



**EVALUATION OF DIFFERENT LEVELS OF *Anogeissus leiocarpus* LEAVES AND WHEAT OFFALS ON GROWTH PERFORMANCE AND HAEMATO-BIOCHEMICAL PARAMETERS OF YANKASA SHEEP**

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**ABSTRACT**

The study was conducted to evaluate different levels of *Anogeissus leiocarpus* and wheat offals on the growth performance and haemato-biochemical parameters of growing *Yankasa* rams. Four diets (16% protein) were formulated using varying levels of African birch (*Anogeissus leiocarpus*) at 0, 10, 20 and 30% in the diets and termed as diets 1, 2, 3 and 4 respectively. Twenty (20) growing *Yankasa* rams with average body weight of 17.2kg were allocated to 4 treatments groups of five (5) animals each in a completely randomized design. Total feed intake differed significantly ( $P<0.05$ ) among the treatments, with treatments 2 and 4 having the highest values of 1057.98g/day and 1051.53g/day followed by 1035.24g/day and 1006.97g/day for T3 and T1 respectively. The result also revealed that weight gain differs significantly ( $P<0.05$ ) across the diets with animals on treatment 2 recording the highest value (126.19g/day) compared to 59.52, 59.52 and 88.90g/day for diets 1, 3 and 4 respectively. Feed conversion ratio (FCR) values were significantly ( $P>0.05$ ) different across the treatments with animal fed diet 2 recording the best FCR, (7.33) followed by those on treatment 4 (10.29). Animal on treatment land 3 recorded lowest FCR values of 15.05 and 15.12 respectively. Crude protein digestibility (CPD) results revealed that all the diets had higher and similar CPD (88.70 to 89.70) values. All the haematological and biochemical values obtained for all parameters across the treatments fell within the normal values for healthy rams. From the result of this study diet 2 (10% AL/20% WO) which gave the best average daily weight gain (126.19g/day) and the best utilized diet (7.33) can be recommended for growing *Yankasa* rams.

**Keywords:** *Anogeissus leiocarpus*, Wheat, Offals, *Yankasa*, Sheep.

**INTRODUCTION**

Sheep production remains a vital component of smallholder and commercial livestock systems worldwide, contributing significantly to meat supply, income, food security and rural livelihoods (Mavrot, 2016). In Nigeria, indigenous breeds such as *Yankasa* sheep are widely reared due to their adaptability to harsh climates, disease resistance and efficient utilization of low-quality forages (Ibrahim *et al.*, 2020). However, feed scarcity especially during the long dry seasons continues to limit growth performance and productivity in ruminants, necessitating research into locally available alternative feed resources that can supplement traditional diets (Mako *et al.*, 2021). Ruminants like sheep derive most of their nutrients from fibrous feeds. However, native forages often decline in nutritive quality during dry periods, resulting in inadequate energy and protein supply. This nutritional gap adversely affects weight gain, feed utilization efficiency and overall physiological status (Mako *et al.*, 2021). To address this, non-conventional feeds such as browse plants, agro-industrial by-products and leaf meals have gained attention for their potential to complement or partially replace conventional Zhang *et al.*, 2024).

Among these, *Anogeissus leiocarpus*, commonly referred to as African birch, is a multipurpose tree widely distributed in West African Savannah ecosystems. Traditionally used for medicinal and ethnoveterinary purposes, *A. leiocarpus* has also attracted interest for its potential as a browse feed in ruminant nutrition (Adekunle, 2024). Although most research has focused on its pharmacological



properties including antibacterial, antiparasitic and antioxidant activities limited studies have evaluated its nutritive value as a feed resource (Adekunle, 2024). Feedipedia reports that *A. leiocarpus* leaves contain tannins and polyphenolic compounds such as ellagic and gallic acids, which could affect palatability and digestibility if not properly managed in ruminant diets (Feedipedia, 2012). Research on goats suggests that browse plants with high tannin concentrations can reduce dry matter intake and growth rates (Feedipedia, 2012), indicating the need for balanced inclusion levels when formulating diets with such feedstuffs. Notwithstanding its traditional use and phytochemical richness, there is a notable gap in scientific evidence concerning the effect of *A. leiocarpus* leaf inclusion levels on growth performance and health indicators in sheep, particularly the *Yankasa* breed. Most studies have explored its anthelmintic activity in vitro and in vivo (Kuisseu *et al.*, 2024), but few have investigated its nutritional potential for enhancing sheep productivity. Therefore, evaluating different levels of *A. leiocarpus* leaves in the diets of growing sheep is critical to understanding their impact on feed intake, body weight gain and health status.

Wheat offals represent another low-cost and readily available agro-industrial by-product with potential utility in sheep feeding. These offals derived from wheat milling operations are characterized by a balanced mix of energy and protein and have been included in various livestock rations at moderate inclusion levels without adversely affecting animal health (Adamu, 2025). A study on West African Dwarf goats showed that diets containing wheat offal influenced hematological and biochemical parameters, suggesting that such by-products can be safely incorporated up to certain levels without compromising blood health indices (Ayandiran *et al.*, 2019). However, research specifically quantifying growth performance and detailed haematobiochemical responses of *Yankasa* sheep to graded wheat offal inclusion is sparse. While older theses suggest potential benefits of wheat offal in sheep diets (Abii, 1986), these findings require verification under contemporary nutritional evaluation frameworks. The physiological response of sheep to dietary changes is often assessed through haematological and biochemical indices, which are important diagnostic tools for monitoring nutritional status, health and metabolic adjustments (Nyametease *et al.*, 2025). For instance, packed cell volume (PCV), red and white blood cell counts, serum proteins, liver enzymes and metabolite levels provide insights into how diet influences immune response, protein metabolism and organ function. Establishing baseline and treatment effects on these parameters helps determine whether feed ingredients support animal welfare as well as productivity (Nyametease *et al.*, 2025). While several studies investigated haematobiochemical profiles in sheep fed forage and supplement combinations (Mako *et al.*, 2021), there is a dearth of data considering *A. leiocarpus* leaves and wheat offal as test ingredients. The rationale for exploring *A. leiocarpus* leaves and wheat offal synergistically stems from the need to optimize feed resources in sustainable sheep production. Ruminant diets often combine browse leaves with energy-rich agro-by-products to achieve nutrient balance, improve feed utilization and reduce production costs. Combining browse leaves like *A. leiocarpus* with wheat offal could help balance crude protein and energy fractions, offset anti-nutritional factors and ultimately improve growth performance while maintaining normal physiological function (Zhang *et al.*, 2024). This strategy aligns with broader livestock development goals in sub-Saharan Africa, where small ruminant nutrition research is increasingly focused on integrating indigenous feed resources with agro-industrial by-products (Mako *et al.*, 2021).

## **MATERIALS AND METHODS**

### **Experimental Site**

The study was carried out at Abubakar Tafawa Balewa University, Bauchi, teaching and research farm Yelwa campus. The university is located at Yelwa along Tafawa Balewa road, Bauchi. Bauchi lies between latitude of 10°, 17°N, longitude 9° 49°E and at attitude of 902 meters above the sea level. There are two distinct season in the area; rainy season, which usually starts in May and end in October and dry season which starts from November to April. The mean annual rainfall is 1091mm (World Atlas, 2015).



**Experimental Diets**

Four diets (16% protein) were formulated using varying levels of African birch (*Anogeissus leiocarpus*) and wheat offals, such that the two ingredients collectively contributed 30% of the diets other ingredients include cotton seed cake, maize offal, cowpea shell, bone meal and salt. The animals were allowed 14 days period for adaptation to confinement and feeds.

Ingredients and chemical composition of the experimental diet are shown in Table 1.

**Table 1:** Ingredients Composition of the Experimental Diets

Ingredients	Diets			
	T1	T2	T3	T4
<i>Anogeissus leiocarpus</i>	0.00	10.00	20.00	30.00
Wheat offal	30.00	20.00	10.00	0.00
Maize offal	50.00	50.00	50.00	50.00
Cotton seed cake	12.50	12.50	12.50	12.50
Cowpea shell	5.00	5.00	5.00	5.00
Bone meal	2.00	2.00	2.00	2.00
Salt	0.50	0.50	0.50	0.50
<b>Total</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>

**Table 2:** Chemical Composition of the Experimental Diets

Ingredients	Diets			
	T1	T2	T3	T4
Dry matter	89.35	87.42	86.52	86.19
Organic matter	74.09	75.21	75.22	76.33
Crude protein	16.41	16.12	16.08	15.97
Ash	15.26	12.21	11.30	9.86
Neutral detergent fibre	39.52	42.65	44.22	45.77
Acid detergent fibre	30.68	32.69	34.73	36.52
Hemicelluloses	8.84	9.96	9.49	9.25

**Experimental Animal and their Management**

About a month to the arrival of animals, the quarantine and experimental pens were cleaned disinfected with Rambo (Pimethrin 0.60 and labelled. Twenty (20) growing *Yankasa* rams approximately 12-20 months old were used for the experiment. The animals were purchased from Durum and Mararraba markets of Bauchi local government. On arrival the animals were weighed and averaged 17.20kg, animals were identified with bands carrying number tags. The animals were quarantined for two weeks during which they were treated with a broad-spectrum anthelmintic (Alhendo zole) against tape worms they were also vaccinated against petes des petits Ruminants (PPR) and external parasites (Ivomestin) administered subcutaneously. During the quarantine period the animals were fed shopped groundnut haulms ad lib and maize offal were given to maintenance ration. They were also providing with good clean drinking water at lib. The quarantine treatments were repeated midway into the experiment. The animals were randomly divided into four groups of five animals each and kept in individual pens, which has been washed and disinfected with Izal solution. The pens have concrete floors and were well ventilated with space of 2.5m X 2.0m each.

**Data Collection**

**Performance of *Yankasa* Rams**

Daily feed intake and daily weight gain were recorded throughout the experimental period. Feed conversion ratio (FCR) was calculated using the relationship:

$$FCR = \frac{\text{Feed intake}}{\text{Weight gain}}$$

While feed efficiency (FE) was calculated as;

$$FE = \frac{\text{Weight gain}}{\text{Feed intake}}$$



**Digestibility study**

Digestibility study was conducted at the end of the experiment. Three animals per treatment (a total of 12) were used for the digestibility study. Each animal was transferred into metabolism cage equipped for separate collection of faeces the animals were maintained on their respective treatment diets and allowed a 7 days adjustment period to the cages before the faecal collection was done for seven days. The quantity of food offered, feed residue and faeces from each animal were determined. Faeces voided daily polythene each weighed and oven-dried in 60-65°C for 24 hours. At the end of collection period, all samples from each animal were bulked. Thoroughly mixed and 10% sub-sample taken for chemical analysis. Daily collection of faeces for each animal were separately bulked and sample taken and stored into labeled containers until it was required for analysis

**Haematological-biochemical studies**

Haematological biochemical studies were conducted using three rams from each treatment (a total of 12 rams). Five ml of blood was collected from each animal from the external jugular vein following proper restraint during the 11th week of the experiment. The blood was collected in heparin tube containing Ethylene Di-amine tetra acetate (EDTA) and other samples in tubes without the anticoagulant. The blood samples were kept refrigerated until transported to the laboratory for analysis. Packed cell volume (PCV) was determined by micro centrifugation and haemoglobin was measured through colorimetric technique of potassium cyanide. Blood samples without anticoagulant were centrifuged 2,500 rpm for 15 minutes) serum was withdrawn and stored at -20°C for biochemical analysis, which were performed by spectrophotometric methods. The examined profile included total protein, glucose and urea.

**Data Analysis**

Data obtained were subjected to analysis of variance (ANOVA) using Statistical Analysis System (SAS, 2010) and mean differences were separated using Duncan's Multiple Range Test (Duncan, 1955).

**RESULTS AND DISCUSSION**

**Growth Performance of Yankasa Rams**

Significant ( $P < 0.05$ ) difference was observed in final body weight (FBW) of sheep fed experimental diets. Animals fed diet 2 recorded the highest FBW value (28.40 kg), while those fed diet 3 had the lowest (21.80kg). Animal fed diet 2 recorded the highest TWG (10.60kg) while those fed diets 4, 3 and 1 had lower values (7.40, 5.00 and 5.00kg) respectively. Similarly, the ADWG was significantly ( $P < 0.05$ ) higher in animals fed diet 2 (126.19g/day) and lower for those fed diets 4, 3 and 1 (88.09, 59.52 and 59.52) respectively. Feed conversion ratio value was better for animals fed diet 2 (7.33) as compared to those fed diet 4, 1 and 3 with (10.29, 15.12 and 15.95) respectively.

**Table 3: Growth Performance of Yankasa Rams Fed Graded Levels of *Anogeissus leiocarpus* Leaves and Wheat Offals**

Parameters	Treatments				SEM
	T1	T2	T3	T4	
Initial weight (kg)	17.40	17.80	16.80	16.80	0.34
Final weight (kg)	22.40 <sup>b</sup>	28.40 <sup>a</sup>	21.80 <sup>b</sup>	24.20 <sup>b</sup>	0.81
Total weight gain (kg)	5.00 <sup>b</sup>	10.60 <sup>a</sup>	5.00 <sup>b</sup>	7.40 <sup>b</sup>	0.66
DMI (g/day)	899.67	924.89	895.69	906.23	5.99
Average daily weight gain (g/day)	59.52 <sup>b</sup>	126.19 <sup>a</sup>	59.52 <sup>b</sup>	88.09 <sup>b</sup>	7.98*
Feed conversion ratio	15.12 <sup>a</sup>	7.33 <sup>c</sup>	15.05 <sup>a</sup>	10.29 <sup>b</sup>	1.09*

<sup>a, b, c</sup>, Means within each row with different superscripts are significantly different ( $P < 0.05$ ), T1 – 0% *A. leiocarpus*, T2 – 10% *A. leiocarpus*, T3 – 20% *A. leiocarpus*, T4 – 30% *A. leiocarpus*, DMI = Dry Matter Intake, SEM: Standard Error of the Means.

### Nutrient Digestibility

The dry matter digestibility values were significantly (1-0) (05) different across the treatments. Animals fed diet 1 recorded the highest DMD value (86.69%), while those fed diets 2, 3 and 4 had the lower values (85.11, 82.05 and 79.14%) respectively. OMD and ADFD followed the same pattern. Organic matter digestibility was significantly (P<0.05) higher in animals fed diet 1 (83.59%) while those fed diets 2, 3 and 4 had the lower values (81.44, 77.24 and 74.96%) respectively. The result of crude protein digestibility of the animals was similar across the treatments. Values ranged from 88.70% to 89.70% for animals fed diets 1 and 4 respectively. Neutral detergent fibre digestibility was significantly (P<0.05) different between treatments. Animals fed diets 1 and 2 had the highest values (81.46 and 80.25%) while those fed diets 3 and 4 the lowest (76.25 and 72.98%) respectively. Acid detergent fibre digestibility was significantly (P<0.05) different across treatments animal fed diet 1 recorded the highest ADFD value (80.95%) while those fed diets 2, 3 and 4 had the lower values (78.84, 74.79 and 71.57%) respectively.

**Table 4:** Nutrient Digestibility of *Yankasa* Rams Fed Graded Levels of *Anogeissus leiocarpus* Leaves and Wheat Offals in the Diets.

Parameters	Treatments				SEM
	T1	T2	T3	T4	
DMD	86.69 <sup>a</sup>	85.11 <sup>b</sup>	82.05 <sup>b</sup>	79.74 <sup>c</sup>	1.09*
OMD	83.59	81.44	77.52	74.96	0.57*
CPD	88.70	88.96	88.83	89.70	1.35*
NDFD	81.46 <sup>a</sup>	80.25 <sup>a</sup>	76.26 <sup>b</sup>	72.98 <sup>c</sup>	1.42*
ADFD	80.95 <sup>a</sup>	78.84 <sup>b</sup>	74.79 <sup>b</sup>	71.57 <sup>c</sup>	1.50*

<sup>a, b, c</sup> Means within each row with different superscripts are significantly different (P<0.05), T1 – 0% *A. leiocarpus*, T2 – 10% *A. leiocarpus*, T3 – 20% *A. leiocarpus*, T4 – 30% *A. leiocarpus*, SEM: Standard Error of the Means, DMD – Dry Matter Digestibility, OMI – Organic Matter Digestibility, CPD – Crude Protein Digestibility, NDFD – Nutrient Detergent Fibre Digestibility, ADFD – Acid Detergent Fibre Digestibility.

### Haematological and Biochemical Indices

Packed Cell Volume did not differ significantly (P > 0.08) across the diets. The PCV values ranged from 28.06% to 28.63% for animal fed diets 3 and 1 respectively. No significant (P>0.05) difference was observed in haemoglobin values of the animals fed experimental diets. Values ranged from 9.50g/dl to 9.8g/dl for animals fed diets 3 and 4 respectively. The values of White Blood Cell were not significantly (P<0.05) different across the diets. The WBC Ranged from 3.60x10<sup>9</sup>/L - 6.26x10<sup>9</sup>/L. The red blood cell count values recorded in this study (7.62 - 8.03x10<sup>12</sup>/L). The values of TP of both before feeding (BF) and 5 hours after (AF) did not differ significantly across the diets. The TP values HF ranged from 6.20 - 7.63g/L while those of 5 hours AF ranged from 6.33 – 7.33g/L. The values of Total Glucose (BF) and 5 hours AF were not significantly (P>0.05) different across the diets. TG values HF ranged from 2.53-2.90mmol/L, while those of 5 hours AF ranged from 3.07-3.57mmol/L. The values of BU for both BF and 5 hours AF did not differ significantly (P > 0.05) The BF value ranged from 3.06-5.56mmol/L, while those recorded 5 hours AF ranged from 3.83-6.30mmol/L.

**Table 5: Haematological and Biochemical Indices of Yankasa Rams Fed Graded Levels of *Anogeissus leiocarpus* Leaves and Wheat Offals in the Diets.**

Parameters	Treatments				SEM	Normal range
	T1	T2	T3	T4		
<b>Haematological</b>						
Haemoglobin (g/dl)	9.73	9.66	9.50	9.80	0.21 <sup>NS</sup>	7.00-15.00 <sup>a</sup>
Packed cell volume (%)	28.63	28.46	28.06	28.52	0.78 <sup>NS</sup>	25.00-30.00 <sup>b</sup>
White blood cell (x10 <sup>9</sup> /L)	3.73	6.26	3.90	3.60	0.53 <sup>NS</sup>	3.20-15.00 <sup>c</sup>
Red blood cell (x10 <sup>9</sup> /L)	7.62	7.74	8.03	7.99	0.34 <sup>NS</sup>	4.00-9.00 <sup>d</sup>
<b>Biochemical</b>						
Total protein (g/L)						5.00-12.30 <sup>e</sup>
0 hours (before feeding)	7.63	6.86	6.20	6.20	0.32 <sup>NS</sup>	
5 hours (after feeding)	7.33	7.03	6.33	6.66	0.28 <sup>NS</sup>	
Total glucose (mmol/L)						2.50-3.90 <sup>f</sup>
0 hours (before feeding)	2.73	2.73	2.90	2.53	0.20 <sup>NS</sup>	
5 hours (after feeding)	3.17	3.30	3.57	3.07	0.18 <sup>NS</sup>	
Urea (mmol/L)						0.80-9.20 <sup>e</sup>
0 hours (before feeding)	3.06	4.46	5.56	4.83	0.42 <sup>NS</sup>	
5 hours (after feeding)	3.83	5.00	4.73	6.30	0.43 <sup>NS</sup>	

TI – 0% *A. leiocarpus*, T2 – 10% *A. leiocarpus*, T3 – 20% *A. leiocarpus*, T4 – 30% *A. leiocarpus*, DMI = Dry Matter Intake, SEM: Standard Error of the Means, source; Merck (1998), Jawasreh *et al.*, (2010), Daramola *et al.*, (2005). a – Akinyemi, b – Opera, c – Scott, d – Tambuwal, e – Daramola. NS – Not Significant.

## CONCLUSION AND RECOMMENDATION

In conclusion however, all the haematological and biochemical values obtained for all parameters across the treatments fell within the normal values for healthy rams. From the result of this study diet 2 (10% AL/20%WO) which gave the best average daily weight gain (126.19g/day) and the best utilized diet (7.33) can be recommended for growing Yankasa rams.

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