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Effect of Moringa (*Moringa oleifera)* Dry Leaf Powder Supplementation on Production Performance and Economics of Lactating Rathi Cows

Himanshu Saini[1], Vijay Kumar[1], Abhishek Joshi[2], M.L. Choudhary[1]

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ABSTRACT

Background: The purpose of this study was to evaluate the effect of Moringa (*Moringa oleifera*) dry leaf powder supplementation on milk yield, composition and milk quality of lactating Rathi cows, as well as the economic impact of this intervention. Fifteen cows were selected from the herd of Rathi cattle of Livestock Research Station Bikaner, Rajasthan University of Veterinary and Animal Sciences, Bikaner, Rajasthan.

Methods: The animals were divided into three treatment groups based on nearness of their body weight, parity and lactation stage. Cows were fed with *Moringa oleifera* leaf powder supplement at the levels of 0 g (control, T_0), 10 g (T_1) and (T_2) 20 g per 100 kg bw/cow/day for 60 days (14 days of adjustment and 46 days of sampling period). Daily milk yield was recorded and samples were taken at every 7 day interval.

Result: The results of the study indicated that the milk fat, lactose, solid not fat and total solids per cent were found significantly higher ($P<0.01$), while lower somatic cell count ($P<0.05$) reported in the supplemented groups when compared with control group. No significant difference was observed in milk yield and milk protein in the moringa supplemented groups. The treatment groups supplemented with moringa also had higher economic efficiency.

Key words: Economics, Milk composition, Milk yield, *Moringa oleifera*, Rathi cows.

INTRODUCTION

India is the world's largest livestock population holding country. In India, livestock is an integral component of agricultural production system and it makes a multifactorial contribution to the growth and development of this sector. Rathi is an important breed of cattle that is mainly found in Rajasthan's desert regions. It is a dual-purpose indigenous cattle breed; nowadays considered a milch breed. Rathi cattle are well known for their ability to withstand the harsh agro-climatic conditions in Rajasthan's arid and semi-arid zones and have a high potential for milk production even in dry conditions (Chouhan *et al*., 2021). The lactation length of Rathi cattle varies between 280-340 days; the lactation yield ranges between 1,100 to 3,000 liters; dry period is 116 to 178 days and the peak yield is 6 to 10 liters (Purohit and Sharma, 2001).

In tropical livestock production systems, Underfeeding is one of the most significant constraints due to the limited availability of high quality feed and fodder (Pfister and Baccini, 2005; Olafadehan and Adewumi, 2009). These limitations led to low milk production and growth rates, which resulted in lower farmer income (Olafadehan and Adewumi, 2008; de Leeuw *et al*., 1999). This is especially noticeable during the dry season, when natural pastures are mature and dry, with low nutritional value. During the dry season, concentrate feeding levels are also low because it is typically unaffordable to supplement with conventional concentrates (de Leeuw *et al*., 1999). As a result, there is a need to find a replacement, cost efficient supplements that can be grown by dairy farmers and are accessible all year. This will aid farmers in raising the nutritional status of dairy animals in tropical regions, which will enhance the financial health of the dairy production system (Mendieta-Araica *et al*., 2011). In the recent years, Moringa is being considered to be used as an effective alternative to conventional diets for livestock. The remarkable nutritional and phytochemical composition of *Moringa oleifera* along with low amount of anti-nutritional factors, makes it suitable for animal feed. It has long been known that the plant moringa (*Moringa oleifera*) is an excellent source of protein for raising livestock (Rizwan *et al*., 2022). Moringa is known for its medicinal

[1]Department of Livestock Production and Management, College of Veterinary and Animal Science, Rajasthan University of Veterinary and Animal Science, Bikaner-334 001, Rajasthan, India.
[2]Livestock Research Station, Bikaner-334 001, Rajasthan, India.

Corresponding Author: Vijay Kumar, Department of Livestock Production and Management, College of Veterinary and Animal Science, Rajasthan University of Veterinary and Animal Science, Bikaner-334 001, Rajasthan, India.
Email: drvijaybishnoi29@gmail.com

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benefits. Its leaves are rich in vitamins minerals and proteins. The leaves as well as the fruits of this tree are used to cure several diseases (Selmi *et al*., 2020). The most widely cultivated tree species in the *Moringaceae* family is *Moringa oleifera* an Indian native plant, which is very nutritive and grows in tropical and subtropical climates worldwide (Bellostas *et al*., 2010).

The *Moringa oleifera* is recognised as a potential non-traditional fodder due to the presence of high nutrient content and low levels of anti-nutritional factors. Moringa is also known by various local names such as Saijihan, Sajna, Drumstick tree, Horseradish tree, Benzolive, Kelor, Marango, Mlonge and Mulangay (Fahey, 2005). Moringa has a variety of essential nutrients *i.e.* vitamins, minerals, amino acids, beta-carotene, anti-oxidants, anti-inflammatory nutrients and omega-3 and omega-6 fatty acids (Fahey, 2005; Hsu *et al.,* 2006; Kasolo *et al.,* 2010). Many researchers examined the impact of *Moringa oleifera* leaves on the production and reproduction performance, physiological and biochemical profiles of goats, sheep and chickens. However, there aren't many reports on the effects of *Moringa oleifera* leaf supplementation in large ruminants especially in Rathi cows; thus the current study was carried out to examine the impact of *Moringa oleifera* dry leaf powder supplementation on the production performance of lactating Rathi cows.

MATERIALS AND METHODS

The study was undertaken at the Livestock Research Station Bikaner, Directorate of Research, Rajasthan University of Veterinary and Animal Sciences, Bikaner, which is situated at northwest semiarid region of Rajasthan. Fifteen lactating Rathi cows were selected at the Livestock Research Station and divided into three treatment groups, each with five cows. The cows were allotted to different treatment groups based on nearness of their body weight (avg. 348.8 kg), parity and lactation stage. Experimental Rathi cows were reared in a loose housing system and fed a basal diet with concentrate (Saras Gold, a product of Rajasthan Cooperative Dairy Federation), roughage (ground nut fodder and wheat straw) and seasonal green fodders with mineral mixture and common salt. Concentrate and supplemented feed was fed to experimental cows at milking time individually. The hand milking method was adopted for milking animals in the morning and afternoon at 5:00 AM and 4:00 PM, respectively.

Sixty days trial was conducted consisting of 14 days of adjustment and 46 days of sampling period to evaluate the effect of Moringa (*Moringa oleifera*) dry leaf powder supplementation on lactating Rathi cattle. In control group (T_0), cows were fed a basal diet without any Moringa supplementation. However, cows in T_1 and T_2 groups were fed a basal di*et al*ong with *Moringa oleifera* dry leaf powder supplementation @ 10g and 20 g per 100 kg body weight, respectively. The nutritional requirements of cows were met as per NRC (2001). *Moringa oleifera* supplementation was given at the time of milking and clean water was supplied ad libitum. A good quality moringa (*Moringa oleifera*) dry leaf powder was procured from a recognised firm in Bikaner City (Rajasthan) in the required quantity. The chemical composition of the concentrate mixture and Moringa leaf powder on a per cent dry matter basis was estimated as per AOAC (2005) and has been presented in Table 1.

Individual milk yield was measured twice a day, at 5:00 AM and 4:00 PM, using a digital weighing machine at each milking. Milk samples were collected aseptically from all experimental cows at every 7day interval on the 15th, 22nd, 29th, 36th, 42nd, 56th and 60th days of the experimental period. Approximately 200 ml of milk from all four quarters was collected in a sterilized vial. Milk compositions (percentage of Milk fat, protein, lactose, SNF and total solids) were estimated using an automatic milk analyzer (LactoScope FT-A). The somatic cell count in milk was carried out as explained by Schalm *et al*. (1971). While, milk smears were stained with Giemsa stain.

In the present experimental design, the collected data were subjected to the one-way ANOVA method of statistical analysis described by Snedecor and Cochran (2004). Wherever the variance ratio (F-values) was found significant at 05% and 01% levels of probability, the significance of mean differences was tested by Duncan's new multiple range test (DNMRT) as modified by Kramer (Kramer, 1956).

RESULTS AND DISCUSSION

The results of the present investigation showed (Table 2) an increasing trend in daily average milk yield in both *Moringa oleifera* leaf powder supplemented groups during the experimental period, but no significant difference ($P>0.05$) was found in overall daily average milk yield between the control and supplemented groups. The overall daily average milk yield (Kg) was found 7.81, 8.1 and 8.26 in T_0, T_1 and T_2 groups, respectively. This beneficial effect of *Moringa oleifera* dry leaf powder supplementation on production performance might be due to improved feed intake, apparent nutrient digestibility and ruminal fermentation conditions (Mendieta-Araica *et al.,* 2011; Cohen-Zinder *et al.,* 2016; Kholif *et al.,* 2018). The higher milk production in cows fed *M. oleifera* was due to its high anti-oxidative activity (associated with its high phenolic components), which has beneficial effects on productive ruminants (Cohen-Zinder *et al*., 2016). The possible reason for an increase in milk yield was increased propionic acid

Table1: Chemical composition of concentrate mixture and *Moringa oleifera* dry leaf powder (%DM basis).

Nutrients%	Concentrate mixture (Saras Gold)	*Moringa oleifera* Dry leaf powder
Dry matter	89	90.86
Crude protein	20	24.81
Crude fiber	10	10.62
Ether extract	4	4.4
Total ash	9.1	9.8
Nitrogen free extract	45.9	50.37

Table 2: Effect of *Moringa oleifera* leaf powder supplementation on milk yield, milk composition and economics of lactating Rathi cows.

Parameters	Control (T0)	T1	T2	P- value
Milk yield (kg/day/cow)	7.81±0.2	8.1±0.223	8.26±0.378	0.5198
Milk composition%				
Fat	3.74^{a}±0.10	3.98^{b}±0.07	4.15^{b}±0.04	0.009458**
Protein	3.37±0.04	3.46±0.07	3.56±0.04	0.0834
Lactose	4.59^{a}±0.05	4.86^{b}±0.02	5.11^{c}±0.05	7.04E-06**
Solid Not Fat	8.78^{a}±0.03	8.85^{a}±0.08	9.06^{b}±0.05	0.017675*
Total solids	12.63^{a}±0.06	12.88^{b}±0.08	13.15^{c}±0.07	0.000699**
Somatic cell count (SCC×10^{3}/ml)	175.85^{b}±10.87	146.91^{ab}±10.77	133.49^{a}±9.48	0.038225*
Economics				
Avg. feed cost (Rs./day)	1308.8	1383.2	1427.4	
Average milk production (kg/day)	39	40.5	41.3	
Income from sale of milk (Rs./day)	1540.5	1640	1693	
Profit/day	231.7	256.8	265.6	
Profit/kg of milk/day	5.9	6.3	6.4	
Relative economic efficiency	100%	106%	108%	

Note- Means bearing different superscript in a raw (small letter a, b, c) differ significantly. Asterisks indicate level of significance (**P<0.01, *P<0.05).

concentrations in the rumen when the animal was fed *Moringa oleifera* because propionate is the precursor for gluconeogenesis and lactogenesis. A curvilinear increase in milk yield was seen when glucogenic precursors were increased (Rigout *et al*., 2003).

The percent of milk fat, lactose and total solids was reported significantly higher (P<0.01) in both T_1 and T_2 groups as compared to the control group, while SNF was found significantly higher (P<0.05) in T_2 group as compared to T_1 and T_0 groups. Cows supplemented with Moringa dry leaf powder had no significant impact (P>0.05) on milk protein per cent. The increased milk fat per cent in Moringa supplemented groups might be due to enhanced fiber digestibility (Kholif *et al.*, 2015). This increased fiber digestibility leads to an increase in ruminal acetate concentration, which is the precursor for fat biosynthesis (Linn, 1988).

The higher milk lactose percent observed in the present investigation could be attributed to enhanced organic matter digestibility and ruminal propionate concentrations (Kholif *et al.,* 2018). According to Vanhatalo *et al*. (2003), higher ruminal propionate concentrations result in an increase in lactose synthesis. The biosynthesis of lactose is primarily dependent on the concentration of propionate, which is the main gluconeogenic volatile fatty acid. The volatile fatty acid proportion in the rumen might be altered due to the positive effects of *Moringa oleifera* leaves and their secondary metabolites, which hinder the growth of Gram-positive bacteria and favors the propionate-producing bacteria species and ultimately lead to an increased propionate proportion in the rumen (Wallace *et al.*, 2002). The unaffected protein content in milk by including *Moringa oleifera* in the diet of dairy cows was probably due to supply of optimum levels of fiber and protein in the basal diets (Kholif *et al*., 2015; Babiker *et al*., 2017; Choudhary *et al.,* 2018 and Zhang *et al*., 2018).

The SCC in milk of rathi cows was significantly lower (P<0.05) in T_2 group as compared to T_0 groups, but no significant variation (P>0.05) was observed between T_1 and T_0 groups. The T_2 group had the lowest overall mean SCC×10^{3}/ml of milk, followed by the T_1 and T_0 groups, with values of 133.49, 146.91 and 175.85, respectively. The lower SCC counts in cows fed Moringa leaf powder supplement in the present study might be due to increase in milk antioxidant capacity. This might be attributed to the beneficial synergistic interactions between the high antioxidant nutrients, phenolic compounds and flavonoids found in *Moringa oleifera* leaves. The functional antioxidants like flavonoids, phenolics, Vitamin E and Se found in *Moringa oleifera* leaves also induce anti-inflammation activities in the mammary gland (Kekana *et al.*, 2020). Lactating dairy cows given a flavonoids-rich herbal supplement showed a decrease in the incidence of mastitis. (Hashemzadeh-Cigari *et al.,* 2014).

According to the economics of the experiment, *Moringa oleifera*-supplemented groups had higher profits compared to the control group due to an increase in milk yield and milk total solids during the experiment period. The per day profit (Rs.) was found to be 231.7, 256.8 and 265.6 in the T_0, T_1 and T_2 groups, respectively. Relative economic efficiency was also higher in both Moringa dry leaf powder supplemented groups than in the control group. In comparison to the control group, relative economic efficiency was 8% and 6% higher in the T_2 and T_1 groups, respectively. Shankhpal *et al.* (2019) also observed that replacing hybrid Napier with Moringa fodder results in an increased average net daily income of 46.21 rupees (P<0.01). According to Sonkar *et al.* (2020), feeding cost per kg milk production

were reduced in *Moringa oleifera* supplemented groups as compared to control group and the profit from sales of milk was increased in moringa-supplemented groups compared to control group with the improved economic efficiency of T_1 and T_2 groups by 8 % and 19%, respectively.

CONCLUSION

The present study concludes that *Moringa oleifera* is a highly nutritious plant that contains various antioxidant properties, vitamins, minerals, fatty acids and amino acids which have reflected in the improvement in milk yield, milk composition and milk quality by reducing SCC; thus improving net daily income of dairy farmers. Therefore, *Moringa oleifera* can be recommended as a supplement in the diets of lactating Rathi cows.

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Conflict of interest

The authors declare that they have no conflict of interest.

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