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Distinct Nutritional Functions of *Leptadenia reticulata* and *Moringa oleifera* in Nutrient Digestibility of Lactating Sahiwal Cattle

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Abstract
The present study was conducted to investigate the differential nutritional roles of *Leptadenia reticulata* and *Moringa oleifera* in nutrient digestibility of lactating Sahiwal cattle. Twenty-eight lactating Sahiwal cattle were randomly allocated to four treatment groups (n = 7) under a completely randomized design and fed for 120 days. Animals in the control group (T_0) received a basal diet, whereas T_1, T_2 and T_3 received dietary supplementation of *Leptadenia reticulata* root powder (90 g/animal/day), *Moringa oleifera* leaf powder (150 g/animal/day) and a combination of both herbs (45 g + 75 g/animal/day), respectively. A five-day digestion trial was conducted at the end of the feeding period to determine digestibility coefficients of dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), crude fibre (CF) and nitrogen-free extract (NFE). Dietary supplementation significantly ($P<0.05$) affected DM, CP and CF digestibility. The highest DM digestibility (63.70%) and CP digestibility (53.32%) were recorded in cattle supplemented with *Moringa oleifera*, representing improvements of 12.88% and 27.26%, respectively, over the control group (56.43% and 41.90%). In contrast, the highest CF digestibility (50.48%) was observed in the *Leptadenia reticulata* supplemented group, which was 15.61% higher than the control value (43.66%). Organic matter, ether extract and nitrogen-free extract digestibility were not significantly influenced by dietary treatments ($P>0.05$). The superior DM and CP digestibility observed with *Moringa oleifera* may be associated with its higher crude protein content, whereas the greater CF digestibility observed with *Leptadenia reticulata* may be related to its comparatively higher fibre content. The findings demonstrate that the two herbal supplements perform distinct nutritional functions in lactating Sahiwal cattle. While *Moringa oleifera* primarily improved dry matter and protein utilization, *Leptadenia reticulata* enhanced fibre digestion. These results provide evidence for the targeted use of herbal feed additives according to specific nutritional objectives and support their application as sustainable nutritional interventions in dairy production systems.

Keywords: *Leptadenia reticulata*, *Moringa oleifera*, Sahiwal cattle, nutrient digestibility, herbal feed additives, crude protein digestibility, crude fibre digestibility

1. Introduction
Efficient utilization of dietary nutrients is a fundamental prerequisite for sustainable and profitable dairy production. In ruminants, productive performance depends not only on the quantity of nutrients supplied through feed but also on the efficiency with which these nutrients are digested, absorbed and utilized for productive and physiological functions. Nutrient digestibility directly influences the availability of energy, protein and structural carbohydrates required for maintenance, milk synthesis, reproduction and health (Van Soest, 1994; McDonald *et al.*, 2011) [30]. Since feed expenditure constitutes the largest component of dairy production costs, improving nutrient utilization efficiency remains a major objective of modern ruminant nutrition (NRC, 2001; Owens and Basalan, 2016) [22, 23].

The digestive efficiency of ruminants is closely associated with the activity of the ruminal microbial ecosystem. The rumen contains a highly specialized microbial population comprising bacteria, protozoa, fungi and archaea that ferment dietary substrates into volatile fatty acids, microbial proteins and other metabolites utilized by the host animal (Russell and Rychlik, 2001; Jami and Mizrahi, 2012) [28]. Adequate protein availability supports microbial

growth and microbial protein synthesis, whereas efficient fibre degradation increases the availability of fermentable substrates and energy for ruminal microorganisms (Hoover and Stokes, 1991; McDonald *et al.*, 2011) [11]. Consequently, nutritional interventions that enhance protein and fibre digestion can substantially improve feed utilization efficiency and productive performance in dairy cattle.

In recent years, increasing emphasis on sustainable livestock production has stimulated interest in herbal feed additives as natural alternatives to conventional growth promoters and synthetic supplements. Plant-derived feed resources contain a variety of bioactive compounds, including flavonoids, tannins, saponins, alkaloids and phenolic compounds, which may influence ruminal fermentation, microbial activity and nutrient utilization (Patra and Saxena, 2009; Patra, 2010) [26, 25]. Such phytogenic additives have attracted considerable attention because of their potential to improve animal productivity while maintaining animal health and product quality (Windisch *et al.*, 2008; Amad and Zentek, 2023) [31, 2].

Among the herbal resources evaluated for livestock feeding, *Moringa oleifera* has received considerable scientific attention because of its exceptional nutritional composition. The leaves are rich in crude protein, essential amino acids, vitamins, minerals and antioxidant compounds, with reported crude protein contents ranging from 20 to 30% (Makkar and Becker, 1996; Moyo *et al.*, 2011) [17, 20]. In addition, *Moringa oleifera* contains several biologically active compounds, including flavonoids, phenolic acids and glucosinolates, which may positively influence ruminal fermentation and nutrient metabolism (Anwar *et al.*, 2007; Gopalakrishnan *et al.*, 2016) [3, 10]. Previous studies have demonstrated improvements in nutrient digestibility, feed utilization and productive performance in ruminants supplemented with *Moringa oleifera* foliage or leaf meal (Sanchez *et al.*, 2005; Kholif *et al.*, 2015; Roy *et al.*, 2016; Cohen-Zinder *et al.*, 2016; Abdel-Raheem and Hassan, 2021; El-Badawi *et al.*, 2023) [1, 6, 7, 14, 27, 29]. These beneficial effects have largely been attributed to its high protein content and ability to support microbial growth and fermentation efficiency within the rumen (Fadiyimu *et al.*, 2010; Liu *et al.*, 2023) [9].

Another important medicinal plant used in traditional livestock production systems is *Leptadenia reticulata* (Jivanti). The plant is valued for its galactagogue, immunomodulatory and healthpromoting properties and has been widely used in indigenous veterinary practices (Patel *et al.*, 2016; Kumari *et al.*, 2024) [24, 15]. Phytochemical investigations have identified the presence of flavonoids, terpenoids, alkaloids, glycosides, steroids and phenolic compounds that contribute to its biological activities (Mohanty *et al.*, 2017; Kumari *et al.*, 2024) [19, 15]. Unlike *Moringa oleifera*, *Leptadenia reticulata* possesses a comparatively higher fibre content, suggesting its potential role in influencing fibre degradation and structural carbohydrate utilization. Fibre-rich feed resources are known to stimulate fibrolytic microbial populations responsible for the degradation of cellulose and hemicellulose in the rumen, thereby improving the utilization of fibrous feed components (Van Soest, 1994; Russell and Rychlik, 2001) [28, 30]. However, information regarding the influence of *Leptadenia reticulata* on nutrient digestibility in dairy cattle remains limited. The response of nutrient digestibility to herbal supplementation is not necessarily uniform across all nutrient fractions. Variations in nutrient composition and phytochemical characteristics may result in differential effects on protein digestion, fibre degradation and overall feed utilization (Patra and Saxena, 2009; Bashar *et al.*, 2020) [26, 5]. Therefore, understanding the specific nutritional functions of different herbal feed resources is essential for developing targeted feeding strategies aimed at improving nutrient utilization efficiency in dairy cattle.

Although numerous studies have independently investigated the nutritional benefits of *Moringa oleifera* and the medicinal properties of *Leptadenia reticulata*, direct comparative evaluations of their effects on nutrient digestibility under identical feeding and management conditions are scarce. Furthermore, information regarding their influence on individual nutrient fractions in indigenous dairy breeds such as Sahiwal cattle remains limited. Based on their contrasting nutrient profiles, it was hypothesized that *Moringa oleifera* would preferentially improve dry matter and crude protein digestibility, whereas *Leptadenia reticulata* would exert a greater influence on crude fibre utilization. Therefore, the present study was undertaken to compare the effects of dietary supplementation with *Leptadenia reticulata* root powder and *Moringa oleifera* leaf powder, administered individually and in combination, on the digestibility of major nutrient fractions in lactating Sahiwal cattle under farm conditions.

2. Materials and Methods

2.1 Experimental Site

The present investigation was conducted at the Instructional Dairy Farm (IDF), Nagla, College of Veterinary and Animal Sciences, Govind Ballabh Pant University of Agriculture and Technology (GBPUA&T), Pantnagar, Uttarakhand, India. The experimental farm is located at approximately 29.0°N latitude and 79.3°E longitude with an altitude of about 243.8 m above mean sea level. The study was carried out under uniform management and feeding conditions during a 120-day experimental period.

2.2 Ethical Approval

The experimental protocol was approved by the Institutional Animal Ethics Committee (IAEC), College of Veterinary and Animal Sciences, GBPUA&T, Pantnagar, Uttarakhand, India. All animal handling and experimental procedures were conducted in accordance with the guidelines of the Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA), Government of India.

2.3 Experimental Animals and Design

Twenty-eight clinically healthy lactating Sahiwal cattle maintained at the university dairy farm were selected for the study. The animals were selected on the basis of similar parity, body condition score and stage of lactation to minimize variation among treatment groups and were maintained under similar managemental conditions throughout the experiment.

The animals were randomly allocated into four treatment groups consisting of seven animals each following a Completely Randomized Design (CRD). Prior to initiation of the feeding trial, all animals were acclimatized to the experimental conditions for one week.

The experimental treatments were as follows:

Table 1: Experimental treatment groups

Treatment	Description
T_0	Basal diet (Control)
T_1	Basal diet + Leptadenia reticulata root powder @ 90 g/animal/day
T_2	Basal diet + Moringa oleifera leaf powder @ 150 g/animal/day
T_3	Basal diet + Leptadenia reticulata root powder @ 45 g + Moringa oleifera leaf powder @ 75 g/animal/day

The feeding trial was conducted for a period of 120 days.

2.4 Feeding and Management

All experimental animals were maintained in a loose housing system with free access to clean drinking water throughout the experimental period. Animals were fed according to the prevailing feeding schedule of the dairy farm.

The basal ration consisted of concentrate mixture, wheat straw and seasonal green fodders, including berseem (*Trifolium alexandrinum*), oat (*Avena sativa*) and mustard greens. Herbal supplements were individually administered once daily during the afternoon milking session to ensure complete consumption.

Routine management practices, including feeding, milking, sanitation and healthcare, were maintained uniformly for all treatment groups throughout the study.

2.5 Digestibility Trial

A five-day digestion trial was conducted at the end of the 120-day feeding period to determine nutrient digestibility coefficients. During the digestibility trial, the quantity of feed offered and feed refusals was recorded daily for each experimental animal.

Representative fecal samples were collected daily from individual animals throughout the collection period. The daily samples from each animal were pooled proportionately to obtain a representative composite sample, which was subsequently processed, preserved and stored for laboratory analysis. Feed and fecal samples were dried, ground and stored in airtight containers until chemical analysis.

2.6 Chemical Analysis

Representative samples of concentrate mixture, roughages, *Leptadenia reticulata* root powder, *Moringa oleifera* leaf powder and feces were analyzed for proximate constituents according to the standard procedures of the Association of Official Analytical Chemists (AOAC, 2005)[4].

The analyzed parameters included dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), crude fibre (CF) and total ash (TA). Crude protein was estimated using the Micro-Kjeldahl method, whereas ether extract was determined using Soxhlet extraction. Crude fibre and total ash were estimated using standard gravimetric procedures. Nitrogen-free extract (NFE) was calculated by difference.

2.7 Calculation of Nutrient Digestibility

Digestibility coefficients of dry matter, organic matter, crude protein, ether extract, crude fibre and nitrogen-free extract were calculated using feed intake and fecal output data according to the following equation:

Digestibility (%) = [(Nutrient Intake − Nutrient Excreted in Feces) / Nutrient Intake] × 100

The calculated digestibility coefficients were expressed as percentages.

2.8 Statistical Analysis

The experimental data were analyzed using Statistical Package for Social Sciences (SPSS) software. Treatment effects on nutrient digestibility parameters were evaluated using one-way analysis of variance (ANOVA) under a Completely Randomized Design.

The statistical model used was:

$$Yij = \mu + Ti + eij$$

where:

- Y_{ij}= observation on the j^{th} animal receiving the i^{th} treatment,
- μ= overall mean,
- T_i= effect of the i^{th} treatment,
- e_{ij}= random experimental error.

When significant treatment effects were detected, treatment means were separated using Duncan's Multiple Range Test (DMRT). Results are presented as Mean±Standard Error (SE), and differences were considered significant at $P < 0.05$.

3. Results and Discussion

3.1 Chemical Composition of Feed Ingredients and Herbal Supplements

The proximate composition of the feed ingredients and herbal supplements used during the experimental period is presented in Table 2. Considerable variation was observed among the feed resources with respect to their nutrient composition, reflecting differences in their nutritional quality and potential contribution to nutrient utilization. Such variations are expected to influence ruminal fermentation patterns and digestibility responses in lactating cattle.

Table 2: Chemical composition (proximate analysis) of feedstuffs and herbal feed supplements used during the experimental trial (%)

Particulars (%)	Roughage	Concentrate Mixture	Leptadenia reticulata	Moringa oleifera
Dry Matter	27.74	89.80	90.28	91.50
Organic Matter	89.89	91.13	85.28	89.97
Crude Protein	10.47	21.56	15.10	27.05
Ether Extract	2.27	2.95	3.66	6.33
Crude Fibre	30.13	7.32	43.20	12.73
Total Ash	10.11	8.87	14.72	10.03
Nitrogen-Free Extract	47.01	59.30	23.32	43.86

Among the herbal supplements, *Moringa oleifera* leaf powder exhibited substantially higher crude protein (27.05%) and ether extract (6.33%) contents than *Leptadenia reticulata*. The high crude protein concentration highlights the potential of *Moringa* as a protein-rich feed resource capable of supporting microbial growth and nitrogen metabolism within the rumen. Similar nutrient profiles have been reported by Makkar and Becker (1996) [17], Moyo *et al.* (2011) [20] and Gopalakrishnan *et al.* (2016) [10], who identified *Moringa* leaves as an excellent source of protein, minerals and bioactive compounds.

In contrast, *Leptadenia reticulata* root powder was characterized by markedly higher crude fibre (43.20%) and total ash (14.72%) contents. The elevated fibre fraction indicates its potential role in influencing structural carbohydrate digestion, whereas the higher mineral content may contribute to improved microbial activity and metabolic functions. Previous phytochemical and nutritional investigations have similarly reported appreciable fibre and mineral concentrations in *Leptadenia reticulata* (Mohanty *et al.*, 2017; Kumari *et al.*, 2024) [19, 15].

The contrasting nutrient composition of the two herbal supplements suggests that they may influence nutrient utilization through different physiological mechanisms. Whereas *Moringa oleifera* may primarily enhance nitrogen availability and microbial protein synthesis, *Leptadenia reticulata* may exert greater influence on fibre degradation and utilization. These compositional differences provide a biological basis for the differential digestibility responses observed in the present investigation.

3.2 Effect of Herbal Supplementation on Nutrient Digestibility

The effects of dietary supplementation with *Leptadenia reticulata* and *Moringa oleifera* on nutrient digestibility are presented in Table 3. Significant treatment effects ($P<0.05$) were observed for dry matter, crude protein and crude fibre digestibility, whereas organic matter, ether extract and nitrogen-free extract digestibility remained statistically comparable among treatment groups.

Table 3: Effect of Leptadenia reticulata and Moringa oleifera supplementation on nutrient digestibility (%) in lactating Sahiwal cattle

Parameter (%)	T_0	T_1	T_2	T_3
Dry Matter	56.43±1.47^a	61.05±0.84^{bc}	63.70±1.70^c	59.09±1.16^{ab}
Organic Matter	$44.42±3.09$	$44.18±1.68$	$38.33±3.30$	$40.94±1.95$
Crude Protein	41.90±2.27^a	44.76±2.66^a	53.32±2.26^b	43.06±2.35^a
Ether Extract	$79.16±0.72$	$80.31±0.53$	$80.80±0.57$	$79.51±0.89$
Crude Fibre	43.66±1.22^a	50.48±1.10^b	45.59±0.97^a	45.12±1.69^a
Nitrogen-Free Extract	$72.99±0.77$	$73.79±1.86$	$74.10±0.87$	$74.04±0.94$

Means bearing different superscripts within a row differ significantly ($P<0.05$). Values are presented as Mean±Standard Error (SE). The effects of dietary supplementation of *Leptadenia reticulata* and *Moringa oleifera* on nutrient digestibility (%) in lactating Sahiwal cattle are graphically illustrated in Figure 1.

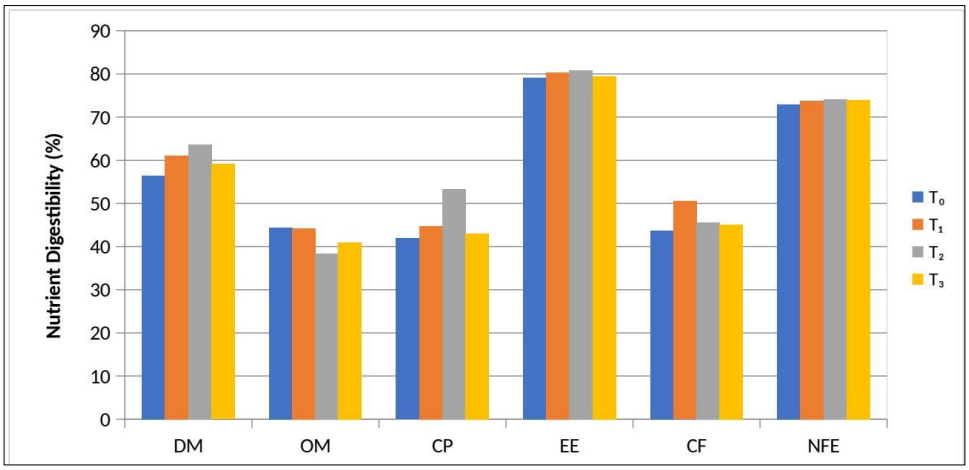

Fig 1: Effect of dietary supplementation of *Leptadenia reticulata* and *Moringa oleifera* on nutrient digestibility (%) in lactating Sahiwal cattle.

3.2.1 Dry Matter Digestibility

Dry matter digestibility was significantly ($P<0.05$) affected by dietary supplementation. The highest dry matter digestibility was recorded in animals receiving *Moringa oleifera* supplementation (63.70%), followed by those supplemented with *Leptadenia reticulata* (61.05%). The control group exhibited the lowest digestibility coefficient (56.43%). The improvement in dry matter digestibility observed in the Moringa-supplemented group may be attributed to the superior protein content and nutrient density of the leaves. Adequate nitrogen supply enhances microbial proliferation and enzymatic activity within the rumen, thereby improving feed degradation and nutrient extraction. Enhanced microbial fermentation increases the efficiency of feed utilization and promotes greater digestibility of dietary dry matter. Similar improvements in dry matter digestibility following *Moringa* supplementation have been reported by Sanchez *et al.* (2005) [29], Kholif *et al.* (2015) [14], Roy *et al.* (2016) [27], Abdel-Raheem and Hassan (2021) [1] and El-Badawi *et al.* (2023) [7].

The numerical improvement observed in the combined treatment group suggests that the beneficial effects of *Moringa* on dry matter utilization were partially retained when administered with *Leptadenia reticulata*. However, the response was lower than that observed in the Moringa-only treatment, indicating that the protein-rich nature of *Moringa* may have played a dominant role in improving dry matter digestion.

3.2.2 Crude Protein Digestibility

Crude protein digestibility was significantly influenced by dietary treatment, with the highest value observed in the *Moringa oleifera* supplemented group (53.32%). This value was significantly higher than those recorded in the control, *Leptadenia reticulata* and combination treatment groups.

The enhanced crude protein digestibility associated with *Moringa* supplementation may be attributed to its high crude protein concentration and favorable amino acid profile. Increased availability of degradable nitrogen supports microbial protein synthesis and improves nitrogen utilization efficiency within the rumen. Enhanced microbial activity facilitates greater degradation of dietary protein, resulting in improved protein digestibility and nutrient utilization. Similar findings have been reported by Kholif *et al.* (2015) [14], Roy *et al.* (2016) [27], Cohen-Zinder *et al.* (2016) [6] and El-Hamd *et al.* (2024) [8].

Furthermore, the presence of antioxidant and phytogenic compounds in *Moringa* leaves may contribute to stabilization of the ruminal environment, thereby promoting efficient microbial metabolism and nutrient degradation. The substantial improvement in both dry matter and crude protein digestibility observed in the present study supports the hypothesis that *Moringa oleifera* functions primarily as a protein-oriented nutritional supplement capable of enhancing nitrogen utilization in lactating dairy cattle.

3.2.3 Crude Fibre Digestibility

Crude fibre digestibility was significantly ($P<0.05$) influenced by dietary supplementation and exhibited a response pattern distinct from that observed for dry matter and crude protein digestibility. The highest crude fibre digestibility was recorded in animals receiving *Leptadenia reticulata* supplementation (50.48%), followed by the *Moringa oleifera* supplemented group (45.59%) and the combination treatment (45.12%). The lowest crude fibre digestibility was observed in the control group (43.66%).

The superior fibre digestibility observed in the *Leptadenia reticulata* supplemented group may be attributed to its comparatively higher crude fibre content and unique phytochemical composition. Fibre-rich feed resources are known to stimulate fibrolytic microbial populations responsible for the degradation of cellulose and hemicellulose in the rumen. Enhanced fibrolytic activity increases the breakdown of structural carbohydrates and improves the utilization of fibrous feed components (Van Soest, 1994; Russell and Rychlik, 2001) [28, 30].

In addition to its fibre content, *Leptadenia reticulata* contains several bioactive compounds, including flavonoids, phenolic compounds and glycosides, which may influence ruminal microbial ecology and digestive activity (Mohanty *et al.*, 2017; Kumari *et al.*, 2024) [19, 15]. Improved microbial adaptation to fibrous substrates may have contributed to the greater crude fibre digestibility observed in the present study. Enhanced fibre degradation improves the release of fermentable carbohydrates and ultimately contributes to better nutrient utilization efficiency.

Interestingly, the highest crude fibre digestibility was not observed in the *Moringa oleifera* supplemented group despite its positive effects on dry matter and crude protein digestibility. This finding suggests that the two herbal supplements exerted different nutritional influences on ruminal digestion. While *Moringa oleifera* primarily enhanced protein utilization and microbial growth through improved nitrogen availability, *Leptadenia reticulata* appeared to favor fibre degradation and structural carbohydrate utilization. Such differential responses highlight the importance of considering nutrient composition when selecting herbal feed additives for specific nutritional objectives.

The findings of the present investigation support the hypothesis that fibre-rich herbal supplements may preferentially improve fibre utilization, whereas protein-rich supplements may exert greater effects on nitrogen metabolism and crude protein digestion. These results indicate that the digestibility responses observed in the present study were closely associated with the nutrient composition of the herbal supplements.

3.2.4 Organic Matter, Ether Extract and Nitrogen-Free Extract Digestibility

Dietary supplementation with *Leptadenia reticulata* and *Moringa oleifera* did not significantly ($P>0.05$) influence organic matter, ether extract or nitrogen-free extract digestibility. Although numerical differences were observed among treatment groups, the magnitude of variation was insufficient to attain statistical significance.

Organic matter digestibility ranged from 38.33% to 44.42% and did not differ significantly ($P>0.05$) among treatment groups. Although numerical variation was observed, dietary supplementation with *Leptadenia reticulata* and *Moringa oleifera* did not produce a measurable effect on overall organic matter utilization. The absence of significant differences suggests that the herbal supplements exerted their primary influence on specific nutrient fractions, particularly crude protein and crude fibre digestibility, rather than on total organic matter digestion.

Ether extract digestibility remained consistently high across all treatment groups, varying between 79.16% and 80.80%. The lack of significant differences may indicate that lipid digestion and absorption were already highly efficient under the prevailing feeding conditions and therefore were not substantially influenced by herbal supplementation. Comparable findings have been reported by Roy *et al.* (2016) [27] and Abdel-Raheem and Hassan (2021) [1], who observed minimal effects of herbal feed additives on ether extract digestibility in ruminants.

Similarly, nitrogen-free extract digestibility remained statistically comparable among treatment groups, with values ranging from 72.99% to 74.10%. Nitrogen-free extract primarily represents readily fermentable carbohydrate fractions such as soluble sugars and starches, which are generally highly digestible under normal ruminal conditions. Consequently, supplementation with the herbal feed additives used in the present study may not have been sufficient to produce measurable alterations in their digestion and utilization.

The absence of significant effects on organic matter, ether extract and nitrogen-free extract digestibility indicates that

the principal influence of the herbal supplements was directed towards specific nutrient fractions rather than generalized enhancement of all digestive processes. This selective response further supports the concept of differential nutritional functionality between *Moringa oleifera* and *Leptadenia reticulata*.

4. Conclusion

Dietary supplementation with *Moringa oleifera* and *Leptadenia reticulata* exerted differential effects on nutrient digestibility in lactating Sahiwal cattle. Significant improvements were observed in dry matter, crude protein and crude fibre digestibility, whereas organic matter, ether extract and nitrogen-free extract digestibility remained unaffected by dietary treatments.

Among the evaluated supplements, *Moringa oleifera* was more effective in improving dry matter and crude protein digestibility, indicating its potential as a protein-rich herbal feed additive for enhancing nutrient utilization and feed efficiency. In contrast, *Leptadenia reticulata* resulted in the highest crude fibre digestibility, suggesting its suitability for improving the utilization of structural carbohydrates in roughage-based feeding systems.

The findings demonstrate that the two herbal supplements perform distinct nutritional functions rather than exerting uniform effects on all nutrient fractions. While *Moringa oleifera* primarily enhanced dry matter and protein utilization, *Leptadenia reticulata* contributed more effectively to fibre digestion. These results suggest that the selection of herbal feed additives should be guided by specific nutritional objectives. *Moringa oleifera* may be preferred for improving protein utilization and feed efficiency, whereas *Leptadenia reticulata* may be strategically utilized to enhance fibre digestion in roughage-based diets. Further studies on rumen fermentation characteristics, microbial ecology and long-term production responses are warranted to elucidate the biological mechanisms underlying these differential digestibility responses.

5. Highlights

- Supplementation with *Moringa oleifera* significantly improved dry matter and crude protein digestibility in lactating Sahiwal cattle.
- *Leptadenia reticulata* supplementation resulted in the highest crude fibre digestibility among the treatment groups.
- The two herbal supplements exhibited distinct nutritional functions, indicating nutrient-specific effects on digestibility.
- Organic matter, ether extract and nitrogen-free extract digestibility were not significantly influenced by dietary treatments.
- *Moringa oleifera* favored protein utilization, whereas *Leptadenia reticulata* enhanced fibre digestion under farm conditions.

Practical Implications

The findings of the present study suggest that *Moringa oleifera* and *Leptadenia reticulata* can be strategically utilized as natural herbal feed additives according to specific nutritional objectives in dairy cattle. Supplementation with *Moringa oleifera* improved dry matter and crude protein digestibility, indicating its potential as a protein-rich feed resource for enhancing nutrient utilization and feed efficiency. In contrast, *Leptadenia reticulata* improved crude fibre digestibility, suggesting its suitability for roughage-based feeding systems where enhanced fibre utilization is desired. Therefore, both herbal supplements may serve as sustainable and plant-based nutritional interventions for improving feed utilization efficiency in lactating Sahiwal cattle under farm conditions.

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