

Production performance and health profiles of Murrah buffaloes fed *Moringa oleifera* leaf meal

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Journal of Livestock Science (ISSN online 2277-6214) 17: 814-820

Received on 9/6/25; Accepted on 23/9/26; Published on 26/9/26

doi. 10.33259/JLivestSci.2026.814-820

Abstract

Moringa plant is well liked in animal ration because of its potential antioxidant properties and viable nutritionally rich compounds in plant parts. In this study, different levels of Moringa leaf meal as supplement were evaluated to determine its effect on milk production, production indices and milk composition. Eighteen lactating Murrah buffaloes were divided three treatment groups (T₁ or control, T₂ and T₃), resulting in six lactating buffaloes per treatment. The experiment was performed between 21 days before calving (pre partum) and 150 days after calving (post-partum). Two levels (75 g in T₂ and 150 g per day in T₃ group) of Moringa plant leaf meal were compared with control group (T₁). The supplementation of dried Moringa leaf meal showed significantly ($P<0.05$) higher lactation yield (kg), 6% fat corrected milk (kg), and lactose (%) in group T₃ as compared to control group. Moringa meal supplementation enhanced significantly ($P<0.05$) the production indices. Current research indicates that supplementing Moringa meal to buffalo's diet improves milk yield, production indices, and milk quality.

Key words: leaf meal, peak yield, total solids, persistency, production and supplementation.

Introduction

It is unacceptable to downplay the significance of buffaloes to the way of life and means of subsistence of people in South Asian countries. Since they act as insurance against the possibility of crop failure due to natural calamities, these animals are actually regarded as financial assets. The global buffalo population is steadily increasing, reflecting the growing importance and acceptance of buffaloes as dairy animals. (Dhillod, 2018). Buffaloes are the second-largest milk producer in the world, producing more than a third of Asia's total milk production (FAO, 2022). It has vital role in providing food security and livelihood income to farmers. Due to its great climate adaptation in many tropical and subtropical regions of the world, as well as its eco-friendly qualities, there are numerous names for the *Moringa oleifera* plant, including Horseradish tree, Miracle tree, Drumstick tree, Ben oil tree, Wonder-tree, Miracle tree, and Mother's Best Friend (Chukwuebuka, 2015). *M. oleifera* plant parts, including leaves, fruits, immature pods, and flowers, are included in traditional human diets of several countries (Abbas, 2013). Moringa is being fed to increase immune status and ameliorate stress in goats (Ukey et al., 2025) and increase egg production in RIR hens (Vaghamashi et al., 2025). Using dried Moringa plant leaf meal as a dietary supplement for dairy buffaloes reared in tropical climates is the main focus of the current investigation. It functions as a promising anti-inflammatory, anti-ulcer, anti-hyperglycemic, antidiabetic, antibacterial, antioxidant, and has secondary bioactive chemicals that may enhance increased feed utilization, milk output, and composition in ruminants (Abdul-Razis et al., 2014; Arora et al., 2017). Additionally, Murrah buffalo calves given calf starter supplemented with moringa showed higher average daily gain (Aharwal et al., 2018). Cohen-Zinder et al. (2017) reported that *M. oleifera* silage supplementation resulted in considerably higher milk production in lactating cows. *M. oleifera* has been demonstrated to increase milk production in cows due to its beneficial impact on the rumen environment brought about by the high bypass qualities of its protein and the increased microbial output (Sarwatt et al., 2004).

Transition phase (defined as the time period from 3 weeks pre partum and 3 week postpartum) is the most crucial time period in the lifecycle of dairy animals; animals undergo remarkable physiological and biochemical change that pushes animals towards certain metabolic disease which adversely affect the productivity and reproductive efficiency of dairy animals. Keeping in view the above facts, the current study was conducted to assess the impact of supplementing with *Moringa oleifera* leaf meal on the body weight, productive efficiency and composition of milk produced by lactating Murrah buffaloes raised in loose housing systems.

Materials and Method

Animal care

The Institutional Animal Ethics Committee, LUVAS, examined and approved the current experiment on February 12, 2021.

Animals, feed, and experimental design

The buffalo farm at Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar, was selected for experiment, which is located at 29.09°N 75.43°E in western Haryana. Three dietary treatment groups of 18 buffaloes from first to fifth lactation were chosen, grouped uniformly, and resulted in six lactating buffaloes per treatment based on similar parity. The experiment was conducted for a period from 21 days pre-partum to 150 days of lactation period to find supplementation impact of *Moringa oleifera* leaf meal (MOLM) in the following treatments, namely, T₁ (control), T₂ and T₃ groups (Table 1). The *M. oleifera* leaf meal was purchased from the nearby marketplace and was given in concentrate mixture to buffaloes for 171 days including pre-partum and postpartum period. The *Moringa oleifera* leaf meal (MOLM) was procured from a reliable commercial source and its quality was assessed before inclusion in the experimental diets. The Chemical composition (% DM basis) of different feed has been presented in table 2.

Data and sample collection

The experimental buffaloes were weighed using electronic platform weighing balance (Capacity 1000 kg) installed at the buffalo farm. Since calving until day 150 after calving, buffaloes were manually milked twice at regular intervals at 4:00 A.M. and 4:00 P.M. Milk samples were routinely collected for composition analysis for twenty weeks during the experiment's duration following calving. Ultrasonic automatic milk analyzer was used for determining milk composition viz. milk fat (%), milk protein (%), solids-not-fat content (%), total solids (%), 6% fat corrected milk (kg). During the experimental trial phase, the yield of milk was

measured twice a day and each experimental buffalo's peak yield, persistency duration, and days needed to reach peak yield were noted down when they were accomplished. **Statistical analysis**

The collected data underwent statistical analysis in accordance with Snedecor and Cochran (2014). All the data were subjected to ANOVA using the General Linear Models procedure of SPSS (2019) software. One way ANOVA procedure was done to analyze all parameters, via the following model: $Y_{ij} = \mu + R_{ij} + E_{ij}$ where: μ is the overall mean of Y_{ij} ; R_{ij} is the treatment effect; E_{ij} is the experimental error. Duncan's multiple range tests were used to isolate the mean differences between the various treatments. Consequently, a level of ($P < 0.05$) was used as the criterion for statistical significance (Duncan, 1955).

Results

Body weight

The average daily gain (ADG) was 0.04, 0.14 and 0.20 kg for treatment groups T_1 , T_2 , and T_3 , respectively (Table 3). In treatment groups T_1 , T_2 , and T_3 , the average body weights of calves were 34.60 kg, 35 kg, and 35.17 kg, respectively. The average body weights showed no significant ($P < 0.05$) differences between the various treatment groups. The birth weights of calves were not determined to be statistically significant. In contrast to the control group, the ADG post-calving was considerably ($P < 0.05$) greater in both supplemented groups (T_2 and T_3).

Lactation performance of lactating buffaloes during experimental period

The mean daily milk production for treatment groups T_1 , T_2 , and T_3 were 10.79, 11.54, and 13.6 kg, respectively and significant difference ($P < 0.05$) in milk yield was observed in T_3 group; presented in figure 1. The milk production was significantly ($P < 0.05$) greater in the T_3 group than control and T_2 groups. The statistical analysis of the data showed that the treatment group fed diet with 150 g of Moringa leaf meal had significantly ($P < 0.05$) greater milk production than the control treatment group and T_2 groups.

Table 1. Details of feeding regimen of buffaloes under different dietary treatments with ration composition

Feeding Regime			
Treatments	T_1 (Control)	T_2	T_3
Groups	Feeding of lactating buffaloes to meet out nutrients requirement as per ICAR standards (2013).	Feeding as per ICAR standards (2013) +75 g <i>Moringa oleifera</i> leaf meal (MOLM) /animal/day.	Feeding as per ICAR standards (2013) +150 g <i>Moringa oleifera</i> leaf meal (MOLM)/animal/day.
Feed ingredients			
Green fodder (Kg/head/day)	39	39	39
Wheat straw (Kg/head/day)	5	5	5
Concentrate(Kg/head/day)	6	6	6
Composition of concentrate mixture			
Ingredients	T_1	T_2	T_3
Barley (%)	19.5	19.5	19.5
Maize (%)	29	29	29
Wheat (%)	18	18	18
Ground Nut Cake (%)	10.5	10.5	10.5
Mustard Cake (%)	11	11	11
Soyabean Meal (%)	9	9	9
Common Salt (%)	1	1	1
Mineral Mixture (%)	2	2	2
<i>Moringa oleifera</i> leaf meal (grams/day/animal)	0	75	150

*The mean values with different superscripts in a row differ significantly ($P < 0.05$).

** DCPI- digestible crude protein intake, TDN- total digestible nutrients, DMI- dry matter intake, ME- Metabolizable energy

*** The cost of *Moringa oleifera* leaf meal supplementation was ₹160/kg, corresponding to ₹0, ₹12, and ₹24 per animal per day for the control (0 g), 75 g in T_2 , and 150 g in T_3 supplementation levels, respectively.

Table 2. Chemical composition (% DM basis) and cost of different feed ingredients fed to the experimental buffaloes

Ingredients	DM	CP	CF	EE	Ash	OM	NFE
Fodder							
Wheat straw	94.68	2.87	35.20	1.20	9.3	85.74	46.47
Green Berseem	22.31	15.2	25.70	1.80	11.08	94.84	52.14
Green Maize	24.93	9.1	24.70	3.41	8.31	84.03	46.82
Concentrate							
Maize	88.92	9.10	2.40	3.40	2.25	91.04	76.14
Barley	92.91	11.9	5.20	2.32	5.21	93.26	73.84
Groundnut cake	95.12	41.5	7.4	9.53	7.30	96.38	37.95
Soyabean meal	88.95	46.80	4.80	1.51	7.31	97.25	44.14
Mustard cake	93.77	31.71	7.56	6.19	7.27	91.51	46.05
<i>Moringa oleifera</i> leaf meal(MOLM)	90.12	23.12	8.95	4.67	10.13	83.21	46.47
Mineral mixture	96.45	-	-	-	-	-	-
Common salt	98.46	-	-	-	-	-	-

* DM- dry matter, CP- crude protein, CF- crude fibre, EE- ether extract, OM- organic matter and NFE- nitrogen free extract

Table 3. Average body weights (kg), average daily gain (ADG), and calf weight at birth (kg) in experimental buffaloes under various dietary regimens.

Parameters	Treatments			P value
	T ₁	T ₂	T ₃	
Initial body weight at -21 days prior calving (kg)	570.50±16.53	580.33±25.55	589.67±15.33	0.79
Body weight after calving (kg)	517.50±18.70	518.50±27.82	534.67±15.62	0.82
Final body weight at 150 days post calving (kg)	523.17±20.43	539.83±26.77	565.00±21.48	0.45
Average daily gain (ADG) from calving day to 150 days postpartum (kg)	0.04±0.02 ^a	0.14±0.03 ^b	0.20±0.07 ^b	0.04
Calf body weight at birth (kg)	34.60±0.51	35.00±0.26	35.17±0.40	0.60

*The mean values with different superscripts in a row differ significantly (P<0.05).

Table 4. Average milk composition of trial buffaloes with various dietary regimens

Milk composition parameters	Treatment groups			P value
	T ₁	T ₂	T ₃	
Milk fat (%)	6.70±0.11 ^a	7.32±0.10 ^b	7.47±0.10 ^b	0.00
Milk solids-not-fat (%)	9.30±0.09 ^a	9.57±0.04 ^b	9.52±0.04 ^b	0.01
6% Fat Corrected Milk (kg)	11.67±0.69 ^a	13.30±0.97 ^a	15.89±0.59 ^b	0.01
Total Solids (%)	16.00±0.16 ^a	16.80±0.15 ^b	16.91±0.09 ^b	0.01
Milk Protein (%)	3.40±0.04	3.42±0.02	3.45±0.02	0.42
Milk Lactose (%)	5.15±0.02 ^a	5.21±0.02 ^{ab}	5.23±0.02 ^b	0.04

*The mean values with different superscripts in a row differ significantly (P<0.05).

Table 5. Average production indices of experimental buffaloes during the experimental period under different dietary treatments

Production Parameters	Treatments			
	T ₁	T ₂	T ₃	P Value
Average lactation yield (kg)	10.79±0.61 ^a	11.54±0.77 ^a	13.6±0.58 ^b	0.02
Peak lactation yield (kg)	12.85±0.91 ^a	13.57±0.8 ^{ab}	15.47±0.72 ^b	0.04
Persistency period (days)	42.00±7.00 ^a	63.00±8.08 ^b	82.83±3.34 ^c	0.00
Days to achieve peak yield	40.83±2.15	39.67±2.33	42.00±3.13	0.82

*The mean values with different superscripts in a row differ significantly (P<0.05).

Milk composition of lactating Murrah buffaloes

Significantly ($P<0.05$) higher milk fat % was observed in both supplemented groups than control group (table 4). Study revealed that the SNF % was significantly ($P<0.05$) better in supplemented groups as compared to T_1 (control) group. The data indicated that 6% FCM was found significantly ($P<0.05$) greater in treatment groups supplemented with 150 g of Moringa leaf meal than T_2 and control treatment. The total solid contents of the milk in both supplemented treatment groups were considerably ($P<0.05$) greater than those of the control group. The mean milk protein levels were comparable among all treatment groups. Significantly ($P<0.05$) better milk lactose (%) was observed in treatment group T_3 as compare to T_1 (control).

Production indices of lactating buffaloes during experimental period

The statistical analysis of data revealed that the peak lactation yield was found significantly ($P<0.05$) better in T_3 treatment group in comparison to T_1 (control) group (Table 5). Average days taken post calving to attain peak lactation yield of experimental buffaloes were 40.83, 39.67 and 42.00 days postpartum in treatment groups T_1 , T_2 and T_3 , respectively. Days taken to attain peak milk yield were not differ significantly ($P<0.05$) among different treatment groups. Persistency period was significantly ($P<0.05$) greater in treatment group T_3 than T_2 and T_1 while treatment groups T_2 and T_1 also differ significantly ($P<0.05$) between themselves.

Discussion

The results from investigation revealed that body weights of buffaloes at different intervals didn't differ significantly. Kekana et al. (2020) also observed similar findings who noticed that Moringa leaf meal supplementation in concentrate ration didn't affect the body weight. Contrary to present results, Numerous studies revealed that buffalo calves' body weight was considerably affected by Moringa plant based leaf meal or leaves or other parts of plant [7]. Significantly ($P<0.05$) better ADG of buffaloes post calving are in accordance with results observed in goats (Jiwuba et al., 2016; Meel et al., 2018). Scanty information is present pertaining to ADG of post calving buffaloes. Certain researchers revealed that daily yield was significantly ($P<0.05$) enhanced in lactating cows offered Moringa leaves, silage, or hay (Dong et al., 2019; Cohen-Zinder et al., 2017). Feeding MOLM improved milk production in Nili-Ravi buffaloes (Imran et al., 2016). Dairy production in cows increased when moringa was added as a protein supplement to low yield diets (Sanchez et al., 2006). In contrast to the current study, the amount of Moringa meal in dairy cows diet did not substantially alter their daily average milk yield (Mendita-Araica et al., 2011). The majority of the findings from past studies concur with the current findings. This research was also supported that the galactagogue property of Moringa leaves was resulted in increased milk production (Kumar, 2013). It can be inferred that increase in daily milk yield by increasing *Moringa oleifera* leaf meal in the ration of lactating Murrah buffaloes might be due to bypass protein property, which results in increased milk yield, as well as due to galactagogue property.

The MOLM supplemented treatments had significantly better milk fat percentage than control group. Babiker et al. (2016) concluded that ewes produced significantly more milk fat when alfalfa hay was supplemented with 25 percent *M. oleifera* leaf powder. In contrary to the results of current study, Tadeo et al. (2019) found that milk fat % showed no significant differences between treatments supplemented with MOLM. Present study revealed that 6% FCM yield was improved by MOLM supplementation in the daily ration of lactating buffaloes. It might be due to combined effect of increased daily milk yield as well as milk fat. According to Cohen-Zinder et al. (2016), lactating Holstein cows supplemented with ensiled *Moringa oleifera* with solid additives as a replacement for wheat silage and hay had higher yields of energy and fat corrected milk (ECM). Similarly, Imran et al. (2016) found that 4% FCM, solid corrected milk (SCM) were significantly better ($P<0.05$) in buffaloes fed Moringa hay as compared to *M. sativa* fed animals. Present results are in accordance with the findings of Babiker et al. (2016); Khalel et al. (2014) who reported that SNF% significantly ($P<0.05$) increased in the lactating animals fed with *Moringa oleifera*.

The results revealed significantly ($P<0.05$) higher total solid contents in milk in treatment groups fed ration differ significantly. The results of Tadeo et al. (2019) are consistent with these outcomes who concluded that total solids content in milk was significantly ($P<0.05$) improved in lactating buffaloes when the MOLM was increased in the diet. Khalel et al. (2014) observed that the total milk solids of cows fed the *M. oleifera*-based ration showed a significant increase ($P<0.05$) in comparison to those fed the berseem ration. Contrarily to present finding, few scientists (Imran et al., 2016; Sanchez et al., 2016) reported that total milk solids did not significantly differ between the Moringa fed and control diet. Feeding *M. oleifera* to dairy cattle given a base diet of *B. brizantha* hay had no negative effects on milk protein (Sanchez et al., 2016). Some researchers found

that feeding dairy cows higher levels of Moringa led to higher protein level in milk, which contradicts the findings of the current study (Tadeo et al., 2019; Khalel et al., 2014). In the current investigation, significantly ($P < 0.05$) better milk lactose (%) in milk was reported in supplemented group than the control treatment group. The results agree that inclusion of Moringa leaves in concentrate mixture increased milk lactose (Tadeo et al., 2019). Aerts (1999) also observed improved lactose in cows that were fed herbs containing moderate phenolic compounds (40 g/100 kg body weight). The increase in peak yield by increasing MOLM in the Murrah buffaloes' diet was because of the galactagogue's ability to improve daily milk production. Scanty research information is present on these production traits. The results indicated that strong relation was observed between production traits and MOLM supplementation.

Conclusion

In conclusion, Moringa supplementation in the ration of buffaloes enhances lactation performance, improving average milk yield, milk composition (fat, SNF, lactose, 6% FCM, and total solids), and production indices such as peak yield and its persistency. Both pre-partum and postpartum inclusion of Moringa leaf meal can be an effective strategy to boost buffalo productivity.

Conflict of Interest

The authors stated that they do not have any conflicts of interest or competing interests.

Acknowledgements

The authors are extremely grateful to the Vice Chancellor of LUVAS, Hisar, for his valuable assistance and cooperation in conducting this research.

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