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## Correlation of udder and teat biometry with milk yield, composition and somatic cell count in Jaffarabadi buffaloes

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### Abstract

An investigation was carried out named correlation of teat biometry with milk yield and composition in Jaffarabadi buffaloes. A total of 40 for experimental Jaffarabadi buffaloes from Cattle Breeding Farm, Junagadh Agricultural University, Junagadh, Gujarat were selected. Milk yield per milking was recorded for each animal during evening milking. Milk composition was also evaluated from the sample milk collected from each animal during the experiment period. Duration of experiment was 3 months. All the teat measurements were taken prior to milking at monthly intervals. All milk samples were analyzed at fortnightly intervals. The result showed that among different teat shapes, conical teats was the most common followed by funnel, cylindrical, pear and bottle shaped teats with 39.17 percent, 34.17 percent, 14.16 percent, 7.5 percent and 5 percent, respectively. The overall mean teat lengths of fore left, fore right, rear left and rear right were 8.29±0.19, 7.75±0.18, 8.53±0.22 and 7.88±0.19 cm, respectively among various teat shapes. The overall mean teat diameters of fore left, fore right, rear left and rear right were 3.30±0.06, 3.20±0.07, 3.27±0.06 and 3.07±0.06 cm, respectively among various teat shapes. The overall mean distance between fore teats, between rear teats and between fore and rear teats among various teat shapes 12.39±0.28, 6.58±0.17, 8.74±1.08 and 7.54±0.18 cm, respectively. The mean values of milk yield per milking among various teat shapes were 4.10±0.20, 4.47±0.21, 4.56±0.35, 4.02±0.68 and 3.08±0.34 kg/milking in funnel, conical, cylindrical, bottle and pear shaped teats, respectively. Distance between rear rear teats was positively and significantly ( $p<0.05$ ) correlated with milk yield but highly significantly ( $p<0.01$ ) correlated with solid-not-fat, lactose, salt and protein percent and density ( $\text{kg/m}^3$ ). However, distance between fore rear right was positively and highly significantly ( $p<0.05$ ) correlated with solid not fat, lactose, salt and protein percent and density ( $\text{kg/m}^3$ ). Therefore, buffaloes with cylindrical shaped teats are taken into consideration as a selection tool for efficient milk production.

**Keywords:** Milk yield, somatic cell, buffalo, teat biometry

### Introduction

Buffaloes are preferred over cattle in India because of their peculiar qualities such as better feed conversion efficiency, more resistance to diseases and higher milk fat percent than cows. Buffaloes are popularly known as black diamond due to their abundant contribution to our national economy through milk, meat and draft power. Buffalo contributes major volume of the total milk produced in India (49 percent of the total milk production in India) (Anonymous, 2021) [3]. Morphological characteristics of udder and teats have a direct relationship with milk production potential in dairy animals. Udder characters like shape and size of teats and placement of teats are the points to be considered while judging animals.

### Materials and Methods

The present study was carried out at Cattle Breeding Farm, Junagadh Agricultural University, Junagadh, Gujarat. A total of 40 experimental Jaffarabadi buffaloes were selected and is managerial practices were followed. Duration of experiment was 3 months. All the teat measurements were taken prior to milking at monthly intervals. All milk samples were analyzed at fortnightly intervals.

**Teat:** Teat measurements were taken from each experimental Jaffarabadi buffaloes three times in the first, second and third months of lactation. These measurements were teat length, teat diameter and distance between teats.

### Teat Length (TL)

The length of the teat (cm) was measured from the upper part of the teat where it hangs perpendicularly from the udder to the tip. Teat length was measured to the nearest 0.01 cm using vernier caliper.

### Teat Diameter (TD)

Teat diameter (cm) was measured at the middle of the teat by vernier caliper to the nearest of 0.01 cm. All four teats were measured individually.

### Distance between Teats

The distance between fore teats, distance between rear teats and the distance between fore and rear teats were measured with vernier caliper to the nearest 0.1 cm, taking care not to touch the teat with the scale. DBTFF= Distance between Fore Fore Teats, DBTRR= Distance between Rear Rear Teats, DBTFL= Distance between Fore and Rear (left and right side) teats.

### Milk yield

Daily milk yield (kg) was recorded during the morning and evening milking at fortnightly intervals. Milk yield was recorded by a digital weighing machine.

### Milk Composition

Milk components (fat, protein, lactose, total solids, salts and solid-not-fat percent) were estimated by "Lactoscan combo" (Milktronic Limited, Bulgaria) at Department of Livestock Production Management. The milk total solids were determined by adding milk fat and milk solids-not-fat. Total solids percent = fat percent + SNF percent.

### Statistical Analysis

Statistical analysis of the data was carried out according to the procedures suggested by Snedecor and Cochran (1994) [15]. Means among different groups were compared by analysis of variance (One way ANOVA). The Pearson's correlation coefficient was estimated to study the relationship of udder and teat measurements and average daily milk yield, SCC and milk composition to find any relationship of these parameters and also to study the overall relationship of udder conformation with milk yield, SCC and milk composition.

## Results and Discussion

### Teat shapes

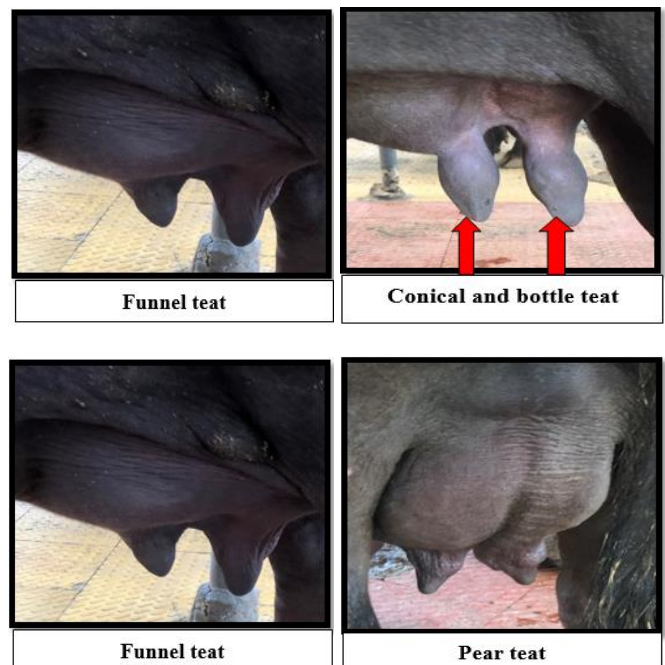
The frequencies and percentages of different types of teats in experimental Jaffarabadi buffaloes are presented in Table 1 In present study, different teat shapes were found viz., conical, funnel, cylindrical, pear and bottle shape of teats. We observed the occurrence of conical shape of teats (39.17 percent) was the most common followed by funnel, cylindrical, bottle and pear shape of teats with 34.17 percent, 14.16 percent, 7.5 percent and 5 percent, respectively. The results of the present study were consistent with the findings of Ahlawat, K. (2007) [11] who recorded that most common Sahiwal cows had conical shape of teats. However Raju, B. (2017) [11] and Ranjitha *et al.* (2021) [12] reported that cylindrical shaped teats were predominant over other shape in buffaloes. Teat Biometry According to Udder Shapes

### Teat length and Teat diameter

The average mean values of teat lengths in different udder shapes are presented in Table 2 The overall mean values for

teat length of fore left, fore right, rear left and rear right were  $8.29 \pm 0.19$  cm,  $7.75 \pm 0.18$  cm,  $8.53 \pm 0.22$  cm and  $7.88 \pm 0.19$  cm, respectively. The mean teat length for bowl, round and pendulous shaped udder were  $7.91 \pm 0.22$  cm,  $8.36 \pm 0.26$  cm and  $8.36 \pm 0.60$  cm, respectively. The overall mean teat length in bowl and round udder recorded in the present study are greater than and lesser than the findings of Prasad *et al.* (2010) [9] in Murrah buffaloes and Raju, B. (2017) [11] in Jaffarabadi buffaloes, respectively. The mean values of teat diameter in different udder shapes are presented in Table 2 The overall mean values of teat diameter for fore left, fore right, rear left and rear right were  $3.30 \pm 0.06$  cm,  $3.20 \pm 0.07$  cm,  $3.27 \pm 0.06$  cm and  $3.07 \pm 0.06$  cm, respectively. Similar findings, Raju, B. (2017) [11] in Jaffarabadi buffaloes and contrast findings, Prasad *et al.* (2010) [9] in Murrah buffaloes observed. Statistically analyzed, effect of udder shape on teat diameter and teat length was non significant ( $p > 0.05$ ) in experimental Jaffarabadi buffaloes.

### Shapes of teat



### Distance between teats

The mean values for distance between fore teats, between rear teats, distance between fore and rear teats according the udder shape are presented in Table 2 The present study revealed that the overall mean values of distance between teats for between fore and fore, between rear and rear, between left fore and rear and between right fore and rear were  $12.39 \pm 0.28$  cm,  $6.58 \pm 0.17$  cm,  $8.74 \pm 1.08$  cm and  $7.54 \pm 0.18$  cm, respectively. Similar to present findings, Musaad *et al.* (2017) [17] reported in 72 camels that the distance between teats were higher in globular shape of udder compared to other shape of udders. Contrast findings, Islam and Islam (2020) observed in Crossbred dairy cows that the average distance between teats were lower compared to present findings. From the present study, experimental Jaffarabadi buffaloes having round shaped udder had were significantly ( $p < 0.05$ ) higher in distance between teats compared to pendulous shaped udder. Distance between teats was significantly lesser in pendulous shape udder. This might be due to larger udder had less space between teats.

## Teat Biometry According to Teat Shapes

### Teat length

The mean values for teat length of fore left, fore right, rear left and rear right according to the teat shapes are presented in Table 3. The present experiment revealed that the overall mean values of teat length of fore left, fore right, rear left and rear right were  $8.29 \pm 0.19$  cm,  $7.75 \pm 0.18$  cm and  $8.53 \pm 0.22$  cm and  $7.88 \pm 0.19$  cm, respectively. Contrast findings, Patel *et al.* (2016) [8] and Singhai, S.K. (2012) [14] who found cylindrical shape of teat had significantly ( $p < 0.05$ ) higher teat length compared to other shape of teats. We observed teat length of fore left and rear left were significantly higher ( $p < 0.05$ ) in bottle shape of teats than conical, cylindrical and pear shape of teats.

### Teat Diameter

The mean values for teat diameter of fore left, fore right, rear left and rear right according to the teat shapes are presented in Table 3. In the present study, it was found that the overall mean values of teat diameter for fore left, fore right, rear left and rear right were  $3.30 \pm 0.06$  cm,  $3.20 \pm 0.07$  cm,  $3.27 \pm 0.06$  cm and  $3.07 \pm 0.06$  cm, respectively. We observed teat diameter of fore left, fore right and rear left were also significantly ( $p < 0.05$ ) higher in bottle shaped of teats compared to other shape of teats. Similar findings, Singhai, S.K. (2012) [14] in Gir cows and Patel *et al.* (2016) [8] in Crossbred cows, they observed bottle shape of teat had significantly ( $p < 0.05$ ) higher teat diameter. Contrast findings, teat diameter of bottle shaped teats in present study was lesser than teat diameter of bottle shape of teat  $4.08 \pm 0.07$  as reported by Khatri *et al.* (2017) [5] in water buffaloes.

### Distance between teats

The mean values for distance between fore teats, between rear teats, distance between fore and rear teats according to the udder shape are presented in Table 3. According to the teat shapes, the overall mean values of distance between teats for fore and fore, rear and rear, fore rear left, fore rear right were  $12.39 \pm 0.28$  cm,  $6.58 \pm 0.17$  cm,  $8.74 \pm 1.08$  cm and  $7.54 \pm 0.18$  cm, respectively. We observed no significant difference in distance between teats according to teat shapes except distance between right fore rear was significantly ( $p < 0.05$ ) higher in cylindrical shape of teats compared to bottle and pear shape of teats.

### Effect of Teat Morphology on Milk Yield

The milk yield in experimental Jaffarabadi buffaloes with different teat shapes is presented in Table 4. We observed that the significantly higher milk yield was found in buffaloes with cylindrical shaped teats but significant ( $p < 0.05$ ) lower milk yield was found in pear shape of teats. The mean values of total daily milk yields recorded for cylindrical, conical, funnel, bottle and pear shaped teats were  $8.91 \pm 0.45$ ,  $8.27 \pm 0.43$ ,  $7.40 \pm 0.39$ ,  $5.99 \pm 0.98$  and  $5.81 \pm 0.56$  kg/day, respectively. The mean values of milk yields per milking recorded for cylindrical, conical, funnel, bottle and pear shaped teats were  $4.56 \pm 0.35$ ,  $4.47 \pm 0.21$ ,  $4.10 \pm 0.20$ ,  $4.02 \pm 0.68$  and  $3.08 \pm 0.34$  kg/milking, respectively. These results are in agreements with the findings of Prasad *et al.* (2010) [9] in Murrah buffaloes, Rahmatullah *et al.* (2017) [10] in Murrah

buffaloes, Raju, B. (2017) [11] in Jaffarabadi buffaloes, who reported, cylindrical shape of teat had significantly ( $p < 0.05$ ) higher milk yield compared to other shape of teats. Contrary to these findings, Ranjitha *et al.* (2021) [12] in Murrah buffaloes, Singhai, S.K. (2012) [14] in Gir cows, reported that funnel shape of teat had significantly ( $p < 0.05$ ) higher milk yield compared to other shape of teats. Buffaloes having cylindrical shaped teat had medium size teat length and diameter favors for higher milk production.

### Effect of Teat Morphology on Milk Composition

The mean values of milk composition according to the teat shape are presented in Table 5. In present study; effect of teat shape on milk composition was non significant in Jaffarabadi buffaloes. But numerically higher Fat percent was found in bottle shape of teat followed by pear, conical, cylindrical and funnel shape of teats. Cylindrical shape of teat had numerically higher Solid not fat, density, lactose and salt percent in Jaffarabadi buffaloes. Protein percent was numerically higher in conical shape teats. However, Total solids were numerically higher in pear shape of teats compared to other shape of teats. Similar findings, Raju, B. (2017) [11] in Jaffarabadi buffaloes, they found that no significant difference was found between teat shape and milk composition. But fat percent was numerically higher in bottle shape of teats compared to other shape of teats. However, solid not fat percent and total solids percent were numerically higher in pear shape of teats. Contrast findings, Singhai (2012) [14], they found that overall fat, SNF, and protein were  $5.08 \pm 0.50$ ,  $2.74 \pm 0.18$ ,  $0.86 \pm 0.07$ ,  $4.54 \pm 0.06$  and  $8.53 \pm 0.04$  and  $3.85 \pm 0.04$ , respectively in Gir cattle.

### Correlation of teat biometry with milk parameters

The correlation co-efficient values among the milk yield, total daily milk yield, milk fat percent, SNF percent, TS percent, lactose percent, salts percent, protein percent and density (kg/m<sup>3</sup>), teat length, teat diameter and distance between teats are presented in Table 4.26. Teat diameter fore left was positively and significantly ( $p < 0.05$ ) correlated with total daily milk yield ( $r = 0.202$ ). However, teat diameter rear left was negatively and significantly ( $p < 0.05$ ) correlated with lactose ( $r = -0.193$ ). Similar findings, Rao *et al.* (2006) reported that negative and significant correlation between anterior teat diameter and lactose but teat length were significantly ( $p < 0.05$ ) correlated with milk yield. However, contrast to present findings, Wagay *et al.* (2017) [17] reported that lactose positively correlated with teat diameter. Distance between rear rear teats was positively and significantly ( $p < 0.05$ ) correlated with milk yield per milking ( $r = 0.222$ ) and total daily milk yield ( $r = 0.229$ ). Similar findings, Tilki *et al.* (2005) [16] in Brown Swiss cows reported that milk yield increased with increasing distance between teats. Contrast findings, Kuczaj *et al.* (2000) [30] reported that fat percent was positive correlated with fore to rear teat distance. Whereas positively and highly significantly ( $p < 0.01$ ) correlated with SNF ( $r = 0.305$ ), density ( $r = 0.286$ ), lactose ( $r = 0.307$ ), salts ( $r = 0.295$ ) and protein ( $r = 0.295$ ). Distance between fore rear right teats with positively and highly significantly ( $p < 0.01$ ) correlated with SNF ( $r = 0.302$ ), density ( $r = 0.244$ ), lactose ( $r = 0.316$ ), salts ( $r = 0.286$ ) and protein ( $r = 0.273$ ).

**Table 1:** Frequencies and percentages of different teat shapes in experimental Jaffarabadi buffaloes

Months Teat Shape	I	II	III	Total
Funnel	14 (35 percent)	14 (35 percent)	13 (32.5 percent)	41 (34.17 percent)
Conical	17 (42.5 percent)	15 (37.5 percent)	15 (37.5 percent)	47 (39.17 percent)
Cylindrical	5 (12.5 percent)	6 (15 percent)	6 (15 percent)	17 (14.16 percent)
Bottle	2 (5 percent)	3 (7.5 percent)	4 (10 percent)	9 (7.5 percent)
Pear	2 (5 percent)	2 (5 percent)	2 (5 percent)	6 (5 percent)

**Table 2:** Mean values for various teat length, teat diameter and distance between teats in experimental Jaffarabadi buffaloes according to udder shapes

Udder shape	Mean teat length (cm)	Mean teat diameter (cm)	Mean distance between teats (cm)
Bowl	7.91±0.22	3.16±0.07	8.62 <sup>ab</sup> ±0.19
Round	8.36±0.26	3.26±0.07	9.43 <sup>b</sup> ±0.73
Pendulous	8.36±0.60	3.31±0.28	7.09 <sup>a</sup> ±0.42
Overall mean	8.11±0.16	3.21±0.05	8.81±0.30

Means with different superscripts within a column (a, b) differ significantly ( $p < 0.05$ )

**Table 3:** Mean values for various teat length, teat diameter and distance between teats in experimental Jaffarabadi buffaloes according to teat shapes

Teat shape	Mean teat length (cm)	Mean teat diameter (cm)	Mean distance between teats (cm)
Funnel	8.36 <sup>ab</sup> ±0.30	3.13 <sup>a</sup> ±0.06	8.33±0.23
Conical	7.81 <sup>a</sup> ±0.25	3.20 <sup>a</sup> ±0.09	9.21±0.69
Cylindrical	7.84 <sup>a</sup> ±0.29	3.01 <sup>a</sup> ±0.10	9.68±0.48
Bottle	9.61 <sup>b</sup> ±0.49	3.93 <sup>b</sup> ±0.10	7.69±0.45
Pear	7.38 <sup>a</sup> ±0.45	3.22 <sup>a</sup> ±0.33	8.18±1.03
Overall	8.11±0.16	3.21±0.05	8.81±0.30

Means with different superscripts within a column (a, b) differ significantly ( $p < 0.05$ )

**Table 4:** Total daily milk yield and evening milk yield in experimental Jaffarabadi buffaloes according to teat shapes

Teat shape	Milk yield (kg/milking)	Total daily milk yield (kg/day)
Funnel	4.10 <sup>ab</sup> ±0.20	7.40 <sup>ab</sup> ±0.39
Conical	4.47 <sup>b</sup> ±0.21	8.27 <sup>b</sup> ±0.43
Cylindrical	4.56 <sup>b</sup> ±0.35	8.91 <sup>b</sup> ±0.45
Bottle	4.02 <sup>ab</sup> ±0.68	5.99 <sup>a</sup> ±0.98
Pear	3.08 <sup>a</sup> ±0.34	5.81 <sup>a</sup> ±0.56
Overall	4.25±0.13	7.77±0.25

Means with different superscripts within a column (a, b) differ significantly ( $p < 0.05$ )

**Table 5:** Milk composition in experimental Jaffarabadi buffaloes according to teat shapes

Teat shape	Fat (percent)	SNF (percent)	TS (percent)	Density (kg/m <sup>3</sup> )	Lactose (percent)	Salts (percent)	Protein (percent)
Funnel	8.73±0.22	9.32±0.12	18.05±0.20	25.64±0.58	5.18±0.06	0.72±0.01	3.42±0.04
Conical	9.24±0.20	9.45±0.11	18.69±0.13	25.60±0.58	5.24±0.06	0.72±0.01	3.49±0.05
Cylindrical	9.00±0.23	9.46±0.17	18.46±0.17	25.91±0.80	5.26±0.09	0.73±0.01	3.47±0.06
Bottle	9.81±0.52	9.07±0.22	18.88±0.42	23.64±1.23	5.05±0.12	0.69±0.02	3.33±0.08
Pear	9.52±0.84	9.39±0.33	18.91±0.52	25.10±2.11	5.22±0.18	0.72±0.03	3.45±0.12
Overall	9.09±0.13	9.38±0.07	18.47±0.10	25.49±0.35	5.21±0.04	0.72±0.01	3.45±0.03

**Table 6:** Correlation of teat parameters with milk composition in experimental Jaffarabadi buffaloes

Parameters	Fat	Solid not fat	Total solids	Density	Lactose	Salt	Protein
TLFL	-0.006	-0.104	-0.077	-0.079	-0.111	-0.102	-0.092
TLFR	-0.076	0.004	-0.094	0.032	0.003	0.015	0.001
TLRL	-0.044	-0.029	-0.076	-0.010	-0.042	-0.029	-0.012
TLRR	0.048	-0.060	-0.021	-0.058	-0.060	-0.058	-0.062
TDFL	-0.057	0.056	-0.035	0.042	0.033	0.036	0.089
TDFR	-0.101	0.069	-0.082	0.074	0.051	0.061	0.091
TDRL	0.059	-0.171	-0.040	-0.158	-0.193*	-0.178	-0.135
TDRR	0.066	-0.014	0.075	-0.043	-0.026	-0.035	0.007
DBTFF	-0.008	0.141	0.085	0.114	0.156	0.128	0.116
DBTRR	-0.178	0.305**	-0.021	0.286**	0.307**	0.295**	0.295**
DBTFR (Left)	0.032	0.142	0.136	0.093	0.151	0.132	0.128
DBTFR (Right)	-0.043	0.302**	0.148	0.244**	0.316**	0.286**	0.273**

\* Significant at 5 percent, \*\* Significant at 1 percent, TLFL; Teat Length Fore Left, TLFR; Teat Length Fore Right, TLRL; Teat Length Rear Left, TLRR; Teat Length Rear Rear, TDFL; Teat Diameter Fore Left, TDFR; Teat Diameter Fore Right, TDRL; Teat Diameter Rear Left, TDRR; Teat Diameter Rear Rear, DBTFF; Distance Between Fore Fore, DBTRR; Distance Between Rear Rear DBTFR; Distance Between Fore Rear (Right & Left), Fat, SNF, TS, protein, lactose, salts percent, density (kg/m<sup>3</sup>)

**Table 7:** Correlation of teat parameters with milk yield in experimental Jaffarabadi buffaloes

Parameters	Milk yield	Total daily milk yield
TLFL	-0.009	-0.036
TLFR	0.008	0.082
TLRL	0.095	0.103
TLRR	0.036	0.083
TDFL	0.172	0.202*
TDFR	0.174	0.152
TDRL	0.111	0.091
TDRR	0.107	0.118
DBTFF	0.092	0.143
DBTRR	0.222*	0.229*
DBTFR (Left)	0.027	0.042
DBTFR (Right)	0.043	0.062

### Conclusions

The occurrence of conical shape of teats were highest followed by funnel, cylindrical, bottle and pear shape of teats in experimental Jaffarabadi buffaloes. Teat length and teat diameter were significantly ( $p < 0.05$ ) higher in bottle shape of teat. Distance between teats was significantly ( $p < 0.05$ ) higher in cylindrical shape teats followed by conical, funnel, pear and bottle shape of teats. Cylindrical shape of teat had significantly ( $p < 0.05$ ) higher milk yield per milking and total daily milk yield. In Jaffarabadi buffaloes, teat shape did not affect milk composition. Relationship of fore left teat diameter with total milk yield was positive and significant ( $p < 0.05$ ). Distance between rear rear teats and distance between fore and rear right side teats had positive and highly significant ( $p < 0.01$ ) correlation with milk composition solid not fat, salts, lactose and protein percent and density ( $\text{kg/m}^3$ ) in experimental Jaffarabadi buffaloes.

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