

NUTRIENT INTAKE AND SENSORY CHARACTERISTICS OF MEAT FROM RED SOKOTO GOATS FED DIETS CONTAINING GRADED LEVELS OF YAM (*Dioscorea Spp*) PEEL MEAL AS SUPPLEMENT TO SHEA BUTTER (*Vitellaria paradoxa*) LEAVES

¹Bukola, O.A, ¹Yahaya, B., ¹Kennedy, N., ²Sulim, P.Y ¹Rabiu, N., ³Sulaiman, Z and ¹Damisa, M.H.

¹Department of Animal Science, Federal University of Kashere, Gombe State, Nigeria

²Department of Animal Production Technology, Bauchi State College of Agriculture, Bauchi, Nigeria

³Department of Animal Science, Saadu Zungur University, Gadau, Bauchi State, Nigeria

(Corresponding Author:: Bukola, O.A : ojoadewale052@gmail.com)

ABSTRACT

The experiment was carried out at the Small Ruminants Unit of the Teachings and Research Farm, Department of Animal Science, Federal University of Kashere Gombe State Nigeria for a period of 50 days. Sixteen (16) red Sokoto goats (bucks) with initial weight range of 9-10kg were allocated in to four treatments of four goats each. The bucks were fed concentrate diets containing graded levels of yam peel meals (YPM) and Shea butter leaves (SBL), at 250g/ goats / day and 500g of Shea butter leaves (SBL) / goats / day for treatment one, treatment two, treatment three and treatment four with 0, 10, 20 and 30 % levels of inclusion of YPM respectively the experimental design was a completely randomized design (CRD) and data were analyzed using a one-way analysis of variance. Treatment 1 and 2 had the best array of nutrients and hence intake. Dry matter intake ranged from 378 – 497 g/day, while crude protein intake ranged from 46.39 to 59.85 g/day. Sensory evaluation revealed that juiciness and leanness were similar for all the treatments. Results for tenderness, flavor and palatability was significantly ($p < 0.05$) highest in treatment three (T3) as compared to other treatments. Values for flavor ranged from 3.67 – 4.19, while that of overall meat quality were 19.22 – 21.59. Meat quality at inclusion level of 21.62% (T3) was enhanced. Yam peel meal can be included in supplement diets for red Sokoto Goats at 10% level of inclusion for enhanced nutrient intake and meat quality

Keywords: Nutrient Intake, Sensory Characteristics, Meat, Red Sokoto Goats, Yam Peel Meal

1.0 INTRODUCTION

The domestic goat (*Capra hircus*) commonly referred to as the "poor man's cow" provide consistent access to meat, milk, skins, and fibre for farmers, most especially in developing countries. The world goat population currently stands at 921 million from 861.9 million in 2008, of which over 90% are found in developing countries (Tsukahara, 2018). Africa accounted for about 35% as the second largest after Asia while Nigeria, Sudan and Kenya have the largest population of goats in Africa (Skapetas and Bampidis, 2016). Goats play a critical role in Nigeria's economy and culture. Economically, goats provide a source of income for rural communities. They are often sold in local markets, and their milk, meat, and skin are highly valued for both local consumption and export. Goat farming also provides employment opportunities, particularly for women and young people who are involved in both the husbandry and marketing of goats (FAPRI, 2020). The

Sahelian and Sudanian ecological zones in the north are particularly favorable for goat farming, as they support various indigenous breeds such as the West African Dwarf goat and the Red Sokoto goat. These breeds are known for their hardiness and ability to withstand high temperatures and limited water availability (FAO, 2018). In Nigeria, Goats are reared traditionally at subsistence level and are usually left to scavenge and cater for their own nourishment (Adeloye, 1985). A major obstacle to ruminant livestock production in most tropical ecosystem is the seasonal fluctuation in forage availability and quality due to modal rainfall patterns. During the dry season, forage yield and quality reportedly decline drastically for both cultivated naturally occurring pastures (Adorlolo, 2014). Yam (*Manihot esculenta*) is an important food crop in many African countries and processing generates yam Peels of which some are improperly disposed, waste, are generated from the processing of yam

(Okike *et al.*, 2015). Yam peel is the main byproduct from the processing of yam into various products such as flour, feed for human consumption and others, such as yam starch. FAO (2001) estimated that about 250-300 kg of yam peel is produced per ton of fresh yam tuber. Livestock farmers in developing countries are faced with various challenges that lead to considerable fall in the production of certain livestock species like goats, cattle, swine and poultry, which further leads to protein shortage. This is due to high cost of production that originates from increase in prices of conventional feed ingredients and livestock species. Ogwuche *et al* (2017) reported that the way goats are fed reflects in their quality, this was further corroborated by the report of Ocheja *et al* (2018). Also some consumers are becoming more health conscious and hence mindful of the quality of meat they consume. There is therefore an urgent need for alternative locally available and cheap sources of feed ingredients particularly those that do not attract competition in consumption between human and livestock or have no direct relevance in human food chain (Shettima *et al.*, 2024), which can enhance nutrient intake and meat quality in goats. This study therefore aims at investigating the Nutrient Intake and sensory characteristics of meat from red Sokoto goats fed diets containing graded levels of yam peel meal as supplement to shea butter leaves.

2.0 MATERIALS AND METHODS

2.1 Study Area

The study was conducted at the Animal Science Teaching and Research Farm, Faculty of Agriculture, Federal University of Kashere in Gombe State, Nigeria. The state is situated within latitude 9°54'46N and longitude 9° 46'27E and 10°57' E and altitude of 349m above sea level. The annual rainfall of Kashere ranges between 800mm-900mm per annum and is characterized by distinct dry season (October-May) and rainy season (June-

September) seasons. The annual mean temperature ranges from 30-32° C and it experiences a relative humidity of 17-90% (National Geospatial Intelligence Agency, 2012).

2.2 Experimental Animals

Sixteen (16) red Sokoto bucks aged between 11-12 months were sourced from within Kashere and its environs. They were brought to the Small Ruminant Unit, Teaching and Research Farm,, Department of Animal Science, Faculty of Agriculture, Federal University of Kashere and housed in individual pens for one week for acclimatization.

2.3 Experimental Design and Procedure

16 bucks were randomly allocated into four (4) Treatments of four (4) goats each. The animals were treated with Albendazole oral solution for endo parasites at 1ml per 10kg body weight and pour-on for ecto parasites at 1ml/10kg; Oxytetracycline hydrochloride and multivitamin injection at 1ml/10kg body weight was given each to take care of bacterial infection/stress and to provide a common health status. The Yam Peels used for the experiment were collected from within Kashere and the University Campus. The feed ingredients consisted of Yam peels, Cassava peels, Sweet potato peels, Maize offal, Groundnut Cake, Eggshell and Table salt. These components were thoroughly mixed after pounding and grinding. Each treatment has four (4) replicates. Treatment one (T₁) was 0.00% level of yam peel meal; treatment two (T₂) was 10.00% level of yam peel meal; treatment three (T₃) was 20.00% level of yam peel meal and Treatment four (T₄) was 30.00% level of yam peel meal. Each treatment had (4) goats; each goat was fed 250g of the concentrate per day, and Shea butter leaves at 500g per Goat per day of which the Shea butter leaves was fed first, then the concentrate one hour later, the Goats were served water *Ad-libitum*. The bucks were fed the experimental diets for 50 days, after an adjustment period of 7 days.

Table 1: Composition of Experimental Diets

Feed Composition	T1	T2	T3	T4
Yam peel	0	10.81	21.62	32.45
Maize Offals	32.45	21.62	10.81	0.00
Sweet Potato Peels	18.37	18.37	18.37	18.37
Cassava Peels	8.10	8.10	8.10	8.10
Grounut Cake	37.84	37.84	37.84	37.84
Egg Sheel Meal	1.08	1.08	1.08	1.08
Table Salt	2.16	2.16	2.16	2.16
Calculated nutrients composition				
Crude protein	19.29	18.22	18.21	17.67
Crude fibre.	7.62	7.60	7.60	7.60
MEKcal/kg	2926.54	2779.45	2738.83	2649.14

(T) Means= treatment

2.4 Feed intake , Weight Gain and Nutrient Intake Determinatin

Weight Gain: Initial weights and final weights of the animals were recorded. The initial weights were subtracted from the final weights to determine the weight gain of the animals.

Feed intake: The concentrate offered to the goats was weigh daily and the left over was also weigh and subtract from the quantity of feeds that was served to determine the feeds intake of the animals.

Weekly weight gain: The animals were weighed on weekly basis to determine their weights

Nutrient Intake Determination

The nutrient intake was determined from the feed intake values and the proximate composition of both the concentrate and the shea butter leaves

2.5 . Carcass Evaluation.

At the end of the experiments 3 bucks per treatment were starved for about 12 hours prior to slaughter but were given water, they were slaughtered, bled, eviscerated and dressed. Four (4) pieces of meat each weighing 20 g was cut from the same thigh of three (3) goats

slaughtered from each treatments (i.e eight (8) pieces of meat from each treatment (eight replicates). The pieces of meat were cut in different shapes for ease of identification as follows:

T1 - cut i

T2- cut ii

T3- cut iii

T4- cut iv

2.6 Sensory Evaluation

The organoleptic quality assessment of the cooked red sokoto goats meat was evaluated using a 5-point hedonic scale (5 = very Good to 1 = poor). The evaluation was based on juiciness, tenderness, flavour/aroma, leanness and palatability and overall qua;ity

2.7 Statistical Analysis

The data obtained from the experiments were subjected to a one-way analysis of variance (ANOVA) procedures (Morris, 1999). Means with significant differences were separated using Least Significant Differences (LSD) with the aid of Statistical analysis system (SAS) version 9.1, (2025 edition)..

3.0 RESULTS AND DISCUSSIONS

3.1 Nutrients Intake (g/day) of Red Sokoto Bucks

The nutrient intake values are presented in Table 3. Nutrient intake patterns in this study revealed that dry matter intake (DMI), crude protein intake (CPI), and metabolizable energy (ME) decreased progressively with higher inclusion of yam peel meal. Treatment 1 (0%

YPM) and Treatment 2 (10% YPM) recorded higher DMI and CPI compared to Treatments 3 (20% YPM) and 4 (30% YPM). This reduction at higher inclusion levels corroborates earlier reports by Baah *et al.* (1999) and Olorunnisomo (2011), who observed reduced voluntary feed intake in ruminants when yam or cassava peel inclusion exceeded moderate levels, due to bulkiness and reduced palatability.

Table 2: Proximate Composition of Experimental Diets, Yam Peel Meals and Shea Butter Leaves

Nutrients	T1	T2	T3	T4	Yam Peel meals	Shea butter leaves
Dry matter	92.50	90.70	92.80	93.30	91.50	67.30
Crude protein	18.60	18.00	17.95	17.80	7.20	10.10
Crude fibre	7.80	7.85	7.85	7.70	12.80	13.90
Ether extra	4.80	4.40	4.50	4.33	2.20	10.50
Ash	4.50	4.80	5.61	5.40	8.84	3.00
NFE	56.80	57.60	56.80	58.07	60.45	29.99
Total	100.00	100.00	100.00	100.00	100.00	100.00
MEKcal/kg	3060.04	3034.72	3012.75	3038.68	2757.90	2277.05

Despite the decline in intake, the diets still provided sufficient metabolizable energy (126–160 kcal/day) and crude fiber (68–89 g/day) to meet maintenance requirements of Red Sokoto bucks, this is consistent with the observations of Okeke and Oji (1987) that yam peels, when ensiled or dried, can serve as an energy supplement during the dry season. Moreover, the high nitrogen-free extract (NFE) values recorded across treatments affirm yam peel's role as an energy-dense feed ingredient. From a nutritional standpoint, the inclusion of yam peel meal at lower levels (5–10%) appears beneficial as it provided an alternative energy source without severely compromising nutrient intake. This supports the work of Lakpini *et al.* (1997), who recommended partial replacement of maize offal with yam peel meal in Red Sokoto goats without adverse effects on performance. However, the

sharp decline in CPI and ME observed at 30% inclusion (T4) suggests that higher levels of substitution may impair nutrient utilization, likely due to fiber build-up and anti-nutritional factors such as residual cyanogenic glycosides. These findings highlight that yam peel meal, when properly processed and moderately included, can serve as a low-cost, readily available feedstuff for small ruminants, particularly during the dry season when conventional forages are scarce. Its energy contribution can help sustain maintenance and moderate growth, while supplementation with protein sources ensures balanced nutrition. However, excessive inclusion reduces intake efficiency and could compromise productivity. Thus, yam peel meal should be viewed as a complementary rather than a primary energy source in goat diets.

Table 2: Nutrients Intake (g/day) of Red Sokoto Bucks

Parameters	Treatments				SEM
	T1	T2	T3	T4	
Dry Matter Intake	497.81 ^a	464.56 ^a	381.75 ^b	378.29 ^b	33.20
Crude Protein Intake	59.85 ^a	56.51 ^{ab}	52.68 ^b	46.39 ^c	1.90
Crude Fiber Intake	88.94 ^a	83.94 ^{ab}	78.46 ^b	68.44 ^c	2.78
Ether Extract Intake	50.21 ^a	47.37 ^{ab}	43.77 ^{bc}	39.85 ^c	1.72
Ash Intake	31.02 ^a	29.26 ^{ab}	27.78 ^b	23.07 ^c	0.96
Nitrogen Free Extract Intake	266.57 ^a	251.04 ^{ab}	237.35 ^b	199.71 ^c	8.20
ME (kcal/kg diet/day)	160.11 ^a	151.45 ^a	139.73 ^{bc}	126.63 ^c	5.50

Means in the same row with different superscript letters differ significantly
SEM , Standard Error of Means

3.2 Sensory evaluation of cooked Red Sokoto goat's meat fed a graded levels of Yam peel meals and Shea butter leaves

Sensory evaluation of cooked red sokoto buck meat is represented in table4 below, the values obtained for Juiciness and leanness was similar for all the treatments. Result on Tenderness, flavor and palatability was significantly higher ($p<0.05$) for treatment three(T3) as compared to other treatments. The difference in treatment

three (T3) which was significantly better than diet in treatment T1,T2 and T4 in term of tenderness, flavor and palatability. The significant value obtained in this study was lower than those reported of (Bello and Tsado, 2013) and (Ronaldo, 2009). The overall meat quality showed that treatment one (T1), treatment three(T3) and treatment four(T4) were similar but better ($p<0.05$) compared to treatment two(T2). this could be attributable to the flavor and leanness of the meat.

Table 4: Sensory evaluation of cooked meat of Red Sokoto goats fed a graded levels of Yam peel meals and Shea butter leaves

Parameters	T1	T2	T3	T4	SEM
Juiciness	4.11	4.00	3.89	3.89	0.10
Tenderness	4.45 ^b	3.68 ^c	5.00 ^a	4.56 ^{ab}	0.15
Flavor	4.11 ^a	3.67 ^b	4.00 ^a	4.19 ^a	0.09
Leanness.	4.11	3.89	3.89	4.11	0.12
Palatability	4.78 ^a	4.36 ^b	5.00 ^a	4.89 ^a	0.08
Over all Meat Quality	21.55 ^a	19.22 ^b	21.28 ^a	21.67 ^a	0.51

Means within the same row with different superscript are significantly different SEM , Standard Error of Means

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

Conclusively, 0% YPM and 10% YPM performed better, with higher nutrient intake compared to higher inclusion levels. This study demonstrated that yam peel meal can be included in the diets of Red Sokoto bucks as a supplementary energy source. However, its use should be limited to moderate inclusion levels to avoid reductions in nutrient intake. 0% and 10% were better in nutrient intake, while 15% inclusion reduced feed intake and nutrient utilization. Therefore, yam peel meal is more effective when used at a lower level and combined with protein-rich feed ingredients. Sensory evaluation showed that juiciness, flavor, and tenderness in treatment three (T3) was highest as compared to other treatments.

4.2 Recommendations

- I. 10% inclusion of yam peel meal is recommended as the best treatment, offering a balance between cost reduction and adequate nutrient intake.
- II. Yam peel meal should always be supplemented with protein-rich ingredients (e.g., groundnutcake, legume forages) to correct its low protein content.
- III. Long-term trials exceeding 50 days should be conducted to evaluate growth, reproductive performance, and carcass quality.

Acknowledgement

Authors declare no area of conflict and no any part or section of this paper is generated by artificial intelligence (AI).

REFERENCES

Adam, A. A. Atta, G.H and Ismail, S.H., (2010). Quality and Sensory Evaluation of Meat from Nilotic Male kids fed on two different diets, *Animal Science Journal*,1,1,7-12p

Adorlolo, A. (2014). "Livestock Production Systems in Northern Nigeria." *Tropical Agriculture Journal*, 10(3), 56-64.

Aeloye, K.K.(1985). Standardization of hydrolysis procedure for saccharification of mango kernel starch. *International Research Journal of Engineering and Technology*, 3 (5), Pp. 679–684. www.irjet.net

Bello, A. A and D. N. Tsado (2013), Feed intake and nutrient digestibility and growing Yankasa rams fed sorghum stover supplemented with graded level of dried Poultry based diet, *Asian Journal of Animal Sciences*. 7(2):56-63.

FAO. (2001). *Animal Genetic Resources and Indigenous Livestock Breeds in Africa*. FAO.

FAO. (2018). *Animal Genetic Resources and Indigenous Livestock Breeds in Africa*. FAO.

FAPRI. (2020). *Economic Importance of Goat Farming in Nigeria*. Food and Agriculture Policy Research Institute.

Lakpini, D.A(1997). Processing and nutritive value of mango seed kernel flour. *Current Research in Nutrition and Food Science*, 2 (3), Pp. 170–175.

<https://doi.org/10.12944/CRNFSJ.2.3.10>
Nnadi, F. O., Ibeawuchi J. A and One S. W (2013) performance of West African Dwarf bucks fed pigeon pea-cassava peel based diets. *Journal of Animal and Veterinary Advances*, 4(12): 1010-1015.

- Okeke, G. C. and Oji, U. I. (1987). *The nutritive value of grass ensiled with cassava peel and poultry excreta for goats. Goat production in the humid tropics*. Proc. of a workshop at the University of Ife, Ile Ife, Nigeria, 20-24 July 1987
- Okike, I., Samireddipalle, A., Naziri, D., Adejoh, V.A., Amole, T., Bordoloi, S. and Kulakow P. (2022). Turning Waste to Wealth: Harnessing the Potential of Cassava Peels for Nutritious Animal Feed. In: Thiele, G., Friedmann, M., Campos, H., Polar, V., Bentley, J.W. (eds) *Root, Tuber and Banana Food System Innovations*. Springer, Cham.
- Ronaldo, M. M. (2009). Health benefits of conjugated linoleic acid found in goat meat. *Food Chemistry*, 345, 128641.
- Shettima, M. C. Ezuma, C. C., Ogbuewe, I. P. and Opara, M. N. (2024). Physiological responses of finisher broilers to yam peel meal: haematology and serum biochemistry. *Journal of Environment, Agriculture and Food Chemistry*, 9(10):1657-1664.
- Tsukahara, P. A., Taofik I., Tamburawa, M.S. and Musa A (2018). Fatty acid composition and health implications of goat meat consumption. *Meat Science*, 170, 108215.