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Variation in Test Day Milk Yield and Composition at Day 15 and 60 Postpartum in Surti and Jafarabadi Buffaloes

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ABSTRACT

The study was carried out to study individual test day variability in yield and composition of Surti and Jafarabadi buffaloes milk at day 15 and 60 postpartum (pp). 10 healthy Surti and Jafarabadi buffaloes of each breed were selected at random from Livestock Research Station, Navsari and Cattle Breeding Farm, Junagadh, Gujarat, respectively. Buffaloes were further divided into four different groups for data analysis and comparisons. Overall mean Test day milk yield (TDMY) was found to be steady without any notable significant differences among the four groups of buffaloes. There was increase of 0.88 kg and 0.33 kg in mean Fat and protein corrected test day milk yield (FPCTDMY) with advancement of lactation between day 15 and 60 pp in Surti and Jafarabadi buffaloes, respectively. The mean FPCTDMY of S15 and J15 groups were found to be significantly different ($p \leq 0.05$), showing 45.07% higher yield in Jafarabadi buffaloes. The mean fat percent of Jafarabadi buffaloes was significantly ($p \leq 0.05$) higher with magnitude of 28.79% over fat% of Surti buffaloes at day 60 pp. The mean SNF% in milk of Jafarabadi buffaloes was 12.27%, significantly ($p \leq 0.05$) higher than Surti buffaloes milk at day 15 pp. The mean protein% in milk of Jafarabadi buffaloes was 17.71 and 10.51% significantly ($p \leq 0.05$) higher than Surti buffaloes milk at day 15 and 60 pp, respectively. The mean lactose% in milk of Jafarabadi buffaloes was 13.39 % higher than Surti buffaloes milk at day 15 pp, the difference being statistically significant ($p \leq 0.05$). As major finding, Jafarabadi buffaloes produced significantly higher milk in terms of FPCTDMY (at day 15 pp) and Fat percent (at day 60 pp) as compared to Surti buffaloes, respectively.

Keywords: Buffalo, Surti, Jafarabadi, milk yield, milk composition

Riverine buffalo (*Bubalus bubalis*) is now established as an economically important species in many Asian and Mediterranean countries. The role of buffalo as a major milk producing species is well recognized in the Indian subcontinents, especially in India and Pakistan. As per latest 19th livestock census, the current buffalo population in India is 108.7 million, which accounts for 21.23 percent of the total livestock population of India. India produces 146.3 million ton of milk per annum out of which, about 51% of milk is contributed by buffaloes (Anonymous, 2015). Milk production in India grew at an annual growth rate of 3.97 percent (Anonymous, 2015). Gujarat has around 9.55 percent buffalo population of the country and bestowed with high milk producing breeds. Buffaloes produced about 5.9 million ton of milk per annum, which contributes about 57.20 percent total milk produced of the state (Anonymous, 2013). Buffalo milk is characterized by higher solids contents for being rich source of lipids, protein, lactose and minerals than cattle. Buffalo milk has long been valued by its important chemical composition determining nutritive properties and suitability in the manufacture of traditional as well as industrial dairy products (Abd El-Salam and El-Shibiny, 1966). Due to this, recently buffalo milk's constituents, their

nutritional importance and bioactive properties have received much attention. One of the important milk yield records is test day milk yield (TDMY). TDMY is the measurement of the milk produced by a milking animal over a period of 24 h. It is one of the important milk yield records depicting the production efficiency of dairy animals. TDMY records are employed in genetic evaluations instead of 305-day total lactation milk yield of animals, in order to find out an alternative to daily milk yield recording, which is a costly and time consuming proposition under field conditions. Comparisons between lactation models and test-day models for the genetic evaluation of dairy animals from various species and breeds have been reported in the literature under various perspectives (Singh *et al.*, 2016). The quality of milk relies on milk composition that varies with stage of lactation, breed, species, milking system, age, size of the animal, environment, climate, temperature, dietary composition, locality and season. Among all these factors breed and stage of lactation are the main factors that affect the milk yield and its composition. Surti is considered as an economical producer of milk and butter fat. While, Jafarabadi buffaloes yield appreciable quantity of milk, with an exceptionally high butter fat content. Considering these diversity, the present study was designed with the objective to study the variability in the test day milk yield and milk composition in Surti and Jafarabadi buffaloes (second and third parity) at day 15 and 60 of lactation at organized farms situated in their home tracts.

MATERIALS AND METHODS

Ethical approval

The prior approval from the Institutional Animal Ethics Committee was obtained for the use of Surti and Jafarabadi buffalo breeds maintained at Livestock Research Station, Navsari, Gujarat and Cattle Breeding Farm, Junagadh Agricultural University, Gujarat, respectively.

Selection of experimental animals

10 healthy Surti and Jafarabadi buffaloes of each breed were selected at random (second and third parity) from Livestock Research Station, Navsari and Cattle Breeding Farm, Junagadh, Gujarat, respectively. Buffaloes were further divided into four different groups for data analysis and comparisons *viz.*, S15 (Surti buffaloes 15th day post partum), S60 (Surti buffaloes 60th day post partum), J15 (Jafarabadi buffaloes 15th day post partum) and J60 (Jafarabadi buffaloes 60th day post partum).

Sample collection

Whole milk sample from each selected animal was collected twice a day (5.00 am and 5.00 pm) into a sterile bucket with full hand milking method. Milk yield was determined using electronic balance. 50 ml aliquot was taken in polypropylene tube and was subjected to milk composition analysis immediately after collection.

Estimation of milk composition parameters

TDMY in kg was calculated by combining morning and evening milk yield of collection day. Cumulative milk yield in first 15 (CMY15) and 60 days pp (CMY60) was calculated by summing up TDMY of first 15 and 60 days pp, respectively. Milk composition of samples such as milk protein, fat, and SNF and lactose% was analyzed using Lactoscan milk analyzer (Netco, India) as per manufacturer instructions. Fat and protein corrected TDMY (FPCTDMY) was calculated by correcting TDMY to 4.0% fat and 3.3% protein using the formula:

FPCTDMY (kg) = TDMY (kg) × [0.337 + (0.116 × fat%) + (0.06 × protein%)] (Anonymous, 2008)

Statistical analysis

The data on milk yield and milk composition was subjected to statistical analysis using Statistical Package for Social Sciences (SPSS, Version 20.0) software. Descriptive statistics specifying mean ± standard error of mean, highest and lowest value were calculated for each group. One-way ANOVA procedure was undertaken to compare means. *Post hoc* multiple comparisons were made using Duncan multiple new range test. Independent sample t-test was used for two-group comparisons. Bi-

Table 1: Mean milk yield and composition traits of Surti and Jafarabadi buffaloes at day 15 and 60 post partum

Traits/Groups	S15	S60	J15	J60	F/ t
N	10	10	10	10	
TDMY (kg)	4.1±0.40	4.92± 0.32	5.28± 0.52	5.41±0.56	1.6
FPCTDMY (kg)	$5.08^{a} \pm 0.73$	$5.96^{ab} \pm 0.40$	$7.37^{b} \pm 0.83$	$7.77^{b} \pm 0.91$	2.82*
CMY15 (kg)	$46.24^{a} \pm 4.00$	—	$70.88^{b} \pm 6.72$	—	3.15**
CMY60 (kg)	—	$235.55^{a} \pm 18.34$	—	$310.20^{b} \pm 27.43$	2.25*
Fat %	$5.79^{a} \pm 0.51$	$5.73^{a} \pm 0.16$	$6.94^{ab} \pm 0.48$	$7.38^{b} \pm 0.41$	4.04**
SNF %	$10.02^{a} \pm 0.39$	$10.11^{a} \pm 0.22$	$11.25^{b} \pm 0.23$	$10.67^{ab} \pm 0.12$	4.95**
Protein %	$3.50^{a} \pm 0.12$	$3.52^{a} \pm 0.06$	$4.12^{b} \pm 0.08$	$3.89^{b} \pm 0.05$	14.02**
Lactose %	$5.45^{a} \pm 0.27$	$5.51^{a} \pm 0.15$	$6.18^{b} \pm 0.12$	$5.83^{ab} \pm 0.07$	3.96**

*Significant at $p \leq 0.05$, **highly significant at $p \leq 0.01$, N= Number of observations. Means bearing different superscript between groups differed significantly. TDMY=Test day milk yield, FPCTDMY=Fat and protein corrected test day milk yield, CMY15=Cumulative milk yield in first 15 days pp, CMY60=Cumulative milk yield in first 60 days pp, SNF=Solid not fat

variate correlations were calculated using Pearson correlation coefficient. The size of correlation (very high, high, moderate, low and negligible) was interpreted as per the standard classification by Hinkle *et al.* (2003).

RESULTS AND DISCUSSION

Test day milk yield

The TDMY recorded in the present study ranged from 2.50 to 6.90 kg, 3.20 to 6.80 kg, 3.10 to 7.50 kg and 2.90 to 8.60 kg among S15, S60, J15 and J60 groups, respectively. Overall mean TDMY was found to be steady without any notable significant differences among the four groups of Surti and Jafarabadi buffaloes at day 15 pp and 60 pp. Similarly, non-significant variation was reported in weekly milk production in Nagpuri buffaloes up to 15th week of lactation which suggested the persistency of weekly milk production in early lactation period in Nagpuri buffaloes (Sahare *et al.*, 2009). In contrast, several other authors reported significant difference in TDMY with advancement of lactation in buffaloes. Steady increasing trend of TDMY with 5.52 ± 0.06 kg in 2nd week to 7.90 ± 0.06 kg in 9th week of lactation had been reported in Murrah buffaloes (Sahoo *et al*., 2014). Milk production was also found to increase between days 16 and 60 (11.35 kg) in Mediterranean buffaloes (Salari *et al.*, 2013).

Fat and protein corrected test day milk yield

The mean FPCTDMY reflected actual milk yield irrespective of protein and fat contents of the milk because these two major factors have been corrected using a formula (Anonymous, 2008). Mean ± S.E. of mean values of FPCTDMY ranged from 2.90 to 13.62 kg among S15, S60, J15 and J60 groups. There was increase of 0.88 kg and 0.33 kg in mean FPCTDMY with advancement of lactation between day 15 and 60 pp in Surti and Jafarabadi buffaloes, respectively. The mean FPCTDMY of S15 and J15 groups were found to be significantly different ($p \leq 0.05$), showing 45.07 % higher yield in Jafarabadi buffaloes. As compared to mean TDMY of S15, S60, J15 and J60 groups, the mean FPCTDMY were 23.90%, 21.13%, 39.58% and 43.62% higher, respectively. This is due to higher protein and fat% in Surti and Jafarabadi buffaloes. The percent increase for mean FPCTDMY compared to mean TDMY was higher in Jafarabadi buffaloes because of their relatively higher protein and fat% increase with advancement of lactation.

Cumulative milk yield of first 15 and 60 days

The cumulative milk yield of first 15 days (CMY15) had ranged from 33.40 to 73.90 kg and 41.40 to 107.15 kg among Surti and Jafarabadi buffaloes, respectively. The lowest to highest cumulative milk yield of first 60 days (CMY60) observed among Surti and Jafarabadi buffaloes were 145.20 to 351.60

kg and 167.70 to 416.50 kg, respectively. The mean CMY15 and CMY60 of Jafarabadi buffalo was 53.28% and 31.69% significantly ($p \leq 0.05$) higher than Surti buffalo. Higher mean CMY60 (313.89 kg) had been reported in Surti buffaloes maintained at Livestock Research Station, Vallabhnagar, Rajasthan (Singh and Tailor, 2014). This may be attributed to variation in various non-genetic factors like location, period of study, size of data sets, parity etc. The CMY15; 70.88 ± 6.72 kg ($p \leq 0.01$) and CMY60; 310.20 ± 27.43 kg were also significantly ($p \leq 0.05$) higher in Jafarabadi as compared to Surti buffaloes. Sethi, (2003), reported similar findings in accordance with the higher standard lactation yield of 1950±79 kg for Jafarabadi buffaloes (Junagarh Centre of the Network Project on Buffalo) as compared to 1477±42 kg of Surti buffaloes (Maharana Pratap University of Agriculture and Technology, Vallabhnagar Centre of the Network Project on Buffalo).

These findings were in accordance with higher standard lactation yield of 3174.79 ± 27.26 kg reported for Jafarabadi buffaloes (Dangar *et al*., 2015) as compared to 1469.71 ± 39.62 kg of Surti buffaloes (Anonymous, 2016) maintained at Cattle Breeding Farm, Junagadh and Livestock Research Station, Navsari, respectively. The higher cumulative milk yield in Jafarabadi buffaloes compared to Surti buffaloes may be attributed to various genetic and non-genetic factors as discussed earlier for similar differences observed in TDMY and FPCTDMY in these two breeds.

Milk composition

The milk composition was analyzed in Surti and Jafarabadi buffaloes at different stages of lactation. While very few literatures is available regarding review that describes the composition traits around day 15 and 60 pp.

Fat (%)

With advancement of lactation in both Surti and Jafarabadi buffaloes no significant variation in fat% was observed. However, the mean fat% of Jafarabadi buffaloes was significantly ($p \leq 0.05$) higher with magnitude of 28.79 % over fat% of Surti buffaloes at day 60 pp. The mean fat% data observed under this study was lower than earlier published reports of 6.17 for Surti buffaloes (Misra *et al.,* 2008). Garaniya *et al*. (2013) reported that increase in fat content from 6.76 to 7.13 gm% in consecutive second month of lactation in Jafarabadi buffaloes. Pasha and Hayat, (2012) reported higher fat% compared to the present study in Jafarabadi (8.5 %) and Surti buffaloes (6.6-8.1 %), respectively. However, fat% reported in the present study was lower than 8.59, 8.10 and 8.40 % of fat reported for water buffaloes in Italy (Rosati and Van Vleck, 2002), Turkey (Yilmaz *et al.,* 2012) and Europe (Borghese, 2013), respectively. Some of the reports of lower fat (6.59%) as compared to the present study were also reported in Mediterranean breed (Macedo *et al.,* 2001).

Significantly higher fat content (8.64%) at the end of the peak production period in Mediterranean buffaloes were also been reported (Salari *et al.,* 2013). Compared to four groups of present study, higher fat content of 8.71% (Bartocci *et al.,* 2002) and 9.01% (Tonhati *et al.,* 2011) were also been reported in Mediterranean buffaloes. However, comparable higher fat (7.0-7.7%) were reported in other several studies (Ahmad *et al.,* 2008; Menard *et al.,* 2010; Wangdi *et al*., 2014).

Solid not fat (%)

The lowest SNF % observed was 9.22%, 9.43%, 10.47% and 10.02 % among milk of S15, S60, J15 and J60 groups, respectively. Highest SNF% observed was 13.43%, 11.95%, 12.96% and 11.06 % among milk of S15, S60, J15 and J60 groups, respectively. The mean SNF% in milk of Jafarabadi buffaloes was 12.27 %, significantly ($p \leq 0.05$) higher than Surti buffaloes milk at day 15 pp. Decrease in the mean SNF% recorded from J15 (11.25) to J60 (10.67) group. Earlier a range of 9.8-10.1% SNF had been reported for Egyptian buffaloes (Abd El-Salam and El-Shibiny, 1966) which was nearly comparable to the SNF% reported in the present study among S15, S60 and J60 groups. The reference of high SNF% comparable to this study was cited in Brazilian buffaloes producing milk with 10.4% SNF (Macedo *et al.,* 2001) and 10.1% in

Murrah buffalo (Verma *et al*., 1990, Akbar *et al*., 1999 and Misra *et al*., 2000). Mean SNF of 9.57 ± 0.03 % during first month reported in Murrah buffaloes (Dubey *et al*., 1997). Lower SNF ranged from 8.98 to 8.69 gm% reported in Jafarabadi buffalo during first 60 days of lactation (Garaniya *et al*., 2013). The mean SNF% data observed under this study was lower than earlier published reports of 8.80 for Surti buffaloes (Misra *et al*., 2008). Contrastingly, mean SNF of 9.4-9.9% had been reported in Murrah buffaloes of Punjab (Sodi *et al*., 2008), Swamp buffaloes of Bangladesh (Khan *et al*., 2007), Bhutan (Wangdi *et al*., 2014) and Bulgarian buffaloes (Peeva, 2001). Similarly, lower mean SNF of 9.2% had also been reported in water buffaloes of Bangladesh (Khan *et al*., 2007). Even lower mean SNF of 8.3% compared to all four groups of present study had also been reported in non-descript buffaloes reared at high altitudes in the Kumaon hills of the centeral Himalayas (Meena *et al*., 2007).

Protein (%)

No significant variation in protein % was observed with advancement of lactation in both Surti and Jafarabadi buffaloes. The lowest protein content in the present study was 3.50% observed in S15 group and that of highest was 4.12% observed in J15 group. The mean protein % in milk of Jafarabadi buffaloes was 17.71 and 10.51% significantly ($p \leq 0.05$) higher than Surti buffaloes milk at day 15 and 60 pp, respectively. Protein content in Jafarabadi buffalo milk remains unchanged from 4.39 to 4.26 gm% in consecutive second month of lactation (Garaniya *et al*., 2013). The mean protein % data observed under this study was comparable with earlier published reports of 3.93 for Surti buffaloes (Misra *et al*., 2008). Lower protein % than the present study (3.35%) was reported in buffalo under Bhutanese conditions (Wangdi *et al*., 2014). Slightly higher protein content (3.60-3.85 %) as compared to S15 and S60 were reported in Egyptian buffaloes (Abd El-Salam and El-Shibiny, 1966; Kholif, 1997).

Protein content ranging from of 3.73 to 3.97% which was in between the observed protein % in milk of Surti and Jafarabadi buffaloes had been reported in Murrah buffaloes of India (Dubey *et al*., 1997; Sodi *et al*., 2008) and Argentina (Patino and Stefani, 2005) as well as water buffaloes of Bangladesh (Khan *et al*., 2007). Comparable protein of 4.11 and 4.13% as compared to J15 group was reported in buffaloes of Pakistan (Imran *et al*., 2008) and Brazil (Macedo *et al*., 2001), respectively. Protein content of 4.35% in buffaloes of Pakistan (Arian *et al*., 2008) and France (Ahmad *et al*., 2008) higher that observed J15 had also been reported in the present study. Also higher protein content of 4.40% and 4.49 % than the J15 group was reported in buffaloes of Turkey (Sekerden *et al*., 1999) and Bulgaria (Peeva, 2001), respectively.

Lactose (%)

The Mean ± S.E. of mean values of lactose % was 5.45± 0.27% , 5.51± 0.15% , 6.18 ± 0.12 % and 5.83 ± 0.07 % in milk of S15, S60, J15 and J60 groups, respectively. The lowest to highest lactose % observed was 4.46 to 7.68%, 5.00 to 6.75%, 5.75 to 7.12% and 5.51 to 6.08% among milk of S15, S60, J15 and J60 groups, respectively. The mean lactose % in milk of Jafarabadi buffaloes was 13.39% higher than Surti buffaloes milk at day 15 pp, the difference being statistically significant ($p \leq 0.05$). Lactose % in the range of 4.99-5.24 reported in buffaloes of Egypt (Abd El-Salam and El-Shibiny, 1966; Kholif, 1997) that are lower than the findings of present experiment. Lactose % in between 4.5-5.0% had been reported in buffaloes of India (Dubey *et al*., 1997; Sodi *et al*., 2008), Italy (Tufarelli *et al*., 2008), Pakistan (Imran *et al*., 2008), Bangladesh (Khan *et al*., 2007), Murrah breed in Argentina (Patino and Stefani, 2005), Jaffarabadi breed in Argentina (Patino and Stefani, 2005) and Bulgaria (Peeva, 2001).

However, lactose % higher than 5.0% showing agreement with the present study were also reported in buffaloes of Pakistan (Arian *et al*., 2008), Bhutan (Wangdi *et al*., 2014) and France (Ahmad *et al*., 2008). Lower Lactose content in Jafarabadi buffalo milk ranged from 3.87 to 3.85 gm%, reported in Jafarabadi buffalo during first 60 days of lactation (Garaniya *et al*., 2013).

Correlation coefficients among milk yield and composition traits

The correlation coefficients among milk yield and

Table 2: Correlation coefficients between milk yield and composition traits at day 15 (above diagonal) and day 60 post partum (below diagonal) in Surti buffaloes

Traits	TDMY (kg)	Fat %	SNF %	Protein%	Lactose %
TDMY (kg)	--	-0.43	-0.43	-0.22	-0.52
Fat %	-0.09	--	-0.16	0.29	-0.43
SNF %	-0.15	-0.53	--	0.89**	0.95**
Protein %	-0.19	-0.30	0.96**	--	0.72*
Lactose %	-0.12	-0.64*	0.99**	0.92**	--

*Significant at *p≤0.05*, ** highly significant at *p≤0.01*.TDMY = Test day milk yield, SNF = Solid not fat

Table 3: Correlation coefficients between milk yield and composition traits at day 15 (above diagonal) and day 60 post partum (below diagonal) in Jafarabadi buffaloes

Traits	TDMY (kg)	Fat %	SNF %	Protein %	Lactose %
TDMY (kg)	—	0.11	0.00	0.00	0.00
Fat %	- 0.22	—	0.30	0.30	0.31
SNF %	0.18	-0.36	—	1.00**	1.00**
Protein %	-0.05	-0.46	0.91**	—	1.00**
Lactose %	-0.14	-0.49	0.87**	0.98**	—

*Significant *at p≤0.05*, ** highly significant at *p≤0.01*.

composition traits of Surti and Jafarabadi buffaloes are presented in Table 2 and 3. Very high positive significant (*p≤0.01*) correlation of SNF% was observed with protein % (0.89) and lactose % (0.95) in Surti buffaloes at day 15 pp. Also high significant positive (*p≤0.01*) correlation between protein and lactose% (0.72) was observed at day 15 pp. The moderate negative significant (*p≤0.05*) correlation (-0.64) at day 60pp was observed between fat and lactose% in Surti buffaloes. Also at day 60 pp high positive significant (*p≤0.01*) correlation was observed between SNF% (0.99) and lactose% and SNF% and protein% (0.96). Protein% and lactose% were also correlated highly significantly (*p≤0.01*) and positively (0.92).

In Jafarabadi buffaloes at day 15 pp very high positive significant (*p≤0.01*) correlation (1.0) was observed between SNF and protein% and SNF and lactose% (1.0). Protein and lactose% (1.0) also expressed same pattern of high positive significant correlation (*p≤0.01*). At day 60 pp very high positive significant (*p≤0.01*) correlations (0.91) was observed between SNF and protein % followed by SNF and lactose % (0.87). Protein% and lactose% (0.98) % were also correlated highly significantly (*p≤0.01*) and positively. All remaining correlations were of low to negligible magnitude between different traits among the four groups. Khalid *et al.* (2013) reported similar results of correlation between milk yield and composition traits in Nili–Ravi buffaloes. They reported very high positive significant correlation of SNF % was observed with protein % (0.90) and lactose (0.97), respectively. Also highly significant positive correlation of protein was observed with lactose % (0.87). Comparable non-significant correlations of low to negligible magnitude among milk yield and composition traits had also been reported by several authors (Gajaila *et al.*, 2014; Hamad *et al.*, 2014)

CONCLUSION

TD milk yield records can be employed in genetic evaluations in absence of 305-day total lactation milk yield of animals. However, in the present study TDMY was found to be steady without any notable significant differences among the four groups of

Surti and Jafarabadi buffaloes at day 15 pp and 60 pp. Protein and fat percent of Jafarabadi buffalo milk was significantly higher than Surti buffalo at day 15 and 60 pp except non-significant difference in fat percent at day 15 in both the buffalo breeds. Jafarabadi buffaloes produced significantly higher milk in terms of FPCTDMY compared to Surti buffaloes at day 15 pp. Also, Test Day fat yield records offer greater advantage compared to 305-day fat yield in selection schemes, information on estimation of genetic parameters based on TD records particularly, monthly records are limited. TD yields could be used as the selection criteria for early evaluation, prediction of lactation and selection of animals.

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REFERENCES

Abd El-Salam, M.H. and El-Shibiny, S. 1966. The chemical composition of buffalo milk I general composition. *Indian J. Dairy Sci.,* **19**: 151–154.

Ahmad, S., Gaucher, I., Rousseau, F., Beaucher, E.M. Piot, J.F. Grongnet and Gaucheron, F. 2008. Effects of acidification on physicochemical characteristics of buffalo milk: A comparison with cows milk. *Food Chem.,* **106:** 11-17.

Akbar, M.A., Kuldip, R.K. and Singh, N. 1999. Effect of feeding bypass protein with and without biopromotor on milk production and certain rumen and blood metabolites in lactating Murrah buffaloes. *Indian J. Anim. Sci.*, **69(11)**: 967-971.

Anonymous. 2008. Feeding standards, feeding advice and nutrition value of feeding ingredients. CVB Table Booklet, Feeding of ruminants. Product Board Animal Feed, CVB Series no. 43, pp. 68.

Anonymous. 2013. 30th survey report on estimates of major livestock products for the year 2012-2013 Gujarat state. Directorate of Animal Husbandry Krishi Bhavan, Sector 10-A Gandhinagar - 382 010, Gujarat state.

Anonymous. 2015. Annual Report 2014-15. Department of Animal Husbandry, Dairying & fisheries. Ministry of Agriculture, Government of India, New Delhi, pp. 107.

Anonymous. 2016. Annual progress report of AGRESCO sub-committee on Animal Production and Fisheries Sciences. Navsari Agricultural University, Navsari-396450, Gujarat.

Arian, H.H., Khaskhali, M., Arian, M.A., Soomro, A.H. and Nizamani, A.H. 2008. Heat stability and quality characteristics of postpartum buffalo milk. *Pak. J. Nutr.,* **7:** 303–307.

Bartocci, S., Tripaldi, C. and Terramoccia, S. 2002. Characteristics of foodstuffs and diets, and the quanti-qualitative milk parameters of Mediterranean buffaloes bred in Italy using the intensive system– An estimate of the nutritional requirements of buffalo herds lactating or dry. *Livest. Prod. Sci.,* **77**: 45–58.

Borghese, A. 2013. Buffalo livestock and products in Europe. *Buffalo Bull.,* **32**: 50–74.

Dangar, N.S., Pandya, G.M. and Vataliya, P.H. 2015. Factors affecting standard lactation milk yield in Jafrabadi buffaloes. In: Proceedings of 12 Convention and Symposium of Society for Conservation of Domestic Animal Biodiversity (SOCDAB). Feb. 2015. Chennai, India, pp. 257.

Dubey, P.C., Suman, C.L., Sanyal, M.K., Pandey, H.S., Saxena, M.M. and Yadav, P.L. 1997. Factors affecting the composition of milk of buffaloes. *Indian J. Anim. Sci.*, **67**: 802–804.

Gajaila, I., Gajaila, G., Dobrea, M. and Cotor, G. 2014. Determination of relationships between milk composition and cheese yield using principal component analysis and logit model. *Bull. UASVM Vet. Med.,* **71(1):** 62-65.

Garaniya, N.H., Ramani, H.R. and Golakiya, B.A. 2013. Nutrient profile of Jaffarabadi buffalo milk at different stages of lactation. *Asian J. Dairy Food Res.,* **32(2):** 168-170.

Hamad, M.N.E., El-Moghazy, M.M. and Abdel-Aziz, M.E. 2014. Phenotypic correlations among Egyptian buffalo milk production and its major chemical constituents. *J. Agric. Sci. Mansoura Univ.,* **10:** 1-8.

Han, B.Z., Meng, Y., Li, M., Yang, Y.X., Ren, F.Z., Zeng, Q.K. and Nout, M.J.R. 2007. A survey on the microbiological and chemical composition of buffalo milk in China. *Food Control,* **18**: 742–746.

Hinkle, D.E., Wiersma, W. and Jurs, S.G. 2003. Applied Statistics for the Behavioral Sciences 5th ed. Boston: Houghton Mifflin.

Imran, M., Khan, H., Hassan, S.S. and Khan, R. 2008. Physicochemical characteristics of various milk samples available in Pakistan. *J. Zheijang Univ. Sci. B - Biomed. Biotech.,* **9**: 546–551.

Khalid, J., Abdullah, M., Khalid, M.S., Ahmad, N., Bhatti, J.A. and Younas, U. 2013. Inter-relationship of milk constituents

with body and udder measurements in Nili-Ravi buffaloes raised at commercial farms of Pakistan. *Buffalo Bull.,* **32(2):** 1170-1173.

Khan, M.A.S., Islam, M.N. and Siddiki, M.S.R. 2007. Physical and chemical composition of swamp and water buffalo milk: a comparative study. *Ital. J. Anim. Sci.,* **6(2):** 1067–1070.

Kholif, A.M. 1997. Effect of number and stage of lactation on the yield, composition and properties of buffalo's milk. *Egypt. J. Dairy Sci.*, **25**: 25–39.

Macedo, M.P., Wechesler, F.S., Ramos, A.A., Macado, M.P., Wechesler, F.S., Ramos, A.A., do Amaral, J.B., de Souza, J.C., de Resende, F.D. and De Oliveria, J.V. 2001. Chemical composition and production of milk from Mediterranean buffalocows raised in western São Paulo State, Brazil (in Portuguese). *Rev. Bras. Zootecn.,* **30**: 1084–1088.

Meena, H.R., Ram, H. and Rasool, T.J. 2007. Milk constituents in non-descript buffaloes reared at high altitudes in the Kumaon hills of the centeral Himalayas. *Buffalo Bull.,* **26**: 72–76.

Menard, O., Ahmad, S., Rousseau, F., Briard-Bion, V., Gaucheron, F. and Lopez, C. 2010. Buffalo vs. cow milk fat globules: Size distribution, zetapotential, compositions in total fatty acids and in polar lipids from the milk fat globule membrane. *Food Chem.,* **120**: 544-551.

Misra, A.K., Samanta, A.K., Singh, A.P. and Verma, N.C. 2000. On-farm trial on ammoniated wheat straw. Effect on intake and milk yield in Murrah buffalo. *Indian J. Anim. Sci.*, **70(8)**: 868-870.

Misra, S.S., Sharma, A., Bhattacharya, T.K., Kumar, P. and Saha, R.S. 2008. Association of breed and polymorphism of α-s1 and α-s2 casein genes with milk quality and daily milk and constituent yield traits of buffaloes (*Bubalus bubalis*). *Buffalo Bull.,* **27**: 294–301.

Pasha, T.N. and Hayat, Z. 2012. Present Situation and Future Perspective of Buffalo Production in Asia. *J. Anim. Plant. Sci*., **22(3)**: 250-256.

Patino, E.M. and Stefani, Y.M. 2005. Milk composition of breed Jafarabadi in Corrientes, Argentina (in Spanish). *Rev. Electron. Vet.,* **6(5):** 1-4.

Peeva, T. 2001. Composition of buffalo milk: Sources of specific effects on the separate components. *Bulg. J. Agric. Sci.,* **7:** 329–335.

Rosati, A. and Van Vleck, L.D. 2002. Estimation of genetic parameters for milk, fat, protein and mozzarella cheese production for the Italian river buffalo *Bubalus bubalis* population. *Livest. Prod. Sci.,* **74**: 185–190.

Sahare, M.G., Sawaimul, A.D., Ali, S.Z., Sirothia, A.R. and Bhojane, G.R. 2009. Weekly milk producation trends in early lactation period of Nagpuri buffalo. *Vet. World,* **2(7)**: 278-279.

Sahoo, S.K., Singh, A., Gupta, A.K., Chakravarty, A.K., Singh, M. and Ambhore, G.S. 2014. Estimation of genetic parameters of weekly test-day milk yields and first lactation 305-day milk yield in Murrah buffaloes. *Vet. World,* **7(12)**: 1094-1098.

Salari, F., Altomonte, I. and Martini, M. 2013. Buffalo milk: A case study of some parameters related to milk production. *Large Anim. Rev.,* **19**: 17–20.

Sekerden, O., Erdem, H., Kankurda, B. and Ozlu, B. 1999. Factors affecting milk composition and changes in milk composition with lactation stage in Anatolian buffaloes (in Turkish). *Turk. J. Vet. Anim. Sci.,* **23**: 505–509.

Sethi, R.K. 2003. Buffalo Breeds of India. Proceedings of Fourth Asian Buffalo Congress, 25 to 28 February, New Delhi, India.

Singh, B. and Tailor, S.P. 2014. Genetic evaluation of Surti sires for part and complete lactation milk yield. *Indian J. Anim. Sci.,* **84(7):** 789–791.

Singh, M., Singh, A., Gupta, A.K., Dash, S.K., Shivahre, P.R., Sahoo, S.K. and Ambhore, G.S. 2016. Genetic parameters of 305 days and monthly test-day milk yields in Murrah buffaloes. *Indian J. Anim. Sci.,* **86(1)**: 55–60.

Sodi, S.S., Mehra, M.L., Jain, A.K. and Trehan, P.K. 2008. Effect of non-genetic factors on the composition of milk of Murrah buffaloes. *Indian Vet. J.,* **85**: 950–952.

Tonhati, H., Lima, A.L., Lanna, D.P., de Camargo, G.M., Baldi, F., de Albuquerque, L.G. and Montrezor, J.M. 2011. Milk fatty acid characterization and genetic parameter estimates for milk conjugated linoleic acid in buffaloes. *J. Dairy. Res.,* **4**: 1-6.

Tufarelli, V., Dario, M. and Laudadio, V. 2008. Diet composition and milk characteristics of Mediterranean water buffaloes reared in South Eastern Italy during spring season. *Livest. Res. Rural Dev.,* **20(10)**: 1–7.

Verma, D.N., Husain, K.Q. and Bharat, R. 1990. Effect of water splashing on feed consumption and nutrient utilisation in buffaloes. *Indian J. Anim. Nutr.,* **7(1)**: 11-14.

Wangdi, J., Bhujel, P., Timsina, M.P. and Wangchuk, S. 2014. Performance of Buffalo (*Bubalus bubalis*) under Bhutanese conditions. *Glob. J. Dairy Farm. Milk prod*., **2(2)**: 67-73.

Yilmaz, O., Ertugrul, M. and Wilson, R.T. 2012. Domestic livestock resources of Turkey Water buffalo. *Trop. Anim. Health Prod.,* **44**: 707–714.