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Effect of Feeding *Moringa oleifera* Replacing TMR on Nutrients Intake, Rumen Fermentation and Economics in Adult Cattle

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ABSTRACT

A study was undertaken at Animal Nutrition Research Station, College of Veterinary Science & Animal Husbandry, Anand Agricultural University, Anand, Gujarat, India during January–March, 2020 to determine effect of feeding *Moringa oleifera* on nutrient intake, rumen fermentation and economics in adult cattle. Fourteen adult cattle were randomly divided into two groups on the basis of body weight viz., T_1 (control): TMR (Wheat straw-70% and Concentrate-30%) and T_2 (Treatment): Control TMR+Green *Moringa oleifera* (replacing TMR with 20% of total protein requirement of animal from green *Moringa oleifera*). The daily dry matter intake (kg), crude protein intake (g), digestible crude protein intake (g), TDN intake (kg) was found non-significant in both the groups, whereas dry matter intake and TDN intake (kg 100 kg^{-} BW and g kg^{-1} W$^{0.75}$) were significantly higher in control group. The crude protein intake (g 100 kg^{-1} BW) and DCP intake (g 100 kg^{-1} BW and g kg^{-1} W$^{0.75}$) were significantly higher in *Moringa* supplemented group. The average ruminal pH, ammonical nitrogen (NH_3-N) (mg dl^{-1}), Non-protein nitrogen (NPN) (mg dl^{-1}), soluble nitrogen (mg dl^{-1}) and TCA precipitable nitrogen (mg dl^{-1}) were found non-significant. However, the concentration of TVFA (mM dl^{-1}) and total nitrogen (mg dl^{-1}) were significantly higher in *Moringa* supplemented group. The daily feed cost was reduced by 8.93% in *Moringa oleifera* supplemented group but statistically the difference was found non-significant.

KEYWORDS: Cattle, *Moringa oleifera*, nutrient intake, rumen fermentation

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1. INTRODUCTION

The non-availability or changing quantity and quality of year-round green fodder supply is one of the primary limitations for dairy production in India. The farmers generally fed crop wastes and low-quality straw/hay to their animals, which are low in nitrogen, high in lignocellulose, and deficient in minerals and vitamins, resulting in poor digestibility and voluntary feed intake (Sultana et al., 2015). The use of fodder plants and shrubs could be a viable approach for increasing productivity. *Moringa oleifera* (*M. oleifera*), is known as the "miracle tree", and grows globally in almost all tropical and subtropical regions, but it is believed to be native to Afghanistan, Bangladesh, India, and Pakistan (Fuglie et al., 1998). The *Moringa* family comprises 13 species (*M. oleifera*, *M. arborea*, *M. rivae*, *M. ruspoliana*, *M. drouhardii*, *M. hildebrandtii*, *M. concanensis*, *M. borziana*, *M. longituba*, *M. pygmaea*, *M. ovalifolia*, *M. peregrina*, *M. stenopetala*), of which *M. oleifera* has become well known for its use in nutrition, biogas production, fertilizer, etc., (Gandji et al., 2018, Chaudhary and Chourasia, 2017). The *Moringa* (*Moringa oleifera*) tree is a drought-tolerant, fast-growing, multi-purpose tree that has been dubbed a "wonder tree" because of its medicinal and nutritional benefits (Ashfaq et al., 2012, Meel et al., 2018). *Moringa oleifera* leaves have a high biological value and have lot of potential for being used as ruminant fodder (Pradhan, 2016). It is a multipurpose tree that is grown in India for both human and animal feed (Anjorin et al., 2010). *Moringa oleifera* with a cutting frequency of 40 days, it may produce large quantity of fresh biomass per unit area, with a dry matter yield ranging from 4.2–8.3 t ha^{-1} (Nouman et al., 2014, Mariswamy et al., 2017). The *Moringa* leaves are commonly thought of as a protein source and protein content varies from 15–30% (on dry matter basis), depending on the stage of maturity and the proportions of leaflets, petioles, and stems in the fodder. It is high in protein, amino acids, fatty acids, minerals, vitamins, calcium, potassium, various phenolic and oxycaroteniod, which are the basic building blocks of the animal body (Deshmukh, 2014). *Moringa* leaves are high in iron, potassium, calcium, and multivitamins, all of which are necessary for livestock weight gain and milk production (Mendieta-Araica et al., 2011). Because of their excellent balanced amino acid composition and high digestible protein content, *Moringa* (*Moringa oleifera*) leaves have drawn the attention of ruminant nutritionists as a source of protein (Babiker et al., 2017). Moreover, antifertility, cardiotonic, anticancerous, antianthelmintic, antitubercular, antispasmodic, abortifacient, antilithic, anti-inflammatory, and antimicrobial phytochemicals with high potency were found in *Moringa* (*Moringa oleifera*) leaves and other parts of the *Moringa* (*Moringa oleifera*) trees (Sholapur and Patil, 2013). *Moringa* (*Moringa oleifera*) has been used in the diets of many different animals as a fresh forage. The fresh *Moringa* in dairy cow meals has also yielded positive results, as *Moringa* leaf meal used as a protein source in concentrate (Sánchez et al., 2006; Mendieta-Araica et al., 2011). Keeping above facts in mind the experiment was designed to study the effect of feeding whole *Moringa oleifera* plant to the adult cattle on different parameters like nutrients intake, nutrients digestibility, rumen fermentation parameters and economic of feeding.

2. MATERIALS AND METHODS

A Study of 75 days on fourteen adult cattle was carried out at Animal Nutrition Research Station, College of Veterinary Science & Animal Husbandry, Anand Agricultural University, Anand, Gujarat, India during January–March, 2020. On the basis of body weight the cattle were randomly divided into two dietary treatments viz., T_1 control group fed control TMR (Table 1) and T_2 fed Control TMR+Green *Moringa oleifera* (replacing 20% of total protein requirement of animal from green *Moringa oleifera*).

Table 1: Ingredient composition of total mixed ration (TMR) offered with cost (₹ kg^{-1})

Ingredient	Proportion	Cost
Wheat Straw	70	6.50
Maize	05	14.77
Soyabean	07	34.00
DORB	07	13.65
Molasses	10	13.00
Mineral Mixture	01	120.00
Total	100	
Moringa oleifera (green)		3.00
Cost of TMR (₹ kg^{-1})		11.12

*Rovimix @ 0.06 kg 100 kg^{-1} feed

The nutrient requirements of cattle in terms of crude protein (CP) and total digestible nutrients (TDN) were met as per ICAR (2013) feeding standards and individual feeding of all the experimental cattle was followed. The animals were housed in sheds with proper ventilation, flooring and tying arrangements with facility of individual feeding. They were let loose daily (except during the period of digestion trial) in an open paddock, for two hours in the morning and two hours in the afternoon under controlled conditions for exercise and to access fresh wholesome drinking water. De-worming of all the cattle was carried out using broad spectrum anthelmintic before initiation of the experiment. The experimental cattle were weighed at biweekly intervals in the morning (8.00 a.m.), before feeding and watering. At the final stage of the feeding experiment a digestion trial was conducted on all the fourteen experimental animals. The arrangement for quantitative collection of faeces and leftover was made during the digestion trial of 7 days. A proper record of feed consumed, refusal and faeces voided by each cattle was maintained during the entire digestion trial period. An analysis of the collected samples was carried out using Anonymous (1995) methods. The data were analyzed following two factorial completely randomized design described in Snedecor and Cochran (1994).

3. RESULTS AND DISCUSSION

3.1. Nutrients composition

The proximate composition of the TMR and *Moringa oleifera* offered to experimental cattle are presented in Table 2. The TMR and *Moringa oleifera* contained 7.55 and 29.43% crude protein, 1.85 and 5.20% ether extract, 33.03 and 13.73% crude fibre, 13.53 and 9.87% total ash, 44.04 and 41.77% NFE, 58.84 and 33.28% NDF, 38.72 and 21.06% ADF, 29.07 and 14.19% cellulose and 20.12 and 12.22% hemicellulose, respectively. Similarly, Elaidy et al. (2017) reported 28.00% CP in *Moringa oleifera*. However, Sonkar et al. (2020) reported that *Moringa oleifera* contained 22.07% CP.

Table 2: Proximate composition (%) of TMR and *Moringa oleifera*

Parameters	TMR	*Moringa oleifera*
CP	7.55	29.43
EE	1.85	5.20
CF	33.03	13.73
NFE	44.04	41.77
Total ash	13.53	9.87
OM	86.47	90.13
NDF	58.84	33.28
ADF	38.72	21.06
Cellulose	29.07	14.19
Hemicellulose	20.12	12.22
Lignin	13.01	9.72

3.2. Dry matter and nutrients intake

The average data for nutrients intake of cattle are presented in Table 3.

During experiment daily dry matter intake (kg) was reported non-significant but in terms of kg 100 kg^{-1} BW and g kg^{-1} W$^{0.75}$ were significantly (p<0.05) higher in control (1.98±0.02, 89.25±0.93) group than *Moringa* supplemented group (1.81±0.01, 80.86±0.54), respectively. Mendieta -Araica et al. (2011) and Khalel et al. (2014) reported no effect on DM intake (kg d^{-1}) by feeding fresh *Moringa*. Bashar et al. (2020) also reported non-significant difference on DM intake (kg d^{-1}) in cow fed *Moringa*, whereas DM intake (kg 100 kg^{-1} body weight) increased significantly in treatment groups. The CP intake (g d^{-1} and g kg^{-1} W$^{0.75}$) were reported non-significant but CP intake g 100 kg^{-1} BW was significantly (p<0.05) increased in treatment group (142.66±0.76) than the control group (139.33±1.38). Bashar et al. (2020) also reported non-significant effect on CPI (g d^{-1}) but significant reduction in CP intake (g kg^{-1} W$^{0.75}$). The average DCP (g d^{-1}) and TDN intake (kg d^{-1}) of cattle T_1 and T_2 groups were 306.77±3.90, 337.21±2.47 and 4.25±0.05, 3.82±0.03, respectively which did not differ from each other. Similar value was reported by Khalel et al. (2014). However, DCP intake g 100 kg^{-1} BW and g kg^{-1} W$^{0.75}$ were significantly (p<0.05) higher in *Moringa* supplemented group. The TDN intake kg 100 kg^{-1} BW and g kg^{-1} W$^{0.75}$ were significantly (p<0.05) higher in control group. Elaidy et al. (2017) reported higher TDN intake (kg d^{-1}) in suckling buffalo calves.

Table 3: Dry matter and nutrients intake of experimental cattle

Particulars	T_1	T_2
No. of animals	7	7
Dry matter intake		
Kg d^{-1}	8.21±0.10	7.36±0.06
Kg 100 kg^{-1} BW	1.98^{a}±0.02	1.81^{b}±0.01
g kg^{-1} W$^{0.75}$	89.25^{a}±0.93	80.86^{b}±0.54
CP intake		
g d^{-1}	575.23±7.32	579.11±4.24
g 100 kg^{-1} BW	139.33^{b}±1.38	142.66^{a}±0.76
g kg^{-1} W$^{0.75}$	6.24±0.06	6.36±0.04
DCP intake		
g d^{-1}	306.77±3.90	337.21±2.47
g 100 kg^{-1} BW	74.30^{b}±0.73	83.07^{a}±0.44
g kg^{-1} W$^{0.75}$	3.33^{b}±0.04	3.70^{a}±0.02
TDN intake		
kg d^{-1}	4.25±0.05	3.82±0.03
kg 100 kg^{-1} BW	1.03^{a}±0.01	0.94^{b}±0.01
g kg^{-1} W$^{0.75}$	46.21^{a}±0.48	41.98^{b}±0.28

Means with different superscripts (a and b) in row differed significantly (p<0.05)

3.3. Rumen fermentation parameters

The average data for rumen fermentation parameters of experimental cattle are presented in Table 4.

Table 4: Rumen fermentation parameters

Particulars	T_1	T_2
No. of animals	7	7
pH	7.00±0.08	7.00±0.04
TVFA (mM dl^{-1})	12.25^b±0.64	13.24^a±0.83
Total N (mg dl^{-1})	90.53^b±2.61	97.30^a±4.90
NH_3-N (mg dl^{-1})	12.13±1.03	11.66±1.53
NPN (mg dl^{-1})	28.23±1.46	26.48±0.31
Soluble N (mg dl^{-1})	39.20±4.20	43.16±4.17
TCA precipitable N (mg dl^{-1})	51.33±1.83	54.13±3.03

Means with different superscripts (a and b) in row differed significantly (p<0.05)

The ruminal pH was statistically similar in both the groups. Li et al. (2019) also reported non-significant on ruminal pH in cows when alfalfa hay was replaced by 10.85% *Moringa oleifera*. Similarly, Zinder et al. (2016) also reported same results in lactating cows fed *Moringa oleifera* silage. However, total volatile fatty acids concentration (mM dl^{-1}) and total nitrogen (mg dl^{-1}) were significantly higher in *Moringa* supplemented group than the control group. Bashar et al. (2020) reported significantly higher TVFA (meq 100 ml^{-1}) concentration in cows fed different levels of *Moringa* feed (50 and 100%, 14.7 and 16.9 meq 100 ml^{-1}, respectively). The NH_3-N (mg dl^{-1}) concentration was statistically similar among the groups. However, Khalel et al. (2014) and Li et al. (2019) were reported significant reduction in concentration of ammonia nitrogen in *Moringa* supplemented groups. The NPN (mg dl^{-1}), soluble nitrogen (mg dl^{-1}) and TCA precipitable nitrogen (mg dl^{-1}) were not differed significantly among the groups. Lunagariya and Pande (2016) reported non-significant effect on NPN (mg dl^{-1}), soluble nitrogen (mg dl^{-1}) and TCA precipitable nitrogen (mg dl^{-1}) concentration by feeding different level of Lucerne straw based TMR (50, 60 and 70%) in crossbred bullock.

3.4. Economics of feeding

The average data for total feed cost and daily feed cost are presented in Table 5.

Table 5: Cumulative feed consumption, total feed cost and daily feed cost

Attributes	T_1	T_2	
		TMR	*M. oleifera*
Cumulative feed consumption (kg)	638.12± 57.08	541.57 ±66.33	146.55± 13.93
Total feed cost (₹)	7095.86± 634.72	6022.29 ±737.57	439.64± 41.80
Daily feed cost (₹ $animal^{-1}$ d^{-1})	94.61± 8.46	86.16± 10.39	

The total feed cost (₹) in T_1 and T_2 were 7095.86±634.72 and 6461.93±779.14, respectively, which was 8.93% lower in T_2 group as compared to control (T_1) with non-significant difference. The daily feed cost (₹ $animal^{-1}$ d^{-1}) in T_1 and T_2 groups were 94.61±8.46 and 86.16±10.39, respectively and the values were lower in treatment group than control group but again with non-significant difference. Similarly, Shankhpal et al. (2019) reported that daily feed cost was decreased significantly when hybrid napier was replaced by green *Moringa* in dairy cows. Sonkar et al. (2020) also reported significantly lower feed cost kg^{-1} milk production in dairy cows when concentrate was replaced by dried *Moringa oleifera* leaves at different level (10 and 20%).

4. CONCLUSION

The supplementation of *Moringa oleifera* in cattle had no adverse effect on dry matter, crude protein and TDN intake. The concentration of TVFA and total nitrogen were higher in *Moringa oleifera* supplemented group than control group. The values for other rumen parameters *viz.*, pH, ammonical N, NPN, soluble N and TCA precipitable N were found to be non-significant in both the groups. The daily feed cost was reduced by 8.93% in *Moringa oleifera* supplemented group than control group.

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