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EFFECT OF SEASON AND STAGE OF LACTATION ON MILK COMPONENTS OF JAFFRABADI BUFFALOES

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ABSTRACT
The present study was designed to see the effect of season and lactation stage on milk components of Jaffrabadi buffaloes. Total 900 milk samples were collected, comprised of 100 samples each from season (winter, summer and rainy) and from lactation stage (early, mid and late) for the study. Overall milk fat, protein, lactose, ash, solid not fat (SNF) and total solids (TS) were observed to be 8.31±0.37, 4.31±0.06, 5.66±0.09, 0.96±0.01, 10.93±0.18 and 19.24±0.43%, respectively. There was significantly (P<0.05) higher protein percent during rainy and lower during winter (4.37±0.05 and 4.20±0.05%, respectively), but milk lactose percent was significantly (P<0.05) higher during winter (5.46±0.07%) and lower during rainy (5.79±0.07%). Stage of lactation had also significant effect on milk components; milk fat, protein and TS percent increased significantly with the advancement of lactation stage; whereas, milk lactose decreased significantly (P<0.05). Milk fat during early, mid and late lactation was 7.65±0.10, 8.36±0.10 and 8.92±0.11%; protein was 4.25±0.04, 4.24±0.05 and 4.44±0.05% and TS was 18.7±0.18, 19.02±0.20 and 19.85±0.22%, respectively (P<0.05). However, milk lactose percent was 5.83±0.06, 5.65±0.07 and 5.51±0.07%, respectively during early, mid and late lactation (P<0.05). Thus, results of the present investigation indicated that season and stage of lactation affect certain milk components in Jaffrabadi buffaloes and could be minimized by better farm management practices.

INTRODUCTION

Dairying in India plays crucial role for livelihood of rural people by providing milk, dung and draft power (Dash, 2010). According to 19th livestock census (GOI, 2012), India possesses 67.54 and 51.05 million milch cows and buffaloes, respectively. However, compared to cows, buffaloes contributed significantly to the milk pail of the country and produced 65.35 million tonnes (51.1% share of the total milk produced i.e. 127.9 million tonnes) milk during 2011-12 (BAHS, 2013). All most all nutrients are also richer in buffalo milk (high content of fat, lactose, protein and ash percent); hence getting more attention and fetches higher price compared to cow milk (Abd El-Salam and El-Shibiny, 2011). In India, milk price is generally fixed based on fat content together with volume. Hence, while procuring milk from farmers in cooperatives, milk was tested for fat percent. However, with the advancement of technology and availability of cost effective milk analyzer, now-a-days it is also possible to measure other milk components such as protein, lactose, ash, SNF and TS (Ravikala *et al.*, 2014). Milk composition is considered as an important attribute essential for dairy farmers to maintain raw milk worth, dairy industries to produce better quality products and consumers to sustain nutritional quality and safety (Malek dos Reis *et al.*, 2013). Although, several factors affect milk composition in buffaloes, stage of lactation and seasonal availability of nutrition play crucial role (Ravikala *et al.*, 2014) and subsequently affect the milk products' quality. Previous studies reported significant effect of season (Abd El-Salam and El-Shibiny, 2011; Ahmad *et al.*, 2013b; Singh, 2013; Yadav *et al.*, 2013b; Claeys *et al.*, 2014) and stage of lactation (Dubey *et al.*, 1997; Abd El-Salam and El-Shibiny, 2011; Yadav *et al.*, 2013b; Claeys *et al.*, 2014; Mahdi, 2014) on buffalo milk composition but these informations are scanty on Jaffrabadi buffalo, although this breed contributed significantly to the national milk pail. The study of milk composition during different season and stage of lactation might give valuable information pertaining to variation of milk components, and further better managerial practices could minimize such effect and improve the milk composition of buffaloes during different lactation stages throughout the year. Hence, the present study was designed to see the effect of seasons and lactation stages on different traits of milk components in Jaffrabadi buffaloes.

MATERIALS AND METHODS

The study was carried out at College of Veterinary Science and Animal Husbandry, Junagadh Agricultural University, Junagadh, Gujarat, India for a period of one year (March 2014-February 2015) on Jaffrabadi buffaloes. Buffaloes were maintained in loose housing system of management at Cattle Breeding Farm and hand milking was practiced at 4.00 am and 4.00 pm per day. As splashing in buffaloes reduces heat stress and enhances feed consumption and nutrient utilization (Verma *et al.*, 1990); therefore, during summer season splashing was practiced at 10-11 am and again 3-4 pm before afternoon milking. The buffaloes were fed adlibitum amount

of seasonal green and dry fodder and mixture of cottonseed cake, ground maize and Amul dan during milking to fulfill the nutrient requirement as per Indian Council of Agricultural Research (ICAR) feeding standard (Anonymous, 1998). Milking was done at the milking parlour and for milk let down, suckling of calf was practiced. A total of 900 milk samples were taken from pluriparous Jaffrabadi buffaloes (2-5th parity) with 100 samples during each season (winter, summer and rainy) and during each lactation stage (early, mid and late). Milk samples were analysed for different milk components such as fat, protein, lactose, ash, SNF and TS using milk analyzer "LACTOSCAN" (New dairy engineering and trading company Pvt. Ltd., Delhi, India).

Statistical analysis

The least-square analysis of variance (Harvey, 1987) was used to see the effect of season and stage of lactation on various traits of milk composition (milk fat, protein, lactose, ash, SNF and TS content). Duncan multiple range test was used to compare the means within a group, difference was considered as significant if $p<0.05$ and the results were presented as Mean $\pm$ SE.

RESULTS AND DISCUSSION

Although the present work is preliminary, provides valuable information regarding significant effects of stage of lactation and season on milk composition in Jaffrabadi buffaloes. The effect of season and stage of lactation on milk fat percent of Jaffrabadi buffaloes are presented in Table 1 and Table 2, respectively. The milk fat percent ranged from 8.17 to 8.49% during different season and 7.65 to 8.92% during different stage of lactation with overall value 8.31%. The variation of milk fat percent remained within the normal range in buffaloes i.e. 5.3-9.0% (Abd El-Salam and El-Shibiny, 2011; Claeys *et al.*, 2014). Previous studies also indicated that milk fat percent showed variation between 7.7 and 8.5% in Jaffrabadi buffaloes (Sethi, 2003; Moioli and Borghese, 2008). Recently, Garaniya et al. (2013) observed variation of milk fat from 6.76 to 9.10% during different stage of lactation in Jaffrabadi buffaloes and supported by our result. In Murrah buffaloes, average milk fat percent was reported to be 7.65% (Dubey *et al.*, 1997) and 8.0% (Yadav *et al.*, 2013b), which is slightly lower than our value. Yadav *et al.* (2013b) observed marked seasonal variation of milk fat percent in buffalo milk with higher value during summer and lower during winter. However, Dubey *et al.* (1997) observed non-significant association of season with milk fat percent and same being observed in the present study. The milk fat is originated by four major pathways such as directly from feed, de novo synthesis in the mammary gland, production in the rumen by microbes and mobilization from reserved body fat (Stoop *et al.*, 2009) might be attributed inconsistent variation during different season as seen in the present study. The milk fat percent increased significantly from early lactation to late lactation which is in agreement with the report of Yadav *et al.* (2013b), who observed significant ($p<0.05$) increase of milk fat percent from 7.19 to 8.63% during first trimester to fifth trimester of lactation. However, Garaniya *et al.* (2013) did not observe any difference statistically among different stages of lactation, though milk fat percent increased gradually with advancement of lactation. Milk fat level remains higher side (7.55%) during 1st month and gradually decreases upto 4th month (7.12%) and then increases gradually and reaches peak (8.54%) at 10th month of lactation (Dubey *et al.*, 1997). The lower milk fat percent during early lactation and gradual increment with advancement of lactation stage might be associated with milk yield as both are negatively associated (Friggens *et al.*, 2007; Ravikala *et al.*, 2014).

In the present study, overall milk protein percent was observed to be 4.3% which is within the normal range (2.7-5.2%) as reported by others in different breeds of buffaloes (Abd El-Salam and El-Shibiny, 2011; Claeys *et al.*, 2014). The milk protein percent varied from 4.2-4.37% during different seasons (Table 1) and 4.24-4.44% during different stages of lactation (Table 2) which is in agreement with the previous report in Jaffrabadi buffaloes (Garaniya *et al.*, 2013), who observed variation of milk protein from 4.26 to 4.42% during different stages of lactation. The protein percent in Jaffrabadi buffaloes is slightly higher than the Murrah buffaloes i.e. 3.5-3.8% (Dubey *et al.*, 1997, Yadav *et al.*, 2013b). Season significantly affected the milk protein percent in Jaffrabadi buffaloes; protein percent was significantly higher during rainy season and lower during winter season ($P<0.05$). Protein remained peak level during September to April (3.5%) and lower (3.4%) during summer i.e. May to August (Yadav *et al.*, 2013b). However, other study reported higher level (3.97%) during rainy season *i.e.* July to September and lower level (3.81%) during December to June but the difference was statistically non significant (Dubey *et al.*, 1997). The seasonal variation might be attributed by climatic stress and seasonal variation of feed and fodder composition (Chen *et al.*, 2014). We observed lower level of milk protein during early to mid lactation and significant increased during late lactation ($p<0.05$) which is in agreement with previous reports in buffaloes (Dubey *et al.*, 1997; Yadav *et al.*, 2013b). Dubey *et al.* (1997) reported that stage of lactation significantly affected milk protein with peak level during 1st month of lactation and lowest level during 4th month of lactation and then gradually increased. Similarly, total milk protein level was observed to be higher level (3.56%) during

Table 1: Relationship between season and milk components

Milk components	Seasons			Overall
	Summer	Rainy	Winter	
FAT (%)	8.27 ± 0.10^{A}	8.49 ± 0.1^{A}	8.17 ± 0.10^{A}	8.31 ± 0.37
Protein (%)	4.36 ± 0.04^{AB}	4.37 ± 0.05^{A}	4.20 ± 0.05^{B}	4.31 ± 0.06
Lactose (%)	5.72 ± 0.07^{A}	5.46 ± 0.07^{B}	5.79 ± 0.07^{A}	5.66 ± 0.09
Ash (%)	0.97 ± 0.01^{A}	0.98 ± 0.01^{A}	0.95 ± 0.01^{A}	0.96 ± 0.01
SNF (%)	11.05 ± 0.11^{A}	10.81 ± 0.12^{A}	10.94 ± 0.12^{A}	10.93 ± 0.18
TS (%)	19.32 ± 0.19^{A}	19.30 ± 0.24^{A}	19.11 ± 0.19^{A}	19.24 ± 0.43

Means with different superscript (A, B) within a row differ significantly ($P<0.05$)

Table 2: Relationship between lactation period and milk components

Milk components	Lactation period			Overall
	<100 days	100-200 days	>200 days	
FAT (%)	7.65 ± 0.10^{A}	8.36 ± 0.10^{B}	8.92 ± 0.11^{C}	8.31 ± 0.37
Protein (%)	4.25 ± 0.04^{A}	4.24 ± 0.05^{A}	4.44 ± 0.05^{B}	4.31 ± 0.06
Lactose (%)	5.83 ± 0.06^{A}	5.65 ± 0.07^{AB}	5.51 ± 0.07^{B}	5.66 ± 0.09
Ash (%)	0.97 ± 0.01^{A}	0.95 ± 0.01^{A}	0.98 ± 0.01^{A}	0.96 ± 0.01
SNF (%)	11.05 ± 0.10^{A}	10.84 ± 0.12^{A}	10.93 ± 0.13^{A}	10.93 ± 0.18
TS (%)	18.7 ± 0.18^{A}	19.02 ± 0.20^{A}	19.85 ± 0.22^{B}	19.24 ± 0.43

Means with different superscript (A, B, C) within a row differ significantly ($P < 0.05$)

1st trimester of lactation and decreased to minimum level (3.468%) at 3rd trimester of lactation and again increased during 4th and 5th trimester (Yadav *et al.*, 2013b). However, Garaniya *et al.* (2013) in Jaffrabadi buffaloes did not observe any difference of milk protein during difference stage of lactation. The milk protein percent and milk yield are associated negatively and yield decreased significantly during late lactation might be attributed to higher milk protein concentration (Friggens *et al.*, 2007; Ravikala *et al.*, 2014).

The mean lactose percent during different season and during different lactation stage are depicted in Table 1 and Table 2, respectively. The overall milk lactose percent observed in the present study was found to be 5.66% which is higher than the previous report by Garaniya *et al.* (2013) in Jaffrabadi buffaloes (3.85-4.04%). However, other studies reported a comparable value (Mahmood and Usman, 2010; Abd El-Salam and El-Shibiny, 2011; Ahmad *et al.*, 2013a) in buffaloes. Mahmood and Usman (2010) observed variation of milk lactose from 4.56 to 6.21% with overall mean 5.41%. Recently, Abd El-Salam and El-Shibiny (2011) reported that buffalo milk lactose level varied from 4.51 to 5.24% throughout the world in different breeds. Similarly, Ahmad *et al.* (2013a) reported that milk lactose varied from 4.6 to 5.6% in buffaloes. In Murrah buffaloes, the lactose percent ranged from 4.5 to 5.78% (Dubey *et al.*, 1997; Bansal *et al.*, 2007; Yadav *et al.*, 2013b). Contrary to milk protein percent, the milk lactose percent was significantly higher during winter season and lower during rainy season ($P < 0.05$). Though previous studies did not observe any seasonal variation of milk lactose in buffalo (Dubey *et al.*, 1997; Yadav *et al.*, 2013b), we observed significantly seasonal variation. Lower lactose content observed during rainy season was unexpected as milk lactose is considered as one of the least variable component (Chen *et al.*, 2014) owing to its osmotic regulatory effect (Ravikala *et al.*, 2014). The lower lactose might be associated with higher somatic cell counts (indicator of mammary infection); as rainy season is hot and humid in the study area, increased chances of udder infection by rising number of pathogens (Rajsevic *et al.*, 2003; Malek dos Reis *et al.*, 2013). In our study, initially lactose level remained higher side and significantly declined with advancement of lactation stage ($p < 0.05$) might be associated with lower yield as both traits are positively associated. Milk lactose concentration increases slightly as production increases and declines slowly at the end of lactation along with production (Friggens *et al.*, 2007; Ravikala *et al.*, 2014). Dubey *et al.* (1997) reported that milk lactose gradually increased with advancement of lactation stage and reach peak at 4th month of lactation and gradually decreased. However, Yadav *et al.* (2013b) observed variation of milk lactose from 4.36 to 4.60%, with a significant increase during last trimester of lactation.

The season (Table 1) and stage of lactation (Table 2) did not affect the milk ash content in Jaffrabadi buffaloes. The overall milk ash content in Jaffrabadi buffaloes was found to be 0.96% which is comparatively higher than previous studies on buffalo milk (Abd El-Salam and El-Shibiny, 2011; Ahmad *et al.*, 2013b). Recently, Abd El-Salam and El-Shibiny (2011) and Claeys *et al.* (2014) reviewed the composition of buffalo milk and reported that ash content in milk varied between 0.71 to 0.85% and 8.0 to 9.0%, respectively. Ahmad *et al.* (2013b) reported ash content in bulk milk from Murrah, Nili ravi and Jaffrabadi between 0.91-0.92% and it remained similar throughout the year. Although fluctuation of calcium, magnesium and chloride concentrations in ash occur significantly but does not confirm any defined trend over the year (Chen *et al.*, 2014); thereby, does not cause any significant alteration of milk ash content as observed in the present study. The lactation stage affects minerals significantly but such effects are nullified by the feed type (Chen *et al.*, 2014) might attributed similar concentration of milk ash percent throughout the lactation.

The overall SNF percent observed in the present study was found to be 10.93% which is higher than the previous report in Jaffrabadi buffaloes by Garaniya *et al.* (2013), who reported SNF percent of milk as 8.49-9.15% during different lactation stages. However, Abd El-Salam and El-Shibiny (2011) reported milk SNF value as 8.3-10.4% in buffaloes and same being supported by our result. We did not observe any significant effect of season (Table 1) or stage of lactation (Table 2) on milk SNF content ($p > 0.05$). However, Dubey *et al.* (1997) reported that milk SNF remained higher level at the initial stage of lactation and reached lower level at 4th month of lactation and then gradually increased with advancement of lactation stage but did not observe any seasonal variation of milk SNF. The milk SNF is not affected by single milk traits, rather affected by milk protein, lactose, ash etc., hence remained similar level with little variation during different seasons throughout the lactation period.

Slightly higher value of milk TS (19.24%) was observed in Jaffrabadi buffaloes compared to other breeds. Abd El-Salam and El-Shibiny (2011) reported that buffalo milk TS variation occurred between 16.3 and 18.4%. Although, higher TS values was observed during summer and lower during winter but not differed significantly (Table 1) in Jaffrabadi buffaloes which is similar with previous report (Dubey *et al.*, 1997). However, Ahmad *et al.* (2013b) reported that TS content of bulk tank buffalo milk (Murrah, Nili ravi and Jaffrabadi) showed significant variation throughout the year and varied between 16% (April-October) and 19% (November-March). The seasonal availability of feed and fodder together with

digestibility of nutrients in rumen (Yadav *et al.*, 2013a) may indirectly affects milk TS by altering availability of precursor of milk components. However, this variation can be minimized by feeding herbal nutraceutical to animals as these compounds increases the dry matter intake and digestibility of nutrients during extreme summer in cattle (Niwas *et al.*, 2013). However, in the present study, milk TS did not differ significantly between different seasons might be attributed by better managemental practices like splashing which reduced heat stress and increased feed intake and nutrient utilization (Verma *et al.*, 1990). There was significant effect of stage of lactation on milk TS percent (Table 2, $p < 0.05$). Dubey *et al.* (1997) reported that milk TS remained higher level at the initial stage of lactation and decreased to 4th month of lactation and then increased significantly with advancement of lactation and same being observed in the present study.

Results of the present study indicate that season and stage of lactation affect certain milk components in buffalo milk. The seasonal availability of feed and fodder affect the nutrient availability to the animals and thereby influence the milk composition. Stage of lactation is a physiological process controlled by numerous internal factors which could not be altered by farm management practices. Thus, feeding of animals with special diet or total mixed ration could result desired composition of milk from buffalo for production of better quality of milk products throughout the year.

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