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# Effect of feeding different levels of *Moringa oleifera* leaves on digestibility of nutrients in Sirohi goat kids

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**Abstract**
A six months study was conducted on 40 Sirohi goat kids to evaluate the effect of feeding different levels of *Moringa oleifera* leaves on digestibility of nutrients. The sirohi goat kids were randomly distributed in five groups of eight in each group on the basis of age and uniform conformation. The group $T_1$ offered 60% Methi straw (*Trigonella foenum-graecum*) as a roughage and 40% commercially available readymade concentrate feed and in groups $T_2$, $T_3$, $T_4$ and $T_5$, the commercially available readymade concentrate feed were replaced by *Moringa oleifera* leaves at 25%, 50%, 75% and 100% levels, respectively. During entire period of experiment, measured quantity of feed were provided to each animal every morning and the left over were weighted in next morning to assess daily consumption. At the end of feeding trial, the digestibility trials were conducted by conventional type collection method for estimation of digestibility of the different nutrients. Results showed that the dry matter intakes and digestibility coefficient of DM, CP, NFE were significantly higher ($P$<0.05) in group $T_4$. The digestibility coefficient of EE and CF were non-significant ($P$<0.05). It can be concluded that feeding of *Moringa oleifera* leaves replacing commercially available concentrate feed at 75% level to improve digestibility of dry matter and gross nutrients in Sirohi goat kids.

**Keywords:** Goat, Moringa leaves, feed intake, digestibility

## Introduction
India's livestock sector is one of the largest in the world with a holding of 11.60 per cent of world livestock population which consist buffalo (57.83 per cent), cattle (15.06 per cent), goat (17.93 per cent), sheep (7.14 per cent) camel (2.18 per cent), equine (1.30 per cent), pig (1.20 per cent), chicken (4.72 per cent) and ducks (1.94 per cent). There are 135.17 million goats. 26.40 per cent of total livestock population out of which 16.03 per cent goats found in the state of Rajasthan (Indian Livestock Census - 2012). India has huge livestock population of 512 million. Livestock sector contribution was 4.5 per cent at current prices of total GDP of India during 2015-16 (National Accounts Statistics-2017: Central Statistical Organization: GoI).
The country is endowed with cattle (40), buffalo (13), sheep (42), and goat (26) breeds (NBAGR. 2016). Sirohi is the predominant goat breed of Rajasthan which accounts for 60% of Rajasthan's total goat population (Animal Husbandry Department Rajasthan. 2016). It is commonly found in arid and semi-arid region along the most parts of aravali hills of Rajasthan. Goats are very adaptable and versatile animal and they can thrive on diverse types of grasses and tree leaves. It is also well known that goat is superior to other ruminants in efficiency of nutrient utilization.
Fodder, the mainstay for livestock rearing, is cultivated on only four per cent of the total cultivable land in India and this figure has remained more or less static for the last three decades. The denuded grasslands, pastures, forest openings and the forests are the major source of herbage for livestock. The 1993 draft report of the Policy Advisory Group on Integrated Grazing Policy, Ministry of Environment and Forests, Government of India indicated that the deficit was 584 and 745 million tones of dry and green fodder, respectively. The present level of availability of animal feeds indicates a deficiency of about 19 per cent DM, 55 per cent DCP and 28 per cent TDN for feeding the existing livestock population.
A major constraint to animal production in developing countries is the scarcity and fluctuating quantity and quality of the year-round feed supply.

These countries experience serious shortages in animal feeds of the conventional type (Singh and Makkar. 2014) [25]. Usually, farmers tried to feed their animals through crop residues and poor quality hay that are little in nitrogen, high in lingo-cellulose (Sultana *et al.* 2014) [26] and poor in vitamin and mineral contents, which leads to low digestibility and reduced voluntary intake (Gerbregiorgis *et al.* 2012). Utilization of fodder trees and shrubs could be a potential strategy for increasing the quality and availability of feeds for resource-limited livestock farmers during the dry season. The trees provide a good and cheaper source of protein and micronutrients (Moyo *et al*. 2012) [19].

*Moringa oleifera* is a relatively fast growing tree of Indian tropical and sub-tropical regions providing a large biomass for the feeding of livestock as top feed and give dry matter yield from 4.2 to 8.3 ton per hectare with a cutting frequency of 40 days interval. Moringa has different names in different countries like "drumstick tree" or "horseradish tree" in India and "Shiferaw" in Ethiopia (Fahey. 2005) [10], 'Cabbage tree', 'benoil tree' or 'benzoil tree', 'miracle tree' and 'mother's best friend tree' (Koul and Chase. 2015) [17]. There are about 33 species of Moringaceae family. *Moringa oleifera* is one of the Moringaceae families (Arora *et al.* 2013) [5].

*Moringa oliefera* tree is a drought-tolerant, fast-growing, multi-purpose and one of most useful tree due to its medicinal and nutritional properties in world and therefore described as a 'miracle tree' (Fuglie. 2003, Amaglo. 2006, Yisehak *et al*. 2011, Ashfaq *et al*. 2012) [11, 3, 32, 7]. *Moringa oleifera* dry leaves contain 9 times proteins than yogurt, 10 times vitamin A than carrot. 25 times iron than spinach, 15 times potassium than bananas, 17 times calcium than milk and 7 times more vitamin C than orange (Rockwood *et al*. 2013) [24]. Moringa leaves are a storehouse of nutrients. Moringa leaves contain fiber, fat, proteins, minerals, vitamin A, B, C, D and E, amino acids, Phytochemicals and flavonoids (Mbikay. 2012, Fuglie. 2005, Ijarotimi *et al*. 2013, Choudhary *et al*. 2013, Jung. 2014) [4, 7, 5, 8]. On a dry matter basis, *Moringa oleifera* leaves contain 27.2% protein, 17.1% fat, 5.9% moisture and 38.6% carbohydrates. (Yameogo *et al*. 2011) [31].

Keeping the aforesaid facts in view, the present investigation was planned to find out the effect of different levels of *Moringa oleifera* leaves feeding on feed intake and digestibility of nutrients in sirohi goat kids.

## Material and Method

Forty Sirohi goat kids were selected on the basis of age and uniform conformation from the Livestock Research Station, Bojunda, Chittorgarh. They were divided into five groups with eight kids in each group using completely randomized block design. All the experimental kids were housed separate from other animals in well ventilated and protected shed and provided individual feeder and water buckets. All kids were managed under standard caring, feeding and management practices. The kids were allowed 10 days of adjustment period prior to experimental feeding. All the Experimental kids were dewormed at the beginning of experiment by using Albendazole as an anthelmintic and were examined periodically for parasitic infestation. Kids did not show any symptoms of clinical ailment or external injury and were looked quite healthy during whole experimental period. Methi straw (*Trigonella foenum-graecum*) were used as a roughage, commercially available readymade feed were used as a concentrate feed and *Moringa oliefera* dry leaves were used as a experimental feed for feeding of sirohi goat kids. *Moringa oliefera* leaves were harvested from the moringa plots of the Livestock Research Station, Bojunda, Chittorgarh. The collected moringa leaves were sun dried on thick plastic sheets and used for feeding. The group $T_1$ offered roughage and commercially available readymade concentrate feed in ratio of 60:40 and groups $T_2$, $T_3$, $T_4$ and $T_5$, the readymade concentrate feed were replaced by *Moringa oleifera* leaves at 25%, 50%, 75% and 100% levels, respectively. Feeding trials of Twenty six weeks were conducted for all the treatment groups. At the end of feeding trial, the digestibility trials were conducted by conventional type collection method for estimation of digestibility of dry matter and gross nutrients.

### Statistical analysis

Analysis of variance of the data obtained in the experiment was conducted based on a completely randomized block design. The differences in the means were compared by least significant differences at 5% level ($P$<0.05).

## Results and Discussion

### 1. Digestibility of dry matter

The per cent values of digestibility coefficient of dry matter of each goat kids from all the groups have been presented along with analysis of variance in Table 1 and 2.

**Table 1:** Average dry matter digestibility coefficient of goat kids in experimental groups

| Animal No. | Treatment groups | | | | |
|---|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | $T_4$ | $T_5$ |
| 1 | 53.00 | 56.83 | 56.96 | 62.26 | 58.21 |
| 2 | 54.13 | 56.80 | 57.39 | 61.67 | 58.04 |
| 3 | 56.00 | 55.91 | 52.73 | 62.48 | 60.00 |
| 4 | 54.26 | 57.24 | 64.09 | 63.33 | 60.97 |
| 5 | 53.96 | 56.64 | 68.89 | 66.10 | 59.21 |
| 6 | 54.82 | 56.98 | 64.17 | 60.87 | 61.21 |
| 7 | 57.78 | 54.35 | 55.52 | 65.77 | 60.50 |
| 8 | 60.10 | 59.62 | 62.42 | 65.50 | 60.68 |
| Mean ± SE | 55.51±0.84[a] | 56.80±0.52[b] | 60.27±1.93[b c] | 63.50±0.72[c] | 59.85±0.43[b c] |

**Table 2:** Analysis of variance of digestibility coefficient of dry matter

| Source of variance | Df | SS | MSS | F – value |
|---|---|---|---|---|
| Treatment Error | 4 | 315.76 | 78.939 | 9.185* |
| | 35 | 300.8 | 8.594 | |

* Significant difference ($P$<0.05)

The mean values of digestibility coefficient of dry matter were found to be 55.51±0.84, 56.80±0.52, 60.27±1.93, 63.50±0.72and 59.85±0.43 per cent under treatment groups $T_1$, $T_2$, $T_3$, $T_4$ and $T_5$, respectively. The statistical analysis of data showed highly significant ($P$<0.05) effect of treatments. The Group $T_3$, $T_4$ and $T_5$ were showed statistically significant ($P$<0.05) difference with $T_1$ whereas the difference between $T_3$, $T_4$ and $T_5$ were non-significant and difference between $T_1$ and $T_2$ were also non-significant. The difference between $T_2$ and $T_4$ were statistically significant. The results obtained in present study are in agreement with Murro *et al.* (2003) [20], Asaolu *et al.* (2011) [6], Sultana *et al.* (2015) [6] and Oyedele *et al.* (2016) [26], they reported that feeding of Moringa leaves significantly increased digestibility coefficient of dry matter. As per Bakshi *et al.* 2004, the dry matter digestibility is dependent on the cell wall constituents of the diets with feedstuffs having lower fibre being more digestable than those with high fibre. In disagreement to present findings Tona *et al.* (2014) [30] who reported non-significant difference in digestibility coefficient of dry matter among the treatment groups.

**2. Digestibility of crude protein**

The digestibility of crude protein is considered as prime indicator of nutritional potentiality of feed. The per cent values of digestibility coefficient of crude protein of each goat kids from all the groups have been presented along with analysis of variance in Table 3 and 4.

**Table 3:** Average crude protein digestibility coefficient of goat kids in experimental groups

| Animal No. | Treatment groups | | | | |
|---|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | $T_4$ | $T_5$ |
| 1 | 65.21 | 62.95 | 76.19 | 65.78 | 71.48 |
| 2 | 59.34 | 64.18 | 70.99 | 72.42 | 60.60 |
| 3 | 56.06 | 65.53 | 52.22 | 79.88 | 77.70 |
| 4 | 57.30 | 79.32 | 79.62 | 73.10 | 54.90 |
| 5 | 64.05 | 64.99 | 66.68 | 75.60 | 61.69 |
| 6 | 65.45 | 77.47 | 77.89 | 57.22 | 75.62 |
| 7 | 67.19 | 46.55 | 61.83 | 66.83 | 73.04 |
| 8 | 70.49 | 76.80 | 70.95 | 79.11 | 74.50 |
| Overall Mean ± SE | 63.14±1.79$^{a}$ | 67.17±1.01$^{ab}$ | 70.98±2.03$^{b}$ | 71.07±1.21$^{b}$ | 70.95±2.18$^{b}$ |

**Table 4:** Analysis of variance of digestibility coefficient of crude protein

| Source of variance | Df | SS | MSS | F – value |
|---|---|---|---|---|
| Treatment | 4 | 393.24 | 98.311 | 4.231* |
| Error | 35 | 813.24 | 23.235 | |

* Significant difference ($P$<0.05)

Digestibility coefficient of crude protein was highest in group $T_4$ followed by $T_3$, $T_5$, $T_2$ and $T_1$. The mean values of digestibility coefficient of crude protein were found to be 63.14±1.79, 67.17±1.01, 70.98±2.03, 71.07±1.21 and 70.95±2.18 per cent under treatment groups $T_1$, $T_2$, $T_3$, $T_4$ and $T_5$, respectively. The statistical analysis of data as revealed significant ($P$<0.05) effect of treatments. The Group $T_3$, $T_4$ and $T_5$ were showed statistically significant ($P$<0.05) difference with $T_1$, whereas the difference between $T_2$, $T_3$, $T_4$ and $T_5$ were non-significant and difference between $T_1$ and $T_2$ were also non-significant. The results obtained in present study are in agreement with Fadiyimu *et al.* (2010) [9], Asaolu *et al.* (2011) [6], Tona *et al.* (2014) [30], Sultana *et al.* (2015b) [11] and Oyedele *et al.* (2016) [26], they reported that feeding of moringa leaves significantly increased digestibility coefficient of crude protein. Increasing CP digestibility with increasing inclusion levels of moringa could be attributed to the higher content of by-pass protein in moringa leaves (Becker, 1995) [13].

**3. Digestibility of ether extract**

The per cent values of digestibility coefficient of ether extract of each goat kids from all the groups have been presented along with analysis of variance in Table 5 and 6.

**Table 5:** Average ether extract digestibility coefficient of goat kids in experimental groups

| Animal No. | Treatment groups | | | | |
|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | T5 |
| 1 | 77.73 | 62.95 | 76.19 | 65.78 | 71.48 |
| 2 | 67.82 | 64.18 | 70.99 | 72.42 | 60.60 |
| 3 | 47.96 | 65.53 | 52.22 | 79.88 | 77.70 |
| 4 | 46.41 | 79.32 | 79.62 | 73.10 | 54.90 |
| 5 | 65.98 | 64.99 | 66.68 | 75.60 | 61.69 |
| 6 | 68.31 | 77.47 | 77.89 | 57.22 | 75.62 |
| 7 | 75.42 | 46.55 | 61.83 | 66.83 | 73.04 |
| 8 | 77.07 | 76.80 | 70.95 | 79.11 | 74.50 |
| Overall Mean ± SE | 65.84±4.36 | 67.23±3.79 | 69.55±3.24 | 71.24±2.69 | 68.69±2.97 |

**Table 6:** Analysis of variance of digestibility coefficient of ether extract

| Source of variance | Df | SS | MSS | F – value |
|---|---|---|---|---|
| Treatment | 4 | 138.94 | 34.736 | 0.3618$^{NS}$ |
| Error | 35 | 3360.2 | 96.007 | |

NS Non-significant difference

The mean values of digestibility coefficient of ether extract were 65.84±4.36 in $T_1$, 67.23±3.79 in $T_2$, 69.55±3.24 in $T_3$, 71.24±2.69 in $T_4$ and 68.69±2.97 per cent in $T_5$ treatment group. The statistical analysis of data revealed non-significant ($P$<0.05) effect of treatments. The results obtained in present study are in concurrence with Fadiyimu *et al.* (2010) [9] and Tona *et al.* (2014) [30], they reported non-significant effect of feeding of Moringa leaves on digestibility coefficient of ether extract. In incongruity to present findings Oyedele *et al.* (2016) [26] and Ahmad *et al.* (2017) [2], they reported significant difference in digestibility coefficient of ether extract among the treatment groups.

**4. Digestibility of crude fibre**

The per cent values of digestibility coefficient of crude fibre of each goat kids from all the groups have been presented along with analysis of variance in Table 7 and 8.

**Table 7:** Average crude fibre digestibility coefficient of goat kids in experimental groups

| Animal No. | Treatment groups | | | | |
|---|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | $T_4$ | $T_5$ |
| 1 | 57.16 | 65.74 | 59.06 | 61.53 | 59.79 |
| 2 | 54.26 | 59.63 | 58.74 | 57.78 | 59.51 |
| 3 | 54.08 | 55.42 | 51.77 | 63.47 | 61.20 |
| 4 | 50.61 | 57.69 | 66.07 | 62.26 | 57.18 |
| 5 | 54.48 | 55.08 | 66.64 | 67.35 | 55.10 |
| 6 | 57.14 | 57.59 | 64.34 | 58.07 | 64.90 |
| 7 | 59.45 | 51.18 | 51.77 | 66.39 | 60.36 |
| 8 | 64.23 | 61.85 | 68.53 | 66.86 | 61.79 |
| Overall Mean ± SE | 56.43±1.46 | 58.02±1.58 | 60.86±2.33 | 62.96±1.34 | 60.09±0.97 |

**Table 8:** Analysis of variance of digestibility coefficient of crude fibre

| Source of variance | Df | SS | MSS | F – value |
|---|---|---|---|---|
| Treatment | 4 | 205.35 | 51.337 | 2.511$^{NS}$ |
| Error | 35 | 715.63 | 20.447 | |

NS Non-significant difference

The mean values of digestibility coefficient of crude fibre were found to be 56.43±1.46, 58.02±1.58, 60.86±2.33, 62.96±1.34and 60.09±0.97 per cent under treatment groups $T_1$, $T_2$, $T_3$, $T_4$ and $T_5$, respectively. The statistical analysis of data as showed non-significant ($P$<0.05) effect of treatments. The results obtained in present study are in agreement with Fadiyimu *et al.* (2010) [9], Adegun *et al.* (2011) [11], Tona *et al.* (2014) [30] and Oyedele *et al.* (2016) [26], they reported non-significant effect of feeding of Moringa leaves on digestibility coefficient of crude fibre. In disagreement to our findings Ahmad *et al.* (2017) [2] who reported significant increase in digestibility coefficient of crude fibre among the treatment groups.

**5. Digestibility of nitrogen free extract**

The per cent values of digestibility coefficient of nitrogen free extract of each goat kids from all the groups has been presented along with analysis of variance in Table 9 and 10.

**Table 9:** Average nitrogen free extract digestibility coefficient of goat kids in experimental groups

| Animal No. | Treatment groups | | | | |
|---|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | $T_4$ | $T_5$ |
| 1 | 51.05 | 53.53 | 54.71 | 63.91 | 56.14 |
| 2 | 55.06 | 56.93 | 57.61 | 65.13 | 54.91 |
| 3 | 61.85 | 56.83 | 57.24 | 59.26 | 56.91 |
| 4 | 58.28 | 58.92 | 61.79 | 63.29 | 63.47 |
| 5 | 54.70 | 59.58 | 68.77 | 64.71 | 57.87 |
| 6 | 54.70 | 56.29 | 62.94 | 62.79 | 57.87 |
| 7 | 56.67 | 57.67 | 58.91 | 66.80 | 58.72 |
| 8 | 57.81 | 57.32 | 60.16 | 63.07 | 56.59 |
| Overall Mean ± SE | 56.26±1.13$^a$ | 57.13±0.65$^a$ | 60.27±1.53$^{ab}$ | 63.62±0.78$^b$ | 57.81±0.91$^a$ |

**Table 10:** Analysis of variance of digestibility coefficient of nitrogen free extract

| Source of variance | Df | SS | MSS | F – value |
|---|---|---|---|---|
| Treatment | 4 | 282.57 | 70.642 | 8.09* |
| Error | 35 | 305.54 | 8.730 | |

* Significant difference ($P$<0.05)

The mean values of digestibility coefficient of nitrogen free extract were found to be 56.26±1.13, 57.13±0.65, 60.27±1.53, 63.62±0.78 and 57.81±0.91 per cent under treatment groups $T_1$, $T_2$, $T_3$, $T_4$ and $T_5$, respectively. The statistical analysis of data revealed significant ($P$<0.05l) effect of treatments. The Group $T_4$ were showed statistically significant ($P$<0.05) difference with $T_1$, $T_2$ and $T_5$, whereas the difference between $T_3$ and $T_4$ were non-significant and difference between$T_1$, $T_2$, $T_3$ and $T_5$ were also non-significant. The results obtained in present study are in agreement with Fadiyimu *et al.* (2010) [9], Tona *et al.* (2014) [30] Oyedele *et al.* (2016) [11] and Ahmad *et al.* (2017) [2], they reported that feeding of Moringa leaves significantly increase digestibility coefficient of NFE in goat. In present study, group $T_4$ showed significantly higher NFE digestibility as *Moringa oleifera* leaves have high nutritional values and relatively well degraded in rumen. This line with the reasoning of Singh and Makkar (2014) [25] that tree foliage fulfill the nutrients deficient in the diet resulting in enhancement of microbial growth and digestion of cellulosic biomass in the ruman.

## Conclusion

It can be concluded that feeding of *Moringa oleifera* leaves replacing commercially available concentrate feed at 75% level to improve digestibility of dry matter and gross nutrients in sirohi goat kids. *Moringa oliefera* leaves can be used as an alternate for concentrate feed in the diet of goat kids due to its high crude protein contents.

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