

# Response of Feeding Concentrate and Inclusion Levels of Hydroponic Maize Fodder to Yankasa Rams in Semi-Arid Environment of Nigeria

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## ABSTRACT

This study evaluated the response of feeding concentrate supplementation and varying levels of hydroponic maize fodder (HPMF) on growth performance, nutrient intake, nutrients digestibility, and nitrogen balance of growing Yankasa rams. The objective was to determine growth rate, nutrients intake, nutrients digestibility and nitrogen balance. Nine (9) rams (average initial weight: 16 kg) were randomly assigned to three dietary treatments with three animals per treatment in a completely randomized design. The control diet consisted of concentrate (13.4% crude protein), while the other treatments included 30% and 60% HPMF. The experiment lasted 90 days. Feed samples were analyzed for proximate and fibre composition. Body weights were recorded at the start and at two-week intervals. Digestibility and nitrogen balance were determined using total faecal and urine collection methods. Feed intake and live-weight changes were recorded to determine weight gain. Data were analyzed using ANOVA, and means were separated using Duncan's Multiple Range Test. Results showed significant ( $P < 0.05$ ) differences in feed intake, weight gain, average daily gain, and feed conversion ratio. Rams fed the control diet had superior growth performance, while those on 60% HPMF recorded higher feed intake. Nutrient digestibility and nitrogen balance were also significantly ( $P < 0.05$ ) higher in the control group. It was concluded that HPMF can be included up to 60% with concentrate supplementation; however, optimal performance is achieved with concentrate-based diets.

**Keywords:** hydroponic maize fodder, Yankasa rams, growth performance, digestibility, and nitrogen balance

## INTRODUCTION

Nutrition is a major determinant of livestock productivity, particularly in tropical and semi-arid regions where seasonal feed scarcity limits performance. During the dry season, both the quantity and quality of natural pastures decline significantly, resulting in reduced feed intake, poor growth, and low productivity in ruminants (Muhammad, 2008; Adewumi and Ajayi, 2010; Jiwuba *et al.*, 2021). Low-quality fibrous feeds commonly available during this period are deficient in crude protein and energy. Consequently, supplementation with concentrates is essential to improve rumen microbial activity, enhance nutrient utilization, and support animal performance (Leng, 2011). Concentrates provide readily fermentable carbohydrates and protein required for efficient rumen function and microbial protein synthesis (Peyraud, 2001; Khampa and Wanapat, 2007).

Hydroponic fodder production has emerged as an alternative strategy for producing fresh forage under limited land and water conditions. Hydroponic maize fodder is produced through the germination of maize grains in a controlled, soil-free environment. This process enhances nutrient availability by converting complex compounds into simpler, more digestible forms, thereby improving palatability and digestibility (Naik and Singh, 2013).

Despite its potential, information on the use of hydroponic maize fodder in diets of indigenous sheep breeds such as Yankasa under semi-arid conditions is limited. Therefore, this study evaluated the effects of concentrate

supplementation and varying levels of HPMF on performance, nutrient utilization, and nitrogen balance of growing Yankasa rams.

## MATERIALS AND METHODS

### Description of the study area

The study was conducted at the Livestock Teaching and Research Farm, Department of Animal Science, Faculty of Agriculture, Bayero University, Kano, Nigeria.

### Experimental Animals and Management

Nine (9) growing Yankasa rams, approximately 12 months old with an average initial body weight of 16 kg, were used for the experiment. Prior to the commencement of the trial, the animals were housed in well-ventilated pens that were cleaned, disinfected, and left to dry for two weeks. The rams were dewormed using albendazole to control internal parasites and treated with an amiticide solution against external parasites. Additionally, long-acting oxytetracycline was administered intramuscularly at a rate of 1 ml per 10 kg body weight as a prophylactic measure against bacterial infections.

### Experimental Diets and Treatments

The experimental diets consisted of concentrate supplementation and varying inclusion levels of hydroponic maize fodder (HPMF). The control diet comprised farmers' concentrate containing 13.4% crude protein, while the other treatments included 30% and 60% HPMF, respectively. Cottonseed cake and soybean meal served as the primary protein sources, while wheat bran and maize bran provided energy. Bone meal and common salt were included as mineral sources. Hydroponic maize fodder was produced following the procedures described by (Akinbobola (2022, Sawant (2021), and Jemimah *et al.* 2018).

Wheat bran	50
Maize bran	35
Soy Bean Meal	4
Cotton Seed Cake	5
Salt	2
Bone meal	3
Toxin binder	1
Total	100
<b>Calculated analysis</b>	
Crude protein	13.4
ME (kcal/kg)	2620

### Experimental Design and Feeding Management

The feeding trial lasted for 90 days and was conducted using a completely randomized design. The rams were randomly assigned to three dietary treatments, with three animals per treatment. Feed was offered daily at 5% of body weight. The concentrate constituted 40% of the daily ration, while the basal diet (fresh grass and soybean hay) accounted for 60%. Feeding was carried out twice daily at 09:00 h and 16:00 h. Body weights were recorded at the beginning of the experiment and subsequently at two-week intervals before morning feeding. Feed allowance was adjusted weekly based on the previous week's intake.

### Digestibility study

At the end of the feeding trial, a digestibility study was conducted using the total faecal collection method. Each animal was fitted with a faecal collection bag and allowed a 14-day adaptation period, followed by 7 days of data collection. Faeces were collected daily, weighed, and oven-dried at 65°C for 24 hours to determine dry

matter content. Feed refusals were collected and recorded each morning before fresh feed was offered. Urine was collected in labelled containers containing 5 ml of 0.1 M tetraoxosulphate (VI) acid (H<sub>2</sub>SO<sub>4</sub>) to prevent nitrogen loss and stored under refrigeration pending analysis. Subsamples of faeces and urine were taken for laboratory evaluation. Nitrogen balance was determined to assess nitrogen utilization. The apparent nutrient digestibility was calculated using the following formula:

$$\text{Nutrient digestibility (\%)} = \frac{\text{Nutrient intake} - \text{Nutrient in faeces}}{\text{Nutrient intake}} \times 100$$

### Data collection and analysis

Feed intake and live weight changes were recorded to determine growth performance. Feed intake was calculated as the difference between feed offered and feed refused.

The following indices were computed:

$$\text{Feed intake (kg)} = \text{Feed offered} - \text{Feed refused}$$

$$\text{Total weight gain (kg)} = \text{Final weight} - \text{Initial weight}$$

$$\text{Average daily gain (kg/day)} = \frac{\text{Total weight gain}}{\text{Number of days}}$$

$$\text{Feed conversion ratio (FCR)} = \frac{\text{Feed intake}}{\text{Weight gain}}$$

### Laboratory analyses

Samples of feed, Orts, and faeces were oven-dried at 65°C for 72 hours following standard procedures (AOAC, 2019). The dried samples were ground to pass through a 1 mm sieve and stored in airtight containers for analysis. Proximate analysis was conducted to determine crude protein (N × 6.25), crude fibre, ether extract, ash, and nitrogen-free extract. Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined using the method of Van Soest (1991). Urinary nitrogen was determined using the Kjeldahl method according to AOAC (2019).

### Statistical analysis

All data were subjected to analysis of variance (ANOVA) using SAS (2003). Treatment means were separated using Duncan's Multiple Range Test at a significance level of P < 0.05. The statistical model used was: Y<sub>ij</sub> = μ + T<sub>i</sub> + e<sub>ij</sub>. Where: Y<sub>ij</sub> = observation on jth animal in ith treatment, μ = overall mean, T<sub>i</sub> = effect of ith treatment (i = 1–3), e<sub>ij</sub> = experimental error

## RESULTS

### Chemical composition of hydroponic maize fodder

Table 2 showed the chemical composition of hydroponic maize fodder (HPMF). The chemical composition showed low dry matter and crude fibre but adequate crude protein, ether extract, ash, and acid detergent fibre within recommended ranges. Nitrogen-free extract and neutral detergent fibre were higher than recommended, while metabolizable energy was at the upper limit.

Parameters	HPM Values	NRC Recommended values
Dry matter	15.10	85–90% in total diet
Crude protein	14.72	12–16% (maintenance) 16–20% (growth/lactation)
Ether extract	2.65	2–5%
Crude fibre	9.67	12–30%
Ash	4.09	<8%

Nitrogen-free-extract	68.8	40–60%
Neutral detergent fibre	51.09	30–40%
Acid detergent fibre	18.08	18–25%
Metabolizable energy (kcal/kg)	2593	2000–2600 kcal/kg (growing sheep)

**Chemical composition of concentrate and levels of hydroponic maize fodder fed to Yankasa rams**

The chemical composition of the experimental diets is presented in Table 3. Diet composition differed significantly ( $P < 0.05$ ) among treatments. Increasing HPMF inclusion reduced dry matter and fibre fractions but improved crude protein (peaking at 30% inclusion) and metabolizable energy (highest at 60% inclusion).

**Table 3: Chemical composition (%) of concentrate and levels of hydroponic maize fodder fed to Yankasa rams**

Parameters	Treatments diets			
	Control	30%	60%	SEM
Dry matter	75.96 <sup>a</sup>	46.84 <sup>b</sup>	33.23 <sup>c</sup>	0.172
Crude protein	14.26 <sup>c</sup>	15.63 <sup>a</sup>	15.24 <sup>b</sup>	0.017
Crude fibre	29.10 <sup>a</sup>	25.86 <sup>b</sup>	21.25 <sup>c</sup>	0.011
Ether extract	6.27 <sup>a</sup>	3.16 <sup>b</sup>	2.94 <sup>c</sup>	0.056
Ash	6.95 <sup>a</sup>	6.28 <sup>a</sup>	5.34 <sup>b</sup>	0.016
Nitrogen-free-extract	44.11 <sup>a</sup>	42.65 <sup>b</sup>	45.09 <sup>a</sup>	0.099
Neutral-detergent-fibre	52.64 <sup>a</sup>	49.04 <sup>b</sup>	49.92 <sup>b</sup>	0.006
Acid-detergent-fibre	35.39 <sup>a</sup>	28.23 <sup>b</sup>	23.88 <sup>c</sup>	0.007
Hemicellulose	17.25 <sup>c</sup>	20.81 <sup>b</sup>	26.04 <sup>a</sup>	0.006
Metabolizable energy (kcal/kg)	1736.6 <sup>c</sup>	1870.3 <sup>b</sup>	2648.3 <sup>a</sup>	281.7

abc Values with the same superscript within rows are not significantly different ( $P < 0.05$ ). Control = farmers’ concentrate diet, 30% = 30% hydroponic maize fodder & 60% = 60% hydroponic maize fodder.

**Growth performance of Yankasa rams fed concentrate and levels of hydroponic maize fodder**

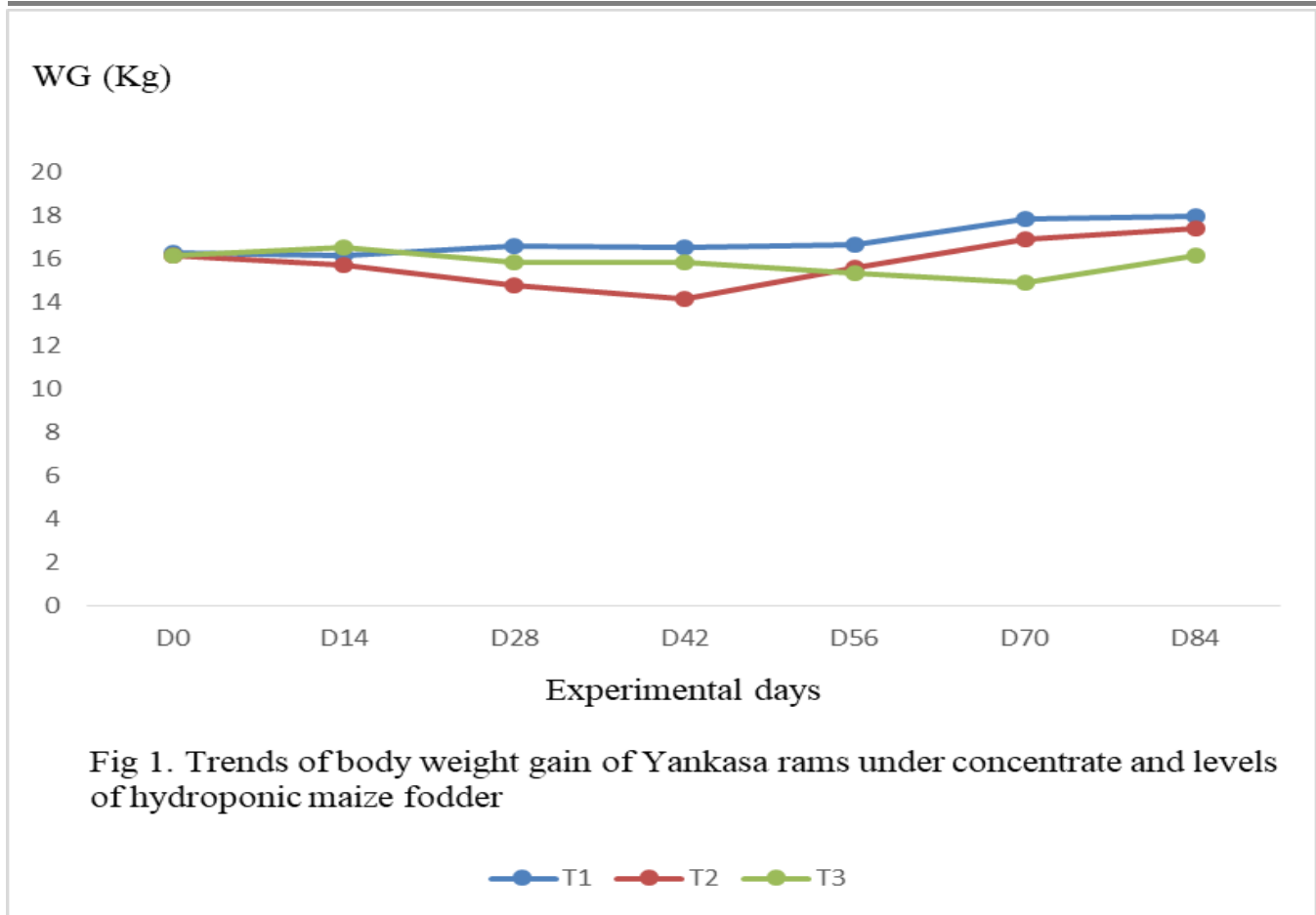
Table 4 presents the growth performance of Yankasa rams fed concentrate and varying levels of hydroponic maize fodder (HPMF). Growth performance was significantly ( $P < 0.05$ ) affected by diet. Rams on the control diet recorded superior final weight, weight gain, and daily gain, while 60% HPMF resulted in poor performance and continuous weight loss.

The trend of body weight changes during the experimental period is presented in Figure 1. Rams fed the farmers’ concentrate diet showed a consistent and progressive increase in body weight throughout the study. In contrast, rams fed the 30% HPMF diet experienced a decline in body weight up to day 42, after which a gradual recovery was observed towards the end of the experiment. However, rams fed the 60% HPMF diet exhibited a continuous decline in body weight throughout the experimental period.

**Table 4: Growth performance of Yankasa rams fed concentrate and levels of hydroponic maize fodder**

Parameters	Treatments			
	Control	30%	60%	SEM
Initial weight (kg)	16.26	16.14	16.15	4.833
Final weight (kg)	17.97 <sup>a</sup>	17.38 <sup>a</sup>	16.17 <sup>b</sup>	4.217
Weight gain (kg)	1.71 <sup>a</sup>	1.24 <sup>b</sup>	0.02 <sup>c</sup>	3.180
Daily weight gain (g/d)	19.00 <sup>a</sup>	13.78 <sup>c</sup>	0.22 <sup>b</sup>	0.0003
Total feed intake (kg)	0.80 <sup>a</sup>	0.77 <sup>b</sup>	0.85 <sup>a</sup>	0.0000
Daily feed intake (g/d)	490 <sup>b</sup>	470 <sup>c</sup>	520 <sup>a</sup>	0.0000
Feed conversion ratio	0.47 <sup>b</sup>	0.62 <sup>b</sup>	42.50 <sup>a</sup>	224.32

abc Values with the same superscript within rows are not significantly different ( $P < 0.05$ ). Control = farmers’ concentrate diet, 30% = 30% hydroponic maize fodder & 60% = 60% hydroponic maize fodder.



**Nutrient intake and digestibility of Yankasa rams fed concentrate and levels of hydroponic maize fodder**

Table 5 presents the nutrient intake of Yankasa rams fed concentrate and varying levels of hydroponic maize fodder. Nutrient intake and digestibility also varied significantly ( $P < 0.05$ ). The control diet had higher dry matter, ether extract, ash, and fibre intake, as well as better overall digestibility. However, crude protein intake increased with HPMF inclusion, peaking at 60%. Digestibility declined as HPMF increased.

Parameters	Treatments diets			
	Control	30%	60%	SEM
<b>Nutrient Intake (g/day)</b>				
Dry matter intake	372 <sup>a</sup>	220 <sup>b</sup>	173 <sup>c</sup>	0.0004
Crude protein intake	69 <sup>c</sup>	73 <sup>b</sup>	79 <sup>a</sup>	0.0004
Ether extract intake	31 <sup>a</sup>	14 <sup>b</sup>	15 <sup>b</sup>	0.0001
Ash intake	34 <sup>a</sup>	30 <sup>b</sup>	28 <sup>c</sup>	0.0004
Neutral-detergent-fibre intake	258 <sup>a</sup>	230 <sup>b</sup>	259 <sup>a</sup>	0.0007
Acid-detergent-fibre intake	173 <sup>a</sup>	133 <sup>b</sup>	124 <sup>c</sup>	0.0010
<b>Nutrient digestibility (%)</b>				
Dry Matter	57.18a	40.59b	35.55c	4.875
Crude Protein	63.36a	56.80b	49.83c	0.073
Crude Fibre	39.26	37.78	37.28	3.938
Nitrogen-free-extract	18.25	18.55	18.46	9.188
Neutral-detergent-fibre	34.43a	24.19b	21.31c	0.897
Acid-detergent-fibre	21.01c	27.48a	24.27b	0.891

abc Values with the same superscript within rows are not significantly different ( $P < 0.05$ ). control = farmers' concentrate diet, 30% = 30% hydroponic maize fodder & 60% = 60% hydroponic maize fodder.

## Nitrogen balance of Yankasa rams fed concentrate and levels of hydroponic maize fodder

Nitrogen balance of Yankasa rams fed concentrate and varying levels of hydroponic maize fodder is presented in Table 6. Nitrogen balance showed significant differences ( $P < 0.05$ ). The 30% HPMF diet had the highest nitrogen intake and balance, while the control diet had superior nitrogen retention efficiency. The 60% HPMF diet resulted in higher nitrogen losses and poorer utilization.

Parameters (g/day)	Treatments			
	control	30%	60%	SEM
N intake	11.65 <sup>c</sup>	14.67 <sup>a</sup>	14.40 <sup>b</sup>	0.159
Faecal N	6.06 <sup>b</sup>	9.34 <sup>a</sup>	9.83 <sup>a</sup>	0.420
Urinary N	0.84 <sup>a</sup>	0.53 <sup>b</sup>	0.44 <sup>b</sup>	0.028
N loss	6.89 <sup>c</sup>	9.87 <sup>b</sup>	10.27 <sup>a</sup>	0.452
N absorbed	5.59 <sup>a</sup>	5.32 <sup>b</sup>	4.57 <sup>c</sup>	0.817
N balance	4.75 <sup>b</sup>	4.80 <sup>a</sup>	4.13 <sup>c</sup>	0.863
N balance (%)	40.77 <sup>a</sup>	32.71 <sup>b</sup>	28.68 <sup>c</sup>	34.696

abc Values with the same superscript within rows are not significantly different ( $P < 0.05$ ). control = farmers' concentrate diet, 30% = 30% hydroponic maize fodder & 60% = 60% hydroponic maize fodder.

## DISCUSSION

### Chemical composition of hydroponic maize fodder (HPMF)

Hydroponic maize fodder (HPMF) showed potential as a supplementary feed for sheep, although with limitations. Its low dry matter (DM) reflects high moisture content, which may reduce voluntary intake and dilute nutrient concentration, necessitating supplementation with dry roughages or concentrates (NRC, 2007; McDonald *et al.*, 2011). The DM value was higher than (Telgote *et al.*, 2022) but lower than (Arif *et al.*, 2023).

Crude protein (CP) was within recommended levels for maintenance and close to lactation requirements, indicating its contribution to protein supply (NRC, 2007). This agrees with reports of moderate protein content in hydroponic fodders (Olorunnisomo, 2012). However, additional supplementation may be required during periods of higher physiological demand. The CP values were comparable to those reported by (Arif *et al.*, 2023) and (Telgote *et al.*, 2022).

Ether extract (EE), ash, and acid detergent fibre (ADF) were within acceptable limits, although EE was slightly lower than some reported values (Telgote *et al.*, 2022; Bhalerao *et al.*, 2019), while crude fibre (CF) was below recommended levels, suggesting the need for additional fibrous feeds to maintain rumen function (McDonald *et al.*, 2011). The CF value was comparable to (Adebisi *et al.*, 2022) but higher than values reported by (Telgote *et al.*, 2022, Bhalerao *et al.*, 2019), and (Naik *et al.*, 2012).

Nitrogen-free extract (NFE) and neutral detergent fibre (NDF) were relatively high, indicating good energy supply but potential limitations in intake due to bulkiness (Akinfala *et al.*, 2002). The NFE value was lower than those reported by (Telgote *et al.*, 2022) and (Bhalerao *et al.*, 2019), while NDF was higher and ADF slightly lower than values reported by (Arif *et al.*, 2023). Metabolizable energy (ME) was at the upper recommended range, confirming HPMF as an energy-rich supplement (NRC, 2007).

### Chemical composition of concentrate and levels of hydroponic maize fodder fed to Yankasa rams

Increasing inclusion of HPMF significantly reduced DM content due to its high moisture level (McDonald *et al.*, 2013). Crude protein increased, peaking at 30% inclusion, likely due to enzymatic changes during germination (Babayemi & Bamikole, 2006), and remained within adequate levels for ruminant production (NRC, 2007).

Fibre fractions (CF, NDF, and ADF) declined with increasing HPMF inclusion, reflecting the breakdown of structural carbohydrates during sprouting (AOAC, 2019; McDonald *et al.*, 2013), although values remained within acceptable limits (NRC, 2007).

Ether extract and ash showed slight reductions, possibly due to lipid utilization and nutrient redistribution during germination (Naik *et al.*, 2014; Fazaeli *et al.*, 2012). Conversely, nitrogen-free extract and metabolizable energy increased, indicating higher availability of soluble carbohydrates and improved dietary energy density (Dung *et al.*, 2010; NRC, 2007).

### **Growth performance of Yankasa rams fed concentrate and levels of hydroponic maize fodder**

Weight gain is a key indicator of feed utilization efficiency in animals. Growth performance was significantly affected by dietary treatments. Rams fed the control diet recorded higher final weight, total weight gain, and daily weight gain, likely due to better feed intake and nutrient utilization (Munza, 2021). This supports the importance of concentrate diets in improving growth (Ferdous *et al.*, 2011). Daily weight gain declined with increasing HPMF inclusion, particularly at 60%, indicating inadequate nutrient supply at higher inclusion levels without supplementation (Osita *et al.*, 2019). While rams on the control and 30% diets gained weight, those on 60% HPMF showed negligible growth, suggesting that high inclusion levels may only meet maintenance requirements. These values were lower than those reported in previous studies (Abu *et al.*, 2023; Teklehaymanot, 2019).

The crude protein content (>14%) of the diets indicates adequate quality for supporting rumen microbial activity. Variations in feed intake compared to earlier studies (Audu *et al.*, 2023; Garba *et al.*, 2021; Mbahi *et al.*, 2023). may be due to differences in breed, diet composition, and environmental conditions. Feed conversion ratio improved at moderate inclusion levels, suggesting better nutrient utilization at 30% HPMF. Hydroponic Maize Fodder enhanced performance at moderate inclusion but was less effective at high levels, confirming that its benefits are maximized when combined with concentrates (Naik and Singh, 2013; Bhalerao *et al.*, 2019; Adebisi *et al.*, 2018).

### **Nutrient intake and digestibility of Yankasa rams fed concentrate and levels of hydroponic maize fodder**

Nutrient intake is largely influenced by feed digestibility, with higher digestibility promoting increased intake (Detmann *et al.*, 2014). Nutrient intake and digestibility were significantly influenced by dietary treatments. Dry matter intake (DMI) declined with increasing HPMF inclusion, likely due to high moisture content, reducing intake substantially at higher inclusion levels (Naik *et al.*, 2014). DMI decreased by 40.86% and 53.49% at 30% and 60% HPMF inclusion levels, respectively. The observed DMI values were comparable to those reported by Sani *et al.* (2022). Crude protein intake increased with HPMF inclusion, with increments of 5.80% and 14.50% at 30% and 60% inclusion levels, reflecting improved protein supply, and remained within reported ranges (Yusuf *et al.*, 2022), though higher than those reported by (Sani *et al.*, 2022) and (Abubakar *et al.*, 2005). Variations in fibre and ash intake were consistent with literature and likely influenced by differences in diet formulation and environmental conditions. Ash intake values were also comparable to previous findings (Yusuf *et al.*, 2022).

Digestibility of dry matter and crude protein was highest in the control diet and declined with increasing HPMF inclusion, indicating reduced nutrient utilization (McDonald, 2013; Fajemisin *et al.*, 2012a). The DMD values (35.55–62.21%) were generally lower than those reported in similar studies (Atsbha *et al.*, 2021; Dan Abba, 2021; Udo *et al.*, 2021; Yakubu *et al.*, 2021), although comparable to some reports (Ezimoha and Nsidinya, 2021). Crude protein digestibility (CPD) followed a similar trend, with higher values observed in the control diet. The CPD range (49.83–68.02%) was slightly lower than values reported by (Abu *et al.*, 2023) and Abubakar *et al.* (2005). The higher CPD in the control treatment indicates more efficient protein utilization and supports the positive relationship between dietary protein level and digestibility (McDonald, 2002).

Fibre digestibility (CFD and NDFD) also decreased, although acid detergent fibre digestibility improved at moderate inclusion levels. The control diet showed higher CFD and NDFD by 3.92% and 42.33% (30% HPMF), and 5.30% and 61.56% (60% HPMF), respectively, while ADFD increased by 30.79% and 15.52% at 30% and

60% HPMF. Nitrogen-free extract digestibility was highest in the control diet, reflecting more efficient utilization of non-structural carbohydrates (Eniolorunda *et al.*, 2018). The control exceeded 30% and 60% HPMF treatments by 42.33% and 61.57%, respectively. Improved digestibility in the control group may be attributed to higher concentrate levels, which enhance rumen microbial activity and fermentation (Banerjee, 2009; Farghaly *et al.*, 2019).

### **Nitrogen balance of Yankasa rams fed concentrate and levels of hydroponic maize fodder**

Nitrogen balance was significantly influenced by dietary treatments and serves as an indicator of protein utilization (Babayemi and Bamikole, 2006). The control diet recorded higher nitrogen retention, indicating more efficient protein digestion and utilization (Hassan, 2014). Positive nitrogen balance reflects adequate intake and effective utilization for tissue deposition (Babayemi and Bamikole, 2006).

Higher nitrogen retention in the control group suggests improved digestion, absorption, and reduced nitrogen losses, supported by efficient rumen microbial protein synthesis (McDonald *et al.*, 2013; Okeniyi *et al.*, 2010; Foster *et al.*, 2009; Ahamefule, 2007). The higher nitrogen absorbed in the control group aligns with the findings of Jiwuba (2020), who reported that increased nitrogen absorption is indicative of positive nitrogen balance.

Faecal nitrogen losses were associated with undigested protein, while urinary nitrogen reflects excess ammonia excretion due to imbalanced energy–protein supply (Abu *et al.*, 2023).

Nitrogen retention values observed in this study were lower than those reported in some previous studies, (Abu *et al.*, 2023; Ahmed *et al.*, 2022; Yakubu *et al.*, 2021), likely due to differences in protein quality, intake levels, and nutrient bioavailability (Lamidi, 2009).

## **CONCLUSION**

In conclusion, Hydroponic maize fodder (HPMF) has potential as a supplementary feed for Yankasa rams due to its adequate crude protein content and high metabolizable energy. However, its low dry matter and fibre content limit its effectiveness when used at high inclusion levels. Increasing HPMF inclusion negatively affected growth performance, nutrient digestibility, and nitrogen utilization, particularly at 60%, where performance declined markedly. In contrast, moderate inclusion (30%) improved protein intake and feed utilization without severe adverse effects. The superior performance observed in the control diet highlights the importance of concentrate supplementation.

## **RECOMMENDATION**

Based on the findings, it is recommended that farmers in semi-arid region of Nigeria should consider incorporating hydroponic maize fodder in the diets of Yankasa rams. The specific levels of concentrate and hydroponic fodder should determine through cost benefit analysis, considering the local availability and price of both feeds resources. Therefore, it is recommended that hydroponic maize fodder (HPMF) should not be used as a sole feed but rather incorporated at moderate levels alongside conventional diets to optimize animal performance and nutrient efficiency.

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