



Elucidating Milking Operation in Jersey Cross-bred Cow for Higher Quantity and Quality of Milk at New Alluvial Zone

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ABSTRACT

Background: At new alluvial zone of WB, milk production has not received adequate attention and this has been a major obstacle in dairy development.

Methods: Experiment was conducted on 14 Jersey crossbred cows to compare 2 milking operation viz. flat-parlor machine (group-I) and full-hand (group-II) milking at NDRI, ERS (WB).

Result: The statistically analysed data of 280 milk samples revealed that milk quantity was significantly higher in group-I as compared to group-II but SCC, CMT, SFMT were significantly lower in group-I than group-II. Other quality parameters (MBRT, fat, SNF, TS, protein, FPR) were varied non-significantly between groups. The time required for milking/animal was significantly higher in group-II than group-I but milk extraction rate significantly lower in group-II than group-I. BCS of animals of both groups varied non-significantly with in a normal range. Significantly higher milk quantity was recorded during morning than evening milking session in both groups. Non-significant variation of SCC, CMT, SFMT, MBRT, fat, SNF, TS, protein, FPR were found in between two milking sessions of each group. The milk extraction rate was significantly lower during evening than morning whereas time required for milking/animal was higher in morning than evening session in both groups. It can be concluded that higher quantity and quality of milk can be produced in flat-parlor machine milking operation in comparison to full-hand milking operation in Jersey crossbred cows at new alluvial zone of West Bengal.

Key words: Flat parlor milking, Jersey crossbred, Milk quantity, Milking operation, New alluvial zone, Quality.

INTRODUCTION

The unsuitable milking operation is an issue of Jersey crossbred cows causing great economic losses due to reduction in milk yield and its quality. Dairy sector in new alluvial zone of WB needs immediate improvement in milk production by applying effective milking operation. Out of the total milk produced, cow milk represents approximately 83% of total milk production (Garai *et al.*, 2017). The milk characteristics in terms of milk composition, yield, somatic cell count (SCC) and quality are important factors for consumer, dairy farmer and industry (Kumari *et al.*, 2020). The SCC is a useful predictor of udder health, therefore, an important component of milk in assessment aspects of quality (Patil *et al.*, 2015). The information on suitable milking operation for Jersey crossbred cows at new alluvial zone of WB are scanty. So, present study was conducted to improve commercial production of higher quantity and quality of milk of Jersey crossbred cows at this region.

MATERIALS AND METHODS

The experiment was conducted in ERS-NDRI, Kalyani organized farm at new alluvial zone (WB) during 2023-2024. A total of 14 Jersey crossbred (J× RS) cows in mid-lactation with almost similar body condition (BCS) and parities of 2 to 4 were selected from the institute's herd and were divided into two comparable groups containing 7 animals in each.

The milking operation of first group was done by using flat-parlor machine (Da-Laval) whereas second group was

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milked by full-hand milking by professional milker. After an adaptation time, the main experimental course was started and continued for 5 months. Almost similar type of other management like feeding, housing and health were provided to both experimental groups. About 50 ml of milk sample was collected from whole milk bucket after complete milking of animals in sterilized glass bottles at fortnightly interval. A total of 280 milk samples were collected. Milk quantity, milking time and milk extraction rate were recorded in morning and afternoon sessions. The milk quality was determined by milk Somatic Cell Count

(SCC), california mastitis test (CMT), surf field mastitis test (SFMT), methylene blue reduction test (MBRT), fat, SNF, total solid (TS), protein, fat-protein ratio (FPR) in morning and evening milk samples in both groups.

Milk quality was assessed by somatic cell count of milk samples which were carried out by an automatic machine. For cross checking of SCC, the manual procedure was also adopted by using microscopic method of somatic cell count (Kumari *et al.*, 2018). The CMT test was conducted as per standard procedure (Singh *et al.*, 2020b). The SFMT (Kumari *et al.*, 2019a) and MBRT (Singh *et al.*, 2020a) of milk samples was determined by using standard method. The CMT and SFMT test is based on the principle of increase in number of leukocytes and alkalinity of milk. Estimation of fat, SNF, protein in milk was performed by automatic machine-Milkoscan (Da-Laval). For cross checking, the manual procedure was also adopted by using Gerbers Butyrometric method. Milk SNF was estimated by lactometer method using the ISI formula. Lactometer reading was taken through the ISI calibrated lactometer at 27°C (Singh *et al.*, 2020c). The time required for milking and milk extraction rate was observed 5 days in a week (Kumari *et al.*, 2019b). The body condition score (BCS) of cows were monitored at fortnightly interval by using standard method where animals were assigned using visual plus palpation technique. This method grades the cow's conditioning status on a six-point scale (1-6). The score 1 reflects very thin and 6 reflects very fat animal (Paul *et al.*, 2020). For assessing the body condition of animals, anatomical regions (critical points) were taken into account meticulous consideration as standardized by Paul *et al.*, (2019) for Jersey crossbred dairy cows of this region. The logarithms of SCC number were used for normalizing data distribution. The data were analyzed by using paired t-test (Snedecor and Cochran, 1994).

RESULTS AND DISCUSSION

Different milking operations

The analysis of data on different milking operation reveals that milk quantity (kg/animal/milking) was significantly ($P<0.05$) higher in flat-parlor machine (group-I) as compared to full-hand (group-II) milking operation (Table 1). The Log_{10} SCC (cells/ml) was significantly ($P<0.01$) higher in full-hand as compared to flat-parlor machine milking operation. The range of Log_{10} SCC (cells/ml) greatly varied in both type of operation. Although SCC varied in normal range in all milk samples in both groups. The CMT was found to be significantly ($P<0.01$) lower in group-I as compared to group-II. A similar trend of observation was recorded in case of SFMT of milk samples from both groups. The MBRT was almost similar in both groups and varied non-significantly. The fat (%) was slightly higher in group-II as compared to group-I with a non-significant variation. The SNF (%) varied non-significantly between two groups with slightly higher value in group-I. Other quality parameters viz: TS (%), protein (%), FP varied non-significantly between two groups. The time required for milking (minute/animal/milking) was found to be significantly ($P<0.01$) lower in group-I as compared to group-II whereas the milk extraction rate (kg/minute) was significantly ($P<0.05$) higher in group-I as compared to group-II. The BCS of cows varied non-significantly between two groups.

All the developed countries are using milk somatic cell counts (SCC) as a marker to determine the quality of milk (Dang *et al.* 2007). Bhakat *et al.* (2016), found that SCC ($\times 10^5$ cells/ml) was higher in SCM (Sub Clinical Mastitis) animals as compared to non-SCM animals. The SCC method is also less expensive than microbiological culture (Pranay *et al.* 2017a). Seeing the importance of milk SCC internationally, SCC is conducted in Jersey crossbred cows

Table 1: Comparative investigation of milking operation in Jersey crossbred cows.

Parameters	Milking operation (Mean $\pm$ SE)		Sig.
	Flat-parlor machine Group-I	Full-hand Group-II	
Milk quantity (kg/animal/milking)	5.61 $\pm$ 0.21	4.54 $\pm$ 0.24	$P<0.05$
Log_{10} SCC (cells/ml)	3.56 $\pm$ 0.05	5.68 $\pm$ 0.09	$P<0.01$
SCC $\times 10^5$ (cells/ml)	1.42 $\pm$ 0.29	1.86 $\pm$ 0.032	
Range of Log_{10} SCC (cells/ml)	1.43 to 1.98	1.45 to 3.92	
CMT	1.56 $\pm$ 0.07	2.19 $\pm$ 0.15	$P<0.01$
SFMT	1.42 $\pm$ 0.16	2.54 $\pm$ 0.19	$P<0.01$
MBRT (min)	350.89 $\pm$ 4.52	346.11 $\pm$ 5.67	NS
Fat (%)	4.12 $\pm$ 0.05	4.21 $\pm$ 0.03	NS
SNF (%)	8.95 $\pm$ 0.02	8.73 $\pm$ 0.05	NS
TS (%)	13.07 $\pm$ 0.03	12.93 $\pm$ 0.02	NS
Protein (%)	3.74 $\pm$ 0.05	3.71 $\pm$ 0.04	NS
FPR	1.10 $\pm$ 0.04	1.13 $\pm$ 0.03	NS
BCS	4.12 $\pm$ 0.14	4.23 $\pm$ 0.19	NS
Time/animal/milking (min)	6.42 $\pm$ 0.33	10.51 $\pm$ 0.42	$P<0.01$
Milk extraction rate (kg/min)	1.39 $\pm$ 0.04	0.71 $\pm$ 0.05	$P<0.05$

$P<0.01$: Significant at 1% level; $P<0.05$: Significant at 5% level; NS: Non-significant.

in present experimentation. Somatic cells of milk are white blood cells and epithelial cells, which slough off from the lining of the mammary gland during normal course of milking (Singh *et al.*, 2020d). They are widely used as marker to determine the mammary health and quality of milk (Pranay *et al.*, 2017b; Bhakat *et al.*, 2017a; Singh *et al.*, 2020e). In the present study, higher SCC in group-II milk sample could be due to higher chance of injury to quarters (unwilling) during manual operation as compared to mechanized operation in group-I and udder faces more exposure to milker or operator during full-hand milking, who can also act as a source of infection (Bhakat *et al.*, 2017b). However, differences in the values of fat, protein, total solid, fat-protein ratio and SNF were non-significant among different milking operational group. The BCS in each group was maintaining a normal grading which indicate that animals in both groups having similar body/physiological status (Paul *et al.*, 2022).

It may be noted that both group of milking operations were followed in the ERS-NDRI farm. Before every milking, all cows were washed by clean water. Their udders were thoroughly cleaned and teats wiped with towel. The milkers also washed their hands before milking. The dipping of teats in iodine solution after each milking was practiced in the farm. Milk was finally pooled in the bulk tank for transportation. In both groups, the higher value of MBRT was almost similar which indicate good quality of milk since MBRT was the indicator of microbial load in milk samples (Pranay *et al.*, 2015b and Singh *et al.*, 2022).

Flat-parlor machine milking operation

The analysis of data of flat-parlor machine milking operation on milk quantity and quality during morning, evening milking session reveals that milk quantity (kg/animal/ milking) was significantly ($P<0.05$) higher in morning milking as compared to evening session (Table 2). $\text{Log}_{10}\text{SCC}$ (cells/ml) was higher in evening session as compared to morning session. The range of $\text{Log}_{10}\text{SCC}$ (cells/ml) greatly varied in both sessions. The CMT and

SFMT varied non-significantly between two milking sessions with higher value during evening as compared to morning session. The MBRT of milk samples from morning and evening milking sessions varied non-significantly with slightly lower during morning as compared to evening time. Although MBRT varied in normal range in all milk samples. The fat (%) was slightly higher during evening time as compared to morning session with a non-significant variation. The SNF, TS, protein, FPR varied non-significantly between two sessions. The time required for milking (minute/animal/ milking) was lower during evening as compared to morning time. The milk extraction rate (kg/minute) was significantly ($P<0.05$) higher during morning as compared to evening session milking.

Pranay *et al.* (2015a) reported that a significant ($P<0.01$) negative correlation of $\text{Log}_{10}\text{SCC}$ with test day milk yield, fat and SNF percentage. Milk from healthy mammary gland has about 1.5 lakh somatic cells/ml and values higher than this indicates secretory disturbances (Dang *et al.*, 2007). In the present study, it was observed that in flat-parlor machine milking systems, human interference was also comparatively less than full-hand milking which may be the reason for less milk SCC under these systems. Another important reason was proper cleaning of flat-parlor machine and its parts (Singh *et al.*, 2020f). Every day flat-parlor was washed with floor-cleaner and milking machines were cleaned by water immediately after each milking. Daily machines were cleaned by using hot water along with BASIX (soapifying agents) of DeLaval company. Once in a week, machines were clean by using an acid *i.e* NOVACID of De-Laval. The teat sphincter and leukocytes (somatic cell) provide defense line for external bacterial attacks which ultimately invaded by pathogenic organisms resulting in increased level of SCC in milk (Bhakat *et al.*, 2018 and Paul *et al.*, 2018a). Under unhygienic conditions, during full-hand milking as compared to flat- parlor machine milking or due to damaged teat canal, pathological bacteria invade internal mammary

Table 2: Flat parlor machine and full hand milking operation during different session.

	Flat parlour machine		Full hand		Leve of sig
	Morning	Evening	Morning	Evening	
Milk quantity (kg/animal/ milking)	6.51±0.34	4.23±0.29	4.95±0.46	4.02±0.51	$P<0.05$
$\text{Log}_{10}\text{SCC}$ (cells/ml)	3.12±0.07	3.45±0.08	5.45±0.08	5.73±0.09	NS
CMT	1.45±0.09	1.61±0.17	2.01±0.08	2.21±0.18	NS
SFMT	1.49±0.17	1.70±0.20	2.23±0.19	2.31±0.28	NS
MBRT	344.32±5.64	351.23±6.02	349.47±6.84	355.36±7.52	NS
Fat (%)	4.03±0.08	4.11±0.09	4.16±0.09	4.35±0.07	NS
SNF (%)	8.98±0.06	8.83±0.06	8.84±0.08	8.63±0.09	NS
TS (%)	13.01±0.05	12.94±0.07	13.00±0.06	12.98±0.08	NS
Protein (%)	3.51±0.06	3.59±0.08	3.69±0.07	3.74±0.09	NS
FPR	1.13±0.05	1.14±0.06	1.12±0.07	1.16±0.08	NS
Time/animal/milking (min)	6.42±0.36	5.98±0.44	10.67±0.42	9.54±0.49	$P<0.05$
Milk extraction rate (kg/min)	1.01±0.05	0.70±0.07	0.46±0.06	0.42±0.08	$P<0.05$

$P<0.05$: Significant at 5% level; NS: Non-significant.

tissues and obliterate mammary cell lines (Singh *et al.*, 2022, Bhakat *et al.*, 2019).

Full-hand milking operation

The analysis of data of full-hand milking operation on milk quantity and quality during morning, evening milking session reveals that milk quantity (kg/animal/milking) was significantly ($P < 0.05$) higher in morning milking as compared to evening session (Table 2). The $\text{Log}_{10}\text{SCC}$ (cells/ml) was higher in evening as compared to morning session. The $\text{SCC} \times 10^5$ (cells/ml) greatly varied in both sessions. The CMT and SFMT varied non-significantly between two milking sessions with higher value during evening as compared to morning session. The MBRT of milk samples from morning and evening milking sessions varied non-significantly. Although MBRT varied in normal range in all milk samples. The fat (%) was slightly higher during evening time as compared to morning session with a non-significant variation. The SNF, TS, protein, FPR varied non-significantly between two sessions of full-hand milking operation. The time required for milking (minute/animal/milking) was found to be lower during evening as compared to morning time. The milk extraction rate (kg/minute) was higher during morning as compared to evening session milking.

The word "Gold Standard" for a somatic cell count of up to 200,000 cells/ml and values of milk above 200,000 cells/ml results in reduction in the milk production and processing properties of milk. In the present study, comparatively higher SCC in full-hand milk sample might be due to the constant exposure of animals to pathogens, which help easy entry of organism through streak canal responsible for higher rate of infection in full-hand milked animals in comparison to flat-parlor machine milked animals. In-fact streak canal of teats consists keratinized layer and accumulated cellular debris, which is wax like and have sebum like nature consisting of long chain fatty acids and provides bacteriostatic effects (Pranay *et al.*, 2019; Paul *et al.*, 2018b and Bhakat *et al.*, 2020). The breakdown of such streak canal barrier with manual error of hand milking leads to increased frequency of infection with successive increase in lactation number (Bhakat *et al.*, 2021; Singh *et al.*, 2021b). The changes occur in milk composition and milk yield due to mastitis and increased SCC level in cow milk in cold dry climate was reported by some workers (Kumaresan 2013 and Ballou *et al.*, 1995). Major concern in new alluvial zone is that even the minimal values of milk SCC are on the higher side indicating that mammary gland is under stress in these conditions (Pranay *et al.*, 2015b). It has been seen that higher SCC due to poor management practices is very critical because more influx of milk SCC not only disrupts the mammary epithelium but also decreases milk quality (Singh *et al.*, 2021a) which in turn leads to lower returns. Several of these issues can be addressed if we are able to link milk quality with payment. In a previous study also, Bailey and Heald (2000) reported that each load of milk picked up at the farm was tested for SCC and premiums or deductions

were made on the milk prices based on the SCC. Similarly, it was also emphasized the need to combine payment of milk for quality not only with SCC but also with the changes in milk composition. So far there is no such practice being followed in new alluvial zone, where farmers are paid for their milk according to the fat percentage of milk. The positive advancement of milk intake by consumers should be encouraged by the high quality of raw milk in dairy practice (Singh *et al.*, 2022). As consumers are becoming more health conscious and general awareness to produce clean milk is increasing, there is a need to educate dairy farmers to follow clean milk production with GMP (good management practices), so that they get a better price for their milk and it matches international quality.

CONCLUSION

The present experimentation can be concluded that higher quantity and quality of milk can be produced in flat-parlor machine milking operation in comparison to full-hand milking operation in Jersey crossbred cows at new alluvial zone of West Bengal.

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Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Informed consent

All animal procedures for experiments were approved by the Committee of Experimental Animal care and handling techniques were approved by the University of Animal Care Committee.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

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