

Variation in milk yield and milk composition during the entire lactation period in Mithun cows (*Bos frontalis*)

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Abstract

The characteristics of the lactation curves and the effect of lactation stage on yield and composition of milk were investigated in 11 multiparous mithun (*Bos frontalis*) cows.

Average lactation length was found to be 340 ± 2 d. The effect of lactation stage on milk yield (0.87 to 1.46 kg) and the milk content of total solids (TS, 20.94 to 22.62%), fat (7.72 to 10.25%) and urea (36.65 to 43.54 mg/dL) was found to be significant ($p < 0.05$). In contrast, the contents of total protein (6.31 to 6.78%), casein (4.38 to 4.77%), solid-not-fat (SNF, 13.40 to 13.70%), lactose (4.36 to 4.60%), non-protein nitrogen (NPN, 0.41 to 0.43%) and ash (0.90 to 0.93%) did not vary among the different stages of lactation. Peak milk yield was recorded on 30 d of lactation and persistency was maintained until 90 d. Milk yield declined significantly ($p < 0.05$) during the late lactation stage with a simultaneous increase ($p < 0.05$) in milk fat, TS and milk urea. The casein and ash contents were found to be the least variable milk constituents. The study revealed that the trend in variation of milk yield and major milk constituents during the entire lactation in mithun was comparable with the other domesticated ruminants. Though mithun produced less amount of milk, but the major milk constituents in mithun milk were found to be much higher than that reported for other domesticated ruminants.

The results of the present study indicate that mithun should not be milked after 255 d of lactation as milk yield was less than 40% of peak yield after this period.

Key words: Calf suckling, fat, milk letdown, peak yield, protein, total solids

Introduction

It is important to determine the characteristics of the lactation curve of a milk animal in order to analyze the milk production potential, improve milk yield and obtain a more desired lactation curve (Keskin and Dag 2006). Moreover the lactation curve is also useful for assessing the nutritional and health status of milking animals (Dudouet 1982) and it helps to determine the suitable time to end milking (Chang et al 2001). Milk composition varies greatly among the different species, which is partly attributed to the inherited capabilities. In exotic dairy cows, peak milk yield occurs at an average between 50 to 70 d of lactation (Roche et al 2006, Weller et al 2006). Persistency of lactation is the ability of a milk animal to maintain milk production at a high level after reaching the peak yield. High persistency is associated with a slow rate of decline in yield following peak milk yield and low persistency is associated with a rapid rate of decline (Appuhamy et al 2007). Lactation stage is one of the major factors influencing yield and composition of milk in cattle (Ibeawuchi and Dangut 1996), buffalo (Şekerden 1999) and goat (Akingbade et al 2003). The concentration of total protein, fat, casein and whey protein increases during the advanced lactation stage in pasture fed dairy cows (Auldust et al 1998). Lactose is the least variable component of milk as a close relationship exists between the lactose synthesis and amount of water drawn into milk. Secretion rates of lactose and water are nearly constant throughout lactation and highly correlated (Pollott 2004). Dietary protein and energy balance is the major determinant of milk urea (MU) concentration (Whitaker et al 1995, Broderick and Clayton 1997). Nevertheless, MU concentration significantly increases during late lactation stages (Dhali et al 2006).

Mithun (*Bos frontalis*) is believed to be the domesticated form of wild gaur. This unique free-range ruminant is found mainly in the hilly regions of North-East India and in many parts of South-East Asia (Simoons 1984). Its habitat is distributed at an elevation of 1000 to 3000 m above mean sea level. The species plays an important role in the socio-economic life of its rearers. This massive animal is reared primarily for meat purpose. However, mithun is also used as a milk animal. Mithun and mithun × cow hybrid are reared for milk in many places of North-East India, Bhutan and Myanmar. The use of mithun bulls to breed with Siri cows is a common practice in those areas (Gupta et al 1999). The mithun is a poor milk yielder, but like buffalo, mithun milk contains a high fat content (Mondal et al 2001).

At present, there is paucity of information on systematic evaluation of mithun as a milk producing animal. The present study was conducted to establish the variation in milk yield and different milk constituents during the entire lactation period in mithun.

Material and methods

Animals and management

The study was conducted on 11 mithun cows (first to third parity) that were maintained at the farm of the National Research Centre on Mithun, Nagaland, India. The experimental animals were allowed for free grazing (0600 to 1600 h) on mixed pasture (21% dry matter and 11.5% crude protein). Two Kg concentrate mixture (88% dry matter, 15% crude protein and 55% total digestible nutrient) fortified with a mineral mixture and salt was offered to each animal daily in evening, when they were tied in a shed. The animals had free access to water throughout the day.

Sample collection and analysis

Milk samples were collected from individual animals at weekly intervals from 7 to 315 d of lactation (day 0 was the day of parturition). On the each collection day, samples were collected twice at 0700 h and 1400 h. Before collection, cows were allowed to nurse by calf briefly for stimulating the process of milk let down. Cows were hand milked and milk was collected from all the four quarters. Milk yield was recorded after complete milking and 100 ml milk sample was collected for analysis. Morning and afternoon milk samples were pooled for analyzing the milk composition.

Fresh milk samples were subjected to the analysis of fat, MU, non-protein nitrogen (NPN), total solid (TS), total protein, casein, ash and lactose. For the determination of fat, milk (10 ml) was precipitated with 20% TCA (15 ml), filtered through a filter paper (Whatman, No.40) and the precipitate along with filter paper was subjected to ether extraction (Mech et al 2007). The filtrate was used for MU and NPN estimation. NPN and MU contents were estimated according to the previously described methods (DePeters and Cant 1992, Dhali et al 2005). TS content was determined by gravimetric method (I.S.I. 1961) and solid-not-fat (SNF) content was derived by subtracting fat from TS. Total protein content was estimated according to the method described by DePeters and Cant (1992). For the estimation of casein, milk (10 ml) was added in distilled water (75 ml) and precipitated with 1% acetic acid. The precipitate was collected in a filter paper (Whatmann, No. 40) by repeated washing and subjected to the Kjeldahl method. Casein was estimated by multiplying 6.38 with the total Kjeldahl N (I.S.I. 1961). The content of ash and lactose was estimated according to the standard methods (I.S.I. 1961).

Statistical analysis

The data were analyzed using the SPSS 10.0.1 software package (SPSS Inc., Chicago, Illinois, USA). Three different lactation stages were defined for the analysis. These were early (7 to 105 d), mid (106 to 210 d) and late (211 to 315 d) lactation stages. To determine whether the effect of lactation stage was significant in

explaining the variations in milk yield and compositions, the data were subjected to ANOVA followed by multiple pair wise mean comparisons using Student-Newman-Keuls (SNK) test. The model included stage of lactation as source of variation. To study the variations in milk yield and compositions through out the lactation period, the data for two adjacent weeks were pooled to present the lactation trend at fortnightly intervals and subjected to repeated measure ANOVA. The model included fortnight as source of variation. All data are presented as mean \pm SE and a probability value of less than 0.05 was considered significant.

Results

Effect of lactation stage on milk yield and milk composition

During the study, average lactation length, defined at the time at which milk yield is less than 30% of peak yield, was found to be 340 ± 2 d. However, the data on milk yield and milk composition are presented until 315 d of lactation as average milk yield was found to be less than 0.5 kg/d after this period. The variations in milk yield, TS, fat, total protein, casein, SNF, lactose, NPN, MU and ash contents in different lactation stages are presented in table 1.

Table 1. Variation (mean \pm SE) in milk yield and the content of total solid (TS), fat, total protein, casein, solid-not-fat (SNF), lactose, non-protein nitrogen (NPN), urea and ash in mithun milk in early (7 to 105 d), mid (106 to 210 d) and late (211 to 315 d) lactation stages

Particulars	Early lactation	Mid lactation	Late lactation
Milk yield, Kg/d	1.46 ± 0.04^a	1.22 ± 0.05^a	0.87 ± 0.05^b
TS, %	20.94 ± 0.19^a	21.76 ± 0.21^a	22.62 ± 0.36^b
Fat, %	7.72 ± 0.15^a	8.61 ± 0.16^b	10.25 ± 0.25^c
Total protein, %	6.31 ± 0.08	6.71 ± 0.16	6.78 ± 0.09
Casein, %	4.38 ± 0.05	4.77 ± 0.09	4.44 ± 0.10
SNF, %	13.41 ± 0.20	13.70 ± 0.38	13.40 ± 0.22
Lactose, %	4.60 ± 0.07	4.36 ± 0.14	4.44 ± 0.08
NPN, %	0.43 ± 0.01	0.41 ± 0.02	0.43 ± 0.01
Urea, %	36.65 ± 0.87^a	39.14 ± 0.94^a	43.54 ± 1.59^b
Ash, %	0.93 ± 0.01	0.90 ± 0.01	0.90 ± 0.01

a, b, c Indicates values with different superscripts within row differ significantly ($p < 0.05$)

Milk yield (kg/d) was found to be significantly ($p < 0.05$) higher in the early (1.46) and mid lactation (1.22) stages than the late lactation stage (0.87). Milk fat content (%) was found to be significantly ($p < 0.05$) lower in the early (7.72) and mid lactation (8.61) stages than the late lactation stage (10.25). The content of TS (%) and MU (mg/dL) was found to be significantly ($p < 0.05$) higher in the late lactation (22.62 and 43.45) stage than the early (20.94 and 36.65) and mid lactation (21.76 and 39.14) stages. In contrast, the content of total protein (6.31 to 6.78%), casein (4.38 to 4.77%), SNF (13.40 to 13.70%), lactose (4.36 to 4.60%), NPN (0.41 to 0.43%) and ash (0.90 to 0.93%) did not vary significantly among the different lactation stages.

Fortnightly variations in milk yield and milk composition

Fortnightly variations in milk yield and different milk constituents are presented in Figure 1 and 2. Peak milk yield was recorded as early as on 30 d of lactation and this was persistent until 90 d. Fortnightly variation in milk yield was found to be significant ($p < 0.05$). Milk yield declined gradually from 105 d and declined approximately 40 to 50% of the peak milk yield from 270 d and onwards (Figure 1).

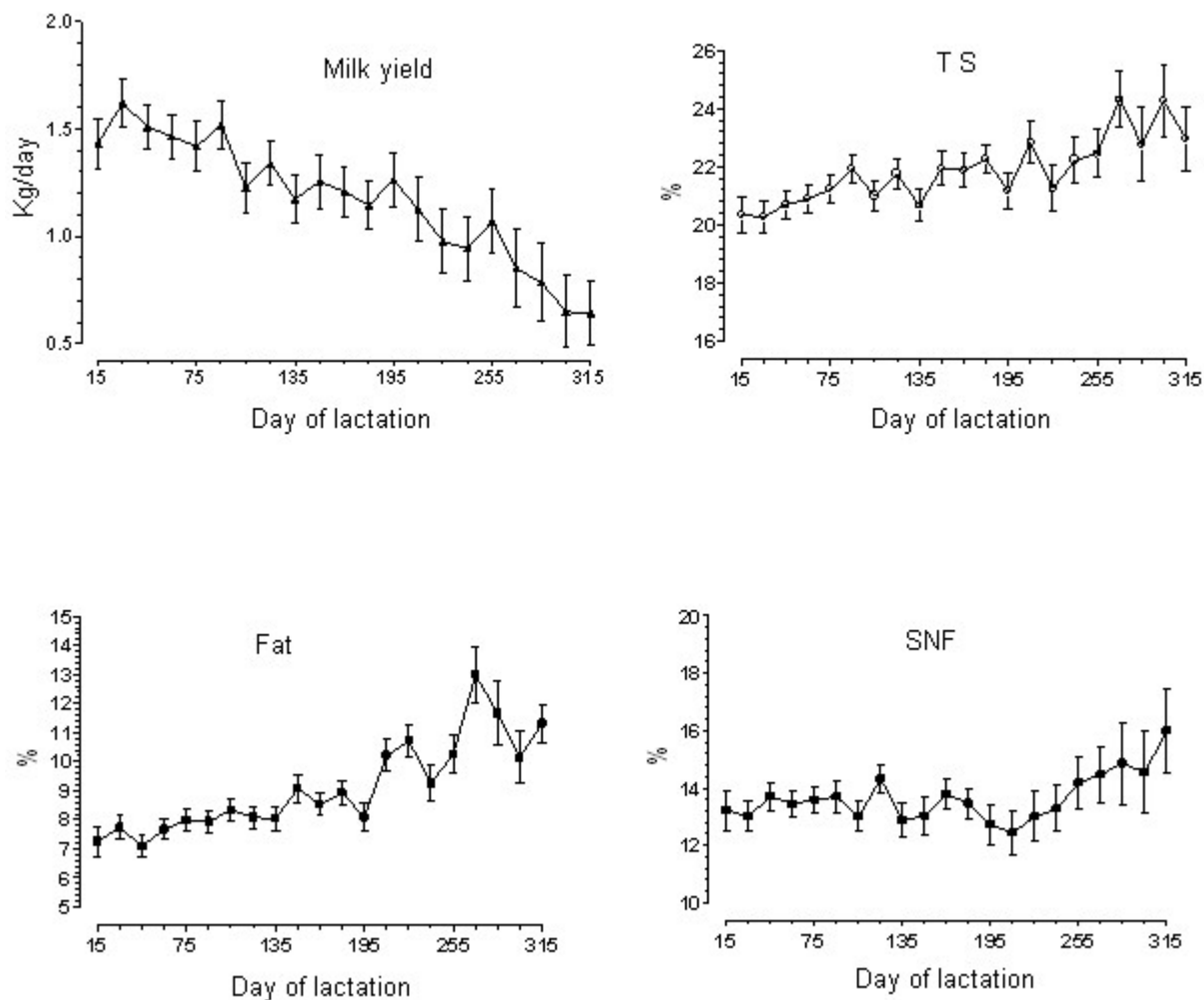


Figure 1. Fortnightly variations (mean \pm SE) in milk yield ($P < 0.05$) and the content of total solid (TS, $P < 0.05$), fat ($p < 0.05$) and solid-not-fat (SNF) in mithun milk

Fortnightly variation in milk fat, TS and MU content was found to be significant ($p < 0.05$) and the higher values for these parameters were found after 210 d and onwards (Figures 1 and 2).

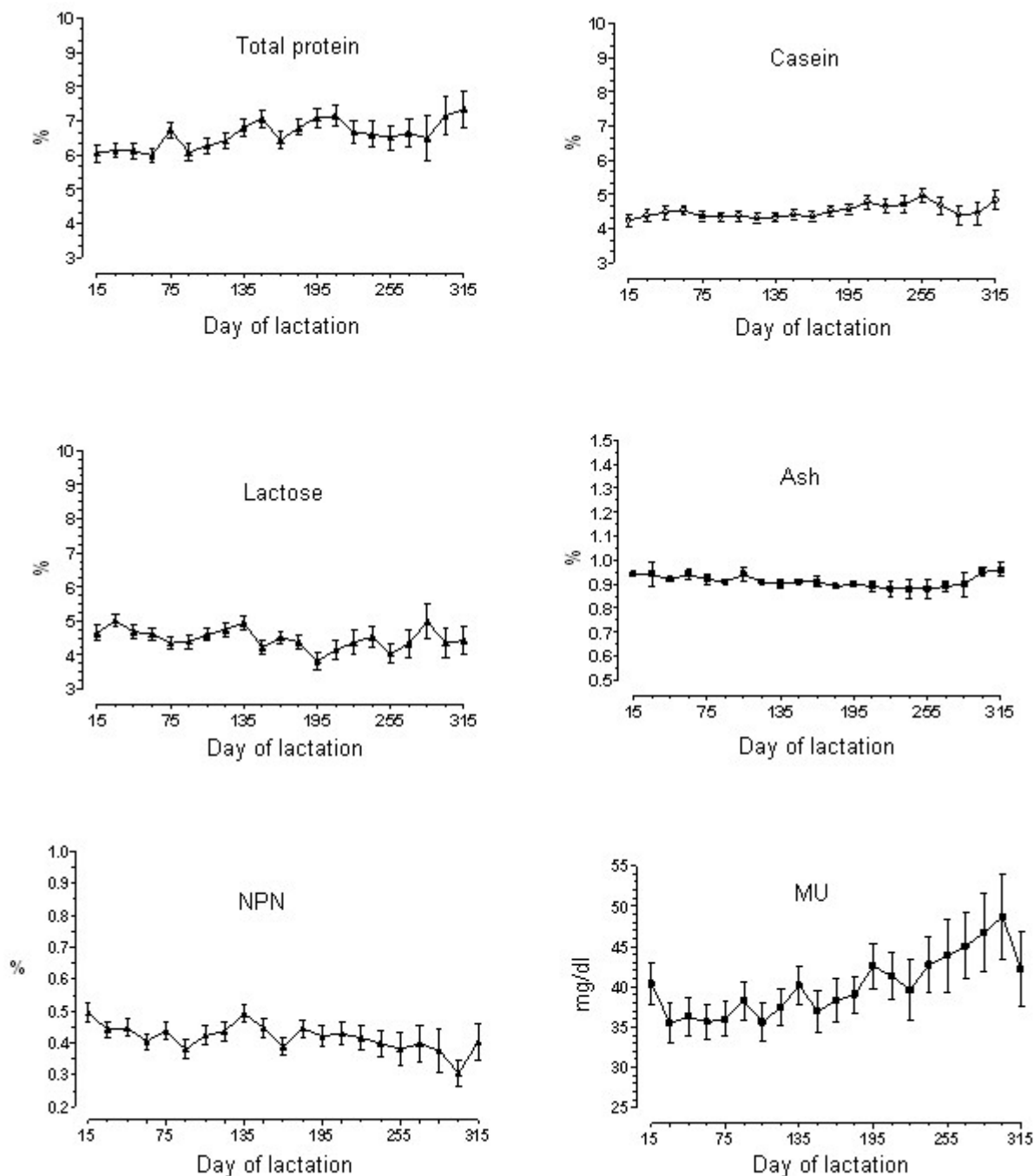


Figure 2. Fortnightly variations (mean \pm SE) in the content of total protein, casein, lactose, ash, non-protein nitrogen (NPN) and urea (MU, $p < 0.05$) in mithun milk

In contrast, the content of SNF, total protein, lactose and NPN did not vary significantly among the different fortnights except some occasional fluctuation. Similarly, the content of casein and ash did not vary significantly among the different fortnights and were found to be the least variable milk constituents throughout the lactation.

Discussion

A systematic study on milk yield and milk composition is of foremost importance to evaluate the milk production ability of a milking animal. Moreover, the shape of the lactation curve that describes the level of milk yield in the course of lactation differs among the different species. The present study is the first systematic evaluation of mithun as a milking animal. The study describes the variations in milk yield and milk

composition during the entire lactation period. The results revealed a long lactation period and a significant effect of lactation stage on the milk yield and concentration of TS, fat and MU.

The average lactation length in mithun was defined at the time at which milk yield was less than 30% of peak yield. The lactation length (340 ± 2 d) in mithun was found to be longer than Yak (120 to 180 d, Sherchand and Karki 1996) and crossbred cattle (256 ± 0.91 d, Mondal et al 2005). The longer lactation length might be due to the effect of continuous suckling by calf. In dairy cows, longer suckling period inhibits the growth of ovarian follicle and prolongs the period of anoestrus, thereby lengthening lactation length (Chandler and Robinson 1974). The milk yield (0.87 to 1.46 kg) in mithun was found to be much lower than that of cattle (29.6 to 33.1 kg, Roche et al 2006) and buffalo (4.21 kg, Metry et al 1994). Nevertheless, the milk yield was comparable with yak (1.63, Das et al 1998) and was found to be 2 to 3 times higher than that reported in wild mithun (0.4 lit/d, Yadav and Verma 1996). The content of TS (20.94 to 22.62%), fat (7.72 to 10.25%), protein (6.31 to 6.78%) and SNF (13.40 to 13.70%) in mithun milk during all lactation stages was found to be much higher than that of sheep (17.48 to 19.50, 8.0 to 9.6, 5.32 to 7.74 and 9.48 to 10.1%), goat (12.60 to 15.17, 3.9 to 5.7%, 1.10 to 3.18 and 8.53 to 9.47%), cow (13.43 to 14.34%, 4.0 to 5.0%, 4.46 to 5.75% and 8.43 to 10.14%) and buffalo (12.73 to 15.90%, 4.0 to 6.5%, 3.12 to 4.12% and 8.28 to 9.40%) (Hadjipanayiotou 1995, Kanwal et al 2004), but ash content was comparable with that of sheep, goat and cow (Hadjipanayiotou 1995). The content of lactose (4.36 to 4.60%) in mithun milk was found to be comparable with that of buffalo (3.28 to 4.80%), cow (3.0 to 4.6%), goat (4.0 to 5.5%) and sheep (3.0 to 4.2%) (Kanwal et al 2004). The average MU (36.65 to 43.54%) content in the present study was found to be within the suggested range for cattle herd (Roseler et al 1993). The higher level of TS, fat, protein, SNF and ash contents in mithun milk were probably due to the unique genetic makeup of this species with low average milk yield, which might be needed to meet the nutritional requirement of calf.

The occurrence of the peak milk yield at the beginning of lactation was comparable with buffaloes (Eltawil et al 1976). However, the duration of persistency of peak milk yield was found to be lower than that of buffalo and cattle (Metry et al 1994, Roche et al 2006). This may be explained with the established fact that low producing animals achieve peak yield early and at the same time have lower persistency (Singh et al 2003, Cole and VanRaden 2006). A significant effect of lactation stage on TS and fat content was comparable with the previous findings in buffalo (Şekerden 1999). The highest TS and fat contents were found in the late lactation stage, which might be due to low milk yield. SNF content did not vary significantly during the different lactation stages. The results indicated that the variation in TS was actually influenced by the variation in milk fat. The content of total milk protein and casein did not vary significantly among the different lactation stages. The results indicated that the protein and casein concentration were probably not a function of milk yield.

In the present study, lactose content did not vary significantly throughout the lactation. Lactose is the main determinant of milk volume. A close relationship between lactose synthesis and the amount of water drawn into milk makes lactose a stable milk component (Pollott 2004). Ash content was found to be a least variable milk component in mithun unlike that reported in Fulani cows, West African Dwarf (WAD) does and WAD ewes in Nigeria (Ahamefule et al 2003). NPN content did not vary significantly throughout the lactation, but MU concentration was found to be significantly higher during the late lactation stage. It is also found in cow that MU concentration increases significantly during the late lactation stages (Dhali et al 2006).

Conclusions

- The trend in variation of milk yield and major milk constituents in mithun during the entire lactation was found to be similar with that reported in other domesticated ruminants.
- The suitable time to end milking in mithun was found to be approximately 255 d as milk yield was less than 40% of peak yield after this period.

- Low milk yield and high milk content of TS, fat, protein, SNF and ash in mithun might be due to the unique genetic makeup of this species.
- In the present study, the higher daily milk yield compared to that reported in wild mithun indicates a further scope for improving milk production potential of this species. Therefore, further systematic studies with suitable management strategies and inputs will be fascinating to improve the milk production potential of this animal.

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