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Original Research

Factors Affecting Somatic Cell Counts in Buffalo (*Bubalus bubalis*) Milk

M. P. Verma[1]* and Shiv Prasad Kimothi[2]

[1]Assistant Professor, Department of Animal Production, College of Agriculture (AU, Jodhpur) Sumerpur, Pali, Rajasthan, INDIA
[2]Principal Scientist & ADG, Coordination Unit, ICAR, New Delhi, INDIA

*Corresponding Author: mpverma_78@rediffmail.com

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Abstract

A study was conducted on 594 healthy buffaloes belonging to Murrah, Surti and Nili-Ravi breed to find out the basal values of somatic cell counts (SCC) in milk with respect to breed, stage of lactation, parity, season and level of production. The relationship of SCC with milk yield and composition was determined using correlation coefficient. The average SCC in Murrah, Surti and Nili-Ravi breeds was 1.096, 0.855 and 0.969 x 10^5 cells/ml, respectively. SCC was highest during early stage of lactation, in rainy season and in animals with higher parity. The milk yield was negatively correlated with SCC. The milk SCC was significantly (P<0.01) but negatively correlated with fat, protein and SNF content of milk. The comparison of SCC categories within sub-clinical mastitis negative buffaloes, revealed that as SCC increased from 0.50 to greater than 1.50 x 10^5 cells/ml milk there were losses in milk yield (3.43 %) as well as the content of milk fat (11.30 %), protein (5.09%) and SNF (3.59%).

Keywords: Buffalo Breed, Milk, Parity, Season, Stage of Lactation, Somatic Cell Counts

Introduction

Somatic cell counts (SCC) in milk are considered as good indicator of udder health and milk quality. In addition, SCC scores widely used for genetic evaluation and managemental decisions of the cattle herd (Schutz, 1994). These principal cell types are epithelial cells and leucocytes (white blood cells) are secreted during milk production process. Elevated SCC primarily consists of leucocytes, which include macrophages, lymphocytes and neutrophils. The concentration of milk leukocytes, or somatic cell count (SCC), is a well-established direct indicator of mammary gland inflammation that is highly correlated with the presence of a mammary infection. Higher the SCC, greater is the risk of raw milk contamination with pathogens and antibiotic residues (Jones, 2006). In the European Union, China, New Zealand, Australia, Switzerland, and Canada, the legal bulk milk SCC (BMSCC) limit is 3-4×10^5 cells/ml, in South Africa and Brazil, 5×10^5 cells/ml and in the USA, 7.5×10^5 cells/ml. The secretion of these cells in milk is affected by the stage of lactation, parity, season, management practices and intra-mammary infection (Munoz *et al*., 2002, Alhussien and Dang, 2018), physiological factors and immune system functioning in individual cow's (Lee, 2015). On account of certain characteristic features like, the long narrow teat canal and tighter sphincter muscles buffalo has traditionally been considered less susceptible to udder infection as compared to cattle. However, not much work has been reported on SCC in buffalo breeds barring a few reports on Murrah buffaloes. Therefore, present study was under taken to study, basal values of somatic cell counts, factors affecting somatic cell counts and relationship of SCC with milk yield and composition of Murrah, Surti and Nili-Ravi buffalo breeds.

Materials and Methods

The present study was conducted on 366 lactating Murrah buffaloes at National Dairy Research Institute, Karnal (Haryana), 97 Surti buffaloes at Livestock Research Station, Vallabhnagar (Rajasthan) and 131 Nili-Ravi buffaloes at Military Dairy Farm Udhampur (Jammu & Kashmir) in 2006. The udders of all buffaloes were tested for mastitis using Modified California Mastitis Test (MCMT). The California Mastitis Test (CMT) as per Schalm and Noorlander (1957) and modified as per Sastry (1978) was performed for screening of the experimental animals against subclinical mastitis. Milk samples from MCMT negative buffaloes alone were included in the study. About 100 ml of milk was collected aseptically in clean milk bottles. The samples were brought to the laboratory immediately after collection and placed in a refrigerator till use. For SCC, slides were prepared within one hour of collection of milk samples. Individual milk samples pooled for all four quarters from the entire animal were collected. A total 594 milk samples were collected from the three breeds of buffalo during summer, rainy and winter seasons to determine the effect of breed, stage of lactation, parity, season, level of milk production as well as to study the relationship of SCC with milk yield and composition. The three stage of lactation were: 0-90 days (early), 91-180 days (mid) and 181 and above days (late). The five parity orders were 1st, 2nd, 3rd, 4th and above 4th parities. The three milk production levels considered were: low producers (<mean-1 SE), medium producer (mean±1 SE) and high producer (>mean+1 SE). Somatic cell counts in milk was counted microscopically by the methods of Das and Singh (1999). An amount of 10 µl milk sample was spread on a glass slide and was stained using methylene blue dye. The analysis of data was carried out using least square analysis of variance. The mean and standard errors and the correlation's between the parameters were also calculated (Sendecore and Cochran, 1980).

Results and Discussion

Effect of Breed

Somatic cell count values (Table 1) indicated that the SCC was significantly (P<0.01) higher in Murrah followed by Nili-Ravi and lowest in Surti buffaloes. The overall mean SCC in buffaloes was 0.974 x 10^5 cells/ml of milk. The SCC in Murrah, Surti and Nili-Ravi breeds averaged 1.096, 0.855 and 0.969 x 10^5 cells/ml, respectively. Somatic cell counts were higher than those reported by Munoz *et al.* (2002), who reported 63610±1856 cells/ml of milk in Murrah buffaloes reared in Brazil. Singh *et al.* (2001) reported that somatic cell counts in buffaloes, crossbred cows and goat averaged 1.0 x 10^5, 1.5 x 10^5 and 8.0 x 10^5 cells/ml of milk. The higher SCC in Murrah *vis a vis* other two breeds may be due to the fact that Murrah buffaloes are higher producer as compared to others.

Effect of Stage of Lactation

Overall mean SCC value were high (P<0.01) during early lactation, decreased to low values during mid lactation and increased marginally during late lactation (Table 1). In the present study significantly (P<0.01) higher values of SCC in early stage of lactation would suggest a direct relationship between SCC and milk production, which would imply that the high yielders may be more prone to udder inflammation because of higher udder pressure or their greater susceptibility to udder infection (Narayana and Iya, 1954, Scott *et al*., 1991). Present trend of SCC with stage of lactation is in line with Randy *et al.* (1991), Singh and Ludri (2001). In the work of Munoz *et al.* (2002) observed that SCC decreased in the second month of lactation and increased thereafter, up to the nine months of lactation in buffaloes. Intra-mammary infections are reported to increase upto third month of lactation which decreases slightly during mid lactation before increasing again during late lactation (Moroni *et al.*, 2006). As milk volume decrease, cell counts get concentrated a phenomenon also referred to as the dilution effect (Dohoo *et al.*, 1984).

Table 1: Effect of breed, stage of lactation, parity, season of the year and level of milk production on somatic cell counts (x10^5 cells/ml) in buffalo milk

Breeds	Murrah	Surti	Nili-Ravi	Overall
Stage of lactation				
Early	1.321^a±0.044 (81)	0.965^a±0.068 (27)	1.058^a±0.068 (30)	1.155^a±0.032 (138)
Mid	0.949^b±0.038(118)	0.746^{bc}±0.056 (39)	0.847^{bc}±0.060 (27)	0.835^b±0.029 (184)
Late	1.059^b±0.036 (167)	0.785^{ac}±0.066 (31)	0.941^{ac}±0.044 (74)	0.930^c±0.027 (272)
Parity Order				
1st	1.082^a±0.036 (132)	0.881±0.092 (20)	1.043±0.056 (35)	1.001^{ad}±0.030 (187)
2nd	1.020^a±0.038 (110)	0.736±0.079 (17)	0.870±0.069 (24)	0.900^{bc}±0.032 (151)
3rd	1.022^a±0.052 (49)	0.838±0.067 (21)	0.902±0.063 (25)	0.922^{ac}±0.035 (95)
4th	1.095^{ab}±0.072 (26)	0.879±0.062 (12)	0.930±0.068 (21)	0.966^{acd}±0.046 (59)
>4th	1.328^b±0.054 (49)	0.881±0.077 (27)	0.999±0.062 (26)	1.078^d±0.036 (102)
Season of the year				
Rainy	1.281^a±0.039 (101)	0.970^a±0.064 (31)	1.066^a±0.047 (42)	1.115^a±0.028 (174)
Summer	1.131^b±0.033 (180)	0.797^b±0.063 (31)	0.987^a±0.062 (46)	0.993^b±0.027 (257)
Winter	0.916^c ±0.044 (85)	0.728^b±0.057 (35)	0.794^b±0.059 (43)	0.812^c±0.030 (163)
Level of production				
Low	1.060±0.047 (41)	0.792±0.074 (16)	0.933±0.033 (12)	0.949±0.035 (108)
Medium	1.080±0.028 (241)	0.845±0.073 (62)	0.952±0.070 (99)	0.953±0.021 (393)
High	1.189±0.053 (84)	0.858±0.042 (19)	0.962±0.085 (20)	1.018±0.039 (93)
Overall	**1.096^a±0.022 (366)**	**0.855^b±0.036 (97)**	**0.969^b±0.033 (131)**	**0.974±0.031 (594)**

**within the same parameter different superscripts in row indicate significantly difference; ** Figures in parenthesis indicate number of observations.*

Effect of Parity Order

The somatic cell counts were significantly higher in above 4th parities and first parity that all the other parities (Table 1). Primiparous buffaloes normally undergo rapid physiological changes and this phenomenon coupled with poor conditioning of the heifer calves to milking routines may lead to increased udder stress and higher prevalence of mastitis infection (Barkema *et al*., 1998; Valde *et al*., 2004). The cell count was higher above 4th parity buffaloes as older animals have greater opportunity for exposure to mastitis pathogen (Brolund, 1985). In study of buffaloes the effect of parity on milk SCC was observed non-significantly differ from 1st to 4th parities (De *et al*., 2011). Streak canal of teat has a keratinized layer and accumulated cellular debris, which provides bacteriostatic effect. The breakdown of such streak canal barrier with advancing lactation may also lead to increase in milk SCC in successive lactation (Schalm *et al*., 1971). Further with the advancement of age, the udder also becomes pendulous and more prone to infection.

Effect of Season

The SCC changes during different season of the study period were significantly ($P<0.01$), being high during rainy season and low during summer and cold seasons (Table 1). The higher cell counts during rainy season could be attributed to prevailing high ambient temperature and relative humidity leading to increased stress on animal which in turn may increase the susceptibility to infection. Significantly higher cell counts were observed in autumn compared with winter, spring and summer season (Tahawy and Far, 2010). Singh and Ludri (2001) in Murrah buffaloes also reported higher cell counts during rainy season (1.36 x 10^5 cells/ml) as compared to other seasons. The low somatic cell counts during winter season were probably due to congenial environment conditions leading to minimum stress in buffaloes. In work of Saravanan *et al. (*2015) observed that SCC was higher in flush season and low during lean season in Deoni and HF cattle.

Effect of Level of Milk Production

The somatic cell count was higher in high milk producing buffaloes and lower in low milk producing buffaloes (Table 1). The high yielding animals are more prone to inflammation/infection owing to lactation stress *vis a vis* their low yielder counterpart (Scott *et al.*, 1991). Higher cell counts in high yielder buffaloes may be due to greater stress on account of physiological function of milk producing on udder thereby rendering them more susceptible to infection.

Association of SCC with Milk Yield and Composition

The correlation coefficient between milk yield and composition with somatic cell counts have been presented in Table 2. The milk yield was negatively correlated (-0.06) with somatic cell counts. The SCC of milk was significantly (P<0.01) negatively correlated with fat, protein and SNF content. The correlation coefficients were -0.34, -0.16 and -0.30 in fat, protein and SNF respectively. The relationship between somatic cell counts and milk yield has been depicted in Table 3.

Table 2: Correlation coefficients of milk yield and milk composition with somatic cell counts in buffalo milk

SCCx10^5	**Murrah**	**Surti**	**Nili-Ravi**	**Overall**
Log SCC: milk yield	-0.07^{NS}	-0.15^{NS}	-0.17^{NS}	-0.06^{NS}
Log SCC: milk fat	-0.34**	-0.43**	-0.29**	-0.34**
Log SCC: milk protein	-0.10*	-0.19^{NS}	-0.08^{NS}	-0.16**
Log SCC: milk SNF	-0.34**	-0.17^{NS}	-0.12^{NS}	-0.30**

*NS, Non-Significant, **Significant (P<0.01), *Significant (P<0.05)*

Table 3: Somatic cell counts in relation to milk yield mean (±SE) in buffaloes

SCCx10^5	**Murrah**	**Surti**	**Nili-Ravi**	**Overall**
<0.50	6.76±0.52(23)	5.76±0.37(20)	6.91±0.51(11)	6.42±0.29(54)
0.50-1.00	7.28±0.22(153)	5.63±0.37(44)	6.46±0.37(67)	6.68±0.16 (264)
1.00-1.50	7.12±0.24(142)	5.54±0.38(31)	6.09±0.23(46)	6.56±0.18 (219)
>1.50	6.40±0.47 (48)	4.75±0.25(2)	5.29±0.58(7)	6.20±0.40 (-3.43) *(-7.2) ** (57)
Overall	6.89±0.15 (366)	5.43±0.22 (97)	6.19±0.18(131)	6.47±0.11 (594)

**3.43 per cent milk yield decreased from SCC increased <0.50 to >1.50x10^5 cells/ml of milk **7.20 per cent milk yield decreased from SCC increased 0.50 to >1.50x10^5 cells/ml of milk*

The overall milk yield was highest (6.68±0.16 kg) under SCC categories 0.50-1.00x10^5 cells/ml and lowest (6.20±0.16 kg) under >1.50 x10^5 cells/ml. As SCC in milk increased from category less than 0.50 to greater than 1.50 x10^5 cells/ml upto non mastitic milk, the losses of milk yield 3.43 percent was observed. However as somatic cell counts increased from category 0.50-1.00 x10^5 to above 1.50x 10^5 cells/ml the milk production losses increased to 7.20 per cent which implies that the high yielding healthy buffaloes tend to maintain moderately high milk somatic cell counts *vis a vis* their low yielding counterpart. The negative correlation coefficients between SCC and milk yield as observed in present study were reported in buffaloes by Munoz *et al.* (2002), Cinar *et al*. (2015) and Costa *et al.* (2020) and in cows (Hortet *et al.*,1999). The losses of milk upto 18 per cent observed by Eberhart *et al.* (1982) on account of increased bulk milk tank somatic cell count from 200x10^3 to 1000x10^3 cells/ml of milk.

Table 4: Somatic cell counts in relation to milk constituents (mean ±SE) in buffaloes

SCCx 10^5	Murrah			Surti			Nili-Ravi			Overall		
	Fat %	Protein %	SNF %	Fat %	Protein %	SNF %	Fat %	Protein %	SNF %	Fat %	Protein %	SNF %
<0.50	8.28±0.16 (23)	4.28±0.05 (23)	9.80±0.07 (23)	8.35±0.16 (20)	4.35±0.16 (20)	9.82±0.09 (20)	8.35±0.27 (11)	4.33±0.17 (11)	9.55±0.03 (11)	8.32±0.10 (54)	4.32±0.07 (54)	9.76±0.05 (54)
0.50-1.00	8.08±0.06 (153)	4.23±0.03 (153)	9.61±0.03(153)	8.19±0.14 (44)	4.18±0.07 (44)	9.79±0.07 (44)	8.06±0.09 (67)	4.29±0.04 (67)	9.54±0.03 (67)	8.10±0.05 -2.64(264)	4.24±0.02 -1.85(264)	9.63±0.02 -1.33(264)
1.00-1.50	7.73±0.13 (142)	4.15±0.03 (142)	9.42±0.03 (142)	7.40±0.12 (31)	4.09±0.07 (31)	9.69±0.08 (31)	7.68±0.18 (46)	4.24±0.05 (46)	9.51±0.04 (46)	7.68±0.06 -7.49(219)	4.16±0.03 -3.70(219)	9.48±0.03 -2.87(219)
>1.50	7.44±0.04 (48)	4.11±0.06 (48)	9.39±0.08 (48)	7.15±0.55 (2)	4.08±0.14 (2)	9.63±0.25 (2)	7.03±0.17 (7)	4.16±0.14 (7)	9.47±0.09 (7)	7.38±0.11 -11.3*(57)	4.10±0.06 -5.09*(57)	9.41±0.07 -3.59*(57)
Overall	7.88±0.04 (366)	4.20±0.02 (366)	9.55±0.02 (366)	7.78±0.09 (97)	4.18±0.05 (97)	9.74±0.04 (97)	7.79±0.08 (131)	4.26±0.03 (131)	9.53±0.02 (131)	7.88±0.04 (594)	4.20±0.02 (594)	9.56±0.02 (594)

**11.30, 5.09 and 3.59 per cent milk fat, protein and SNF, respectively decrease from <0.50 to >1.50 cells/mil of milk*

The relationship between SCC and milk constituents has been depicted in Table 4. The losses in milk fat, protein and SNF were 11.30, 5.09 and 3.59 per cent, respectively under SCC increased from category less than 0.50 to above 1.50 x10^5 cells/ml of milk. A significant negative relationship was observed between SCC and milk composition by Tahawy and Far (2010). The results showed that milk fat, protein, lactose and SNF significantly decreased with elevations of somatic cell counts. As SCC increases or as leucocytes enter the milk, they also bring blood protein with them, which replace milk proteins thereby resulting in lower content of milk protein in such milk.

Conclusion

The overall somatic cell counts in milk of buffaloes is 0.974 x 10^5 cell/ml of milk. Somatic cell count is significantly higher in Murrah as compared to Surti and Nili-Ravi buffaloes. The SCC is affected by breed, stage of lactation, parity and season of the year. The milk yield was negatively correlated with SCC in milk. The SCC is also negatively correlated with fat, protein and SNF content of milk.

Conflict of Interests

There is no conflict of interest.

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