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Carcass and Organoleptic parameters of West African Dwarf Bucks Fed Cassava Peel-Based Diets Containing Varying Levels of Shivan and Sandpaper Leaf Meals

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ABSTRACT

The study was conducted to assess the carcass, organoleptic and meat quality of West African Dwarf (WAD) goats fed with five experimental diets; namely; a cassava peel-based diet (CPBD) without shivan or sandpaper leaves (0GLM0FLM), and CPBD containing varying levels of shivan and sandpaper leaf meals (10 GLM, 20 GLM, 10 FLM, 20 FLM). Study lasted for 56 days. Thirty (30) WAD bucks weighing 5.00 ± 0.08 kg were used. Six (6) animals, balanced for weight, assigned to each diet. Carcass, organoleptic and meat quality assessment was done. Values were subjected to one-way analysis of variance of SAS (2000) and Duncan New Multiple Range Test were used to separate the means. Significant differences ($p<0.05$) were observed among the animals on bled weight (BW), dressing percentage (DP), skinning (S), skinning weight (SW), eviscerated weight (EW), neck (N), rib (R). Animals on Diet 0GLM0FLM was significantly ($p<0.05$) higher than other diets in BW (66.61 %), DP (60.00 %) S (7.67%), SW (47.50 %), EW (22.50 %) N (3.70 %), R (9.17 %) and F (3.45 %). Animals on Diet 20 FLM was least in BW (46.65 %), DP (40.00 %), SW (27.50 %) and R (5.91 %) respectively. Animals on Diet 20 GLM and 10 FLM gave the best results in terms of overall acceptability on organoleptic. Meat obtained can be recommended to WAD goat farmers. Study concludes that cassava peel-based diet containing shivan and sandpaper leaf meals had a positive effect on all the parameters measured in WAD goats.

Word count: 248

Keywords: West African Dwarf goats, Carcass, Organoleptic properties, Shivan, Sandpapers

Introduction

INTRODUCTION

Carcass characteristics is an important aspect of goat meat production, as it provides information on the quality and yield of the meat. Several methods are used for carcass evaluation, including visual appraisal, measurements of weight and dimensions, and grading systems based on conformation and fatness. Studies have shown that visual appraisal and measurements of weight and dimensions are reliable methods for predicting carcass characteristics in goats (Fernandez *et al*., 2007). Carcasses of goats are evaluated to give an estimation of the ratio of muscle to fat and bone or the amount of edible meat that will be obtained. In order to ensure long-term profitability, feed must also be efficiently digested and converted to body tissues that can be assessed as carcass, which translates to financial gains (Wuanor and Carew, 2018). However, the yield of dressed carcass, sensory and meat quality must be done as it is the major economic interest to the farmers. Notable among the fodder species that are currently under-utilized in animal feeding for goat meat production in Nigeria are *Gmelina arborea* (shivan*)* and *Ficus exasperata* (sandpaper leaves). *Gmelina arborea* is a leguminous browse plant, that has been identified as one of the cheapest ways in reducing feeding cost in ruminant production in the tropics (Okpara *et al*., 2012) while sandpaper (*Ficus exasperata*) is also another browse plant that has gained interest in recent years due to its potential as a forage resource for ruminant animals. This study has therefore made an attempt to assess the carcass, organoleptic and meat quality of West African Dwarf (WAD) goats fed *Gmelina arborea* and *Ficus exasperata* leaf meals for ruminants.

Objectives were to:

(i) Evaluate carcass characteristics of West

African Dwarf bucks fed cassava peel-based diets containing varying levels of shivan and sandpaper leaf meals

(ii) Assess the organoleptic properties and meat quality of West African Dwarf bucks fed cassava peel-based diets containing varying levels of shivan and sandpaper leaf meals

MATERIALS AND METHODS

Experimental Site

The formulation and milling of the experimental diets were carried out at the Small Ruminant Unit (SRU) of Teaching and Research Farm, Ladoke Akintola University of Technology (LAUTECH), Ogbomoso, Oyo State, Nigeria. Ogbomoso is situated in the derived savanna zone of Nigeria on longitude 4^0 10' East of the Greenwich Meridian and Latitude $8^0$10 North of the Equator. The altitude is between 300 and 600m above sea level. The mean annual rainfall and temperature are 1247mm and 27^0C respectively. (Google Earth Map, 2023).

Sourcing and processing of shivan and sandpaper leaves

Fresh fodders (primarily leaves) of shivan and sandpaper were sourced from uncultivated plots within LAUTECH and Ogbomoso. These fodders were separately air dried to constant weight on nylon sheets that were spread on a clean concrete floor. Each fodder was thereafter made free of impurities, crushed, and milled to pass through about 2mm mesh size using a laboratory hammer mill. They were subsequently individually bagged for further processing into the desired experimental diets.

Procurement of cassava peels and other experimental dietary ingredients

Dried cassava peels were purchased from Arada market a popular market in Ogbomoso where there is a gaari processing unit, while the other experimental dietary ingredients; namely wheat offals, maize, palm kernel cake, groundnut cake, soya bean meal, salt, bone meal, limestone and vitamin-mineral premix, were purchased from a reputable feed mill store within Ogbomoso.

Preparations of Experimental Diets

The procured dried cassava peels were re-dried to constant weight and then milled. A portion of the milled cassava peels without any other ingredient served as Mix 1 while some of the milled cassava peels were mixed with either shivan or sandpaper leaves to serve as Mixes 2 and 3 respectively. Milled samples of maize, groundnut cake, palm kernel cake and soybean meal were mixed in the desired proportions to constitute Mix 4. Mix 5 comprised bone meal, limestone, salt and vitamin-mineral premix in the desired proportions. Thereafter, Mix 1 was added unto and thoroughly mixed with Mixes 4 and 5 to constitute Experimental diet 1, while Mixes 2 and 3 were separately added unto and thoroughly mixed with Mixes 4 and 5 respectively to constitute Experimental diets II, III, IV, and V respectively as shown in Table1.

Table 1: Percentage ingredient Compositions of Cassava Peel-based Diets Containing varying level of Shivan and Sandpaper Leaf Meals

Ingredients	Inclusion levels (%) of GLM and FLM				
	0GLM0FLM	10GLM	20GLM	10FLM	20FLM
Cassava peel	40.00	40.00	40.00	40.00	40.00
GLM	0.00	10.00	20.00	0.00	0.00
FLM	0.00	0.00	0.00	10.00	20.00
Wheat offal	20.00	10.00	0.00	10.00	0.00
Maize	10.00	10.00	10.00	10.00	10.00
GNC	10.00	10.00	10.00	10.00	10.00
PKC	9.00	9.00	9.00	9.00	9.00
SBM	5.00	5.00	5.00	5.00	5.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Limestone	2.00	2.00	2.00	2.00	2.00
Premix	0.50	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50	0.50
TOTAL(KG)	100	100.00	100.00	100.00	100.00

0GLM0FLM = Control diet (No leaf meal); 10GLM = Diet containing 10 % GLM; 20GLM = Diet containing 20 % GLM; 10FLM = Diet containing 10 % FLM; 20FLM = Diet containing 20 % FLM; GLM= Gmelina leaf meal; FLM=Ficus leaf meal; PKC= Palm Kernel Cake; SBM=Soybean Meal; GNC= Groundnut Cake

Experimental animals and management

Data collection

Carcass evaluation

Thirty (30) growing West African Dwarf bucks weighing 5.00 ± 0.08kg were used for the experiment. They were purchased from a reputable local small ruminant market in Ogbomoso, Oyo state. The experimental pens covered with aluminium roofing sheets, with raised slated floors were swept, washed and disinfected before the acquisition of the animals. On arrival of the animals to the farm, they were quarantined for 21 days. During the quarantine period, multivitamins was administered, and were treated against endo- and ecto-parasites with ivermectin (subcutaneously at 0.1ml to 10 kg). Long-acting antibiotics (oxytetracycline) at 1.00 ml to 10 kg body weight and PPR *(pests de petit ruminants*) vaccine were also administered subcutaneously at 1.00 ml to 10 kg body weight. There were five experimental diets; namely a cassava peel-based diet without shivan or sandpaper leaf meals (0GLM0FLM), a cassava peel-based diet containing shivan leaf meal at 10 % (10GLM), a cassava peel-based diet

containing shivan leaf meal at 20% inclusion level (20GLM), a cassava peel-based diet containing sandpaper leaf meal at 10 % (10FLM), and a cassava peel-based diet with sandpaper leaf meals at 20% (20FLM). Six (6) bucks, balanced for weight, were randomly assigned to each diet. The bucks were fed twice daily at 4 % of body weight, and fresh water was made available *ad-libitum* for the animals. The experiment lasted for 56 days.

Data collection

Slaughtering, carcass and organ evaluation

Two bucks from each diet were slaughtered for carcass evaluation. The bucks were starved for 12 hours before slaughtering. Just before slaughter, each animal was weighed. The animals were bled by cutting the throat at its jugular vein. The weighing was further carried out post-slaughter and dressing respectively. The dressing percentage was calculated as the weight of a dressed warm carcass to live weight before slaughter. A dressed warm carcass refers to the weight of the goat after the removal of the head, skin, contents of thoracic and pelvic cavities (including the diaphragm and kidney) and limbs distal to the carpal and tarsal joints have been removed. The gut in each case was weighed and gut content was cleansed and reweighed. The parameters that were measured were bled weight, skinned weight skin weight, eviscerated weight, head weight, neck weight, fore and hind limb weight, and rib cage were weighed and recorded.

Organoleptic parameters

Meat samples were taken from the thigh region of each sacrificed experimental goat for comparison after cooking. The fresh meat portions were cut into pieces of small cubes of equal size approximately 2.5 cm^3 before cooking without any salt or seasoning. The cooking was done at 80°C for approximately 5 minutes and offered to a 9-man panel of evaluators. The following organoleptic parameters; appearance, tenderness, juiciness, flavour and overall acceptability were determined by a nine-point Hedonic scale as developed by Mahendraka, *et al.* (1988).

Chemical Analyses

Ground samples of cassava peel-based diets were analyzed for their proximate components by the standard methods of AOAC (2005).

Statistical Analyses

Values obtained for each parameter were subjected to one-way analysis of variance using SAS (2000) procedure. Significant means were separated using Duncan New Multiple Range Test (DNMRT) of the same package ($p<0.05$).

RESULTS

Chemical composition of cassava peel-based diets containing varying levels of shivan and sandpaper leaf meals are presented in (Table2). The dry matter contents of the experimental diets showed no significant ($P>0.05$) differences with a range of 91.84 for Diet 10FLM to 92.90 % for Diet 20FLM. The values for all the other parameters however showed significant differences ($p<0.05$) across the dietary treatments. Diet 20FLM contained the highest significantly levels ($p<0.05$) of CP (12.72 %), CF (17.95 %), NDF (63.00 %), ADF (37.60) ADL (11.40), P (0.26 %) and Zinc (24.80 ppm). Diet 10 FLM was highest ($P<0.05$) in Ash (11.83 %) and EE (3.15 %). However, Diet 20 GLM had the highest ($P<0.05$) of NFE (63.16 %) but lowest CP (7.47 %), Ash (6.80 %) CF (12.65 %), EE (2.40 %), NDF (50.25 %), ADF (28.75 %), ADL (4.95 %), P (0.21 %) and Zn (22.20ppm).

The results on Table 3 show the carcass characteristics of West African Dwarf bucks fed cassava peel-based diets containing varying levels of shivan and sandpaper leaf meals. Significant differences ($p<0.05$) were observed among the dietary treatments on bled weight, dressing percentage, skinned weight, eviscerated weight, neck, rib and flap. Diet 0GLM0FLM resulted in significantly ($p<0.05$) higher percentages of bled weight (66.61%), dressing percentage (60.00%) skinning (7.67%), skinning weight (47.50%), eviscerated weight (22.50 %) neck (3.70%), rib (9.17%) and flap (3.45 %) than the other diets. Diet 20FLM resulted in least percentages of bled weight (46.65 %), dressing percentage (40.00 %), skinned weight (27.50 %) and rib (5.91 %) respectively. The percentages of the head, fore limbs and hind limbs showed no significant ($p>0.05$) difference across dietary treatments.

Table 4 reveals results of the organoleptic parameters of meat from the experimental animals fed cassava peel-based diets containing varying inclusion levels of shivan and sandpaper leaf meals. Significant differences ($p<0.05$) were observed among the dietary treatments for all parameters, i.e. colour, flavour, tenderness, juiciness and overall acceptability. In terms of overall acceptability, meat samples from animals fed Diets 10 GLM and 20 FLM were rated

significantly ($p<0.05$) higher than other meat samples, with meat samples from Diet 20 GLM being rated least. Diet 10 GLM produced the meat with the highest scores in flavor (7.56) and juiciness (7.78) while Diet 20 FLM produced the meat with the highest score in tenderness (6.00) and a higher but comparable score in overall acceptability with meat from animals on Diet 10 GLM (8.00 vs 8.00).

Table 2. Chemical composition of the cassava peel-based diets containing varying levels of shivan and sandpaper leaf meals.

Parameter (%)	0GLM0FLM	10GLM	20GLM	10FLM	20FLM	SEM
DM	91.99	92.16	92.48	91.84	92.90	0.10
CP	7.91^{d}	8.72^{b}	7.47^{e}	8.36^{c}	12.72^{a}	0.63
Ash	9.50^{c}	10.25^{b}	6.80^{e}	11.83^{a}	7.38^{d}	0.79
CF	14.90^{d}	17.05^{b}	12.65^{e}	15.70^{c}	17.95^{a}	0.65
EE	2.70^{c}	3.05^{ab}	2.40^{d}	3.15^{a}	2.65^{c}	0.93
NFE	58.98^{b}	53.12^{e}	63.16^{a}	52.80^{e}	52.20^{d}	1.45
NDF	55.59^{bc}	62.95^{a}	50.25^{d}	56.95^{b}	63.00^{a}	1.61
ADF	35.39^{c}	36.50^{b}	28.75^{e}	33.20^{d}	37.60^{a}	1.04
ADL	8.70^{d}	10.75^{b}	4.95^{e}	9.55^{c}	11.40^{a}	0.76
Ca (%)	0.13	0.14	0.12	0.13	0.14	0.00
Mg (%)	0.14	0.15	0.13	0.14	0.15	0.00
P (%)	0.22^{c}	0.25^{b}	0.21^{c}	0.24^{b}	0.26^{a}	0.01
Zn (ppm)	22.35^{d}	23.60^{b}	22.20^{e}	23.15^{c}	24.80^{a}	0.32

0GLM0FLM = Control diet (No leaf meal); 10GLM = Diet containing 10 % GLM; 20GLM = Diet containing 20 % GLM; 10FLM = Diet containing 10 % FLM; 20FLM = Diet containing 20 % FLM; DM=Dry Matter; CP=Crude Protein; CF=Crude Fibre; EE=Ether-Extract; NFE=Nitrogen Free Extract; NDF= Neutral Detergent fibre; ADF = Acid detergent. fibre; ADL= Acid detergent lignin; Ca= Calcium; Mg= Magnesium; P= Phosphorus; Zn= Zinc

Table 3. Carcass characteristics of West African Dwarf bucks fed cassava peel-based diets containing varying levels of shivan and sandpaper leaf meals

Parameter (%)	0GLM0FLM	10GLM	20GLM	10FLM	20FLM	SEM	P-Value
Body weight (kg)	6.70	6.00	5.55	6.85	4.75	3.01	0.36
Carcass characteristics as % body weight							
Bled weight	66.61^{a}	59.12^{b}	54.14^{d}	56.58^{c}	46.45^{e}	3.02	0.03
Dressing percentage	60.00^{a}	52.50b	47.50^{c}	52.50^{b}	40.00^{d}	2.01	0.04
Skinned weight	47.50^{a}	38.50^{ab}	35.00^{ab}	32.50^{ab}	27.50^{b}	2.83	0.04
Eviscerated	22.50^{a}	20.00^{b}	17.50^{c}	22.50^{a}	12.50^{d}	1.63	0.02
Head	6.85	6.07	5.95	6.34	5.90	0.19	0.66
Neck	3.70^{a}	3.01^{ab}	2.37^{b}	2.98^{ab}	2.84^{ab}	0.17	0.03
Forelimb	7.55	6.35	5.67	6.17	5.37	0.33	0.27
Rib	9.17^{a}	6.84^{ab}	6.91^{ab}	6.92^{ab}	5.91^{b}	0.43	0.03
Flap	3.45^{a}	2.31^{b}	2.47^{ab}	2.63^{ab}	2.70^{ab}	0.16	0.01
Hind limb	12.21	10.25	9.30	10.38	8.12	0.62	0.35

$^{a,b\,c}$Means with different superscripts within rows are significantly different at $p<0.05$.SEM = Standard error of the mean; 0GLM0FLM = Control diet (No leaf meal); 10GLM = Diet containing 10 % GLM; 20GLM = Diet containing 20 % GLM; 10FLM = Diet containing 10 % FLM; 20FLM = Diet containing 20 % FLM

Table 4. Organoleptic parameters of West African Dwarf bucks fed cassava peel-based diets containing varying levels of shivan and sandpaper leaf meals.

Parameter (%)	0GLM0FLM	10GLM	20GLM	10FLM	20FLM	SEM	P-Value
Color	6.44^{ab}	5.44^{b}	4.22^{c}	6.88^{a}	6.33^{ab}	0.22	0.00
Flavour	5.67^{ab}	7.56^{a}	6.33^{ab}	4.33^{b}	5.22^{b}	0.35	0.05
Tenderness	5.67^{ab}	3.89^{bc}	3.11^{c}	4.00^{bc}	6.00^{a}	0.31	0.05
Juiciness	6.44^{b}	7.78^{a}	4.22^{d}	4.89^{c}	6.44^{b}	0.27	0.00
Overall acceptability	7.44^{b}	8.00^{a}	4.78^{d}	5.78^{c}	8.00^{a}	6.88	0.00

$^{a,b\,c}$ Means with different superscripts within rows are significantly different at $p<0.05$.SEM = Standard error of the mean; 0GLM0FLM = Control diet (No leaf meal); 10 GLM = Diet containing 10 % GLM; 20GLM = Diet containing 20 % GLM; 10 FLM = Diet containing 10 % FLM; 20 FLM = Diet containing 20 % FLM

DISCUSSION

Chemical composition of the cassava peel-based diets containing varying levels of shivan and sandpaper leaf meals

Dry matter (DM) range of the experimental diets (91.84 - 92.90 %) were comparable with 91.32-91.74 % reported by Jiwuba *et al*. (2018) when cassava peel-centrosema leaf meals were fed to WAD goats. The low moisture content of the experimental diets (7.10-8.16%) suggest that the feed ingredient would have a longer shelf life when included in goats' diets. This is because moisture forms an important factor in feed formulation (Islam *et al*., 2015), Optimum moisture levels of between 10.00 and 12.00 % are generally considered safe for storing livestock feeds without the risk of deterioration from bacteria, mold growth, insect damage and sprouting (Alengadan *et al*., 2013). The observed protein values of Diet 0GLM0FLM (7.91 %), Diet 20 GLM (7.47 %), and Diet 10 FLM (8.36 %) were comparable to the critical requirement of 8 % CP by ruminants for optimum microbial activities in the rumen (Ibhaze *et al*., 2020) while Diet 20 FLM had a CP level (12.72 %) which was between 11.00 to 13.00 % known to be capable of supplying adequate protein for maintenance and moderate growth performances in goats (NRC, 2002). Diet crude fibre (CF) levels between 12.95-17.95 % are considered optimal in goats' diets (Mamoon, 2008). An adequate fibre content in diet is regarded as an essential component of ruminants' diets which is considered to support rumination and balance microbial ecology while a high level of fibre has been acknowledged to be inversely related to feed digestibility and nutrient availability (Tejeda and Kim, 2020). The CF contents of the diets (12.65- 17.05 %) were adequate to support the digestion of nutrients mediated through mastication, microbial fermentation in the rumen, and rate of passage in the gastrointestinal tract (Li *et al.*, 2021). Ash contents (6.80 to 11.83 %) of the experimental diets fell within the range of 6.09 to 9.44 % which is essential for optimum production of small ruminants (Ilori *et al*., 2013). Ash contents represent the mineral level in a feed, such as phosphorus, calcium and magnesium (Verma, 2006), although such values are not known to reflect the levels of the individual mineral in the diets. Neutral Detergent Fibre (NDF) values in Diet 10 GLM (62.95 %) and 20 FLM (63.00 %) fell within the range of 60.00-65.00 % suggested as the critical limit above which the efficiency of utilization of tropical forages by ruminants would be impaired (Muia, 2000).

Calcium contents (0.12 to 0.14 %) of the experimental diets were observed to be below the required calcium requirements (0.21-0.41%) for goat and sheep without the need of supplementation (NRC, 2007). Calcium is an essential mineral that is closely related to various physiological and pathological processes (Morris *et al.,* 2016). Phosphorus is vital for differentiation as a component of RNA and is also

responsible for the formation of organic bone matrix in farm animals (NRC, 2000). The values of phosphorus obtained (0.21 to 0.25 %) were within the NRC recommendation of (0.16-0.31 %) for phosphorus for ruminants (NRC, 2007). Magnesium contents (0.13 to 0.15 %) in the experimental diets were adequate and could meet the requirements of goats and sheep when compared to the recommended values of 0.12 to 0.18 % (NRC, 1985). Magnesium is vital in metabolism as it works as a cofactor for hundreds of enzymes in the body. It influences farm animals' production and fertility, improve feed digestibility (Pinotti *et al.*, 2021). Zinc levels (22.20 to 24.80 ppm) in the experimental diets were safe as they were below the maximum tolerable level of 1000 ppm for sheep and goat (NRC,1985). Zinc is an essential element for the health of animals, it is engaged in biochemical processes that maintain life (Ciosek *et.al*., 2023). Variations in the values of nutrient contents in the diets could be attributed to physical fibrousness, levels of starch content and carbohydrate solubility of the different dietary treatments used.
Dressing percentage is the proportion of the live weight of the animal which is sold as meat and can be used to assess performance of meat producing animals (Yusuf, 2014). Experimental animals were bled, skinned and eviscerated. Animals on Diet 0GLM0FLM had dressing percentage 60.00 % which were above the range 32.94 to 55.35 % reported by (Ozoemelam *et al*., 2014; Ifut *et al*., 2015; Ukanwoko and Okpechi, 2015; Jiwuba *et al.,* 2018b) as the baseline reported for WAD goats. Higher values of dressing percentage in Diet 0GLM0FLM, 10 FLM and 10 GLM strongly reflect the higher intake and weight gain in the animals a function of intake and digestibility among other factors. Nath *et al*. (2017) reported that nutrition greatly influences dressing percentage through variation in weight of gut content or variations in actual organ weight. Dressing method can also affect the dressing percentage because parts that are considered as offal may not be considered offal in some dressing methods.
In meat organoleptic, color has its highest value on Diet10 FLM (6.88 %). Holman *et al.* (2017) proposed that consumer associate the colour of meat as an indicator of quality and freshness. Flavour and juiciness of meat was highest in Diet 10 GLM (7.56 and 7.78) respectively. The relationship between the measured parameters and the overall acceptability agrees with the report by Omojola *et al*., (2013) who observed that juiciness among other parameters is made up of two effects, moisture released during chewing and also the salivation produced by flavor factors. Gandi *et al*. (2016) similarly reported that meat juiciness plays an important role in conveying the overall impression of palatability to the consumer

Recommendation

All the experimental diets resulted in comparable carcass, organoleptic characteristics and meat quality as the control diet, an indication of the likely consumer acceptability of the meat of WAD goats fed the diets at the various inclusion levels of GLM and FLM. The inclusion of 10 GLM and 20 % FLM in the diets of goats produced tender and juicy meat with high overall acceptability.

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