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Association of Lameness with Body Condition Score, Udder Health and Milk Quality in Sahiwal Dairy Cows

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ABSTRACT

Background: Bovine lameness predominantly due to foot disorders is a severe herd health concern instigating substantial influence on dairy economics owing to increased odds of mastitis and reduced fertility. Timely diagnosis and treatment of lameness can save these economic losses. The current study was aimed to evaluate lameness and its effect on animal health in terms of body condition score and on udder health in Sahiwal cows.

Methods: 204 lactating Sahiwal dairy cows in different lactation lengths and parities, from local Sahiwal farms in Punjab were evaluated for lameness. Cows were scored for body condition and lameness. Quarter foremilk used to determine the quarter health status of the cows by California mastitis test (CMT) and bacteriological culture and cow composite milk samples for estimation of somatic cell count (SCC), electrical conductivity, pH and milk composition, in terms of fat, solids not fat, protein and lactose were collected maintaining aseptic conditions.

Result: 34 per cent had asymmetry in gait or mild lame, 5 per cent had moderate lameness and 1 per cent had severe lameness. Lameness had no significant effect on the body condition scores of Sahiwal cows. Subclinical mastitis was found in 40.2 per cent of Sahiwal dairy cows. It was concluded that incidence of mastitis was higher in the lame group as revealed by CMT and bacteriological culture and the lame group had significantly ($P<0.05$) more SCC and electrical conductivity than healthy cows. However, milk composition was not affected by lameness.

Key words: Cow, Lameness, Mastitis, Sahiwal.

INTRODUCTION

Lameness is a deviation in gait to reduce pain (Scott, 1989) and is the third most important health-related cause of economic loss in the dairy industry after fertility and mastitis (Booth *et al.*, 2004). Cows that become lame tend to be higher yielding (Green *et al.*, 2002; Archer *et al.*, 2011), as the time they spend standing to eat increases with increment in milk yield (Gomez *et al.*, 2010) which may increase foot trauma in lactation and the risk of future cases of lameness. Once lameness develops, the time cows spent standing to eat decreases (Gonzalez *et al.*, 2008) with a subsequent decrease in body condition score (BCS) due to incomplete feeding. An increase in lying time in lame cows increases the chances of mastitis (Ito *et al.*, 2010) as lying in lame cows might expose their udders to various intra-mammary infections, due to the close proximity to the underfoot slurry. Bacterial contamination of bedding might be a link between infection of the tarsus and udder (Sogstad *et al.*, 2006). There is a 1.4 fold increase in the odds of clinical mastitis and subsequently somatic cell count (SCC), in clinically lame animals (Peeler *et al.*, 1994). Milk composition is also affected by lameness in crossbred dairy cattle with a significant decrease in mean monthly milk production, as well as in fat, protein and lactose production in clinically lame cows (Olechnowicz and Jaoekowski, 2010).

Sensitivity analysis indicates that the reduction in milk volume and quality is highly influential on estimates of economic loss from clinical lameness (Enting *et al.*, 1997). However, the evidence for the impact of lameness on milk yield is conflicting. Some authors report a decreased milk yield (Whitaker *et al.*, 1983; Warnick *et al.*, 2001), others reported a decrease in milk yield before a cow was treated as well as after (Lucey *et al.*, 1986) and others say that there is no change in milk yield (Cobo-Abreu *et al.*, 1979). However, an increased milk yield from 100 to 270 days in milk (DIM) in the same lactation in cows with sole ulcer was also reported by Barkema *et al.*, 1994.

Most of the data accessible are of crossbred and exotic dairy cattle but not ample research is done on Sahiwal, indigenous cattle breed of cattle of India. So this study was undertaken to elucidate the relationship between lameness and udder health in Sahiwal dairy cattle.

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MATERIALS AND METHODS

Selection of animals and management practices

A total of 204 lactating Sahiwal dairy cows were included in the study. The cows were maintained at three different local Sahiwal dairy farms in Punjab, India. Out of which 2 farms were well organized in which animals were stall fed and 1 farm adopted pasture grazing system. Machine milking was done in one of the organized farms whereas rest two farms practiced hand milking. Hoof trimming was not practiced on any of the farms. Stall fed animals were fed seasonal fodder including legumes such as lucerne (*Medicago sativa*) and berseem (*Trifolium alexandrium*), grown in Rabi season and non-legumes such as sorghum (*Sorghum vulgare*), maize (*Zea mays*) and bajra (*Pennisetum typihoideus*) grown in the Kharif season. Dry roughages included wheat straw and hay of Lucerne and Sorghum. Silage feeding and mineral mixture supplementation were also done in organized farms. Pasture grazed animals were let loose in pastures and only milking animals were supplemented with concentrate and mineral mixture supplementation in the feed.

Sampling and observations

On the day of milk sampling, each animal was allowed to walk on a flat surface and the gait of each animal was examined using a five-point numerical scoring scale. Score 0 was assigned for 'No gait abnormality', 1 for 'Mild lameness with slight disparity from normal gait symmetry', 2 for 'Moderate lameness with reasonable and constant gait asymmetry', 3 for 'Severe lameness with clear gait asymmetry or severe symmetric abnormality' and 4 for 'Non-ambulatory or recumbent status'.

Body condition score

Body condition score was evaluated on a five-point scale described by Ferguson *et al.*, (1994) (Table 1).

Milk sampling

Milk samples were collected after proper disinfection of the teat surface with 70% ethanol. About 10 mL and 20 mL of quarter foremilk and cow composite samples, respectively, were collected aseptically in separate sterile containers after squirting a few initial streams. The milk samples were placed in an ice box and carried to the laboratory where they were kept at 4°C in a refrigerator for further laboratory testing.

Analytical processing of milk

Bacteriological examination of milk was performed as per the standard microbial procedures (Kelton and Godkin, 2000). The California Mastitis Test was conducted and interpreted as per the standard method (Pandit and Mehta, 1969). The result of culture and CMT was interpreted as in Table 2 for determining quarter health. The somatic cell count in composite milk was analysed by a flow cytometry based automatic analyser (Somascope, Delta Instruments, Nether Lands) and the results were expressed in $\times 10^3$ cells/mL. Electrical conductivity was recorded with the help of a digital conductivity meter (Eutech Instruments, CON 700) and the results were expressed in milli Siemens per cm (mS/cm) at 25°C. The pH was recorded by an electrical pH recorder (Systronics, µpH system 361). Milk composition, in terms of fat, SNF, protein and lactose, was estimated by a milk analyzer (Lactoscan, Bulgaria) in percentages.

Ethics approval

Institutional animals ethics committee' permission was taken at the 52nd meeting of the IAEC of Guru Angad Dev Veterinary and Animal Sciences University (GADVASU) held on 15th November, 2019 (Friday) at GADVASU, Ludhiana. The experiment was approved with proposal number: (GADVASU/2019/IAEC/52/15).

Statistical analysis

Data were analysed using MINITAB statistical software to analyse the relationship between lameness and milk quality. Cows having healthy and/or latent quarter health status were categorized in the healthy group. However, cows having at least one quarter with specific or non-specific mastitis were considered as the mastitis group. Cows with a locomotion score '0' were grouped as non-lame and cows having locomotion scores 1 (mild), 2 (moderate) or 3 (severe) were considered as the lame group. Pearson chi-square test was applied to analyse the relation between lameness and body condition score and lameness and mastitis. Data pertaining to somatic cell count (SCC) was log transformed (LnSCC) to obtain normal distribution and descriptive statistics (mean, standard error) were calculated using the general linear method. Least squares means (LSM) were also calculated and compared for SCC log, TP, SNF, Lactose, Fat, EC and pH. The results were expressed as statistically significant at $P<0.05$.

RESULTS AND DISCUSSION

Sixty per cent of animals out of 204 were healthy non lame, 34 per cent had asymmetry in gait or mild lame (lameness score 1), 5 per cent had moderate lameness (lameness score 2) and 1 per cent had severe lameness (lameness score 3).

Table 1: Principles of body condition scoring (Five-point scale by Ferguson *et al.*, 1994).

Principle descriptive of body region	BCS
Rump region has V shape	>=5
Hook bone is rounded	5
Hook and pin bones are angular. Pin bones have palpable fat pad	4
Pin bones don't have palpable fat. Transverse processes of lumbar vertebrae are sharp	3
Thurl is prominent and the cow has saw toothed spine	2
Severly emaciated. All skeletal structures are visible.	1

Body condition score in Sahiwal cows in relation to lameness

Body condition scoring of 204 Sahiwal cows is depicted in Figure 1. Lameness in Sahiwal cows did not affect their body condition score (BCS) (Table 3). This finding could be attributed to a very low per cent of clinical lameness in Sahiwal cows. Moreover, most of the animals which displayed clinical lameness were moderately lame and body condition score decreases only when the animal becomes chronically lame. These animals might have become lame a few days before our examination or this breed may be sturdy enough and has a higher threshold to the pain reflex that originated during lameness. Similar to this finding, Raber *et al.*, (2004) also stated that BCS was not associated with lameness as both high and low BCS can equally make the animal susceptible to lameness due to the alteration in the fat of the digital cushion found in the hooves of dairy cattle. In contrast, Lim *et al.*, (2015) and Randall *et al.*, (2015) reported that a loss of body condition was seen to precede the onset of lameness, measured both by visual detection and lesion treatment.

Effect of lameness on udder health

Subclinical mastitis was found in 40.2 per cent of Sahiwal dairy cows. Lameness score was positively correlated with the occurrence of mastitis (Table 4) and odds of mastitis increased with an increase in locomotion score (Fig 2). Associations between locomotion score, quarter health status and various milk quality parameters were studied using a general linear model (Table 5). Lame cows were found to have significantly (P<0.05) higher milk SCC and milk electrical conductivity than non-lame cows but pH did not reveal any significant difference. With respect to milk composition, a non-significant (P>0.05) variation was observed in fat, SNF, lactose and total protein between lame and non-lame cows.

A higher incidence of mastitis was observed in a lame group which could be accredited to fact that lame cows tend to sit for a longer time making the udder more exposed to

Table 2: Determination of quarter health status on basis of CMT and culture.

CMT	Culture	Quarter Health Status
Negative	Negative	Healthy
Negative	Positive	Latent
Positive	Negative	Non-Specific
Positive	Positive	Specific

Table 3: Relation of BCS and lameness score in the Sahiwal cows.

LS	BCS			N (204)	df	P-value
	2	3	4+5			
0	20 (16.3%)[a]	69 (56.1%)[a]	34 (27.6%)[a]	123	4	0.084
1	5 (7.3%)[a]	37 (53.6%)[a]	27 (39.1%)[a]	69		
2+3	1 (8.3%)[a]	4 (33.3%)[a]	7 (58.3%)[a]	12		

[a,b] value of the different superscript showing significant difference (P<0.05).

Table 4: Relation between lameness score and mastitis.

Lameness score		Healthy cow	Mastitis affected cow	Df	P-value
0	N(123)	84	39	2	0.002
	%age	68.29%	31.71%[a]		
1	N (69)	35	34		
	%age	50.72%	49.28%[b]		
2+3	N (12)	3	9		
	%age	25%	75%[c]		

[a,b,c] value of the different superscript showing significant difference (P<0.05).

Table 5: General linear model describing lameness score association with various milk quality parameters.

Variable	LSM			P-value	DF	F
Lameness score	0	1	2+3			
N	123	69	12			
SCC log	5.15562[a]	5.20337[a]	5.57482[b]	0.020	2	4
TP	3.32984[a]	3.40377[a]	3.45917[a]	0.147	2	1.94
SNF	8.81057[a]	9.19159[b]	9.01667[ab]	0.024	2	3.79
Lactose	5.15928[a]	5.15928[a]	5.03417[a]	0.172	2	1.78
Fat	4.88919[a]	5.77957[b]	4.66667[ab]	0.004	2	5.78
EC	3.72940[a]	3.44913[b]	5.05250[c]	0.021	2	3.92
pH	6.84577[a]	6.90667[a]	6.98333[a]	0.051	2	3.01

[a,b] value of the different superscript showing significant difference (P<0.05).

infectious pathogens from the underfoot slurry. These infections lead to an increase in milk SCC and electrical conductivity as both get increased in mastitic milk. Similar reports inform that there is a significant relationship between lameness and mastitis (Peeler *et al.*, 1994; Arvidson, 2011) as a significant association between poorly trimmed hooves, lameness, milk yield, lying and rising behaviour exists (Rajala-Schultz, 1999). These might act as possible risk factors for teat infections leading to clinical mastitis (Elbers *et al.*, 1998). However, in some reports, there was no relationship found between udder health and lameness and observed that the effect of lameness could only be seen in severely lame dairy cows, but not in mild and moderate lame dairy cows (Hultgren *et al.*, 2004). In disagreement to all one report of Archer *et al.* (2011) indicated a negative association between lameness and udder health with animals having high locomotion score were found to have less milk SCC as lame cows stand for a longer time, preventing udder from getting an infection from the floor.

In the present study total protein, SNF, lactose, fat and pH revealed the non-significant difference between the healthy and lame animals (P>0.05). This could be assigned to the fact that all the moderate and severely lame animals were combined in the lame group which might have mitigated the effect of severe lameness if any on the milk composition. The reason for a non-significant change in milk fat percentage could be that the milk composition was assessed in the composite foremilk in which fat is usually low. This finding is in agreement with previous reports (Pavlenko *et al.*, 2011; Olechnowicz *et al.*, 2012) in which no change in milk composition was recorded between healthy, digital dermatitis affected cows and sole ulcers affected cows and cow composite milk (CC) from healthy and mastitic cows/udders showed significant differences with respect to EC, SCC and

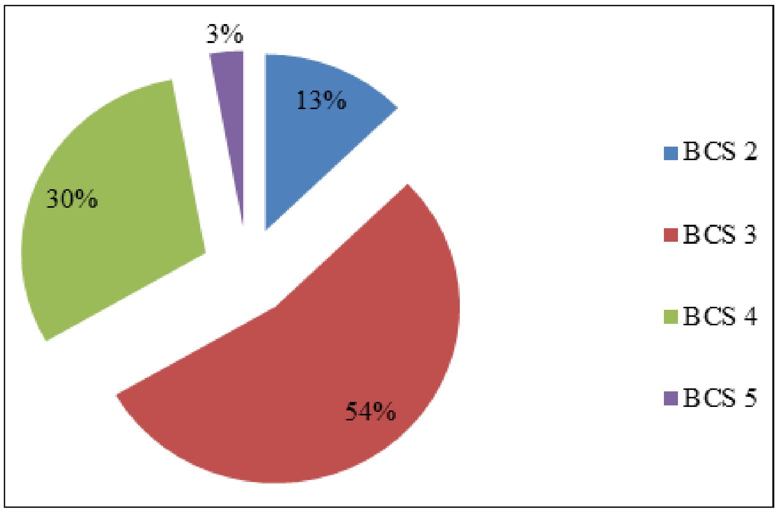

Fig 1: Pie diagram showing percentage of BCS in Sahiwal dairy cows.

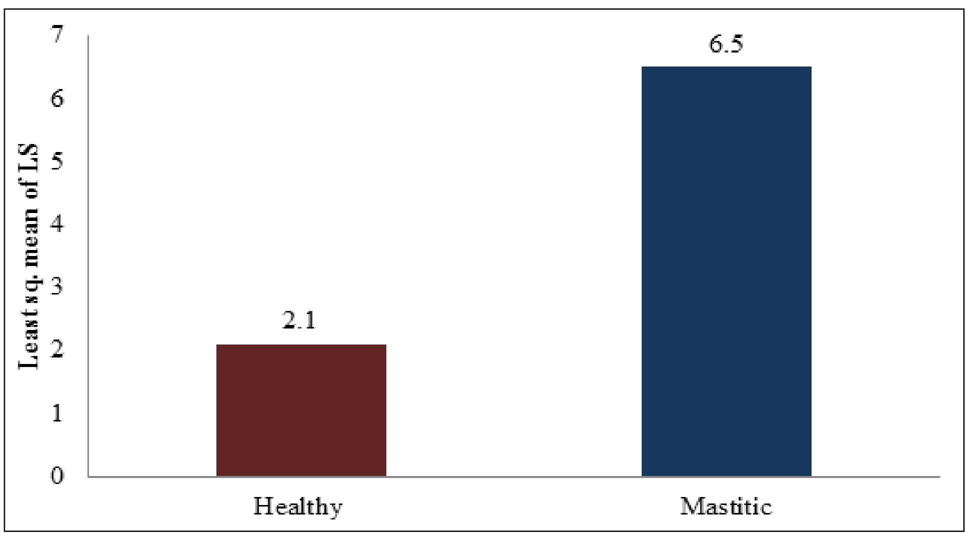

Fig 2: Odds of mastitis in relation to lameness score.

lactose, but not with respect to fat, protein and pH. No conclusive mastitis-related changes in pH in the previous study also (Holdaway *et al.,* 1996).

However, in contrast, some researchers noticed significantly lower mean monthly fat, protein and lactose production in lame cows as compared to non-lame cows (Olechnowicz and Jaoekowski, 2010). The reason suggested for this change in milk composition was stress, pain, increased oxidative agents, poor absorption and assimilation of various nutrients from the daily diet due to lameness. Though this effect was non-significant when clinical lame cows which remained lame for one or two months during lactation were compared with cows that were never lame. Similarly, Reis *et al.* (2013) observed that subclinical mastitis reduced lactose, non-fat solids and total solids content, but no difference was found in the protein and fat content between infected and uninfected quarters.

CONCLUSION

The prevalence of severe clinical lameness is low in Sahiwal cows. Lameness and body condition score had no relation in Sahiwal cows. Lame cows are more prone to mastitis than non-lame cows. Lame cows had higher values of somatic cell count and electrical conductivity but all other milk parameters like pH, SNF, fat, lactose and total protein did not reveal any significant difference among lame and non-lame animals irrespective of their udder status.

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