Int.J.Curr.Microbiol.App.Sci (2021) *10*(03): 241-248

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 10 Number 03 (2021)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2021.1003.032

Studies on Relationship between Udder and Teat Measurements and Milk Yield as Affected by Parity in Jaffarabadi Buffaloes

B. Raju, Ch. Harikrishna* and R. M. V. Prasad

Department of Livestock Production Management, College of Veterinary Science, PVNR Telangana Veterinary University, Rajendranagar, Hyderabad (TS), India

**Corresponding author*

Keywords

Jaffarabadi buffalo, Milk yield, Parity, Teat measurements, Udder measurements

Article Info

Accepted:
04 February 2021
Available Online:
10 March 2021

A B S T R A C T

A study was undertaken to assess the relationship between variation in udder and teat measurements and milk yield as affected by parity in Jaffarabadi buffaloes. A total of 150 buffaloes selected from private dairy farms located around Hyderabadwere considered for the study. The mean and SE values of udder length (UL), udder width (UW) and udder depth (UD) in buffaloes of different lactations were ranged from 59.86 ± 1.00to 68.51 ± 1.02 cm, 49.17 ± 0.47to 52.38 ± 0.51 cm and 15.24 ± 0.19to 20.06 ± 0.43 cm, respectively. Significantly (P<0.01) positive correlation was observed between udder measurements viz., UL, UW and UD and daily milk yield. The UL, UW and UD in 4th parity were significantly (P<0.05) higher than 1st and 2nd parity but was found comparable with 3rd parity. The mean teat length of left fore, right fore, left hind and right hind teats were 7.69 ± 0.10 cm, 7.79 ± 0.11 cm, 8.63 ± 0.16 cm and 8.67 ± 0.16cm, respectively and teat diameter of left fore, right fore, left hind and right hind teats were 3.05 ± 0.03cm, 3.04 ± 0.03cm, 3.26 ± 0.03cm and 3.31 ± 0.04cm, respectively. The average teat length and teat diameter recorded for different parities were 8.20 ± 0.12cm and 3.17 ± 0.03cm, respectively. A positive correlation existed between average daily milk yield and various teat measurements like teat length, teat diameter and distance between fore and hind teats. However, the correlation was significant (P<0.05) only between milk yield and teat diameter. The study concludes that there is an increase in udder and teat measurements with increase in lactation number, specifically UW and teat diameter, due to their significant positive correlation with milk yield could be considered as criteria for selection of Jaffarabadi buffaloes for higher milk yield.

Introduction

Buffalo occupies an important place in livestock economy of Asian region including India, because of their adaptability to harsh climatic conditions, tolerance to tropical diseases and poor management practices. Buffaloes play a distinct role in improving the rural economy, which is primarily based on agricultural production systems. In fact, these animals can be considered as a financial asset since they serve as an insurance against the risk of crop failure due to natural calamities (Dhanda, 2004). They are vital source of

income and employment especially to the weaker sections comprising landless labourers, marginal farmers and small farmers who form the majority in rural India. India had 302.79 million bovine population (cattle and buffalo) in 2019 and the total buffalo population in India is 109.85 million (which shows an increase of 1.1% over the previous census) and contributes around 20.45% of the total livestock population in India (Anonymous, 2019). Buffaloes contribute for major volume of the total milk produced in India, even though their population is less compared to that of the cattle. India has emerged as the world's largest milk producer and milk production continues to grow at a fairly high rate and accounting for 18.5% of world production. Milk production in India during the period 1950-51 to 2015-16, has increased from 17 million tons to 155.5 million tons as compared to 146.3 million tons during 2014-15 recording a growth of 6.27% (Anonymous, 2017). Tilki *et al.*, (2005) reported that both morphological and physiological mammary gland properties affect the milk yield in cattle. Prasad *et al.*, (2010) reported that positive and significant correlation was observed between udder measurements viz., UL, UW and UD and daily milk yield in Murrah buffaloes, but not much research data was available on the relationship between udder and teat biometrics, parity and milk yield in Jaffarabadi buffaloes.

Therefore, keeping in view on the significance of milk production, an attempt was made to study the relationship between udder and teat measurements and milk yield as affected by parity in Jaffarabadi buffaloes.

Materials and Methods

The present investigation was carried out at various private dairy farms located in and around Hyderabad. A total of 150 Jaffarabadi milch buffaloes were selected and were kept in a closed housing system (tail to tail type), provided with sufficient space. Animals were kept in similar enclosures by all the farm owners including infrastructure of farms so that there was no farm effect observed as such. They were fed roughages ad-lib consisting of mixture of green fodders available in surrounding areas of dairy farms and concentrates were offered during milking, both at morning and evening as per the requirement. They were milked twice in a day and strict sanitary measures were taken before and after milking.

The following udder and teat measurements were recorded as followed by Prasad *et al.*, (2010).

Udder length (UL): The measurement from the rear attachment of the udder to the place where the udder smoothly blended with the body and expressed in cm.

Udder width (UW): The distance between widest point of udder near the stifle joint of animal and passing the tape in between the fore and rear teats, to the widest point of udder near the stifle joint of the other side and expressed in cm.

Udder depth (UD): It was measured by taking the differences of two under mentioned measurements and expressed in cm.

Distance from ground floor to the base of the udder.

Distance from ground floor to the lowest point of udder at the place of attachment of teat.

Teat length: Teat length was taken with a self-retracting measuring tape from the upper part of the teat, where it hangs perpendicularly from the udder to the tip of the teat and expressed in cm.

Teat diameter: It was measured at the middle of the teat with a thread and measured the circumference of the teat. Using the formula calculated the diameter of the teat and expressed in cm.

$C = \pi d$

Where, C=Circumference of the teat; d= Diameter of the teat

Distance between teats: The distance between fore teats, distance between hind teats and the distance between fore and hind teats were measured with a scale, to the nearest 0.1 cm, taking care not to touch the teat with the scale and expressed in cm.

Statistical analysis

The data obtained on various udder and teat parameters and milk yields were analyzed using SPSS statistical package (version 12.0.1). Analysis of variance was utilized to test the significance of various treatments and the difference between treatment means was tested for significance by Duncan's Multiple Range and F Test (Duncan, 1955).

The Pearson's Correlation Coefficient was estimated between udder and teat measurements and the average daily milk yield to find any relationship of these measurements with milk yield.

Results and Discussion

Udder measurements

The mean values of udder measurements in Jaffarabadi buffaloes belong to different lactations are presented in Table 1. According to the parity of animal, the mean and SE values of UL, UW and UD were in the range of 59.86 ±1.00 to 68.51 ± 1.02 cm, 49.17 ± 0.47 to 52.38 ± 0.51 cm and 15.24 ± 0.19 to 20.06 ± 0.43 cm, respectively. The overall average values of UL, UW and UD were found to be 65.74 ± 0.52 cm, 51.19 ± 0.26 cm and 18.16 ± 0.22 cm, respectively. Perusal of the data showed a gradual increase in length, width and depth of the udder as the parity increases.

The UL, UW and UD in 4th parity were significantly ($P<0.05$) higher than 1st and 2nd parity but was found comparable with 3rd parity.

The findings of the present study are consistent with that of Bhuiyan *et al.*, (2004), Tilki *et al.*, (2005), Prasad *et al.*, (2010) and Deng *et al.*, (2012), who reported all the udder measurements were affected by lactation number. This might be due to continuous development of udder tissues up to 6th parity, after that the tissues start to regress as the age advances.

Similarly, Lavania *et al.*, (2011) also reported gradual increase in udder measurement with parity that declined in 5th parity onwards in Surti buffaloes. Patel *et al.*, (2016) reported a gradual increase in length, width and depth of the udder as the parity number increases except for the UL, which showed a decline in 4th parity and then again increased in 5th parity. Khatri *et al.*, (2017) also found that all the udder measurements were found to increase with the increment in lactation number.

Positive and significant correlation was observed among all udder measurements. The phenotypic correlation between UL, UW and UD were highly significant ($P<0.01$), indicating, all three udder measurements were closely inter-related.

The results now recorded are in agreement with that of Patel *et al.*, (2017) in CB cows and Khatri *et al.*, (2017) in buffaloes.

Teat measurements

Teat length

The mean values for teat length in Jaffarabadi buffaloes along with the order of parity are depicted in the Table 2. From the present study, it was found that the overall mean values recorded for teat length of left fore, right fore, left hind and right hind teats were 7.69 ± 0.10cm, 7.79 ± 0.11cm, 8.63 ± 0.16 cm and 8.67 ± 0.16cm, respectively. The average teat length in different parities ranged from 6.82 ± 0.14 cm in 1stparity to 9.16 ± 0.30 cm in 4thparity and the average teat length was increasing with parity.

There was a gradual increase of left fore, right fore, left hind and right hind teat length with advancement of the parity (Table 2). The differences observed in teat length in different parities were statistically significant (P<0.05). These results are corroborating with the findings of Lavania *et al.,* (2011), who observed an increasing trend of udder and teat measurements up to the 5thparity and the significant (P<0.05) effect of parity on teat length has also been observed in Murrah buffaloes by earlier workers (Prasad *et al.,* 2010 and Bharti *et al.,* 2015). Antalik and Strapak (2010) stated that the increase in length of teat might be due to increase in size of udder as per synthesis of mammary tissues with advancement of age.

Table.1 Mean udder measurements (cm) in Jaffarabadi buffaloes according to parity

Parity	No. of Animals	Udder length	Udder width	Udder depth
		(Mean ± SE)		
1	20	59.86^{a}± 1.00	49.17^{a}± 0.47	15.24^{a}± 0.19
2	40	63.55^{b} ± 0.58	49.85^{a}± 0.41	15.98^{a} ± 0.19
3	56	67.76^{c}± 0.91	52.15^{b} ± 0.45	19.61^{b}± 0.30
4	34	68.51^{c} ± 1.02	52.38^{b} ± 0.51	20.06^{b}± 0.43
Overall Mean ± SEM	**150**	**65.75 ± 0.52**	**51.19 ± 0.26**	**18.16 ± 0.22**

Means with similar superscripts within column do not differ significantly (P<0.05)

Table.2 Mean teat length (cm) in Jaffarabadi buffaloes according to parity

Parity	Teat length (Mean ± SE)				Average teat length (Mean ± SE)
	Left fore	Right fore	Left hind	Right hind	
1	6.52^{a} ± 0.16	6.60^{a} ± 0.14	7.03^{a} ± 0.17	7.15^{a} ± 0.17	6.82^{a}± 0.64
2	7.36^{b} ± 0.08	7.38^{b} ± 0.07	7.76^{a} ± 0.11	7.81^{a} ± 0.12	7.58^{b}± 0.09
3	7.78^{b} ± 0.15	7.85^{b} ± 0.15	9.30^{b} ± 0.26	9.25^{b} ± 0.30	8.55^{c} ±0.19
4	8.64^{c} ± 0.30	8.89^{c} ± 0.30	9.49^{b} ± 0.40	9.61^{b} ± 0.36	9.16^{c}± 0.30
Overall Mean ± SEM	**7.69 ± 0.10**	**7.79 ± 0.11**	**8.63 ± 0.16**	**8.67 ± 0.16**	**8.20 ± 0.12**

Means with similar superscripts within column do not differ significantly (P<0.05)

Table.3 Mean teat diameter (cm) in Jaffarabadi buffaloes according to parity

Parity	Teat diameter (Mean ± SE)				Average teat diameter (Mean ± SE)
	Left fore	Right fore	Left hind	Right hind	
1	2.81^{a} ± 0.03	2.78^{a} ± 0.04	3.00^{a}± 0.04	3.01^{a} ± 0.04	2.90^{a} ± 0.03
2	2.95^{a} ± 0.03	2.94^{ab} ± 0.03	3.08^{a} ± 0.02	3.09^{a} ± 0.02	3.01^{ab} ± 0.02
3	2.96^{a} ± 0.03	2.98^{b} ± 0.04	3.29^{b} ± 0.04	3.37^{b} ± 0.05	3.15^{b} ± 0.03
4	3.47^{b} ±0.11	3.41^{c} ± 0.10	3.56^{c} ± 0.11	3.65^{c} ± 0.11	3.52^{c} ± 0.10
Overall Mean ± SEM	**3.05 ± 0.03**	**3.04 ± 0.03**	**3.26± 0.03**	**3.31 ± 0.04**	**3.17 ± 0.03**

Means with similar superscripts within column do not differ significantly (P<0.05)

Table.4 Mean distance between teats (cm) in Jaffarabadi buffaloes according to parity

Parity	Distance between front teats	Distance between hind teats	Distance between front and hind teats
	Mean ± SE		
1	9.45^{a} ± 0.30	5.49^{b}± 0.19	9.59^{a}±0.36
2	9.55^{ab} ± 0.24	5.45^{b}± 0.14	9.21^{a}± 0.24
3	9.70^{ab} ± 0.19	5.04^{a} ±0.08	9.00^{a}± 0.23
4	10.24^{b} ± 0.26	4.92^{a}± 0.11	9.11^{a}± 0.31
Overall Mean ± SEM	**9.75 ± 0.12**	**5.18 ± 0.06**	**9.16± 0.14**

Means with similar superscripts within column do not differ significantly (P<0.05)

Table.5 Correlation among various udder and teat measurements and average daily milk yield in Jaffarabadi buffaloes

	Udder Length (UL)	Udder Width (UW)	Udder Depth (UD)	Average teat length (ATL)	Average teat diameter (ATD)	Distance b/n fore teats (DFT)	Distance b/n hind teats (DHT)	Distance b/n fore and hind teats (DFHT)	Average daily milk yield (ADMY)
UL	1	0.410**	0.522**	0.135	00.156	0.187*	-0.103	-0.071	0.441**
UW		1	0.588**	0.145	0.290**	0.010	0.071	-0.035	0.325**
UD			1	0.349**	0.351**	0.095	-0.059	-0.040	0.338**
ATL				1	0.581**	0.034	-0.145	-0.035	0.150
ATD					1	0.142	-0.073	-0.133	0.161*
DFT						1	0.024	0.283**	0.149
DHT							1	0.053	0.020
DFHT								1	-0.074
ADMY									1
***Correlation is significant at 0.05 level (2-tailed) **Correlation is significant at 0.01 level (2-tailed)**									

Teat diameter

According to the parity, average teat diameter recorded for left fore, right fore, left hind and right hind teats were 3.05 ± 0.03 cm, 3.04 ± 0.03 cm, 3.26 ± 0.03 cm and 3.31 ± 0.04 cm, respectively. The average teat diameter ranged from 2.90 ± 0.03 cm in 1stparity to 3.52 ± 0.10 cm in 4thparity (Table 3), indicating, a gradual increase in diameter of left fore, right fore, left hind and right hind teat diameter with advancement of the parity. The differences observed in teat diameter in different lactations were statistically significant (P<0.05).These results are in agreement with the findings of Tilki *et al.*, (2005), who reported, all the udder measurements were affected by lactation number as the udder tissues continuously develop up to 6th parity with the advancement of age. Similarly, significant (P<0.05) effect of parity on teat diameter has also been observed in Murrah buffaloes by earlier workers (Prasad *et al.*, 2010 and Bharti *et al.*, 2015).

Distance between teats

The mean and SE values recorded for distance between fore teats, distance between hind teats and distance between fore and hind teats according to the order of parity are presented in Table 4. According to parity, the average distance between fore teats, hind teats and fore and hind teats ranged from 9.45 ± 0.30cm to 10.24 ± 0.26 cm,4.92 ± 0.11 cm to 5.49 ± 0.19 cm and 9.00 ± 0.23 cm to 9.59 ± 0.36 cm, respectively.

The average distance between fore teats, hind teats and fore and hind teats varied among the parities from 9.45 ± 0.30 cm in 1stparity to 10.24 ± 0.26cm in 4thparity, showing the distance between fore teats is increasing with parity. Similar results were reported by Prasad *et al.*, (2010) in Murrah buffaloes. The distance between hind teats decreased significantly (P<0.05) with parity. The distance between fore and hind teats decreasing with parity but the decrease was not statistically significant. Contrary to these findings, Prasad *et al.*, (2010) stated that the distances were in general increasing with the parity.

Relationship between udder biometrics and milk yield

The data pertaining to relationship between udder measurements viz., UL, UW and UD and average daily milk yield (ADMY) were presented in Table 5. The correlation of udder measurements with average teat length and teat diameter was positive but significantly (P<0.01) positive correlation was observed in case of UW with teat diameter and UD with teat length and teat diameter. The correlation of UL, UW and UD with distance between fore teats was positive but statistically significant (P<0.05) correlation was noted only for UL with distance between fore teats. The correlation of udder measurements with distance between hind teats and with distance between the fore and hind teats was negative and insignificant except for UW with distance between hind teats where, a positive correlation was observed.

The perusal of Table 5 revealing that, the correlation between the udder measurements viz., UL, UW and UD and ADMY were highly significant (P<0.01). Similar results were reported by Tomar (1973), with a conclusion that the ADMY was significantly correlated (P<0.01) with each of the three udder measurements in Hariana cattle. Kshatriya *et al.*, (2009) also reported that the correlation coefficients of ADMY with UL, UW and UD were positive and highly significant (P<0.01) in Kankrej and crossbred cows, Lavania *et al.*, (2011) reported that a positive and significant correlation (P<0.05)

was found between ADMY with UL and UW. Prasad *et al.,* (2010) also reported a positive correlation between udder measurements and ADMY in Murrah buffaloes. Badekar (2016) reported that the ADMY showed positive correlation with UW and UL, while, Patel *et al.,* (2016) and Khatri *et al.,* (2017) reported that the correlations between ADMY and all three udder measurements viz., UL (0.499), UW (0.413) and UD (0.178) were found positive and significant (P<0.01) in crossbred cows and buffaloes, respectively.

The relationship between teat measurements and ADMY is also presented in Table 5. The correlation between the average teat length and average teat diameter was positive and significant (P<0.01). The correlation of average teat length and teat diameter with ADMY was positive but the correlation was significant (P<0.05) only for teat diameter. A positive correlation was noted in case of distance between fore teats with average teat length and also with average teat diameter, whereas, the correlation of teat length with distance between hind teats and with distance between fore and hind teats was negative. Similarly, a negative correlation was observed for teat diameter with distance between hind teats and with distance between fore and hind teats. However, none of them were statistically significant.

The correlation of distance between fore teats with distance between hind teats, fore and hind teats and ADMY was positive but the correlation was significant (P<0.01) only for the distance between fore teats with distance between fore and hind teats. The correlation of distance between hind teats with the distance between fore and hind teats and ADMY was positive. The correlation of distance between the fore and hind teats with the ADMY was negative. However, none of them being statistically significant.

Similar to the present observations, Prasad *et al.,* (2010) reported positive correlation between the ADMY and the various teat measurements such as teat length, teat diameter and the distance between front and hind teats, but found significant (P<0.01) only between the average teat diameter and ADMY in Murrah buffaloes. Abdullah *et al.,* (2013) also reported, average teat length and teat diameter had highly significant (P<0.01) and positive relationship with ADMY (0.315 and 0.494, respectively) in Nili-Ravi buffaloes.

From the results of the present study, it can be understood that the udder measurements are effective tools for higher ADMY from buffaloes similar to the opinions of Gajbhiye *et al.,* (2007), Kshatriya *et al.,*(2009) and Prasad *et al.,* (2010). The study concludes that, there is an increase in udder and teat measurements with increase in lactation number, specifically UW and teat diameter, due to their significant positive correlation with ADMY could be considered as criteria for selection of Jaffarabadi buffaloes for higher milk production.

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How to cite this article:

Raju, B., Ch. Harikrishna and Prasad, R. M. V. 2021. Studies on Relationship between Udder and Teat Measurements and Milk Yield as Affected by Parity in Jaffarabadi Buffaloes. *Int.J.Curr.Microbiol.App.Sci.* 10(03): 241-248. doi: https://doi.org/10.20546/ijcmas.2021.1003.032