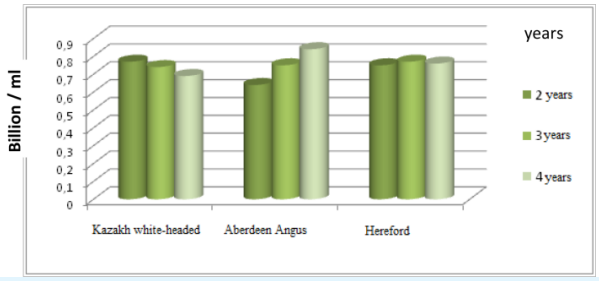


**Fig. 9.** Sperm concentration according to age

Aberdeen-Angus increase is noted up to the age of 3 years - by 0.47 ml (11%), in Herefords - by 0.68 ml (16%), at the age of 4 years - by 0.44 ml (10%).

An interbreed difference is noted in the ejaculate volume. The Aberdeen Angus servicing bulls at the age of 2 and 3 exceed Kazakh white-headed and the Hereford bulls in terms of ejaculate volume by 0.52 (16%) and 0.39 ml (10%); by 0.67 ml (15%) and 0.27 ml (4%). The Hereford bulls at the age of 3 years are inferior with a small difference to Aberdeen-Angus bulls, and at 4 years they advance ultimately - by 0.52 ml (12%). Thus, the volume of ejaculate in bulls of all breeds increased with advancing ageing.

Determination of sperm stiffness by eye estimation provides an approximate idea of the amount of male germ cells in the sperm. In order to calculate accurately how many times it is possible to dilute the freshly obtained sperm, how many females can be inseminated with one ejaculate and determine the dose of sperm for insemination of females, it is necessary to know the concentration of sperm.

Many researchers note that sperm quality depends on the age of the servicing bulls and the volume of ejaculate increases with advancing aging.

According to other authors, sperm quality, including concentration is very dependent on the season. The sperm concentration decreases in the summer months, and it increases in autumn and winter (Chetvertakova 2009, 2012).

The studied qualitative indicators of all bulls revealed that they had an average male germ cells concentration in the semen below 1 billion per 1 ml and was in the range of 0.64--0.84 billion / ml.

As shown in the figure, the change in sperm concentration over the years of use was observed significantly in the Aberdeen Angus bulls. The difference in the direction of increase in 2 and 3 years was - 0.11 billion / ml (15%), in 3 and 4 years - 0.09 billion / ml (10%).

The tendency towards the decrease in concentration throughout the entire period, with an increase in the volume of ejaculate starting from 2 to 4 years of use was observed in Kazakh white-headed.

Based on the foregoing, we came to the conclusion that the maximum concentration indicator was observed in the Aberdeen-Angus bulls at the age of 4 years, for Kazakh white-headed at young age and for Herefords at middle age. And with an increase in the age of the bulls, the change in the concentration of sperm becomes unequal, for some it decreases slightly, then increases, for some it will remain at the same level in the following years.

The degree of influence of the exterior and live weight indicators is reflected on reproductive abilities in many ways.

When studying the dependence of the dynamics of measurements and live weight on breeding categories, scientists concluded that the grading down bulls had a large live weight and were more massive than animals of other categories. As a rule grading up bulls were characterized by a lower live weight and minimal indicators of measurements (Chetvertakova 2009, 2012, Gunn et al. 2014).

As a result of the reproductive qualities study, the exterior indicators and their connection were taken into account (**Tables 3** and **4**).

In the course of the study, the degree of connection of measurements with the characteristics of the reproductive ability of bulls was revealed.

So, the ejaculate volume had a positive correlation with certain measurements, such as the heart girth and the metacarpus girth in bulls of the Kazakh white-headed breed. A negative correlation with values from – 0.42 to – 0.47 is present in measurements of the depth and width of the chest, and the oblique length of the body.

**Table 3.** The relationship of reproductive ability indicators of bulls with their measurements

| breed | indicator | height at the withers | Depth of chest | Width of chest | Oblique length of body | the heart girth | the metacarpus girth |
|---|---|---|---|---|---|---|---|
| Kazakh whiteheaded | ejaculate volume | -0.09 | -0.47 | -0.47 | -0.42 | 0.23 | 0.26 |
| | Sperm concentration | -0.29 | -0.17 | -0.18 | 0.22 | -0.18 | -0.55 |
| Aberdeen | ejaculate volume | -0.10 | -0.49 | 0.25 | 0.37 | 0.45 | 0.92 |
| | Sperm concentration | 0.33 | -0.32 | 0.37 | -0.15 | -0.15 | -0.29 |
| Hereford | ejaculate volume | 0.31 | 0.28 | 0.54 | -0.23 | -0.24 | -0.34 |
| | Sperm concentration | -0.38 | 0.44 | 0.50 | -0.44 | -0.15 | -0.17 |

**Table 4.** Relationship of servicing bulls sperm production indicators with body indices

| breed | index | Leg height | elongation | chest | blockiness | boniness |
|---|---|---|---|---|---|---|
| Kazakh whiteheaded | Ejaculate volume | 0.33 | -0.42 | 0.03 | 0.38 | 0.26 |
| | ejaculate concentration | 0.00 | 0.38 | -0.01 | -0.24 | -0.26 |
| Aberdeen | ejaculate volume | 0.34 | 0.36 | 0.54 | -0.13 | 0.76 |
| | ejaculate concentration | 0.36 | -0.22 | -0.20 | 0.07 | -0.36 |
| Hereford | ejaculate volume | -0.06 | -0.53 | -0.09 | 0.17 | -0.53 |
| | ejaculate concentration | -0.51 | -0.13 | -0.26 | 0.52 | 0.28 |

In sperm concentration, an average negative correlation (-0.55) with metacarpus girth is observed; with other measurements, a low correlation.

In the bulls of Aberdeen-Angus breed the volume of the ejaculate had a correlation with all measurements except the height at the withers. Sperm concentration correlated with height at the withers (positive), chest depth (negative), chest width (positive) and the metacarpus girth (negative).

In bulls of the Hereford breed the ejaculate volume is positively correlated with the height at the withers, chest depth and chest width. The sperm concentration is correlated with the depth and width of the chest, and an average negative relation is found with the height at the withers and oblique length of the body.

Body indices had different correlation values for each indicator of sperm production. So, for the Kazakh white-headed bulls, the volume of ejaculate positively correlated with the indices of leg height, blockiness, boniness, and with chest index the relationship is insignificant. A negative relationship was found with the index of elongation, and the more the animal is elongated, the lower the ejaculate volume is. There is a positive relationship between the concentration of the sperm and the index of elongation, and a negative one with the index of blockiness and boniness.

In the Aberdeen-Angus bulls there is a high correlation between the ejaculate volume and the chest and a boniness index and is 0.76 and 0.54 respectively. Sperm concentration correlated with all indices except for blockiness.

The indices of elongation and boniness in bulls of the Hereford breed indicate the average concentration of male germ cells with a negative value of the ejaculate volume. The presence of a high positive correlation was found between the sperm concentration and the indices of leg height and blockiness, where the first is negative, the second is positive.

The relationship between live weight and the main indicators of sperm productivity of bulls was studied using correlation analysis (**Table 5**).

**Table 5.** The relationship between live weight and indicators of sperm production of servicing bulls of different ages

| Correlation indicators | Kazakh whiteheaded | Aberdeen | Hereford |
|---|---|---|---|
| **2 years-old bulls** | | | |
| Live weight x ejaculate volume | 0.16 | -0.67 | -0.39 |
| Live weight x concentration | 0.06 | 0.77 | -0.25 |
| **3 year-old** | | | |
| Live weight x ejaculate volume | 0.25 | -0.40 | 0.34 |
| Live weight x concentration | 0.04 | 0.32 | -0.26 |
| **4 years-old** | | | |
| Live weight x ejaculate volume | -0.47 | -0.55 | 0.57 |
| Live weight x concentration | -0.34 | 0.69 | 0.85 |

A study of the positive relationship between the ejaculate volume and the live weight revealed that bulls of the Hereford breed at the age of 4 years are characterized by the highest level of correlation. In the Aberdeen-Angus bulls in all age periods, this relationship is negatively correlated, and positively with concentration.

The weak relationship between live weight and ejaculate volume and sperm concentration was established in bulls of the Kazakh white-headed breed at 2 and 3 years of age.

## CONCLUSION

Thus, in the Aberdeen-Angus bulls the correlation coefficients between live weight and ejaculate volume are negative, and between the concentration are positive. And in 4-year-old bulls of the Kazakh whiteheaded breed, the correlation between the volume of ejaculate and live weight and concentration is negative.

The exterior measurements of the servicing bulls show that the intensive development of their organism occurs in the period up to 3 years of age, only a gradual increase in certain measurements is observed in subsequent years.

When studying the body indices of the servicing bulls of 3 breeds, the difference in the values of the indices of chest and boniness was insignificant, although changes were noted in the value of the indices of leg height, elongation and blockiness.

Exterior indicators affect the productivity of bulls, this is especially reflected in the volume of ejaculates, to a lesser extent on the variability of sperm concentration. It is known that the live weight indicator of bulls changes with advancing ageing. In the course of our study, an increase in the live weight of breeding bulls with actual values was observed in 3 breeds. Consequently, the bulls at the age of 2 years have a high fertilizing capacity of the sperm.

The age of the bulls affects the ejaculate volume, the cause of which is, first of all, the increase in live weight and the weight of the testes, although no significant changes are observed in the concentration of the sperm.

Thus, the results of the study show that in bulls of different age groups, the relationship between the indicators of sperm production and live weight has a different degree.

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