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Digestibility and Carcass Characteristics of West African Dwarf Goats fed *Pleurotus tuber regium* Biodegraded Ground Nut Shells Included Diets

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Abstract

A total of twenty (20) West African Dwarf (WAD) bucks having an average weight of 6.5 kg were used to study their nutrient digestibility and carcass characteristics. The animals were allotted to five treatment group four animals each randomly. The treatment diets contained varying levels of un-degraded ground nutshells (UGNS) and *Pleurotus tuber regium* biodegraded Ground Nut Shells (PT-GNS) in a Completely Randomized Design (T1=100% UGN; T2=75% UGN+25% PT-GNS; T3=50% UGN+50% PT-GNS; T4=25% UGN+75% PT-GNS; and T5=100% PT-GNS). Each animal served as a replicate. Feed and water were provided ad libitum. The experiment lasts for 84th day of feeding trial. Data on nutrient digestibility and carcass characteristics were taken and subjected to one-way Analysis of Variance (ANOVA) and where significant differences occurred, means were separated using Duncan's Multiple Range Tests (DMRT). The results showed that nutrient digestibility had no significance (p>0.05) difference among the treatment diets, although the digestibility coefficient of Dry Matter (DM) was high, the observed values ranging from 92.10% (T1) to 93.21% (T5). Bucks in T5 had the highest digestibility coefficient of crude protein (93.41) while bucks in T1 had the least values. The carcass characteristics showed a significant difference (p<0.05) among the treatments for carcass yield, carcass weight, and dressing percent increased as the percent substitution of Un-degraded Ground Nut Shells (UGNs) with *Pleurotus tuber*-Groundnut Shell (PT-GNS) increased from 0 to 100%. Wholesale cuts also showed significant difference (p<0.05) among treatments. Thus, *Pleurotus tuber* can be used to improve the low-quality farm by-product such as groundnut shell to increases animal protein production.

Keywords: Digestibility; Carcass; *Pleurotus tuber regium;* Groundnut shell; Goat

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Introduction

Agricultural by-products such as rice straw, groundnut haulms, maize stover, oil palm fronds, and sugarcane bagasse, are abundantly available in many countries [1-3]. Agricultural wastes are the most abundant ones present on earth comprising 50% of all biomass with an estimated annual production of 50 billion tons [4]. In the developing countries, inclusion of fibrous feed in the diet of ruminant animals is a common practice. The animals are fed with materials left in the field after harvesting the target crops [5]. These fibrous materials are low in protein, vitamins, and mineral, and high in crude fiber [6,7]. A successful exploitation of agricultural waste will not only improve environmental sanitation but also provides economically utilizable products [8].

The inadequate utilization of lignocelluloses is due to lignin which surrounds and protects the cellulose from enzyme hydrolysis, for example, in plant residues having more than 10% lignin content [5].

Different technologies have been investigated to improve the feeding value of such by-products. Physical treatments, steaming, grinding and pelleting have been reported to increase the intake and digestibility of oil palm fronds and hence the performance of cattle [9], however, such physical and chemical treatments can be expensive, harmful to users or environmentally unfriendly [10].

Biological methods, including the use of white-rot fungi and their enzyme extracts to improve the nutritive value of low-quality feeds, are regarded as environmentally friendly and potentially economically viable alternatives [11].

The use of microorganisms to convert carbohydrates, lignocelluloses, and other industrial wastes into feedstuffs rich in protein is possible due to the ability of microorganisms to grow very fast on the substrate [12]. In Nigeria, groundnut shells abound, bio-converting them to livestock feeding will reduce the environmental hazard of burning them and also help in providing better quality feedstuff for ruminant animals [13]. The aim of this study is to evaluate nutrient digestibility and carcass characteristics of West African Dwarf Goats fed *Pleurotus tuber regium* biodegraded ground nut shells included diets.

Materials and Methods

Study Area The study was conducted at the Farm Unit of the College of Agriculture, Lafia, Nasarawa State. Lafia is located on Latitude 080 North, Longitude 080 East and Altitude 164.5 m in the guinea savannah vegetation with its sandy loam soil texture [14].

Experimental animals and their management

A total of twenty (20) West African Dwarf (WAD) bucks having an average weight of 6.5 kg were sourced within Lafia L.G.A, Nasarawa State. A week to their arrival, the pens were swept, washed and disinfected using a strong disinfectant solution (Morigard). The feeding and drinking trough were all properly washed and sun-dried. The animals were quarantined for fourteen (14) days and vaccinated against Pest de Petits Ruminant using Rinderpest Tissue Culture (RTCV) vaccine, subcutaneously at 1 ml/10 kg body weight. They were also given a complete course of antibiotics (Tridox L.A) to produce a uniform health status among the animals. The animals were also dewormed using ivomectin, intramuscularly at 3 ml/10 kg body weight. The animals were weighed and randomly distributed into five treatment groups of four animals per treatment such that each animal served as a replicate. Fourteen days were allowed for adjustment to the feed as well as the environment after which they were randomly allotted the treatment diets containing varying levels of Un-degraded Ground Nut Shells (UGNS) and *Pleurotus tuber* regium biodegraded Ground Nut Shells (PT-GNS) in a Completely Randomized Design for the feeding trial (T1=100% UGN; T2=75% UGN+25% PT-GNS; T3=50% UGN+50% PT-GNS; T4=25% UGN+75% PT-GNS; and T5=100% PTGNS). Feed and water were provided *ad libitum*.

Collection of groundnut shells and *Pleurotus tuber-regium* (PTR)

Groundnut Shells were obtained from the Eggon Women Groundnut Oil Processing Industry, Nasarawa Eggon L.G.A, Nasarawa State. It was milled to reduce its particle size and create a greater surface area for microbial activity. The sample of PTR was obtained from Lafia modern Market, Lafia Nasarawa State.

Treatment of groundnut shells with *Pleurotus tuber-regium*

Tubers of PTR were weighed, washed and soaked in water for one hour after which they were removed and put in white transparent buckets and covered for two days to enable spore formation of the tubers. After two days, the tubers were removed and dissected to smaller bits carrying the spores. The composted shells were loaded on a three-tier wooden tray of dimension 1.5 m × 1.2 m × 0.75 m (height, breadth, and width) constructed using 2 × 2 wood and wire mesh base. The base of the wooden tray was covered with white transparent polyethylene sheet disinfected using methylated spirit soaked cotton wool. Spores of PTR were then inoculated into the composted groundnut shells at the rate of 1.0 kg per 5.0 kg groundnut shells. The ends of the polyethene sheets were brought together and sealed to create an airtight environment. This was allowed for 30 days to allow the mass of the composted shells to be completely colonized by mycelium of the fungus showing whitish growths. After 30 days, the colonized mass of composted shells was taken out from the inoculation room and sundried to terminate growth of the fungus. The material was sundried to a constant weight and then put in sacks for use.

Collection of data

Daily feed intake: This was calculated by subtracting the quantity of feed not consumed from the amount given.

Weekly weight gain: This was calculated weekly by subtracting the final weight from initial weight.

Feed Conversion Ratio (FCR) was calculated using the formula:

FCR=Total feed intake/Total gain weight

Nutrient digestibility study

The third experiment was a digestibility trial to evaluate the utilization of diets containing different levels of treated and untreated groundnut shell as a supplement. Ten bucks were transferred to the metabolic cages (i.e. two bucks from each treatment cage) fitted with plastic nets below to collect fecal droppings. Collection of faeces was done daily; the collected faeces were weighed and oven-dried to a constant weight, after which they were put in desiccators. At the end of seven days, all the samples were bulked by replicates, thoroughly mixed and sub-samples were taken for analysis of their proximate constituents.

Apparent nutrient digestibility was calculated using the formula:

$$\text{Apparent nutrient digestibility} = \frac{(\text{Nutrient consumed - nutrient voided})}{\text{Nutrient consumed}} \times 100$$

Carcass characteristics of WAD goats fed diets containing *Pleurotus tuber-regium* biodegraded groundnut shells and untreated groundnut shell

Two bucks from each treatment (total of ten goats) were randomly selected and used for carcass evaluation. The goats were fasted for 24 hours prior to slaughter, during which they were given plenty of drinking water, after which the goats were weighed and slaughtered for carcass evaluation at the end of the experiment following the procedure of USDA [15]. The bodies were skinned; the head and feet were removed. The carcass was eviscerated and the internal organs were weighed.

Carcass evaluation: At the end of the study, ten animals were slaughtered at the rate of two animals per treatment to evaluate following the procedure of USDA [15]. The bodies were skinned; the head and feet were removed. The carcass was eviscerated and internal organs were weighed.

The carcass yield: Body-weight at Slaughter, bled weight, hot carcass weight, and dressing percentage

Wholesale cuts: Shoulder, Rack, Breast, Loin, Flank, and the thigh

Carcass by-products: Head, Feet, Skin, Kidney, Liver, Lungs, Heart, Spleen, Full gut, Empty gut, Testicles, and Abdominal fat

Statistical analysis

Data obtained from the study were subjected to one-way analysis of variance (ANOVA) using the Minitab 14 [16] Statistical Software and where significant differences occurred, means were separated using the Duncan's Multiple Range Test (DMRT).

Result and Discussion

Results for the dry matter and nutrient digestibility of the West African Dwarf goats fed diets containing untreated and treated groundnut shells are presented in (**Table 1**). The results showed no significance (p>0.05) difference among the treatment diets. The digestibility coefficient of Dry Matter (DM) was high, the observed values ranging from 92.10% (T1) to 93.21% (T5). Bucks in T5 had the highest digestibility coefficient of crude protein (93.41) while bucks in T1 had the least values. The digestibility coefficient of crude fiber was highest in goats fed diet T1 (88.36%), while goats fed diet T5 had the least digestibility value of crude fiber (82.40%). bucks in T5 had the highest value of digestibility coefficient for nitrogen-free extract (96.27%), while bucks fed diet T1 had the least value (93.10%). The dry matter and nutrient digestibility did not show any significant variation (p<0.05) among the dietary treatments. This implies that incorporation of PT-GNS in the diets did not decrease DM and indeed nutrient digestibilities. Values of 65.37%-82.11% were reported by Akinfemi et al. [6,7] while evaluating the chemical composition of maize straw using white-rot fungi on the performance of WAD bucks. CP digestibility recorded in this study was high. The value ranged from 91.81% (T1) and 93.41% (T5), implying that CP was well digested by all the bucks [17]. Values obtained were however comparable to the findings of Maigandi and Abubakar [18] who reported CP digestibility values of 89.68%-91.40% for Red Sokoto goats fed varying levels of *Faidherbia albida* pods. The crude fiber digestibility values ranged from 82.40%-88.36% and showed similarity among the treatment groups. This was probably because the rumen microbes were able to effectively digest the nature of fibre in the diets containing PT-GNS. These values were higher than 78.40%-80.62% reported by Maigandi and Abubakar [18] for Red Sokoto goats fed varying levels of *Faidherbia albida* pods. Anigbogu and Anosike [19,20] reported 70.32%-84.38% for Maradi goats fed degraded sawdust with live-enzymes (*Zymomonas mobilis*). These variations may be due to differences in the CF content of the diets as well as the type of fibre fraction, and their levels in the diet. Nitrogen free extract digestibility coefficient values were higher than those of the other nutrients indicating an enhancement of nutritive quality of the diets. It was also higher than 88.00%-90.81% reported by Olatunji et al. [12] for goats fed diets containing yam peels, 63.30%-75.20% by Anigbogu et al. [19,20] for WAD goats on varying forage/concentrate ratio feeding system. Maigandi and Abubakar [18] reported NFE values of 74.50%-75.82% for red sokoto goats fed varying levels of *Faidherbia albida* pods. Ether extract digestibility coefficient values were also high and ranged between 91.25%-94.31%. These values were higher than 62.17%-89.32% reported by Jonathan et al. [21] for goats fed diets containing wood waste treated with *Pleurotus tuber-regium*. Lower range of (70.62%-81.13%) EE digestibility coefficient was reported by Maigandi and Abubakar [18] for red Sokoto goats fed varying levels of *Faidherbia albida* pods. Abdulrazak et al. [17] reported EE digestibility values of 85.22%-93.18% for red Sokoto goats fed graded level of groundnut and melon husk diet. Akinfemi et al. [6,7] relative to the present findings of 93.10%-96.27%, reported lower values of 73.26%-78.71% NFE digestibility for WAD goat fed graded levels of cassava peels treated with two species of white-rot fungi (*Pleurotus pulmonarisu and P. otstreatus*). Same for CF, digestibility coefficient for other nutrients progressively increased from T1-T5 (0% PT-GNS-100% PT-GNS). This is an indication that PT-GNS did not have negative effect on the population of the rumen microbes which are responsible for the breakdown of the feed nutrients and corroborate the findings of Dijkstra et al. [22].

Table 1. Dry matter and nutrient digestibility of WAD goats fed diets containing untreated and fungal treated groundnut shells.

	Experimental Diets					
Nutrients (%)	**T1**	**T2**	**T3**	**T4**	**T5**	**SEM LOS**
Dry matter	92.1	92.35	92.45	92.8	93.21	0.57 ns
Crude protein	91.81	92.03	92.74	93.22	93.41	0.72 ns
Crude fibre	88.36	86.91	84.52	84.12	82.4	0.42 ns
Ether extract	91.25	93.18	93.71	90.62	94.31	0.19 ns
Nitrogen free extract	93.1	95.5	95.31	96.11	96.27	0.17 ns

SEM: Standard Error of Mean; ns: Not Significantly different (p>0.05)
T1: 100% UGN; T2: 75% UGN+25% PT-GNS; T3: 50% UGN+50% PT-GN; T4: 25% UGN+75% PT-GNS; T5: 100% PT-GNS

The result for carcass yield and wholesale cut of the experimental animals are presented in (**Table 2**). There was a significant difference (p<0.05) among the treatments for carcass yield, carcass weight and dressing percent increased as the percent substitution of UGNS with PT-GNS increased from 0 to 100%. Wholesale cuts also showed significant difference (p<0.05) among treatments. Shoulder values ranged from 11.92%-17.10%. Values obtained in T5 were significantly higher (p<0.05) than those for T1-T4. Rack followed the same trend, increasing from 6.97%-11.43%, and showed significant difference (p<0.05) among the treatment groups. This was also the case with the breast, loin, flank and thigh which showed significant differences (p<0.05) as dietary PT-GNS increased. The body weight at slaughter, weight, hot carcass weight as well as dressing percentage were all significantly affected by the level of untreated groundnut shells and fungal treated groundnut shells. The dressing percentage was similar to 45.60%-50.85% reported by Hassan and Idris for Red Sokoto goats. Aliyu et al. [23] reported a dressing percentage of 39.99%, 41.17% and 45.41% for Balaami, Uda and Yankassa sheep, and at 1.3 years and 1.8 years, the dressing percentage was between 39.78%-40.16% which was lower than the results obtained from this study. Fasae et al. [24] evaluating the carcass yield and composition of WAD rams, reported a dressing percentage of 46.77% to 48.42% which is comparable to the result obtained in this study. In other findings, Devendra and Mc

Table 2. Carcass characteristics of wad bucks fed diets containing untreated and treated groundnut shells using white-rot fungus (*Pleurotus tuber-regium*).

Parameter	T1	T2	T3	T4	T5	SEM	LOS
Body weight at slaughter (kg)	9.25^{d}	10.13^{c}	10.26^{c}	11.35^{b}	12.34^{a}	0.77	*
Bled weight (kg)	8.10^{c}	9.00^{c}	9.47^{b}	10.63^{a}	11.96^{a}	1.33	*
Hot carcass weight (%)	3.91^{d}	4.68^{c}	4.77^{c}	5.11^{b}	6.78^{a}	0.77	*
Dressing percentage (%)	46.02^{d}	48.28^{d}	49.74^{c}	50.38^{b}	51.81^{a}	1.13	*
Whole sale cuts (Expressed as % slaughter weight)							
Shoulder (%)	11.92^{e}	13.36^{d}	14.73^{c}	16.38^{b}	17.10^{a}	0.74	*
Rack (%)	6.97^{d}	8.22^{c}	9.34^{b}	8.21^{c}	11.43^{a}	0.77	*
Breast (%)	4.31^{d}	3.34^{e}	4.85^{b}	4.47^{c}	5.35^{a}	0.83	*
Loin (%)	7.26^{e}	7.37^{d}	9.40^{c}	9.58^{b}	10.55^{a}	0.82	*
Flank (%)	1.66^{d}	2.11^{d}	2.37^{c}	2.91^{b}	2.93^{a}	0.56	*
Thigh (%)	9.00^{e}	11.22^{d}	12.37^{c}	13.00^{b}	14.81^{a}	1.16	*

a,b,c,d,e: Means on the same row with different superscripts are significantly different (p<0.05)
SEM: Standard Error of the Mean; LOS: Level of Significance, ns: Not Significantly different
*-Significantly different (p<0.05)
T1: 100% UGN;
T2: 75% UGN+25% PT-GNS
T3: 50% UGN+50% PT-GNS
T4: 25% UGN+75% PT-GNS
T5: 100% PT-GNS

Leroy, [1] reported that on balance most tropical sheep and goats dress out 40%-50% since particularly all of the by-products are consumed as food with some parts and organs selling at a higher price than the carcass meat. Hassan and Idris [25], reported that the dressing percentage is influenced by age, feed, weight, breed, and sex. The variation in the dressing percentage in the report of various researchers might be as a result of nutrition, breed difference and slaughter technique procedure [21]. This supports the observation of Cassey and Van Nickrek [26] when evaluating the carcass and meat quality of Boer goat, they asserted that dressing percentage can be influenced by many factors such as fleece and hide weight, alimentary tract size and fill, slaughtering procedure and partitioning of the body fat. The wholesale cuts showed significant (p<0.05) difference among the treatments. The results obtained showed that the animals on diets containing PT-GNS better-utilized feed for meat production, particularly T5 (100% PT-GNS) which had the highest percentage of the PT-GNS. Shoulder value showed the same trend as breast. T5 which was statistically higher than all the other treatments was an indication that better feed utilization for muscle build-up was conferred by the diet with the highest PT-GNS. Although values for loin, rack, and thigh were similar, all T5 values for these cuts were highest and T1 values were lowest. This probably indicates that T5 (100% PT-GNS) influenced better feed utilization for meat production. The result of the wholesale cuts obtained in this study agrees with the report of Hassan and Idris [24] when assessing the dressing out percentage of Red Sokoto goats. The weight of head, feet, skin, lungs, spleen, full gut, empty gut testicle showed significant (p<0.05) differences among the treatments except the heart, kidney, and liver. However, since there were no significant differences among internal organs (heart, kidney, and liver), it implies that the diet is safe for animal feeding. The non-significant variation between the values for heart is an indication that blood circulation among the entire dietary group was normal. The kidney, on the other hand, is an excretory organ, non-significance in the values obtained is an indication that kidney was not burdened by the inclusion of PT-GNS in the dietary treatments, thus its excretory function was not impaired.

Conclusion

This study concluded that PT-GNS had no significant (p>0.05) difference in nutrient digestibility which implies that it had no effect on digestibility of West Africa Dwarf goat. The carcass characteristics showed a significant difference (p<0.05) among the treatments for carcass yield, carcass weight, and dressing percent increased as the percent substitution of Undegraded Ground Nut Shells (UGNS) with *pleurotus tuber*-groundnut shell (PT-GNS) increased from 0%-100%. Thus, *pleurotus tuber* can be used to improve the low-quality farm by-product such as groundnut shell to increase animal protein production.

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