Influence of the genotype of breeding bulls on the quality of sperm production

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Abstract. The article presents the studies carried out at JSC "Krasnoyarskagroplem" during 2012-2015 years. The object of research is breeding bulls of red-mottled and Holstein breeds and their sperm production. We compared two groups of bulls, a red-mottled breed (n = 18 heads) and the Holstein red-and-white suit (n = 18 heads) at the age of 24.3 months at the beginning of the study. The quality of sperm production was evaluated in accordance with the current GOST 23745-79 "Undiluted freshly obtained sperm of breeding bulls". The fertilizing ability of sperm was evaluated by the insemination index. The authors revealed the dependence of the quantitative and qualitative indicators of the seed on the breed of bulls. The period of bull’s sexual functions formation of the Holstein breed ends at the age of four. The period of bull’s sexual functions formation of the red-mottled breed ends at the age of five. The insemination index of red-mottled bulls is on average 1.3, in Holstein bulls it is 1.7. It confirms that the quality of the sperm is good. Breeding bulls with a low insemination index were identified, e.g., Discont 29590 of the red-mottled breed has index of 2.4, Kozir 1676 and Snaiper 1802 of Holstein breed have indexes of 3.9 and 6.03, respectively.

1. Introduction
At the present stage of development, livestock breeding is characterized by a radical reconstruction of the existing breeds and new breeds creation with a high genetic potential for productivity, suitability for intensive technologies [1]. The genetic potential of the created breeds and intra-breed types is high, since the original breeds have a unique gene pool, and the allele combinations give results that meet the breeders' expectations.

The large-scale selection, artificial insemination, embryo transfer have a significant impact on the gene pool of the bred cattle, enrich it with desirable alleles that increase productivity, etc. But the use of breeding bulls who are heterozygous carriers of lethal and semi-lethal genes can reduce to zero all breeding work with the cattle. Breeding farms use breeding bulls as sperm donors; so, the resulting products must meet the requirements of GOST [2].

The quality of the sperm, its ability to deeply cool depends on hereditary and external factors, and that is why, breeding bulls need to be more thoroughly evaluated in terms of viability, reproductive capacity, disease resistance [1; 3; 4].

The sperm quality is the main criterion for its use in artificial insemination. The biotechnological parameters of sperm are significantly influenced by the breed and individual characteristics of bulls [5; 6; 7].
The filling of the gene pool with alleles of the desired type, their concentration in the homozygous state and the capability of transmission to offspring depend on the level of selection work with the breed.

In this regard, the purpose of this study is to investigate the influence of the genotype of breeding bulls on the quality indicators of sperm production.

The objectives of the research include the analysis of changes in the quantitative and qualitative indicators of bulls’ sperm production of two genetically similar breeds during some years.

2. Materials and research methods
The research was carried out at JSC "Krasnoyarskagroplem" during 2012-2015. The object of research is breeding-bulls of red-mottled and Holstein breeds and their sperm production. Two groups of breeding bulls were formed. The first one included breeding bulls of the red-mottled breed (n = 18 heads), the second one included the Holstein red-and-white suit (n = 18 heads). All purebred bulls were of the same age (24.3 months). The initial data were taken from the forms of zootechnical registration. The quality of sperm production was evaluated in accordance with the current GOST 23745-79 "Undiluted freshly obtained sperm of breeding bulls". We took into account such indicators as the volume of ejaculate (ml); concentration (billion/ml); the number of sperm in the ejaculate (billion); total seed received (ml); marriage of native sperm (%). To analyze the fertilizing ability of sperm, the insemination index was calculated, i.e., the number of inseminations spent on one resulted one. The insemination index can have the following result: excellent is 1.5; good is 1.6-1.8; satisfactory is 1.9-2.0; low is more than 2.0 [8].

The obtained results were processed by mathematical methods [9], using the Microsoft Excel program.

3. Research results and their discussion.
The program for realization the genetic potential depends on the breed. The reproductive ability of bulls, like any other feature, is genetically determined. This is also expressed in terms of the quality of the sperm and its ability to be cooled deeply and fertilized. In this regard, the authors studied bulls’ qualitative and quantitative indicators of different breeds during four years (figures 1-4).

Figure 1. Change in bulls’ volume of ejaculate of different breeds by year, ml.

| Year | Red-mottled breed | Holstein red-and-white suit |
|------|-------------------|-----------------------------|
| 2012 | 3.77              | 3.68                        |
| 2013 | 4.23              | 4.3                         |
| 2014 | 4.3               | 4.51                        |
| 2015 | 3.91              | 3.51                        |

Figure 2. Change in sperm concentration, billion/ml.

| Year | Red-mottled breed | Holstein red-and-white suit |
|------|-------------------|-----------------------------|
| 2012 | 1.27              | 1.2                         |
| 2013 | 1.11              | 1.1                         |
| 2014 | 1.16              | 1.15                        |
| 2015 | 1.08              | 1.15                        |
Figure 3. Dynamics of the number of sperm in the ejaculate, billion.

Figure 4. Change in the amount of seed obtained from bulls during four years, ml.

At the beginning of the study, the age of breeding bulls was on average 24.3 months, i.e. they were at the stage of the sexual functions formation [5].

At the age of two years bulls of the red-mottled breed, the concentration of spermatozoa in one ml exceeded that of the producers of the Holstein red-and-white suit by 0.07 billion, respectively, and the number of sperm in the ejaculate they had more by 0.14 billion with a lower volume of ejaculate in comparison with indicators of bulls of the Holstein breed (figures 1-4). A fraction of the sperm defective ranged from 16.7% in red-mottled breed to 20.3% in Holstein bulls (figure 5). During the formation of sexual functions, fluctuations in the quantitative and qualitative indicators of sperm production were observed. In our studies, under the same conditions of keeping, bulls of the studied breeds already at the stage of formation of sexual functions show different results in the quality of sperm production, which indicates a different adaptive ability, expressed in the fraction defective of the native seed.

At the age of three years one can observe an increase in sperm production, a significant increase was noted with the Holstein red-and-white suit. In terms of the volume of ejaculate and the amount of obtained sperm, they exceed those of red-mottled breed by 0.23 ml (P>0.999) and 147.7 (P>0.999) respectively. A fraction defective of native seed decreased to 17.7% (figure 5). The studied indicators also increased with the bulls of the red-mottled breed, but a fraction defective of the native seed increased to 20.6%.

At the age of four, all sperm indicators of Holstein red-and-white suit exceeded those of red-mottled breeders. The number of sperm in the ejaculate of bulls of the Holstein red-and-white suit increased to 4.99 billion. It is in 0.38 billion more than in the sperm of the breeding dulls of the red-mottled breed (P >0,95).
At the age of five, red-mottled bulls continued to increase such indicators as the volume of ejaculate by 0.83 ml (P>0.95) and the number of sperm in the ejaculate by 0.39 billion.

4. Conclusion

Thus, the dependence of the quantitative and qualitative indicators according to the sperm of the breed of bulls was established. The period of bull’s sexual functions formation of the Holstein breed ends at the age of four, since the growth of indicators stops and the fraction defective sperm decreases to 16.3%. The bulls’ sexual functions of the red-mottled breed stabilize at the age of 5 years.

Bulls of the Holstein breed of the red-and-white suit, regardless of the year of research, give sperm of the better quality. It indicates a more stable genotype.

The analysis revealed changes in the quality of sperm production of breeding bulls of both breeds during some years. The seed quality indicators do not remain at the same level: they are constantly changing. The reasons for these changes require further investigation.

The insemination index of red-mottled breed is, on average, 1.3, and the insemination index of Holstein red-and-white suit is 1.7. These results indicate good quality of the seed and its high fertility. Breeders with a low insemination index were identified among both red-mottled and Holstein bulls. Among the red-and-white breeds, the lowest insemination index has Disco 29590 bull is 2.4. For example, breeders of the Holstein red-and-white suit, Khozir 1676 and Snaiper 1802 showed the worst insemination index values of 3.9 and 6.03, respectively.

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