

Results of Using Sexed and Traditional Bull Semen on Holstein Replacement Heifers

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Abstract

The article presents the results of the use of sexed sperm of bulls on Holstein heifers of the breeding flock of State Agri-Enterprise "Chaika", the Dudarkiv branch of Kyiv Region.

In 2012, the farm purchased 75 sperm doses of sexed sperm obtained from two bulls of Holstein breed, American selection: Ri-Val-Re MOUNTAINEER-ET 60815578 (50 sperm doses) and Diamond-Oak FROSTY 31520543 (25 sperm doses). As a result, 38 live calves were obtained, accounting for 58 - 44% of the fertilization of the calves, with a sex ratio of litters ♀89 : ♂11 and ♀91 : ♂9%.

The level of milk yield of firstborns obtained from the use of sexed bull sperm was 7717 kg of milk for the first 305 days of lactation, which exceeds the milk yield of mothers ($d = +862$ kg, $P \geq 0.999$) and insignificantly that of peers ($d = +276$ kg). Moreover, these first-borns show reduced fat content in milk ($d = -0.02 \dots 0.05\%$, $P \geq 0.99$).

Farm specialists are advised to pay special attention to the strict adherence to the technology of use of sexed sperm of bulls, taking into account the expediency of its use and economic justification.

Keywords: *Holstein Bulls; Sexed and Traditional Semen; Dairy Productivity; Firstborns*

Introduction

Development, acquisition and practical use of sexed sperm of sire bulls is the greatest achievement of biological science in breeding, selection and reproduction of agricultural animals of the 21st century. This will effect the methods of preserving the gene pool of living organisms, the rate of their evolution and the intensity of the selection process, especially in relation to the creation and functioning of paternal and maternal lines, the use of the matrocline effect and other aspects.

Artificial insemination of cows and heifers with sperm, which were previously separated by X and Y chromosomes (sexed sperm) is now a new biotechnological method that is gaining widespread commercial use in the world [11,12,14].

Work on forecasting the desired offspring has been carried out in the world for a long time. Back in the late 70's of last century, a method of flow cytometry was tested to separate living cells after passing them through a high-speed sorter. The application of this approach to sexing bull sperm made it possible in the early 90's to obtain calves of the desired sex after insemination of cows with sexed sperm [6,7,15].

Since 1996, X&Y has patented a method of sorting sperm using laser equipment in the United States [2,3]. Cogent (Great Britain) was the first company in the world to use the method of dividing the sperm of breeding bulls by sex in production conditions (1999). The first foal from the use of sexed sperm in industrial conditions was obtained in 1998, the first lamb - in 2001, during 2003 - 2005 the first offspring of Atlantic dolphins - bottlenose dolphins, kittens, puppies.

Today, the use of products obtained from sorting has become very popular in the world and widely used in various fields of animal husbandry. The world leader in the production, sale and quality of a sexed semen is the American company CRI (Cooperative Resources International). The company's products are sold in 67 countries.

The developed method of sperm division by sex determines the use of the best bulls in the selection process, which are among the top five or ten world leaders INTERBULL - International Bull Evaluation Service. After getting and appropriate cultivation of such a heifer, which in the future is the repair of the herd, we obtain a cow with significantly increased genetic potential [2,3,12].

In Ukraine, sexed bull semen has been used in dairy farming since 2005. The high cost of sperm sorting equipment hinders the spread of this biotechnological method in Ukraine. This does not make it possible to obtain sexed semen from bulls of their own production, although the provision of appropriate scientific personnel is sufficient. Therefore, foreign companies sell in our country sexed semen of bulls. Among them are Wright Frank LLC (representative of the British company Gogent), Genus Ukraine LLC (representative of the American company ABS Global), SEMEX Alliance Ukraine LLC, Alta Genetics Ukraine LLC and others [1]. Today in Ukraine a number of farms use sexed semen of bulls of foreign selection. Among them are STOV AF Glushky, STOV Promin, STOV Agrofirma Kyivska, OJSC Poltavaplemservice, PSP Pleshkani and others.

To use a sex semen, you need certain conditions and qualified technicians. For insemination, sexed semen are allowed healthy heifers aged 14 to 16 months with a fattening of at least 3 points and a live weight of 380 kg. Heifers should be well developed and have pronounced signs of sexual hunting. Fertilization should be performed after determining the immobility reflex in 8 - 12 hours. The farm must have a high level of fertility of heifers. It is undesirable to use semen divided by sex during stressful situations. Improper storage and thawing of sexed semen can have a negative impact on its fertilizing ability. This is repeatedly pointed out by the originators of development and scientific practices [4,7,9].

The rather high cost of one sexed sperm dose of a bull (900 - 1200 UAH), estimated by a set of selection traits, requires a balanced and economically based approach. Unfortunately, not all farms in Ukraine have a positive experience of using sexed bull semen. Therefore, on the example of one of the leading enterprises in the dairy industry of Ukraine, we decided to share the results.

Materials and Methods

Studies on the use of sexed sperm in breeding herds of Ukraine, which were started by us in 2012 in STOV "AGROKO" Chornobayiv district of Cherkasy region, continued in SSE "Seagull" branch Dudarkiv Boryspil district of Kyiv region [10]. The choice of direction of further research was due to the fact that in the selection of cows on a set of traits (reproductive capacity, milk productivity, duration of economic use) in this herd did not have enough own breeding stock for its repair [5].

To this end, in 2012 the farm, with the help of a representative British firm in Ukraine, Wright Frank LLC, purchased from Cogent 75 spermatozoa of sexed sperm belonging to two Holstein bulls of American selection: Ri-Val-Re MOUNTAINEER-ET 60815578 (50 spermatozoa) and Diamond-Oak FROSTY 31520543 (25 sperm doses).

Cogent is not only the founder of sperm separation technology, but also further improves the existing technology, performs research that is useful for agriculture. Given the needs of the modern dairy industry, the company is successfully developing breeding programs to inherit the productive qualities of offspring. Cogent works with the largest herd of bulls in the UK and has the best British genetics. This is the result of the introduction of its own innovative developments in cattle breeding and programs for testing and evaluation of British livestock, a combination of genetic material from the best American and Italian bulls, provided by the US market leader - World Wire Sires. Cogent now supplies high-quality genetic material to more than 40 countries.

The bulls Ri-Val-Re MOUNTAINEER-ET US 60815578 and Diamond-Oak FROSTY ET US 31520543 belong to the well-known lines Chif 1427381.62 and Marshall 2290977.95, respectively. It should be noted that the semen of these bulls is sexed (Sexxed), has increased fertilizing ability (Repromax) and selection of the udder of their daughters to robotic milking parlors (Robot Ready) with the estimated and transmitting ability for protein content in milk: κ -casein AB and β -casein A2A2 [17,18].

Sexed semen of these bulls was used on heifers of mating age, and the available heifers of the herd were mated with bull semen Ri-Val-Re MOUNTAINEER during May-October 2012, and bull semen Diamond-Oak FROSTY during October 2014 - April 2015. From birth heifers from the use of sexed bull semen was formed a control group of animals. According to their origin, a group of mothers was selected and according to the dates of calving - a group of their peers. Animals belonging to the "mother" and "peer" groups were obtained using traditional non-sexized bull semen.

The established system of feeding animals on the farm meets modern standards for nutrients and macronutrients, and the technology of keeping cows provides, mainly, the realization of hereditary genetic potential of productivity. Under these conditions, the average annual milk yield for a herd of purebred Holsteins of black-spotted color in 2010 - 2018 amounted to 6928, 7698, 7733, 7739, 7825, 7399, 8086, 7808, 7840 kg of milk, respectively. This gave grounds to conduct a comparative analysis of milk productivity of the formed groups of animals that have already completed the first lactation, using the formed database of CMS "Intesel ORSEC".

Statistical processing of the obtained data was carried out using the computer program Excel for Windows'10 and "Guidelines for the selection of animals in the herd" [8].

Results and Discussion

The data obtained on the use of sexed semen of bulls Ri-Val-Re MOUNTAINEER-ET US 60815578 and Diamond-Oak FROSTY ET US 31520543 are grouped in table 1.

Indexes	Bulls inseminators	
	Ri-Val-Re MOUNTAINEER-ET 60815578	Diamond-Oak FROSTY 31520543
Purchased sperm, pieces	50	25
Crossed heifers, heads	50	25
Fertilization, %	58	44
Received offspring - total, heads.	27	11
Of them heifers	24	10
Bulls	3	1
stillborn	2	-
Daughters were introduced to the dairy herd, of them completed 1 lactation	12 10	10 10

Table 1: The effectiveness of the use of sexed sperm of Holstein bulls.

They give reason to state that the fertility of heifers with sperm of both bulls is quite low. This is primarily due to the lack of qualifications of artificial insemination technicians available on the farm and non-compliance with the terms of optimal insemination of heifers according to their sexual desire. As a result, 27 and 11 calves were obtained from each bull with the ratio of articles ♀89: ♂11 and ♀91: ♀9.

In the process of raising the daughters of Ri-Val-Re MOUNTAINEER, only 12 heifers out of 24 came to mating age. The mean age of 1st insemination of all heifers with sexed semen was 16.2 months (with fluctuations in daughters Ri-Val-Re MOUNTAINEER - 15.6 months, daughters Diamond-Oak FROSTY - 16.8 months).

In general, the first lactation was completed by 10 first-borns of each bull. Their milk productivity in comparison with the milk productivity of their mothers and peers is presented in table 2.

Indexes	Dairy productivity			Difference (d)	
	Daughters	Mothers	Peers	Daughters - mothers	Daughters - peers
Diamond-Oak FROSTY 31520543					
n	10	10	11	x	
Duration of lactation, days	438 ± 25	338 ± 16	436 ± 22	+100	+2
Hope, kg	11189 ± 569	7117 ± 269	10580 ± 450	+4072***	+609
Milk productivity for the first 305 days of lactation:					
Milk yield, kg	8222 ± 183	6630 ± 152	7772 ± 128	+1592***	+450
Fat content, %	3,60 ± 0,01	3,67 ± 0,01	3,64 ± 0,02	-0,07***	-0,04
The amount of milk fat, kg	296 ± 6	243 ± 5	283 ± 4	+53	-13
Protein content, %	3,08 ± 0,01	3,04 ± 0,01	3,08 ± 0,01	+0,04	0
The amount of milk protein, kg	253 ± 6	201 ± 5	240 ± 4	52	+13
Ri-Val-Re MOUNTAINEER-ET 60815578					
n	10	10	34	x	
Duration of lactation, days	382 ± 17	377 ± 18	469 ± 37	+5	-87
Milk yield, kg	8842 ± 520	8472 ± 347	10254 ± 683	+370	-1412
Milk productivity for the first 305 days of lactation:					
Milk yield, kg	7212 ± 168	7103 ± 134	7314 ± 119	+109	-102
Fat content, %	3,66 ± 0,01	3,63 ± 0,02	3,69 ± 0,02	+0,03	-0,03
The amount of milk fat, kg	264 ± 6	258 ± 5	270 ± 4	+6	-6
Protein content, %	3,11 ± 0,01	3,16 ± 0,01	3,10 ± 0,01	-0,05	+0,01
The amount of milk protein, kg	224 ± 4	224 ± 4	226 ± 4	0	-2
In general					
n	20	20	45	x	
Duration of lactation, days	408 ± 21	356 ± 17	460	+52	-52
Milk yield, kg	9953 ± 581	7762 ± 331	10344 ± 623	+2191**	-391
Milk productivity for the first 305 days of lactation:					
Milk yield, kg	7717 ± 171	6855 ± 127	7441 ± 109	+862***	+276
Fat content, %	3,63 ± 0,01	3,65 ± 0,01	3,68 ± 0,01	-0,02	-0,05***
The amount of milk fat, kg	280 ± 7	250 ± 5	274 ± 5	+30***	+6
Protein content, %	3,09 ± 0,01	3,09 ± 0,02	3,09 ± 0,01	0	0
The amount of milk protein, kg	238 ± 5	212 ± 4	230 ± 3	+26***	+8

Table 2: Dairy productivity of first-borns obtained from the use of sexual semen of individual bulls and its comparison with the products of mothers and peers.

These indicators show that for the cows of the Holstein breed of the herd DSP “Chaika” Dudarkiv branch is characterized by a fairly long period of lactation. According to our research, in the adjacent generations of “daughter-mother” the duration of lactation increased by an average of 50 days and for daughters obtained from sexed semen was 382 and 438 days. Due to this, there is a significant difference in the level of milk yield during the entire lactation of first-born daughters and their mothers ($d = +2191$ kg; $P \geq 0.99$).

During the first 305 days of lactation, a significant difference in milk productivity is observed only in daughters obtained from the use of sexed semen of a bull Diamond-Oak FROSTY. Thus, the level of their milk yield increased and amounted to 8222 kg of milk compared to milk yields for the corresponding period of mothers (+1592 kg; $P \geq 0.999$) and peers (+450 kg). At the same time, the first-born daughters decreased the fat content in milk from 3.67% and 3.64% to 3.60% and the tendency to decrease the protein content in milk kept compared to mothers and their peers.

No significant and statistically significant difference in milk productivity was found in the daughters of the Ri-Val-Re MOUNTAINEER bull.

It was also found out whether there were changes in the birth of heifers and bulls before the use of sexed bull semen and after it in the whole herd of cows and heifers (Table 3).

Years	Received offspring			The ratio of articles (♀ : ♂), %
	Total	Including		
		Heifers	Bulls	
2012	267	131	136	♀49,0 : ♂51,0
2013	236	99	137	♀42,0 : ♂58,0
2014	284	139	145	♀49,0 : ♂51,0
2015	216	109	107	♀50,5 : ♂49,5
2016	264	134	130	♀51,0 : ♂49,0
2017	256	129	127	♀50,4 : ♂49,6
2018	214	99	115	♀46,0 : ♂54,0

Table 3: Receipt of offspring from the breeding stock in the breeding herd of SSE «Chajka» Dudarkiv branch.

To do this, we analyzed the dynamics of offspring from the uterus for the last seven years (2012-2018). The daughters of the bull Ri-Val-Re MOUNTAINEER calved mainly during 2014, and the daughters of the bull FROSTY - in late 2015-early 2016. As a result of the birth of 34 heifers, which were obtained from sexed semen of bulls during 2014-2016, no significant change in the ratio of offspring sex was detected.

Conclusion

The performed researches allow to draw the following conclusions:

1. Sexed semen of bulls should be used only in those herds of cattle where heifers meet the breed standard, artificial insemination of prepared animals should be carried out intrauterinely with a clear manifestation of sexual desire, follow the rules of thawing of sexed semen, and farm staff should be on the farm. compliance with the technology of using sexed sperm. Failure to comply with these requirements led to a fairly low fertility of heifers - 58-44%.

2. The use of 75 spermatozoa of sexed semen of bulls Ri-Val-Re MOUNTAINEER-ET US 60815578 and Diamond-Oak FROSTY ET US 31520543 on heifers of purebred Holstein breed in DSP "Chaika" Dudarkiv branch allowed to change the ratio of sexes in 89 offspring and receive % of cases of heifers.
3. Of the 34 heifers obtained from the use of sexed bull semen, 22 first-borns were introduced into the dairy herd, and 20 cows completed the first lactation, which is almost 60% of the potential.
4. The level of milk yield of first-borns obtained from the use of sexed semen of bulls is quite high (7717 kg of milk for the first 305 days of lactation) and exceeds the expectations of mothers ($d = +862$ kg) and not much - peers ($d = +276$ kg). At the same time in such first-borns the fat content in milk decreases ($d = -0.02... 0.05\%$).

Further use of sexed bull semen in each of the farms should be justified and economically feasible.

Due to the uncontrolled flow of various biological products to Ukraine, including genetic material, in the absence of a scientifically based breeding program and forecast of the end result, it is necessary to assess the reproductive potential of cattle when importing both breeding animals and sperm, to implement effective laboratories. methods and rapid analyzers required for quality control of cryopreserved sexed semen of bulls.

Summary

The development of technology for semen separation by sex by high-speed flow cytometry is the greatest achievement of biological science. This technology makes it possible to double the intensity of reproduction of the breeding stock of farm animals, which in turn contributes to a double increase in the gross volume of production of those types of products that are limited by sex (milk, meat, wool, eggs, etc). This technology requires further development, especially criteria for the selection of sex gametes bearing an X- or Y-chromosome. An analysis of the consequences of using this technology after 3 - 4 generations of animals will show what factors are really necessary for a successful system of reproduction and evolution of animals.

In Ukraine, for the next 5 years, it will inevitably be necessary to import sperm from abroad, but not so much the Holstein breed as other breeds, for example, France, Germany, Austria, Switzerland, where the type of animals is similar to the type of Ukrainian dairy cattle and the conditions for their maintenance and feeding. In addition, the main criterion for evaluating imported and domestic breeds should be considered not milk productivity, but fertility, duration of economic use and product quality. At the same time, for the development of the domestic breeding system, it is urgently necessary to form a network and raise the status of Ukrainian state breeding factories, breeding enterprises for growing and evaluating producers, cryobanks and service departments.

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