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Impact of milk feeding frequency on performance, health and behaviour of crossbred cattle calves

JAVID REHMAN HAJAM[1], G K GAUR[2], NARAYAN DUTTA[3], P K BHARTI[4], MUKESH SINGH[5] and TRIVENI DUTT[6]

ICAR-Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh 243 122 India

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ABSTRACT

The present study was undertaken to study the impact of milk feeding frequency on performance, health and behaviour of crossbred cattle calves. A total of 12 crossbred (*Vrindavani*) calves were allocated equally in to two groups viz. control (G-I) and experimental group (G-II). During the experimental period (from16th to 70th day of birth), the calves in Gr-II and G-I group were fed milk once and twice daily, respectively without any change in total offered milk quantity. The mean birth weight (kg) of calves in control and experimental group were 21.01±0.88 and 21.25±0.88 kg, respectively. The total body weight gain of calves in control and experimental group were 21.06±0.39 and 21.08±0.39 kg, respectively. The average weekly body weights, gains and body measurements in general were non-significantly different in control and G-II group from 1st to 10th week of age. However, the body length was significantly (P<0.05) higher in G-II from third week to end of experiment. As a whole, 16.67% calves in G-I and 33.34% calves in G-II suffered from calf scour. The change in feeding schedule had no significant effect on immune status and behavioral activities of calves. Once daily feeding saved 29.41% (36 man minutes) labour than twice daily feeding schedule. It was concluded that reduction in milk feeding frequency to calves did not affect growth, feed intake, health, behaviour and overall performance, hence one time milk feeding to calves may be adopted at organized herds, where weaning is being practiced, in view of saving labor cost.

Key words: Crossbred calves, Feeding frequency, Growth, Health, Behaviour

Raising dairy calves and heifers from birth to calving incurs second largest expense on the dairy farm, since no revenue is derived until the onset of lactation (Heinrichs, 1993). Many experiments involving dairy calves and heifers have focused on ways to reduce the cost associated with the growth period or hastening the onset of the production stage. However, the peak labour requirement for calf rearing occurs during 12-week period when calves are offered milk-based diet. Frequency of milk feeding has a direct effect on labour costs. An ideal scenario would be to minimize the labour input required during this time, without compromising calf health and welfare. Studies have shown that practices such as grouping calves and feeding milk once per day may reduce labour requirement (Gleeson *et al*. 2008). Newborns are in metabolically unstable conditions, which make them sensitive to perinatal diseases resulting in to high mortality (Dwyer, 2008). Once daily versus twice daily feeding to dairy calves may be beneficial to reduce labour cost without affecting immune response and post weaning performance (Hulbert *et al.* 2011). However, non-nutritive sucking is common in calves just after a meal which may be due to taste of milk (Passille *et al.* 1997).

In addition to nutrient intake and quantity of milk or milk replacer offered, feeding frequency may also be manipulated to alter nutrient intake and modify the amount of delivery of nutrients throughout the day. These manipulations can be used as a tool to improve weight gain, increase starter intake, reduce labour costs and also the convenience of feeding at a time which does not clash with periods of peak labour such as milking time. The present investigation was therefore undertaken to study the impact of milk feeding frequency on performance, health and behaviour of crossbred cattle calves.

MATERIALS AND METHODS

The experiment was conducted on crossbred cattle (*Vrindavani*) calves at Cattle and Buffalo Farm, Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh (India). A total of 12 cross bred calves were selected for the experiment. The calves were allowed to suckle the colostrum from their dams for first three days after birth. Thereafter, the calves were transferred to individual pens. The calves were allocated to two groups, viz. control (G-I) and experimental (G-II) with six animals in each group.

Present address: [1]MVSc Scholar (jvdrehman7@gmail.com), [2,3]Principal Scientist (gyanendrakg@gmail.com, dutta65 @gmail.com), Department of Animal Nutrition; [4]Scientist (pkish.1002@gmail.com), [5,6]Principal Scientist (drmsingh9 @gmail.com, triveniduttivri@gmail.com), Department of Livestock Production and Management.

The calves in both the groups were fed milk individually twice daily (@10% of body weight) up to 15 days of age. The calves in control group were fed milk equally in both morning and evening meals. But the calves in the experimental group were fed unequally in both the feedings till they became adapted to consume their whole daily milk allowance in one feeding at 15 days of age. The actual experiment was started from 16th day of age and continued till 70th day, when milk feeding was completely stopped. During the experimental period, the calves in experimental and control group were fed milk once and twice daily, respectively. Feeding level did not vary between the groups. Milk was fed @ 1/10th of the body weight of calves up to 8 weeks of age, which was subsequently reduced to 1/20th and 1/40th of body weight during 9th and 10th week of age, respectively. The calves were given free access to roughage and calf starter rations from 2nd week of age. The calves were given free access to fresh, clean and wholesome water along with green fodder in the open paddock.

The calves were housed individually in well ventilated, clean and dry pucca pens for 20 hours (from 2:00 p.m to 10:00 a.m) throughout the experimental period. They were let loose for 4 hours (from 10:00 a.m to 2:00 p.m) daily in an open paddock for exercise and also to facilitate washing, cleaning and drying of calf pens.

The body weight (kg) and body measurements viz. body length, height at withers and heart girth of calves were recorded at weekly interval. Weighing was done before offering any feed and water on a digital weighing balance. The average daily gain and total weight gain were also calculated. The feed intake (milk, calf starter and fodder) of calves in both the groups was recorded based on difference of feed offered and feed refused by them as per the feeding schedule. Green fodder was mainly chopped maize and berseem which was given as per availability during the season. Calf starter included 50% crushed maize, 30% Soyabean oil cake, 17% wheat bran, 2% mineral mixture and 1% salt. The amount of feed consumed was calculated. The dry matter intake (DMI) was calculated based on dry matter contents of milk, calf starter and green fodder. Feed efficiency was calculated as gain in body weight (kg) per unit kg dry matter intake.

Health parameters were recorded based on direct observations. The number of calves suffered, kind and duration of illness such as diarrhoea, dysentery, respiratory problems, navel ill or other health related clinical symptoms were recorded for each calf. Faecal consistency score (FCS) from 1 to 4 was recorded as per the standards given by Larson *et al*. (1977).

Time required for different activities of calf rearing like transportation and warming of milk, milk feeding and cleaning of utensils, taking away of animals from shed, cleaning and washing of pens, application of bedding, concentrate and green fodder supply, placing of animals in shed were recorded during start, middle and towards the end of experimental period. Behavioral activities (feeding of concentrate / green fodder, standing idle, sitting, licking of inanimate objects, cross suckling of mouth and self licking) of the calves were recorded without disturbing the day to day managemental activities. Observations were taken from a distance of 2 to 3 meters. The calves were observed for one hour after milk feeding for recording of any abnormal behaviour at 3, 9 and 10 weeks of age.

Blood samples from all the calves were collected at 15, 45 and 70 days of age through jugular vein puncture for assessing hemoglobin, packed cell volume and other blood-biochemical parameters viz. serum glucose, albumin, globulin, total protein, albumin-globulin ratio and urea. The cell mediated immunity or delayed type hypersensitivity (DTH) reaction to injection of phyto-haemagglutinin-p (PHA-p) in calves were measured through skin thickness test. The data were analyzed through least squares and maximum likelihood computer program (Harvey, 1990).

RESULTS AND DISCUSSION

Performance of calves

Average birth weight of calves in control and experimental group was 21.01±0.88 and 21.25±0.88 kg, respectively, the difference being statistically non-significant. The weekly body weights increased steadily from birth to 70th day (44.16±0.96 and 44.61±0.96 kg) in both groups. The weekly body weights however did not differ significantly at any stage in both the groups. The body weight gains also did not differ significantly in both the groups at any stage from 3rd (2.06±0.14 and 1.95±0.14 kg) to 10th (2.78±0.13 and 2.98±0.13 kg) week of age. The total body weight gain of calves in control and experimental group was 21.06±0.39 and 21.08±0.39 kg, respectively which was also non-significantly different. The overall average daily gain (ADG) of calves in two groups was 0.38±0.01 and 0.38±0.01 kg, respectively. ADGs also did not differ significantly either at any week or during entire period of experiment. Previous investigations in various breeds of cattle have also revealed that body weight gain did not differ between calves fed once versus twice daily (Kehoe *et al.* 2007; Economides and Georghiades, 2008; Feyzi *et al*. 2008; Kmicikewycz *et al.* 2013).

The average body length of calves at birth in G-I and G-II was 60.73±0.85 and 62.76±0.85 cm, respectively. The difference in body length at birth was non-significant between the groups. Body length was significantly (p>0.05) higher in G-II from 3rd to 10th week of age. The final body length in G-I and G-II was 73.16±1.30 and 77.33±1.30 cm, respectively. The average height at wither in G-I and G-II was 65.23±1.66 and 65.40±1.66 cm, respectively at birth. The difference in height at wither was non-significant (p>0.05) between two groups from 3rd to 10th week of age. The final height at wither in G-I and G-II was 74.85±1.41 and 75.00±1.41 cm, respectively. The average heart girth of calves at birth in G-I and G-II was 65.26±1.54 and 68.71±1.54 cm, respectively. The difference in heart girth was non-significant between the groups up to 9th week of age. The final heart girth in G-I and G-II was 80.50±1.80 and 86.33±1.80 cm, respectively, the difference being

statistically significant. The present results were in agreement with Willett *et al.* (1969), who reported non-significant differences in heart girth and wither height gains from birth to weaning at 40 days of age on once versus twice daily feeding to Holstein calves. Yanar and Ockerman (1993) and Kehoe *et al.* (2007) also reported that feeding frequency had no effect on structural measurements and skeletal development.

The total milk consumed by calves in G-I and G-II group was 142.77±4.23 and 143.49±4.23 kg, respectively. The corresponding values for dry matter intake (DMI) were 18.33±0.56 and 18.50±0.56 kg, respectively. The weekly and overall milk intake was not significantly different at any age from birth to 10 weeks. This was because of the similar body weight gain in both the groups, since milk was fed to the calves based on their body weight. Weekly milk intake showed an increasing trend along with body weight in both the groups till 8 weeks of age and decreasing trend, thereafter.

Feed intake

The calves were offered calf starter from 2nd week of age and intake continued to increase till 10th week. The total calf starter consumed by calves in G-I and G-II was 23.20±1.10 and 26.58±1.10 kg, respectively. The corresponding values for DMI were 21.06±0.97 and 24.33±0.97 kg, respectively. The weekly starter intake in the two groups did not show any significant difference till 6th week of age. However, the starter intake was significantly ($p<0.05$) higher in G-II during 7th, 8th and 9th week of age. The starter intake was again similar in two groups at 10th week of age. Hulbert *et al*. (2011) and Kmicikewycz *et al.* (2013) also noticed non-significant difference in calf starter intake between calves milk fed once or twice daily.

The calves were also offered green fodder from 2nd week of age and intake continued to increase till 10th week. The total green fodder consumed by calves in G-I and G-II was 65.70±1.77 and 70.03±1.77 kg, respectively. The corresponding values for DMI were 9.08±0.25 and 9.65±0.25 kg, respectively. The weekly and overall green fodder intake was non-significantly different in both groups during entire period. However, calves of G-II group consumed more fodder than G-I during most of the experimental period. The increase in green fodder intake in both the groups was pronounced, when the whole milk was reduced. The total dry matter consumed by calves in G-I and G-II was 48.36±1.28 and 52.20±1.28 kg, respectively. Milk constituted more than half of the diet's dry matter during the initial stages of life. The dry matter from calf starter was relatively higher than green fodder in both the groups, which may be due to lower capacity of developing rumen to accommodate large quantity of bulky fodder. The total dry matter intake increased steadily in both the groups over the period. However, a small decrease in dry matter intake was observed in both the groups during 9th week of age, despite of an increase in calf starter and green fodder intake. This might be due to change in the milk feeding schedule during this period. The total dry matter intake in G-I and G-II was not different significantly till 6th week of age. However, it was significantly higher ($p<0.05$) in G-II from 7th to 10th week of age. The overall total dry matter intake was similar in both the groups. Galton and Brackel (1976) also reported comparatively high dry matter intake in calves fed milk once daily (2.27 kg dry matter per kilogram gain) than two times feeding group (2.04 kg dry matter per kilogram gain).

The overall feed efficiency in G-I and G-II was 0.43±0.01 and 0.40±0.01, respectively. It was not different significantly between the groups. The weekly feed efficiency was also non-significantly different between two groups during all weeks, except 6th week of age. The findings of present investigation were in agreement with Hulbert *et al.* (2011) and Kmicikewycz *et al.* (2013), who observed that feeding frequency had no effect on growth, starter intake and feed efficiency in calves.

Health status of calves

During the experimental period, a total of three calves viz. one in G-I (16.67%) and two in G-II (33.34%) suffered from some kind of illness. Calf scour was the main disease affecting all the three cases. In both the groups, no mortality was observed throughout the experimental period. The average duration of illness for calf scour was 3.33 days per case, indicating that the calves recovered from diarrhea within a short span of time. In G-I, the FCS value was comparatively higher during 3rd week of age when one calf suffered from diarrhea. Similarly, FCS value was higher in G-II during 4th week of age. During this period, two calves in G-II group had suffered from diarrhea. The inter-group differences for faecal consistency score were, however non-significant during the whole experimental period from 16th to 70th day. Owens & Stake (1971) and Kehoe *et al.* (2007) also reported non-significant difference in faecal scores of calves, fed milk once versus twice daily. In general, both the groups (control and experimental) were similar with respect to their health status. Willett *et al.* (1969) and Hopkins (1997) also found that once-daily as compared to twice-daily feeding had no adverse effect on health and did not increase incidence of digestive disorders in calves.

Blood parameters

The mean hemoglobin level (g/dl) of calves at various periods ranged from 9.60±0.20 to 10.33±0.20 g/dl in both the groups and was well within the normal range. The hemoglobin concentration was non-significantly different between two groups during most of the periods, except 45 days of age, where G-I had significantly ($P<0.05$) higher (10.33±0.20) hemoglobin than G-II (9.96±0.14), which might be due to feeding schedule. The mean packed cell volume (%) of calves ranged from 31.16±0.73 to 32.33±0.89% in both the groups and did not differ significantly across the feeding frequency. The mean total serum protein (g/dl) of calves ranged from 6.16±0.12 to

6.71±0.18 g/dl in both the groups. The total protein content was significantly (P<0.05) higher in G-II (6.63±0.12) than G-I (6.16±0.12) at 15 days of age. However, the difference was non-significant at 45 and 70 days of age. Van Saun (2000) reported that serum protein and albumin is a potent indicator of protein status of animals. The comparable value of serum proteins in both G-I and G-II calves is indicative of adequacy of protein intake even on reduced feeding frequency of milk. The mean serum albumin (g/dl) was significantly (P<0.05) higher in G-II at 15 days (3.81±0.14) than G-I (3.28±0.14). The mean serum globulin (g/dl) of calves ranged from 2.75±0.09 to 3.20±0.17 g/dl and was within the normal range in different periods. Globulin concentration increased over the age in both groups. The mean globulin concentration was significantly (P<0.05) higher in G-I at 45 days. However, the difference was non-significant at 15 and 70 days of age. The albumin globulin ratio was significantly (P<0.05) higher in G-II at 45 days of age, but the difference between two groups was non-significant at 45 and 70 days of age. The serum glucose levels ranged from 60.80±1.17 to 66.86±3.52 mg/dl in both groups and were within the normal range. Glucose values did not differ significantly at any period. Stanley *et al.* (2002) observed that feeding calves milk replacer once daily or twice daily did not adversely affect glucose metabolism. The mean serum urea level (mg/dl) of calves ranged from 23.48±0.67 to 24.86±0.61 mg/dl in both groups. The urea concentration showed an increasing trend with age in both the groups. The present findings are in agreement with Kehoe *et al.* (2007) who also reported that calf performance is not affected by weaning early and feeding once daily.

Behaviour of calves

Time spent by the calves to eat calf starter/green fodder was less in the early age and increased thereafter with the increase in age during the experimental period. During one hour after milk feeding, it was 7.16±0.77 min/hr at 3 weeks of age and subsequently increased to 15.91±1.02 and 24.33±1.17 min/hr at 9 and 10 weeks of age, respectively. The corresponding values for G-I and G-II during one hour after milk feeding were 6.66±1.10 and 7.66±1.10 min/hr at 3 weeks of age, 15.83±1.45 and 16.00±1.45 min/hr at 9 weeks of age and 24.33±1.65 and 24.33±1.65 min/hr at 10 weeks of age, respectively. The time spent in eating concentrate/green fodder was non-significant between the groups during all periods of observation. The time spent by the calves in standing idle during one hour after milk feeding was more during the early age and subsequently decreased at 10 weeks of age. During one hour after milk feeding, it was 20.83±1.13 min/hr at 3 weeks of age and thereafter decreased to18.33±0.89 and 15.08±0.66 min/hr at 9 and 10 weeks of age respectively. The difference between G-I and G-II was non-significant (P>0.05). Similar findings have been reported by Maity (1999).

The calves in both the groups spent more time in sitting during the early phase of growth as compared to the later stages of experiment. The mean time spent by the calves in this activity was recorded as 20.00±1.55 min/hr at 3 weeks of age. It subsequently reduced to 16.50±0.70 and 12.83±0.51 min/hr at 9 and 10 weeks of age. These values did not show any significant difference between the groups.

During one hour after milk feeding, mean time spent on licking inanimate objects was 3.41±0.43 min/hr at 3 weeks of age and thereafter the time spent on this activity was 3.58±0.39 and 2.83±0.51 min/hr at 9 and 10 weeks of age, respectively. In G-II calves, it showed a decreasing trend from start to the end of experimental period. In case of G-I group, the time spent on licking inanimate objects was higher at 9 weeks than 3 weeks of age. However, it decreased again at the end of experimental period. This activity did not show any significant difference between the groups at any period of experiment. The time spent by the calves in cross suckling during one hour after milk feeding was more during the early age and subsequently decreased at 10 weeks of age. During one hour after milk feeding, it was 5.41±0.50 min/hr at 3 weeks of age and thereafter decreased to 3.83±0.46 and 3.00±0.65 min/hr at 9 and 10 weeks of age, respectively. The corresponding values for G-I and G-II during one hour after milk feeding were 5.00±0.71 and 5.83±0.71 min/hr at 3 weeks of age, 3.83±0.65 and 3.83±0.65 min/hr at 9 weeks of age and 2.83±0.92 and 3.16±0.92 min/hr at 10 weeks of age, respectively. The time spent in cross suckling was non-significant between the groups during all periods of observation. This indicates a non-significant effect of an altered feeding frequency on this behaviour.

Immune response

The results of *in-vivo* delayed type hypersensitivity (DTH) reaction to injection of phyto-haemagglutinin-p (PHA-p) in calves were measured through skin thickness test. Calves in both the groups exhibited an increase in skin thickness following an intra-dermal injection of PHA-p. The mean value of skin thickness and% increase in skin thickness did not differ significantly between the groups. Also, the change in skin thickness at different periods did not differ significantly between the groups.

Chronic deficiencies of protein, energy, minerals or vitamins have been found to be associated with increased disease susceptibility as a result of depressed immune function (Goff and Horst, 1997). Inadequate protein nutrition impairs cell mediated immunity and immunoglobin production. Chronic malnutrition is one of the most important causes of several metabolic, immune and neuro-endocrine dysfunctions (Giovambatista *et al*. 2000). The present results did not show any significant difference between the groups with respect to their immune status. Hence, the immune status of calves was unaffected by the alteration of feeding schedule.

Time and motion study

The total time spent in various operations is presented as per the sequences of activities carried out in the farm. Each day, the milk quantity differed as per the standard

needs. Transport of milk from milking parlour was made through a rickshaw pulled by a labourer. It took about 18.05 and 9.25 man minutes to transport milk required by calves in G-I and G-II groups, respectively. Hence, G-I calves required 48.75% (8.8 man minutes) more labour than G-II for milk transportation. Milk was fed at body temperature of calves. Therefore, it was warmed to about 40° C. It took about 12.9 and 6.64 man minutes in heating & other associated works like cleaning utensil for G-I and G-II, respectively. Hence, G-I calves required 48.53% (6.26 man minutes) more labour than G-II for warming of milk. This was the highest time consuming activity in case of two time feeding (G-I) group. It took 29.04 man minutes in feeding the morning and evening portion of milk to calves. In case of one time feeding (G-II) group, the time required was 13.80 man minutes. Hence, G-I calves required 52.48% (15.24 man minutes) more labour than G-II for feeding of milk. It was observed that the new born calves consumed more time than older calves to drink milk. This was because they were inexperienced and needed to learn the process of milk feeding from buckets. Hence, the labourer spent more time on training rather than actual consumption of milk. These calves on an average took 3–4 minutes to drink milk. Older calves finished the process with a minute.

The present results are in agreement with Schick and Buscher (1992) who reported that feeding accounted for 62% and calf care 25% of daily working time, respectively. Kehoe *et al*. (2007) also reported that milk feeding once a day did not negatively affect the growth performance of calves and reduced the cost of labour. The total labour required in the activities related to feeding of milk (i.e. transportation, warming and feeding) was 59.99 and 29.69 man minutes per day for G-I and G-II, respectively. Hence, G-II calves required 50.50% (30.30 man minutes) less labour in milk feeding related activities. The labour required for feeding milk, concentrates and green fodder was 74.99 and 44.33 man minutes for G-I and G-II, respectively. Hence, labour required in all feeding activities was 40.89% (30.66 man minutes) lower for G-II group. The total time spent on all the activities in calf rearing was 2.04 and 1.44 man hours per day for G-I and G-I, respectively. Hence, overall G-II required 29.41% less labour than G-I.

The results obtained from this study suggest that reduction in frequency of milk feeding to calves had no adverse/negative effect on their growth, feed intake, health and overall performance. Once daily fed calves performed equally well to those fed twice daily with respect to their weight gain, feed intake, body measurements, feed efficiency and health status. Once daily feeding of milk did not increase incidence of scour, especially during initial stage of experiment. Hence, one time milk feeding, preferably during lean hours, may be recommended to calves at organized herds, where weaning is being practiced, in view of reduction in labor requirement.

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