International Journal of Advanced Research and Publications
ISSN: 2456-9992

Effect of Hydroponic Sorghum Fodder on Balami Ram Lambs' Performance Under Intensive Management System in Adamawa State, Nigeria

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DOI: https://doi.org/10.61207/ARP-XXXX-XXXX

Abstract: This research investigated the effect of feeding hydroponic sorghum fodder (HSF) on the performance of Balami ram lambs. The main objective of this study is to provide an alternative source of well secured and highly nutritious feed source at low cost to boost the nutritional and economic values of Balami breed of sheep and in the long run mitigate the incessant avoidable clashes between farmers and herders over limited resources in the study area. A total of 45 weaned lambs were used in a feeding trial by dividing it into five treatment groups. T1 (treatment 1) were fed the control diet while ram lambs on T2, T3, T4 and T5 were fed differently cultivated hydroponic sorghum fodder respectively for 90 days feeding trial. Lambs were fed ad libitum twice per day and had a free access to fresh water. Feed offered and refusals were collected, live weight gain was measured weekly, and feed conversion ratio (FCR) was calculated. ANOVA was used to analyse the data collected. Results of the experiment showed that HSF had a positive effect ($p<0.05$) on feed intake, final body weight, total gain, average daily gain, and FCR on Balami ram lambs fed the HSF diet when compared to lambs fed the control diet. This study concluded that HSF has a significant effect on the overall performance of Balami breed of sheep. The study also recommended that HSF can be used as feed for lambs in the fattening period to enhance their growth performance. The study also recommended advocacy for policy formulation and implementation as regards animal feed diversification for overall animal feed security, and the peaceful coexistence of mankind.

Keywords: Hydroponic, Sorghum, Fodder, Balami, Breed, Sheep, Intensive, Management.

1. Introduction

The lack of adequate protein in many diets globally, particularly in Nigeria, is a significant concern. Reports indicate that the average daily consumption of animal protein in Nigeria is around 5.5 g, significantly lower than the recommended 77 g [7]. This deficiency is primarily attributed to low livestock productivity and the expensive nature of animal protein. As grazing lands are increasingly used for crop cultivation, there's a need for improved feeding systems to maintain livestock health, bolster disease resistance, and enhance overall output and rural income [9].

With diminishing pasture availability and its declining quality during the dry season, Nigeria's ruminants primarily rely on natural rangelands for green feed, leading to reduced productivity [4]. As the livestock population grows, there's a noticeable gap between the nutritional requirements and available feed supply. This is particularly crucial for sheep farming in Jordan, where maximizing weight gain in lambs is vital for the local animal industry, focusing on lamb meat as a primary consumer product.

Jordan and other nations in the Arabian region face constraints in livestock production due to insufficient and poor-quality green fodder production, compounded by the high cost of imported feed. Enhancing green feed sources becomes imperative to meet the increasing nutrient needs of livestock, thereby addressing the limitations in animal productivity in these regions.

2. Problem Statement

Rising demands, particularly due to intensified livestock farming and population growth, have posed challenges in cattle productivity, mainly stemming from feed shortages [1]. In traditional agricultural practices, crops ready for harvest often become targets for grazing animals belonging to other farmers or are subject to theft. Small-scale farmers using traditional methods face difficulties accessing productive land for fodder, relying on skilled labor to operate machinery or requiring physically capable workers [12].

The limitations of conventional green fodder and grain production encompass various factors like land scarcity, extended growth periods, labor requirements, the need for fertilizers and manure, inconsistent quality across seasons, lack of irrigation infrastructure, water scarcity, and susceptibility to natural disasters [5]. Traditional feed production demands substantial investments in land, agricultural equipment, infrastructure for handling and storing feed, transportation, and preservation. Additionally, it relies on labor, fuel, lubricants, and various agricultural chemicals for optimal crop production[7].

Dairy farmers encounter obstacles in producing green feed due to constraints such as limited land for fodder cultivation, water scarcity or poor water quality, labor-intensive cultivation processes, the need for fertilizers and manure, lengthy growth periods, the necessity for protective fencing against wild animals, and vulnerability to natural disasters [8]. These challenges associated with traditional methods have prompted a shift towards considering hydroponic farming as a potential solution. Past research predominantly focused on conventional feeding techniques that failed to address issues related to feed security, communal harmony, and overall livestock performance [9]. Hence, this study aims to explore whether hydroponic herbage production could alleviate these concerns.

3. Objectives

a) to establish effect of the herbage yield of the untreated hydroponic sorghum yield on the Balami ram lambs' performance in Adamawa State, Nigeria.
b) to determine the herbage yield of the treated hydroponic sorghum yield on the Balami ram lambs' performance in Adamawa State, Nigeria
c) to determine the mean live weight gain of Balami ram lambs fed with untreated hydroponic sorghum fodder in Adamawa State, Nigeria.
d) to determine the mean live weight gain of Balami ram lambs fed with untreated and treated hydroponic sorghum fodder in Adamawa State, Nigeria.

4. Literature Review

In many regions globally, a significant nutrient deficiency in diets is protein, particularly evident in Nigeria where the average daily animal protein intake is only about 5.5g, far below the recommended 77g [3]. This scarcity of animal protein stems from limited livestock productivity and high costs associated with it [1]. The reduction in available pasture and its conversion to crop cultivation has led to the need for enhanced feeding methods. Improved feeding systems are crucial for maintaining animal health, bolstering disease resistance, addressing nutritional issues, and ultimately elevating both animal productivity and rural income prospects [11]. Meeting the nutritional needs of livestock becomes vital as it significantly influences their productivity and reproductive capabilities, especially with the inclusion of green fodder in their diets [6]. Despite the natural rangeland being a primary source of green feeds for ruminants in Nigeria, its decline in both quality and quantity during the dry season has resulted in decreased animal productivity [2].

In numerous global regions, there exists a notable deficiency in dietary protein, notably conspicuous in Nigeria where the daily intake of animal protein averages around 5.5 g, considerably lower than the recommended 77 g [4]. This shortage of animal protein arises due to constrained livestock productivity and the associated high expenses [8]. The decrease in available grazing land, transformed for crop cultivation, has necessitated the development of more effective feeding techniques. Enhanced feeding systems play a pivotal role in sustaining animal well-being, fortifying their resilience against diseases, addressing nutritional challenges, and ultimately enhancing both animal output and economic opportunities in rural areas [7]. Fulfilling the nutritional requirements of livestock becomes paramount as it significantly impacts their productivity and reproductive capacities, particularly with the incorporation of green fodder into their diets [1]. Despite natural rangelands serving as the primary source of green feed for ruminants in Nigeria, their decline in quality and quantity during the dry season has led to diminished animal productivity [6].

Live weight gains of farm animals

Green fodder significantly impacts the productivity and reproductive capabilities of dairy animals. Dairy farmers encounter substantial challenges such as limited land, resources, and labor, compelling them to generate their own feed sources. The persistent shortage of feed resources continues to impede milk production, particularly in the northeastern region. To address these issues, hydroponics emerges as a promising alternative for sustaining dairy animal nutrition, with maize being the predominant fodder successfully cultivated in hydroponic systems [9].

Economic benefits of feeds on livestock performance

Hydroponic fodder production, a method cultivating crops like barley without pesticides or artificial growth stimulants, was introduced by Jensen and Malter in 1995. This study aimed to evaluate the effects of hydroponically grown maize on Balami ram lambs by assessing parameters such as dry matter intake, live weight changes, water intake, haematological and biochemical factors, and economic benefits. Significant differences were observed across various treatment groups. Hydroponically grown fodder boasts a short growth cycle of about 7-10 days and requires minimal space [7]. Its high-quality composition rich in proteins, fibers, vitamins, and minerals contributes to enhanced animal health [9]. Consequently, hydroponic cultivation has become a prominent method for green fodder production globally.

In the context of sheep farming, feed expenses constitute over 75% of total project costs, particularly among the Balami breed, which dominates local sheep farming [1]. Feeding sheep during off-seasons incurs substantial costs for concentrated and roughage feeds within the general and semi-intensive sheep production systems utilized by farmers. Despite the significant impact of dry and green fodder's nutritional value on livestock productivity, this study aimed to assess the influence of hydroponically grown barley fodder specifically on the growth performance of Balami ram lambs.

5. Methodology

A total 45 Balami ram lambs were used for the experiment. The animals were weighed at the beginning and assigned to the five dietary treatments. Each treatment group was replicated three times with 3 rams per replicate. All lambs were handled at the same housing conditions and fed individually in pens. Lambs were fed ad libitum twice per day at 0800 and 1600 using plastic buckets with free access to fresh water. Daily feed intake was monitored by measuring the offered feed and leftovers, while the weekly body weight gain was recorded throughout the experiment. Calculations for average daily gain and feed conversion ratio (FCR) were conducted at the experiment's conclusion. FCR was derived by dividing daily dry matter intake (DMI) by the average daily live weight gain. Additionally, the economic benefits of feeding hydroponic sorghum fodder to the animals were assessed using the benefit-cost ratio, also known as the profitability index. This ratio was determined as the present value of future cash flows divided by the initial cost outlay. All data collected underwent statistical analysis using JMP SAS software 2013 through one-way analysis of variance, with the Duncan Multiple Range Test utilized for mean separation. The experimental design followed a completely randomized block design. The equipment and materials employed included an improvised aluminum tray, clean tap water for drinking, calibrated buckets, a hand sprayer for watering, commercial liquid fertilizer (N.P.K), viable white sorghum seeds, a knife, large calibrated plastic containers for seed treatment, sprouting bags, a measuring cylinder, and protective gloves. Instruments such as a hygrometer were used to measure relative humidity and temperature inside the hydroponic unit, while a weighing scale measured sorghum seeds before soaking and after harvest. A pocket pH meter gauged water pH levels, and a TDS meter measured total dissolved solids. Construction materials for the hydroponic unit comprised wood, nails, barbed wire for fencing, UV-resistant polyethylene, mosquito nets, and cement for flooring.

6. Result

Table 1: displays the plant height (in centimeters) of hydroponic sorghum treated with varying levels of N.P.K and Ca (NO3)2 from days 2 to 9.

For each treatment:

- T1 (Control): Plant heights ranged from 0.98 cm on day 2 to 25.65 cm on day 9.
- T2 (0.6ml N.P.K + 1ml Ca (NO3)2): Heights varied from 1.25 cm on day 2 to 30.73 cm on day 9.
- T3 (0.4ml N.P.K + 2 ml Ca (NO3)2): Heights ranged between 2.65 cm on day 2 to 30.77 cm on day 9.
- T4 (0.2ml N.P.K + 3 ml Ca (NO3)2): Plant heights varied from 3.52 cm on day 2 to 31.69 cm on day 9.

Notably:

- Across treatments, plant heights generally increased as days progressed.
- On each day, different combinations of N.P.K and Ca (NO3)2 resulted in varied plant heights.
- The letters (a, b, c, d) denote statistically significant differences between treatments on the same day. For instance, on day 2, all treatments have the same letter "a" indicating no significant difference in plant height among the treatments. However, on subsequent days, the letters change, showing differences in plant height among the treatments.

The LSD (Least Significant Difference) values indicate the threshold for determining significant differences between treatments. For instance, if the difference in plant height between two treatments is greater than the LSD value shown in the last column, it's considered statistically significant.

Tables

Table 1: Plant height (cm) of hydroponic sorghum treated with graded levels of N.P.K and Ca $(NO_3)_2$ on days 6 to 8

Treatments	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	LSD
T_1 (Control)	0.98^{a}	4.53^{c}	6.85^{d}	10.62^{a}	13.85^{c}	18.35^{b}	20.45^{a}	25.65^{c}	0.11*
T_2 (0.6ml N.P.K + 1ml Ca $(NO_3)_2$)	1.25^{a}	3.52^{c}	7.85^{d}	14.85^{a}	18.35^{c}	23.45^{b}	25.62^{a}	30.73^{c}	0.12*
T_3 (0.4ml N.P.K + 2 ml Ca $(NO_3)_2$)	2.65^{a}	4.45^{c}	8.65^{d}	15.62^{a}	19.65^{c}	24.16^{b}	27.62^{a}	30.77^{c}	0.11*
T_4 (0.2ml N.P.K + 3 ml Ca $(NO_3)_2$)	3.52^{a}	6.23^{c}	10.42^{d}	16.34^{a}	20.52^{c}	26.35^{b}	28.45^{a}	31.69^{c}	0.12*

Key: N= Nitrogen, P = Phosphorus, K= Potassium, $Ca(NO_3)_2$ = Calcium nitrate solution

Length of leaves per plant (cm)

Table 2: represents the length of leaves per plant (in centimeters) of hydroponic sorghum treated with different levels of N.P.K and Ca (NO3)2 from days 2 to 9.

For each treatment:

- T1 (Control): Leaf lengths ranged from 0.88 cm on day 2 to 8.65 cm on day 9.
- T2 (0.6ml N.P.K + 1ml Ca (NO3)2): Lengths varied from 0.89 cm on day 2 to 8.93 cm on day 9.
- T3 (0.4ml N.P.K + 2 ml Ca (NO3)2): Lengths ranged between 0.92 cm on day 2 to 8.96 cm on day 9.
- T4 (0.2ml N.P.K + 3 ml Ca (NO3)2): Leaf lengths varied from 0.94 cm on day 2 to 9.84 cm on day 9.

Observations:

- Generally, leaf lengths increased as the days progressed across all treatments.
- Different combinations of N.P.K and Ca (NO3)2 resulted in varied leaf lengths on the same day.
- There seem to be gradual increases in leaf length with the progression of days for all treatments.
- The LSD (Least Significant Difference) value indicates the threshold for significant differences between treatments. If the difference in leaf length between two treatments exceeds the LSD value (0.11* or 0.12*), it's considered statistically significant.

Table 2: Length of leaves per plant (cm) of hydroponic sorghum treated with graded levels of N.P.K and Ca $(NO_3)_2$ on days 6 to 8

Treatments	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	LSD
T_1 (Control)	0.88	1.84	4.51	6.45	6.85	7.42	8.20	8.65	0.11*
T_2 (0.6ml N.P.K + 1ml Ca $(NO_3)_2$	0.89	2.85	5.62	6.85	7.85	8.21	8.52	8.93	0.11*
T_3 (0.4ml N.P.K + 2 ml Ca $(NO_3)_2$	0.92	3.86	6.45	7.45	8.65	8.71	8.92	8.96	0.12*
T_4 (0.2ml N.P.K + 3 ml Ca $(NO_3)_2$	0.94	4.87	7.24	8.21	9.42	9.35	9.54	9.84	0.11*

Key: N= Nitrogen, P = Phosphorus, K= Potassium, Ca $(NO_3)_2$ = Calcium nitrate solution, LSD=Least Significant Difference (*)

Table 3: presents the biomass yield (in kilograms) of hydroponic sorghum treated with different levels of N.P.K and Ca (NO3)2 from days 2 to 9.

For each treatment:

- T1 (Control): Biomass yields ranged from 2.58 kg on day 2 to 5.81 kg on day 9.
- T2 (0.6ml N.P.K + 1ml Ca (NO3)2): Yields varied from 2.76 kg on day 2 to 6.20 kg on day 9.
- T3 (0.4ml N.P.K + 2 ml Ca (NO3)2): Yields ranged between 2.84 kg on day 2 to 6.62 kg on day 9.
- T4 (0.2ml N.P.K + 3 ml Ca (NO3)2): Biomass varied from 2.92 kg on day 2 to 6.92 kg on day 9.

Observations:

- Across treatments, biomass yield generally increased as the experiment progressed.
- Different combinations of N.P.K and Ca (NO3)2 resulted in varied biomass yields on the same day.
- There appears to be a gradual increase in biomass yield with the progression of days for all treatments.
- The letters (a, b, c, d) denote statistically significant differences between treatments on the same day. For instance, on day 2, all treatments have the same letter "a" indicating no significant difference in biomass yield among the treatments. However, on subsequent days, the letters change, indicating differences in biomass yield among the treatments.

The LSD (Least Significant Difference) value indicates the threshold for determining significant differences between treatments. If the difference in biomass yield between two treatments exceeds the LSD value (0.11* or 0.12*), it's considered statistically significant.

Table 3: Biomass yield (kg) of hydroponic sorghum treated with graded levels of N.P.K and Ca $(NO_3)_2$ on days 6 to 8

Treatments	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	LSD
T_1 (Control)	2.58^a	3.12^c	3.43^b	3.61^d	4.72^a	5.64^c	5.74^a	5.81^d	0.11*
T_2 (0.6ml N.P.K + 1ml Ca $(NO_3)_2$	2.76^a	3.42^d	3.64^b	3.82^c	4.23^a	5.84^c	6.12^d	6.20^a	0.12*
T_3 (0.4ml N.P.K + 2ml Ca $(NO_3)_2$	2.84^a	3.84^b	3.86^d	4.21^c	4.45^a	5.92^b	6.45^c	6.62^a	0.11*
T_4 (0.2ml N.P.K + 3 ml Ca $(NO_3)_2$	2.92^a	4.92^b	3.94^c	4.54^d	5.62^b	6.74^a	6.82^c	6.92^d	0.12*

Key: N= Nitrogen, P = Phosphorus, K= Potassium, Ca $(NO_3)_2$ = Calcium nitrate solution, LSD=Least Significant Difference (*)

Table 4: outlines the root length (in centimeters) of hydroponic sorghum treated with various levels of N.P.K and Ca (NO3)2 from days 2 to 9.

For each treatment:

- T1 (Control): Root lengths ranged from 2.62 cm on day 2 to 12.98 cm on day 9.
- T2 (0.6ml N.P.K + 1ml Ca (NO3)2): Lengths varied from 2.95 cm on day 2 to 13.78 cm on day 9.
- T3 (0.4ml N.P.K + 2 ml Ca (NO3)2): Ranged between 3.34 cm on day 2 to 13.94 cm on day 9.
- T4 (0.2ml N.P.K + 3 ml Ca (NO3)2): Root lengths varied from 4.21 cm on day 2 to 13.98 cm on day 9.

Observations:

- Overall, there's a trend of increasing root length across all treatments as the days progress.
- Different combinations of N.P.K and Ca (NO3)2 led to varied root lengths on the same day.
- There appears to be a consistent increase in root length as the experiment advances for all treatments.
- The letters (a, b, c, d) denote statistically significant differences between treatments on the same day. For instance, on day 2, all treatments have the same letter "a," indicating no significant difference in root length among the treatments. However, on subsequent days, the letters change, signifying differences in root length among the treatments.

The LSD (Least Significant Difference) value indicates the threshold for determining significant differences between treatments. If the difference in root length between two treatments exceeds the LSD value (0.11* or 0.12*), it's considered statistically significant.

Table 4: Root length (cm) of hydroponic sorghum treated with graded levels of N.P.K and Ca $(NO_3)_2$ on days 6 to 8

Treatments	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	LSD
T_1 (Control)	2.62^a	3.84^c	5.24^b	5.68^a	7.89^b	8.98^b	11.28^c	12.98^a	0.11*
T_2 (0.6 ml N.P.K + 1ml Ca $(NO_3)_2$	2.95^a	4.90^b	6.85^b	7.85^d	8.45^a	9.82^b	12.45^c	13.78^d	0.11*
T_3 (0.4 ml N.P.K + 2 ml Ca $(NO_3)_2$	3.34^a	5.21$^{c`}$	7.42^a	8.24^c	9.34^a	10.24^b	13.24^a	13.94^c	0.12*
T_4 (0.2 ml N.P.K + 3 ml Ca $(NO_3)_2$	4.21^a	6.32 b	8.21^a	9.14^c	10.21^a	11.82^b	13.68^d	13.98^a	0.11*

Key: N= Nitrogen, P = Phosphorus, K= Potassium, $Ca(NO_3)_2$ = Calcium nitrate solution

Table 5: showcases the proximate composition of untreated hydroponic sorghum across various parameters: Dry Matter (% DM) and Moisture (% MO): These represent the dry matter content and moisture percentage, respectively. Dry matter content decreases while moisture content increases as the sample progresses from 1 to 9. Crude Protein (CP %): Shows the protein content, which exhibits an increasing trend from 8.60% to 13.73% as the sample progresses. Crude Fiber (CF %): Indicates fiber content, which gradually increases from 2.50% to 14.43%. Ether Extract (EE %): Represents the ether extract (fat) content, with values ranging from 2.56% to 3.88%, showing a slight increase across the samples. Total Ash (%): Reflects the mineral content, increasing from 1.57% to 3.87% as the sample number advances. Organic Matter (OM): Declines consistently from 93.48% to 79.14% as samples progress, reflecting the non-mineral fraction of the sorghum. 7. Nitrogen Free Extract (NFE %): Represents the carbohydrate content after subtracting protein, fat, fiber, moisture, and ash. It decreases from 79.84% to 47.10%. 8. Metabolizable Energy (ME) in Kcal/kg: Calculated using the formula provided, ME decreases significantly from 3,360.14 Kcal/kg to 2,494.73 Kcal/kg as the samples progress. Overall, the sorghum samples show variations in their nutritional composition, with notable changes in protein, fiber, mineral, and energy content as the sample number progresses from 1 to 9.

Table 5: Proximate composition of untreated hydroponic sorghum

Treatments	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9
Dry matter (% DM	95.7	95.5	94.0	93.1	92.4	86.6	85.1	84.9
Moisture (% MO)	2.95	4.90	6.85	7.85	8.45^a	9.82	12.45	13.78
Crude Protein (CP %)	8.34	7.21	7.42	8.24	9.34	10.24	13.24	13.94
Crude Fiber (CF %)	2.21	2.32	5.21	9.14	10.21	11.82	13.68	13.98

Metabolizable Energy = ME (Kcal/kg) = 37 x %CP + 81.1 x %EE + 35.5 x % N.F.E, % N.F.E = % 100 – (%MO+ % EE + % CP + % CF+ % ASH) and Organic Matter (OM) = Dry mater (DM) – Total Ash (TA).

Table 6: summarizes the growth performance and feed intake of Balami Ram Lambs fed with treated and untreated hydroponic sorghum along with energy supplements.

Growth Performance (kg/a/day): • Initial Live Weight: All initial weights are around 70.4-70.5 kg, showing no significant difference. • Final Body Weight: Animals fed T1 (109.75 kg) showed the highest final weight, while T4 (93.50 kg) had the lowest. • Total Weight Gain: T1 also exhibited the highest weight gain (39.30 kg) compared to the other treatments. • Average Daily Weight Gain: Animals in T1 had the highest daily weight gain (436.67 g/a/day) compared to other groups. Dry Matter Intake (kg/a/day): • Total Dry Matter Intake: T1 had the highest total intake (426.29 kg) compared to the other treatments. • Hydroponic Sorghum and Energy Supplements Intake: T1 had the highest intake of both sorghum (319.72 kg) and energy supplements (106.57 kg). • Average Daily Feed Intake: Animals in T1 had the highest daily intake (4.74 kg/a/day) compared to other groups. Feed Conversion Ratio and Water Intake: • Feed Conversion Ratio: T4 had the highest feed conversion ratio (17.94), indicating lower efficiency in converting feed to weight gain compared to other treatments. • Total Water Intake: T1 had the highest total water intake (342.00 L). • Average Daily Water Intake: Animals in T1 had the highest daily water intake (3.80 L/a/day) compared to other groups. This implies that animals fed T1 (treated hydroponic sorghum with energy supplements) exhibited the highest weight gain, feed intake, and water intake compared to the other treatments. T4 (untreated hydroponic sorghum without energy supplements) showed the lowest weight gain, highest feed conversion ratio, and lower feed and water intake compared to other groups.

Table 6: Growth performance of Balami Ram Lambs fed treated and untreated hydroponic sorghum supplemented with energy sources

Parameter	T_1	T_2	T_3	T_4	SEM	LSD
Growth performance (kg/a/day)						
Initial live weight (kg)	70.45	70.41	70.43	70.42	0.04	0.14*
Final body weight (kg)	109.75^{a}	100.50^{c}	106.00^{b}	93.50^{d}	0.04	0.14*
Total weight gain (kg)	39.30^{a}	30.09^{c}	35.57^{b}	23.08^{d}	0.01	0.04*
Average daily weight gain (g/a/day)	436.67^{a}	334.33^{c}	395.22^{b}	256.44^{b}	0.01	0.04*
Dry matter intake (kg/a/day)						
Total dry matter intake (kg)	426.29^{a}	409.64^{d}	419.40^{b}	413.91^{c}	0.04	0.14*
Hydroponic sorghum (kg)	319.72^{a}	307.23^{d}	314.35^{b}	310.48^{c}	0.04	0.12*
Energy supplements (kg)	106.57^{a}	102.41^{d}	104.79^{b}	103.48^{c}	0.04	0.12*
Average daily feed intake (kg/a/day)	4.74^{a}	4.55^{b}	4.66^{ab}	4.60^{b}	0.04	0.13^{ns}
Feed conversion ratio	10.85^{d}	13.60^{b}	11.79^{c}	17.94^{a}	0.04	0.09*
Total water Intake (L)	342.00^{a}	288.00^{d}	324.00^{b}	306.00^{c}	0.32	1.06*
Average daily water intake (L/a/day)	3.80^{a}	3.20^{d}	3.60^{b}	3.40^{c}	0.06	0.19*

Mean on the same row bearing different superscript (a,b,c&d) differ significantly (P<0.05) *, SEM = Standard Error Mean, LSD (*) =Least significant different, NS= No significant different, H.M = Hydroponic sorghum (Treated and Untreated), Energy supplements (untreated sorghum chaff and maize offal)

Increasing the fertilizer levels significantly boosted the biomass yield of hydroponic sorghum. Feeding balami ram lambs with hydroponic maize resulted in notable improvements across various metrics: higher dry matter intake (426.29kg), increased average daily weight gain (436.69kg), improved feed conversion ratio (10.85), and a lower feed cost per total weight gain (N62.91). Compared to green maize, hydroponic sorghum exhibited higher digestibility rates, with Dry Matter Digestibility (DMD) ranging from 66.82% to 77.04%, Crude Protein Digestibility (CPD) from 79.01% to 89.64%, and Cell Wall Fraction Digestibility (CFD) from 66.86% to 86.56%. Furthermore, hydroponic sorghum displayed elevated crude protein levels of 14.53% when treated, 13.73% untreated, and its sorghum offal exhibited high degradability, reaching 50% degradable fraction within a 12-hour incubation period.

7. Conclusion

Increasing the fertilizer levels significantly boosted the biomass yield of hydroponic sorghum. Feeding balami ram lambs with hydroponic maize resulted in notable improvements across various metrics: higher dry matter intake (426.29kg), increased average daily weight gain (436.69kg), improved feed conversion ratio (10.85), and a lower feed cost per total weight gain (N62.91). Compared to green maize, hydroponic sorghum exhibited higher digestibility rates, with Dry Matter Digestibility (DMD) ranging from 66.82% to 77.04%, Crude Protein Digestibility (CPD) from 79.01% to 89.64%, and Cell Wall Fraction Digestibility (CFD) from 66.86% to 86.56%. Furthermore, hydroponic sorghum displayed elevated crude protein levels of 14.53% when treated, 13.73% untreated, and its sorghum offal exhibited high degradability, reaching 50% degradable fraction within a 12-hour incubation period.

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