https://dx.doi.org/10.4314/dujopas.v9i3a.22
ISSN (Print): 2476-8316
ISSN (Online): 2635-3490
**Dutse Journal of Pure and Applied Sciences (DUJOPAS),** *Vol. 9 No. 3a September 2023*

# Effect of Feeding Diets Containing Levels of Ginger (Zingiber officinale) on Digestibility and Nitrogen Balance of Red Sokoto Bucks

***[1]Ibrahim U.M., [2]Abdu S.B., [2]Musa A. and [3]Saleh I.**

*[1]National Animal Production Research Institute,
Shika-Zaria,
Nigeria

[2]Department of Animal Science,
Ahmadu Bello University Zaria,
Nigeria

[3]National Agricultural Extension and Research Liaison Services,
ABU,
Zaria

Email: umibrahim@abu.edu.ng

## Abstract
*The apparent digestibility and nitrogen balance of nutrients in isocaloric and isonitrogenous diets containing 0, 250, 500 and 750 g ginger inclusion levels was studied in a 14-day trial involving twenty (20) red Sokoto bucks (RSB) weighing on the average 17.86 kg. The treatments were replicated five times in a completely randomized design. The animals were individually fed at 4% of their body weight for both the concentrate (1.5% as supplement) and Digitaria smutsii hay (2.5% as basal diet). The trial consisted of 7-day adjustment period followed by a 7-day total collection of faeces and urine. Nutrient digestibility, faecal and urine outputs were recorded. Results indicated a similar dry matter intake across the treatments. Crude protein and crude fiber intakes were significantly (P<0.05) affected by ginger inclusion levels with higher values recorded in the group fed 250 g. Dry matter digestibility significantly (P<0.05) increased with increase in ginger levels. Nitrogen retention was significantly (P<0.05) higher in bucks fed with 750 g ginger. It was therefore concluded that, varying inclusion levels of ginger improved nutrient digestibility and nitrogen retention of RSB. RSB can be fed up to 750 g/100 kg diet ginger.*

**Keywords:** Red Sokoto bucks, Ginger, Nutrient digestibility, Nitrogen retention, Diet.

## INTRODUCTION
Goats play an important role in the life of small-holder farmers via their ability to convert low-cost feed resource to high value products (meat and milk) (Aregawi *et al*., 2013). Goat is one of the most important, adaptable and geographically widespread livestock species, which provides a good source of meat, milk and other by-products and is therefore referred to as "poor man's cow" (Ajibike *et al.,* 2016). The role of goats in providing protein to humans is increasingly being recognized. However, feed constraint is the most important limiting factor

**Author for Correspondence*

in livestock production. This necessitates a high concern in developing some alternatives for improvement of their productivity through improved nutrition (Aregawi *et al*., 2013).
Ginger is widely used in animal nutrition and has been found to possess medicinal properties (Daharia *et al.,* 2022). Ginger is known for its biological effects such as antioxidants properties, anti-bacterial action and anti-inflammatory effects (Panpatil *et al.,* 2013). It is also a natural growth promoter and can improve feed utilization and nutrient digestibility of livestock (Pandey *et al*., 2019).

*Zingiber officinale* (ginger), a member of the Zingiberaceae family, is a rhizome plant that has been used as a spice in cooking throughout the world and as a therapeutic herb for a very long time (Ibrahim *et al.,* 2022). Ginger is rich in gingerols, shogaols and paradols, which are the main active phytochemicals that have strong antioxidant and chemopreventive properties (Panpatil *et al.,* 2013). Ginger essential oil contains several terpene components, such as β-bisabolene, a-curcumene, zingiberene, a-farnesene, and β-sesquiphellandrene (Elazab *et al*., 2022).

Tannins and saponins found in ginger prevent protein degradation in the rumen so that it can be effectively digested in the abomasum and the small intestine (Fajemisin and Adeleye, 2005). Muhammed *et al.* (2016) reported higher digestibility values for Yankasa Rams fed varying levels of ginger. Prediction of animal response to nutrients is the main focus of practical application of nutrients. Hence, the study was to determine the effect of feeding diets containing levels of ginger on digestibility and nitrogen balance of RSB.

## MATERIALS AND METHODS

### Study Area

The experiment was conducted at the National Animal Production Research Institute (NAPRI), Ahmadu Bello University (ABU), Shika, Zaria, Nigeria. Shika is located on latitude 11$^{o}$ 12'N and longitude 7$^{o}$ 33'E at an altitude of 640 meters above sea level (GPS, 2018). The climate is relatively dry with annual rainfall range of 700 – 1400 mm. The rain starts between late April and early May to September. The dry season begins in October with cold weather that ends in January (IAR, 2018).

### Experimental Feed Preparation

Feeds were compounded (Table 1) with inclusion levels of ginger at 0, 250, 500, and 750 g/100 kg diet. The formulation was done at the Feeds and Feeding Unit of NAPRI. They were compounded to contain 12% crude protein. Dry ginger was sourced from Samaru local market in Zaria and ground into powder using grinding machine before inclusion.

### Metabolism Trial of Red Sokoto Bucks

Twenty (20) RSB with 5 bucks per treatment were used for the trial. They were housed in individual metabolism cages with facilities for separate collection of faeces and urine as described by Osuji *et al.* (1993). Each buck was individually fed to evaluate the digestibility of the diet. The study had a 7-day preliminary period of adaptation to the metabolic crates and a 7-day collection of samples.

The faecal and urine samples were collected each morning before feeding. Urine was collected into plastic jerricans containing 10 ml. of 10% v/v of $H_2SO_4$ acid. Urine collected was measured daily and 10% sampled, bulked for each animal and kept at -4 °C in freezer until required for chemical analysis. Daily total faecal samples were collected from each buck,

weighed and 50 g was collected for dry matter determination and was bulked and stored in polythene bags until required for laboratory analysis.
Nutrient digestibility was calculated as the portion of nutrient intake not recovered in faeces. Nitrogen balance (NB) was calculated as the amount of average daily nitrogen intake (NI) not excreted in faeces (FN) and urine (UN).

**Chemical Analysis**
The feeds and faecal samples were analyzed for dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF), and ash using the procedures outlined by the Association of Official Analytical Chemists (AOAC) (2007). Acid detergent fibre (ADF) and neutral detergent fibre (NDF) were determined according to the procedures reported by Van Soest *et al.* (1991), procedures. Nitrogen N was determined using Micro Kjeldal method (AOAC, 2007).

**Statistical Analysis**
Data generated on nutrient digestibility coefficients and nitrogen retention were analyzed using the General Linear Model (GLM) procedure of SAS (2005). Significant differences between treatment means at 5% probability level were determined using Duncan's Multiple Range Test of the same software.

## RESULTS

**Nutrient Intake, Nutrient Digestibility and Nitrogen Balance of RSB Fed with Varying Inclusion Levels of Ginger**
Results of nutrient intake of RSB fed varying inclusion levels of ginger are presented in Table 2. Animals fed diet containing 250 g ginger had the numerically higher ($P>0.05$) intakes of DM, Ash and EE. Intakes of CF and CP were significantly higher ($P<0.05$) in the group fed diet containing 250 g ginger.

Results of nutrient Digestibility of RSB fed varying inclusion levels of ginger are presented in Table 3. It showed no significant difference ($P>0.05$) in crude fiber and organic matter digestibility. But all other parameters (DM, Ash, EE, CP, EE, NDF and ADF), respectively were significantly affected ($P<0.05$) by ginger inclusion. They recorded higher values in animals fed diet containing 750 g ginger.

Results of nitrogen balance in RSB fed varying inclusion levels of ginger are presented in Table 4. Total nitrogen intake was significantly ($P<0.05$) influenced by inclusion levels of ginger. Animals fed diet containing 750 g ginger had the higher nitrogen intake of 45.71 g/day, while those fed diet containing 500 g ginger recorded the lower intake (40.00 g/day). Daily urinary N loss (g/day) was significantly ($P<0.05$) higher in animals fed diet containing 500 g ginger (4.87 g/day) while the least value (1.44 g/day) was recorded in animals fed diet containing 0 g ginger. Animals fed diet containing 750 g ginger had the higher ($p<0.05$) N retained.

**Table 1: Gross composition of the experimental diets fed to Red Sokoto Bucks**

| Parameters (%) | Inclusion levels of ginger (g/100kg diet) | | | |
|---|---|---|---|---|
| | 0 | 250 | 500 | 750 |
| Maize grain | 15.00 | 15.00 | 15.00 | 15.00 |
| Maize offal | 20.00 | 20.00 | 20.00 | 20.00 |
| Wheat offal | 10.00 | 10.00 | 10.00 | 10.00 |
| Cotton Seed Cake | 5.00 | 5.00 | 5.00 | 5.00 |
| Cowpea Husk | 46.50 | 46.50 | 46.50 | 46.50 |
| Bone meal | 2.50 | 2.50 | 2.50 | 2.50 |
| Salt | 1.00 | 1.00 | 1.00 | 1.00 |
| TOTAL | 100.00 | 100.00 | 100.00 | 100.00 |
| Calculated Chemical Composition | | | | |
| M. E. (Kcal/kg) | 2488.00 | 2490.00 | 2493.00 | 2496.00 |
| Crude Protein % | 12.00 | 12.00 | 12.00 | 12.00 |
| Crude Fiber % | 18.00 | 18.00 | 18.00 | 18.00 |

M.E.=metabolizable energy

**Table 2: Nutrient intake of Red Sokoto Bucks fed diets containing varying levels of ginger**

| Parameters (g/day) | Inclusion levels of ginger (g/100 kg diet) | | | | |
|---|---|---|---|---|---|
| | 0 | 250 | 500 | 750 | SEM |
| Dry matter | 772.14 | 791.31 | 757.14 | 786.43 | $20.01^{NS}$ |
| Ash | 58.10 | 59.52 | 57.02 | 59.17 | $1.75^{NS}$ |
| Organic matter | 714.04 | 731.79 | 700.12 | 727.26 | $16.00^{NS}$ |
| Ether extract | 31.19 | 31.90 | 30.60 | 31.79 | $1.02^{NS}$ |
| Crude fiber | $184.52^{b}$ | $193.45^{a}$ | $185.12^{b}$ | $192.26^{a}$ | $2.40^{*}$ |
| Crude protein | $70.95^{b}$ | $75.71^{a}$ | $72.38^{a}$ | $75.24^{a}$ | $2.20^{*}$ |
| Neutral detergent fiber | $352.14^{ab}$ | $360.95^{a}$ | $345.36^{b}$ | $358.69^{a}$ | $5.80^{*}$ |
| Acid detergent fiber | $178.81^{ab}$ | $183.21^{a}$ | $175.36^{b}$ | $182.14^{a}$ | $2.38^{*}$ |

$^{ab}$Mean within the same row with different subscripts are significantly different (P<0.05) *significant at 0.05; OM=organic matter, EE = ether extract, CF = crude fiber, CP = crude protein, SEM=Standard error of means and NS= not significant

**Table 3: Nutrient Digestibility of diets containing varying levels of ginger fed to Red Sokoto Bucks**

| Parameter (%) | Inclusion levels of ginger (g/100 kg diet) | | | | |
|---|---|---|---|---|---|
| | 0 | 250 | 500 | 750 | SEM |
| Dry Matter | $80.14^{c}$ | $81.94^{ab}$ | $81.27^{b}$ | $82.71^{a}$ | $0.56^{*}$ |
| Ash | $74.14^{c}$ | $77.10^{ab}$ | $75.88^{b}$ | $78.43^{a}$ | $0.86^{*}$ |
| Organic matter | 78.35 | 78.60 | 78.15 | $78.57_{NS}$ | $0.23^{NS}$ |
| Ether extract | $61.71^{bc}$ | $67.00^{a}$ | $60.15^{c}$ | $67.53^{a}$ | $2.37^{*}$ |
| Crude fiber | 80.71 | 80.63 | 80.85 | $81.90_{NS}$ | $0.73^{NS}$ |
| Crude Protein | $77.02^{b}$ | $78.32^{ab}$ | $77.27^{b}$ | $79.57^{a}$ | $0.77^{*}$ |
| NDF | $83.42^{c}$ | $83.63^{b}$ | $83.80^{ab}$ | $83.82^{a}$ | $0.09^{*}$ |
| ADF | $82.82^{b}$ | $83.13^{a}$ | $83.23^{a}$ | $83.39^{a}$ | $0.14^{*}$ |

$^{abc}$Mean within the same column with different superscripts are significantly different (P<0.05) *significant at 0.05, SEM=Standard error of means, NS= not significant, NDF=neutral detergent fiber and ADF=acid detergent fiber.

**Table 4: Nitrogen balance in Red Sokoto Bucks fed diets containing varying inclusion levels of ginger**

| Parameter (g/day) | Inclusion levels of ginger (g/100 kg diet) | | | | |
|---|---|---|---|---|---|
| | 0 | 250 | 500 | 750 | SEM |
| Nitrogen intake | $42.86^{b}$ | $45.71^{a}$ | $40.00^{c}$ | $45.71^{a}$ | $0.45^{*}$ |
| Fecal nitrogen loss | 3.64 | 3.46 | 3.58 | 3.02 | $0.32^{NS}$ |
| Urinary nitrogen loss | $1.44^{c}$ | $1.80^{bc}$ | $4.87^{a}$ | $2.01^{b}$ | $0.28^{*}$ |
| Total N outgo | $5.08^{b}$ | $5.26^{b}$ | $8.45^{a}$ | $5.03^{b}$ | $0.39^{*}$ |
| Nitrogen absorbed | $39.22^{b}$ | $42.25^{a}$ | $36.42^{c}$ | $42.69^{a}$ | $0.44^{*}$ |
| Nitrogen retained | $37.78^{b}$ | $40.45^{a}$ | $31.55^{c}$ | $40.68^{a}$ | $0.42^{*}$ |
| Nitrogen retained (as % of Intake) | $88.15^{a}$ | $88.49^{a}$ | $78.87^{b}$ | $88.99^{a}$ | $1.05^{*}$ |

$^{abc}$Mean within the same column with different superscripts are significantly different (P<0.05) *significant at 0.05 SEM=Standard error of means and NS= not significant.

## DISCUSSION

### Nutrient Intake of Red Sokoto Bucks Fed with Varying Inclusion Levels of Ginger

The high DMI recorded in this study might be attributed to high soluble carbohydrates of the diets. However, the values reported in this study were lower than the values reported by Muhammad *et al.* (2016), when Yankasa rams were fed with varying inclusion levels of ginger. But the values reported herein are higher than the values reported by Fajemisin and Adeleye (2005), when treated corncob silage was fed to West African dwarf (WAD) goats. The crude protein intake values observed in this study were lower than those reported by Muhammad *et al.* (2016), when graded levels of ginger were fed to Yankasa rams. The differences could be due to variation in dietary chemical composition and the species of animals used.

### Nutrient Digestibility of Diets Containing Varying Levels of Ginger Fed to Red Sokoto Bucks

FAO (1991), classified digestibility of feeds as high (>60), medium (40-60) and low (<40). Digestibility of all the nutrients were high as observed in this study. It was reported that maximum dietary CF digestion in the rumen occurs when dietary CP is between 12 and 16% (Mc Allan, 1991). The CP digestibility in this study showed that dietary protein was properly utilized by the animals. This could be due to some phyto-chemicals like tannins and saponins found in ginger that are known to prevent protein degradation in the rumen so that it can be effectively digested in the abomasum and the small intestine. It was further reported that adequate nitrogen in diets enhanced the activities of rumen microbes which eventually improved the CP digestibility in diets (Fajemisin and Adeleye, 2005; Garba and Maigandi, 2008). The same reason could be attributed to higher DM, OM, CF, CP, EE, Ash, NDF and ADF digestibility recorded in this study. This is because CP intake and digestibility can affect digestibility of other nutrients too (Muhammad *et al.,* 2011). Consequently, the digestibility values obtained in this study are higher than the findings of Ikyume *et al.* (2017), when WAD goats were fed with varying levels of garlic powder.

### Nitrogen Balance in Red Sokoto Bucks Fed with Diets Containing Varying Inclusion Levels of Ginger

The results of nitrogen balance showed reduced faecal and increased urinary nitrogen losses with increasing levels of ginger compared to the group fed with diet containing 0 g ginger. The reduction in faecal N loss may be attributed to some phytochemicals like saponin in ginger which may inactivate protozoa resulting in a lower predation of bacteria by protozoa and a higher bacterial population leading to slower protein turnover in the rumen (Makkar *et al.,* 1998). The slower protein turnover leads to an increase in bacterial nitrogen flow to the duodenum and increase in productivity. Ginger reduces amino acid degradation due to selective action on certain rumen microorganisms, specifically some bacteria (Hert *et al.,* 2008).

## CONCLUSION

Ginger inclusion levels in the diets of RSB improved nutrient digestibility and nitrogen retention. Further studies should be conducted to investigate the comparative evaluation of ginger and garlic on nutrient digestibility and nitrogen retention of Red Sokoto bucks.

## REFERENCES

Ajibike, A. B., Ilori, B. M., Awotunde, E. O., Adegboyega, R. A., Osinbowale, D. A., Bemji, M. N., Durosaro, S. O. and Adebambo, A. O. (2016). Genetic diversity and effect of selection at the mitochondrial hypervariable region in major Nigerian indigenous goat

breeds. *Asian-Australasian Journal of Animal Sciences*. DOI: http://dx.doi.org/10.5713/ajas.15. 0775

AOAC (Association of Official Analytical Chemists) (2007). *Official Methods of Analysis.* 19th Edition. Washington DC.

Aregawi, T., Animut, G. and Kassa, H. (2013). Utilization and nutritive value of sesame (*Sesamum indicum* L.) straw as feed for livestock in the North western lowlands of Ethiopia. *Livestock Research for Rural Development*. (25), 124.

Daharia, A., Jaiswal, V. K., Royal, K. P., Sharma, H., Joginath, A. K., Kumar, R., and Saha, P. (2022). A comparative review on ginger and garlic with their pharmacological action. *Asian Journal of Pharmaceutical Research and Development*. 10: 65-69.

Elazab, M. A., Khalifah, A. M., Elokil, A. A., Elkomy, A. E., Rabie, M. M., Mansour, A. T. and Morshedy, S. A. (2022). Effect of dietary rosemary and ginger essential oils on the growth performance, feed utilization, meat nutritive value, blood biochemicals, and redox status of growing nzw rabbits. *Animals*. 12: 375.

Fajemisin, A. N., and Adeleye, I. O. A. (2005). Time related qualitative changes in the haematological values of rat blood kept at room temperature. *Proceedings of the 30th Annual Conference of Nigerian Society for Animal Production,* 30: 41–44.

FAO (1991). *Food and Agricultural Organization of the United Nations.* In Production Year Book Rome, Italy.

Garba Y. and Maigandi S. A. (2008). *Nutrient digestibility and utilization by growing lambs fed ensiled fore stomach digesta (FSD) with poultry litter waste (PLW)*. Usmanu Danfodiyo University, Sokoto.

GPS (Global Positioning System) (2018).

Hert, K. J., Yanez, R., Duval, S. M., Ewan, N. R. and Newbold, C. J. (2008). Plants extract to manuplate rumen fermentation. *Animal feed science technology,* 147; 8-35.

Ibrahim, U. M., Lakpini, C. A. M., Abdu, S. B. and Musa, A. (2022). Evaluation of ginger (*Zingiber officinale*) as feed additive on the performance and cost benefit of Red Sokoto bucks fed *Digitaria smutsii* basal diet. *Animal Research International,* 19(2): 4523 – 4529

Ikyume, T., Sowande, T. T., Dele, O. S. and Yusuf, A. O. (2017). Effect of varying levels of garlic powder on growth, apparent nutrient digestibility, rumen ecology, blood profile and cost analysis of feeding WAD goats. *Malaysian Journal of Animal Science,* 20(2): 60 – 74.

Institute for Agricultural Research (2018). Meteorological data. Meteorological unit of Ahmadu Bello University, Zaria, Kaduna. Nigeria.

Makkar, H. P. S., Sen, S., Blummel, M. and Becker, K. (1998). Effect of fractions containing saponins from *Yucca schidigera*, *Quillaja saponaria* and *Acacia auriculo* forms on ruminant fermentation. *Journal of Agricultural and Food Chemistry,* 46**:** 4324-4328.

McAllan, A. B. (1991). *Sources of nitrogen supplements to maximum cereal crop residue digestion in rumen: In H.G.C. Galle (Ed.), Production and utilization of lignocellulosics*. Elsevier Science Publishers Ltd England 378–385.

Muhammad, N., Tukur, H. M., Maigandi, S. A. and Daneji, A. I. (2011). Performance and cost of production of fattening Uda sheep fed diets containing different energy levels in a semi-arid Environment. *International Journal of Applied Agricultural and Agricultural Research*, 7: 79 – 85

Muhammad, N., Ibrahim, U. M., Maigandi, S. A. and Abubakar, I. A. (2016). Live Performance and Rumen Microbial Composition of Yankasa Rams fed with Supplemented Levels of *Zingiber officinale*. *Journal of Agriculture and Ecology Research International,* 8(4): 1 - 10.

Osuji, P. U., Nsahlai, I. V. and Khalili, H. (1993). *Feed evaluation.* ILCA manual 5: ILCA, Addis Ababa, Ethiopia. 40.

Panpatil, V. V., Tattari, S., Kota, N., Nimgulkar, C. and Polasa, K. (2013). *In vitro* evaluation on antioxidant and antimicrobial activity of spice extracts of ginger, turmeric and garlic. *Journal of Pharmacognosy and Phytochemistry*. 2: 143-148.

Pandey, A. K., Kumar, P. and Saxena, M. (2019). Feed Additives in Animal Health. *Nutraceuticals in Veterinary Medicine*. Springer. pp. 345-362.

SAS (2005). *Institute Incorporated SAS/STAT user's guide*. 6.03 Edition, Gray NC U.S.A

Van Soest, P. J., Robertson, J. B. and Lewis, B. A. (1991). Methods for dietary fiber, neutral detergent fiber and nonstarch polysaccharides in relation to animal nutrition. *Journal of Dairy Science,* 74: 3583 – 3597.