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RESEARCH ARTICLE
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Influence of Fossil Shell Flour Diets Supplemented with Varying Inclusion Levels of Baobab Oilseed Cake on Water Intake and Growth Performance of Angora Goats

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ABSTRACT

The current study investigated the impact of fossil shell flour diets supplemented with varying inclusion levels of baobab oilseed cake on the growth performance and water intake of Angora goats. Twenty-four castrated Angora goats aged 5-6 months, weighing an average of 12.75±1.5kg, were kept in individual pens for 105 days of successive feeding, which included a 14-day adaptation period. Goats were randomly allocated to four dietary treatments: 0, 5, 10, and 15% baobab oilseed cake (n = 6) in a Completely Randomized Design. Fossil shell flour was fed at 4% across all four treatments. Each goat was offered an experimental diet of about 4% of its body weight at 08h00 daily. Goats were then released to graze on natural pasture at 10h00 and returned to their respective pens at 16h00 for 105 days of successive feeding. Average daily feed intake, average daily water intake, average daily weight gain, and feed conversion ratio were determined. Average feed intake increased linearly ($P<0.05$) across BOSC inclusion levels. Average daily weight gain increased linearly at 10% BOSC ($P<0.05$), with sharp quadratic increases at 0% (weeks 5–6), and at 5 and 15% BOSC (weeks 4-5) ($P<0.05$). Feed conversion ratio decreased linearly ($P<0.05$) in goats fed 5% BOSC throughout the trial, while goats fed 0% and 15% BOSC showed sharp quadratic declines ($P<0.05$) between weeks 4–5, and those fed 10% BOSC exhibited a quadratic decrease ($P<0.05$) between weeks 5–6. The average daily water intake was the same across all diets ($P>0.05$). Therefore, a fossil shell flour diet supplemented with 15% baobab oilseed cake significantly improved the ADFI and ADG of Angora goats without negatively affecting water intake. Thus, farmers could incorporate FSF diets with baobab oilseed cake to achieve maximal productivity in Angora goats.

Keywords: Angora goats, Average daily feed intake, Average daily weight gain, Feed conversion ratio, Water intake.

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INTRODUCTION

Ruminant livestock production is a fundamental component of agricultural economies, especially in sub-Saharan Africa (Madu et al., 2024). Smallholder farmers in this region contend with significant challenges, including inadequate feed resources, high input costs, and the escalating effects of climate change (Ikusika & Mpendulo, 2022; Teixeira et al., 2024). Consequently, there is a critical need to develop and implement innovative, sustainable, and locally sourced feed supplements to enhance production efficiency and bolster animal welfare. According to Mpendulo et al. (2020), water intake and growth performance are key physiological indicators of health and productivity, particularly in economically significant species such as the Angora goat (*Capra hircus*). Angora goats are highly prized for their mohair, a luxury fiber that makes a substantial contribution to the economies of countries like South Africa, Turkey, and the United States (Utaaker et al., 2021; Mthi et al., 2024). As with other ruminants, a balanced diet is essential for Angora goats to support their physiological functions, including fiber synthesis, reproduction, and overall growth (Utaaker et al., 2021). The central challenge lies in formulating cost-effective and sustainable diets that optimize these parameters while simultaneously minimizing environmental impact.

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Recent research has focused on alternative feed sources and supplements that can improve livestock performance (Ikusika et al., 2019). Fossil shell flour (FSF), a naturally occurring mineral supplement rich in calcium, silica, and other trace minerals, has been posited as a potential feed additive (Ikusika et al., 2019). It is recognized for its abrasive properties, which may aid in the control of internal parasites, and its high mineral content, which could contribute to skeletal development and general health (Mwanda et al., 2020; Ikusika & Mpendulo, 2023). The use of such natural supplements aligns with the increasing consumer demand for organic and natural animal products. Concurrently, baobab oilseed cake (BOSC), a byproduct of baobab oil extraction, has emerged as a promising feed supplement (Erwa et al., 2019). The baobab tree (*Adansonia digitata*) is indigenous to arid regions, and its byproducts are being extensively studied for their nutritional value. Baobab oilseed cake is a rich source of protein, fiber, and essential fatty acids, which can supply valuable energy and nutrients for ruminant growth and development (Chisoro et al., 2018; Shehu et al., 2021).

Despite the well-documented individual benefits of fossil shell flour and baobab oilseed cake, their combined physiological effects on Angora goats, specifically on water intake and growth performance, have not been thoroughly investigated. Water intake is intrinsically linked to feed consumption and overall metabolic efficiency; thus, any dietary supplement that affects it could significantly impact growth (Saho et al., 2020). Similarly, modifications to dietary composition can alter nutrient utilization, leading to improvements or declines in growth rate and body condition score (Bezuidenhout, 2025). Therefore, this study aims to evaluate the influence of diets containing fossil shell flour supplemented with varying levels of baobab oilseed cake on the water intake and growth performance of Angora goats. The findings will contribute valuable insights into sustainable and effective feeding strategies for mohair production, with the potential to enhance both animal welfare and economic viability for Angora goat farmers. It was postulated that the FSF diets supplemented with varying inclusion levels of BOSC significantly enhance the average daily water intake, average daily feed intake, average daily weight gain, and feed conversion ratio of Angora goats.

MATERIALS & METHODS

Study Site

The present experiment was undertaken at Driefontein Farm in the Karoo region of the town of Somerset East, a locality in South Africa's Eastern Cape (Smuts, 2012). The Driefontein farm lies along -32.23 S, 21.34 E (Smuts, 2012). The estimated altitude is 519 m above sea level. The farm experiences a dry winter and a rainy summer. Annual rainfall is approximately 660 mm, with temperatures of about 21°C. The area remains dry for 240 days, with a humidity level of approximately 35 percent. Driefontein Farm is dominated by the shrub *Pentzia incana* vegetation.

Goats Management, Feeding and Experimental Design

Twenty-four castrated Angora goats aged 5-6 months, weighing an average of 12.75±1.5kg, were kept in well-ventilated individual pens (1.5m x1.5m) in a Completely Randomized Design with a wooden floor for 105 days of successive feeding. Before the experiment commencement, goats were ear-tagged and treated against internal parasites using valbantel (dosage of 2 mL per 10 kg body weight). They were randomly allocated to each treatment (0, 5, 10, and 15% BOSC) with six replicates per treatment. The varying inclusion levels of BOSC form the four treatments. A 14-day adaptation period to experimental diets was allowed within 105 days of successive feeding. Goats were offered experimental diets of about 4% of their body weight daily as recommended by Nipane et al. (2023) at 08h00 and released for grazing at 10h00. The goats returned to the pens to access experimental diets at 16h00. Each goat was provided with fresh, clean water in its pen using graduated 8-liter buckets. To ensure accurate measurement of individual water intake, goats were not allowed access to drinking water while in the grazing camp. The experimental diets contained fossil shell flour at a 4% inclusion level across all four treatments tested, as recommended by previous studies to enhance performance and overall productivity in small ruminants (Ikusika et al., 2020). Table 1 below shows the experimental diet in each treatment. Table 2 illustrates the mineral composition of Fossil Shell Flour (FSF) and its quantity.

Table 1: The experimental diets for all four treatments of the current study

Ingredients (Kg)	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Maize	5.00	5.00	5.00	5.00
Soybean Meal	15.00	10.00	5.00	0.00
Molasses	5.00	5.00	5.00	5.00
Wheat bran	15.00	15.00	15.00	15.00
Lucerne	60.00	60.00	60.00	60.00
BOSC	00.00	5.00	10.00	15.00
Total	100.00	100.00	100.00	100.00
		Supplements (kg)		
Bone meal	1.00	1.00	1.00	1.00
Goat premix	5.00	5.00	5.00	5.00
Salt	0.25	0.25	0.25	0.25
Fossil shell flour	4.00	4.00	4.00	4.00

Abbreviation: BOSC stands for Baobab oilseed cake.

Table 2: The mineral composition of Fossil Shell Flour (FSF) and its quantity

Items	Quantity
Dry Matter (mg/kg)	930.000
Calcium (mg/kg)	4.000
CaO (calculated from Ca) (mg/kg)	5.500
Magnesium (mg/kg)	2.100
MgO (calculated from Mg) (mg/kg)	3.400
Potassium%	0.160
Copper (%)	0.003
Sodium (%)	0.092
Zinc (%)	0.012
Iron (%)	0.794
Manganese (%)	0.007
Phosphorus (as P2O5) (mg/kg)	400.000
Sulfate Sulfur (S)(mg/kg)	600.000
Aluminium (Al) (mg/kg)	700.000
Vanadium (V) (mg/kg)	43.80
Boron (B) (mg/kg)	23.00

Sourced from (Ikusika et al., 2020). CaO: Calcium Oxide; MgO: Magnesium Oxide.

Measurements

Feed Analytical Procedure

Dry matter (DM) of the feed and baobab oilseed cake was determined by oven-drying samples at 135 °C for 24 h (AOAC 930.15). Ash content was determined through a

muffle furnace at 550 °C for five hours (AOAC 938.08), and the difference between DM and ash gave organic matter (OM). Nitrogen (N) was analysed using the Kjeldahl method with selenium (Se) as a catalyst, and crude protein (CP) was calculated as N × 6.25. Gross energy (GE) was assessed by a bomb calorimeter (C200, IKA Works Inc., Germany). Ether extract (EE) was measured by weight loss after removal with diethyl ether in a Soxhlet apparatus for eight hours (AOAC 920.85). Table 3 and 4 show the results of this analysis.

Table 3: The proximate composition of Baobab oilseed cake

Nutrient	Quantity (%)
Dry Matter (%)	90.47
Moisture (%)	9.53
Organic Matter (%)	83.75
Crude Protein (%)	25.28
Crude Fiber (%)	12.88
Ether Extract (%)	5.92
Ash (%)	6.72
ADF (%)	25.23
NDF (%)	43.53
Total Nitrogen (%)	4.05
Starch (%)	16.42
Phosphorus (%)	0.07
Calcium (%)	0.79
Magnesium (%)	0.79
Sodium (mg/kg)	8.00
Copper (mg/kg)	12.00
Iron (mg/kg)	65.00
Manganese (mg/kg)	7.00

Abbreviations: ADF- Acid Detergent Fiber, NDF- Neutral Detergent Fiber.

Table 4: The chemical composition of the experimental diets of all four treatments

Ingredients	Experimental diets			
	0% BOSC	5% BOSC	10% BOSC	15% BOSC
DM (g/kg)	88.96	88.72	88.73	88.83
OM	79.68	79.88	79.95	79.52
Moisture	11.04	11.28	11.27	11.17
CP	13.34	12.91	12.67	11.57
EE	1.79	1.82	2.04	1.98
Ash	9.32	8.84	8.78	9.31
ADF	17.47	21.34	31.08	41.70
NDF	39.11	51.09	51.22	59.10
Nitrogen	2.13	2.07	2.03	1.85
Starch	10.68	10.02	10.62	9.79

BOSC: baobab oilseed cake.

Average Daily Water Intake

Water was offered using calibrated 8-liter buckets placed close to feed troughs. Water intake was measured daily at 08h00 by recording the water remaining in each bucket. Buckets were then refilled to their original level immediately after measurement, and the process was repeated the following day at the same time. Water loss due to evaporation was measured by placing an identical bucket filled with the same amount of water in a location where goats were not able to reach it (Mdletshe et al., 2015). Water intake for each goat was calculated by subtracting the water leftovers and evaporation loss from the 8 liters offered. Each goat's average daily water intake (ADWI) was computed weekly by dividing the total water intake for seven consecutive days by seven, across the 13 weeks of successive feeding.

Average Daily Feed Intake

Feed intake was determined by subtracting the feed leftovers from the feed offered the previous day, daily at 08h00. Feed offered to each goat was recorded, while orts were collected using bags for each animal (Ikusika et al., 2019). Sacks were placed under all feed troughs to collect spillages. Weights of orts and spillages were deducted from the total weight of the feed offered to each Angora goat to determine concentrate intake (Mdletshe et al., 2015). Angora goats were fed at 08h00 and weighed before grazing at 10h00. At 16h00, the goats were weighed again before they were returned to their pens. The weight difference was assumed to be pasture feed intake (Smith et al., 2021). The concentrate feed was added to pasture intake to determine the animals' actual feed intake and then divided by 7 days to calculate the average daily feed intake.

$$AVERAGE\ FEED\ INTAKE = \frac{Concentrate\ intake + Intake\ on\ pastures}{7\ days}$$

Average Daily Weight Gain

All 24 goats were weighed at the beginning and end of each week during the successive feeding periods. The average daily weight gain was determined by dividing the difference between the initial and final weight of that particular week by seven days (Mdletshe et al., 2015).

Feed Conversion Ratio

The FCR is determined by dividing average feed intake by average daily weight gain (Mpendulo et al., 2020). Lower FCR values indicate better feed efficiency, whereas higher FCR values reflect poorer feed utilization. Below is the formula.

$$FCR = \frac{Average\ daily\ feed\ intake}{Average\ daily\ weight\ gain}$$

Statistical Analysis

Data on the effects of varying inclusion levels of BOSC on the ADWI, ADFI, ADG, and FCR were analyzed using PROC MIXED of Statistical Analysis Software (SAS) (Version 9.3, 2010) for repeated measures. The PDIFF option of SAS was used to generate significant differences among least square means. The means were considered significantly different at $P \leq 0.05$. A regression analysis test was conducted to identify relationships among the inclusion levels of BOSC, average daily feed intake, average daily weight gain, and feed conversion ratio, as well as the successive weeks of feeding. The linear model used is as follows:

$$Y_{ijk} = u + M_i + W_k + (M+W)_{ijk} + E_{ijk};$$

Where:

Y_{ijk} = Observation (ADWI, ADG, FCR, ADFI)

U= Overall mean common to all observations

M_i = Effect of BOSC inclusion level

Wk= Effect of feed weeks.

$(M \times W)_{cjk}$ = Interaction between treatment and week

Eik= Random error for I and j=1, 2, 3, 4 and K=1

RESULTS

Proximate Composition of Diets and Baobab Oilseed Cake (BOSC)

Table 3 shows the proximate composition of baobab oilseed cake, while Table 4 shows the analyzed chemical composition of the experimental diet.

Water Intake and Growth Performance

Table 5 presents the results of the influence of FSF diets supplemented with varying inclusion levels of baobab

oilseed cake on Angora goats. The diets significantly affected average daily feed intake (ADFI), with the highest values observed at 5% and 15% BOSC inclusion levels (P<0.05). Average daily weight gain (ADG) was the lowest at 0% BOSC compared to diets supplemented with BOSC (P>0.01). The feed conversion ratio (FCR) of Angora goats had the lowest means at 0% up to 10% BOSC inclusion levels compared to other dietary treatments (P>0.01). Average daily water intake (ADWI), as well as initial and final weight, did not differ significantly (P>0.05) across all different inclusion levels of BOSC. However, the diets significantly affected total weight gain, with the highest total weight gain observed in goats fed 15% BOSC inclusion levels and the lowest in goats fed 0% BOSC (P<0.05).

Table 6 illustrates the relationship between growth performance parameters (ADFI, ADG, FCR) and various treatments with different inclusion levels of BOSC (T1 = 0%, T2 = 5%, T3 = 10%, T4 = 15%, respectively), alongside the results from successive weeks of feeding. Average daily feed intake showed a linear increase (P<0.05) in all BOSC inclusion levels over the feeding period. Goats fed 0% BOSC showed a sharp quadratic increase in ADG between weeks 5 and 6 (P<0.05), while those fed 5% and 15% BOSC showed a sharp quadratic increase between weeks 4 and 5 (P<0.05). Goats fed 10% BOSC inclusion level ADG increased linearly (P<0.05) across the feeding weeks. Feed conversion ratio showed a linear decrease (P<0.05) in goats fed 5% BOSC as the trial progressed, while goats fed 0% and 15% BOSC showed sharp quadratic declines (P<0.05) between weeks 4–5. Similarly, goats fed 10% BOSC exhibited a quadratic decrease (P<0.05) between weeks 5 and 6. Fig. 1 indicates that ADFI increased linearly with the advancing weeks of feeding for Angora goats across all treatments. Fig. 2 depicts the relationship between ADG and the 13 weeks of successive feeding in all four treatments. Fig. 3 illustrates a decrease in the FCR of Angora goats over the 13 weeks of the feeding trial across all treatment groups.

DISCUSSION

Growth performance is a crucial indicator of livestock productivity and is directly influenced by dietary composition. The study evaluated the effects of FSF-based diets supplemented with varying levels of baobab oilseed cake (BOSC) on average daily water intake (ADWI), average daily feed intake (ADFI), average daily weight gain (ADG), and feed conversion ratio (FCR) in Angora goats.

Average Daily Feed Intake

Average daily feed intake (ADFI) is a key parameter for determining growth performance, with numerous studies exploring how dietary composition affects livestock (Figueroa et al., 2020). The findings on the increase in ADFI over time (in weeks) align with those of Adeyemo & Longe (2007), who observed a rise in feed intake as the age (in weeks) of all broilers increased, all while being fed graded levels of cottonseed meal. The 15% inclusion group

Table 5: Effects of varying levels of BOSC on the growth performance of Angora goats

Parameters	Treatments (BOSC)				SEM ±	P-value
	0%	5%	10%	15%		
ADFI (Kg/d)	1.950^{b}	1.850^{b}	1.910^{b}	2.460^{a}	0.070	0.013
ADG (Kg/d)	1.280^{b}	1.380^{a}	1.350^{a}	1.520^{a}	0.020	<0.0001
Average daily water intake (L)	0.910	0.860	0.910	0.930	0.100	0.113
FCR	11.896^{b}	10.684^{b}	11.088^{b}	12.638^{a}	0.324	0.001
Initial weight (Kg)	11.670	11.000	12.000	12.080	1.860	0.220
Final weight (Kg)	18.250	17.170	18.170	18.000	1.220	0.330
Total weight gain (Kg)	5.170^{b}	6.170^{a}	6.170^{a}	6.330^{a}	0.310	0.011

Least square means within the same row bearing different superscripts differ significantly (P ≤ 0.05). Abbreviations: ADFI- average daily feed intake, SEM- standard error of mean, ADG - average daily weight gain, FCR – Feed conversion ratio, BOSC- Baobab oilseed cake.

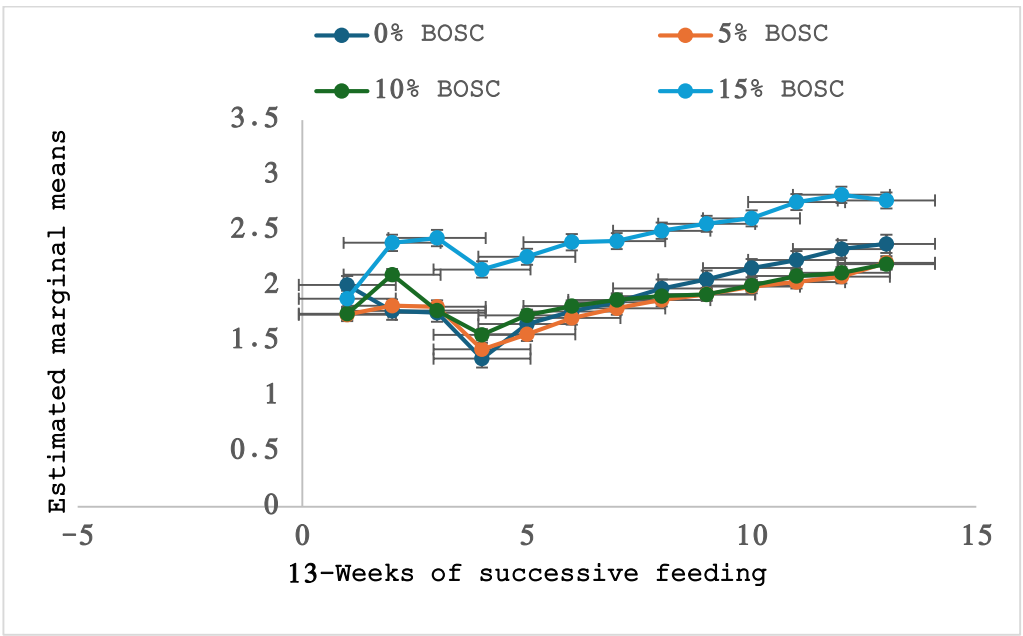

Fig. 1: The effect of different inclusion levels of BOSC on average daily feed intake of Angora goat wethers across 13 weeks of the feed trial.

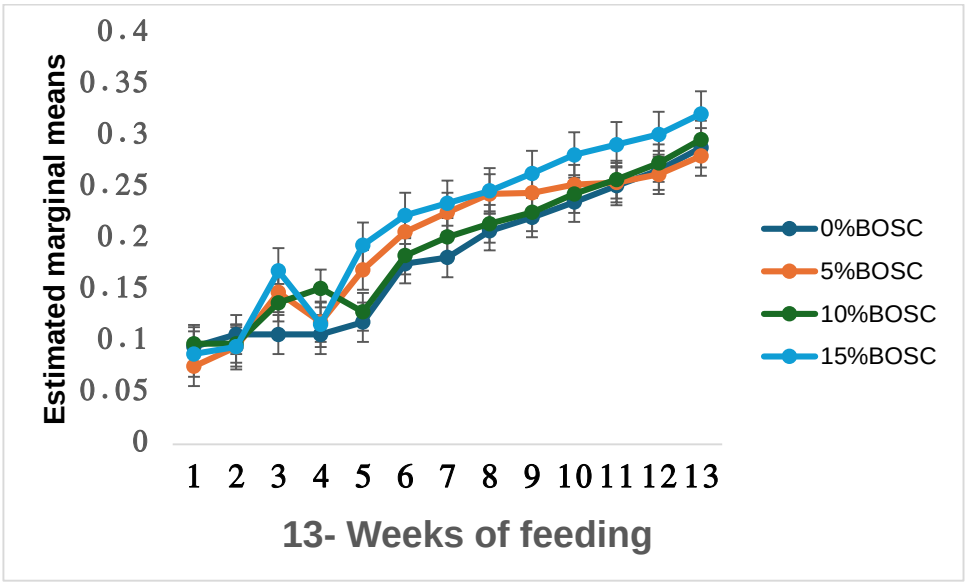

Fig. 2: The effect of different BOSC inclusion levels on average daily weight gain of Angora goat wethers across 13 weeks of the feed trial.

Table 6: Mean values of growth performance parameters of Angora goats fed diets containing different inclusion levels of BOSC over 13 weeks of successive feeding

Parameters	Diets (%)	Successive weeks of feeding													SEM	Contrasts		
		1	2	3	4	5	6	7	8	9	10	11	12	13		Linear	Quadratic	*Sig*
ADFI (kg/d)	0	2.009	1.774	1.758	1.342	1.654	1.769	1.852	1.977	2.058	2.161	2.235	2.334	2.381	0.132	0.002	0.071	**
	5	1.740	1.820	1.811	1.426	1.561	1.709	1.797	1.873	1.924	1.993	2.035	2.083	2.210	0.132	0.001	0.064	**
	10	1.748	2.102	1.776	1.558	1.734	1.817	1.873	1.908	1.923	2.004	2.089	2.119	2.198	0.132	0.016	0.680	*
	15	1.885	2.390	2.433	2.149	2.264	2.396	2.406	2.499	2.562	2.612	2.759	2.825	2.774	0.132	<.0001	0.140	**
ADG (kg/d)	0	0.095	0.107	0.107	0.107	0.119	0.176	0.182	0.208	0.221	0.236	0.252	0.267	0.289	0.074	0.009	0.009	**
	5	0.076	0.095	0.148	0.119	0.170	0.207	0.226	0.244	0.245	0.253	0.255	0.263	0.281	0.074	<.0001	0.014	**
	10	0.098	0.098	0.138	0.152	0.129	0.184	0.202	0.215	0.226	0.244	0.258	0.274	0.297	0.074	<.0001	0.303	**
	15	0.088	0.095	0.169	0.117	0.194	0.223	0.235	0.247	0.264	0.282	0.292	0.302	0.322	0.074	<.0001	0.002	**
FCR	0	21.147	16.579	16.430	12.542	13.899	10.051	10.176	9.505	9.312	9.157	8.869	8.742	8.239	1.294	<.0001	0.010	**
	5	22.894	19.158	12.236	11.983	9.182	8.256	7.951	7.676	7.853	7.877	7.980	7.980	7.865	1.294	0.0008	0.060	**
	10	17.837	21.449	12.870	10.250	13.762	9.875	9.272	8.874	8.509	8.213	8.097	7.734	7.401	1.294	<.0001	0.002	**
	15	21.420	25.158	14.396	18.368	11.670	10.744	10.238	9.915	9.705	9.262	9.449	9.354	8.615	1.294	<.0001	0.008	**

** means (P ≤ 0.01), * means P ≤ 0.05; Abbreviations: ADFI- average daily feed intake, SEM- standard error of mean, ADG - average daily weight gain, FCR – Feed conversion ratio, Sig –Significance.

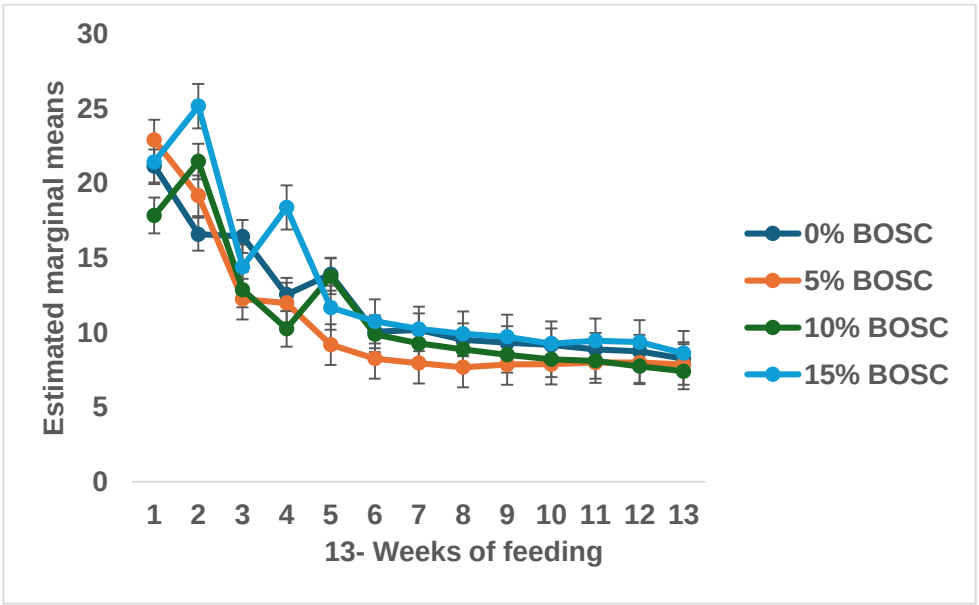

Fig. 3: The effect of different inclusion levels of BOSC on Angora goat wethers' average feed conversion ratio across 13 weeks of the feed trial.

consistently exhibited the highest feed intake throughout the 13-week trial, which is directly linked to the enhanced growth performance observed in this group. This finding aligns with previous research indicating that aroma and a pleasant smell can enhance feed intake by improving palatability and digestibility (Adedokun & Olojede, 2019; Chisoro et al., 2025). The increase in ADFI at the 15% BOSC level is likely attributable to the inherent palatability and appealing aroma of baobab oilseed cake, which is known to make feed more attractive to animals (Komwihangilo & Malago, 2021). In addition, the linear increase in ADFI suggests that the ingredient is highly palatable and does

not contain anti-nutritional factors that would otherwise deter consumption (Adedokun & Olojede, 2019). Pleasing aroma in baobab oilseed cake might also be attributed to vitamin C (15 times that orange) (Madu et al., 2024). The research findings suggest that a 15% BOSC inclusion level may be optimal for enhancing intake, possibly due to the pleasant aroma acting as an appetizer and stimulating feed intake. The results could also reflect the relative acceptability and palatability, as reported by Madu et al. (2024). These findings are consistent with Ikyume et al. (2018), Saho et al. (2020) and Madu et al. (2024), who reported a positive correlation between feed palatability and intake. Similarly, Ikyume et al. (2018) found that goat kids fed the highest level of baobab leaf supplementation had a greater feed intake compared to other dietary treatments. Furthermore, an increase in average feed intake in all levels of BOSC supplementation in the current study might also be associated with the quality of protein (22. 86% CP) present in baobab oilseed cake, which might be higher than the minimum of 70g/kg DM CP required to support optimal microbial activity in the rumen. This agrees with Tadesse et al. (2016), who reported that supplementing good protein feed might increase nitrogen availability in the rumen, thereby enhancing the feed's degradation rate and utilisation.

Average Weight Gain

Weight gain is a primary determinant of goats' market value and overall productivity (Bilal et al., 2025). The Angora goats in this study exhibited an increase in ADG across all dietary treatments from week six to the end of the trial. Notably, weight patterns were inconsistent during the initial five weeks, possibly due to the goats' adaptation to a new environment and diet. This initial struggle to adapt could be linked to the documented weak immune systems of Angora goats (Mazinani & Rude, 2020; Nair et al., 2021) and their historical grazing habits in open Karoo regions, which contrasts with the confined setting (Beinart, 2018). Furthermore, the freezing weather conditions during the early weeks of the trial may have negatively impacted performance, as Sacchero et al. (2023) reported that Angora goat weight gain worsens in cold environments. These findings on ADG align with the findings of Agboola (2012), who also reported variations in ADG values over successive feeding weeks in West African Dwarf sheep. The ADGs were linearly and quadratically increasing ($P<0.05$) in all the treatments except for the 10% BOSC inclusion level. This finding is contrary to the results obtained by Saho et al. (2020), who reported no significant difference ($P>0.05$) in goats fed varying levels of BOSC compared to a crossbred goat over a 9-week consecutive period. This could be due to the different composition of the feed ingredients used. Moreover, Saho et al. (2020) conducted their research during the summer. In addition, the present findings disagree with those of Madu et al. (2024), who reported that baobab seed meal maintained goats' body weights ($P>0.05$) without any adverse effects. The difference may arise from the use of BOSC in the present study, which likely has a reduced oil content and altered nutrient composition compared to seed meal. These compositional differences may have reduced nutrient availability and influenced animals' weights. However, the results of this present study were corroborated by the report of Agboola (2012), who reported significant ($P<0.05$) differences in daily gain in WAD rams fed a diet with 25% baobab bark inclusion. Furthermore, the results observed on ADG in the current study were within the acceptable range of 29 to 51 g/day reported for Small East African goats (Wallie et al., 2012).

Feed Conversion Ratio

The feed conversion ratio (FCR) is a key metric for evaluating the efficiency with which an animal converts feed into body weight (Thabethe et al., 2022; Ogbuewu & Mbajiorgu, 2023). Good quality feed generally has a relatively low feed conversion ratio and high feed conversion efficiency. Davison et al. (2023) reported that the lower the FCR, the less the feed an animal utilises to produce a unit of body weight. The feed conversion ratio (FCR) is inversely proportional to body weight, with increased body weight resulting in a lower FCR. The study findings showed a linear decrease ($P<0.05$) in FCR across all inclusion levels from week six onwards, indicating improved feed efficiency as the trial progressed. The current results are consistent with the observed increase in ADG. Notably, the 10% BOSC dietary treatment resulted in the lowest FCR, suggesting its potential for enhancing feed utilisation in Angora goats. This indicates that goats on the 10% BOSC diet were more efficient at converting feed into body weight than other groups. These results align with the report of Inayat & Salim (2005), who reported a lower FCR in the diet with a 10% BOSC inclusion level. In addition, the result aligns with Ikyume et al. (2018), who observed an enhanced FCR in West African Dwarf goats fed baobab oilseed cake-supplemented diets over time. However, the results in this study contradict the report of Yakubu et al. (2024), who reported the lowest FCR in goats on a 0% baobab diet. The improved FCR over time suggests that the positive effects of BOSC became more pronounced as the goats adapted to their diet, leading to enhanced digestion and nutrient utilization. This could be attributed to the rich composition of essential fatty acids and fiber in BOSC, which are known to improve nutrient absorption.

Average Daily Water Intakes

Adequate water intake is crucial for the digestion and absorption of nutrients (Yirga et al., 2018). Increased water intakes usually encourage goats to eat more feed (Ikusika et al., 2019). Findings from this study showed that average daily water intake (ADWI) did not differ significantly ($P = 0.113$) across the BOSC inclusion levels, which may be attributed to the diets' similar dry matter content and nutrient composition. These results contrast with Ikusika et al. (2019), who reported that Dohne Merino sheep on a 0% FSF diet had the highest ADWI compared to those on a 4% FSF diet. The discrepancy may result from the BOSC supplementation in the current study, which was not included in the experimental diets of Ikusika et al. (2019).

Conclusion

This study demonstrates that dietary supplementation with Baobab Oilseed Cake (BOSC) can significantly enhance the growth performance of Angora goats. The most notable improvements in average daily feed intake and average daily weight gain were observed in Angora goats fed a diet supplemented with 15% BOSC. Furthermore, the 10% BOSC inclusion level resulted in the most favourable feed conversion ratio, indicating superior conversion of feed to body mass at this specific inclusion level. These findings suggest that baobab oilseed cake can be effectively utilised as an alternative protein source in the diets of Angora goats, offering a viable strategy for farmers aiming to maximise animal productivity. However, to further validate these results and broaden their applicability, it is recommended to replicate this experiment under different environmental conditions, particularly during the summer season, to assess the effects of climatic variations on the observed outcomes.

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