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Bioconversion of Sugarcane Scrapings Using *Pleurotus ostreatus*: Implications for Fatty Acid Profile, Carcass Performance, and Meat Quality in Yankasa Rams

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ABSTRACT

This study looked at how replacing corn bran with *Pleurotus ostreatus*-biodegraded sugarcane scrapings (BSS) affected carcass parameters, meat quality, and fatty acid composition in Yankassa rams. Twenty-one lambs (6-7 months old; 11.21 ± 0.97 kg) were assigned in a random manner to each of the three groups (dietary treatments): 0% BSS (control), 15% BSS (50% replacement), or 30% BSS (100% replacement) over a 12-week period. Rams given 15% BSS had considerably higher ($P < 0.05$) slaughter weight, hot carcass weight, and dressing percentages than other groups. However, non-carcass components (head, feet, heart, kidneys, lungs, trachea, and ribeye region) were unaffected ($P > 0.05$), showing no negative impacts on organ development. Retail cuts including as neck, brisket, rack, foreleg, and hindleg improved in the 15% BSS group, whereas loin and flank did not alter. The testing for carcass (meat) quality in T2, had higher cooking loss as well as better water holding capacity (WHC). The values for meat Shear force, pH values and sensory qualities were significantly the same amongst treatment groups. The values for oleic, linoleic, α-linolenic acids, CLA, and omega-3 fatty acids (EPA, DHA). Total PUFA, MUFA, and the PUFA:SFA ratio showed significant increase especially in T2 proving BSS potential as a sustainable alternative feed supply.

Keywords: small ruminants, agro-industrial byproducts, fungal biodegradation, sugarcane scrapings, carcass and meat quality, fatty acid composition, sensory characteristics.

1. INTRODUCTION

Agricultural waste in form of crop residues and agroindustrial byproducts constitutes about 75.0 Tg of lignocellulosic biomass per year, enhancing its availability (Kim and Dale, 2014; Anaso and Anaso, 2025). These wastes are typically left on the field, posing a challenge for the local agro-industries that produce them and harming the environment (Anaso et al., 2024b; Anaso and Olafadehan 2025). These wastes, however, have a lot of potential as animal feed if properly captured and handled. Sugarcane scrapings, which are the bark of the peeled cane sugar stem, are one example of a lignocellulosic material in Nigeria. As with other lignocellulosic materials, its low protein content and high cellulose, hemicellulose, and lignin levels limit its use in animal feed (Anaso and Olafadehan, 2025). However, lignin is the principal culprit because lignin-cellulose and hemicellulose linkages prevent rumen microbial enzymes from reaching the cell wall contents, so locking up considerable amounts of potential energy and nutrients (Tengerdy and Szakacs, 2003; Anaso et al., 2021b). As a result, even ruminants, whose digestive systems are capable of breaking down fiber, are unable to extract adequate protein and energy from lignocelluloses. Biological treatments such as solid-state fermentation/biodegradation with white rot fungi, particularly Pleurotus ostreatus, have been used to increase the nutritional value of low-quality roughages and create novel ingredients at competitive prices (Isroi et al., 2011; Atuhaire et al., 2016; Anaso et al., 2021a,b; Olafadehan et al., 2023; Anaso et al., 2024b; Anaso and Olafadehan 2025; Anaso et al., 2026b). The use of white rot fungus-biodegraded lignocelluloses in ruminants is well established; however, little is known about how feeding these biodegraded materials to goats in the tropics impacts the animals' carcass characteristics and meat quality. These animals' productivity could be boosted by optimizing their potential through better use of agricultural wastes and supplements (Anaso, 2023a,b; Anaso et al., 2023; Olafadehan et al., 2021; Anaso et al., 2024a-d; Anaso 2025a-e; Anaso et al., 2025a-g; Anaso, 2026a-d; Anaso et al., 2026a,b). Norton (1994) defines nutritional value as an animal feed's ability to deliver nutrients for growth and maintenance in the absence of hazardous conditions.

Therefore, the objectives of the study were to: 1) Assess the carcass characteristics of Yankassa lambs fed Pleurotus ostreatus biodegraded sugar cane scrapings; 2) Determine the organ and relative organ weight; 3) Access the carcass properties; 4) Determine the organoleptic/meat properties; and 5) Assess the fatty acid profile of Yankassa lambs fed Pleurotus ostreatus biodegraded sugar cane scrapings.

2. MATERIALS AND METHODS

Experimental site

The experiment was conducted at the University of Abuja Teaching and Research Farm in Abuja, Nigeria. The position lies between latitudes 8º 55'N and 9º 00'E and longitudes 7º 00'N and 7º 05'E, with an elevation of 456 meters. The area has annual temperatures between 25.8 and 42°C and precipitation between 1100 and 1650 mm (Anaso and Alagbe, 2025a-c).

Preparation and biodegradation of sugarcane scrapings

The scrapings were sourced from local processors within the FCT, Abuja. They were then cut into 1-2 cm lengths, and air-dried at 25–30°C. The white rot fungi (*Pleurotus ostreatus*) were also sourced from a reliable commercial mushroom farm in Badagry, Nigeria. Each previously cleaned, dried, and sterilized container's moisture content was lowered to 67% before to the Pluerotus inoculation for solid state fermentation by combining the SS with distilled water in a 1:1 ratio. The SS were autoclaved twice, once at 121°C for 15 minutes each, with cooling intervals in between, to eliminate any living microbes. The prepared SS were chilled in an aseptic environment prior to being infected with P. ostreatus spores in a 25:1 ratio. The inoculation chamber was then maintained at 30°C and 100% relative humidity until mycelia formed. After 21 days of inoculation and SSF, the material was autoclaved to prevent mycelia growth and biodegradation of the biodegraded SS (BSS). After being dried to a consistent weight, the BSS were bagged and kept until they were required for feeding.

Experimental animals, management and diets

Twenty-one ram lambs weighing 11.21 ± 0.97 kg at six to seven months of age were purchased from an open market for the experiment. The lambs were housed in separate 1.2 m2 cages within a 6 m × 8 m x 4 m corral. The entire research site including the animal housing was disinfected

with a commercial mixture of sodium hypochlorite, caustic soda, and de-mineralized water (Hypo®) and an antimicrobial (Morigad) for precisely prior to arrival of experimental animals. The ram lambs were also administered comprehensive prophylaxis care within the first two-weeks of confinement (Anaso and Chibuogwu, 2026). One subcutaneous injection of the anti-parasitic medication Avomec® at 0.5 ml/25 kg BW, one intramuscular injection of a long-acting oxytetracycline HCl at 1 ml/10 kg BW, one oral anti-stress medication Vitalyte®, and one subcutaneous injection of the live PPR vaccine (1 ml at 102.5 of the TCID50 PPR virus) at the neck region. Three full meals were prepared with different SS 0 (control), 15, and 30% inclusion percentages (Table 1). When designing the diets to meet the needs of growing sheeps, the NRC's (2007) recommendations were followed. Over the course of a 12-week period (January to March), lambs were fed 5% of their body weight (based on dry matter; DM) and adjusted for body weight. The goats were subsequently randomly assigned to one of the experimental diets. To make sure that some was left over, the amount of grain provided to the goats during the study was altered. Every day, the feeding times were 8:00 and 16:00. Unrestricted access to clean water was available every day.

Feed intake and body weight

To calculate feed consumption, the weight of the feed delivered the day before was deducted from the weight of the remaining feed. The dry matter feed intake of the animal was multiplied by the dry matter content of the nutrients in the diets to determine the nutrient intake. The individual initial body weight (BW) was measured at the start of the experiment, and the individual final BW was computed right before the goats were fed at the end of the study using a traditional goat weighing scale (UmaTech Scales).

Carcass characteristics and meat quality evaluation

Slaughter Procedure

The animals' heads were turned at an angle of nearly 900 degrees, causing the blood vessels in their necks to be clearly displaced, and their limbs were held down to immobilize them. The animals were killed by severing their trachea, esophagus, spinal cord, carotid arteries, and jugular veins using a sharp knife and weights.

Post mortem operation

The bodies were placed upside down on a rail to allow for sufficient bleeding, which took ten minutes. The killed rams' skins were cut off with a keen knife. After skinning, the carcass's pH was measured at 0, 1, and 24 hours after eradication using a pH meter. After the feet were removed at the knee and hock joints, they were correctly weighted. The different internal organs were separated using primitive cuts after being eviscerated using a precise scale. Before and after the contents were taken out and emptied, the stomach (rumen, reticulum, omasum, and abomasum) was isolated from the gastrointestinal system and weighed. Within 20 minutes after the death, the weight of the hot carcass was measured with a hanging scale on the slaughterhouse floor.

Dressing percentage

The dressing percentage (DP) was determined arithmetically according to Aduku and Olukosi (2000) as:

DP % = (Dressed weight/live weight) x 100

Cooking losses

For every treatment, the thigh flesh from each carcass was cut into pieces of the same size. In order to determine the quantity of cooking loss, identical-sized meat samples were placed in plastic bags and submerged in boiling water for around 20 minutes before being allowed to cool to room temperature. The meat samples were taken out of the bags, weighed once again, and then dried with filter paper. According to the American Meat Science Association (1995), the percentage loss in the meat's weight divided by its starting weight prior to cooking was used to illustrate cooking loss. The formula for calculating cooking loss is shown below.

Cooking loss (%) = W1- W2/W1 x 100

Where W1 = weight of meat before cooking and W2 = weight of meat after cooking

The cooking yield percentage was obtained by subtracting the cooking loss from 100

Water holding capacity (WHC)

To develop the WHC, samples of loin meat were used. For this work, the filter paper press method was used. About 1 g of meat samples were pressed between two 9 cm pieces of Whatmann filter paper. Between 10.2 × 10.2 cm plexiglasses, this was compressed for one minute at an absolute pressure of roughly 35.2 kg/cm. Meat samples were removed and allowed to air dry. The area of the pressed meat samples was used to indirectly estimate the amount of water released from the samples (Moawad et al., 2013). The WHC was calculated thus:

WHC = 1 – MA/WA x 100

Where MA= Area of meat sample (cm^2) and WA = Area of water released from meat sample (cm^2).

Fatty acid profile determination

Lipid Extraction

The Muchenje et al. (2009) and Anaso et al., (2025g) method was used to quantitatively extract total lipids from muscle samples. To stop lipid oxidation, butylated hydroxytoluene (BHT) was added at a concentration of 0.001% to the extraction solvent, which was a chloroform–methanol mixture (2:1, v/v). Phosphorus pentoxide was used as a desiccant while the lipid extracts were concentrated under vacuum using a rotary evaporator and then dried overnight at 50 °C in a vacuum oven. The total extractable intramuscular fat was determined gravimetrically and expressed as the percentage of fat (w/w) per 100 g of tissue. The lipids which were extracted were then subsequently stored in glass vials (polytop) with push-in tops and flushed with nitrogen gas. They were finally stored and kept to remain frozen at −20 °C up until the commencement analysis in the laboratory.

Methylation of Fatty Acids

A disposable glass Pasteur pipette was used to transfer around 10 mg of the extracted lipid into a screw-cap test tube lined with Teflon. In accordance with Anaso et al. (2025g), the lipid samples were methylated using a methanol–boron trifluoride (BF_3) reagent to produce fatty acid methyl esters (FAME).

Gas Chromatography Analysis

A Varian GX 3400 gas chromatograph properly fitted with Chrompack (CPSIL 88; 100 m × 0.25 mm i.d.; 0.2 μm thickened film). Subsequently, the flame ionization detector was employed to adequately examine the FAME. After holding the column temperature at 40 °C for two minutes, it was raised to 230 °C at a rate of 4 °C per minute and kept there isothermally for ten minutes.

A Varian 8200 CX autosampler with a split ratio of 100:1 was used to automatically inject samples (1 μL in n-hexane). The temperature of the injector and detector was kept constant at 250 °C. The makeup gas was nitrogen, while the carrier gas was hydrogen (45 psi). Varian Star Chromatography Software was employed to visualize the chromatographic procedure and final reports.

Identification and Quantification of Fatty Acids

The fatty acids for each sample was identified using the Supelco 37 Component FAME Mix, 47885-U; Sigma–Aldrich, South Africa. This was achieved by appropriately comparing their retention durations with those of actual/genuine numerical standards, Matreya Inc. (Pleasant Gap, USA) provided conjugated linoleic acid (CLA) standards, including cis-9,trans-11; cis-9,cis-11; trans-9,trans-11; and trans-10,cis-12 isomers. Merck Chemicals (Pty) Ltd., located in Halfway House, South Africa, provided all of the analytical-grade reagents and solvents.

Percentages for each sample of fatty acid and the actual initial total detected fatty acids was used to express the fatty acid composition. The fatty acid parameters and total polyunsaturated fatty acids (PUFA), the PUFA/SFA ratio (P/S), and the n-6/n-3 ratio were all computed.

Sensory evaluation

Meat samples for sensory assessments were obtained from thigh muscle and cooked until the internal temperature reached 72°C. Ten trained individuals were used to evaluate the quality of the cooked meat samples. To guarantee bite size uniformity between treatments, blind coding was employed. replicated three times and put on an odorless plastic plate. The color, flavor, juiciness, tendeness, texture, and general acceptability of each sample were assessed using a nine-point Hedonic scale. Cracker biscuits and sachet water were used to rinse the palate in between samples (American Meat Science Association 1995).

Statistical analyses

Data on carcass characteristics and properties were subjected to an analysis of variance with SPSS (24.0) in a fully randomized design. The same software's Duncan multiple range test was performed to assess the significance of the mean difference at the $P \leq 0.05$ level.

3. RESULTS & DISCUSSION

Chemical components and composition of experimental diets

The ingredients and chemical makeup of the experimental diets are displayed in Table 1. With the exception of the CP, EE, and hemicellulose fractions, which improved, the organic matter, NSC, cellulose, and fiber fractions decreased as the amount of test ingredient (BSS) in the diets rose. The somewhat higher CP and EE concentrations showed that BSS had somewhat higher CP and EE contents than maize bran. Nevertheless, the dietary CP continued to be isonitrogenous. The levels of these structural carbohydrates in BSS in comparison to the corn bran it replaced are indicated by the diets' increased hemicellulose and reduced OM, NSC, cellulose, and fiber fraction contents. However, the NDF of the experimental diets was much lower than the 55–60% DM threshold level where ruminant feed utilization was reduced (Meissner and Paulsmeier, 1995; Anaso and Chibuogwu, 2026).

Carcass characteristics of Yankassa lambs fed biodegraded sugar scrapings-based diet

The carcass characteristics of Yankassa lambs fed diets based on biodegraded sugarcane scrapings (BSS) are shown in Table 2. Similar trends were seen in slaughter weight, hot carcass weight, and dressing percentage, with T2 showing considerably greater ($P < 0.05$) values than T1 and T3. On the other hand, there was no significant difference ($P > 0.05$) in the weights of the head, feet, heart, kidney, lungs, trachea, and ribeye region between treatments.

The increased feed palatability, intake, nutrient digestibility, and subsequent growth performance linked to modest BSS inclusion are responsible for the improved dressing percentage shown in T2. A crucial economic metric, dressing percentage is the percentage of live weight that is transformed into a marketable carcass and is impacted by a number of variables, including live weight, age, breed, sex, fat deposition, and management techniques. Under this dietary level, the better performance in T2 indicates effective partitioning toward muscle accretion and optimal nutrient utilization.

The dressing percentage values found in this study are in line with reports by Peter and Bassey (2019) and previous research by Steele (1996) and Devendra and McLeroy (1982), who observed that under balanced feeding regimes, tropical small ruminants usually achieve dressing percentages between 40 and 50%. This report was similar and could be compared to Atti & Mahouachi, 2009 and Ribeiro et al., 2020 who both highlighted how factors such as breed adaptability and feed characteristics in terms of quality affected carcass yield in most tropical settings. The perceived impression and hypothesis that the dressing percentage improves with quality nutrients in the diet, as well as developmental rates, and physiological growth is further supported by the observed improvement as seen in T2.

It is also worthy to note that the presence of BSS in the diet did not deter muscular development or organ integrity, as indicated by the observed absence of substantial variations in ribeye area and internal organ weights between treatment groups. Also, the stability liver weights amongst treatment group, further proves the lack of inflammation, hepatotoxic factors or metabolic abnormalities. These are all indicative of absence of atrophy and hypertrophy (Anaso et al., 2024c). finally validating BSS's physiological safety as a dietary ingredient in small ruminant production systems.

Furthermore, the same organ weights found are consistent with the results of Peter and Bassey (2019), suggesting that when diets are nutritionally balanced, the addition of additional feed supplies does not always jeopardize the development of visceral organs. Adequate metabolic functioning and the lack of systemic stress are further shown by the preservation of normal organ proportions.

According to earlier research by McIntosh et al. (2003), higher muscle deposition, improved protein synthesis, and effective nutrition partitioning may also be associated with improved carcass yield in T2. Additionally, the fermentation procedure used to produce BSS may have decreased anti-nutritional agents and increased nutrient availability, improving feed efficiency and growth performance. Better growth and carcass development were supported by greater voluntary feed intake, which was probably influenced by improved palatability and dietary acceptance.

The noted increases in dressing percentage from a production perspective demonstrate the financial and economic prospect of BSS inclusion in small ruminant diets. Enhance marketability/ profitability for livestock producers are closely correlated with higher carcass/meat percentage (Anaso et al., 2024c). Several reports on phytogenic and alternative feed additives has also been proven to efficiently enhance carcass qualities in similar ways according to Arteaga-Wences et al. (2021) and Anaso et al. (2025f,g), further providing evidential support for the importance of these tactics in sustainable livestock production.

Table 1. Ingredient and chemical composition of the experimental diets (% DM)

Ingredient	T1	T2	T3
Maize	25	25	25
Corn bran	30	15	0
Biodegraded sugarcane scrapings	0	15	30
Groundnut cake	17	17	17

Cowpea husk	25	25	25
Salt	0.5	0.5	0.5
Limestone	2	2	2
Premix	0.5	0.5	0.5
Total	100	100	100
Chemical composition			
Crude protein	15.70	15.80	15.89
Organic matter	93.76	91.96	91.55
Ether extract	5.78	5.80	5.82
Non-structural carbohydrate	33.59	29.74	27.24
Neutral detergent fiber	38.69	40.62	42.60
Acid detergent fiber	20.95	23.10	25.24
Lignin	2.89	3.21	4.45
Cellulose	18.06	19.89	20.79
Hemicellulose	17.74	17.52	17.36

BSS, biodegraded sugarcane scrapings. T1, 0% biodegraded sugarcane scrapings; T2, 15% biodegraded sugarcane scrapings; T3, 30% biodegraded sugarcane scrapings

Table 2. Carcass characteristics of Yankassa lambs fed biodegraded sugar scrapings-based diet

Parameter	T1	T2	T3	SEM
Body at slaughter (kg)	16.34^{b}	18.35^{a}	16.13^{b}	0.36
Hot carcass (kg)	9.03^{b}	10.78^{a}	8.74^{b}	0.32
Dressing percentage (%)	49.08^{b}	53.79^{a}	47.65^{b}	2.50
Head (%)	6.51	6.64	6.42	0.13
Feet (%)	3.15	3.19	3.07	0.01
Heart (%)	0.64	0.66	0.60	0.01
Kidney (%)	0.32	0.33	0.31	0.00
Lung (%)	1.53	1.56	1.47	0.01
Trachea (%)	0.30	0.31	0.29	0.00
Rib eye area (%)	16.41	16.92	15.96	0.48

^{abc} *Means with the different superscripts along the row are significantly ($P < 0.05$) different. BSS, biodegraded sugarcane scrapings. T1, 0% biodegraded sugarcane scrapings; T2, 15% biodegraded sugarcane scrapings; T3, 30% biodegraded sugarcane scrapings*

Table 3. Proportion of carcass weight of retail cut of Yankassa lambs fed biodegraded sugar scrapings-based diet

Parameter	T1	T2	T3	SEM
Neck (kg)	5.33^{ab}	5.56^{a}	5.26^{b}	0.10
Rack (kg)	5.93^{a}	6.08^{a}	5.67^{b}	0.10
Loin (kg)	6.25	6.48	6.12	0.17
Flank (kg)	2.70	2.96	2.71	0.16
Brisket (kg)	3.63^{ab}	3.88^{a}	3.49^{b}	0.10
Foreleg (kg)	7.24^{b}	6.74^{a}	5.98^{c}	0.10
Hindleg (kg)	8.00^{a}	8.89^{a}	7.41^{b}	0.15

^{abc} *Means with the different superscripts along the row are significantly ($P < 0.05$) different. BSS, biodegraded sugarcane scrapings. T1, 0% biodegraded sugarcane scrapings; T2, 15% biodegraded sugarcane scrapings; T3, 30% biodegraded sugarcane scrapings*

Carcass weight of retail cut of Yankassa lambs fed biodegraded sugar scrapings-based diet

The retail cuts of rams given a diet based on BSS are displayed in Table 3. The greatest values in T2 were seen in the neck, brisket, rack, foreleg, and hindlegs ($P < 0.05$). However, there was no difference ($P > 0.05$) in the loin and flank between treatments.

These findings implied that a 50% replacement of maize bran with BSS improved intake, digestion, and utilization, which in turn led to an increase in the weight of the experimental animals. The results were in line with those of Peter and Bassey (2019), who discovered that the dietary interventions had no discernible effect on certain retail cuts. This may indicate that the parameters of sheep retail slices were not significantly affected by the experimental diets. Other retail cut features, such as the neck, rack, brisket, foreleg, and hindlegs being highest in T2, showed that the diet was effective in increasing the performance and growth of the rams' body parts (Xazela et al., 2011; Anaso et., 2021a,b; Anaso et., 2024c). The whole sale cut usually increases with an individual's age, sex, weight gain, and feed intake.

Physical qualities of carcass from Yankassa lambs fed biodegraded sugar scrapings-based diet

The carcass characteristics of rams fed diets including biodegraded sugarcane scrapings (BSS) are shown in Table 4. Water-holding capacity (WHC) was significantly higher in BSS-fed rams (T2 and T3), while cooking loss was significantly ($P < 0.05$) highest in T2 and lowest in the control group. On the other hand, dietary interventions did not significantly ($P > 0.05$) impact parameters such as the shear force and muscle pH.

Anaso et al. (2024c; 2025f), suggests that the higher loss in moisture in treatment groups, most especially T2, undeniably suggests some level of structural modification in muscle tissue indirectly linked to protein denaturation. Increased losses may lower the nutritional value of beef through exudate depletion because cooking loss is a measure of the quantity of fluid and soluble nutrients lost during heat processing (Anaso et al., 2024c). Nevertheless, the noticeably greater WHC in T2 and T3 suggests that BSS enhanced muscle's capacity to hold onto bound water in non-thermal environments. This implies that the total water retention capacity was increased since there was less water in free form and more was held inside the myofibrillar matrix.

Shear force, a direct measure of meat tenderness, did not differ substantially across treatments, suggesting that the structural arrangement of muscle fibers or connective tissues was unaffected by the addition of BSS. The uniformity shown across treatments suggests constant meat texture and no negative impact of dietary BSS on tenderness, as lower shear force values are generally linked to increased softness.

Further evidence that BSS had no effect on postmortem biochemical processes comes from the non-significant variations in pH at 0, 1, and 24 hours after death. Glycogen reserves before slaughter and subsequent glycolysis play a major role in muscle pH reduction (Ameha, 2006). The fact that pH levels stayed constant throughout the treatments indicates that the addition of BSS had no detrimental effects on the shelf life or preservation of meat because it did not impede the metabolism of glycogen or the buildup of lactic acid.

Bioactive substances such dietary fiber, polyphenols, flavonoids, phytosterols, and long-chain fatty alcohols produced during fermentation may be responsible for the increased WHC shown in BSS-fed rams (Viuda-Martos et al., 2010; Anaso et al., 2025g).

Phytogenic feed additives have also been demonstrated in earlier studies to enhance the technical and sensory quality of meat (Miller et al., 2012; Kholif & Olafadehan, 2021). The simultaneous rise in WHC indicates a complicated interplay between thermal and non-thermal water retention characteristics despite the significantly higher value cooking loss in T2 (Ameha, 2006; Anaso et al., 2024c).

Organoleptic properties of carcass from Yankassa lambs fed biodegraded sugar scrapings-based diet

The organoleptic characteristics of Yankassa lambs fed diets containing biodegraded sugarcane scrapings (BSS) are shown in Table 5. shows no significance ($P > 0.05$) in all parameters studied. Which strongly indicates that BSS inclusion, even up to 30% showed no negative consequence on the meat's sensory trait.

The lack of treatment effects on discomfort indicates that BSS inclusion had no influence on the structural integrity of muscle fibers and connective tissue. Muscle fibers, collagen properties, and oral processing during mastication all affect how tender meat is (NRC, 1976). Therefore, the similarity in discomfort between treatments suggests that the muscle fiber–connective tissue matrix was not negatively impacted by solid-state fermented BSS.

The color of the meat, which is a major factor in consumer acceptance, showed no significant difference along treatments, might be due to several factors such as Myoglobin and oxymyoglobin, which are primarily responsible for the known pink to reddish color of meat post slaughter (Anaso et al., 2024c). The general insignificance seen as absence of certain variations imply that neither concentration of physical pigments and the postmortem metabolic changes which significantly influence color developments were not affected by BSS inclusion.

Additionally, dietary interventions had no effect on juiciness, suggesting that the groups' intramuscular fat content and water-holding capacity were similar. Instead of just management parameters, moisture release during mastication and salivary stimulation have a significant impact on the sense of juiciness (Lawrie, 1966; Cross et al., 1986; Omojola et al., 2003). The lack of notable variations suggests that BSS had no effect on the distribution of lipids in the tissue or the state of muscle hydration.

Similarly, the addition of BSS had no discernible impact on the meat flavor. In the cooking (heating) process, factors such as the amino acids, peptides, reducing sugars, and lipid-derived chemicals present, interact considerably to produce meat flavors, especially through known and standard Maillard reactions (Mottram, 1994; Anaso et al., 2024c).

Table 4. Physical qualities and properties of Yankassa lambs fed biodegraded sugar scrapings-based diet

Parameter	T1	T2	T3	SEM
Cooking loss (%)	45.19^{c}	40.30^{a}	42.24^{b}	0.59
Shear force kg/m^{3})	1.50	1.50	1.60	0.01
Water holding capacity (%)	53.26^{b}	57.32^{a}	56.92^{a}	0.71
pH at 0 hour	6.30	6.60	6.51	0.01
pH at 1 hour	6.11	6.30	6.26	0.01
pH at 24 hours	6.17	6.05	6.25	0.11

^{abc} *Means with the different superscripts along the row are significantly ($P < 0.05$) different. BSS, biodegraded sugarcane scrapings, T1, 0% biodegraded sugarcane scrapings; T2, 15% biodegraded sugarcane scrapings; T3, 30% biodegraded sugarcane scrapings*

Table 5. Organoleptic properties of Yankassa lambs fed biodegraded sugar scrapings-based diet

Parameters	T1	T2	T3	SEM
Colour	6.97	7.35	7.03	0.16
Flavour	5.79	6.31	5.81	0.22
Texture	6.65	6.88	6.26	0.42
Tenderness	7.04	6.93	6.86	0.03
Juiciness	6.16	6.71	6.42	0.29
Overall acceptability	8.23	8.85	8.11	0.09

^{abc} *Means with the different superscripts along the row are significantly ($P < 0.05$) different. BSS, biodegraded sugarcane scrapings. T1, 0% biodegraded sugarcane scrapings; T2, 15% biodegraded sugarcane scrapings; T3, 30% biodegraded sugarcane scrapings*

Table 6. Meat fatty acid profile of Yankassa lambs fed biodegraded sugar scrapings-based diet

Fatty Acid	**T1**	**T2**	**T3**	**SEM**
C14:0	1.82^{b}	1.95^{a}	1.70^{c}	0.06
C14:1 n-9	0.21^{b}	0.25^{a}	0.18^{c}	0.01
C15:0	0.48^{a}	0.46^{a}	0.44^{a}	0.02
C15:1 n-10	0.26^{b}	0.30^{a}	0.22^{c}	0.02
C16:0	23.80^{b}	24.65^{a}	23.10^{c}	0.25
C16:1 n-9	2.10^{a}	1.98^{b}	1.85^{c}	0.07
C17:0	1.15^{a}	1.10^{a}	1.05^{a}	0.03
C17:1 n-10	0.46^{b}	0.50^{a}	0.40^{c}	0.02
C18:0	19.20^{c}	19.85^{b}	20.60^{a}	0.28
C18:1 t9	1.55^{b}	1.78^{a}	1.32^{c}	0.06
C18:1 n-9	27.80^{c}	29.60^{a}	28.50^{b}	0.40
C18:2 n-6 (LA)	3.10^{b}	3.35^{a}	2.90^{c}	0.10
CLA (C18:2 c9t11)	0.45^{b}	0.50^{a}	0.40^{c}	0.02
C20:0	0.25	0.28	0.22	0.01
C18:3 n-3	1.10^{b}	1.25^{a}	0.98^{c}	0.05
C22:0	0.45^{a}	0.47^{a}	0.42^{a}	0.03
C20:3 n-3	0.35^{b}	0.40^{a}	0.30^{c}	0.02

Fatty Acid	T1	T2	T3	SEM
C20:4 n-6	2.80^{b}	3.05^{a}	2.55^{c}	0.09
C22:2 n-6	0.20^{b}	0.24^{a}	0.18^{c}	0.02
C20:5 n-3 (EPA)	0.30^{b}	0.35^{a}	0.25^{c}	0.02
C22:5 n-3 (DPA)	0.80^{b}	0.90^{a}	0.70^{c}	0.04
C22:6 n-3 (DHA)	0.05^{b}	0.07^{a}	0.04^{c}	0.01
PUFA	13.20^{b}	14.80^{a}	12.40^{c}	0.35
MUFA	32.10^{b}	33.90^{a}	31.20^{c}	0.45
SFA	49.80^{c}	50.60^{b}	52.10^{a}	0.50
n-6	6.50^{b}	7.20^{a}	6.00^{c}	0.20
n-3	2.60^{b}	2.90^{a}	2.30^{c}	0.10
PUFA:SFA	0.27^{b}	0.29^{a}	0.24^{c}	0.01
n-6/n-3	2.50^{a}	2.48^{a}	2.61^{b}	0.06

^{abc} *Means with the different superscripts along the row are significantly ($P < 0.05$) different. BSS, biodegraded sugarcane scrapings. T1, 0% biodegraded sugarcane scrapings; T2, 15% biodegraded sugarcane scrapings; T3, 30% biodegraded sugarcane scrapings*

Meat fatty acid profile of Yankassa lambs fed biodegraded sugar scrapings-based diet

Table 6 shows the meat fatty acid composition of Yankassa lambs fed diets based on biodegraded sugarcane scrapings (BSS). The majority of individual fatty acids and lipid fractions were significantly ($P < 0.05$) impacted by dietary interventions.

In terms of saturated fatty acids (SFA), rams given 15% BSS (T2) had considerably greater levels of myristic acid (C14:0) and palmitic acid (C16:0), whereas stearic acid (C18:0) grew gradually and peaked in T3. Dietary interventions had no significant effect ($P > 0.05$) on minor saturated fatty acids such C15:0, C17:0, and C22:0. Higher BSS inclusion often resulted in higher overall SFA content; T3 had the highest value (52.10%), followed by T2 (50.60%) and T1 (49.80%).

In comparison to T1 and T3, monounsaturated fatty acids (MUFA), especially oleic acid (C18:1 n-9), were considerably ($P < 0.05$) higher in T2 (29.60%). The same pattern was seen in other MUFA, including C14:1 n-9, C15:1 n-10, and C17:1 n-10, with T2 having the greatest values. T2 had the highest total MUFA (33.90%), followed by T1 (32.10%), and T3 (31.20%).

Dietary interventions also had a major impact on polyunsaturated fatty acids (PUFA). Increase of conjugated linoleic acid (CLA), α-linolenic acid (C18:3 n-3), and linoleic acid (C18:2 n-6) ($P < 0.05$) were seen in T2, suggesting better essential fatty acid deposition with low BSS inclusion.

In comparison to T1 and T3, T2 has comparable levels of long-chain omega-3 fatty acids, such as EPA (C20:5 n-3), DPA (C22:5 n-3), and DHA (C22:6 n-3). T2 had the greatest total PUFA (14.80%), followed by T1 (13.20%) and T3 (12.40%).

Similar trends were seen in the overall levels of omega-6 (n-6) and omega-3 (n-3) fatty acids, which were much higher in T2 (7.20% and 2.90%, respectively). The n-6/n-3 ratio, however, was much greater in T3 (2.61) but similar in T1 (2.50) and T2 (2.48). Additionally, T2's PUFA:SFA ratio (0.29) was substantially better ($P < 0.05$) than T1's (0.27) and T3's (0.24). Pleurotus ostreatus-mediated solid-state fermentation may be responsible for the improved fatty acid composition shown at 15% BSS inclusion (T2), especially the elevated levels of MUFA, PUFA, CLA, and n-3 fatty acids. In addition to increasing nutritional availability, this process may change the dynamics of rumen fermentation, which could lessen the extensive biohydrogenation of unsaturated fatty acids and make it easier for them to be absorbed and deposited in muscle tissues (Patra & Yu, 2012; Calsamiglia et al., 2007). Furthermore, it is recognized that fungal biodegradation (SSF) alters lignocellulosic bonds/substrates further introducing bioactive compounds affecting antioxidant status and enhanced metabolism of lipids (Sánchez, 2010; Olafadehan et al., 2023).

The current results are in line with studies by Morsy et al. (2016) and Zhang et al. (2020), who found that dietary treatments that alter rumen microbial activities (Frank et al., 2016; Adegbeye et al., 2019).

The 30% inclusion level (T3), on the other hand, produced higher SFA and lower PUFA and MUFA proportions, indicating that too much BSS may restrict its advantageous effects on lipid metabolism.

Overall, the findings show that adding 15% of Pleurotus ostreatus-biodegraded sugarcane scrapings to mutton optimizes its fatty acid profile by increasing health-promoting fatty acids while preserving a favorable lipid balance. This demonstrates that it can be used as a useful and sustainable feed component to enhance meat quality in ruminant production systems.

4. CONCLUSION

Based on the present findings of this research, BSS inclusion enhanced general carcass performance in the experimental animals without necessarily compromising sensory traits and directly enhancing nutritional quality through favorable modulation of the fatty acid. Notably, the 15% inclusion level (equivalent to 50% replacement of corn bran in T2) consistently produced the best results/outcomes in terms of carcass yield directly related to the muscle development, and health-promoting lipid compositions, suggesting an optimal balance between nutrient availability and physiological utilization.

Therefore, partial substitution of conventional energy sources with BSS at 15% is recommended as a sustainable feeding strategy for improving productivity, enhancing meat quality, and promoting resource efficiency in goat production systems.

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EUA: Conception, Research, Analysis, and Writing.

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Conflict of interest

The authors declare that they have no conflicts of interest, competing financial interests or personal relationships that could have influenced the work reported in this paper.

Ethical approval

In this article, the animal & fungal regulations are followed as per the ethical committee guidelines of Department of Animal Science, Federal University of Agriculture Mubi, Adamawa, Nigeria; the authors observed the findings of *Pleurotus ostreatus*-biodegraded sugarcane scrapings (BSS) affected carcass parameters, meat quality, and fatty acid composition in Yankassa rams. The Animal & fungal ethical guidelines are followed in the study for species observation, identification & experimentation.

Informed consent

Not applicable.

Data availability

Data that support the findings of this study are embedded within the manuscript.

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