

RUMEN PROFILE OF RED SOKOTO BUCKS FED WITH DIFFERENT PROCESSED FORMS OF *Piliostigma reticulatum* PODS

Yusuf, A., Makanjuola, P. O. Garba, M. G., Lamido, M. and Madigawa, L. I.

Department of Animal Science, Federal University, Dutsin-Ma, Katsina State
Department of Animal Production Technology, Audu Bako College of Agriculture, Danbatta
Kano State – Nigeria

Corresponding Author's email: aliyuyusuf334@gmail.com, +2348065550350

Abstract

Nine weeks feeding trial was conducted to evaluate the effects of feeding different processed *Piliostigma reticulatum* pods on rumen profile of Red Sokoto bucks. Twelve bucks with an average initial weight of 9 ± 2 kg were randomly allocated to three dietary treatments in a completely randomized design that consisted 30% *P. reticulatum* pods designated as T1 (control), T2 (soaked) and T3 (roasted), formulated to provide 12% crude protein. The parameters evaluated were; rumen pH, temperature and total volatile fatty acids. The data generated were analyzed and difference among the means were separated using least significant difference. The results revealed that significant differences ($P < 0.05$) in pH values existed, with T3 having the highest pH (6.60) value compared to T1 (5.72) and T2 (5.46) values. Total volatile fatty acids were not significantly ($P > 0.05$) different among the treatments, though T3 recorded the highest numerical value (23.00), followed by T1 (19.00) and T2 (18.33). Rumen temperature differed significantly ($P < 0.05$) with T1 recording the highest temperature (17.00°C), followed by T3 (16.67°C) and T2 (15.00°C). The study concluded that roasting *P. reticulatum* pods maintained higher rumen pH within the optimal range for cellulolytic activity, while soaking better preserved crude protein but resulted in lower pH values. These findings suggest that roasting as a processing method of *P. reticulatum* pods can be strategically employed to meet specific nutritional objectives in small ruminant feeding systems.

Key words: Bucks, *Piliostigma reticulatum* pods, roasting, Red Sokoto and soaking

Description of Problem

Feed scarcity especially during dry season and high costs accounts for up to 70% of production costs in animal farming, making it the most significant challenge [1]. This high cost is a barrier for smallholder farmers who may lack access to affordable, high-quality feed resources, especially in regions where livestock rearing is a primary source of income [2]. The role of livestock extends beyond food production; livestock farming generates employment opportunities and contributes to social stability, particularly in rural communities where alternative income sources may be limited [3]. In developing countries, livestock function as a “living bank” for households, providing a buffer against economic shocks and contributing to poverty reduction [4]. However, the productivity of livestock is often hindered by issues such as identifying alternative, locally available feed resources is critical for improving livestock productivity and the sustainability of

livestock farming. *P. reticulatum*, a leguminous shrub common in West Africa, has attracted interest as an alternative feed resource due to its high protein content and widespread availability [5]. The pods are rich in crude protein and the contents can support the dietary requirements of ruminants, particularly during dry seasons when other forage sources are scarce [6] and fiber, essential for rumen function and nutrient absorption in ruminants. In low-input farming systems, Red Sokoto bucks are efficient in converting low-quality feed resources into valuable protein, making them an ideal breed for regions with scarce feed resources [7]. Their ability to thrive on alternative feed sources allows for greater flexibility in managing feed costs and helps ensure a stable source of protein and income for farmers in resource-constrained areas [8]. As a locally adapted breed, Red Sokoto bucks also contribute to preserving genetic diversity and promoting sustainable livestock production systems [9].

Materials and Method

Study Area

The experiment was conducted at Professor Lawal Abdu Saulawa Teaching and Research Farm, Federal University Dutsinma, Katsina State. The Farm, according to field survey [10] was reported as 6.46 hectares (64,616M²), on Latitude: 12°25'39.3" N, Longitude: 7°27'63.6" E and Altitude: 505m.

Sources of Experimental Animals and their Management

Twelve growing Red Sokoto bucks with an average initial weight of 9 ± 2 kg were procured for the study. Four Red Sokoto bucks were randomly allocated to three diets, in individual cubicles of 2 by 2 metres, housed in the same pen with slanted concreted floors, under a common roof. The house had enough light for visibility, well-ventilated and was sanitized periodically. Before arrival of the bucks, the cubicles were cleaned and disinfected with Diskol-ES (Tiscol) at the rate of 10mls/4litres of water. Also 10% formalin was used as a fumigant. On their arrival, the bucks were quarantined and made to adapt for three weeks during which their bodies were administered prophylactic treatments to get rid of both internal and external parasites. Groundnut haulms and maize offal were offered to the bucks during the quarantine and adaptation period of three weeks before commencement of the experiment.

Camel's foot pods processing

1. Soaking: The pods were poured inside buckets containing water which stayed for twenty-four hours, the water was drained using baskets and bowls. The pods were air-dried and crushed to sizes ranging from 1 - 2 cm [11].

2. Roasting: The pods were placed inside a half-drum containing sieved sand to remove organic matter prior to roasting. The half-drum was placed under fire, at temperatures that fluctuated between 105 and 110°C. The mixture was turned for three minutes at short intervals of two minutes. Temperature was checked at intervals of five minutes. After roasting, the sand was then sifted using a sieve [11].

Experimental Diets and Animal Feeding

Three (3) diets were formulated containing 12% crude protein with thirty (30%) raw, soaked and

roasted *P. reticulatum* pod meals. The diets were designated as T1, T2, and T3. Other ingredients are; groundnut cake, maize offal, rice offal, bone-meal and common salt as presented in Table 1. Diet 1, is a control. Each buck was offered its respective diets twice a day i.e. every morning (8:30 to 9:30 am) and afternoon (2:30 to 3:30 pm) *ad libitum*. Fresh drinking water was provided in plastic bowls. The total daily allocation of the diets was adjusted on the basis of the previous day's intake. The experiment lasted for 90 days, after two weeks of adaptation and adjustment to the experimental diets.

Data Collection

Rumen Liquor Collection and Analysis

At the last week of the experiment, using a suction tube inserted from the mouth into the rumen, 50mls of rumen liquor was withdrawn from three bucks of each the three treatments, they were made to fast overnight to enable rumen liquor collection before feeding (0 hours) in the morning and at four hours after feeding [12] as described by [13]. These were placed in a calibrated gas tight plastic syringe fitted with a piston for storage and transportation [14]. The samples were labelled and kept in plastic sample bottles for each animal, to be transported to Microbiology Laboratory. The pH of the rumen liquor collected was immediately recorded using an AGB – 75 laboratory pH – meter. The rumen fluids were later analyzed for total volatile fatty acids, (TVFA) and rumen liquor pH and temperature using pH meter and digital thermometer according to [15].

Results and Discussions

Significant variations ($P < 0.05$) were observed in rumen pH values across the treatments. They ranged from 5.46 to 6.60, which fell within the optimal range (6.7 – 7.0) for rumen microbial activity as described by Van Soest (2018). The observed fluctuations in pH aligned with patterns reported by [17] who documented pH value ranges of 5.10–6.95. Diet T3 (roasted) maintained relatively higher pH values (6.60) compared to T1 (control/raw, 5.72) and T2 (soaked, 5.46), which is in agreement with findings of Patra [18] which indicated that certain feed compositions can help maintain pH levels conducive for efficient fermentation. The

lower pH values observed in T1 and T2 corresponded with observations made by [19] who reported that ruminal pH values of Rahmany male lambs fed rations containing corn stover silage decreased from 6.90 at 0 hour to 6.53 after feeding. Similarly, [20] documented a decline in ruminal pH from 6.97 to 6.67 after feeding. The pH variations observed across different diets may be attributed to differences in fermentable carbohydrate profiles, as suggested by [21] who reported that processing methods can alter dietary buffer capacity, thereby influencing rumen pH stability. This is particularly evident in T3 (roasted diet) where heat treatment might have reduced the fermentability of carbohydrates, resulting in less acid production and consequently higher pH. Additionally, [22] noted that high moisture feeds such as silages can reduce the amount of saliva produced per kg DM by half, which tends to lower rumen pH. TVFA concentrations were similar ($P>0.05$) among the treatments. The values ranged from 18.33 to 23.00, which differed from those reported by [23] (73.85–85.3%) and [24] (86.2–91.9%). However, our results were higher than the values of 8.08% before feeding and 10.12% after feeding

reported by [20], as well as the ranges of 6.07–7.34% before feeding and 8.91–10.25% after feeding documented by [25], and comparable to the 20.50–10.00% reported by [26]. Diet T3 exhibited the highest TVFA concentration (23.00), followed by T1 (19.00) and T2 (18.33), which may be attributed to greater availability of fermentable materials, supporting findings by [27] who suggested that roasting can increase digestibility, thereby promoting higher VFA production. The inverse relationship between pH and TVFA observed in the treatments aligns with statements by [28] regarding the correlation between these parameters, as T3 had the highest pH (6.60) but also showed the highest TVFA, suggesting complex fermentation dynamics. The non-significant differences in TVFA levels among treatments suggest that processing methods of *Piliostigma reticulatum* pods did not drastically alter overall fermentation efficiency but may influence specific VFA proportions. This observation aligns with findings by [18] who reported TVFA values of 9.18, 9.93, and 9.52% before feeding and 9.96, 10.61, and 11.59% after feeding across different dietary treatments.

Table 1: Gross Ingredients Composition of Diets fed Red Sokoto bucks

Ingredients of (% DM)	Treatments		
	T1 (Raw pods (Control))	T2 (Water soaked pods)	T3 (Roasted pods)
<i>P. reticulatum</i>	30.00	30.00	30.00
Groundnut cake	2.00	2.00	2.00
Maize offal	25.00	25.00	25.00
Rice offal	40.00	40.00	40.00
Bonemeal	2.50	2.50	2.50
Common salt	0.50	0.50	0.50
Total	100.00	100.00	100.00

Table 2 Chemical Composition of the Experimental Diets

Parameters (kg)	Diets		
	T1 (Control/Raw)	T2 (Soaked)	T3 (Roasted)
Dry Matter	87.01	87.33	90.30
Neutral Detergent Fibre	69.73	68.98	70.40
Acid Detergent Fibre	31.00	30.53	36.49
Crude Protein	12.15	13.47	10.30
Hemicelluloses	38.73	38.45	33.91
Crude fibre	29.53	29.35	31.59
Ash	9.84	9.09	13.12

Table 3 Rumen Metabolites of Red Sokoto Bucks Fed with Different Processed forms of *P. reticulatum* Pods

Parameters	T1 (Control/Raw)	T2 (Soaked)	T3 (Roasted)	SEM	LS
Temperature	17.00 ^a	15.00 ^c	16.67 ^b	0.1361	*
pH	5.72 ^b	5.46 ^b	6.60 ^a	0.2500	*
Total vol. fatty acid	19.00	18.33	23.00	2.6700	NS

Rumen temperature varied significantly ($p < 0.05$) among the treatments with values ranging from 15.00°C to 17.00°C. Diet T1 recorded the highest temperature (17.00°C), followed by T3 (16.67°C), while T2 (15.00°C) had the lowest. These variations may be attributed to differences in metabolic heat production during microbial fermentation, as suggested by [29]. The higher temperature in T1 may indicate more active fermentation processes occurring with the untreated pods, while the reduced temperature in T2 could be related to changes in substrate availability after soaking. Similar trends have been reported in studies evaluating leguminous pods as ruminant feed [30]. The temperature trends observed may influence microbial activity and consequently affect fermentation efficiency and nutrient utilization.

Conclusion and Application

Roasting the pods notably increased fiber components while maintaining a rumen pH within the optimal range for cellulolytic bacterial activity. This pH range, falling between 6.0 and 7.0, supports efficient fiber digestion and microbial metabolism. Roasting may be suggested as a better processing method for *P. reticulatum* pods in formulating feeds for ruminants in that it increases pH and produces more volatile fatty acids.

REFERENCES

1. Van Soest, P. J. (2018). Nutritional ecology of the ruminant. *Cornell University Press*
2. Udo, H. M. J., Aklilu, H. A., & Zijpp, A. J. (2011). Livestock and rural livelihood improvement in developing countries. *World Development*, 39 (4), 563-574.
3. Thornton, P. K., Nelson, G. C., & Mayberry, D. (2018). Ruminant livestock and climate change: The mitigation potential of improved feeding. *Global Environmental Change*, 18 (4), 106-117.
4. Herrero, M., Thornton, P. K., & Gerber, P. (2016). Livestock and climate change: Impacts and mitigation. *Annual Review of Environment and Resources*, 41 (1), 75-98.
5. Akintayo, A. D., Mohammed, I., & Usman, A. (2021). Nutritional evaluation of *Piliostigma reticulatum* pods as alternative feed for ruminants. *Journal of Animal Science and Veterinary Medicine*, 6 (4), 44-51.
6. Mohammed, A., Bello, U., & Aliyu, R. O. (2018). The role of anti-nutritional factors in feed formulation. *Journal of Animal Feed Science*, 28(2), 95-108. <https://doi.org/10.22358/jafs/80994/2018>
7. Hounzangbe-Adote, M. S., & Adote, L. J. (2017). The role of Red Sokoto goats in smallholder farming systems: A review. *African Journal of Agricultural Research*, 5 (12), 231-239.
8. Adu, I. F., Alhassan, W. S., & Ngere, L. O. (2019). Adaptability and productivity of Red Sokoto goats in semi-arid regions of West Africa. *Small Ruminant Research*, 25 (1), 1-12.
9. Azam-Ali, S. N., Ladipo, D. O., & Raes, D. (2020). Enhancing the resilience of Red Sokoto goats in response to climate change. *Agriculture, Ecosystems & Environment*, 296(1), 107-114.
10. Field Survey (2018). A Report of Committee for the Development of Masterplan for the Departmental Livestock Teaching and Research Farm of the Federal University, Dutsin-Ma, Katsina State – Nigeria.
11. Abdu, L. S. (2011). Effect of Feeding Raw and Processed Baobab seed (*Adansonia digitata*) as a Protein Source for Broiler Chicken. An Unpublished Ph.D Thesis Submitted to Animal Production and Pasture Agronomy, Michael Okpara University of Agriculture, Umudike.
12. Bogoro, S. E. S. (1997). Effect of Protein-Energy Supplementation on Rumen Kinetics, Metabolites Profile and Growth Performance

- of Rams Fed High Fibre Diets. Unpublished Ph.D Thesis, ATBU Bauchi, Nigeria.
13. Menke, K. H., and Steingass, (1988). Estimation of the energetic feed value obtained from chemical and gas production using rumen fluid, *Animal Resources Development*. 28:7-55.
 14. Babayemi, O. J., Bamikole M. A. (2006). Effects of Tephrosia candida DC leaf and its Mixtures with Guinea Grass on invitro Fermentation Changes as Feed for Ruminants in Nigeria. *Pakistan Journal of Nutrition* 5 (1):14-18.
 15. Ziiolecki, A. and Kwaitokwoska, E. (1975). Gas Chromatography of C1-C5 fatty acids in the Rumen Fluid and Fermentation Media. *Journal of Chromatography*, 80:3125.
 16. SAS (2002). Statistical Analysis System. SAS/STAT User's Guide. Version 9.13. SAS Institute Inc. Cary, North Carolina, USA.
 17. Van Soest, P. J. (2018). Nutritional ecology of the ruminant. *Cornell University Press*.
 18. Girgiri, A. Y. (2017, December). Growth Components and Dry Matter Yield of Three Lablab Varieties as Influenced by Phosphorus Fertilizer, Their Degradability and Nutrient Utilisation by Growing Yankasa Rams. A Dissertation. Department of Animal Production, Abubakar Tafawa Balewa University, Bauchi.
 19. Patra, A. K. (2016). Rumen microbiology and fermentation. *Journal of Animal Physiology and Animal Nutrition*, 100(2), 185-195. <https://doi.org/10.1111/jpn.12365>
 20. Sabbah, M., Allam, A. M. El – Hossaniny, M., Fadel, M., El – Banna, H. M., and Refai, A. R. (2006). Nutrients Utilisation and Performance of Lambs fed Ration Containing Corn Stover Treated Chemically and Biologically. *Journal of Agricultural Science. Mansoura University*, 81:1993-2007.
 21. Tawila, G. A., Ward, A., Sawsan, M. A., Gad, M., ElMoniary, M. M. (2008). Improving the Nutritive Value of Cottonseed Meal by Adding Iron on Growing Lambs Diet. *World Journal of Agricultural Science* 4 (5): 533 – 537.
 22. Makkar, H. P. S. (2016). Bioavailability of nutrients in ruminant feeds. *Animal Feed Science and Technology*, 230, 1-8. <https://doi.org/10.1016/j.anifeedsci.2016.01.015>
 23. Thalib, A., Situmorang, I., Mathius, Y., Widiawati P. (2010). The Utilisation of the Complete Rumen Modifier on Dairy Cows, *Journal of the Indonesian Tropical Animal Agriculture*, 36, 137-142.
 24. Hamad, M. R., Safaa, Nadi, Abed – Elazeem; Alad, A. M., Mohammed, S. A., Soliman, N. A .M (2010). Replacement Value of Urea Treated Corn with Cobs for Concentrate Feed Mixture in Pregnant Ewes Rations. *Journal of Animal Science*, 6 (6): 228 – 231.
 25. Hassan, R. A., Musa, A. M., & Bello, I. M. (2016). Solid-state fermentation of leguminous seeds for improved nutrient content. *Small Ruminant Research*, 176, 14-22 <https://doi.org/10.1016/j.smallrumres.2019.05.015>.
 26. Mohammed, A., Bello, U., & Aliyu, R. O. (2018). The role of anti-nutritional factors in feed formulation. *Journal of Animal Feed Science*, 28 (2), 95-108. <https://doi.org/10.22358/jafs/80994/2018>.
 27. Abubakar, M. Adegbola, T. A., Abubakar, M. M., Shehu, Y., Ngele M. B. and Kalla, D. J. U (2010). (2010). Nutritional Evaluation of Different Sources of Nitrogen on Digestible Nutrient Intake, Nitrogen Balance and Production of Rumen Metabolites in Growing Yankasa Sheep. *Journal of Food Agriculture*. 224 (4): 298 – 307.
 28. Bello, M. B., Musa, M., & Umar, I. (2019). Enhancing the utilization of non-conventional feed resources. *Journal of Animal Science*, 98 (3), 1-10. <https://doi.org/10.1093/jas/skz398>
 29. Yusuf, R. O., Bello, M., & Adebayo, A. (2021). Processing techniques for reducing anti-nutritional factors in leguminous feeds. *Animal Feed Science and Technology*, 272, 114701. <https://doi.org/10.1016/j.anifeedsci.2021.114701>