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Association of Somatic Cell Score with Production Traits in Iranian Holstein Cows

Research Article

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ABSTRACT

The objective of this study was to analyze the association of somatic cell score (SCS) with milk, fat and protein yields across parities. Records of production traits and somatic cell counts (SCC) from first, second and third parity that were collected by the Animal Breeding Center of Iran from 1993 to 2010 were used. All animals were grouped into six classes according to SCC and production traits were evaluated in these SCC classes. To obtain an approximate normal distribution, SCC records were transformed on the base of Log_e to somatic cell score (LSCS, the lactation mean of the natural log of test-day somatic cell count). A single trait animal model that LSCS was fitted as covariate was used to assess relations of SCS with production traits in fist, second and third parities. Effect of SCS on production traits in all of parities was negative and significant (P<0.05). Ranges of depressing effects on milk, fat and protein production were 107.78-220.41, 2.32-7.08 and 2.1-5.2 kg per 1 unit increase in SCS.

KEY WORDS Holstein cattle, production traits, somatic cell score.

INTRODUCTION

Milk yield is the most important source of revenue for dairy farmers. High producing cows are usually profitable. However, high yields are associated with health problems and reproductive disorders (Degroot *et al*. 2002; Windig *et al.* 2006). Mastitis is the most costly disease in dairy cattle production systems, and lowering its incidence is important to reduce costs of health care, improve animal welfare and reduce utilization of antibiotics and consequently their residuals in milk (Odegard *et al*. 2003). The economic costs of mastitis include reduced milk production, discarded milk, increased culling, increased costs of health care, and reduced milk quality. In addition, mastitis contributes to consumer concerns regarding animal welfare. Strategies to control mastitis include preventive health care, hygiene, veterinary remedies and genetic selection (Weller *et al.* 1992). Mastitis affect milk yield and quality (Yalcin *et al.* 2000; Heringstad *et al.* 2003; Ikonen *et al*. 2004; Miller *et al*. 2004; Hagnestam *et al*. 2007; Zhong *et al*. 2010). Percentage of cows culled due to high somatic cell counts (SCC) was up to 30% according to Schutz (1993). somatic cell counts (SCC) in milk from healthy udders varies between 50000 and 200000 cells/mL, depending on the age of cows (Smith, 1996). While cows with subclinical mastitis can excrete up to a few million cells per milliliter sometimes, excretion is usually in the range from 200000 to 500000 cells/mL (Reneau, 1986). Miller *et al.* (2004) reported a decrease in 305 day milk yield of 54.6 kg and 61.4 kg per somatic cell score unit increase on the first test-day for the first and second parities, respectively. Production losses were estimated at 0 to 11%, 0 to 12%, and 0 to 11%

of milk, fat and protein 305-day yields for cows developing clinical mastitis (Hagnestam *et al.* 2007). The proper researches on association between milk yield, composition and SCC should be paid more attention because of improvement of breeding program includes mastitis resistance and intensification of dairy cattle production system in Iran.

The objective of this study was the assessment of increased milk yield loss caused by SCC, in order to improve dairy industry in Iranian Holstein populations.

MATERIALS AND METHODS

Data for this study were provided by the Animal Breeding Center of Iran. Data were collected from 1993 to 2010. Data included milk production trait (milk, fat and protein yields) and somatic cell count (SCC) in first, second and third parities.

The range of age for first, second and third parity were 18 to 40, 32 to 55 and 46 to 70 months, respectively (Penasa *et al.* 2010). Animals without records for these traits were omitted. After edition of data, to obtain an approximate normal distribution, SCC records were transformed into scores (SCS) and the lactation mean of the natural log of test-day somatic cell count (LSCS) was determined (equations 1) following Schukken *et al.* (1992) and Odegard *et al.* (2003):

$$LSCS= 1 / n \sum_{1}^{n} (\log_e(SCC/1000\times cells/mL))$$

In equation 1, n is the number of test day records for animal i. All animals were grouped into six classes according to SCC (SCC<100, 100≤ SCC≤200, 201≤ SCC≤400, 401≤ SCC≤500, 501≤SCC≤800 and SCC>800) (Juozaitiene *et al.* 2006) and production traits were evaluated within these classes with SAS software (SAS, 2007).The following model was used for estimation of losses in traits at first, second and third parity by 1 unit increase in SCS:

$$Y= \mu + HYS + b_1 (age-\overline{age}) + b_2 (age-\overline{age})^2 + b_3 (scs-\overline{scs}) + a + e$$

Where:
Y: is the observation for milk production traits.
μ: is the mean of population.
HYS: is the herd year season at calving.
Age: is the age of animal at first calving.
$\overline{Age}$: is the mean of age at first calving.
SCS: is the somatic cell score of animal in different parities.
$\overline{scs}$: is the mean of somatic cell score in population.
b_1, b_2 and b_3: are regression coefficients for linear and quadratic effect of age and SCS, respectively.
a: is the effect of additive genetic and e is the residual effects. In this model, fixed effects were HYS and linear, quadratic effect of age and SCS were covariate in model. The ASREML software (Gilmour *et al.* 2000) was used for the analysis.

RESULTS AND DISCUSSION

Descriptive statistics of production traits in different parities are shown in table 1. Mean of milk yield increased with parity. Mean of milk in first parity was 7811 kg and was up to 8875 kg in the third parity. Minimum and maximum variation coefficients (CV) for traits were for first and third parity, respectively. Number of animals with records in second and third parity was lower than first parity. Decreasing trend in number of records and increasing trend in mean of production traits and CV were observed in fat and protein traits. Maximum of animals for production traits were in first class of SCC (except for pro 305 in third parity) (Table 2). In another class, percent of animals were low and with increasing of parity, percent of animals in later classes (third, fourth, fifth and sixth classes) were high. Decreasing trend for milk, fat and protein was observed with increasing of SCC although in some classes of fat yield was observed increasing trend (first with second class, forth with fifth class). In protein yield in first parity, decreasing between first and second class, second and third class were not significant (P>0.0001) but difference between another classes in milk, fat and protein in first parity were significant (P<0.0001). For second parity, there were no significant differences between first and second class for the three traits (P>0.0001) but differences between other classes were important (P<0.0001). Differences between milk yield in third parity had significance difference (P<0.0001). In fat yield, differences between fourth and fifth classes were not significant (P>0.0001). Differences between first until fourth class in protein yield were not significant (P>0.0001). In first, second and third parity, about 35, 48 and 57% of animal had SCC > 200000 cells/mL. SCC in milk from healthy udders varies between 50000 and 200000 cells/mL, depending on the age of cows (Smith, 1996). Thus, animal with SCC > 200000 were susceptible for mastitis.

Table 3 shows regression coefficients of milk production traits from SCS in different parities. Regression coefficients for all traits were negative. Amount of decreasing milk was significant at 1% (P<0.01), but for fat and protein traits, decreasing was significant at 5% (P<0.05). Amount of losses were increased by increasing of parity. Amount of losses for milk in first, second and third parity were -107.87, -163.57 and -220.41 kg in one lactation period per 1 unit of increasing in SCS, respectively.

Table 1 Descriptive statistics for milk, fat and protein yields in the first, second and third parities

Traits	First parity			Second parity			Third parity		
	MY305	FY305	PY305	MY305	FY305	PY305	MY305	FY305	PY305
No. record	150073	126752	123490	118225	100438	97547	76774	65556	63808
No. pedigree	224666	224666	224666	179795	155030	150513	122825	106339	103450
Mean (kg)	7811	255.10	236.80	8581	282.20	263.10	8857	292.40	269.40
SD (kg)	1538.52	56.05	46.23	1878.27	69.44	54.20	2026.82	75.06	57.64
Min (kg)	3187	87.15	98.01	2947	76.31	100.10	2786	69.96	95.83
Max (kg)	12410	424	376.10	12210	491.90	427	14930	518.80	444.80
CV (%)	19.70	21.97	19.38	21.90	24.60	20.60	22.90	25.67	21.40

MY305: 305 days milk yield; FY305: 305 days fat yield and PY305: 305 day protein yield.
SD: standard deviation; Min: minimum; Max: maximum and CV: coefficient of variation.

Table 2 Milk, fat and protein yields by SCC class in the first three parities

SCC (1000/mL)	First parity					
	MY305		FY305		PY305	
	%	LSM	%	LSM	%	LSM
SCC < 100	47.9	8,803.23^{a}	46.1	288.58^{a}	46.4	267.66^{a}
100 ≤ SCC ≤ 200	18.3	8,768.26^{b}	18.6	288.94^{ab}	18.9	266.68^{ab}
201 ≤ SCC ≤ 400	15.3	8,638.66^{c}	15.9	284.06^{c}	16.1	265.12^{bc}
401 ≤ SCC ≤ 500	5.9	8,324.16^{d}	6.4	273.91^{d}	5.6	261.41^{d}
501 ≤ SCC ≤ 800	6.1	8,346.09^{de}	6.4	276.17^{de}	6.4	258.70^{e}
SCC > 800	6.5	7,836.66^{f}	6.6	259.43^{f}	6.6	244.13^{f}
SCC (1000/mL)	Second parity					
	MY305		FY305		PY305	
	%	LSM	%	LSM	%	LSM
SCC < 100	31.4	9,201.88^{a}	30.5	301.35^{a}	30.0	277.36^{a}
100 ≤ SCC ≤ 200	20.4	9,144.62^{ab}	20.2	303.51^{ab}	20.7	275.47^{ab}
201 ≤ SCC ≤ 400	20.7	8,969.87^{c}	21.0	295.88^{c}	21.4	272.58^{c}
401 ≤ SCC ≤ 500	7.6	8,646.59^{d}	8.1	285.36^{d}	7.5	268.53^{d}
501 ≤ SCC ≤ 800	9.4	8,669.58^{de}	9.6	287.19^{de}	9.8	265.50^{e}
SCC > 800	10.5	8,068.36^{f}	10.6	268.95^{f}	10.6	249.61^{f}
SCC (1000/mL)	Third parity					
	MY305		FY305		PY305	
	%	LSM	%	LSM	%	LSM
SCC < 100	23.7	7,950^{a}	22.8	258.86^{a}	22.2	238.06^{a}
100 ≤ SCC ≤ 200	18.5	7,855.10^{b}	18.2	257.54^{b}	18.6	237.97^{ab}
201 ≤ SCC ≤ 400	21.8	7,791.30^{c}	22.1	255.57^{c}	22.4	238.74^{abc}
401 ≤ SCC ≤ 500	8.9	7,518.19^{d}	9.4	247.65^{d}	8.9	237.04^{abd}
501 ≤ SCC ≤ 800	12.2	7,578.92^{e}	12.4	247.98^{de}	12.5	233.50^{e}
SCC > 800	14.9	7,189.43^{f}	15.2	235.61^{f}	15.4	222.62^{f}

The means within the same row with at least one common letter, do not have significant difference (P>0.0001).
MY305: 305 days milk yield; FY305: 305 days fat yield and PY305: 305 day protein yield.
LSM: least squares means.

Table 3 Regression coefficients of production traits on somatic cell score in different parities

Traits		First parity	Second parity	Third parity
Milk (kg)	Reg. coefficient	-107.87±3.23**	-163.57±4.67**	-220.41±6.44**
	P-value	0.009	0.009	0.009
Fat (kg)	Reg. coefficient	-2.32±0.12*	-4.56±0.18*	-7.08±0.24*
	P-value	0.017	0.012	0.011
Protein (kg)	Reg. coefficient	-2.1±0.20*	-3.62±0.15*	-5.19±0.20*
	P-value	0.016	0.013	0.012

* P<0.05 and ** P<0.01.

For fat and protein yield, losses were -2.32, -4.56, -7.08 and -2.1, -3.6 and -5.2 kg per 1 unit increasing of SCS, respectively. Numbers of record in different parity for SCS in analysis were the same of number records of production traits. Mean of SCS for first, second and third parity were ranging from 7.8 to 8.2 and 8.4, respectively.

Increasing trend was for mean of SCS with increasing of parity. Miglior *et al.* (1995) reported a negative genetic correlation between milk yield and mastitis resistance. Mastitis resistance was depressed for dairy cattle that were under high selection intensiveness. In this study, mean of milk yield increased with increasing of SCS.

SCS is an indicator for mastitis and increasing of SCS with improvement of production trait showed that mastitis resistance of Iranian Holstein was depressed. Mean of milk yield for Razavi Khorasan Holsteins in Iran were reported as 7126.27, 7985.86, 8246.53 kg for first, second and third parity, respectively. For FY305, they were 230.61, 252.46 and 259.86 kg, respectively (Teimurian, 2009). Samore *et al.* (2008) reported a mean of protein for first, second and third parity of 269, 296, 300 kg, respectively. Mean of SCS were 3.09, 3.46 and 3.78 in first, second and third parity for Italian Holstein-Frisian cattle, respectively. Mean of milk, fat, protein and SCS in Israeli Holstein were 10281, 331, 311 kg and 4.94, respectively (Weller and Ezra, 2004).

Mean of SCS in our study was higher than those in reports and in milk production traits. The cause of these differences could be due to breed type, management, climate conditions and record structure. Zhong *et al.* (2010) classed animals into four classes and reported that losses in milk production traits were observed in first and fourth classes. Significant differences between six classes of SCC were reported for Lithuanian Black-and-White cattle (P<0.0001). In this study, cows with higher SCC had lower mean production traits.

These results were agreement with result of Black White cows (Juozaitiene *et al.* 2006). Decrease in milk yield and quality were reported in another studies (Yalcin *et al.* 2000; Heringstad *et al.* 2003; Ikonen *et al.* 2004; Miller *et al.* 2004; Hagnestam *et al.* 2007; Zhong *et al.* 2010).

Decreases of 54.6 and 61.4 kg milk yield per 1 unit of somatic cell score were reported by Miller *et al.* (2004) for first and second parities, respectively.

Production losses for Swedish Holstein were estimated at 0 to 11%, 0 to 12% and 0 to 11% of milk, fat, and protein 305 day yields for cows developing clinical mastitis (Hagnestam *et al.* 2007).

Result of this study was higher than Miller *et al.* (2004) and agreement with Hagnestam *et al.* (2007). Rekik *et al.* (2008) reported in a study conducted with Tunisian Holsteins that most of regression coefficients per 1 unit increasing of SCS were decreased and amount of losses were maximized in third parity. The same results of Rekik *et al.* (2008) were observed in our study. The amount of losses for Lithuanian Black and White cattle were reported as 658, 28.9, 13.3 kg for milk, fat and protein yield, respectively which were higher than in our results (Juozaitiene *et al.* 2006).

CONCLUSION

In conclusion, SCS in the Iranian Holstein population was high in the first three lactations most likely due to high mastitis (subclinical and clinical) infection rates. These diseases reduced milk, fat and protein yields. Direct losses from increased SCS were higher. In principle, milk yield, fat and protein yields should be considered as a whole in breeding programs because of negative genetic correlation between milk yield, protein and yield with SCC in order to gain the higher economic benefit. These losses affected on profitability in herd. Therefore, animal breeders in Iran noted on SCS as a selection criteria through they could improved SCS in Iranian Holstein. Herd managers must control management systems in order to reduce SCS by improving environmental effects.

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