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Effect of calf birth weight on milk production of Holstein dairy cattle in desert climate

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Abstract The hypothesis in this study was that calf birth weight (CBW) would effect on cow's milk production. Data were collected from two commercial dairy milking 15,000 Holsteins in central region of Iran with desert climate from 2006 to 2012. Animals were enrolled at parturition until 7,737 calvings were available for analysis. Data consisted of on-farm measurements of calf birth weight and milk production, and data were analyzed using a multivariable regression model. Independent variables were parity, herd-year-season, calving interval, calving age, retained placenta, days open, dry period length, days in milk, linear and quadratic CBW. The mean CBW was 40.84 ± 4.9 kg (SD) with a range of 20 to 60 kg. There was a trend for milk305 based on calf birth weight, i.e., the amount of milk305 of dam was significantly dependent on that weight of calf was born ($P < 0.01$). Cows with CBW between 20 and 25 kg had the lowest of milk production. By increasing of CBW range up to 40 and 45 kg, the trend of milk production increased and then decreasing trend observed. In conclusion, calf birth weight could be considered as an important trait in dairy cattle breeding programs in desert climate.

Keywords: calf, weight, milk, Holstein, desert climate

Introduction

Size at birth is important for calving ease of the dams and neonatal survival of the calves (Johanson and Berger 2003). Increased calf birth weight (CBW) is associated with dystocia, stillbirths, and calf mortality, all of which were associated with lower calf and cow performance, which can lead to economic losses (Meijering 1984). One report indicated that high CBW was associated with increased perinatal calf mortality and dystocia in dairy cattle (Johanson and Berger 2003). Stillbirths themselves are a large economic loss; Meyer et al (2001) reported that losses associated with stillbirths were close to $125 million/yr. Also, economic losses from stillbirth parturitions include not only the value of the lost calf, but also decreased milk production (Bicalho et al 2007, 2008). Sieber et al (1989) demonstrated that higher CBW was related to increased dystocia.

Atashi et al (2013) suggested that genetic selection for lowering the calf birth weight could be one means of reducing the incidence of dystocia in dairy cattle. Lombard et al (2007) reported that calves born from assisted parturitions were not only at higher risk of stillbirth, but for mortality until 30 d after birth. Furthermore, the relative size of the calf in relation to the dam can play an important role on the detrimental effect of calf size on the dam's subsequent lactation; birth weight and maternal pelvic size are the 2 most important predictors of fetus-pelvic disproportion dystocias (Meijering 1984). Another study reported that dystocia cases had negative effects on 305-d milk yield (Dematawewa and Berger 1997). More specifically, Bicalho et al (2007) showed that severe dystocia was associated with a reduction in milk production of 0.8 kg/d for the rest of their lactation when compared with cows that did not have dystocia. Few studies have examined the relationship between CBW and subsequent cow milk production in dairy cattle. Therefore, our objective was to estimate the effect of calf birth weight on milk production of Holstein dairy cattle in desert climate.

Materials and Methods

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Data were collected from two commercial dairy farms located in central region of Iran (around of Isfahan city) with 32º 38' north latitude and 51º 39' east longitude and 1575 m altitude; calving occurred between 2006 and 2012. The climate here that is classified as BWk by the Köppen-Geiger system is desert. The herds evaluated were purebred Holsteins, managed under conditions similar to those used in most developed countries, and were under official performance and pedigree recording. Monthly milk recording was performed by trained technicians of the Iranian Animal Breeding Center, according to the guidelines of the International Committee for Animal Recording (ICAR 2011). In total, the data were from 15,000 Holstein cows milked 3 times daily. Cows were housed in free stall barns bedded with sand and cleaned by scrapers. The cows were fed a TMR consisting of about 55% forage (corn silage, alfalfa hay, and wheat straw) and 45% concentrate (corn meal, soybean meal, canola, cottonseed, and supplements). NRC recommendations were used to balance rations (National Research Council 2001).

Cows approaching parturition were housed in free stalls bedded with sand and cleaned by skid steers 2 to 3 times daily. Maternity pens were adjacent to the free stall area of the barn, and pack bedded with wheat straw and cleaned once weekly. Cows approaching parturition and in maternity groups were monitored 24 h/d by farm employees. Employees walked the barns at least once hourly, looking for visual signs of parturition (contractions, observation of fetal membranes or feet), and moved cows to the maternity pens upon detection of parturition signs. After parturition, calves were immediately removed from the maternity pens into a heated calf pen. Before the calves were fed colostrum, they were weighed on a digital scale. Farm employees fed 4 L of colostrum within the first hour of birth by esophageal tube. Stillbirth was defined as calf mortality shortly before, during, or within the first 12 h after parturition. Calves were transferred twice daily to the calf facility where they were housed in individual pens and fed pasteurized milk twice daily, along with free choice grain and water.

Measurements and Data Collection

Cows were enrolled upon parturition. Farm employees measured CBW just after calving. Identification numbers for both dam and calf were recorded, as well as calving ease and whether it was a stillbirth or not.

Statistical Analyses

Calvings that occurred before 260 d of gestation were excluded as our objective was to consider full-term pregnancies and not abortions. The mean birth weights, with standard errors for offspring were calculated overall. Multivariable regression model for CBW and milk production was fitted in SAS (SAS Institute Inc., Cary, NC) using the GLM procedure. Residual values were examined for normality by visual inspection of frequency histograms, and by performing the following goodness of fit tests: Kolmogorov-Smirnov, Cramer-von Mises, and Anderson-Darling tests. The following variables were offered to the model as independent variables; parity, herd-year-season (HYS), calving interval (CI), calving age (CA), retained placenta (RP), days open (DO), dry period length (DPL), days in milk (DIM), linear and quadratic CBW. For model described above, independent variables were kept in the models when $P < 0.10$ in an attempt to reduce the type II error risk while maintaining a stringent type I error risk at 5%. Twinnings were excluded to facilitate analysis and interpretation. Parity was defined by the orders of calvings for each cow in the dataset. For twin calving, the birth weights of both twins were excluded from the analysis but the calving still gave rise to an increase in parity. Parity was coded individually for 10 parities, while subsequent parities were excluded due to the low number of observations. Season of calving were categorized into quartiles based on month of partum. “Spring calving” was defined as births between 21 March and 21 June while the “Summer calving” season was set to 22 June to 22 September. Also, “autumn calving” was defined as births from 23 September to 21 December and “Winter calving” season was set to 22 December to 20 March.

Results and Discussion

Climatic Conditions in the center of Iran

In this study, we collected meteorological data of the around of Isfahan city from 2006 to 2012. Summer was the warmest season of the year. The temperature in summer averaged 27.6 °C. Also, the driest season was summer, with 0.19 mm of rain. The greatest amount of precipitation occurred in autumn, with an average of 20.4 mm. For wind speed, the highest average was in spring, with 2.3 m/s (Table 1).

Descriptive Statistics

After the data exclusion criteria were met, a total of 7,737 calving were available for analysis. The mean CBW was 40.84 ± 4.9 kg (SD) with a range of 20 to 60 kg. The mean milk305 was 11,775.3 ± 1,981.4 kg with a range of 5040.9 to 17959.6 kg. Cows ranged from 474 to 5,359 d in CA, with a mean of 1,281.1 ± 623.2 d in age. The mean CI and DIM were 351.1 ± 159.6 d and 351 ± 84.2 d, respectively. Cows ranged from 29 to 783d in DO, with a

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mean of 136.6 ± 93.7 d. Also, the mean DPL was 38.4 ± 37.5 d with a range of 0 to 375 d. frequency of RP incidence was 7.3% (383 animals). Total calvings occurred at the following frequencies by season, from spring to winter respectively: 1,450 calvings (18.8%), 2,151 calvings (27.8%), 2,285 calvings (29.5%), and 1,851 calvings (23.9%).

Table 1 The average of temperature, precipitation and wind speed for each season during 2006 to 2012.

	Season			
Parameters	Spring	Summer	Autumn	Winter
Temperature (°C)	22.7	27.6	10.7	7.5
Precipitation (mm)	13.5	0.19	20.4	20.3
Wind speed (m/s)	2.3	1.5	0.92	1.9

Model including all animals

Results from the multivariable model including all animals are given in Table 2. The regression model estimated that animals without RP (defined as 0) had 326 kg milk305 higher than animals with RP ($P < 0.01$) and that milk305 in the spring and summer yielded 806 and 609 kg lower than winter milk305, respectively ($P<0.001$). Furthermore, milk305 for the first 4 parities was higher than milk305 from older animals ($P < 0.01$).

There was a trend for milk305 based on CBW, i.e., the amount of milk305 of dam was significantly dependent on that weight of calf was born ($P < 0.01$; Table 2). Cows with CBW between 20 and 25 kg had the lowest of milk production. By increasing of CBW range up to 40 and 45 kg, the trend of milk production increased and then decreasing trend observed (Figure 1).

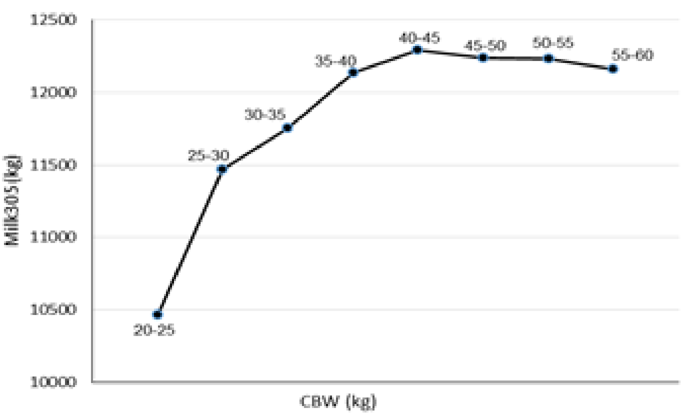

Figure 1 Trend of cow milk305 based on CBW in Holstein.

In the following discussion, we compare mean of CBW and its association with cow milk production from this study with other results in the literature. Our result for the mean of CBW was 40.84 ± 4.9 kg. Kertz et al (1996) reported the mean birth weight for calves was 41.4 kg. Also, Atashi et al (2013) reported the mean (SD) calf birth weight was 41.72 (5.13) kg in Holstein dairy cows in Iran.

Contreras et al (2015) obtained 40.12 ± 6.63 kg for overall mean and standard error of CBW in Charolais cattle. However, Kamal et al (2014) reported higher calves birth weight (43.6 5.78 kg) and Yaylak et al (2015) and Bar-Peled et al (1997) reported lower mean of birth weight (39.6±0.15 and 38 ± 0.4 kg, respectively) in Holstein calves. For value of calf birth weight, different results were observed among the mentioned authors, considering that CBW depends largely on feeding, health and reproductive management, which vary from herd to herd. Pabst et al (1977) reported that birth weight (BW) has a positive relationship with performance. In other words, the calves with higher BW will have higher growth rate than those with lower BW (Boligon et al 2010; Coffey et al 2006; Dawson et al 1947). Furthermore, those calves with higher BW also had higher persistency than low-BW calves (Lamb and Barker 1975; Singh et al 1970).

Plasse and Koger (1967) reported that average milk production of animals with a higher birth weight was higher than those animals with a lower birth weight. On the other hand, Chew et al (1981) obtained that the relationship between calf birth weight and each yield measure was linear and positive for calf birth weights between 23 and 50 kg. Expected difference in 200-day yields of milk was 15.2% higher for 50 kg calf birth weight as compared to 30 kg calf birth weight. Corresponding difference in 305 day milk was 9.4%. Thus, yield of milk in Holsteins increased with increasing CBW. However, yield of milk in this study increased with increasing CBW up to range of 40-45 kg (from 10465 to 12295 kg) and then decreased when the CBW increased to range of 55-60 kg (from 12295 to 12163 kg). Malau-Aduli et al (1996) studied phenotypic relationship between birth weight and subsequent milk production of Friesian-Bunaji crossbreds. The values of intercept and regression coefficient are reported -1564.62 and 87.79, respectively. They concluded that body weight at birth has little value in the prediction of future milk yield of Friesian-Bunaji heifers. In the present study, the values of intercept and regression coefficient were -2662.45 and

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176.47, respectively. Rahnefeld et al (1990) noticed the milk production of beef cows was highly related to calf birth weight at Manyberries (b: 0.023, P: 0.0007) while there was no relationship at Brandon. Linden et al (2009) studied CBW and its association with calf and cow milk production in Holstein. The mean CBW calculated 42.9 6.0 kg (SD). Also, similar to findings of the present study, they noticed the CBW can be associated milk production.

Table 2 Variables significantly associated with milk305 of Holstein cows. Multivariable estimates and *P*-values from a multilevel regression model. The analysis included 7,737 calving in two Holstein herds.

Variable	Levels	Estimates	*P*
	Intercept	-2662.45	0.13
CI		0.83	<0.001
Parity	1st	3359.13	0.002
	2nd	3137.35	0.002
	3rd	3203.61	0.001
	4th	2542.99	0.007
	5th	1705.69	0.06
	6th	1368.43	0.13
	7th	54.09	0.95
	8th	-4.92	0.99
	9th	615.23	0.6
	10th	Referent	
Herd	1	525.55	0.004
	2	Referent	
Year	2006	-2357.53	<0.001
	2007	-1854.93	<0.001
	2008	-1998.48	<0.001
	2009	-1235.51	<0.001
	2010	-1293.05	<0.001
	2011	-300.91	0.005
	2012	Referent	
Season	Spring	-806.3	<0.001
	Summer	-609.48	<0.001
	Autumn	5.97	0.94
	Winter	Referent	
Calving age	Linear	0.56	0.008
DPL	Linear	-2.47	0.02
DO	Linear	-16.38	<0.001
RP	0	326.57	0.002
	1	Referent	
DIM	Linear	25.58	<0.001
CBW	Linear	176.47	0.003
CBW*CBW	Quadratic	-1.56	0.02

Ghoraishy and Rokouei (2013) studied impact of birth weight of Iranian Holstein calves on their future milk production. The results indicated that birth weight positively affected on milk yield ($p < 0.001$). In this study, the regression coefficient similarly obtained positive for linear CBW. Hamad and Moghazy (2015) reported CBW between

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30 and 50 kg had no a significant (p>0.05) effect on milk yield at 30, 60, 90, 120 and 150 days in the Egyptian buffaloes. For Holstein cows, we found significant effect of CBW between 20 and 60 kg on milk yield 305d.

Conclusions

The results of this research showed that birth weight is a significant parameter in cow milk production trait in desert climate. Therefore, birth weight could be considered as an important trait in dairy cattle breeding programs in desert climate.

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References

Atashi H, Zamiri MJ, Dadpasand M (2013) Association between dry period length and lactation performance, lactation curve, calf birth weight, and dystocia in Holstein dairy cows in Iran. Journal of Dairy Science 96:3632-3638.

Bar-Peled U, Robinzon B, Maltz E, Tagari H, Folman Y, Bruckental I, Voet H, Gacitua H, Lehrer AR (1997) Increased weight gain and effects on production parameters of Holstein heifer calves that were allowed to suckle from birth to six weeks of age. Journal of Dairy Science 80:2523-2528.

Bicalho RC, Galvao KN, Cheong SH, Gilbert RO, Warnick LD, Guard CL (2007) Effect of stillbirths on dam survival and reproduction performance in Holstein dairy cows. Journal of Dairy Science 90:2797-2803.

Bicalho RC, Galvao KN, Warnick LD, Guard CL (2008) Stillbirth parturition reduces milk production in Holstein cows. Preventive Veterinary Medicine 84:112-120.

Boligon AA, Mercadante MEZ, Forni S, Lobo RBL, Albuquerque G (2010) Covariance functions for body weight from birth to maturity in Nellore cows. Journal of Animal Science 88:849-859.

Chew BP, Maier LC, Hillers JK, Hodgson AS (1981) Relationship between calf birth weight and dam's sub-sequent 200- and 305-day yields of milk, fat, and total solids in holsteins1. Journal of Dairy Science 64:2401-2408.

Coffey MP, Hickey J, Brotherstone S (2006) Genetic aspects of growth of Holstein-Friesian dairy cows from birth to maturity. Journal of Dairy Science 89:322-329.

Contreras VIP, Bracamonte GMP, Bustamante LAL, Medina VRM, Rincon AMS (2015) Milk composition and its relationship with weaning weight in Charolais cattle. Revista Brasileira de Zootecnia 44:207-212.

Dawson WM, Phillips RW, Black WH (1947) Birth weight as a criterion of selection in beef cattle. Journal of Animal Science 6:247-257.

Dematawewa CM, Berger PJ (1997) Effect of dystocia on yield, fertility, and cow losses and an economic evaluation of dystocia scores for Holsteins. Journal of Dairy Science 80:754-761.

Ghoraishy SH, Rokouei M (2013) Impact of birth weight of Iranian Holstein calves on their future milk production and reproductive traits. Journal of Livestock Science and Technologies 1:39-44.

Hamed MNF, El-Moghazy MM (2015) Influence of sex and calf weight on milk yield and some chemical composition in the Egyptian buffalo's. Journal of Animal and Veterinary science 2:22-27.

ICAR (International Committee for Animal Recording) (2011) Guidelines approved by the General Assembly held in Riga on June 2010.

Section 2.1, pages 23–56, in ICAR Rules, Standars and Guidelines for Recording Milk and Milk Constituents. Accessed Mar. 8, 2013. http://www.icar.org/Documents/Rulesandregulations/Guidelines/Guidelines_2011.pdf.

Johanson JM, Berger PJ (2003) Birth weight as a predictor of calving ease and perinatal mortality in Holstein cattle. Journal of Dairy Science 86:3745-3755.

Kamal MM, Van Eetvelde M, Depreester E, Hostens M, Vandaele L, Opsomer G (2014) Age at calving in heifers and level of milk production during gestation in cows are associated with the birth size of Holstein calves. Journal of Dairy Science 97:5448-5458.

Kertz AF, Reutzel LF, Barton BA, Ely RL (1997) Body weight, body condition score, and wither height of prepartum Holstein cows and birth weight and sex of calves by parity: a database and summary. Journal of Dairy Science 80:525-529.

Lamb RC, Barker BO (1975) Genetic relationship be-tween birth weight and adult weight in Holsteins. Journal of Dairy Science 58:724-728.

Linden TC, Bicalho RC, Nydam DV (2009) Calf birth weight and its association with calf and cow survivability, disease incidence, reproductive performance, and milk production. Journal of Dairy Science 92:2580–2588.

Lombard JE, Garry FB, Tomlinson SM, Garber LP (2007) Impacts of dystocia on health and survival of dairy calves. Journal of Dairy Science 90:1751-1760.

Malau-Aduli AEO, Abubakar BY, Dim NI (1996) Phenotypic relationship between body weights and subsequent milk production of Friesian-Bunaji crossbreds. proceedings of the Australian Society of Animal Production 21:274-277.

Meijering A (1984) Dystocia and stillbirth in cattle–A review of causes, relations and implications. Livestock Production Science 11:143-177.

Meyer CL, Berger PJ, Koehler KJ, Thompson JR, Sattler CG (2001) Phenotypic trends in incidence of stillbirth for Holsteins in the United States. Journal of Dairy Science 84:515-523.

National Research Council (2001) Nutrient requirements of dairy cattle. 7th rev. ed. Washington, DC: National Academic Science.

Pabst W, Kilkenny JB, Langholz HJ (1977) Genetic and environmental factors influencing calf performance in pedigree beef cattle in Britain. 2. The relationship between birth, 200-day and 400-day weights and the heritability of weight for age. Animal Production 24:41-48.

ISSN 2318-1265

Plasse D, Koger K (1967) A study of birth weight. Mems Assoc. Lat. Ameri. Prod. Anim. 2:7-22.

Rahanefeld GW, Weiss GM, Fredeen HT (1990) Milk yield and composition in beef cows and their effect on cow and calf performance in two environments. Canadian Journal of Animal Science 70:409-423.

SAS institu (2003) SAS user`s guide, version 9.1, SAS inst., inc., cary, NC.

Sieber M, Freeman AE, Kelley DH (1989) Effects of body measurements and weight on calf size and calving difficulty of Holsteins. Journal of Dairy Science 72:2402-2410.

Singh AR, Schalles RR, Smith WH, Kessler FB (1970) Cow weight and preweaning performance of calves. Journal of Animal Science 31:27-30.

Yaylak E, Orhan H, Daskaya A (2015) Some environmental factors affecting birth weight, weaning weight and daily live weight gain of Holstein calves. Turkish Journal of Agriculture - Food Science and Technology 3:617-622.

DOI http://dx.doi.org/10.14269/2318-1265/jabb.v4n3p65-70