Nigerian J. Anim. Sci. 2021, 23 (2): 240-246

Apparent digestibility and nitrogen utilization by West African Dwarf (WAD) goats fed tiger nut meal as replacement for maize offal

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***Target Audience**: Livestock and crop farmers, Animal scientists, feed vendors and millers*

Abstract

The replacement value of tiger nut meal (TNM) for maize offal was evaluated in this trial. Four bucks averaging 11.0kg live weights were transferred into separate metabolism crates and fed four dietary treatments designated T1, T2, T3 and T4, which were formulated to contain 0, 30; 10, 20; 20, 10 and 30, 0 percentages of maize offal and TNM respectively in a 4×4 Latin square design. Samples obtained from the test ingredients, diets and faeces were analyzed for proximate compositions and energy, while the urine was examined for urea nitrogen. The result shows that the diets; T1, T2, T3 and T4 contained 14.35, 13.58, 13.31 and 13.33 % CP and 1.74, 1.70, 1.73 and 1.73 MJ/kg of energy respectively. Except ether extract, all the nutrients evaluated for apparent digestibility did not differ (P>0.05) significantly. Increasing levels of TNM recorded higher ether extract digestibility (P<0.05). Ether extract digestibility values ranged from 48.97 to 69.82%. The apparent nitrogen (N) utilization study revealed that all the parameters determined were not affected (P>0.05) by the treatments. Dry matter intake (DMI) value observed was within the range of 2.85 and 3.07% of live weights. It could be deduced that tiger nut meal completely replaced maize offal without compromising nutrients digestibility.

***Keywords**: WAD goats, tiger nut, maize offal, digestibility*

Description of Problem

In Nigeria, goats raise under agro-pastoral system obtained their feed majorly from uncultivated and unimproved pastures that are characterized with poor forage yield both in quality and quantity. The situation is aggravated during the dry season due to scarcity of forage materials. Consequently, ruminants are unable to meet their protein and energy requirements from available poor-quality fodder with marked weight loss and low productivity (1, 2). This implies that the low energy and crude protein contents of dry season forages confer severe nutritional stress on ruminants consuming such forages without supplementation. Effort has been made to search for alternative feed resources to supplement declining forage quality and quantity. Among the alternative feed resources that had been explored, maize offal (a by-product of maize processing) has been widely utilized due to its availability with relatively less laborious.

Recently, maize offal, which has been in use for ages, is becoming very expensive and even adulterated, perhaps; due to the very high cost of maize from which it is processed. It therefore becomes imperative to search for possible alternatives to the by-product which could give similar or even better nutritional value.

Nutritional composition of tiger nut tubers shows some unique features, between other tubers and nuts (3). It has high content of soluble glucose and oleic acid, along with high energy content, rich in minerals for bones, tissue repair, muscles, blood stream and for body growth and development and is rich in vitamins E and C (4). Crude protein content of 8.44% has been reported by (5) while (6) recorded 29.67% ether extract with caloric value of 524.6 Kcal (7). Also, a crude protein content of 7.54±0.15%, ether extracts value of 29.40±0.23% and crude fibre of 7.10±0.43% have been reported (8). Ether extract values of 28.43%, 25.84% and 20.28% were reported in three different varieties of tiger nut (9).

In a study with grass cutters, increasing levels of tiger nut meal up to 40% did not produce any significant effects on the performance parameters evaluated when compared to the control (8). Goats on Tiger nut meal-based diets gained more weight than those on a control diet (10). In vitro studies involving three different varieties of tiger nut predicted non-significant differences in their energy contents for ruminants (9), suggesting tiger nut as a valuable source of energy for ruminant animal production.

Leveraging on the nutritional value of tiger nut as stated above, thus, the study was conducted to evaluate apparent digestibility and nitrogen utilization by WAD goats.

Materials and Methods

Location of the experiment

The experiment was conducted in the Sheep and Goat Unit of the Michael Okpara University of Agriculture, Teaching and Research Farm, Umudike, Ikwuano Local Government Area, Abia State. It is located on latitude 05^0 29^1 North of the equator and longitude 07^0 33^1 East of the Greenwich Meridian. It has an altitude of 122 meters above the sea level. The area has a warm humid climate and experiences an average ambient temperature of 25^0C with a range of 22^0C to 32^0C and a relative humidity range of 50 to 90%. The environment is characterized by long rainfall and a short dry season. Annual rainfall reaches 2200 mm distributed over 8 months; March to November (11). The vegetation of the area is typical of a rainforest.

Experimental animals and their management

Four intact West African Dwarf (WAD) goats (all bucks) averaging 11.0kg were used in this experiment. The goats were sourced from small ruminant farmers in villages around Umudike. On arrival, they were held in quarantine for 21 days in a thoroughly sanitized pen in the university quarantine house. They were fed mixtures of forages comprising browse plants, grasses and legumes and later, gradually introduced to the experimental diets at the end of quarantine. Water was provided ad-libitum. Prophylactic treatments were administered using long-acting Oxytetracycline injection at the rate of 0.10 ml/kg body weight repeated after 48 hours. Levamisole injection was also administered subcutaneously (s/c) at the rate of 1 ml per buck to control endo-parasites while ivermectin injection was given s/c to manage common ecto-parasites. Peste des petits ruminants (PPR) vaccine was given s/c at the rate of 1 ml per buck towards the end of the 21 days quarantine.

Experimental diets

Four diets, as shown on Table 1, were formulated and compounded from the following ingredients: *Panicum maximum* (PM) hay meal, TNM, maize offal, palm kernel cake, soya bean meal, bone meal and common salt. The grass hay was processed from PM harvested from uncultivated lands around the university before the boot stage of growth. The grass chopped into 3 cm length and sun dried for 4 – 5 days was later ground in a local mill to form PM hay meal. Tiger nuts were procured from major dealers from northern part of the country, dried and later milled to form TNM while other ingredients were procured from livestock feed dealers.

Table 1: Composition (%) of the experimental diets

Ingredients	Diets			
	T1	T2	T3	T4
Panicum maximum (PM) hay meal	40.0	39.5	39	38.5
Tiger nut meal	0	10	20	30
Maize offal	30	20	10	0
Palm kernel meal	16	16	16	16
Soyabean meal	10	10.5	11	11.5
Bone meal	3	3	3	3
Common salt	1	1	1	1
Total	100	100	100	100

Digestibility studies

The four bucks were transferred into individual metabolism crates constructed as described by (12) to provide maximum comfort for the animals. The design of the crates enabled separate collection of faeces and urine. Feed and water were offered *ad-libitum* and provided in enclosures attached to the crates. They received measured quantity of feed daily at two feeding periods (09.00 am and 02.00 pm). The feed offered in a 4 x 4 Latin square design were adjusted according to weekly body weight changes and rate of feed intake of the bucks over a 28-day period. This method of feeding ensured at least 10% left-over of the previous day feed in the feeders. A 21-day preliminary feeding was followed by a 7-day collection (faeces and urine). Feed refusals were collected and weighed to determine daily feed intake by difference before the next feeding. Total faecal and urine collections for the 7 days were weighed and measured in the morning before the next feeding and watering. Urine was collected in a glass container placed under the crates into which 10 mls of concentrated Sulphuric acid was added in order to reduce nitrogen loss by ammonia volatilization. Faeces and urine collected were bulked together according to the treatments and replicates for the 7 days then stored in a refrigerator for analyses. Individual weekly weighing of the animals was carried out in the morning before feeding.

Analytical procedures

Feeds, and faecal samples were analysed for proximate components using (13) methods for dry matter (%DM), crude protein (%CP), crude fibre (%CF), ether extract (%EE) and % Ash. Urine nitrogen was also determined by (13) methods. % Nitrogen Free Extract (NFE) in feed and faeces were calculated using the formula:

$$\%NFE = DM - (\%CP + \%CF + \%EE + \%Ash)$$

Feed and faecal gross energy (GE) were calculated according to (14) formula given below.

$$GE\ (MJkg^{-1}DM) = 0.0226CP + 0.0407EE + 0.0192CF + 0.0177NFE$$

Data collected were subjected to one-way analysis of variance (ANOVA) appropriate for LSD experiment using SPSS package for windows 2010. Treatment means showing statistical differences at a probability of 5 % ($P<0.05$) were compared using the Duncan's multiple range procedure of the same package.

Results and Discussion

Nutrient composition of maize offal, tiger nut and experimental diets

The nutrient compositions of maize offal, tiger nut meal (TNM) and the four experimental diets as formulated are summarized on Table 2. Some constituents of maize offal used in the present study were within the range of those published in literature. The dry matter (DM) content was higher than the value of 83.20% report by (15) in maize bran but similar to the value of 88.95% obtained by (16) in maize offal. Crude protein content in maize offal compared favourably with the value of 11.90% recorded by (17) whereas (16) obtained 13.21% while (15) recorded 9.42%.

TNM used in this study had lower DM content compared with the values reported earlier in literature. (18) and (5) recorded 3.63% and 7.62% moisture representing 96.37% and 92.38% DM respectively in TNM. The crude protein value of 9.26% in TNM was similar to the value of 8.44±1.63% recorded by (5) whereas (18) reported a value of 2.68% CP. Ether extract in the present study fell far below the value of 25.70% recorded by (7) while the crude fibre was slightly higher than the value of 5.50% given by the same authors.

Table 2: Nutrient composition of experimental diets, maize offal and tiger nut meal

Parameter (% DM)	Diets				Maize offal	Tiger nut meal
	T1	T2	T3	T4		
Dry matter	90.83	89.65	89.56	89.45	88.69	88.46
Crude protein	14.35	13.58	13.31	13.33	11.64	9.26
Crude fibre	18.56	18.24	16.34	16.59	12.28	6.80
Ether extract	3.63	4.28	5.92	5.85	6.93	12.79
Nitrogen free extract	51.68	49.13	49.16	49.12	54.55	52.80
Ash	2.61	3.42	3.38	3.56	3.29	3.81
Energy (MJ/kg DM)	1.74	1.70	1.73	1.73	1.75	1.65

Disparities in the compositions of maize offal and TNM used in the present study and those of earlier reports could be due to differences in species of maize and tiger nut used in processing the offal and the TNM, methods of processing, duration of storage as well as the soil and water condition of the area the crops were cultivated.

DM content of T1 slightly surpassed the DM contents of the other three treatments despite the similarity in the DM contents of the two test feedstuffs. This may be due to the inclusion level of maize offal at 30% in treatment 1. Increasing levels of maize offal produced a slight increase in the CP level in T1 with the other 3 treatments within the same range. As the level of tiger nut increased, the crude fibre contents decreased up to T3 with a small increase between T3 and T4. This may not be readily explained on the basis of the inclusion levels of both maize offal and tiger nut in the two treatment diets. Feed sampling could, perhaps be responsible. Similar trend was also observed for the ether extracts of the diets. Nitrogen free extract was highest in T1 while the other treatments were within close ranges. Ash contents of the diets were lowest in T1 while T2 – T4 were within comparable range. Finally, the energy content of diet T1 was highest while T2 recorded the least energy. T3 and T4 had similar energy levels.

Apparent digestibility coefficients by WAD goats fed diets containing tiger nut as replacement for maize offal

Apparent nutrient digestibility coefficients for the various dietary treatments are shown on Table 3. All the nutrients evaluated were not differed (P>0.05) except ether extract (EE) that was influenced (P<0.05) by the treatments. Higher ether extract digestibility (69.83%) was obtained in T3, but statistically similar to that of T4. This could have been resulted from increased ether extract content of the diets as well as better utilization of the fat in the TNM by the bucks. (19) had reported on the beneficial effect of tiger nut oil compared with olive oil. (10) reported significantly higher ether extract digestibility in WAD goats fed 20% TNM in their diets as against the 10% inclusion level.

Table 3: Apparent digestibility coefficients by WAD goats fed diets containing tiger nut meal as replacement for maize offal

Parameter (%)	Diets				SEM
	T1	T2	T3	T4	
Dry matter	56.45	54.96	53.38	55.93	1.53
Crude protein	52.95	55.67	57.24	56.16	1.52
Crude fibre	72.58	73.25	68.94	71.09	1.11
Ether extract	48.97^{b}	56.94^{b}	69.82^{a}	66.95^{a}	2.50
Nitrogen free extract	67.63	59.97	56.24	57.95	1.75
Energy	64.28	61.55	60.62	61.42	1.33

^{a,b} Means on the same row with different superscripts are significantly different (P<0.05)
SEM: Standard error of mean

Nitrogen utilization by WAD goats fed diets containing tiger nut meal as replacement for maize offal

The nitrogen balance and utilization by the WAD goats fed the four treatment diets are shown on Table 4. All the parameters evaluated were not affected (P>0.05) by the dietary treatments. DMI as percentage of body weight were within the 2.80% reported (20) as maintenance requirement for goats. (21) had reported that meat type goats in the tropics seldom exceed 3% of their body weights as DM intake. The positive non-significant nitrogen balance is an indication that the diets could meet the requirements of goats for maintenance and production.

Table 4: Nitrogen utilization by WAD goats fed diets containing tiger nut as replacement for maize offal

Parameters	Diets				SEM
	T1	T2	T3	T4	
Mean body weight (kg)	11.38	11.13	11.50	11.63	0.41
Mean body weight ($KgW^{0.75}$)	6.19	6.07	6.23	6.29	0.17
DMI (g/d)	333.04	323.12	347.05	331.71	7.60
DMI ($g/d/kgW^{0.75}$)	77.92	76.21	80.40	77.59	1.34
DMI (as % LW)	2.85	3.00	3.07	2.85	0.10
CP intake (g/d)	47.79	43.88	46.19	44.22	1.07
CP output (g/d)	22.43	19.43	19.73	19.65	0.92
N-intake (g/d)	7.65	7.02	7.39	7.08	0.17
N-faeces (g/d)	3.59	3.11	3.16	3.13	0.15
N-urine (g/d)	0.63	0.55	0.64	0.44	0.06
N-absorbed (g/d)	4.06	3.92	4.23	3.94	0.13
N-balance (g/d)	3.43	3.37	3.60	3.51	0.15
N-intake ($g/d/kgW^{0.75}$)	4.60	4.31	4.48	4.33	0.08
N-absorbed ($g/d/kgW^{0.75}$)	2.85	2.78	2.95	2.79	0.07
N-balance ($g/d/kgW^{0.75}$)	2.51	2.48	2.61	2.55	0.08
Apparent N-digestibility (%)	52.96	55.75	57.23	56.35	1.54

SEM: Standard error of mean; DMI: Dry matter intake

Conclusion and Applications

1. Replacing maize offal with tiger nut meal did not produce significant variations in the digestibility coefficients and nitrogen utilization studies, except in ether extract digestibility.
2. The improved digestibility of ether extract as the level of tiger nut meal increases suggests that the crude lipid in the seeds can increase energy supply and availability in addition to other health benefits of the oil to goats than maize offal.
3. The findings therefore suggest that tiger nut meal could be harnessed in place of maize offal to improve goat production.

Acknowledgement

The authors deeply appreciate Prof. J.A. Ibeawuchi for the guidance and support during the course of this research.

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