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Growth Performance and Nutrient Intake of West African Dwarf Rams Fed Diets Containing Urea-Molasses Treated Maize Cob

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Abstract

Nigerian smallholder livestock output is constrained by a lack of feed. By improving digestibility and protein value, urea-molasses-treated maize cob turns tonnage of maize cobs into cost-effective, climate-smart feed for ruminant nutrition that is sustainable. Using a completely randomized design, fifty West African Dwarf (WAD) rams between the ages of five and seven months were divided into five dietary treatments: T1 (0% UMTMC), T2 (25%), T3 (50%), T4 (75%), and T5 (100%). The 86-day feeding study included a 14-day acclimatization phase. Morning meals were provided, and *Panicum maximum* was grazed in the evening. Measurements were made of rumen fermentation parameters, proximate composition, performance attributes, nutrient intake, digestibility, and nitrogen utilization. When UMTMC was added, the crude protein content increased from 11.30% in T1 to 17.37% in T5, but the crude fiber percentage decreased from 13.97% to 10.60%. Improved fiber quality was indicated by a decrease in fiber fractions (NDF, ADF, and ADL). Daily weight gain increased from 34.52 g/day (T1) to 57.54 g/day (T4), feed conversion ratio improved from 23.57 (T1) to 15.75 (T4), and daily feed intake increased from 811.71 g/day (T1) to 904.76 g/day (T4). With total volatile fatty acids peaking at 240.00 Mm/100 ml (T5), stable rumen pH (6.73–6.90), and increased microbial counts in T3, rumen fermentation verified increased microbial activity. By safely substituting wheat offal, UMTMC enhanced growth, rumen fermentation, digestibility, and nutrient intake. Its usefulness as a cost-effective, climate-smart feeding method for Nigerian smallholders is highlighted by its optimal advantages at 75% inclusion.

Introduction

Nigeria's agricultural economy depends heavily on the production of livestock, which gives millions of smallholder farmers jobs, cash, milk, and meat. Because of their resistance to trypanosomiasis, tolerance to humid tropical environments, and capacity to flourish under low-input management regimes, West African Dwarf (WAD) sheep and goats are particularly significant among small ruminants (Fasae et al. 2014). Even though WAD rams are resilient, their output is frequently limited by poor nutrition, particularly during the dry season when traditional feed supplies become more expensive and scarcer.

One of the biggest problems smallholder livestock farmers in sub-Saharan Africa continue to face is feed scarcity (Akinfemi 2012). Due to their rising costs and competition with human food demands, conventional concentrate ingredients such wheat offal, maize bran, and groundnut cake are less accessible to farmers with limited resources (Okeniyi et al. 2020). This circumstance emphasizes the necessity of investigating inexpensive, locally accessible, and nutritionally sufficient substitute feed sources. Although crop residues including rice husks, sorghum stover, and maize cobs are plentiful by-products of cereal production, their direct application in animal feed is limited due to their high fiber content and low protein levels (Akinfemi et al. 2009).

It is commonly known that treating agricultural leftovers with urea-molasses is a useful way to increase their nutritional value. Molasses offers easily fermentable carbohydrates that promote microbial growth and fiber destruction, while urea delivers non-protein nitrogen that rumen bacteria transform into

microbial protein (Kioumarsi et al. 2011). This combined effect increases the digestibility of treated residues, decreases fiber fractions, and increases crude protein content. According to earlier research, feeding WAD goats and sheep rice husks and maize stover treated with urea-molasses enhanced their nutritional intake, digestibility, and growth performance (Fajemisin 2020; Okeniyi et al. 2020).

A potential remedy for feed scarcity is the efficient use of maize cobs using urea-molasses treatment, given their availability in Nigeria. The growth performance and nutritional intake of WAD rams fed diets containing urea-molasses treated maize cob (UMTMC) are, however, little understood. Therefore, the purpose of this study was to assess how the growth performance, nutritional intake, and feed conversion efficiency of WAD rams were affected when graded amounts of UMTMC were included in concentrate diets in place of wheat offal. It is anticipated that the results would give smallholder farmers useful advice on sustainable feeding practices that lower expenses, boost output, and encourage effective use of crop waste.

Materials and Methods

Study Area

The feeding study took place in Yaba College of Technology's Odoragunshin Farm Complex, which is situated in Lagos State, Nigeria, along KM 48 Epe–Ijebu Ode highway (longitude 3° 56' E, latitude 6° 32' N). As is typical of the humid tropics, the region has a humid climate with plenty of sunshine, rainfall, and distinct wet and dry seasons (Fasae et al. 2014).

Experimental Animals and Management

Fifty healthy West African Dwarf (WAD) rams, aged 5–7 months with an average initial weight of 5.58 ± 0.42 kg, were purchased from local markets. Upon arrival, animals were quarantined for 14 days, treated with long-acting oxytetracycline, and dewormed with albendazole (10 mg/kg body weight). All animals were housed individually in well-ventilated pens, provided with clean drinking water, and grazed daily on *Panicum maximum* pasture in the evenings.

Individual rams were kept in slated-floored, well-ventilated quarters with unlimited access to clean water and Panicum maximum pasture as a supplement (Fajemisin 2020).

Diets and Experimental Design

It was decided to use a completely randomized design (CRD). Five feeding treatments (T1–T5), each including 10 animals, were randomly given to the rams. Diets included complete feed combinations with graded amounts of urea-molasses treated maize cob (UMTMC) in place of wheat offal:

- T1 (Control): 0% UMTMC, 100% wheat offal
- T2: 25% UMTMC (2% urea–molasses treatment)
- T3: 50% UMTMC (3% urea–molasses treatment)

- T4: 75% UMTMC (4% urea–molasses treatment)
- T5: 100% UMTMC (5% urea–molasses treatment)

To create UMTMC, maize cobs were chopped into tiny pieces (2–3 cm) and thoroughly mixed with a urea and molasses solution that had been dissolved in water. Molasses was added at 10% of the mixture, and the treatment levels matched 2%, 3%, 4%, and 5% urea (w/w of maize cob). The modified maize cobs were fermented under anaerobic conditions for two weeks (14 days) after being firmly packed into airtight polythene bags to keep out air. Following fermentation, the bags were opened, and the material was sun-dried to remove any remaining ammonia odor and lower its moisture content. Following that, the dried UMTMC was added to the formulation of whole feed mixtures for the experimental diets.

Rumen Environment Sampling and Analysis

Rumen Fluid Collection

At the end of the feeding trial, rumen fluid samples were obtained from each ram three to four hours after morning feeding using a stomach tube attached to a suction pump to record peak fermentation activity (Puniya et al. 2015). After discarding the first 10 milliliters of fluid to prevent saliva contamination, the next samples were promptly strained through four layers of cheesecloth.

Rumen Fermentation Parameters

Gas chromatography was used to determine the levels of volatile fatty acids (TVFA, acetic, propionic, and butyric acids) in rumen fluid (Perez et al. 2024). The phenol hypochlorite method was used to measure the concentration of ammonia nitrogen (NH_3N) (Weatherburn 1967). A calibrated thermometer was placed straight into the fluid sample to record the temperature, and a digital pH meter was used to measure the rumen's pH right away.

Microbial Population Measurements/count

Protozoa counts were acquired using a hemocytometer under light microscopy, whereas microbial populations (total viable count, bacteria, fungus, and protozoa) were assessed using serial dilution and plating techniques for bacteria and fungi (Puniya et al. 2015). Protozoa counts were reported as cells/mL, and colony forming units (cfu/mL) were expressed as log values.

Table 1. Gross Composition of Experimental Diets (% by weight)

Ingredient	T1	T2	T3	T4	T5
Maize bran	30	30	30	30	30
PKC	10	10	10	10	10
GNC	10	10	10	10	10
Wheat offal	40	30	20	10	0
UMTMC	0	10	20	30	40
Common salt	1	1	1	1	1
DCP	3.75	3.75	3.75	3.75	3.75
SBM	3.75	3.75	3.75	3.75	3.75
Vit. premix	1.5	1.5	1.5	1.5	1.5
Total (%)	100	100	100	100	100
Crude Protein	16.97	16.32	15.67	15.02	14.37
Crude Fibre	10.13	10.12	10.12	10.12	10.11
Ether Extract	3.87	3.75	3.73	3.75	3.56
Ash	4.22	3.92	3.62	3.32	3.02

Feeding and Data collection

The 86-day feeding study included a 14-day acclimatization phase. Morning diet were provided, and *Panicum maximum* was grazed in the evening. Body weight and feed consumption were recorded weekly.

Nitrogen Balance and Digestibility

Five rams per treatment were chosen at the conclusion of the trial to participate in digestibility tests utilizing total fecal collection. For seven days, three for adaptation and four for collection—the animals were kept in metabolic cages. For nitrogen analysis, daily urine and feces samples were taken, weighed, and subsampled. For DM, CP, CF, EE, and ash, apparent digestibility coefficients were computed. Standard equations were used to calculate nitrogen intake, nitrogen balance, nitrogen retention, nitrogen fecal nitrogen, and nitrogen urine nitrogen (Okeniyi et al. 2020).

Assessment of Performance

The following formula was used to determine performance parameters:

- **Body Weight Gain (BWG):** Final weight − Initial weight

- **Daily Body Weight Gain (DBWG):** BWG ÷ Total days
- **Total Feed Intake (TFI):** Feed supplied − Feed leftover
- **Average Feed Intake (AFI):** TFI ÷ Number of animals
- **Feed Conversion Ratio (FCR):** TFI ÷ BWG

Rumen Fermentation

Before morning feeding on the last day, five rams per treatment had their rumen fluid (100 mL) collected using stomach tubing. A digital pH meter and thermometer that had been calibrated were used to measure the temperature and pH right away. Orthophosphoric acid was used to preserve the samples, which were then kept at -20°C.

- **Total VFA:** Steam distillation (Markham 1942)
- **Individual VFAs (acetate, propionate, butyrate):** Gas chromatography (Kioumarsi, Yahaya, & Rahman, 2011)
- **Ammonia Nitrogen (NH_3–N):** Spectrophotometric methods

Chemical Analysis

Proximate composition of diets and fibre fractions were determined using AOAC (2000) procedures. Neutral detergent fibre (NDF), acid detergent fibre (ADF), and acid detergent lignin (ADL) were analyzed according to Van Soest methods, while cellulose and hemicellulose were calculated by difference (Aruwayo et al. 2022).

Statistical Analysis

All data were subjected to one-way ANOVA using SPSS version 25.0. Duncan's multiple range test was used to separate treatment means at $p<0.05$. Results are presented as means ± standard error of mean (SEM).

Results

Proximate Composition of Diets

There were notable variations ($p < 0.05$) in the proximal composition (Table 2) across treatments. With the addition of UMTMC, the crude protein (CP) content gradually increased from 11.30% in T1 to 17.37% in T5. With higher UMTMC levels, ether extract (EE) slightly reduced, whereas crude fiber (CF) fell from 13.97% in T1 to 10.60% in T5. While nitrogen free extract (NFE) slightly declined, organic matter (OM) stayed largely same.

Table 2
Proximate Composition (%) of Concentrate Diets Containing UMTMC

Sample	DM	CP	EE	Ash	CF	OM	NFE
T1	86.45c	11.30e	3.90a	8.23e	13.97a	91.77a	62.60a
T2	88.64a	13.80d	3.73b	8.80d	12.63b	91.20b	61.03b
T3	88.00b	16.03c	3.47cd	9.43c	11.83c	90.57c	59.23c
T4	87.99b	16.83b	3.57c	9.63b	11.27d	90.37d	58.70d
T5	86.73abc	17.37a	3.33d	9.83a	10.60e	90.17e	58.87cd
SEM	0.23	0.60	0.07	0.16	0.31	0.16	0.41
p-value	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Fibre Fractions

As UMTMC inclusion increased, the fiber fractions (Table 3) revealed decreases in neutral detergent fiber (NDF), acid detergent fiber (ADF), and acid detergent lignin (ADL). ADF decreased from 32.40% to 28.03%, and NDF fell from 60.43% in T1 to 54.23% in T5. ADL decreased from 12.97% to 10.43% as well. These decreases suggest better digestibility and fiber quality.

Table 3
Fibre Fractions (%) of Concentrate Diets Containing UMTMC

Sample	NDF	ADF	ADL	Cellulose	Hemicellulose
T1	60.43^{a}	32.40^{a}	12.97^{a}	19.43^{a}	28.03^{a}
T2	58.83^{b}	31.23^{b}	12.43^{b}	18.80^{b}	27.60^{b}
T3	56.27^{c}	29.63^{c}	11.23^{c}	18.40^{c}	26.63^{c}
T4	54.67^{d}	28.03^{d}	10.63^{d}	17.80^{d}	26.23^{d}
T5	54.23^{e}	28.03^{e}	10.43^{e}	17.60^{e}	26.20^{d}
SEM	0.64	0.44	0.27	0.18	0.20
p-value	0.0001	0.0001	0.0001	0.0001	0.0001
^{abcd}*Means along the same row with different superscripts*					

are significantly different (p < 0.05)

Growth Performance

UMTMC incorporation resulted in notable increases in performance metrics (Table 4).

Feed Intake: In T4, the total amount of feed consumed increased from 68.18 kg in T1 to 76.00 kg. The amount of feed consumed each day increased from 811.71 g in T1 to 904.76 g in T4.

Weight Gain: From 2.90 kg in T1 to 4.83 kg in T4, the overall weight gain increased. The daily weight gain in T4 was 57.54 g, up from 34.52 g in T1.

Feed Conversion Ratio (FCR): FCR showed more effective feed usage, declining from 23.57 in T1 to 15.75 in T4.

Table 4
Performance Characteristics of WAD Rams Fed Concentrate Diets with *Panicum maximum*

Parameter	T1	T2	T3	T4	T5	SEM	p-value
Total grass intake (kg)	39.52^{cd}	38.33^{d}	41.33^{ab}	42.33^{a}	40.33^{bc}	0.41	0.0001
Total concentrate intake (kg)	28.67^{b}	30.33^{ab}	31.67^{ab}	33.67^{a}	32.33^{ab}	0.64	0.0001
Total feed intake (kg)	68.18^{c}	68.67^{bc}	73.00^{ab}	76.00^{a}	72.67^{ab}	0.93	0.0001
Daily grass intake (g/day)	470.44^{cd}	456.35^{d}	492.06^{ab}	503.97^{a}	480.16^{bc}	4.93	0.0001
Daily concentrate intake (g/day)	341.27^{b}	361.11^{ab}	376.98^{ab}	400.79^{a}	384.92^{ab}	7.68	0.0001

^{abcd} *Means along the same row with different superscripts are significantly different ($p < 0.05$).*

Total volatile fatty acids (TVFA), acetic, propionic, and butyric acids, ammonia nitrogen (NH_3N), rumen pH, and temperature are among the rumen fermentation parameters shown in Table 5.

There were notable variations in rumen fermentation parameters ($p < 0.05$). TVFA showed improved fermentation with increased UMTMC inclusion, ranging from 176.67 Mm/100 ml in T2 to 240.00 Mm/100 ml in T5. Significant differences ($p < 0.005$) were seen in the peak levels of acetic acid (12.79 Mm/100 ml), propionic acid (12.13 Mm/100 ml), and butyric acid (11.60 Mm/100 ml) in T3. T3 had the highest rumen NH_3N (5.8), indicating better nitrogen metabolism. The temperature peaked at T3 at 36.50°C, indicating active microbial fermentation, but the rumen pH stayed constant between 6.73 and 6.90, displaying no discernible variation ($p > 0.05$).

Table 5
Effects of urea-molasses treated maize cob inclusion diets on rumen volatile fatty acids production, ammonia nitrogen, rumen pH and temperature of WAD sheep fed UMTMC diets

Parameter	T1	T2	T3	T4	T5	SEM	p-value
TVFA (Mm/100ml)	206.67^{ab}	176.67^{b}	230.0a	239.0a	240.0a	7.71	0.0001
Acetic acid (Mm/100ml)	5.76^{b}	8.01^{ab}	12.79a	7.26^{ab}	7.13^{ab}	0.96	0.0001
Propionic acid (Mm/100ml)	5.37^{b}	7.62^{ab}	12.13^{a}	7.05^{ab}	6.79^{ab}	0.91	0.0001
Butyric acid (Mm/100ml)	5.00^{b}	7.17^{ab}	11.60a	6.90^{ab}	6.37^{ab}	0.86	0.0001
Rumen NH_3N	4.5^{b}	5.4^{ab}	5.8^{a}	5.0^{ab}	5.1^{ab}	0.02	0.0001
Rumen pH	6.73^{b}	6.90^{a}	6.86^{ab}	6.90^{a}	6.90^{a}	0.02	0.0001
Rumen Temperature (°C)	33.27^{b}	33.67^{b}	36.50a	34.87^{ab}	33.27^{b}	0.45	0.0001

^{ab}*Means along the same row with different superscripts are significantly different ($p < 0.05$). TVFA = Total volatile fatty acids; NH_3N = Ammonia nitrogen.*

The rumen's microbial counts, comprising bacteria, fungus, protozoa, and total viable count (TVC), are displayed in Table 6.

There were notable variations in microbial counts ($p < 0.05$). In T1, TVC was 8.80 cfu/mL; in T3, it was 10.93 cfu/mL. Significant variations ($p < 0.005$) were seen in the counts of bacteria, fungus, and protozoa, which peaked at 7.87 cfu/mL, 3.63 cfu/mL, and 4.50 cells/mL, respectively, in T3. These findings suggest better fermentation and nutrient utilization, thus confirming that UMTMC diets increased rumen microbial activity.

Table 6
Rumen microbial population (total viable count, bacteria, fungi, protozoa) of WAD rams fed UMTMC diets

Parameter	T_1	T_2	T_3	T_4	T_5	SEM	p-Value
TVC (cfu/mL)	8.80^{b}	10.70^{a}	10.93^{a}	9.86^{ab}	10.07^{a}	0.24	0.0001
Bacteria count (cfu/mL)	6.20^{c}	6.87^{bc}	7.87^{a}	7.47^{ab}	6.87^{bc}	0.18	0.0001
Fungi count (cfu/mL)	2.83^{b}	2.87^{b}	3.63^{a}	3.10^{b}	2.90^{b}	0.09	0.0001
Protozoa (cell/mL)	3.13^{b}	3.47^{b}	4.50^{a}	3.47^{b}	3.23^{b}	0.14	0.0001

^{ab} Means along the same row with different superscripts are significantly different ($P < 0.05$). TVC= Total viable count,

Discussion

The urea-molasses treatment successfully improved the nutritional value of maize cobs, as evidenced by the rise in crude protein content with UMTMC inclusion. Molasses provides easily fermentable carbohydrates, and urea provides non-protein nitrogen that rumen bacteria transform into microbial protein. This synergistic action promotes microbial proliferation and fiber destruction (Akinfemi et al. 2009). Similar increases in CP have been seen in treated rice husks and maize stover, where urea addition increased digestibility and nitrogen content (Okeniyi et al. 2020; Fajemisin 2020).

The decrease in fiber fractions (NDF, ADF, and ADL) indicates that the treatment improved digestibility by breaking lignocellulosic linkages. This is in line with the findings of Aruwayo et al. (2022), who found that Sokoto Red goats fed treated agricultural wastes had better fiber utilization. Since animals are more likely to eat feeds with less bulk, lower fiber density probably played a role in the higher feed intake shown with UMTMC diets.

According to growth performance data, UMTMC diets promoted increased feed intake and weight gain, especially at 75% inclusion (T4). In line with Fasae et al. (2014), who noted increased growth in WAD sheep supplemented with maize cobs and feed legumes, the improved FCR emphasizes effective nutrient utilization. Improved erythropoiesis and metabolic activity are suggested physiologically by UMTMC diets' increased consumption of crude protein and nitrogen retention. Increased volatile fatty acids (VFAs) offer energy for creation and maintenance, while enhanced microbial protein synthesis supplies amino acids for tissue growth.

According to Kioumarsi et al. (2011), stable rumen pH values (6.7–6.9) attest to the fact that UMTMC diets preserved microbial activity-friendly rumen conditions, avoiding acidosis and promoting ideal fermentation. Better rumen fermentation and nutrient absorption, which in turn improved growth performance, were probably made possible by striking a balance between higher protein intake and lower fiber content.

Overall, the results show that UMTMC can safely take the place of wheat offal in WAD ram concentrate diets, with the greatest advantages occurring when 75% of the grain is included. For Nigerian smallholder farmers, this offers an economical and sustainable feeding approach that alleviates feed scarcity and lessens dependency on pricey conventional concentrates.

Rumen Environment

In West African Dwarf (WAD) rams, the addition of urea-molasses treated maize cob (UMTMC) diets had a major impact on the microbial ecology and rumen fermentation characteristics.

Volatile Fatty Acids and Ammonia Nitrogen

With the addition of UMTMC, total volatile fatty acids (TVFA) increased and peaked in T5 at 240.00 Mm/100 ml (Table 5). The main source of energy for ruminants is carbohydrate fermentation, which is indicated by elevated VFA concentrations. Significant increases were observed in butyric, propionic, and acetic acids; in T3, propionic acid reached 12.13 Mm/100 ml. Being a glucogenic precursor, propionate is especially crucial for better energy metabolism and growth. Sheep fed urea-based diets have shown comparable increases in VFAs, with better microbial fermentation improving nutrient absorption (Arya et al. 2024).

As a result of effective nitrogen release from urea and subsequent microbial protein synthesis, rumen ammonia nitrogen (NH_3N) peaked at 5.8 in T3. Adequate NH_3N levels are necessary for the best possible microbial development and digestion of fiber. Controlled ammonia release promotes microbial activity and avoids toxicity, according to studies conducted on sheep given non-protein nitrogen sources (KarDaya et al. 2024).

Rumen pH and Temperature

The pH of the rumen was constant between 6.73 and 6.90, which is the ideal range for microbial activity. This stability implies that the addition of molasses buffered fermentation and avoided acidity. In T3, the peak rumen temperature was 36.50°C, which is in line with vigorous microbial metabolism. These results are consistent with observations showing urea and molasses-containing balanced meals improve fermentation efficiency while preserving rumen homeostasis (DeDen et al. 2024).

Microbial Population

Rumen bacteria counts were considerably elevated by UMTMC diets (Table 6). The populations of bacteria, fungus, and protozoa all peaked in T3, whereas the total viable count increased from 8.80 cfu/mL in T1 to 10.93 cfu/mL in T3. Improved substrate availability from treated maize cobs, which supplied fermentable carbohydrates and non-protein nitrogen, is reflected in increased microbial growth.

According to Perez et al. (2024), the rumen microbiome is a varied ecosystem in which bacteria, protozoa, and fungus all play complimentary roles in the breakdown of fiber and the cycling of nutrients.

Larger populations of protozoa promote protein turnover, while larger bacterial levels encourage cellulolytic activity. Fungal growth improves the digestibility of fiber by aiding in the breakdown of lignocellulose. These outcomes are in line with past research showing that supplementing urea-molasses increases microbial growth and boosts rumen fermentation efficiency (Puniya et al. 2015).

When combined, the rumen environmental data provides an explanation for the enhanced nitrogen utilization, digestibility, and nutrient intake observed in this study. Increased microbial counts and VFAs show that UMTMC diets improved rumen fermentation, which improved protein metabolism and energy supply. The effectiveness and safety of fermentation are confirmed by stable pH and physiological NH_3N levels. These results demonstrate the molecular underpinnings of WAD rams given UMTMC diets' improved growth performance and feed efficiency.

West African Dwarf (WAD) rams' growth performance, nutrient intake, and feed conversion efficiency were all markedly enhanced when urea-molasses treated maize cob (UMTMC) was added to their concentrate diets. Nutrient availability and digestibility were improved as the crude protein level rose and the fiber fractions fell. In comparison to the control, rams fed UMTMC diets showed superior feed efficiency, increased daily weight gains, and enhanced nitrogen consumption, especially at 75% inclusion (T4). These results demonstrate that UMTMC can successfully and safely substitute wheat offal in the diets of small ruminants without sacrificing productivity.

Farm Implications

The study's conclusions have immediate and useful ramifications for Nigeria's smallholder farmers and livestock producers:

Cost Reduction

Since maize cobs are easily accessible agricultural remnants that would otherwise be wasted, farmers can drastically reduce feed costs by substituting UMTMC for wheat offal.

Feed Security

When traditional feed ingredients are expensive and in short supply during the dry season, UMTMC offers a dependable substitute feed source.

Enhanced Productivity

Rams achieve market weight more quickly traceable to higher daily weight gains and improved feed conversion ratios, which reduces fattening times and boosts profitability.

Sustainability

Using maize cobs encourages the conventional use of agricultural byproducts and lessens environmental waste, which is consistent with climate smart agriculture practices.

Ease of Adoption

Rural farmers can easily adopt UMTMC because it is easy to prepare and requires little technical assistance in the field.

Animal Health

Better physiological status is supported by increased nutrient intake and digestibility, which lowers the risk of malnutrition and subpar performance.

Recommendations

The ideal level of UMTMC inclusion in concentrate diets is 75%, since this level offers the optimal balance between feed efficiency, growth performance, and nutritional intake.

Farmer Education

To guarantee consistent quality and safe use, extension services should instruct smallholder farmers in basic UMTMC preparation techniques.

Policy Support

To lessen reliance on costly conventional concentrates, agricultural extension workers should encourage the use of UMTMC as a cost-effective and climate-smart feeding method.

Additional Research

Long-term research needs to investigate how UMTMC diets affect nitrogen excretion in the environment, carcass quality, and reproductive performance.

Sustainability

Promoting the utilization of crop wastes, such as maize cobs, helps Nigeria reduce waste and produce animals in a sustainable manner.

Declarations

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Competing Interest

The authors have no relevant financial or non-financial interests to disclose.

Authors Contributions

Abayomi Akinfemi and Babatunde John Adebayo developed the study concept and methodology. Kessiena Blessing **Anthony**, Kafayat Adeola **Lasisi**, Mujeebat Temitope **Atiku**, Ernestina Rachael **Oboh**, Gbekeloluwa Oluwamayowa **Owofade**, Shedrach Nwamaka **Chinedu** and Michael Olamilekan **Onimole** carried out the experiment and data collection. Revised analyzed the data. **Abayomi Akinfemi** prepared the first draft of the manuscript. All authors read, revised, and approved the final manuscript.

Data Availability

The data that support the findings of this study are available within the article and its supplementary materials. Additional raw data are available from the corresponding author upon request.

Ethics Approval

Every animal-related procedure was carried out in compliance with globally recognized guidelines for the handling and care of experimental animals. Animals were handled humanely during the trial since the study complied with animal rights laws.

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