Biological Times

Volume No. 4 | Issue No. 12 | Pages 1-2

Evaluating the Digestibility of Non-Forage Fiber Sources in Goat TMR Supplemented with Fibrolytic Enzymes

Ahtesham Khalid[1], Kamran Ahmad Nasir[1], Zainab Sami Ullah[1], Ammara Ameer[2], Muhammad Mahboob Ali Hamid[1*]

1. Institute of Animal and Dairy Sciences, Faculty of Animal Husbandry, University of Agriculture, Faisalabad, Pakistan.
2. Department of Food Science & Technology, Government College Women University Faisalabad, Pakistan

*Corresponding Author: **dr.mmahboob@uaf.edu.pk**

ABSTRACT

The goats form a large portion of livestock industry in Pakistan due to their capacity to effectively use fibrous and low-quality feeddstuffs. Nevertheless, the low digestibility and lignin levels in traditional forages still limit productivity of majority of production systems. Sources of non-forage fiber (NFFS) especially soybean hulls and beet pulp are highly fermentable and palatable substitutes that stabilize rumen functionality as well as provide a stable supply of nutrients. These ingredients in combination with exogenous fibrolytic enzymes can enhance the degradation of cellulose and hemicellulose and improve intake, growth performance, digestibility and feed efficiency. NFFS is also useful in promoting sustainable feeding systems through less reliance on cereal grains and the utilization of agro-industrial by-products. This is a synthesis of existing data on nutritional value of NFFS and fibrolytic enzymes in goat diets in terms of their impact on digestibility, rumen health, growth performance, and production efficiency at Pakistani production conditions.

Keywords: Goats, livestock, forage

To cite this article: Khalid A, KA Nasir, ZS Ullah, A Ameer & MMA Hamid. Evaluating the Digestibility of Non-Forage Fiber Sources in Goat TMR Supplemented with Fibrolytic Enzymes. Biological Times. 2025. December 4(12): 1-2.

Introduction

Goats play a key role in the Pakistan livestock economy, with a significant portion of the produce being in the form of meat and hides, with a large number of smallholders being sustained by the goats. They are adapted to changing behavior, high reproductive rate and the capacity to exploit a large variety of fibrous plant materials ensures they can survive even when the quality of feeds vary greatly over the course of the year. Still, even goats, with their higher browsing ability and their highly selective feeding habits, have their performance restricted, when subjected to the low-quality and highly-lignified forages normally found in arid and semi-arid areas of the nation. Forages that are harvested at a high level of maturity or at extreme climatic conditions lignify and therefore become less ruminal degradable and less metabolizable energy [1]. These limitations have led to the need to find ways of feeding that increase the digestibility of fibers and optimize the overall efficiency of nutrient use among producers and nutritionists. Even though high-grain diets are a quick way to increase the level of energy, they put goats at risk of ruminal acidosis, dysbiosis, and metabolic disorders because of the fast-fermentation pattern and the ability to inhibit fibrolytic microorganisms [6]. There is therefore an increased interest in fiber based dietary alternatives that do not undermine rumen stability but in maintaining energy supply. Non-forage fibre sources (NFFS) include hulls of soybean, beet pulp and citrus pulp, which are slowly fermentable structural carbohydrates that promote fermenting fibrolytic microbial populations, reduce rumen pH variability and increase fermentation performance. In addition to exogenous fibrolytic enzymes, i.e., cellulases and xylanases, the use of such feed resources can greatly increase the degree and speed of fibre digestion, shorten the rumen retention time, and enhance more effective utilization of fibrous feedstuffs [2,3]. Integration of NFFS and enzymes therefore is a viable cost-efficient approach to complicating the issue of nutrition in goat producers in Pakistan.

Non-Forage Fiber Sources in Goat Nutrition

The sources of non-forage fibers are mainly agro-industrial and are a very cheap substitute to traditional forages. The specific characteristics of soybean hulls and beet pulp include good chemical composition: low lignin levels, high amounts of hemicelluloses, and a structural form that allows for quick yet controlled ruminal fermentation [4]. These features make NFFS highly adaptable to the rumen physiology of goats, whose rumen is specialised for digesting fibrous substances and maintaining a stable microflora.

Structural and Fermentation Characteristics

The composition of soybean hulls consists mostly of neutral detergent fiber and a large amount was rapidly fermentable hemicellulose. Their small bulk density and high palatability promote an increase in the amount of feed consumed and inhibit the occurrence of the selective feeding behavior- a widespread problem in goats because they are browsers. Beet pulp on the other hand has a special composition of soluble and insoluble fiber that includes pectins which ferment quickly without causing the lactic acid to build up. This property promotes good volatile fatty acid (VFA) composition, which is majorly acetate and propionate, which increase the availability of energy and rumen motility.

Role in Pakistani Production Systems

Inequalities in the supply of nutrients are also caused by seasonal changes in the availability of native forage in Pakistan. In dry seasons, the local forages can reduce to very low levels of crude protein and digestible energy thus interfering with growth and reproductive performance. NFFS provide a reliable and stable source of fiber which can be added to mixed rations or serve as a partial replacement of forage when that becomes scarce. Since these ingredients are by-products of processing, they also contribute to the sustainability of reducing the feed waste streams and decreasing the feed costs.

Importance of Non-Forage Fiber Sources in Goat Nutrition

Significance of Non-Forage Source of Fiber in Goat Feeding. Psychologically slow fermentation of NFFS is highly critical in maintaining the rumen steady. Unlike cereal grains whose fermentation is rapid and makes lactate producing bacteria active, NFFS provide a stable feed supply to maturing fibrolytic microbial communities. It is a moderated fermentation process that reduces the risks of subacute ruminal acidosis, promotes optimum development of VFA and prevents unexpected rumen PH declines [6].

Nutritional Advantages Increased energy: NFFS supply uniform energy in terms of fermentable carbohydrates, which enhance the growth of rumen microbes and, as a result, the synthesis of microbial protein.

Reduced risk of dysbiosis: By preventing lactic acid accumulation, NFFS help maintain a balanced microbial ecosystem.

- **Higher palatability:** Feed intake increases when diets include highly palatable ingredients like soybean hulls.
- **Lower reliance on grains:** Reducing grain inclusion helps decrease production costs and improve metabolic safety.

Economic and Practical Benefits

NFFS has aided in developing cost-effective strategies of feeding, which are particularly useful in the smallholder systems in Pakistan. They enable them to compete minimally with human food chains, produce less feed, and be nutritionally resilient to feed scarcity. Since goats tend to graze marginal lands, NFFS fortifies the production systems by offsetting the poor nutrient content of the grazing resources.

Role of Fibrolytic Enzymes

Exogenous fibrolytic enzymes boost the dismantling of cell wall components by hydrolyzing cellulose, hemicellulose and related polysaccharides. Despite the fact that ruminal microbes naturally synthesize

fibrolytic enzymes, the process is usually sluggish and incomplete particularly when animals are given lignified forages. Extrinsic cellulase and xylanase supplementation maximize the hydrolysis rate and the enzyme activity spectrum of the rumen microbiome cannot do this on its own [2].

Mechanism of Action

The action of fibrolytic enzymes occurs in a number of ways: Pre-ruminal hydrolysis: There is a pre-ruminal enzyme activity, which makes fiber more complex even before it reaches the rumen. Examples Enzymes break down lignin-structural carbohydrate linkages, which enables rumen microbes to have easier access to fiber. Synergistic interactions with the microbes: Enzymes (via raising the availability of oligosaccharides and simple sugars) induce growth and fermentative ability of microbes. Greater retention time of rumen: Shorter fiber degradation decreases the rate of digesta retention that promotes high feed consumption.

Performance Outcomes

It has been shown that enzyme supplementation facilitates the general increase in VFA production, the increase in the production of microbial proteins, and the efficiency with which nitrogen is utilized [7,8]. Moreover, goats that have been given enzyme diets have been found to be less susceptible to nutritional stress and have limitations on immune systems, likely due to the improved balance of energy and reduced burden on their metabolism.

Nutrient Digestibility

Feed Intake and Dry Matter Intake (DMI)

Feed intake refers to the quantity of feed that a dairy cow should be able to consume each day in order to meet her weight gain objectives. Soybean hulls and beet pulp are highly palatable which encourages increased feed consumption as compared to the roughages which are traditional. They have lower physical fill which stimulates goats to eat more of the dry matter. Intake is further enhanced by better fiber breakdown when rumen fill is reduced, and fermentation is increased by the added enzymes, which are fibrolytic ones. Various studies have indicated that supplementation of small ruminant diets with enzymes has been found to increase DMI by 10-15 percent [7,8].

Fiber Digestibility (NDF and ADF)

The structural features of NFFS make them more digestible in nature. Breakdown of NDF and ADF is further enhanced with enzyme supplementation in which more cell wall polysaccharides are available to fermentation by microorganisms. This increases VFA production, especially acetate which promotes fat deposition and milk fat production [4,9]. Better digestibility is translated into greater energy harvesting, less feed waste, and greater animal performance.

Average Daily Gain (ADG)

The increase in the rate of digestible energy is manifested in increased growth rates. Studies in goats and sheep have found out that the NFFS mixed with fibrolytic enzymes results in a faster weight gain, healthier muscle accretion, and enhanced growth performance [10]. This has been particularly effective on goats that are reared by using intensive or semi-intensive production systems that prefer rapid growth.

Feed Conversion Ratio (FCR)

The number of feed units to produce one unit of body weight gain reduces as there is an increment in the use of fiber. The improvement of FCR is typically 6-22 when enzyme supplement has been added that is testimony to a more efficient feed to tissue translations [11]. The second one is more advantageous to systems in case a large portion of production costs is feeds.

Gain-to-Feed Ratio (G:F)

The digestible organic matter is better uptaken and fermentation routes are increased leading to better G:F ratios. Animals fed on NFFS with enzyme additives show homogeneous response to the most significant measure of feed efficiency [9].

Body Condition Score (BCS)

Regular production of nutrients and high metabolic rate set high score and optimal body condition of goats, especially, when they are under the pressure of nutritional conditions, e.g., drought or early lactation. Optimized BCS promotes reproductive performance, augmented immune performance, and to the consistent production performance [12].

Fecal Score and Digestive Health

The NFFS and enzyme dietary plans promote healthy feces and general digestive stability. Enhanced digestion of fibers leads to decreased feces and increased absorption of nutrients thus signifying balanced rumen activity and gut health [10].

Sustainability and Broader Implications

The implementation of NFFS in the goat feeding programs will ensure the sustainability of agriculture through the use of the agro-industrial by-products which in other cases will amount to wastage. Such feeding mechanisms also minimize the use of cereal grains which contributes to food-feed competition. Improved nutrient digestibility decreases the excretion of nitrogen and fibers and decreases the environmental impact of goat production systems. To smallholder producers in Pakistan who frequently have limited economic and climatic resources, the introduction of NFFS and fibrolytic enzymes is a viable solution to raising productivity without necessarily having to raise costs. There is also the use of fiber diets, which facilitate rumen microbial diversity and long-term rumen healthy, which contributes to stronger and tougher animals [14,15].

Conclusion

The nutritionally desirable non-forage fiber sources like the hulls of soybean and the pulp of beet provide a cheaper and healthier alternative to the traditional roughage sources of goats. They have a stable rumen activity and nutrient supply due to their structural and fermentation properties and improved performance. In conjunction with fibrolytic enzyme supplements, the quality of NFFS is enhanced significantly leading to tremendous gains in digestibility, feed consumption, growth rate and feed efficiency. These strategies are quite similar to the requirements of the goat production systems in Pakistan as they offer viable and sustainable solutions of improving the level of productivity and profitability.

References

[1] Government of Pakistan. Pakistan Economic Survey 2024-25. Islamabad; 2025.
[2] Beauchemin KA, Colombatto D, Morgavi DP, Yang WZ. Use of exogenous fibrolytic enzymes to improve feed utilization by ruminants. J Anim Sci. 2003;81:37-47.
[3] Durge A, Tiwari J, Nair PM, Singh AK, Yadav SK, Chouraddi R, et al. Role of fibrolytic enzymes in ruminant nutrition. Curr J Appl Sci Technol. 2022;41:45-58.
[4] Chellapandian. Nutritional evaluation of soybean hulls in small ruminants. J Entomol Zool Stud. 2019;7:408-410.
[5] Gurung NK, Rush J, Pugh DG. Feeding and nutrition of small ruminants. In: Sheep, Goat, and Cervid Medicine. Elsevier; 2020.
[6] Bo Trabi E, Seddik H, Xie F, Lin L, Mao S. Ruminal bacterial community and fermentation of lambs fed high-grain rations. Anim Feed Sci Technol. 2019;253:1-12.
[7] Salem AZM, El-Adawy M, Gado H, Camacho LM, González-Ronquillo M, Alsersy H, et al. Exogenous enzymes and growth performance in goats. Trop Subtrop Agroecosyst. 2011;14:867-874.
[8] Azzaz HH, Aboamer AA, Alzahar H, Hassaan NA, Murad HA. Effect of cellulases supplementation on milk yield and feed utilization in goats. Int J Dairy Sci. 2020;15:48-53.
[9] Zhou G, Liang X, He X, Li J, Tian G, Liu Y, et al. Enzyme supplementation improves goat performance. Appl Microbiol Biotechnol. 2023;107:7287-7299.
[10] Bilal M, Malik MI, Rashid MA, Khurshid MA, Yousaf MS, Rehman HU. Influence of physical forms of non-forage diet on growth and digestibility in goats. Small Rumin Res. 2025;242:107407.
[11] NE E-B, HM E-S, Hemmat S, AT M. Evaluation of fibrolytic enzymes in ruminants. J Environ Sci. 2017;39:69-90.
[12] Ghosh CP, Datta S, Mandal D, Das AK, Roy DC, Roy A, et al. Body condition scoring in goats. J Entomol Zool Stud. 2019;7:554-560.
[13] Van der Laan S, Breeman G, Scherer L. Animal lives affected by meat consumption in G20. Animals. 2024;14:1662.
[14] Zhang X, Liu X, Xie K, Pan Y, Liu F, Hou F. Rumen microbial structure under different fiber diets. BMC Microbiol. 2025;25:180.
[15] Weimer PJ. Degradation of cellulose and hemicellulose by rumen microbes. Microorganisms. 2022;10:2345.