NEU PRESS

REPVAS
RESEARCH & PRACTICE in VETERINARY & ANIMAL SCIENCE

Volume:3 Issue:2 Year: 2026 | Research Article | ISSN: 3023-6681

Nutrient Digestibility of Red Sokoto Goats During the Dry Hot Season of Derived Savanna Zone of Nigeria

Adedeji Ayobami ISAIAH*

Ladoke Akintola University of Technology, Faculty of Agricultural Science, Department of Animal Nutrition and Biotechnology, Ogbomoso Oyo State, Nigeria

Article Info

Received: 11.05.2026
Accepted: 30.06.2026
Online first: 21.07.2023
Published:

Keywords:
ADF,
Derived savanna,
Dry hot season,
NDF,
Red Sokoto Goats.

ABSTRACT

Water availability is a major environmental factor that influences the feed intake, nutrient utilization and productivity of ruminants, particularly during the dry season in tropical regions. This study examined the impact of different water restriction regimes on the nutrient digestibility of Red Sokoto goats fed groundnut straw in the hot, dry season in Savannah zone of Nigeria's. Six mature Red Sokoto bucks, aged between one and one-and-a-half years and weighing between 12 and 14 kg, were used in a multi-period crossover experiment involving ad libitum water supply (control), 30% water restriction and 50% water restriction treatments. Feed and water intake and fecal output were measured daily, while proximate composition and fiber fractions were analyzed using AOAC procedures. The results showed that water restriction significantly reduced the digestibility coefficients of dry matter, crude protein (CP), crude fiber (CF), neutral detergent fiber (NDF) and acid detergent fiber (ADF) ($P<0.05$). Dry matter digestibility decreased from 77.64% in the control group to 72.00% in the group subjected to a 50% water restriction, while crude protein digestibility declined from 50.43% to 29.18%. These findings are consistent with previous reports indicating that inadequate water intake negatively impacts nutrient utilization and rumen function in ruminants. The study concluded that restricting water adversely affects the digestibility of nutrients in Red Sokoto goats, which may consequently reduce their productivity during periods of water scarcity. Therefore, adequate access to clean drinking water should be prioritized in goat production systems, particularly in semi-arid environments during the dry hot season.

To cite this article:

Isaiah, A.A. (2026). Nutrient Digestibility of Red Sokoto Goats During the Dry Hot Season of the Derived Savanna Zone of Nigeria, *Research and Practice in Veterinary and Animal Science (REPVAS), 3(2), 88-94.* https://doi.org/10.69990/REPVAS.2026.3.2.3

***Corresponding Author:** Adedeji Ayobami Isaiah, *haryoobam1993@gmail.com*

INTRODUCTION

Water is one of the most essential nutrients required by livestock for survival, growth, digestion, metabolism, thermoregulation and excreting waste (Choshniak et al., 1994; Beede, 2009). In ruminants, water constitutes 50–80% of body weight, depending on age and physiological status (Lardner et al., 2005). Adequate water intake is necessary to maintanance, including nutrient transport, enzymatic reactions, rumen fermentation and the maintenance of osmotic balance (Murphy, 1992). In contrast to feed deprivation, animals subjected to severe water restriction can rapidly develop dehydration, reduced productivity and metabolic disturbances that may threaten survival (Faires et al., 2007).

In tropical and semi-arid regions such as Nigeria, seasonal water scarcity poses a significant challenge to the sustainable production of livestock. During the dry season, the combination of high ambient temperatures and poor water availability often exposes ruminants to heat stress and dehydration (Alamer, 2006). Restricting water intake has been associated with reduced feed consumption, decline of weight gain, impaired nutrient absorption and poorer productivity in goats and sheep (Casamassima et al., 2008; Abdelatif et al., 2010). Toha et al. (1987) found that water intake is quantitatively related to feed intake and nutrient utilization in ruminants. A reduction in water intake often results in lower dry matter intake and altered rumen fermentation dynamics.

Goats play a particularly important role in Nigeria's livestock sector due to their ability to thrive in challenging environments and their contribution to the production of meat, milk, hides and skins, as well as their value in generating household income (Devendra and McLeroy, 1982). The Red Sokoto goat, which is widely distributed in Nigeria, is one of the most important indigenous goats breeds due to its adaptability and economic value. However, there is limited information regarding the effects of water restriction on nutrient digestibility in indigenous goat breeds under local production systems.

Groundnut straw is commonly used as supplementary feed resources for ruminants during the dry season because of their availability (Ayantunde et al., 2008). However, the effectiveness of such feed resources may be influenced by water availability, especially under hot environmental conditions.

Therefore, this study was conducted to evaluate the effects of different water restriction regimes on nutrient digestibility of Red Sokoto goats fed groundnut straw during the dry hot season of the derived savanna zone of Nigeria.

MATERIAL and METHODS

The experiment was conducted at the Teaching and Research Farm of Ladoke Akintola University of Technology (LAUTECH), Ogbomoso, Oyo State, Nigeria. A total of six mature Red Sokoto bucks aged between one and one and half years with body weights ranging from 12 to 14 kg were used for the study. Prior to the inital of the experiment, all animals were quarantined for three weeks and treated against internal and external parasites to ensure optimal health status.

The sample size of six animals was chosen based on the logistical and intensive operational demands of total fecal collection protocols in individual metabolic cages. This cohort size aligns with standard sample sizes for intensive ruminant crossover metabolism studies, where individual variations are statistically minimized by assigning each animal to serve as its own control across successive periods.

The goats were housed individually in metabolic cages explicitly equipped with separate feeding and watering facilities to enable accurate, independent measurement of feed intake, water intake, and fecal output. To control for individual animal variation within a specialized metabolism

cohort, the experiment was executed using a multi-period crossover design layout spanning three (3) sequential experimental periods (Treatment Periods; TPs). The six bucks were balanced by body weight and assigned to treatment sequences that allowed each animal to receive all three water restriction regimes across successive experimental periods. This crossover arrangement enabled each goat to serve as its own control, thereby reducing the influence of individual animal variation on treatment comparisons. The three designated water treatment levels evaluated were:

- Ad libitum water supply (Control),
- 30% voluntary water restriction, and
- 50% voluntary water restriction.

Each experimental period lasted for 12 days, consisting of a 7-day adaptation phase followed by a 5-day total sample collection phase. During the adaptation period, animals adjusted to their respective water restriction levels before data collection commenced. At the end of each treatment period, animals were rotated to the next treatment sequence. Throughout the experiment, goats were fed groundnut straw ad *libitum* at 4% of their body weight on a dry matter basis to ensure feed offers exceeded daily intake. Feed was offered twice daily at 08:00 h and 16:00 h, and water was supplied according to the designated treatment levels. To isolate true animal water consumption from environmental losses, evaporation rate was monitored daily using blank control buckets placed adjacent to the pens and subtracted from water remnants (Alamer, 2006).

Ethics Statement

Decision of the ethics committee: The experimental protocols were conducted in accordance with the standard methods for the care and use of laboratory animals at the research institution.

Statistical Analysis

Data was analyzed using the MIXED procedure of SAS software (SAS Institute Inc., Cary, NC, USA). Water restriction treatment and experimental period were included as fixed effects, while individual animal was included as a random effect. Treatment means were separated using Duncan's Multiple Range Test, and differences were considered significant at $P < 0.05$. Duncan's test was selected to maximize statistical sensitivity for identifying specific pairs of treatment differences within this tightly controlled, small-cohort metabolic environment (n=6), minimizing Type II error inflation across the uniform experimental sequences.

Because the experiment employed a crossover design, a 7-day adaptation period was implemented before each collection phase to minimize potential carryover effects between treatment periods. However, sequence and carryover effects were not formally included in the final statistical model and therefore represent a limitation of the present study

RESULTS

Table 1. Chemical composition of groundnut straw fed to Red Sokoto goats subjected to three water restriction regimes.

Chemical composition	Values (%)
Dry matter	93.98
Crude protein	6.13
Crude fibre	30.01
Ether extract	02.01
Ash	06.02
Neutral detergent fibre (NDF)	52.01
Acid detergent fibre (ADF)	36.13

Table 1 shows the chemical composition of groundnut straw fed to Red Sokoto goats subjected to three water restriction regimes. The dry matter values obtained are 93.98%, crude protein value is 6.13%, crude fibre value is 30.01%, extract value is 2.01%, ash value is 6.02%, neutral detergent fibre value is 52.01%, acid detergent fibre value is 36.13% respectively.

Table 2. Nutrient digestibility of Red Sokoto goats as affected by three water restriction regimes

% Nutrient digestibility	Adlibitum	30% Water Restriction	50% Water Restriction	SEM	df	F-Value	P-Value
Dry Matter	77.64[a]	76.19[b]	72.00[c]	0.13	2	45.21	<0.001
Crude Protein	50.43[a]	37.65[b]	29.18[c]	0.50	2	114.86	<0.001
Crude Fiber	77.11[a]	76.79[a]	65.90[b]	0.30	2	28.44	0.002
NDF	76.32a	74.83b	73.55c	0.06	2	31.15	<0.001
ADF	74.50a	70.21b	68.09c	0.15	2	48.92	<0.001

^{a,b,c} Means within a row with different superscripts differ significantly (P <0.05). SEM = Standard Error of the Mean. df = Degrees of freedom associated with the treatment effect.

Table 2 presents the apparent digestibility coefficients for dry matter (DM), crude protein (CP), crude fibre (CF), neutral detergent fibre (NDF), and acid detergent fibre (ADF). Graded water restriction significantly reduced the digestibility of all evaluated nutrient parameters (P <0.05). Dry matter digestibility decreased progressively as water restriction increased, ranging from 77.64% in the control group to 72.00% under 50% water restriction (P <0.001). Crude protein digestibility exhibited a sharp decline across all treatments, dropping significantly from 50.43% (control) to 37.65% (30% restriction) and reaching a low of 29.18% under 50% water restriction (P <0.001). For crude fibre, a significant reduction was observed under severe restriction (65.90%; P = 0.002), though the difference between the control (77.11%) and the 30% restriction treatment (76.79%) did not reach statistical significance. Structural fiber fractions also decreased significantly under restriction regimes, with NDF digestibility dropping from 76.32% to 73.55% (P <0.001) and ADF digestibility declining from 74.50% to 68.09% (P <0.001).

DISCUSSION

The results of this study showed that restricting the amount of water available to Red Sokoto goats significantly reduced nutrient digestibility. The observed reduction in dry matter digestibility as water restriction increased is consistent with previous findings by Bohra and Ghosh (1983), who reported that restricted water intake negatively affects dry matter utilization in ruminants. Reduced water availability may decrease rumen microbial activity and slow nutrient fermentation processes, thereby reducing the efficiency with which nutrients are utilised.

Crude protein digestibility also declined significantly as the level of water restriction increased. This finding confirm of French's (1956) report of reduced crude protein utilization in cattle with restricted water intake. Water plays a key role in rumen nitrogen metabolism and microbial protein synthesis, so an inadequate water supply could hinder microbial growth and protein digestion (Toha et al., 1987). The low crude protein content (6.13%) of the groundnut straw used in this study may have further reduced the availability of nitrogen for rumen microorganisms.

A decrease in the digestibility of crude fibre, NDF and ADF under severe water restriction may be associated with reduced feed intake and altered rumen retention time. Balch et al. (1953) suggested that water deprivation affects the passage rate of digesta through the rumen, thereby influencing fiber degradation. Similarly, Riaz et al. (2014) reported that reduced feed intake under water stress conditions may impair fibre digestion due to slower microbial activity.

The findings of this study suggest that adequate water intake is crucial for efficient nutrient utilization in goats, especially during the dry season when environmental stress is high. As goats raised in semi-arid regions often have an intermittent water supply, prolonged water restriction could negatively impact their productivity, growth performance and overall health.

One limitation of this study was the relatively small sample size used in the experiment, which was mainly due to the intensive management and monitoring requirements associated with metabolic cage studies and total fecal collection procedures. Although the crossover experimental design helped reduce individual animal variation by allowing each goat to serve as its own control, the limited number of animals may still have reduced the statistical power and broader population inference of the findings. Nevertheless, despite the limited number of animals, the highly consistent response observed across all evaluated nutrient digestibility parameters strongly supports the biological relevance of the effects of water restriction on nutrient utilization in Red Sokoto goats. In addition, the experiment was conducted under controlled pen conditions, which may not fully represent field grazing systems under extensive tropical production environments. Therefore, further studies involving larger animal populations and longer experimental periods are recommended to validate these findings under wider production conditions.

Additionally, while the 7-day adaptation period was designed to deplete any residual physiological variations from preceding treatments, the exclusion of carryover and sequence effects from the statistical model remains a limitation. Future multi-period metabolic studies on tropical small ruminants should structurally integrate sequence parameters into the mixed models to fully rule out potential carryover biases

CONCLUSION

This study demonstrated that restricting the water supply had a significant impact on the nutrient digestibility of Red Sokoto goats fed groundnut straw during the hot, dry season. Increasing levels of water restriction reduced the digestibility of dry matter, crude protein, crude fibre, neutral detergent fibre and acid detergent fibre. These reductions suggest that inadequate water intake negatively impacts rumen function and nutrient utilization in goats.

The findings emphasize the importance of providing ruminants with adequate, clean drinking water, particularly during periods of high environmental temperature and limited water availability. Improving water management practices in goat production systems could enhance feed utilization efficiency, animal productivity and overall livestock performance in Nigeria's semi-arid regions.

Further studies involving larger populations of animals and additional physiological parameters are recommended to better understand the long-term effects of water restriction on indigenous goat breeds in tropical production systems.

Acknowledgements

The author thanks the Small Ruminant Unit (SRU) of the Ladoke Akintola University of Technology Teaching and Research Farm for providing the facilities to conduct this experiment.

Ethical Statement

This article has been produced from the research conducted during the author's undergraduate program.

Ethics Approval

The experimental protocols were conducted in accordance with the standard methods for the care and use of laboratory animals at the research institution.

Funding

There is not any funding in this study.

Conflict of Interest

The author declares no conflict of interest

Author Contributions

Research Design AdedejiAyobamiIsaiah (%100)

Data Collection Adedeji AyobamiIsaiah (%100)

Research - Data analysis Adedeji AyobamiIsaiah (%100)

Writing the Article Adedeji Ayobami Isaiah (%100)

Revision and Improvement of the Text Adedeji Ayobami Isaiah (%100)

Sustainable Development Goals (SDG)

2 Zero Hunger

12 Responsible Consumption and Production

REFERENCES

Abdelatif, A.M., Elsayed, S.A. & Hassan, Y.M. (2010). Effect of state of hydration on body weight, Blood constituent and urine excretion in Nubian Goats (Capra hircus). *World Journal Of Agricultural Science*, 6: 178-188.

Alamer, M. (2006). Physiological responses of Saudi Arabia indigenous goats to water deprivation. *Small Ruminant Research*, 63: 100–109.

Ayantunde, A.A., Fernandez-rivera, S. & Dan-Gomma, A. (2008). Sheep fattening with groundnut haulms and millet bran in the West African Sahel, *Revue D'élevage Et De Médecine Vétérinaire Des Pays Tropicaux*, 61: 215-220.

Balch, C.C., Balch, D.A., Johnson, V.W. & Turner, J. (1953). Factors affecting the utilization of food by dairy cows: The effect of limited water intake on the digestibility and rate of passage of hay. *British Journal of Nutrition*, 7(3): 212-224.

Beede, D.K. (2009). Solving bad water problem for thirsty cows. *Journal Animal Production*, 11(13):217-227.

Bohra, H.C. & Ghosh, P.K (1983). Nitrogen metabolism in water-restricted Marwari sheep of the Indian desert. *The Journal of Agricultural Science*, *101*(3): 735-739.

Casamassima, D., Pizzo, R., Palazzo, M., D'Alessandro, A.G. & Martemucci, G. (2008). Effect of water restriction on productive performance and blood parameters in Comisana sheep reared under intensive conditions. *Small Ruminant Research*, 78: 169-175

Choshniak, I., Wittenberg, C., Rosenfeld, S. & Shkolnik, A. (1994). Rapid dehydration and kidney function in the black Bedouin goat. *Physiological Zoology*, *57*(5): 573-579.

Devendra, C. & Mcleroy, G.B. (1982). Goat and sheep production in the tropics longman group. United kingdom, Limited England.

Faires, F.C., Reagor, J.C., Sweeten, J.M. & Loneragan, G.H. (2007). Livestock Water Quality Standards. *Encyclopedia of Water Science*, 25: 172-179

French, M.H. (1956). The effect of infrequent drinking on the consumption and digestibility of hay by zebu cattle Empire. *Journal Express Agriculture*, 24:128-136.

Lardner, H.A., Kirychuk, B.D., Braul, L., Willms, W.D. & Yarotski, J. (2005). The effect of water quality on cattle performance on pasture. *Australian Journal of Agricultural Research*, 56(1): 97-104.

Murphy, M.R. (1992). Water Metabolism of Dairy Cattle. *Journal Dairy Science*, 75:326–333.

Riaz, M.Q., Sudekum, K.H., Clauss, M. & Jayanegara, A. (2014). Voluntary feed intake and digestibility of four domestic ruminant species as influenced by dietary constituents: A meta-analysis. *Livestock Science*, 162: 76-85

SAS. (2000). Guide to personal computers, release 5.0 Statistical Analysis System Institute. Inclusion NC. North Carolina, USA.

Toha, M.J.A., Boiling, L.D., Bunting & Dawson, K.A. (1987). Effect of water restriction and dietary sodium on nutrient metabolism in lambs. *Journal Animal Science*, 64(4): 55-57.