



**EFFECT OF SENNA *TORA* LEAF MEAL COMBINED WITH  
YEAST-FERMENTED SORGHUM STALKS ON GROWTH PERFORMANCE AND  
ECONOMICS OF RED SOKOTO BUCKS**

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**ABSTRACT**

The study evaluated the effects of *Saccharomyces cerevisiae* inoculant on the silage quality of sorghum stalks and its nutritional impact when combined with *Senna tora* leaf meal (STLM) in diets for growing Red Sokoto bucks (RSBs). Sorghum stalks were ensiled with yeast and molasses under anaerobic conditions for 21 days. Fifteen (15) healthy RSBs of between 8 – 9 months with an average weight of  $9.62 \pm 0.88$  kg were randomly assigned to five dietary treatments over a 47-day trial. The diets incorporated varying proportions of ensiled sorghum stalks (ESS) and STLM: A (0% ESS:100% STLM), B (100% ESS:0% STLM), C (95% ESS:5% STLM), D (90% ESS:10% STLM), and E (85% ESS:15% STLM), formulated per 100 kg of dry matter. STLM demonstrated high nutritional value, with elevated crude protein (26.99%), metabolizable energy (2,265.60 kcal/100 g), and low fiber content (8.85%). Phytochemical analysis revealed tannins (8.03 mg/100 g), phytates (4.61 mg/100 g), glycosides (1.09 mg/100 g), and trace sennosides (0.1 mg/100 g), while saponins and cyanide were absent. Diets containing (STLM: ESS) significantly influenced ( $P < 0.05$ ) nutrient composition, with treatment C showing the highest nitrogen-free extract (NFE) of 48.00% and lowest crude ash (6.99%) and fiber (22.37%), enhancing NFE ( $P < 0.05$ ). Growth performance was notably improved by the inclusion of STLM and ensiled sorghum stalks, with treatment E having the highest ( $P < 0.05$ ) average daily gain (85 g/day) and most efficient feed conversion ratio (5.62 kg) feed/kg gain; . Diet E (85% ESS:15% STLM) is hereby recommended for optimum nutrient utilization and feed efficiency in Red Sokoto Bucks.

**Keywords:** Red, Sokoto, Bucks, *Saccharomyces*, *Cerevisiae*, Sorghum

**INTRODUCTION**

In Sub-Saharan Africa, goat rearing remains a vital source of livelihood for smallholder farmers, contributing to household nutrition, income stability, and adaptive capacity in the face of climate variability. As farming systems increasingly shift toward sustainable, integrated crop–livestock models, there is growing interest in utilizing locally available feed resources to reduce costs and improve resilience (Ndonga *et al.*, 2024; Ngambi *et al.*, 2025; Assan, 2021). *Senna tora* (also known as *Cassia tora* or sicklepod) is a leguminous species gaining attention for its potential in small ruminant nutrition (Assan, 2021). Its foliage offers a moderate supply of crude protein (12.4%) and fibre (18.8%), along with key minerals such as calcium and phosphorus (Buba *et al.*, 2024). Despite these benefits, its use in goat diets is limited by the presence of antinutritional compounds namely tannins, anthraquinones, and lectins which can interfere with digestion and overall health (Kumar *et al.*, 2019; Singh & Sharma, 2020). Tannins, for instance, may reduce protein availability by forming indigestible complexes (Mueller-Harvey, 2006).

Sorghum stalks, when processed into silage or pelleted complete rations, serve as a reliable roughage source for goats, providing sufficient fiber and energy while supporting consistent weight gain and maintaining favorable nitrogen and mineral balance (Dhore *et al.*, 2025). Recent advances in feed processing have further enhanced the nutritional value of sorghum stalks.

The purpose of this study is to investigate the potential of *Senna tora* leaf meal (STLM) in suitable combination with yeast treated sorghum stalks as a cost-effective alternative to conventional feed concentrates in goat production systems. Specifically, we evaluate the chemical composition and



antinutritional profile of STLM, identify optimal inclusion levels in (STLM-ESS) based diets, and assess their effects on growth performance and economic returns in growing Red Sokoto bucks.

## **MATERIALS AND METHODS**

### **Study Area and Environmental Conditions**

The research was carried out at the Ruminant Unit of the Teaching and Research Farm, of the Department of Animal Science, Federal University Gashua, Yobe State, Nigeria. The experimental site experienced a very high average temperature in March and April, reaching up to 41.34°C, while the rainy season spans from June to September, with August being the wettest month (237.09 mm). During the dry season, relative humidity averages between 12% and 35%, with April recording 18.48% (Climatemp, 2025).

### **Experimental Design and Animal Management**

Fifteen (15) clinically healthy Red Sokoto bucks (RSBs), with age of 8-9 months and weight average of  $9.6 \pm 0.88$  kg, were sourced from the Garin Alkali livestock market and subjected to veterinary screening prior to the trial. Animals were randomly allocated to five dietary treatments in a Completely Randomized Design (CRD), with three replicates per group. Each buck was housed individually in a well-ventilated  $1.2 \times 0.8$  m pen enclosed with wire mesh. A two-week quarantine period preceded the experiment, during which ivermectin (1 mL/50 kg BW) and oxytetracycline (1 mL/10 kg BW) were administered. Bucks were fed a total mixed ration (TMR) at 5% of body weight (600 g/day DM), split into two meals at 08:00 am and 5:00 pm, with ad libitum access to clean water. Feed refusals were removed prior to each feeding. Initial body weights were recorded, and weekly measurements were taken throughout the 47-day trial. Following a two-week acclimatization period, data on feed intake, nutrient consumption, price of feed ingredients and feed conversion ratio were collected.

### **Ensiling Process of Sorghum Stalks**

The yeast (*Saccharomyces cerevisiae*) used for the fermentation process was sourced from Animal Care Consult, Kano, Nigeria. Following the procedure outlined by Musa *et al.* (2024), a 5-liter solution containing 50 g of yeast and 2 kg of molasses was prepared and thoroughly mixed with 92.95 kg of chopped sorghum stalks to produce a 100 kg silage batch. Two such batches were prepared for the experiment. The mixture was packed into thick black polythene bags and sealed tightly to promote anaerobic fermentation. Air was expelled manually by compressing the bags as much as possible, using a heavy metal weight carefully placed on top to minimize oxygen exposure. After a 21-day fermentation period, the silage was opened and exposed to ambient air overnight in a shaded area to allow the dissipation of volatile ammonia gases, as recommended by Olafadehan *et al.* (2016).

### **Measurement, Source, and Formulation of Experimental Diets**

*Senna tora* leaves were sourced from the Garin Alkali Livestock Market, thoroughly cleaned to remove impurities, air-dried, and milled into leaf meal (STLM). Sorghum stalks and all supplementary feed ingredients were procured from the Gashua Market in Yobe State. Five experimental diets were formulated and labeled as A, B, C, D, and E. Diet A served as the control, containing no yeast-treated sorghum stalks (ESS) or STLM. Diet B consisted entirely of (100% ESS + 0% STLM:), while diets C, D, and E incorporated increasing levels of STLM at 5%, 10%, and 15%, respectively, with corresponding reductions in ESS (i.e., C: 95% ESS + 5% STLM; D: 90% ESS + 10% STLM; E: 85% ESS + 15% STLM), based on 100 kg of dry matter (DM). The detailed composition of each diet (kg/100 kg DM) is presented in Table 1.

**Table 1: Gross Composition of Experimental Diets (kg/100kg DM)**

Ingredients	A	B	C	F	E
Ensiled Sorghum Stalks (ESS)	0.00	15.0	14.25	13.5	12.75
<i>Senna tora</i> leaf meal (STLM)	0.00	0.00	0.75	1.50	2.25
Cowpea husk	22	7	7	7	7
Maize	20	20	20	20	20
Wheat bran	20	20	20	20	20
Peanut Cake	10	10	10	10	10
<i>Ziziphus spp.</i> leaf meal	25	25	25	25	25
Salt	1	1	1	1	1
Ruminant premix	2	2	2	2	2
<b>TOTAL</b>	100kg	100kg	100kg	100kg	100kg
Calculated analysis					
Crude protein (%)	13.49	13.42	13.33	13.48	
GE (KJ/100g DM)	8.22	8.31	8.29	8.24	

GE: Gross energy, A; (0% ESS: STLM), B; (100%: 0%ESS), C; (95%ESS:5% STLM), D; (90%ESS:10%STLM) and E; (85%ESS: 15% STLM) kg/100kg of dry matter (DM)

### Phytochemical Analysis

Phytochemical screening of *Senna tora* leaf meal was carried out to identify bioactive compounds relevant to ruminant nutrition. Air-dried and ground samples were analyzed for tannins, saponins, alkaloids, and glycosides using spectrophotometric methods, following protocols described by (Subramanian et al., 2021).

### Chemical Analysis of Experimental Diets

Representative samples from five experimental diets containing *Senna tora* leaf meal (STLM) and yeast-treated sorghum stalks (ESS) were collected in sterile bags (labelled A–E) and transported for laboratory analysis. Samples were oven-dried at 60 °C for 96 h, ground (Wiley mill), and sieved (1 mm mesh). Proximate composition was determined in triplicate following AOAC (2016) protocols. Moisture was measured gravimetrically (105 °C), ash via dry ashing (550 °C), and crude protein by micro-Kjeldahl digestion (Cu–Se catalyst, H<sub>2</sub>SO<sub>4</sub>, distillation, titration). Lipid content was extracted using petroleum ether (40–60 °C) in a Soxhlet apparatus, and crude fibre was quantified by sequential acid–alkali digestion and correction for ash. Nitrogen-free extract (NFE) was calculated by difference. Fibre fractions (NDF, ADF, ADL) were analyzed using an ANKOM fibre analyzer (Van Soest *et al.*, 1991), with hemicellulose and cellulose derived by subtraction. Gross energy (MJ/kg DM) was estimated using the predictive equation:  $GE = (\%CP \times 16.7) + (\%EE \times 37.7) + (\%CHO \times 16.7)$  described by (Robinson *et al.*, 2004).

### Growth Performance Study

Bucks were weighed individually at the beginning of the experiment and, thereafter, weekly for the duration of the experiment. Weighing was done before the morning feeding. The parameters determined for the evaluation of growth performance were initial weight (g), average daily feed intake (g), average daily weight gain (g) and feed conversion ratio. Weight gain for each animal was calculated by subtracting the initial weight (g) from the final weight (g), while the feed conversion ratio was calculated by dividing the total feed intake (g) by the total weight gain (g).

### Economic Evaluation

Profitability of feeding ruminants with diets containing *Senna tora* leaf meal (STLM) and *Saccharomyces cerevisiae*-treated sorghum stalks silage was assessed relative to a control diet. Total feed costs were calculated based on ingredient prices, and key economic indicators average weight gain, feed cost per kg gain, and feed intake per kg gain were evaluated. Cost savings (in Naira) were computed by comparing feed cost per kg gain against the control, then converted to USD using the Central Bank of Nigeria exchange rate (1 USD = NGN 1666.00, as of 24/06/2025).



### Statistical Analysis

All data were subjected to analysis of variance (ANOVA) using SAS software (version 9.4; SAS Institute Inc., Cary, NC, USA, 2004) within a Completely Randomized Design (CRD) framework. Dietary treatment was modeled as the primary fixed effect. Where significant differences were detected, mean separation was performed using the Least Significant Difference (LSD) test. Statistical significance was declared at  $P < 0.05$ .

## RESULTS AND DISCUSSION

### The Proximate Profiles of *Senna tora* Leaf Meal (STLM) and Sorghum Straw (SS)

The result revealed that *Senna tora* leaf meal (STLM) had 26.99 % Crude Protein (CP) and 2,266 kcal ME 100 g<sup>-1</sup>, whereas SS contained only 5.56 % CP and 683 kcal ME 100 g<sup>-1</sup>. The CP and ME values of ESS were close to 3.7 % CP and 18 MJ GE kg<sup>-1</sup> DM for sorghum residues (INRA. 2017). Conversely, STLM had higher CP within the range (17–39 %) reported for high-protein *S. tora* ecotypes (Bañares, *et al.* 2019) and matches the 27 % CP value recently measured for *C. tora* foliage (Sahu, *et al.* 2019). The higher ether extract (7.04 % vs. 4.60 %) further boosts the energy density of STLM, positioning it as a dual protein–energy diet capable of correcting the N and energy deficits of straw-based rations. ESS exhibited an extreme crude-fibre concentration (39 %), aligning with 39–40 % CF and 77 % NDF for sorghum straw (INRA. 2017). Such lignified cell walls depress fermentability and voluntary intake. STLM, by contrast, contained only 8.85 % fibre, providing a readily fermentable carbohydrate pool that can stimulate rumen microbial growth when co-fed with high-fibre residues. Both feeds were ash-rich (16.08 % in STLM; 14.49 % in SS), suggesting that either ingredient could contribute macro- and micro-minerals. High ash levels in legume leaves are often linked to desirable Ca and trace-element concentrations. Leaf meals with 24–27 % CP have repeatedly improved straw intake and average daily gain.

**Table 2:** Nutritional Value of *Senna tora* Leaf Meal and Ensiled Sorghum Stalks Treated with Yeast (% DM basis)

Parameter	<i>Senna tora</i> Leaf Meal	Sorghum straw*
Crude Protein	26.9	5.56
Ether Extract	7.04	4.60
Moisture Content	5.45	4.24
Dry Matter	94.56	95.51
Crude Fibre	8.85	39
Ash Content	16.08	14.49
Nitrogen-Free Extract	35.60	32.11
Carbohydrate Content	44.44	ND
Metabolizable Energy (Kcal/100g)	2265.60	683

\*(Tian *et al.*, 2024)

### Phytochemical Composition of *Senna tora* Leaf Meal (STLM)

The phytochemical analysis of *Senna tora* leaf meal revealed the presence of several bioactive compounds with moderate values (Table 3). Tannins were detected at 8.03 mg/100 g, a level consistent with the moderate range (3–8 mg/100 g) reported to enhance protein protection in ruminants without impairing digestibility (Min & Solaiman, 2018). Phytates were present at 4.61 mg/100 g, which is slightly above the 3–4 mg/100 g threshold commonly associated with reduced mineral bioavailability. While phytates was 4.61 agreeing with the value of *Cassia tora* fed to sheep. (Nkwocha *et al.*, 2014). Saponins and cyanide were not detected in the analyzed samples, suggesting a favorable safety profile. This contrasts with findings in some tropical forages where saponins exceed 3 mg/100 g and may impair rumen microbial activity (Roy *et al.*, 2014). Glycosides were present at 1.09 mg/100 g, a level considered low and unlikely to exert toxic effects. Sennosides, known for their laxative properties, were detected at 0.1 mg/100 g, indicating minimal risk of gastrointestinal disturbance under typical feeding conditions. These results suggest that STLM contains beneficial



phytochemicals at safe concentrations, supporting its potential as a functional feed ingredient in small ruminant diets. The absence of toxic compounds and the presence of moderate tannins and glycosides may contribute to improved nutrient utilization and immune modulation, as observed in recent goat trial. (Hamid *et al.*, 2025; Min & Solaiman, 2018).

**Table 3: Phytochemical Composition of *Senna tora* Leaf Meal (STLM)**

Phytochemical	Presence (+) / Absence (-)	Value (mg/100g)
Tannins	+	8.03
Phytates	+	4.61
Saponins	-	0.00
Glycosides	+	1.09
Cyanide	-	0.00
Sennosides	+	0.10

The chemical analysis of ration A–E showed that dry-matter, organic-matter contents, ADF and NDF did not differ statistically ( $P > 0.05$ ), whereas all other measured parameters varied significantly (Table 4). Ration C recorded the highest dry matter (92.09 %) and organic matter (93.01 %), pointing to better preservation and limited residual moisture an outcome comparable to that reported for leguminous feeds by Zhang *et al.* (2023). Crude-protein values fell between 13.45 % (ration E) and 15.28 % (ration A). The crude protein values observed in this study, ranging from 13.45% to 15.28%, align with recent findings that confirm dietary CP levels of (13.00% - 16.00%) effectively support maintenance and growth in Boer crossbred goats (Hamid *et al.*, 2025). Crude-ash content ranged from 6.99 % in sample C to 10.67 % in sample D ( $P < 0.05$ ), a span consistent with the mineral residues typically observed in plant-derived feedstuffs (Kumar *et al.*, 2022). Crude fibre peaked in sample E at 30.13 %, the overall range of 22.37–30.13 % was significant ( $P < 0.05$ ) and mirrors variation documented for tropical forages (Adeyemi *et al.*, 2021). Crude fat of ration E reached 2.17 %, whereas ration D contained only 0.67 %. This parameter was significant ( $P < 0.05$ ), and the higher lipid level in sample E may reflect fermentation influences noted by Chen *et al.* (2023). The NFE was significant ( $P < 0.05$ ). The nitrogen-free extract (NFE), that is the readily soluble carbohydrate fraction of ration C was 48.00 %, with ration A having the lowest at 36.63 %. Acid-detergent fibre (ADF) dropped from 29.23 % to 25.21 %, and neutral-detergent fibre (NDF) from 31.21 % to 28.02 %. Although these reductions were not statistically significant ( $P > 0.05$ ).

**Table 4: Nutrient Composition of Experimental Rations (% DM)**

Item (%)	Treatments					SEM	P-value
	A	B	C	D	E		
Dry Matter	89.53	90.29	92.09	90.79	91.70	4.78	0.34
Organic Matter	89.62	89.51	93.01	89.33	91.70	4.96	0.26
Crude ash	10.38 <sup>a</sup>	10.49 <sup>a</sup>	6.99 <sup>c</sup>	10.67 <sup>a</sup>	8.06 <sup>b</sup>	1.75	0.02
Crude fibre	25.57 <sup>a</sup>	23.24 <sup>a</sup>	22.37 <sup>c</sup>	25.63 <sup>a</sup>	30.13 <sup>a</sup>	1.35	0.03
Crude protein	15.28 <sup>a</sup>	13.82 <sup>b</sup>	13.56 <sup>b</sup>	15.20 <sup>a</sup>	13.45 <sup>b</sup>	1.40	0.02
Crude fat	1.67 <sup>b</sup>	1.17 <sup>c</sup>	1.16 <sup>c</sup>	0.67 <sup>d</sup>	2.17 <sup>a</sup>	0.26	0.04
NFE	36.63 <sup>c</sup>	41.57 <sup>b</sup>	48.00 <sup>a</sup>	46.53 <sup>a</sup>	37.90 <sup>c</sup>	2.30	0.04
ADF	29.23	28.11	27.76	26.04	25.21	3.75	0.17
NDF	31.21	30.14	29.46	29.00	28.02	3.57	0.05

NFE; Nitrogen free extract, NDF; Neutral detergent fibre, ADF; acid detergent fibre, A; (0% ESS: STLM), B; (100%: 0%ESS), C; (95%ESS:5% STLM), D; (90%ESS:10% STLM) and E; (85%ESS: 15% STLM) kg/100kg of dry matter (DM)

Table 5 below shows the growth performance of Red Sokoto Bucks fed diets containing varying levels of *Senna tora* leaf meal and yeast treated ensiled sorghum stalks. Final weights (FW) showed significant differences ( $P < 0.05$ ), with goats in group E reaching the highest average of

14.40 kg, compared to 12.57 kg in group A. This suggests that diets containing higher levels of *Senna tora* leaf meal and yeast-treated sorghum stalks may enhance growth outcomes of the Red Sokoto bucks (RBs). Weight gain (WG) followed a similar trend, increasing from 2.67 kg (A) to 4.17 kg (E), with a significant effect ( $P < 0.05$ ). Average daily weight gain (ADW) ranged from 53 g/day (A) to 85 g/day (E), also statistically significant ( $P < 0.05$ ). The growth performance of Red Sokoto bucks (RBs) in the present study showed significant variation across dietary treatments, with final weights ranging from 12.57 kg (A) to 14.40 kg (E) and average daily gains from 53 g/day to 85 g/day, respectively. These results are consistent with recent findings by Hyelda *et al.* (2017), who reported that supplementing urea-treated maize stover with *Balanites aegyptiaca* leaf forage significantly improved weight gain and nutrient digestibility in Red Sokoto goats. Their highest treatment group achieved an average daily gain of 52 g/day, closely matching the lower end of the present study's range. Similarly, Ibrahim *et al.* (2014) demonstrated that inclusion of *Guiera senegalensis* (Sabara leaf meal) at 20–30% in goat diets enhanced body weight and feed conversion ratio, with significant improvements in final weight and nutrient uptake. Total feed intake (TFI) and daily feed intake (DFI) in the present study increased significantly across treatments, ranging from 18.63 kg to 23.42 kg and 397.53 g/day to 498.28 g/day, respectively ( $P < 0.05$ ). Total feed intake (TFI) and daily feed intake (DFI) increased with values of 18.63 kg to 23.42 kg and 397.53 g/day to 498.28 g/day, respectively ( $P < 0.05$ ). This increase may reflect enhanced palatability and digestibility of the yeast-treated silage, consistent with Faverdin (2024), who emphasized the role of nutrient composition and microbial fermentation in regulating feed intake in ruminants. These values are consistent with recent findings by Hamid *et al.* (2025), who reported that Boer crossbred goats fed protein-optimized diets exhibited daily feed intakes between 420 g/day and 510 g/day, depending on crude protein concentration and fiber digestibility. Feed conversion ratio (FCR), a critical indicator of feed efficiency, was significantly improved in groups C, D, and E ( $P < 0.05$ ). The lowest FCR was observed in group C (5.37), indicating superior efficiency compared to group A (6.98). Lower FCR values suggest better utilization of feed for weight gain, a trend supported by VandeHaar *et al.* (2016), who highlighted Feed conversion ratio as a key driver of sustainability in ruminant production systems. This trend mimics the results of Mutimura *et al.* (2025), who found that Galla goats fed a Mulato II–Leucaena leaf meal blend achieved FCRs as low as 5.2, outperforming Napier-based diets with FCRs above 6.5, indicating superior nutrient utilization and growth efficiency. The study highlights superior nutrient utilization and enhanced growth efficiency in bucks fed diets incorporating *Senna tora* leaf meal and yeast-treated sorghum stalks. A key objective was to achieve an effective protein–fibre balance tailored for growing goats. This goal aligns with recent findings indicating that optimal growth and feed efficiency are supported when dietary crude protein levels range between 14–18%, and crude fibre levels fall within 22–28%, depending on the feed source and its digestibility (Chana *et al.*, 2025; Zhang *et al.*, 2025). study, Ration E, which incorporates E; (85%ESS: 15% STLM), resulted in the highest feed cost saving of \$0.16 per male goat compared to conventional diets.

**Table 5:** Growth Performance of Red Sokoto Goats Fed Diets Containing Varying Levels of *Senna tora* Leaf Meal and Yeast-treated Ensiled Sorghum Stalks

Item	Treatments					SEM	P-Value
	A	B	C	D	E		
Initial Weight (kg)	9.90	10.50	9.62	9.90	10.23	1.15	0.33
Final Weight (kg)	12.57 <sup>b</sup>	13.34 <sup>ab</sup>	13.35 <sup>a</sup>	13.86 <sup>a</sup>	14.40 <sup>a</sup>	1.20	0.02
Weight gain (kg)	2.67 <sup>b</sup>	2.84 <sup>b</sup>	3.73 <sup>a</sup>	3.96 <sup>a</sup>	4.17 <sup>a</sup>	0.90	0.04
Average Daily Gain (g/d)	53.00 <sup>d</sup>	59.00 <sup>c</sup>	77.00 <sup>b</sup>	79.00 <sup>a</sup>	85.00 <sup>a</sup>	6.18	0.02
Total Feed Intake (kg)	18.63 <sup>c</sup>	20.46 <sup>b</sup>	20.02 <sup>b</sup>	21.56 <sup>b</sup>	23.42 <sup>a</sup>	1.80	0.04
Daily Feed Intake DMI (g/d)	397.53 <sup>d</sup>	435.25 <sup>c</sup>	426.05 <sup>c</sup>	458.63 <sup>b</sup>	498.28 <sup>a</sup>	16.90	0.03
FCR (kg feed kg <sup>-1</sup> gain)	6.98 <sup>a</sup>	7.20 <sup>a</sup>	5.37 <sup>c</sup>	5.44 <sup>c</sup>	5.62 <sup>c</sup>	0.40	0.02
Feed cost/kg (\$)	0.39	0.30	0.27	0.25	0.23	-	-
Feed cost saving (\$)	-	0.09	0.12	0.14	0.16	-	-



SEM: Standard Error of the Mean, A; (0% ESS: STLM), B; (100%: 0%ESS), C; (95%ESS:5% STLM), D; (90%ESS:10% STLM) and E; (85%ESS: 15% STLM) kg/100kg of dry matter (DM)

## CONCLUSION AND RECOMMENDATION

Incorporating *Senna tora* leaf meal and yeast-treated sorghum stalks in the diets of RS bucks demonstrates the potential of locally available, unconventional feed resources to enhance both productivity and sustainability. Optimizing dietary formulation with these components led to marked improvements in , total weight gain and average daily gain with Diet E (85% ESS:15% STLM) yielding the highest growth performance. Feed conversion ratios were also improved, particularly in Diet C (95% ESS:5% STLM ), indicating more efficient nutrient utilization. These findings underscore the value of integrating agro-industrial by-products into animal nutrition strategies, offering a cost-effective and environmentally responsible approach to improving growth performance in intensive production systems. Diet E (85% ESS:15% STLM) is hereby recommended for optimum nutrient utilization and feed efficiency in Red Sokoto

## ETHICAL APPROVAL STATEMENT

This Research is approved by the Animal Research Ethics Committee of Federal University Gashua, Protocol No. FUGA/C/ANS/2025/00033, dated 03 March, 2025.

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