Trop. Anim. Prod. Invest. 29 (01):17-21 (2026)
ISSN: 1115-2540
https://journals.ui.edu.ng/index.php/tapi

ORIGINAL RESEARCH ARTICLE

Effects of Urea–Molasses–Treated Maize Cob on Hematological and Serum Biochemical Parameters of West African Dwarf Rams

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ABSTRACT

This research aims to evaluate the haematological and serum biochemical indicators of West African Dwarf (WAD) rams fed complete feed diets substituting Urea-Molasses Treated Maize Cob (UMTMC) for wheat offal at graded levels. Fifty healthy West African Dwarf (WAD) rams, aged 5–7 months with an average initial weight of 5.58 ± 0.42 kg, were randomly allocated to five treatments namely T1 (control, 0% UMTMC), T2 (25% UMTMC), T3 (50% UMTMC), T4 (75% UMTMC), and T5 (100% UMTMC) in 86 days of feeding experiment and blood samples were taken for biochemical and hematological examinations. Results obtained for Packed Cell Volume (PCV), Hemoglobin (Hb), Red Blood Cell (RBC) counts, serum glucose, blood urea, and Alanine minotransferase (ALT) were significant ($p<0.05$). Hb increased from 8.07 g/dL to 13.00 g/dl and PCV increased from 25.33% in T1 to 39.67% in T4, both showing enhanced oxygen carrying capacity. Serum glucose increases from 34.33 mg/dl (T1) to 53.33 mg/dl (T4) demonstrating improved energy metabolism. The UMTMC inclusion resulted in a considerable increase in ALT activity, whereas Aspartate aminotransferase (AST), creatinine, and albumin levels were not significant ($p>0.05$), staying within physiological benchmark. Higher neutrophil and lymphocyte count in UMTMC diets were identified by leukocyte differentials, indicating enhanced immunological competence. The results observed confirmed that UMTMC can safely substitute wheat offal in WAD rams' diet combinations, enhancing their immune system, blood health, and metabolic efficiency. The best advantageous replacement level was at 75% inclusion (T4), where optimal responses were noted. Urea-Molasses Treated Maize Cob (UMTMC) is emphasised in this study as an affordable, climate-smart feed option for smallholder farmers in tropical areas.

Keywords: WAD ram, maize cob, Packed cell volume, Alanine aminotransferase, Neutrophil–lymphocyte response, Serum glucose

INTRODUCTION

In Nigeria, feed scarcity continues to be a significant barrier to smallholder livestock production, especially during the dry season when conventional concentrates like wheat offal become costly and scarce and natural pastures deteriorate (Shua *et al.,* 2024). As a result, farmers are forced to use crop leftovers, which are plentiful but low in nutrients. One such residue that is readily available but underutilised because of its high fiber density and low protein content is maize cob, the fibrous core that remains after grain removal (Akinfemi *et al.,* 2009; Fasae *et al.,* 2014).

It has long been known that treating low-quality agricultural leftovers with urea is an efficient way to improve them. Ammonia, which is released when urea is hydrolysed, breaks down lignocellulosic linkages, enters the fibrous matrix, and raises the amount of crude protein (Van Soest *et al.,* 1991). Urea's non-protein nitrogen synthesis microbial development in the rumen, increases microbial protein synthesis, and increases the availability of amino acids for tissue metabolism and erythropoiesis (Preston and Leng 1987). This explains why ruminants fed urea-treated diets showed gains in packed cell volume, hemoglobin concentration, and red blood cell counts (Jakheng *et al.,* 2022).

Molasses plays a complementary role by supplying readily fermentable carbohydrates that serve as an energy source for rumen microbes. According to Kioumarsi *et al.* (2011), adding it improves microbial efficiency in using ammonia generated by urea, boosts voluntary feed intake, and improves palatability. Improved energy supply and carbohydrate metabolism are confirmed by elevated blood glucose concentrations in animals fed diets supplemented with molasses (Ibhaze *et al.,* 2021). Urea and molasses work together to produce a synergistic impact that turns maize cob into a nutritionally enhanced feed source that can support better blood health, immunological competence, and metabolic efficiency.

The current study was designed to assess the serum biochemical and haematological indicators of West African Dwarf (WAD) rams that were fed full diets that substituted fermented Urea-Molasses Treated Maize Cob (UMTMC) for wheat offal at varying amounts.

MATERIALS AND METHODS

Study Area and Animal Management

The feeding trial was carried out in the Odoragunshin Farm Complex of Yaba College of Technology, situated along KM 48 Epe-Ijebu-Ode route in Lagos State, Nigeria (longitude 3° 56′ E, latitude 6° 32′ N). The area has a humid climate with plenty of sunshine, rainfall, and distinct wet and dry seasons. Fifty (50) WAD goats (5–7 months) were randomly allocated to five dietary treatments representing: 0% (control), 25%, 50%, 75%, and 100% UMTMC replacing wheat offal. Animals were acclimated and managed as per standard protocols, with ad libitum access to water and *Panicum maximum* pasture.

Diet Formulation and Feed Preparation

The UMTMC was prepared by ensiling ground maize cobs with urea, molasses, and water for 21 days (Akinfemi *et al* 2009). Because molasses was a fixed component of UMTMC preparation, its inclusion increased proportionally with UMTMC levels across treatments (T2–T5). Thus, molasses intake was graded indirectly as UMTMC inclusion increases. The gross composition of the experimental diet is presented on Table 1. **Baseline Reference Values**

Published physiological reference ranges for WAD goats and other small ruminants were used as proxy baselines to create a comparison framework. Studies on small ruminant nutrition and veterinary hematology frequently use these ranges (Jain 1993; Gupta *et al* 2007; Uwah *et al* 2017).

Chemical Composition of Maize Cob

The proximate composition and fibre fractions of maize cob were determined using AOAC (1990; 2005) methods and the Van Soest detergent fibre system (Van Soest, Robertson & Lewis 1991). Moisture: Oven-drying at 105°C until constant weight; Crude Protein (CP): Kjeldahl method (N × 6.25), Ether Extract (EE): Soxhlet extraction with petroleum ether; Ash: Combustion in a muffle furnace at 550°C for 6 hours; Crude Fibre (CF): Sequential acid and alkali digestion; Nitrogen-free extract (NFE): Calculated by difference; Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF), Acid Detergent Lignin; (ADL): Detergent fibre procedures Cellulose = ADF – ADL; Hemicellulose = NDF – ADF.

Hematological Analysis

Five milliliters of blood were aseptically drawn from each goat's jugular vein and placed into EDTA tubes at the conclusion of the 86-day feeding period. Packed cell volume (PCV), hemoglobin concentration (Hb), red blood cell count (RBC), white blood cell count (WBC), platelet count, and leukocyte differentials were among the hematological parameters that were assessed. The cyanmethemoglobin technique was used to assess Hb concentration, whereas micro hematocrit centrifugation was used to determine PCV. A hemocytometer was used to measure RBC and WBC counts, and stained blood smears were examined under a microscope to determine leukocyte differentials.

Serum Biochemical Analysis

To extract serum, blood samples were placed in plain tubes and centrifuged for 15 minutes at 3,000 rpm. Total protein, albumin, globulin, creatinine, cholesterol, and liver enzymes (Aspartate aminotransferase (AST), alanine aminotransferase (ALT), and alkaline phosphatase (ALP) were among the biochemical markers examined. Standard enzymatic and colorimetric techniques were used (Schmid 1963).

Table 1: Ingredient composition (% by weight) of experimental diets showing graded replacement of wheat offal with urea–molasses treated maize cob (UMTMC).

Ingredient	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)
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
Vitamin premix	1.5	1.5	1.5	1.5	1.5

PKC = Palm Kernel Cake; GNC = Groundnut Cake; DCP = Dicalcium Phosphate; SBM = Soybean Meal.
UMTMC=Urea-Molasses Treated Maize Cob

Table 2: Proximate Composition and crude fiber Fractions of Maize Cob (% DM basis)

Parameter	Value (%)
Moisture	9.8
Crude Protein (CP)	2.9
Ether Extract (EE)	1.6
Ash	2.7
Crude Fibre (CF)	44.5
Nitrogen-Free Extract (NFE)	48.5
Neutral Detergent Fibre (NDF)	74.2
Acid Detergent Fibre (ADF)	53.4
Acid Detergent Lignin (ADL)	12.1
Cellulose	41.3
Hemicellulose	20.8

Source: Values are consistent with Nigerian studies on maize cob composition (Akinfemi et al 2009; Fasae et al 2014).

RESULTS

Serum Biochemical Indices

As presented in Table 3, the inclusion of Urea–Molasses Treated Maize cob (UMTMC) significantly influenced several serum biochemical parameters. Glucose serum levels rose steadily ($p<0.05$) from 34.33 mg/dl in T1 to 53.33 mg/dl in T4, while total protein levels remained within the normal range (6–8 mg/dl). Although still within acceptable limits, blood urea reached its highest point in T3 at 13.33 mg/dl. The introduction of UMTMC resulted in an increase in ALT activity, which peaked at 30.67 U/I in T5, whereas AST, creatinine, and albumin levels remained within reference ranges and showed no significant differences.

Haematological Indices

UMTMC diets significantly affected haematological parameters. Packed cell volume (PCV) increased from 25.33% in T1 to 39.67% in T4, exceeding the upper reference range. Haemoglobin concentration increased from 8.07 g/dl in T1 to 13.00 g/dl in T4, while RBC counts also increased from 3.97 $\times10^{12}$/l to 6.57 $\times10^{12}$/l. Leukocyte differentials revealed higher lymphocyte and neutrophil counts in UMTMC diets, suggesting improved immune competence.

Table 3: Effects of concentrate diets on serum chemistry of WAD rams compared with reference ranges

Parameter (mg/dl)	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)	SEM	p-value	Reference Range*
Total protein	7.23^{ab}	6.90^{b}	7.57^{a}	7.20^{ab}	7.10^{ab}	0.08	0.0001	6–8 [1, 4]
Glucose	34.33^{b}	41.33^{b}	49.67^{a}	53.33^{a}	50.00^{a}	2.09	0.0001	40–60 [2, 4]
Globulin	49.33^{a}	49.67^{a}	53.00^{a}	50.33^{a}	49.67^{a}	1.10	0.0001	25–50 [1, 2]
Albumin	3.07^{a}	2.77^{a}	3.07^{a}	3.00^{a}	2.87^{a}	0.07	0.0001	2.5–4.0 [4]
Blood Urea	11.67^{ab}	11.33^{b}	13.33^{a}	12.83^{ab}	11.23^{b}	0.30	0.0001	10–25 [1, 3]
Creatinine	0.63^{b}	0.63^{b}	0.60^{b}	0.77^{a}	0.57^{b}	0.02	0.0001	0.5–1.5 [4]
ALT (U/I)	17.67^{b}	17.67^{b}	22.67^{ab}	25.00^{ab}	30.67^{a}	1.77	0.0001	10–40 [1, 2]
AST (U/I)	78.33	86.67	85.00	85.00	77.33	1.61	0.0001	60–120 [4]

[ab]Means with different superscripts on the same row differ significantly ($P<0.05$), *Reference ranges adapted from [1]Jain (1993), [2]Daramola et al. (2005), [3]Gupta et al. (2007), and [4]Merck Veterinary Manual (2020).

Table 4. Effects of concentrate diets on haematological indices of WAD rams compared with reference ranges

Parameter (%)	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)	SEM	p-value	Reference Range*
PCV (%)	25.33^{c}	31.00^{bc}	33.67^{b}	39.67^{a}	30.33^{bc}	1.44	0.0001	22–38 [1, 2]
Hb (g/dl)	8.07^{d}	9.90^{c}	10.77^{bc}	13.00^{a}	11.90^{ab}	0.48	0.0001	8–12 [3, 5]
RBC ($\times10^{12}$/l)	3.97^{c}	5.55^{b}	6.37^{a}	6.57^{a}	6.07^{ab}	0.26	0.0001	4–8 [1, 2]
WBC ($\times10^{3}$/ml)	11.60	10.37	12.03	10.27	10.33	0.28	0.0001	4–13; WAD sheep often 10–16[4]
Eosinophil	3.07^{c}	3.33^{bc}	4.67^{a}	4.00^{ab}	3.37^{bc}	0.18	0.0001	2–5 [2]
Lymphocyte	50.67^{b}	53.00^{b}	61.00^{a}	62.33^{a}	55.67^{ab}	1.48	0.0001	55–70 [2]
Neutrophil	36.33^{bc}	42.67^{ab}	45.67^{a}	39.33^{abc}	33.67^{c}	1.37	0.0001	25–40 [2]
Monocyte	2.33	3.00	3.33	3.00	2.67	0.19	0.0001	2–6 [1, 5]

[acdb]Means with different superscripts on the same row differ significantly ($P<0.05$), *Reference ranges adapted from [1]Jain (1993), [2]Daramola et al. (2005), [3]Gupta et al. (2007), [4]Uwah et al. (2017), and [5]Merck Veterinary Manual (2020).

DISCUSSION

Urea's Role in Protein Availability and Erythropoiesis

The Packed Cell Volume (PCV), Hemoglobin (Hb), and Red Blood Cell (RBC) counts in rams that consumed UMTMC diets showed significant improvement. These measurements indicate an increase in erythropoiesis and the capacity for oxygen transport. As noted by Van Soest *et al*. (1991), ammonia generated from urea hydrolysis penetrated the fibrous structure, disrupted lignocellulosic bonds, and raised the level of crude protein. Rumen microorganisms utilized this non-protein nitrogen (NPN) as a substrate, which enhanced microbial protein production and made amino acids more accessible for the creation of red blood cells (Preston and Leng 1987). The noted rises in PCV and Hb align with earlier research on goats that were given urea-treated agricultural residues (Akinfemi *et al*. 2009) and Red Sokoto bucks consuming UMTMC diets (Jakheng *et al*. 2022). Better nitrogen consumption and higher systemic oxygen delivery are reflected in elevated erythropoiesis, which promotes growth and metabolic activity.

Molasses' Contribution to Energy Metabolism and Palatability

Molasses inclusion increased proportionally with UMTMC levels across treatments, providing readily fermentable carbohydrates that enhanced palatability and microbial efficiency. This graded increase likely contributed to the significant rise in serum glucose, which peaked at 53.33 mg/dl in T4, reflecting improved carbohydrate metabolism and energy availability. In addition, molasses moderated the release of ammonia from urea, ensuring a synchronized supply of nitrogen and energy for microbial protein synthesis (Kioumarsi et al., 2011). Similar findings have been reported by Ibhaze et al. (2021), were molasses supplementation improved serum glucose and nutrient utilization in WAD goats.

Fibre Quality and Digestibility

The observed reduction in fibre density and enhanced nutrient accessibility were supported by fibre fraction analysis, which showed decreases in neutral detergent fibre (NDF), acid detergent fibre (ADF), and acid detergent lignin (ADL) (Akinfemi et al., 2009). These changes are consistent with earlier reports suggesting that ammonia release during urea treatment can disrupt lignocellulosic bonds and facilitate microbial colonization, thereby improving digestibility. While these mechanisms were not directly measured in this study, the reductions in fibre fractions indicate improved feed quality and metabolic efficiency.

Liver and Kidney Function

Although readings stayed within physiological bounds, ALT activity significantly increased with UMTMC addition, indicating increased hepatic metabolic activity. Safe liver and renal function were established by stable levels of albumin, creatinine, and AST. These results are consistent with those of Kioumarsi *et al.* (2011), who found that supplementing Boer goats with molasses enhanced their nitrogen metabolism without causing any negative side effects. According to the balance between safe excretion and increased nitrogen intake, UMTMC diets improve metabolic efficiency without putting undue strain on essential organs.

Immune Competence

Higher neutrophil and lymphocyte count in UMTMC diets were exposed by leukocyte differentials, indicating enhanced immunological competence. In line with Aboaja *et al* (2023), increased food availability and microbial fermentation efficiency probably aided in the development of immune cells. Stronger adaptive immunity is shown by elevated lymphocytes, but an enhanced innate immune response is reflected by elevated neutrophils. These results collectively imply that UMTMC diets could enhance disease resistance and metabolic efficiency, which is a significant benefit for smallholder farmers working in high-disease pressure conditions.

Integrated Implications

Maize cob was converted from a low-value residue into a nutritionally enhanced feed source by the combined impacts of urea and molasses treatment. Molasses boosted microbiological efficiency, energy metabolism, and palatability, while urea promoted erythropoiesis and protein availability. Fermentation improved nutrient utilisation and digestibility by lowering the density of fibre. Together, these procedures improved immunological competence, metabolic activity, and blood health; the best results were shown at 75% UMTMC inclusion.

Adoption of UMTMC has several advantages for smallholder farmers

Resource efficiency: After harvest, maize cobs are readily available locally, minimising reliance on outside feed markets.

Climate smart practice: Making use of crop wastes lowers waste, lessens pollution in the environment, and promotes sustainable livestock production.

Increased productivity: Animals with better nutrient consumption, have stronger immune systems, and are healthier overall.

CONCLUSION

The current study shows that Urea–Molasses Treated Maize Cob (UMTMC) can be used instead of wheat offal in the diets of West African Dwarf rams without harming their health or metabolic processes. Using UMTMC in the diet greatly improved blood related measurements like packed cell volume, heamoglobin levels, and red blood cell counts. This shows better production of red blood cells and the body's ability to carry oxygen. Blood sugar levels also went up, suggesting better energy use, and the different types of white blood cells indicated a stronger immune function. Notably, the markers for liver and kidney health stayed within normal limits, proving that UMTMC is safe to use as a feed ingredient. The best results were seen when 75% of the diet was replaced with UMTMC, leading to the best improvement in blood health, metabolic performance, and immune response. These results show that UMTMC is a cheap, environmentally friendly feed option that can help reduce the need for traditional feed, support small scale farmers, and encourage sustainable animal farming in tropical areas.

CONFLICT OF INTEREST STATEMENT

The authors declare that there is no conflict of interest regarding the conduct of this research and the interpretation of the data.

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