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# Effect of replacing whole milk by skimmed milk on behaviour and health performances in crossbred dairy calves

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ABSTRACT

The study was aimed to investigate the impact of replacing whole milk by skimmed milk on behaviour and health performances in crossbred dairy calves. A total of 24 crossbred calves were allotted randomly into four groups, viz. Control (C), Treatment-1 (T1), Treatment-2 (T2) and Treatment-3 (T3) based on the birth weight and age. The calves in group C were fed on whole milk whereas skimmed milk was introduced to treatment groups at 22nd day of age @ 25, 50 and 75% of total liquid feed requirement for T1, T2 and T3, respectively. At 45th day of age, skimmed milk was fed @ 50, 75 and 100% of the total requirement, respectively for T1, T2 and T3 groups. From 64 to 72 days onwards calves were fed only on skimmed milk. The total time spent on standing, resting and moving in all groups were comparable. The total play time was significantly higher in T2 group than other groups. The fecal consistency score was significantly higher in T3 as compared to other groups. The blood parameters like hemoglobin, packed cell volume, total protein, albumin, globulin, creatinine and urea had varied significantly between the groups at some stages of experiment. The skimmed milk can replace the whole milk from 75 to 100% in early age of dairy calves without adversely affecting behavior and health performance.

**Keywords**: Behaviour, Cortisol health, Skimmed milk, *Vrindavani*

Nutritional and health care aspects of calf rearing are the prime concern for dairy calf management. Apart from that, economics of rearing should always be kept in mind as whole milk feeding may affect the profitability of dairy farm. In view of obtaining good growth economically, the whole milk can partly or completely be replaced with variety of ingredients such as skimmed milk, whey protein (Shekar, 2009) and soymilk (Ghorbani *et al*. 2007). It has been reported by various workers that the use of skimmed milk in calf feeding is economical in compared with the whole milk (Thamothiran *et al*. 2019). On the other hand, if whole milk is replaced with milk replacer, it may affect the health and behaviour of crossbred calves (Bharti *et al.* 2014). Apart from the health status of the calves, milk replacer may tend to alter the hemato-biochemical parameters or the behaviour of calves (de Passillé and Rushen, 2006). Keeping all these facts in view, the present study was undertaken to compare the health status, hemato-biochemical and behavioural parameters of calves fed with different proportions of whole milk and skimmed milk.

## MATERIALS AND METHODS

*Location and climatic conditions:* The experiment was conducted from November, 2017 to April, 2018 at Cattle and Buffalo Farm, Indian Veterinary Research Institute, Izatnagar, Bareilly, (India). The farm is situated at 28.22° N latitude, 79.22° E longitude and at an altitude of 173 meter above mean sea level.

*Animals and experimental design:* Twenty-four healthy crossbred (*Vrindavani*) calves were selected and grouped alternately into four groups (6 calves per group), viz. Control (C), Treatment-1 (T1), Treatment-2 (T2) and Treatment-3 (T3) based on their birth weight. Birth weight of calves was non-significant between the groups. The calves in control group were fed on whole milk based upon their age and body weight (Table 1). Skimmed milk was introduced from 22nd days onward @ 25%, 50% and 75% of total liquid feed requirement for T1, T2 and T3, respectively. The quantity of skimmed milk was further increased to the tune of 50%, 75% and 100% of total

Table 1. Feeding schedule whole milk and skimmed milk to calves in different groups

| Day | Amount of BW | Control (C) | Treatment (T1) | | (T2) | | (T3) | |
|---|---|---|---|---|---|---|---|---|
| | | WM | WM | SM | WM | SM | WM | SM |
| 4–21 | 1/10th | 100% | 100% | Nil | 100% | Nil | 100% | Nil |
| 22–44 | 1/10th | 100% | 75% | 25% | 50% | 50% | 25% | 75% |
| 45–63 | | | | | | | | |
| I.(45–56) | 1/10th | 100% | 50% | 50% | 25% | 75% | Nil | 100% |
| II.(57–63) | 1/20th | 100% | | | | | | |
| 64–72 | 1/40th | 100% | Nil | 100% | Nil | 100% | Nil | 100% |

BW, Body weight; WM,Whole milk; SM, Skimmed milk.

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requirement of liquid feed from 45th days onwards for T1, T2 and T3, respectively. 100% replacement of whole milk by skimmed milk was done in all three treatment groups from 64th days onward till the end of liquid feeding phase. The skimmed milk was procured from the Dairy Technology unit of the institute. The compsition of whole milk and skimmed milk fed in the experiment is presented in Table 2.

Table 2. Chemical composition of whole milk and skimmed milk

| Particular | Fat | Protein | Lactose | SNF | Total Solids | Moisture |
|---|---|---|---|---|---|---|
| Whole milk (%) | 4.42 | 3.11 | 4.72 | 8.56 | 12.98 | 87.02 |
| Skimmed milk (%) | 0.23 | 3.36 | 4.68 | 8.90 | 9.13 | 90.87 |

*Management of calves:* From 4th day of age onwards the calves were fed with whole milk and skimmed milk as per the schedule of respective group. Calf starter and green fodder were provided *ad lib.* to all the calves from 2nd week of age onwards. The green fodders provided were maize (*Zea mays*), oats (*Avena sativa*) and berseem (*Trifolium alexandrium*). The calves were housed individually in well ventilated, clean and dry cemented concrete pens which had the dimension of 2.20 × 1.16 $m^2$ (per calf) for 20 h (from 2:00 PM to 10:00 AM) and they were let loose for 4 h (10:00 AM to 2.00 PM) daily in an open paddock for exercise and also to facilitate washing, cleaning and drying of calf pens. Fresh, clean and wholesome water was made available to the calves throughout the day.

*Health parameters:* Health parameters were recorded by direct observation of calves on daily basis throughout the experimental period. Incidences of disease conditions were observed for each calf individually. Faecal consistency score (FCS) was recorded daily as per the four point scale (1: faeces in semi-solid consistency; 2: slightly loose faeces; 3: moderately loose faeces and 4: watery faeces) as per the standards given by Larson *et al.* (1977). The calves with FCS values more than 2 were considered as diarrheic calves. Calves suffered with more than onedisease and repeated incidences were also observed for analysis of data.

*Blood analysis:* Blood samples were collected from all the calves at 21, 44 and 63 days of age through jugular vein puncture for hemato-biochemical analysis. For biochemical analysis the blood was collected in a sterile tube devoid of anticoagulant but for blood glucose estimation blood was collected in a separate sterile tube coated with sodium fluoride. Serum was separated from the collected blood and was stored in deep freeze (–20°C) for subsequent biochemical estimation.

Hematological and biochemical analysis were done in laboratory as per the standard procedures.

*Behavioural study of calves:* The calves were observed for behavioural attributes both in closed pen and in open paddock using closed circuit television (CCTV) camera. The behavioural activities like time spent for moving, standing and sitting were recorded at weekly intervals for two consecutive days during the experimental period. The total recording time in open paddock was 6 h (9 AM to 3 PM) per day whereas only 30 min recording was done inside the shed during each feeding time to record feeding/post-feeding behavioural activities.

*Statistical analysis:* The data generated in this study was recorded and analyzed as per the standard procedures (Snedecor and Cochran, 1994) using SPSS version 22.0 statistical software. One way analysis of variance (ANOVA) was used to compare the control and treatment groups.

## RESULTS AND DISCUSSION

*Effect on behavioural parameters of dairy calves:* The total time spent in standing was higher in T3 followed by T1, T2 and C. This might be due to the fact that calves in T3 spent most time in taking solid feed which was overlapped with standing; however the difference was not significant between the groups. Feeding time was higher in T3 followed by T2, T1 and C but the difference was not significant. This might be due their higher solid feed intake during the experimental period. Both the drinking time and the time spent near feed trough did not show any significant difference among the groups. The time spent on rumination, idling, grooming, milk intake, inter-sucking, licking inanimate objects and sleeping were similar and non-significant between the groups. Play behaviour was recorded in the form of loco-motor play like jumping and social play like pushing. Playing time was significantly ($P<0.05$) higher in T1 compared to C but non-significant with T2 and T3. Calves during summer and monsoon spent comparatively less time in resting as compared to winter which might be indication of lack of comfort which reduced time spent resting and a subsequent increase in time spent standing (Haley *et al.* 2001). Calves received milk *ad lib* had high lying time compared the calves with restricted milk feeding regimes (Borderas *et al.* 2009). From the findings of present study, it can be said that feeding schedule did not had any influence over the rumination, which was in accordance with the report of Babu *et al.* (2009). The feeding of calves on skimmed milk (@ 25–100% of total liquid feed requirement) had no adverse effect on behaviour of crossbred calves.

*Health performance of calves:* The incidence of health disorders in different groups has been recorded and presented in the Table 3. The incidence like calf scour, respiratory infection, ocular infection, fever and wound were observed among calves in different groups during the experiment. Total numbers of calves affected with diseases were higher in T3 and T2 followed by T1 and C. In C, 17% of calves were suffered from more than one disease whereas in T1, T2 and T3 no animal was suffered from more than one disease. The percentage of calves suffered from one kind of disorder in C, T1, T2 and T3 was 0, 33, 50 and 50 per cent, respectively. The incidence of calf scour was noticed in T1 (17%) and T2 (17%) groups whereas no calf was affected with calf scour in C and T3 groups. Respiratory infection was noticed in C (17%) and T3 (17%) groups but no occurrence was observed in T1 and T2 groups. Wound

Table 3. Incidence of health disorders in calves (4–10 weeks)

| Attribute | C | T1 | T2 | T3 |
|---|---|---|---|---|
| % of calves suffered | 16.67 (1) | 33.33 (2) | 50 (3) | 50 (3) |
| % of calves suffered from calf scour | 0 | 16.67 (1) | 16.67 (1) | 0 |
| % of calves suffered from respiratory infection | 16.67 (1) | 0 | 0 | 16.67 (1) |
| % of calves suffered from wound | 0 | 0 | 33.33 (2) | 33.33 (2) |
| % of calves suffered from ocular infection | 16.67 (1) | 0 | 0 | 0 |
| % of calves suffered from fever | 0 | 16.67 (1) | 0 | 0 |

Values in parentheses indicate the number of calves.

was noticed only in T2 and T3 with affection rate of 33% of animals in each group respectively. Incidence of ocular infection (17%) and fever (17%) was noticed in C and T1. Percentage of affected days was 0.98 days for calf scour, 1.31 days for wound and 0.65 days each for respiratory infection, ocular infection and fever. The fecal consistency score was significantly (P<0.05) higher in T3 compared to C, but non-significant with T1 and T2. The same trend was noticed from 6 to 10 weeks of age whereas from 4 to 5 weeks of age the difference was non-significant between the groups.

The introduction of skimmed milk did not increase the incidence of calf scour in treatment groups, which is in agreement with findings of Babu *et al.* (2009) who reported lower incidence of calf scour in skimmed milk fed group compared to whole milk fed group. However, the incidence of calf scour was contrary to the findings of Srivastava (1977) who reported more diarrhea in skimmed milk fed group due to lack of butter fat. Similarly, Bharti *et al.* (2014) also reported higher days in diarrhea in milk replacer feeding than whole milk.

*Hemato-biochemical parameters of calves:* The hematological parameters of calves at different periods have been analyzed and presented in Table 4. The overall hemoglobin concentration of all groups was within the normal range and significantly higher (P<0.05) in T3 compared to C but T1 and T2 were non-significant with either C or T3. The PCV of all groups was within the normal range and non-significant between the groups. However, it was significantly higher (P<0.05) in T3 compared to C but T1 and T2 were non-significant with either C or T3 at 63 days of age. The total leukocyte count (TLC) value was within the normal range for all the groups.

The overall total protein was non-significant between the groups, however at 63 days of age the total protein level was significantly higher (P<0.05) in T2 compared to T1 but remained non-significant with C and T3 at 63 days of age (Table 5). Albumin level was significantly (P<0.05) higher in T3 compared to T2 but non-significant with C and T1 at 21 days of age. However, the overall serum albumin was non-significant between the groups. Globulin level was significantly higher (P<0.05) in T2 compared to T1 but remained non-significant with C and T3 at 63 days of age. The albumin: globulin ratio was within the normal range for all the groups and it did not significantly differ from each other. The overall blood glucose value was higher in groups received skimmed milk than the group received only whole milk however the difference of which was not significant. The overall serum creatinine value was well within the normal range and non-significantly differed from each other. However, the creatinine value was significantly higher (P<0.05) in C compared to T1 but remained non-significant (P>0.05) with T1 and T2 at 63 days of age. The mean serum urea was significantly (P<0.05) higher in T3 compared to C and T1 but non-significant with T2. At 44 days of age, the serum urea level was significantly (P<0.05) higher in T3 compared with C but non-significant with T1 and T2. The overall serum cholesterol value was higher in T3 followed by T2, T1 and C; however, the difference was not significant between the groups. This result indicates that the feeding of skimmed milk had lowered the serum cholesterol levels in crossbred calves. The overall alkaline

Table 4. Hematological parameters (mean±SE) of calves

| Parameter | Interval (days) | Control | Treatment-1 | Treatment-2 | Treatment-3 |
|---|---|---|---|---|---|
| Hemoglobin (g/dl) | 21 | 8.98±0.28 | 9.34±0.32 | 9.33±0.34 | 9.37±0.43 |
| | 44 | 9.01±0.28 | 9.80±0.28 | 9.87±0.44 | 10.18±0.27 |
| | 63 | 9.06±0.20$^{b}$ | 10.04±0.57$^{ab}$ | 10.01±0.25$^{ab}$ | 11.32±0.35$^{a}$ |
| | Overall | 9.02±0.22$^{b}$ | 9.73±0.36$^{ab}$ | 9.74±0.31$^{ab}$ | 10.29±0.30$^{a}$ |
| Packed cell volume (%) | 21 | 28.92±0.91 | 29.06±0.72 | 29.69±0.76 | 29.36±0.91 |
| | 44 | 29.20±0.46 | 30.40±0.72 | 30.76±0.87 | 31.05±0.65 |
| | 63 | 29.33±0.75$^{b}$ | 31.13±1.33$^{ab}$ | 31.33±0.58$^{ab}$ | 33.50±0.84$^{a}$ |
| | Overall | 29.15±1.50 | 30.20±2.07 | 30.60±1.56 | 31.30±1.66 |
| Total leukocyte count($10^3$/µl) | 21 | 8.38±0.53 | 8.09±0.73 | 8.62±0.65 | 8.27±0.78 |
| | 44 | 8.87±0.62 | 8.80±1.29 | 8.93±0.71 | 8.26±0.76 |
| | 63 | 8.94±0.54 | 8.50±0.97 | 8.74±0.65 | 8.45±0.75 |
| | Overall | 8.73±0.53 | 8.47±0.98 | 8.76±0.66 | 8.32±0.74 |

Means bearing different superscripts (a, b) within a row differ significantly (P<0.05).

Table 5. Biochemical parameters (mean±SE) of calves

| Parameter | Interval (days) | Control | Treatment-1 | Treatment-2 | Treatment-3 |
|---|---|---|---|---|---|
| Total serum protein (g/dl) | 21 | 6.24±0.33 | 6.85±0.51 | 6.03±0.52 | 6.35±0.29 |
| | 44 | 6.95±0.30 | 6.46±0.68 | 6.30±0.33 | 6.19±0.21 |
| | 63 | 6.81±0.21$^{ab}$ | 6.01±0.13$^{b}$ | 6.94±0.21$^{a}$ | 6.74±0.26$^{ab}$ |
| | Overall | 6.67±0.20 | 6.44±0.39 | 6.43±0.34 | 6.43±0.12 |
| Serum albumin (g/dl) | 21 | 3.20±0.31$^{ab}$ | 3.08±0.24$^{ab}$ | 2.65±0.22$^{b}$ | 3.77±0.25$^{a}$ |
| | 44 | 3.64±0.23 | 2.89±0.31 | 2.88±0.21 | 3.03±0.14 |
| | 63 | 3.45±0.33 | 3.29±0.29 | 3.08±0.36 | 3.14±0.30 |
| | Overall | 3.43±0.27 | 3.09±0.15 | 2.87±0.20 | 3.31±0.16 |
| Serum globulin (g/dl) | 21 | 3.05±0.43 | 3.77±0.72 | 3.38±0.36 | 2.58±0.30 |
| | 44 | 3.32±0.24 | 3.58±0.50 | 3.42±0.38 | 3.16±0.19 |
| | 63 | 3.36±0.25$^{ab}$ | 2.71±0.27$^{b}$ | 3.86±0.20$^{a}$ | 3.59±0.11$^{a}$ |
| | Overall | 3.24±0.21 | 3.36±0.31 | 3.56±0.22 | 3.11±0.13 |
| Albumin / globulin ratio | 21 | 1.23±0.28 | 1.11±0.35 | 0.82±0.08 | 1.68±0.41 |
| | 44 | 1.13±0.11 | 0.86±0.11 | 0.91±0.15 | 0.98±0.09 |
| | 63 | 1.09±0.18 | 1.36±0.33 | 0.83±0.16 | 0.89±0.10 |
| | Overall | 1.15±0.15 | 1.11±0.12 | 0.86±0.08 | 1.19±0.16 |
| Blood glucose (mg/dl) | 21 | 79.79±8.35 | 77.93±6.82 | 93.47±9.26 | 86.74±4.04 |
| | 44 | 67.76±4.73 | 84.17±2.57 | 94.32±11.49 | 90.00±5.23 |
| | 63 | 82.19±9.07 | 76.15±4.55 | 88.00±9.20 | 93.85±12.00 |
| | Overall | 76.58±3.97 | 79.42±3.14 | 91.93±9.60 | 90.19±5.76 |
| Serum creatinine (mg/dl) | 21 | 1.02±0.11 | 0.97±0.17 | 1.06±0.13 | 1.10±0.16 |
| | 44 | 0.82±0.13 | 0.82±0.12 | 1.12±0.21 | 1.00±0.16 |
| | 63 | 1.45±0.30$^{a}$ | 0.70±0.14$^{b}$ | 0.86±0.10$^{ab}$ | 1.01±0.12$^{ab}$ |
| | Overall | 1.10±0.10 | 0.83±0.09 | 1.01±0.13 | 1.03±0.07 |
| Serum urea (mg/dl) | 21 | 21.88±2.42 | 20.48±3.74 | 29.24±3.26 | 29.78±3.25 |
| | 44 | 19.51±2.57$^{b}$ | 22.77±2.96$^{ab}$ | 26.55±3.44$^{ab}$ | 34.20±3.51$^{a}$ |
| | 63 | 19.25±3.98 | 24.24±3.87 | 26.55±2.09 | 30.27±1.53 |
| | Overall | 20.21±1.10$^{c}$ | 22.50±1.02$^{bc}$ | 27.45±2.42$^{ab}$ | 31.41±1.91$^{a}$ |

Means bearing different superscripts (a, b) within a row differ significantly (P<0.05).

Table 6. Behavioural activities (minutes) of calves in open paddock

| Attribute | Control | Treatment-1 | Treatment-2 | Treatment-3 |
|---|---|---|---|---|
| *Major behavioural activities* | | | | |
| Standing | 162.75±6.40 | 171.90±10.17 | 164.25±9.20 | 185.85±10.65 |
| Resting | 180.00±5.57 | 162.30±9.90 | 175.65±9.74 | 158.40±9.96 |
| Moving | 17.25±2.76 | 25.80±5.73 | 20.10±4.25 | 15.75±2.82 |
| *Routine behavioural activities* | | | | |
| Feeding | 64.20±4.45 | 67.50±6.93 | 68.34±5.43 | 77.40±7.88 |
| Drinking | 3.45±0.78 | 3.15±0.42 | 2.10±0.56 | 2.85±0.65 |
| Near feed trough | 13.50±1.96 | 13.50±3.32 | 11.70±1.76 | 15.15±3.17 |
| Rumination | 49.50±5.70 | 58.80±5.14 | 66.84±5.77 | 70.20±5.26 |
| Idling | 85.50±6.12 | 69.60±6.45 | 70.05±4. 86 | 73.95±4.17 |
| Grooming | 56.55±2.88 | 58.20±5.29 | 53.70±4.48 | 52.80±4.88 |
| Sleeping | 17.40±4.07 | 25.20±2.50 | 29.70±5.43 | 22.80±7.32 |
| Playing | 3.30±0.70$^{b}$ | 7.20±0.92$^{a}$ | 5.40±1.08$^{ab}$ | 4.26±0.68$^{ab}$ |
| Licking inanimate objects | 52.65±5.39 | 55.80±5.34 | 51.30±3.31 | 41.85±3.44 |

Means bearing different superscripts (a, b) within a row differ significantly (P<0.05).

phosphatase (ALP) value of calves was non-significant between the groups.

All the haematological parameters studied were within the normal range as reported in a similar kind of study by Shekar (2009). The increased hemoglobin and packed cell volume values in T3 might be due to higher fecal consistency score (FCS) which might have lead to hemo-concentration. However, in contrast to present findings Babu *et al.* (2009) reported non-significant difference in hemoglobin and packed cell volume values between the whole and skimmed milk fed calves. Shakya (2015) reported that blood hemoglobin and packed cell volume levels of buffalo calves were not affected after replacing whole milk with soy milk up to 40% level. The higher total

protein and albumin in blood might be due to cold stress. Higher concentrate feed intake also reported to increase the total protein and albumin in serum (Babu *et al.* 2009). Both the globulin and albumin: globulin ratio in the present study was comparable with the findings of Kamal *et al.* (2016) who conducted experiment on a similar environment. The present result is in agreement with Babu *et al.* (2009) who reported that replacement of whole milk by skimmed milk did not have any effect on glucose concentration on blood; however Yunta *et al.* (2015) reported a lower plasma glucose concentration in calves receiving 4 l of milk replacer per day than calves receiving 8 l of milk replacer per day. Contrast to the present study, Shukla (2014) observed non-significant difference between the whole milk and milk replacer fed calves in level of serum creatinine. The increased serum urea level in T2 and T3 might be due to higher concentrate: roughage ratio which provided increased crude protein intake that might have led to higher serum urea level (Kaneko, 2008).

Replacement of whole milk with skimmed milk from 22$^{nd}$ and 45$^{th}$ days of age @ 75% and 100%, respectively had equivalent performance pertaining to health and behavior in compared with whole milk feeding. The biochemical parameters were within the normal range. From this study, it is concluded that substitution of whole milk by skimmed milk (@75 to 100%) can be followed without any adverse impact on health and behaviour of dairy calves at organized herd.

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