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Effects of Sexed and Conventional Semen Use and Calf Gender on Milk Yield Parameters, Body Weight and Milk Electrical Conductivity in Holstein Cows

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Abstract

This study was designed to determine the effects of semen type and calf gender on milk yield parameters, milk electrical conductivity and milk flow values and postpartum maternal body weight. A total of 265 Holstein cows in the first lactation were used in the study. The effect of sperm type on maternal body weight levels after calving and milk electrical conductivity values was significant (P<0.05). The effect of calf gender on postpartum maternal body weight values was significant (P<0.05). But, calf gender did not have any effect on milk electrical conductivity values and milk flow rates (P>0.05). Heifers inseminated with sexed semen had higher 100-days milk yield, milk peak yield and postpartum maternal body weight in the first lactation. Milk peak duration was higher in heifers inseminated with conventional semen (P<0.05). The effect of semen type and calf gender on maternal body weight after calving were significant (P<0.05). However, calf gender had no effect on 100, 305-days and lactation milk yields, milk peak yield and duration, milking duration and lactation length (P>0.05). In conclusion, heifers inseminated with sexed semen had higher maternal body weights, 100-days milk yield, milk peak yields and milk electrical conductivity levels in the first lactation than inseminated with conventional semen.

Key Words: Body weight, milk electrical conductivity, milk yield, sexed sperma

Holstein İneklerde Cinsiyeti Belirlenmiş ve Konvansiyonel Semen Kullanımı ve Buzağı Cinsiyetinin Süt Verim Parametreleri, Canlı Ağırlık ve Süt Elektriksel İletkenliği Üzerine Etkileri

Öz

Bu çalışma, sperma tipinin ve buzağı cinsiyetinin süt verimi parametreleri, süt iletkenlik ve akışkanlık değerleri ve doğum sonrası maternal canlı ağırlıkların üzerine etkisini belirlemek için tasarlandı. Çalışmada, birinci laktasyonda olan toplam 265 Holştayn inek kullanıldı. Sperma tipinin doğum sonrası maternal canlı ağırlık ve süt iletkenlik değerleri üzerine etkisi önemli bulundu (P<0.05). Buzağı cinsiyetinin doğum sonrası maternal canlı ağırlık değerleri üzerine etkisi önemliydi (P<0.05), fakat süt iletkenlik değerleri ve süt akışkanlık oranları üzerine cinsiyetin herhangi bir etkisi yoktu (P>0.05). Cinsiyeti belirlenmiş sperma ile tohumlanan düvelerin ilk laktasyondaki 100 günlük süt verimleri ve süt pik verimleri daha yüksekti. Pik süresi ise, konvansiyonel semen ile tohumlanan düvelerin ilk laktasyonunda daha yüksek bulundu (P<0.05). Buzağılama sonrası maternal canlı ağırlık üzerine sperma tipinin ve buzağı cinsiyetinin etkisi önemliydi (P<0.05). 100 gün, 305 gün ve laktasyon süt verimi, süt pik verimi ve süresi, sağım süresi ve laktasyon uzunluğu üzerine ise, buzağı cinsiyetinin herhangi bir etkisi yoktu (P>0.05). Sonuç olarak, cinsiyeti belirlenmiş sperma ile tohumlanan düvelerin ilk laktasyondaki maternal canlı ağırlıkları, 100 gün süt verimleri, süt pik verimleri ve süt elektriksel iletkenlik değerleri konvansiyonel sperma ile tohumlananlardan daha yüksek olduğu tespit edildi.

Anahtar Kelimeler: Canlı ağırlık, cinsiyeti belirlenmiş sperma, süt elektriksel iletkenlik, süt verimi

INTRODUCTION

The most important breeding material of dairy cow breeding enterprises is female calves. More female heifers are needed to ensure the continuity and size of the dairy farm. It is also very important to increase the genetic progress of the herd and to supply female animal material to other dairy farm (1). One of the most important methods of providing the source of female heifer in milk production enterprises is insemination with sexed semen. The rate of female calves obtained from insemination with sexed semen is over 90%. This rate obtained from insemination with conventional semen is almost half (2).

Milk yield is affected by genetics and many environmental factors. In addition, it is stated that the sex of the offspring also affects the milk yield (3). The development of the mammary glands increases in late pregnancy and is controlled by maternal and placental hormones (lactogen, estrogen, and progesterone) (4). The secretion of milk occurs through a complex physiological and behavioral interaction between dam and offspring. Sex-related milk synthesis can occur with different cellular capacity programmed through hormonal stimuli from the fetal-placental structure (5).

It is not an easy but reliable method to evaluate body condition scores of lactating cows independently of body weight. The transition from late pregnancy to lactation involves metabolic challenges. In the early lactation period, milk yield increases rapidly and energy needs increase. Since it cannot consume enough nutrients to meet its energy needs, this energy demand causes the mobilization of fat and muscle tissues. Due to the negative energy balance, it is very important that the body weight is at the desired level (6).

Milk flow rate and milk electrical conductivity are important indicators of selection and determining the level of sub-clinical and clinical mastitis in dairy cattle breeding (7). As the milking flow rate increases, the teat canal widens and becomes a target for pathogenic microorganisms (8). The electrical conductivity of milk increases with the change of anion and cation concentrations due to the inflammation in the mammary tissue. Also, there is a positive genetic correlation between the electrical conductivity of milk and mastitis (9).

In the study, it will be useful to use data on milk electrical conductivity, milk flow rate, body weight change and milk yield. Using the data, we wanted to determine how the use of sexed and conventional semen changed milk yield, electrical conductivity, body weight changes and milk fluidity values. The aim of this study is to determine the effects of semen type and calf gender on milk yield parameters, postnatal maternal live weight changes, milk electrical conductivity and flow rate values.

MATERIAL AND METHODS

Animal Management and Feeding

The study was carried out in a total of 265 cows (Holstein) in the first lactation in a private agriculture and livestock farm. The data of the heifers in the first lactation, which were inseminated 150 heads with sexed (2.5 x 106 sperm/dose), and 115 heads with conventional semen (20 x 106 sperm/dose), were used. *Brucella, IBR, BVD, neospora caninum* blood tests of all cows used in the study were negative. Animal shelters had free stalls, rubber beds, automatic drinkers and cooling systems. Primiparous cows were milked 3 times a day in an automatic milking system at 8 hour intervals (Rotary Magnum 90 Milking Parlor, Westfalia Surge, Germany). Milk yield parameters, milk electrical conductivity (Conductivity Meters, Westfalia Surge, Germany), milk flow rate and body weight values (Taxatron, Westfalia Surge, Germany) of cows were obtained from the herd management program (Dairy Plan C21, Westfalia Surge, Germany) in the milking parlor computer. Cows were fed with total mixed ration (TMR) three times a day at 8 hour intervals, after each milking. In the early lactation period, each cow was fed with an average of 10 kg of concentrate, 25 kg of corn silage, 3 kg of dried alfalfa, 2 kg of wheat straw and 3 kg of vetch + triticale mixture. In addition, 250 ml of propylene glycol, 400 g of bypass fat and 300 g of sodium bicarbonate per animal were added to the ration.

Statistical Analysis

Independent samples t test, one of the parametric tests, was preferred because of the normal distribution of the data, homogeneity of variances, and low values of kurtosis and skewness. In the study, descriptive statistics were expressed as mean and standard deviation.

RESULTS

The differences in the postpartum (in 1-4 weeks) body weight changes and milk electrical conductivity levels of the heifers inseminated with sexed and conventional semen were statistically significant (P<0.05). There was no effect of semen type on milk flow rate (P>0.05) (Table 1).

Table 1. Effects of insemination with sexed and conventional semen on body weight, milk electrical conductivity and flow rate in Holstein cows

Parameters	Semen Type	
	Sexed Semen X±Sx	Conventional Semen X±Sx
		Body weight (kg)
Weeks	n=150	n=115
1	501.68 ± 38.14^{a}	481.57 ± 40.29^{b}
2	490.57 ± 39.11^{a}	473.33 ± 37.46^{b}
3	483.31 ± 39.76^{a}	464.93 ± 38.56^{b}
4	481.86 ± 40.92^{a}	464.03 ± 36.87^{b}
Total	489.35 ± 39.12^{a}	470.97 ± 37.01^{b}
Weeks		Conductivity (mS/cm)
1	509.46 ± 34.53^{a}	498.64 ± 32.39^{b}
2	497.98 ± 30.85^{a}	485.90 ± 29.95^{b}
3	491.08 ± 29.18^{a}	479.97 ± 28.84^{b}
4	488.12 ± 31.11^{a}	473.70 ± 28.72^{b}
Total	496.66 ± 27.27^{a}	484.55 ± 27.44^{b}
		Milk flow rate (kg/min)
Weeks		
1	1.26 ± 0.44	1.36 ± 0.40
2	1.56 ± 0.39	1.57 ± 0.39
3	1.63 ± 0.40	1.71 ± 0.46
4	1.64 ± 0.41	1.75 ± 0.39
Total	1.52 ± 0.32 NS	1.60 ± 0.39 NS

a, b: The difference between groups with different letters in the same line is significant (P<0.05)
NS: Not significant
Body weight: Pospartum maternal body weight after calving

The effect of calf gender on maternal body weight, milk electrical conductivity and flow rate is given in Table 2. The effect of calf gender on maternal body weight changes by weeks (in 1-4 weeks) was significant (P<0.05). This difference is due to the higher body weights of female calving cows. However, calf gender had no effect on milk electrical conductivity values and milk flow rates (P>0.05).

Table 2. Effect of calf gender on body weight, milk electrical conductivity and flow rate

Parameters	Semen Type	
	Sexed Semen X±Sx	Conventional Semen X±Sx
		Body weight (kg)
Weeks	n=195	n=70
1	496.93 ± 37.23ᵃ	467.56 ± 45.95ᵇ
2	486.29 ± 37.53ᵃ	461.00 ± 41.92ᵇ
3	478.56 ± 38.94ᵃ	453.60 ± 41.55ᵇ
4	476.43 ± 39.07ᵃ	455.96 ± 41.35ᵇ
Total	484.55 ± 38.19ᵃ	459.53 ± 42.69ᵇ
Weeks		**Conductivity (mS/cm)**
1	503.34 ± 32.36	505.64 ± 38.57
2	490.76 ± 30.62	494.40 ± 31.89
3	485.45 ± 29.65	486.84 ± 29.22
4	481.00 ± 31.82	480.44 ± 27.40
Total	490.14 ± 31.11	491.83 ± 31.77
	NS	NS
		Milk flow rate (kg/min)
Weeks		
1	1.39 ± 0.42	1.33 ± 0.34
2	1.58 ± 0.41	1.50 ± 0.30
3	1.66 ± 0.44	1.69 ± 0.41
4	1.70 ± 0.42	1.71 ± 0.35
Total	1.58 ± 0.42	1.56 ± 0.35
	NS	NS

a, b: The difference between groups with different letters in the same line is significant (P<0.05)
NS: Not significant
Body weight: Pospartum maternal body weight after calving

Heifers inseminated with sexed semen had high milk yields at 100-days milk yield and milk peak yields in the first lactation. Peak duration was higher in heifers inseminated with conventional semen (P<0.05). In addition, maternal body weights after calving were higher in dams inseminated with sexed semen (P<0.05). There was no effect of semen type on 305-days and lactation milk yield, , lactation length and milking duration (P>0.05) (Table 3).

Table 3. Effects of insemination with sexed and conventional semen on production parameters in Holstein cows

Parameters	Semen Type	
	Sexed Semen X±Sx	Conventional Semen X±Sx
Milk yield (100-days, kg)	3113.82 ± 136.20ᵃ	2943.96 ± 154.10ᵇ
Milk yield (305-days, kg)	9115.37 ± 258.00	8806.64 ± 223.00
Lactation milk yield, kg	9808.89 ± 311.00	9430.18 ± 291.00
Milk peak yield, kg	37.79 ± 16.12ᵃ	35.81 ± 15.34ᵇ
Lactation length, days	328.25 ± 34.72	324.25 ± 5.37
Milk peak duration, days	61.25 ± 18.68ᵃ	69.44 ± 18.69ᵇ
Milking duration, minutes	6.51 ± 0.10	6.51 ± 0.11
Body weight, kg	498.31 ± 39.12ᵃ	480.56 ± 37.01ᵇ

a, b: The difference between groups with different letters in the same line is significant (P<0.05)
Body weight: Pospartum maternal body weight after calving

The effect of calf gender on milk production parameters and maternal body weight after calving in Holstein cows are given in Table 4. The effect of gender postpartum maternal body weight was determined to be significant. These values were higher in female calving heifers (P<0.05). Calf gender had no effect on 100-days, 305-days and lactation milk yield, milking duration, milk peak yield, milk peak duration and lactation length (P>0.05).

Table 4. Effect of calf gender on milk production parameters and body weight after calving in Holstein cows

Parameter	Calf Gender	
	Female X±Sx	Male X±Sx
Milk yield (100-days, kg)	3061.80 ± 130.40	2872.28 ± 194.10
Milk yield (305-days, kg)	8946.38 ± 267.00	8777.80 ± 207.00
Lactation milk yield, kg	9602.14 ± 313.00	9465.52 ± 306.00
Milk peak yield, kg	37.20 ± 11.14	34.84 ±12.28
Lactation length, days	326.44± 35.84	325.90 ± 32.51
Milk peak duration, days	63.69 ± 18.15	70.10 ± 19.87
Milking duration, minutes	6.53 ± 0.82	6.47 ± 0.85
Body weight, kg	494.58 ± 39.12ᵃ	468.33 ± 42.06ᵇ

a, b: The difference between groups with different letters in the same line is significant (P<0.05)
Body weight: Pospartum maternal body weight after calving

DISCUSSION AND CONCLUSION

Although the effect of body condition score on milk and fertility is an important research topic, few studies have been reported between milk yield and body weight changes. Significant relationships are reported between body weight with milk and reproductive yields (10,11). Postpartum body weight losses vary according to the severity of negative energy balance. High milk yield and insufficient food intake increase live weight losses. This leads to loss of body weight and decrease in milk yield in the following days (12). In the present study, postpartum maternal body weights (first 4 weeks) of heifers inseminated with sexed semen were higher than inseminated with conventional semen. In addition, it was observed that cows inseminated with sexed semen had higher milk yields at 100, 305-days and lactation. These data show that high postpartum body weight has a positive effect on milk yield.

The electrical conductivity value of milk is a parameter frequently used in automatic milking systems to determine sub-clinical and clinical mastitis in recent years. Electrical conductivity occurs with the variation of anion and cation ions. In the case of sub-clinical or mastitis occurring in milk, the concentration of Na^+ and Cl^- ions increases. This increase increases the electrical conductivity of milk (13). The genetic correlation between electrical conductivity and mastitis is reported to be between 0.65 and 0.8. The use of electrical conductivity in genetic evaluation may be an important criterion for herd management and animal selection (9). In another study, it was stated that electrical conductivity, milk flow rate and milk production rate are important in determining animal health (before clinical signs of mastitis) (14). In the present study, the electrical conductivity of milk in the first lactation was found to be higher in heifers inseminated with sexed semen. This high value may be due to the use of semen from different bulls of the same breed.

Hormones released from the fetus during pregnancy can cross the placenta and affect the hormone levels in the dam depending on the fetal sex (15). Differences in hormones secreted during the lactation period may affect the milk yield of dams giving birth to male or female calves. If differences in these increased hormones affect udder development, calf gender may have an impact on milk yield in all lactations (16). A numerically increase was detected in 100, 305-days milk yield, lactation and peak milk yields of heifers giving birth to female calves compared to giving birth to male calves. In a study conducted in New Zealand in Holstein and Jersey breed cows, it was stated that the milk yield of dams giving birth to female calves was higher. The researchers explained the high milk yield by the fact that the gestation period of the dams giving birth to male calves was two days longer. Also, in the study conducted with Holstein cows, it was reported that female giving birth dams had higher milk yield. In addition, it was stated that the calf gender in the first parity also affects the milk yield in the next lactation (17,18). In a study in Danis Holstein cows, it was reported that cows with male fetuses had lower milk yield. They explained that higher milk yield in cows that gave birth to females after birth may cause cows with male fetuses to spend more energy and decrease milk yield (19). The higher birth weight of male calves increases the difficulty birth. Difficult birth causes decreases in milk yield after calving (20). In our study, cows inseminated with sexed semen had higher milk yields. However, Diers et al. (21) reported that the milk yield of cows inseminated with conventional semen was 200 kg higher than cows inseminated with sexed semen. Postpartum body weights of dams giving birth to female calves were higher than giving birth to male calves. Male calves have higher birth weights than females. In the fetal period, male calves have more space in the uterus and pressure on the digestive system (2). For this reason, body weight gain may have increased due to the increase in prenatal feed consumption of dams giving birth to female calves. In the development of the prenatal mammary gland, the presence and concentrations of hormones, immune factors and milk bioactive components that affect offspring development may differ in the milk secreted according to sex (22).

The effect of semen type on milk peak duration was significant. Cows inseminated with conventional semen and giving birth to male calves had a longer milk peak duration. In the study conducted in primiparous Holstein cows, milk peak yield and peak duration were reported as 35.31kg and 88.6 days, respectively. It is seen that the milk peak yield is lower than the current study and the peak duration is longer (23). Hinde et al. (18) reported that the effect of calf gender on peak milk yield was insignificant. Milk yield at 100-days was found to be high in heifers inseminated with sexed semen. Similarly, Waheeb et al. (24) stated that 305-days milk yields in the first lactation were numerically higher in heifers inseminated with sexed semen. In another study, semen type had no effect on milk yield (25).

As a result, postpartum maternal body weights and milk electrical conductivity levels of heifers inseminated with sexed semen were higher than inseminated with conventional semen. In addition, 100-days milk yield and milk peak yield were found to be higher in heifers inseminated with sexed semen. In dams giving birth to female calves, postpartum maternal body weight was significantly increased.

REFERENCES

1. Cottle DJ, Wallace M, Lonergan P, Fahey AG. (2018). Bioeconomics of SexedSemen Utilization in A High-Producing Holstein-Friesian Dairy Herd. J Dairy Sci. 101(5): 4498-4512.
2. Norman HD, Hutchison JL, Miller RH. (2010). Use of Sexed Semen and Its Effect on Conception Rate, Calf Sex, Dystocia, and Stillbirth of Holsteins in The United States. J Dairy Sci. 93: 3880–3890.
3. Landete-Castillejos T, Garcia A, Lopez-Serrano FR, Gallego L. (2005). Maternal Quality and Differences in Milk Production and Composition for Male and Female Iberian Red Deer Calves (Cervus elaphus hispanicus). Behav Ecol Sociobiol. 57(3): 267–74.
4. Sternlicht MD, Kouros-Mehr H, Lu P, Werb Z. (2006). Hormonal and Local Control of Mammary Branching Morphogenesis. Differentiation. 74(7): 365-381.
5. Hinde K. (2009). Richer Milk for Sons But More Milk for Daughters: Sex-Biased Investment during Lactation Varies with Maternal Life History in Rhesus Macaques. Am. J Hum Biol. 21(4): 512-519.
6. Beam SW, Butler WR. (1999). Effects of Energy Balance on Follicular Development and First Ovulation in Postpartum Dairy Cows. J Reprod Fertil. 54: 411–424.
7. Samaraweera AM, Boerner V, Disnaka S, van der Werf JJ, Hermesch S. (2022). Genetic Associations between Mastitis, Milk Electrical Conductivity, and Milk Flow Rate in Temperate Dairy Cows in Tropics. Livestock Science. 264: 105064.
8. Carlstrom C, Strandberg E, Johansson K, Pettersson G, Stålhammar H, Philipsson J. (2016). Genetic Associations of In-Line Recorded Milkability Traits and Udder Conformation with Udder Health. Acta Agric. Scand. 66: 84–91.
9. Norberg E. (2005). Electrical Conductivity of Milk as a Phenotypic and Genetic Indicator of Bovine Mastitis: A Review. Livestock Production Science. 96: 129–139.
10. Roche JR, Macdonald KM, Burke CR, Lee JM, Berry DP. (2007). Associations between Body Condition Score, Body Weight and Reproductive Performance in Seasonal-Calving Pasture-Based Dairy Cattle. J Dairy Sci. 90: 376–391.
11. Hristov AN, Price WJ, Shaf B. (2005). A Meta-Analysis on The Relationship between Intake of Nutrients and Body Weight with Milk Volume and Milk Protein Yield in Dairy Cows. J Dairy Sci. 88: 2860–2869.
12. Horan B, Dillon P, Faverdin P, Delaby L, Buckley F, Rath M. (2005). Strain of Holstein-Friesian by Pasture-Based Feed System Interaction for Milk Production, Bodyweight and Body Condition Score. J Dairy Sci. 88: 1231–1243.
13. Kitchen BJ. (1981). Review of The Progress of Dairy Science: Bovine Mastitis: Milk Compositional Changes and Related Diagnostic Tests. J Dairy Res. 48: 167–188.

14. Inzaghi V, Zucali M, Thompson PD, Penry JF, Reinemann DJ. (2021). Changes in Electrical Conductivity, Milk Production Rate and Milk Flow Rate Prior to Clinical Mastitis Confirmation. Ital. J Anim Sci. 20(1): 1554–1561.
15. Ivell R, Bathgate RA. (2002). Reproductive Biology of The Relaxin-like Factor (RLF/INSL3). Biol Reprod. 67(3): 699-705.
16. Hess MK, Hess AS, Garrick DJ. (2016). The Effect of Calf Gender on Milk Production in Seasonal Calving Cows and Its Impact on Genetic Evaluations. PloS one. 11(3): e0151236.
17. Chegini A, Zadeh NGH, Moghadam HH. (2015). Effect of Calf Sex on Some Productive, Reproductive and Health Traits in Holstein Cows. Spanish Journal of Agricultural Research. 13(2): 2.
18. Hinde K, Carpenter AJ, Clay JS, Bradford BJ. (2014). Holsteins Favor Heifers, Not Bulls: Biased Milk Production Programmed During Pregnancy as A Function of Fetal Sex. PloS one. 9(2): e86169.
19. Græsbøll K, Kirkeby C, Nielsen SS, Christiansen LE. (2015). Danish Holsteins Favor Bull Offspring: Biased Milk Production as a Function of Fetal Sex, and Calving Difficulty. PloS one. 10(4): e0124051.
20. Johanson JM, Berger PJ. (2003). Birth Weight as A Predictor of Calving Ease and Perinatal Mortality in Holstein Cattle. J Dairy Sci. 86(11): 3745–55.
21. Diers S, Heise J, Krebs T, Groenewold J, Tetens J. (2020). Effect of Sexed Semen on Different Production and Functional Traits in German Holsteins. Vet Anim Sci. 9: 100101.
22. Neville MC, Anderson SM, McManaman JL, Badger TM. (2012). Lactation and Neonatal Nutrition: Defining and Refining The Critical Questions. J Mammary Gland Biol. 17(2): 167–188.
23. Atashi H, Asaadi A, Hostens M. (2021). Association between Age at First Calving and Lactation Performance, Lactation Curve, Calving Interval, Calf Birth Weight, and Dystocia in Holstein Dairy Cows. PloS one. 16(1): e0244825.
24. Waheeb RS, Harb HM, El-Amrawi GA. (2020). Research Article GnRH at Time of Insemination of Sexed Semen Enhanced Conception Rate in Holstein Heifers. Asian J Anim Vet Adv. 15 (2): 60–66.
25. Chebel RC, Guagnini FS, Santos JEP, Fetrow JP, Lima JR. (2010). Sex-sorted Semen for Dairy Heifers: Effects on Reproductive and Lactational Performances. J Dairy Sci. 93(6): 2496–2507.

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