ALTERATIONS IN MILK COMPOSITION DUE TO SEASONAL AND LACTATIONAL STAGES IN TARAI BUFFALO

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ABSTRACT

Thirty-six healthy Tarai buffaloes (280-350±10 kg body weight, 2nd to 4th parity) were selected to investigate their milk composition. The selected animals were divided into four groups having nine buffaloes in each group as; each group from early, mid and late lactation and another group of dry buffaloes. The study carried out in four seasons and climatic variants of temperature and relative humidity were recorded for each month where temperature-humidity index (THI) was calculated. Results of milk composition with advancing in lactation stage showed significantly ($P<0.05$) higher values for milk fat, urea and total solids. In season-wise, milk constituents of fat, protein and total solids were found significantly ($P<0.05$) higher during winter season except higher milk urea in summer season. Other milk constituents include lactose, SNF and pH were remain unaffected throughout the lactation period and seasons. Milk somatic cell count (SCC) is affected by both lactation period and seasons but the variations stood non-significant. Calculated THI in tarai region was found higher ($79<THI<84$) during summer and rainy seasons. It may be concluded that Tarai buffalo performances are affected by seasonal variations and lactation period as indicated in milk composition variations. Thus, Tarai buffalo could perform better if improvement in their management system of housing and feeding of quality nutrients.

Keywords: *Bubalus bubalis*, buffaloes, milk compositions, lactation, seasons, temperature-humidity index, Tarai buffalo

INTRODUCTION

Tarai region is agro-climatologically consist of grasslands, savannas and forests located at the outer foothill of the Himalaya and Shiwalik hills in North India, Himachal Pradesh, Uttarakhand, Uttar Pradesh and Bihar. The region is known for its hot and humid climate with high water table that favours abundant availability of fodders and forests throughout the year. Buffaloes are considered very sensitive to weather changes and adverse climatic conditions may affects buffalo milk productivity and composition (Bansal *et al*., 2009). Several factors affecting the milk compositions and production are breed, age, number of lactations, lactation phases, technology

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of housing, seasons and availability of feed (Mech *et al*., 2008).

Tarai buffalo has a medium jet black coat, grayish brown hairs with white poll, medium and compact body with poor milk yield i.e. lactation length varying from 250 to 295 days and nearly 450 kg of milk yield per lactation. This breed is of dual purpose and better known for excellent draught purpose rather than for milk (Anonymous, 2014). It is reared by the marginal and small land-holding farmers of Van Gujjar living in the Tarai forests of Uttarakhand state. Unlike other breeds of buffaloes, there is an inherent beauty of this breed that it thrives well under adverse climatic conditions, resist to many tropical diseases and maintained only on natural lush grasses available in forest round the year with minimum inputs. Keeping all these into consideration, the present study was carry out to explore the seasonal variation and lactational stages effecting milk compositions in lactating Tarai buffaloes.

MATERIALS AND METHODS

Study site

The present study was conducted at the Department of Veterinary Physiology and Biochemistry, College of Veterinary and Animal Sciences, Pantnagar, Udham Singh Nagar District of Uttarakhand. It is located at 344 m above mean sea level (79°E longitude and 29°N latitude) in the northern upper Gangetic plains, having annual rainfall of 1405 mm. The area is known for hot-humid climate during summer and intense cold in winter with a short spring season.

Animal selection

Thirty-six healthy Tarai buffaloes (280 to 350±10 kg body weight) of 2nd to 4th parity were selected from the herds maintained in semi-open sheds constructed with locally available materials. Animals had access to water and grass fodders from available natural forest with minimal provision to concentrate feeds. Selected buffaloes were divided into four groups having nine buffaloes in each group as; early lactation (30 to 90±15 days), mid lactation (100 to 180±15 days), late lactation (200 to 280±15 days) and dry non-lactating buffaloes.

Climatological measurements

Seasons to be studied were spring (15th February to 31st March), summer (1st May to 15th June), rainy (15th August to 30th September) and winter (1st December to 30th January). The meteorological parameters *viz*. environment air temperature (°C) at 7.00 AM and 14.00 PM, and relative humidity (%) were recorded daily for each month and seasons-wise. Temperature-Humidity Index (THI) was calculated as per McDowell *et al*. (1976) from obtained values.

$$THI = 0.72 (td + tw) + 40.6$$

Where, td means dry bulb temperature in °C, tw means wet bulb temperature in °C,

THI values commonly used to assign heat stress levels were categorized as follows: <70 as comfortable, ≤74 as mild stress or alert, 74<THI<79 = stressful or danger, 79<THI<84 as severe stress or emergency and >86 = lethal (LWSI:LCI, 1970).

Milk sampling and analysis of milk composition

Prior to milk sampling, initial few streaks of milk were discarded and milk samples were collected in the morning under hygienic measures by manual full hand milking technique. Collected

milk samples in a sterile vial containing formalin (ratio of 1:20,000) were then transferred to the laboratory in icebox and subsequently stored at -20°C, whereas the samples for assessment of milk SCC were collected separately without any preservative.

Milk constituents were evaluated as milk pH using electronic pH meter (Narang Scientific Works, New Delhi), fat (Gerber's method, IS:1224, 1977), lactose (Colorimetric method, Oser, 1979), protein (Kjeldahl's method, AOAC, 2000), total solids and solid-non-fat (IS:1479, 1961) and milk urea using colorimetric p-dimethylaminodenzaldehyde (DMAB) method (Dhali *et al.,* 2006). Fresh milk sample for SCC (10^5/ml) as described by Schalm *et al.* (1971).

Statistical analysis

The statistical analysis of the data was done using one-way ANOVA (for more than two groups of data), IBM SPSS ver. 20 software.

RESULTS

Means±SE values of milk constituents during different stages of lactation and seasons are given in the Table 1 and 2 respectively.

Variation of milk constituents due to lactation stages

Milk fat percent, urea and total solid (TS) contents showed a significantly (P<0.05) rising trend from early to late lactation stage. Milk protein, lactose, solid-not-fat (SNF) and pH content in the milk showed no significant change during the entire lactation period. Milk somatic cell count (SCC) showed insignificantly higher in early and late lactation stages (Table1).

Variations of milk components due to seasons

Milk fat and protein percent were found more responsive to seasonal variation which stood significantly (P<0.05) highest during the winter season followed by spring and summer seasons, while lowest during rainy season. Milk urea content showed significantly (P<0.05) higher values during summer season followed by rainy and spring seasons while lowest during winter season. Milk total solid (TS) percent varied significantly (P<0.05) in different seasons and showed highest percent during winter followed by spring and summer seasons, while lowest during rainy season. Other milk constituents including lactose, solid-not-fat (SNF) and pH remain the same throughout the entire lactation period. Seasonal variations effecting milk SCC showed insignificantly higher during summer and rainy season (Table 2).

Temperature humidity index (THI) of different seasons

THI was calculated from recorded temperature and relative humidity for the entire seasons of the year in month-wise. THI is significantly (P<0.05) higher (79<THI<84) during summer and hot-humid rainy seasons in Tarai region (Figure 1) that indicates severe environmental stress during these seasons.

DISCUSSION

The present study showed that Tarai buffalo milk fat, total solid and urea contents increased significantly (P<0.05) while protein, lactose, solid-not-fat and pH showed insignificant changed with advanced lactation. All our results are in confirmation with other studies done in buffaloes (Banerjee, 1985; Ozrenk and Inci, 2008).

Table 1. Variations (Means±SE) of milk constituents due to lactation stages in Tarai buffaloes.

Milk constituents	Stages of lactation		
	Early	Mid	Late
Fat (%)	6.13^{a}±0.06	6.35^{a}±0.05	7.63^{b}±0.06
Protein (%)	4.70±0.04	4.76±0.04	4.79±0.04
Lactose (%)	4.46±0.01	4.49±0.04	4.50±0.04
Urea (mg/dl)	26.52^{a}±0.54	33.83^{b}±0.061	42.82^{c}±0.41
SNF (%)	8.43±0.02	8.61±0.03	8.85±0.03
TS (%)	12.44^{a}±0.10	13.58^{b}±0.10	14.77^{c}±0.17
pH	6.58±0.17	6.70±0.17	6.78±0.13
SCC (x 10^{5}/ml)	1.22±0.04	0.80±0.02	1.11±0.07

$^{a, b,c}$ Indicates means±*SE* values with different superscripts within row differed significantly (P<0.05).

Table 2. Variations (Means±SE) in milk constituents due to different seasons in Tarai buffaloes.

Milk constituents	Seasons of year			
	Winter	Spring	Summer	Rainy
Fat (%)	7.88^{b}±0.07	6.82^{a}±0.07	6.44^{a}±0.06	6.20^{a}±0.05
Protein (%)	5.87^{b}±0.05	4.90^{ab}±0.02	4.61^{a}±0.02	4.43^{a}±0.04
Lactose (%)	4.49±0.01	4.59±0.01	4.51±0.02	4.36±0.01
Urea (mg/dl)	29.28^{a}±0.91	32.97^{b}±0.93	39.24^{d}±0.83	36.08^{c}±0.91
SNF (%)	8.99±0.04	8.64±0.03	8.47±0.02	8.31±0.02
TS (%)	14.87^{c}±0.19	13.84^{b}±0.14	13.23^{b}±0.13	12.19^{a}±0.14
pH	6.82±0.01	6.73±0.01	6.65±0.02	6.56±0.02
SCC(x 10^{5}/ml)	0.92±0.07	0.96±0.06	1.10±0.06	1.19±0.06

$^{a, b, c}$Indicates means±*SE* values with different superscripts within row differed significantly (P<0.05)

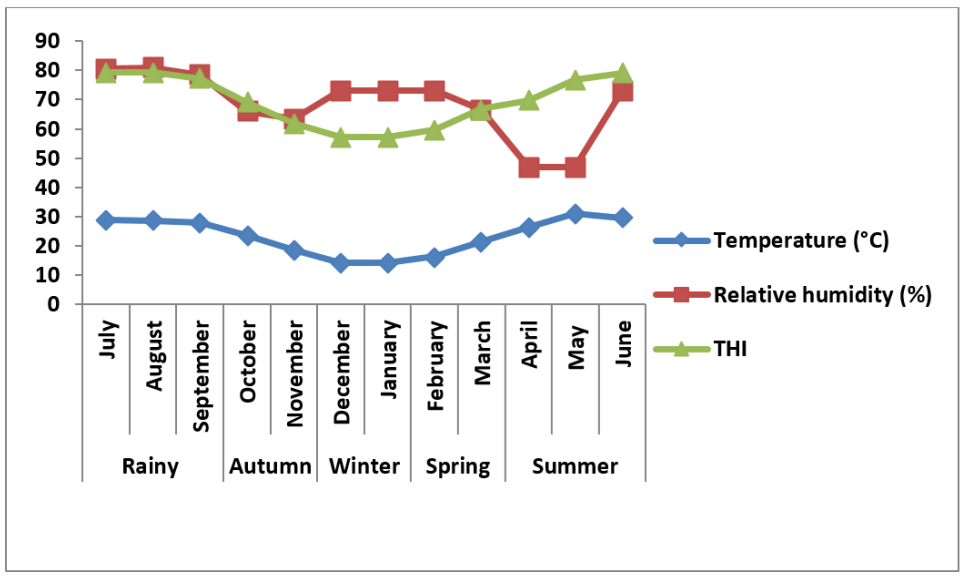

Figure 1. Temperature-humidity index of different seasons in Tarai region.

Normally urea present in normal milk constituent as milk urea and is part of the non-protein nitrogen (NPN) or as protein metabolite. It is reported that in buffaloes, NPN content remain unchanged during entire lactation period, but milk urea content showed significantly higher in late lactation stage (Dhali *et al*., 2006). Similarly, like other buffaloes there is higher milk total solid and fat percent's with advance lactation and decreased milk yield in Tarai buffalo. Therefore, itis considered that besides nutrition and climatic conditions, lactation stages influenced milk yield and composition in buffaloes (Şekerden, 1999). Among the milk components during lactation period, lactose is considered as the least variable milk component and maintain milk volume along with water.Seasonal variations influences the milk constituents of Tarai buffalo and the variations are found similar to other studies reported in Murrah buffaloes (Roy *et al*., 2004). However, other buffaloes reported to have higher milk lactose percent during autumn and winter (Adeela *et al*., 2012) and milk pH variations is affected significantly by the production month, lactation stage and calving year in other lactating buffaloes (Şekerden, 1999). While milk lactose and pH of Tarai buffalo milk remains unaffected by seasonal variations. Even though, Tarai buffaloes are more heat tolerant (Manjari *et al*., 2016), it is observed that most of the milk components are affected by summer and rainy seasons. This might be due to the fact that lactating buffaloes were subjected to high hot and humid environmental stress. Environment climatic conditions during summer and rainy seasons in Tarai region are categorized as emergency according to the Livestock of Weather Safety Index (LWSI:LCI, 1970). Environmental stress along with poor management systems together hinders the milk synthesis and its components. In addition, exposure to high light-to-dark ratio leading to a reduction in percent buffalo milk fat and protein. This is probably as a consequence of a greater secretion of

prolactin in plasma during summer than in winter seasons (Sevi *et al.,* 2004). Similar findings have been reported in earlier studies (Ozrenk and Inci, 2008; Sharma *et al*., 2002; Chashnidel *et al.,* 2010; Zeki *et al*., 2013).Seasonal variation also affects the forest grasses in Tarai region and most abundant forest grass and fodders are available only during winter season. This might be one major factor affecting the milk components as Tarai buffaloes survival and production is solely depends on forest and very less provision to external inputs.

Milk SCC consists of mainly milk-secreting epithelial cells from the lining of the mammary gland and white blood cells (leukocytes) which are normally present in milk. Increased numbers of milk SCC is always accompanied with mammary gland injury or infections (Dairyman's Digest, 2009). Other factors responsible for milk SCC variation are number and stage of lactation and management practices of lactating animals (Harmon, 1994). In the present study, milk SCC is insignificantly higher in early and late lactation stages, which is accordance with other studies in buffaloes (Reichmuth, 1975; Singh and Ludri, 2001; Marija *et al*., 2003). Increased milk SCCs in early lactation has been linked with innate immune response of the animal in preparation for calving and to enhance the mammary gland defense mechanism at critical calving time (Reichmuth, 1975). It may also due to excessive desquamation of alveolar epithelial cells indicates resumption of mammary gland functional activity after a dormant period of gestation (Schalm *et al.,* 1971). Seasonal variation affecting Tarai buffalo milk SCC was found insignificantly higher during summer and rainy seasons. Whereas Murrah buffaloes milk SCC reported to be higher in late summer and lower in winter months (Khate and Yadav, 2010). High milk SCC as a defense mechanism during hot and humid seasons where prevalence of infections are at par to lactating buffaloes.

It may be concluded form this study that Tarai buffaloes have enormous inherent beauty and advantages that thrives quite well in tarai region, but like other buffaloes have poor capacity to dissipate their body heat gain and prefer wallowing during extreme climatic condition. Seasonal variations and lactation stages are found to affect the normal physiological states of Tarai buffaloes, which indicated in milk composition variations. Seasons directly affects the availability of forest grasses and indirectly affects the quality of milk. Another reason may be due to improper housing systems where buffaloes are kept under stressful environment. All these together greatly affects the buffalo performance that may results into high calf mortality and decrease milk yield. Thus, Tarai buffalo could performances better if their management system of housing and feeding of quality nutrients are improved.

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