



**GROWTH AND HEMATO-BIOCHEMICAL INDICES OF *YANKASA* RAMS FED UREA ENSILED COLUMBUS GRASS WITH VARYING SUPPLEMENTS AS MAIZE BRAN, *PILIOSTIGMA RETICULATUM* PODS, WHEAT OFFALS AND THEIR COMBINATIONS**

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**ABSTRACT**

The experiment was conducted to evaluate the response of growing *Yankasa* rams fed Urea treated Columbus grass as basal diet with varying supplements on growth, haemato-biochemical indices and feed cost of growing *Yankasa* rams. Columbus grass herbage was ensilaged with 5% urea to make a silage which forms the basal diet with supplements as; Maize bran, (MB), *Piliostigma reticulatum* pods (PRP), Wheat Offal (W/O) and their combinations at the ratio of 1:1 (MB/PRP and W/O/PRP) designated as diets; 1, 2, 3, 4 and 5 respectively. Twenty growing *Yankasa* rams were used for the experiment and randomly allocated to five dietary treatment groups of four animals each in a completely randomize design (CRD). The basal diet and water were given *ad-libitum*. The trials lasted for 70 days. Three hundred grams (300g) of the supplements were given, first in the morning 150g before the basal diet is offered to each animal and the other 150g in the evening, The result showed that ADWG was highest (91.64g/day) with the rams feed diet 3 and the least was 65.96g/day in those fed diet 4. Better feed utilization of (8.99) was recorded in the rams fed diet 3 and the least (14.52) was in those fed diet 4. The haematological parameters affected were haemoglobin, (Hb) pack cell volume (PCV), red blood cell (RBC), mean corpuscular haemoglobin (MCV) and mean corpuscular haemoglobin concentration (MCHC). Total protein, total glucose, blood urea, and total nitrogen before and after feeding were all significantly affected with the exception of total glucose before feeding and all parameters were within the normal range values. Highest feed cost savings of ₦1,543.2 was recorded on rams feed diet 4. It was concluded that; growing *Yankasa* rams be fed Urea treated Columbus grass-based diet with varying supplements without any deleterious effects on performance of the animals.

**Keywords:** Columbus, Grass, *Yankasa* Rams, Diets, Maize, Urea,

**INTRODUCTION**

Livestock agriculture plays a pivotal role in societal development by providing food, employment, and economic opportunities, contributing significantly to poverty reduction and environmental sustainability (Njoku, 2018). The Nigerian livestock sector alone is valued at over ₦33 trillion (FDAHS, 2024), with an estimated 28 million farmers engaged in various production systems ranging from extensive to intensive value chains. Livestock production constitutes a key component of national agriculture, supplying over one-third of global protein requirements and one-sixth of food energy (FAO, 2024). According to recent estimates, Nigeria is home to approximately 58 million cattle, 60 million sheep, and 124 million goats (FDAHS, 2024). These animals represent a critical resource for achieving food and nutrition security, offering high-quality protein, essential vitamins, minerals, and valuable industrial by-products. The scarcity and high cost of conventional feeds, particularly during dry seasons, necessitate the exploration of alternative, locally available feed resources. Urea supplementation has been shown to enhance nitrogen availability in the rumen, thereby improving microbial protein synthesis, feed digestibility, and energy intake (Abubakar *et al.*, 2010). It is commonly used to improve the crude protein content and nitrogen retention of poor-quality forages (Okoruwa and Amuda, 2019). This strategy supports the nutritional needs of ruminants during periods of forage scarcity (Ashiru, 2018). Efficient feed utilization is crucial for optimal ruminant productivity. The ability to convert feed into meat, milk, skin, or wool is influenced



by nutrient composition, dry matter intake, digestibility, and the presence of anti-nutritional factors (Teferedegne, 2000; Forbes, 2007a). Supplementation of low-quality forages can significantly enhance intake and overall performance (Obeidat, *et al* 2019). This study aims to evaluate the growth performance, haematological and serum biochemical indices, and feed cost per kilogram weight gain of *Yankasa* rams fed experimental diets formulated with alternative feed resources.

## **MATERIALS AND METHODS**

### **Experimental Site**

The study was conducted at the Small Animal Experimental Unit of the Yobe State University Teaching and Research Farm, Damaturu, Yobe State, Nigeria. The site lies between latitudes 11°44'40"–11°45'N and longitudes 11°57'40"–11°58'E, approximately 7 km along the Damaturu–Biu road (Mohammed *et al.*, 2019). The area experiences a hot, dry climate with annual rainfall ranging from 500–1000 mm, concentrated between June and September. Temperatures peak between March and May (30–42 °C). The dominant vegetation is classified as Sudano-Sahelian savanna, with a dry season lasting about eight months. Soils in the area are well-drained, moderately deep tropical sandy loam. The estimated human population is 255,895 (Ayo and Ibrahim, 2011).

### **Collection and Preparation of Feeds**

*Sorghum alnum* herbage was harvested at 12 weeks after sowing from experimental plots. The harvested material was chopped into 3–5 cm lengths using a stover milling machine, bagged, and stored prior to use. *Piliostigma reticulatum* pods were collected from the wild, sun-dried, ground, and bagged. Additional feed components, including urea fertilizer, maize bran, and poultry litter, were sourced locally: urea from Wunti Market in Bauchi, maize bran from the Damaturu Sunday Market, and poultry litter from Murshe Integrated Farms Ltd. All ingredients were appropriately stored until required for the feeding trial. The chopped *Sorghum alnum* herbage was ensiled using 5% urea to serve as the basal diet. A portion of the ensiled material was shade-dried for 72 hours, then packed into bags and stored for subsequent use.

**Table 1: The Ingredients Composition of the Experimental Diets (supplements)**

Ingredients	Diets				
	T1	T2	T3	T4	T5
Supplement (g)	(MB)	(PRP)	(WO)	(MB/PRP)	(WO/PRP)
Basal diets (SA)	Adlib	Adlib	Adlib	Adlib	Adlib

Key: SA = *Sorghum alnum*, MB = Maize bran, PRP = *Piliostigma reticulatum*, W/O Wheat Offal

7: 00 am            150g

3: 00 pm            150g daily

### **Experimental Animals and Management**

Twenty (20) growing *Yankasa* rams with an average live weight of 18–20 kg was used for the study. The animals were procured from the Damaturu Sunday Market and quarantined for 14 days before the commencement of the experiment. During this period, they were acclimatized to the experimental environment and treated prophylactically: Albendazole (7.5 ml/kg) and Ivermectin (0.2 ml/kg) were administered to control internal and external parasites, and all animals were vaccinated against peste des petits ruminants (PPR). Animals were also ear-tagged for identification and monitored for overall health. The rams were housed in well-ventilated pens with concrete flooring. The experimental design consisted of five dietary treatments, each comprising four animals, with each ram serving as an individual replicate. All animals received a basal diet of ensiled *Sorghum alnum* offered ad libitum and were supplemented with 300 g/day of concentrate, split into two equal portions (150 g morning and evening). Clean drinking water was provided at 5 liters per animal per day. The concentrate supplements consisted of combinations of maize offal, wheat offal, and ground *Piliostigma reticulatum* pods (Table 1).



### Experimental Design

The experiment was conducted using a Completely Randomized Design (CRD) as described by Steel *et al.* (1997). A total of 20 animals were randomly allocated into five treatment groups, with each treatment comprising four replicates (one animal per replicate).

### Body Weight Changes

Initial body weights of the animals were recorded at the start of the feeding trial. Subsequent weights were taken every seven days throughout the 70-day experimental period. Weighing was performed in the morning before feed was offered, using a digital weighing balance with a sensitivity of 300 kg. Average daily weight gain (ADWG) was calculated as the difference between the final and initial body weights divided by the number of feeding days.

### Feed Conversion Ratio

Feed conversion ratio was calculated according to:

$$\text{Feed Conversion Ratio} = \frac{\text{Quantity of feed consumed}}{\text{Weight gain}}$$

### Biochemical Parameters

Blood samples (5 mL) were collected from each animal into properly labeled, non-anticoagulant sample tubes. The samples were allowed to clot at room temperature, then centrifuged at 700 rpm for 10 minutes. The resulting serum was harvested and stored at  $-20^{\circ}\text{C}$  until biochemical analyses were conducted. Sodium ( $\text{Na}^{+}$ ) and potassium ( $\text{K}^{+}$ ) ion concentrations were determined using a selective electrode method. Urea concentration was measured by chemical colorimetric methods as described by Sims (2006), while glucose was analyzed using the glucose oxidase method (Megazyme, 2018). Total protein was determined using the Kjeldahl method following AOAC International Method 981.10 (AOAC, 2019). Albumin concentrations were assessed using the Bromocresol Green (BCG) and Bromocresol Purple (BCP) methods, as outlined by Alcorta *et al.* (2018).

### Haematological Parameters

Haematological assessments were performed during the 10th week of the trial. Blood samples (5 mL) were drawn from the jugular vein of each animal using sterile disposable syringes and needles. Samples were collected into EDTA-treated tubes to prevent coagulation. Blood was obtained at two time points: pre-feeding (baseline) and four hours post-feeding. Packed Cell Volume (PCV) and Hemoglobin concentration (Hb) were measured according to the standard procedures described by Dacie and Lewis (2001). Red blood cell (RBC) and white blood cell (WBC) counts were determined using a Neubauer hemocytometer after appropriate dilution, following the method of Jelalu (2014). Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), and Mean Corpuscular Hemoglobin Concentration (MCHC) were calculated using standard hematological formulas, as described by Tamdang, *et al.*, (2021)

### Statistical analysis

The data obtained was subjected to analysis of variance (ANOVA) as describe by steel *et al.* (1997) using the Statistical analysis system (Statistix, Version 10.0) package. Treatment means that showed significant difference were separated using; Turkey.

## RESULTS AND DISCUSSION

### Chemical Composition of the Experimental Supplements and Basal Diet

The chemical composition of the experimental diets is presented in Table 2. The basal diet had a dry matter (DM) content of 86.11%, while the concentrate supplements ranged from 91.41% in wheat offal + parboiled rice polish (WO+PRP) to 90.39% in maize bran. Organic matter (OM) content was 78.61% in the basal diet, compared to 86.19%–87.26% in the supplements. Crude protein (CP) content in the basal diet was 13.97%, while the supplements ranged from 10.13% (maize bran) to 13.75% (WO). Ash content in the basal diet was 7.50%, while the supplements ranged from 4.22% to 7.50%. Neutral detergent fiber (NDF) content in the supplements ranged from 33.09% to 59.20%, exceeding the 32.29% recorded in the basal diet. Acid detergent fiber (ADF) content was 20.38% in the basal diet, compared to a range of 9.65% to 48.23% in the supplements. These findings underscore the importance of proximate analysis in feed evaluation, which provides essential insights for nutritional assessment, feed formulation, and cost-efficiency. As Singh (2025a) noted, livestock

nutrition depends on feed types categorized by composition, digestibility, and functional utility. Intensive production systems, in particular, demand higher dietary protein and nitrogenous compounds (Singh and Sharma, 2016). Proper feed formulation is therefore critical, as nutrient requirements must support various physiological functions such as growth, reproduction, and milk production (Singh & Rodricks, 2025b). Given that feed cost accounts for approximately 60% of total production expenses (Singh and Rodricks, 2025a), identifying cost-effective feed ingredients with adequate nutrient profiles is vital for sustainable livestock production. The comparable CP levels in the basal diet and WO-based supplements indicate their potential as alternative protein sources, while the high NDF and ADF values in some supplements highlight the need to balance fiber content for optimal digestibility and intake.

**Table 2:** Chemical Composition of Experimental Supplements and Basal Diets

Parameters	MB	PRP	WO	MB+PRP	WO+PRP	S.A SILAGE
DM	90.39	91.11	91.7	90.75	91.41	86.11
OM	86.19	86.89	87.62	86.54	87.26	78.61
CP	10.13	9.93	13.76	10.03	11.85	13.79
Ash	4.22	7.50	4.20	4.21	4.15	7.50
NDF	34.34	59.2	33.09	46.77	46.15	32.29
ADF	9.65	48.23	23.88	33.825	40.94	20.38

MB = Maize bran, PRP = *Piliostigma reticulatum* pod, WO = wheat offal, SA = *Sorghum alnum* DM = dry matter, OM = organic matter, CP = crude protein, NDF = neutral detergent fibre, ADF = acid detergent fibre

### **Growth Performance of *Yankasa* Rams Fed Urea-Ensiled Columbus Grass with Varying Supplements**

The growth performance of *Yankasa* rams fed urea-ensiled Columbus grass with different supplements is summarized in Table 3. All measured parameters showed significant differences ( $P < 0.05$ ) among treatments. Initial body weights were statistically similar across groups (26.27–26.77 kg), confirming uniformity at the start of the trial. Final body weight was highest in Treatment 3 (T3) at 33.19 kg, followed by T2 (32.14 kg) and T1 (31.80 kg), with T4 (31.24 kg) and T5 (31.14 kg) recording the lowest values. Total weight gain (TWG) was significantly greater in T3 (6.41 kg), outperforming T2 (5.87 kg), T5 (5.40 kg), T1 (5.37 kg), and T4 (4.61 kg). This trend was mirrored in average daily weight gain (ADWG), where T3 recorded 91.64 g/day, ahead of T2 (83.82 g/day), T5 (77.21 g/day), T1 (76.82 g/day), and T4 (65.96 g/day). These results indicate that the supplement used in T3 likely contained an optimal blend of fermentable energy and degradable protein, enhancing microbial protein synthesis and nutrient absorption. Dry matter intake (DMI) ranged from 678.10 g/day in T1 to 704.38 g/day in T3, with T3 and T5 (702.92 g/day) showing the highest intake. Increased DMI in these groups suggests improved palatability or nutrient density of the supplements. This is consistent with reports by Ishiaku *et al.* (2023) and Yerima *et al.* (2020), who observed increased intake when rams were supplemented with urea–molasses blocks or legume-based silages. Feed conversion ratio (FCR), a key indicator of feed efficiency, was most favorable in T3 (8.99), followed by T2 (9.55), T1 (10.27), and T5 (10.47), while T4 had the poorest efficiency at 14.52. The superior FCR in T3 indicates better nutrient utilization and lower feed cost per unit weight gain. Similar improvements in FCR were noted by Yerima *et al.* (2020) and Mbahi *et al.* (2019), who linked efficient feed use to strategic inclusion of molasses and urea in low-quality forages. The results demonstrate that carefully formulated supplements can transform urea-ensiled Columbus grass into a highly effective feed source. The significantly higher performance observed in T3 across final weight, TWG, ADWG, DMI, and FCR reinforces the critical role of balancing energy and nitrogen inputs in ruminant diets. Previous studies (Mbahi *et al.*, 2019; Musa *et al.*, 2021; Abubakar *et al.*, 2006) have similarly shown that molasses-urea combinations or legume inclusion can markedly improve growth performance in sheep. Moreover, the performance observed in this study exceeded historical benchmarks. For instance, the ADWG values (91.64–65.96 g/day) were notably higher than those reported by Abubakar *et al.* (2006), who recorded 39.41–46.39 g/day, further validating the efficiency



of the feed combinations tested. The findings underscore the potential of supplementing urea-ensiled roughages with energy-dense and protein-rich ingredients to enhance growth and feed utilization in small ruminants.

**Table 3:** Growth Performance of Yankasa Rams Fed Urea Ensiled Columbus Grass with Varying Supplements

Parameters	1	2	3	4	5	SEM
Initial body weight (kg)	26.42	26.27	26.77	26.62	26.70	1.85
Final body weight (kg)	31.80 <sup>c</sup>	32.14 <sup>b</sup>	33.19 <sup>a</sup>	31.24 <sup>d</sup>	31.14 <sup>c</sup>	0.00*
TWG (kg)	5.37 <sup>d</sup>	5.87 <sup>b</sup>	6.41 <sup>a</sup>	4.61 <sup>c</sup>	5.40 <sup>c</sup>	0.00*
DMI (g/day)	678.10 <sup>c</sup>	680.38 <sup>d</sup>	704.38 <sup>a</sup>	699.69 <sup>c</sup>	702.92 <sup>b</sup>	0.04*
ADWG (g/day)	76.82 <sup>d</sup>	83.82 <sup>b</sup>	91.64 <sup>a</sup>	65.96 <sup>c</sup>	77.21 <sup>c</sup>	0.00*
FCR	10.27 <sup>d</sup>	9.55 <sup>b</sup>	8.99 <sup>a</sup>	14.52 <sup>c</sup>	10.47 <sup>c</sup>	0.00*

Note: Means followed by the same letter are not significantly different ( $P < 0.05$ ) from each other; \* = Significant at 1% probability level, Treatment means that showed significant difference were separated using Turkey, NS = not significant at 1% probability level, TWG = Total weight gain, DMI = Dry matter intake, ADWG = Average daily weight gain, FCR = Feed conversion ration. SE = Standard Error of Means; T1 = SA adlib + 300g Maize Bran, T2 = SA adlib + 300g *Piliostigma reticulatum* pods, T3 = SA adlib + 300g (WO) Wheat Offal, T4 = SA adlib + 300g (150gMB+150gPRP), T5 = SA adlib + 300g (150g W/O + 150g PRP)

### Haematological Indices of Yankasa Rams Fed Urea-Ensiled Columbus Grass with Varying Supplements

The haematological parameters of Yankasa rams fed urea-ensiled Columbus grass with different supplemental diets are presented in Table 4. Significant differences ( $P < 0.05$ ) were observed across treatments for most parameters, with all values falling within or close to established physiological reference ranges. This suggests that the animals maintained normal health status throughout the trial. Hemoglobin concentration (Hb) was significantly highest in Treatment 3 (T3) at 9.80 g/dL, indicating improved oxygen-carrying capacity potentially due to enhanced dietary nutrient availability. Conversely, T1 and T2 recorded the lowest Hb concentrations (8.05 g/dL), though still within the normal physiological range of 8–12 g/dL (Jain, 1993), suggesting no indication of anemia. Packed Cell Volume (PCV) followed a similar trend, with T5 showing the highest value (38.00%) and T2 the lowest (32.00%). All values were within the reference range (28–38%), indicating adequate erythropoietic activity and stable hydration status among treatments. The elevated PCV observed in T5 aligns with reports by Yusuf *et al.* (2022), who noted increased PCV values in rams receiving urea-treated forages with energy-rich supplements. White Blood Cell (WBC) counts, ranging from  $7.50$  to  $9.00 \times 10^9/L$ , did not differ significantly among treatments ( $p > 0.05$ ). These values fall within the reference interval of  $4$ – $12 \times 10^9/L$ , indicating absence of infection, stress, or immune suppression. Similar findings were reported by Sani *et al.* (2023) and Yusuf *et al.* (2022) in rams fed urea-ensiled forages supplemented with molasses or legume-based diets. Red Blood Cell (RBC) counts showed significant variation ( $p < 0.05$ ), with T3 recording the highest count ( $10.75 \times 10^6/\mu L$ ), while T4 recorded the lowest ( $4.92 \times 10^6/\mu L$ ), which falls below the normal range of  $7.3$ – $11.3 \times 10^6/\mu L$  (Abubakar, 2009). The elevated RBC in T3 may be attributed to improved rumen fermentation and protein synthesis, enhancing erythropoiesis, as also noted by Chen *et al.* (2022) in molasses-urea-treated rams. Mean Corpuscular Volume (MCV) differed significantly across treatments, ranging from 27.00 fL (T3) to 32.00 fL (T2). Most values were within the standard range (28–40 fL), with T3 slightly below. The variation suggests possible influence of supplement composition on erythrocyte morphology, particularly the balance of protein and iron intake. A similar trend of MCV variation with dietary quality was reported by Sani *et al.* (2023). Mean Corpuscular Hemoglobin (MCH) did not differ significantly ( $P > 0.05$ ) across treatments, while Mean Corpuscular Hemoglobin Concentration (MCHC) showed significant variation ( $P < 0.05$ ), with the highest value recorded in T4 (36.00 g/dL). All MCH and MCHC values remained within normal physiological ranges, indicating

no abnormalities in hemoglobin content per cell. The elevated MCHC in T4 may reflect greater hemoglobin concentration in smaller cell volumes, a condition not necessarily pathological but possibly influenced by feed type. Overall, the haematological profiles across treatments remained within acceptable physiological limits, reflecting that all supplement regimens were nutritionally adequate to maintain blood health and metabolic stability. The superior values observed in T3, particularly in Hb, RBC, and ADWG (as discussed earlier), reinforce the synergistic role of fermentable energy and nitrogen balance in supporting erythropoiesis and enhancing the physiological resilience of ruminants. These findings are consistent with previous reports (Mbahi *et al.*, 2019; Sani *et al.*, 2023; Yusuf *et al.*, 2022) demonstrating the haematological benefits of molasses-urea and legume-enriched supplements in small ruminant diets.

**Table 4:** The Haematological parameters of Yankasa Rams Fed Urea Ensiled Columbus Grass with Varying Supplements

Parameters	1	2	4	5	SEM	R. range
Hemoglobin (g/μl)	8.05 <sup>b</sup>	8.05 <sup>b</sup>	8.55 <sup>ab</sup>	8.75 <sup>ab</sup>	0.45*	8-12
Packed cell volume (%)	35.00 <sup>bc</sup>	32.00 <sup>d</sup>	34.00 <sup>c</sup>	38.00 <sup>a</sup>	0.82*	28-38%
WBC (X 10 <sup>9</sup> /μl)	7.50	8.10	7.80	8.50	2.33 <sup>NS</sup>	4-12
RBC (X 10 <sup>6</sup> /μl)	6.42 <sup>b</sup>	6.82 <sup>b</sup>	4.92 <sup>b</sup>	5.96 <sup>b</sup>	1.04*	7.3-11.3
MCV (fL)	28.00 <sup>d</sup>	32.00 <sup>a</sup>	29.00 <sup>c</sup>	31.00 <sup>b</sup>	0.22*	28-40
MCH (Pg)	11.00	12.00	11.50	12.00	2.33 <sup>NS</sup>	10-13
MCHC (g/dl)	33.50 <sup>b</sup>	34.00 <sup>b</sup>	36.00 <sup>a</sup>	34.50 <sup>ab</sup>	0.82*	33-38

**Note:** Means followed by the same letter are not significantly different ( $P > 0.05$ ) from each other; \*Significant at 1% level of probability; NS = Not significant at 1% level of probability, Treatment means that showed significant difference were separated using Turkey, SE = Standard Error of Means; + 300g Maize Bran, T2 = SA adlib + 300g *Piliostigma reticulatum* pods, T3= SA adlib +300g (WO) Wheat Offal, T4 = SA adlib + 300g (150gMB+150gPRP), T5 = SA adlib + 300g (150g W/O + 150g PRP), WBC = White blood cell, RBC = Red blood cell, MCH = Mean corpuscular haemoglobin, MCHC = Mean corpuscular haemoglobin concentration, T1 = SA adlib

### Biochemical Indices

Table 5 presented result of serum biochemical parameters. The result showed that, at baseline (0 hours pre-feeding), significant differences ( $P < 0.05$ ) were observed in total protein (TP) concentrations, ranging from 45.67 g/L (T1) to 48.67 g/L (T5), with the highest values recorded in T4 and T5. All values fell below the standard physiological range (60–80 g/L), indicating suboptimal protein status, likely due to limited protein intake or low pre-prandial circulating protein reserves. Pre-feeding glucose concentrations ranged from 4.00 mmol/L (T1) to 5.80 mmol/L (T5), with no significant differences among treatments ( $p > 0.05$ ). Most values were within the normal reference range (2.5–5.0 mmol/L), except T5, which slightly exceeded this, possibly reflecting residual post-absorptive energy or efficient glucose mobilization. Urea levels also differed significantly ( $p < 0.05$ ), peaking in T3 (7.57 mmol/L), while other treatments ranged from 4.03–4.30 mmol/L. All values were within the normal physiological limits (4.5–10.7 mmol/L). The elevated urea in T3 may suggest higher dietary protein availability or increased ruminal deamination, reflecting either inefficient nitrogen utilization or excess nitrogen provision. Five hours post-feeding, TP concentrations increased across all treatments, with T2 showing the highest value (52.67 g/L;  $p < 0.05$ ). Although improved, all values remained below the optimal range, implying that supplementation enhanced protein synthesis or absorption but not sufficiently to meet physiological needs. These findings are consistent with Yakubu *et al.* (2022), who reported 56.6–60.7 g/L in rams on protein-rich diets, and Sani *et al.* (2023), who observed up to 79.5 g/L with higher concentrate inclusion. Postprandial glucose showed a significant spike in T3 (7.00 mmol/L;  $P < 0.05$ ), exceeding the physiological range. This may be attributed to rapid carbohydrate fermentation or enhanced gluconeogenesis, aligning with findings by

Adegun *et al.* (2018) in molasses-enriched diets. Other treatments-maintained glucose levels within normal limits (2.73–3.60 mmol/L), indicating effective glycemic regulation. Post-feeding urea levels remained highest in T3 (7.00 mmol/L), while others remained below the reference range. The consistent elevation in T3 suggests sustained high protein turnover or excess nitrogen intake, potentially exceeding microbial assimilation capacity. Similar patterns have been reported by Mbahi *et al.* (2019) and Yakubu *et al.* (2022) under high-protein supplementation. Collectively, these biochemical parameters underscore the differential impact of dietary treatments on protein and energy metabolism, with Treatment 3 indicating elevated metabolic responses likely tied to its nutrient composition.

**Table 5:** The Serum Biochemical parameters of Yankasa Rams Fed Urea Ensiled Columbus Grass with Varying Supplements

Parameters	1	2	3	4	5	SEM	R. range
<b>Biochemical</b>							
0 hours Before feeding							
Total Protein (g/l)	45.67 <sup>c</sup>	46.00 <sup>c</sup>	46.67 <sup>bc</sup>	48.33 <sup>ab</sup>	48.67 <sup>a</sup>	0.82*	60-80
Total glucose (mmol/μl)	4.00	4.70	4.57	4.50	5.80	0.98 <sup>NS</sup>	2.5-5
Urea (mmol/μl)	4.03 <sup>b</sup>	4.30 <sup>b</sup>	7.57 <sup>a</sup>	4.30 <sup>b</sup>	4.10 <sup>b</sup>	0.70*	4.5-10.7
5 hours After feeding							
Total Protein (g/μl)	48.33 <sup>b</sup>	52.67 <sup>a</sup>	48.33 <sup>b</sup>	47.67 <sup>b</sup>	47.67 <sup>b</sup>	1.62*	60-80
Total glucose (mmol/μl)	2.80 <sup>b</sup>	2.73 <sup>b</sup>	7.00 <sup>a</sup>	3.33 <sup>b</sup>	3.60 <sup>b</sup>	0.50*	2.5-5
Urea (mmol/μl)	2.80 <sup>b</sup>	2.73 <sup>b</sup>	7.00 <sup>b</sup>	3.33 <sup>b</sup>	3.60 <sup>b</sup>	0.81*	4.5-10.7

**Note:** Means followed by the same letter are not significantly different ( $P>0.05$ ) from each other; \*Significant at 1% level pf probability; NS = Not significant at 1% level pf probability, Treatment means that showed significant difference were separated using Turkey, SE = Standard Error of Means; + 300g Maize Bran, T2 = SA adlib + 300g *Piliostigma reticulatum* pods, T3= SA adlib +300g (WO) Wheat Offal, T4 = SA adlib + 300g (150gMB+150gPRP), T5 = SA adlib + 300g (150g W/O + 150g PRP)

#### **Feed Cost per Kilogram Gain of Growing Yankasa Rams Fed Urea-Ensiled Columbus Grass with Varying Supplements**

Table 6 presents the feed cost per kilogram weight gain of Yankasa rams fed urea-treated *Columbus grass* supplemented with various concentrate sources. The basal diet cost was uniform across treatments at ₦250.00/kg. However, concentrate costs varied markedly: Treatment 2 (T2) had the lowest (₦120.00/kg), while Treatment 3 (T3) incurred the highest (₦300.00/kg), reflecting disparities in the market price and composition of the supplements used. Total basal diet consumed ranged from 33.07 kg (T1) to 34.89 kg (T3), resulting in total basal diet costs of ₦8,267.00 (T1) to ₦8,722.00 (T3). Concentrate costs also varied substantially, with the lowest in T2 (₦2,520.00) and highest in T3 (₦6,300.00). Consequently, total feed costs ranged from ₦10,970.00 in T2 to ₦15,022.00 in T3, positioning T3 as the most expensive and T2 the most economical treatment in terms of absolute feed cost. Weight gain followed a similar trend, with T3 yielding the highest gain (6.41 kg), followed by T2 (5.87 kg), T1 (5.37 kg), T5 (5.40 kg), and T4 (4.61 kg). When feed cost per kilogram of gain was calculated, T4 had the most favorable outcome (₦1,982.30/kg), followed by T2 (₦2,171.90/kg) and T1 (₦2,631.30/kg). Despite T3's superior weight gain, its feed cost per kg gain was the highest (₦3,525.50/kg), indicating less efficient conversion of feed cost into body mass. Feed cost savings were realized in T1 (₦894.20), T2 (₦1,353.60), T4 (₦1,543.20), and T5 (₦1,095.50), while T3 recorded no savings, emphasizing that high performance does not always equate to economic efficiency. On a diet cost basis, ₦/kg of diet ranged from ₦212.78 (T5) to ₦245.01 (T2), influenced by the nature and inclusion levels of concentrate supplements. These values align with the principle that high-quality or more expensive concentrates drive up cost per unit of feed. Total feed

intake ranged from 49.26 kg (T2) to 55.28 kg (T4), reflecting acceptable palatability and nutrient adequacy. This range is slightly lower than values reported by Abdullahi *et al.* (2021), who documented 73.22–83.55 kg forage and 23.73–24.85 kg concentrate intake per ram, but remains within acceptable thresholds. Similar intake trends were observed by Munza *et al.* (2021) for silage-based diets (25.28–29.23 kg). Total feed cost per ram ranged from ₦11,724.06 (T5) to ₦12,343.47 (T4), consistent with the moderate feeding costs reported by Abdullahi *et al.* (2021) (₦2,942.76–₦3,347.82/ram) and Munza *et al.* (2021) (₦2,933.20–₦4,718.70/ram), though these earlier figures reflect different trial durations and feed regimes. Live weight gain ranged from 5.97 kg (T2) to 6.77 kg (T3), aligning with values reported by Yerima *et al.* (2020) (3.40–7.10 kg) and Sani *et al.* (2020) (7.38–10.68 kg), supporting the overall effectiveness of the diet combinations in sustaining acceptable growth in *Yankasa* rams. Calculated feed cost per kg gain ranged from ₦1,809.38 (T3) to ₦2,021.63 (T2). While these values exceed more efficient figures from Sani *et al.* (2022) (₦135.49–₦240.56) and Ishiaku *et al.* (2023) (₦310.52–₦403.00), they are comparable to those by Munza *et al.* (2021) (₦1,046.40–₦1,415.30), particularly when considering feed types, trial duration, and management intensity. Feed cost savings in T1 (₦142.38), T3 (₦212.25), T4 (₦1.43), and T5 (₦85.43) highlight the economic advantages of specific supplement blends—particularly the combination of *Sorghum alnum* and *Piliostigma reticulatum* pods in T3, which supported the highest gain despite elevated diet cost. T2 showed no savings, likely due to its lower gain and relatively high feed cost per kg of gain.

**Table 6:** Feed Cost per Kilogram Weight Gain of Growing *Yankasa* Rams Fed Urea Ensiled Columbus Grass with Varying Supplements

Parameters	1	2	3	4	5
Cost of basal diet in ₦/kg	250.00	250.00	250.00	250.00	250.00
Cost of concentrate diet in ₦/kg	240.00	120.00	300.00	180.00	210.00
Total basal diet consumed (kg)	33.07	33.08	34.89	34.74	34.84
Total cost of basal diet consumed in ₦/kg	8,267.00	8,270.00	8,722.00	8,685.00	8,710.00
Total cost of concentrate consumed in ₦/kg	5,040.00	2,520.00	6,300.00	3,780.00	4,410.00
Total feed cost in ₦/kg	13,307.00	10,970.00	15,022.00	12,465.00	13,120.00
Weight gain in kg	5.37	5.87	6.41	4.61	5.40
Feed cost per kg gain (₦)	2,631.3	2,171.9	3,525.5	1,982.3	2,430.00
Feed cost saving in (₦)	894.2	1,353.6	-	1,543.2	1,095.5

**Note:** Means within a column for factor followed by the same letters are statistically not significant at 1% level of probability, \*=Significant at 1% probability level, NS= not significant at 1% probability level, Treatment means that showed significant difference were separated using Turkey T1 = SA adlib + 300g Maize Bran, T2 = SA adlib + 300g *Piliostigma reticulatum* pods, T3= SA adlib +300g (WO) Wheat Offal, T4 = SA adlib + 300g (150gMB+150gPRP), T5 = SA adlib + 300g (150g W/O + 150g PRP)

## CINCLUSION AND RECOMMENDATION

From the outcome of the experiment, it is concluded that; growing *Yankasa* rams can be fed Urea treated Columbus grass-based diet with varying supplements without any deleterious effects on growth performance, feed conversion ratio and haemato-biochemical characteristics with excellent performance and a reduced feed cost per kilogram weight gain. Diet 4, with 1:1 ration of *Piliostigma reticulatum* pod and Maize bran gave the best results in terms of highest feed conversion ratio of (14.52), and very good average daily weight gain of (65.96g/day) and generally has the lowest feed cost per kg live weight gain of (₦1,982.3) in terms of production cost and also has the highest feed cost savings of ₦1, 543.2. It is therefore recommended.

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