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EFFECTS OF SOURSOP (*Annona muricata*) LEAF MEAL ON GROWTH PERFORMANCE AND SEMEN CHARACTERISTICS OF RABBIT BUCKS

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ABSTRACT

The increasing search for natural feed additives with growth-promoting and reproductive-enhancing potentials in livestock production has necessitated the evaluation of soursop (*Annona muricata*) leaves, known for their rich phytochemicals and medicinal properties, as a dietary supplement for rabbit bucks. This study investigated the effects of soursop (*Annona muricata*) leaf meal on growth performance and semen characteristics of adult rabbit bucks. Sixty mixed-bred rabbit bucks of 20 weeks, with an average weight of 7.1–2.0 kg were acclimatized for two weeks and randomly assigned into five dietary treatments containing 0, 100, 200, 300, or 400 g/kg of soursop leaf meal for 8 weeks. Each treatment consisted of 4 rabbits, replicated 3 times. Growth performance and semen characteristics were evaluated, and data were analysed using one-way ANOVA, with means separated by Duncan's Multiple Range Test ($p < 0.05$). The proximate analysis of *A. muricata* leaves revealed 9% moisture, 11% crude protein, 4% crude fat, 18% crude fibre, 10% ash, and 48% carbohydrate. Rabbits fed the 200 g/kg diet showed superior growth performance with the highest final weight, weight gain, feed intake, and best feed conversion ratio (FCR = 7.16). Rabbits fed 400 g/kg diet exhibited superior semen quality, with the highest semen volume (0.33 ml), sperm count (544.44 × 10^6 ejaculate^1), active motility (82.22%), viability (86.67%), and normal morphology (86.67%), with reduced sluggish motility (7.22%), abnormal morphology (13.33%), and dead sperm cells (10.56%). Soursop leaf meal is nutritionally valuable, improves growth and feed conversion in rabbit bucks at 200 g/kg inclusion, while semen quality is improved most at a higher inclusion level of 400 g/kg.

Keywords: phytobiotics, reproductive traits, feed efficiency, growth promoters, motility, nutrient utilization, rabbit nutrition

INTRODUCTION

Traditional medicine, especially plant-based remedies, has long served the health needs of both humans and animals. In Africa and Asia, medicinal plants comprise nearly 95% of traditional preparations because they are affordable, accessible, and trusted for their therapeutic effects (Gude, 2023; Ozioma & Okaka, 2019). These plants are rich in minerals, vitamins, fatty acids, and phytochemicals that help minimize oxidative stress, a condition closely linked with reduced reproductive efficiency (Shakoor *et al.*, 2021). Antioxidant-rich plants have been shown to protect against toxicants, improve fertility, and support animal productivity (Uno *et al.*, 2017; Zeweil *et al.*, 2023).

One such plant of growing interest is soursop (*Annona muricata*), valued for its high vit-

amin, mineral, and antioxidant content. Its phytochemicals, such as quercetin, luteolin, and acetogenins, possess strong antioxidant and anti-inflammatory properties (Muthu & Durairaj, 2015; Abd-Ella & Mohammed, 2016). Previous studies have associated soursop extracts with enhanced growth, improved reproductive performance, and increased resistance to oxidative stress in animals (Jimoh *et al*., 2018; Coria-Téllez *et al*., 2018).

Rabbit production is crucial in Nigeria as a cheap and efficient source of animal protein. Rabbits are highly prolific, fast-growing, and able to utilize fibrous feed, making them ideal for resource-limited farmers (Biobaku & Oguntona, 2017; Taiwo *et al*., 2019). However, production is often constrained by heat stress, which reduces semen quality and reproductive performance through oxidative damage (Jimoh & Ewuola, 2018; Attia *et al*., 2020). Antioxidants have been shown to alleviate these effects by preserving sperm DNA and membrane integrity (Alahmar, 2019).

Despite the known benefits of fruits as antioxidants, little is documented on the impact of soursop leaf meal on rabbit growth, and semen quality. This study therefore investigated the effects of dietary inclusion of soursop (*Annona muricata*) leaf meal on growth performance and semen characteristics of rabbit bucks.

MATERIALS AND METHODS

Experimental Site

This study was carried out at the Rabbitry Section of the Teaching and Research Farm of the Department of Animal Science, Faculty of Agriculture, Rivers State University, Nkpolu-Oroworokwo, Port-Harcourt, Rivers State. The farm is situated at an elevation of about 20 m above sea level and is located at the Northern wing of the school campus. Port-Harcourt is in the South-South region of Nigeria, characterized by a tropical climate with temperatures ranging from about 26^{0}C – 28^{0}C with significant rainfall in most months of the year, with a short dry season. February is the warmest month of the year, with an average temperature of about 27.6^{0}C, while August is the coolest, with an average temperature of about 25.2^{0}C . Average annual precipitation is approximately 2708 mm. Port-Harcourt is situated on latitude 4º48'N and longitude 6 º58'E (Uko *et al.,* 2016).

Collection and Processing of *A. murata* Leaf meal

A. Murata leaves were harvested manually from the Crop Section of the Rivers State University Teaching and Research Farm, Nkpolu- Oroworokwo, Port-Harcourt and sorted to remove insects, dead leaves and woody stems. The leaves were spread on a mat in a room with average temperature of 26^{0}C to air dry for three weeks, making them crispy. Afterwards, the leaves were weighed into separate containers and milled into powder form using an electric blender machine. The *A. Murata* leaf meal was mixed with grower's feed and fed to the rabbit bucks (Table 1).

Table 1: Experimental Diets Containing *A. murata* Leaf Meal (ALM)

Ingredient (g/100 kg)	Diet 1 (0% ALM)	Diet 2 (5% ALM)	Diet 3 (10% ALM)	Diet 4 (15% ALM)	Diet 5 (20% ALM)
Maize	45.00	42.50	40.00	37.50	35.00
Wheat Offal	20.00	20.00	20.00	20.00	20.00
Soybean Meal	15.00	15.00	15.00	15.00	15.00
Groundnut Cake	10.00	10.00	10.00	10.00	10.00
Fish Meal	3.00	3.00	3.00	3.00	3.00
Bone Meal	2.00	2.00	2.00	2.00	2.00
Salt	0.50	0.50	0.50	0.50	0.50
Premix	0.50	0.50	0.50	0.50	0.50
A. murata Leaf Meal	0.00	5.00	10.00	15.00	20.00
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Experimental Animals and Management

A total of Sixty (60) mixed bred bucks of 20 weeks of age, with an average weight of 1.7-2.0 kg were used for this study. The bucks were procured from Phenix Farm in Rivers State. Prior the arrival of the bucks, the hutches were cleaned and disinfected. Upon arrival, the rabbits were administered multivitamins to mitigate transportation stress. The rabbits were acclimated to their new environment for 2 weeks, during which they were fed with commercial grower's mash and had access to clean drinking water *ad libitum*. The rabbits received prophylactic dose of Ivermectin (Ivomec injection) to prevent mange and gastrointestinal nematodes, as well as coccidiostat and broad-spectrum antibiotics against bacterial and viral infections. Thereafter, the bucks were weighed to obtain their initial body weight and randomly assigned to five treatment groups, each with four (4) rabbits in three (3) replicates. The five treatments were: T_1 (control, 0 g/kg *A. muricata* leaf meal), T_2 (100 g/kg *A. muricata* leaf meal), T_3 (200 g/kg *A. muricata* leaf meal), T_4 (300 g/kg *A. muricata* leaf meal), and T_5 (400 g/kg *A. muricata* leaf meal).The rabbits were housed in wooden cages in a Completely Randomized Design (CRD). Feeders, drinkers and other necessary housing requirement were provided. Good sanitary and environmental conditions were maintained while water and feed were provided *ad libitum* throughout the 10-week study.

Data Collection

Data were collected on the following parameters:

Growth Performance:

The animals were weighed at commencement of the experiment and weekly thereafter. Feed intake data were taken daily. The animals were weighed weekly, using a weighing scale. Final body weight was taken at termination of the study, following the methods of Ogbuewu *et al.* (2009) and Nuhu (2010).

Semen Collection and Analysis:

Semen was collected between 9:00 am and 10:00 am at the end of the experiment. A doe was used to tease the bucks and then

semen collected using an artificial vagina. Each ejaculate was evaluated for quality parameters including: semen colour, pH, live and dead sperm, sperm motility, sperm count, semen volume and viability as described by Herbert and Adejumo (1995).

Proximate Composition of Soursop Leaf Meal:

Proximate analysis of soursop leaf meal to determine moisture, crude protein, fat, ash, fibre and total carbohydrate content was carried out in triplicates according to standard methods (AOAC, 2006).

Statistical Analysis

Data obtained were statistically analyzed using the One-Way Analysis of Variance (ANOVA) technique. Where significant differences existed, means were separated using the Duncan's Multiple Range Test (DMRT) of SAS (version 16.0), as described by Duncan (1955).

The linear model used for the analysis was:

$X_{ij} = \mu + T_i + E_{ij}$

Where:

X_{ij} = Value of observation made on each rabbit (jth receiving the ith treatment level

μ = Population mean common to all observations receiving all the treatment levels

T_i = Treatment effect; effect of the ith treatment (i=1,2,3,4,5)

E_{ij} E_{ij} = Error mean

RESULTS

The soursop leaf meal had: 9.00% moisture content, 11.00% crude protein, 4.00% crude fat, 18.00% crude fibre, 10.00% ash and 48.00% carbohydrate content (Table 2).

Table 2: Proximate Composition (%) of Soursop (*Annona muricata*) Leaf Meal

Nutrients	Quantity (%)
Moisture	9.00
Crude protein	11.00
Crude fat	4.00
Crude fibre	18.00
Ash	10.00
Carbohydrate content	48.00

Growth Performance

Significant differences due to treatment effects were observed in all the parameters evaluated except initial weight, which ranged from 1188.89 ± 96.39 g to 1355.56 ± 123.73 g with no significant difference (Table 3). For final weight, rabbits fed 200 g/kg Soursop Leaf Meal (SLM) had the highest weight (2155.56 ± 129.22 g) which was significantly higher than all other treatments. The control group (T1) had the lowest final weight (1600.00 ± 133.33 g). A similar pattern was observed for weight gain, where 200 g/kg SLM treatment recorded the highest gain (966.67 ± 123.60 g), (722.22 ± 126.69 g) and (611.11 ± 67.59 g). The control group showed the least weight gain (244.44 ± 29.40 g). Weekly weight gain and daily weight gain followed the same trend, with rabbits fed 200 g/kg SLM showing the highest values (120.83 ± 15.45 g/week and 17.26 ± 2.21 g/day respectively), which were significantly higher than from other groups. Feed intake also differed significantly among treatments. Total feed intake was highest with rabbits fed 200 g/kg

SLM (6035.56 ± 361.81 g), followed by rabbits fed 300 g/kg SLM (5600.00 ± 333.27 g) and rabbits fed 400 g/kg SLM (5506.67 ± 319.93 g). The control (T1) recorded the least feed intake (4480.00 ± 373.33 g). Similar significant trends were observed for daily feed intake. It was highest in rabbits fed 200 g/kg SLM: 107.78 ± 6.46 g/day and weekly feed intake was highest in rabbits fed 200 g/kg SLM: 754.44 ± 45.23 g/week. The feed conversion ratio (FCR) was best (lowest) in rabbits fed 200 g/kg SLM (7.16 ± 0.96), indicating superior feed utilization efficiency. In contrast, the poorest FCR, which was the highest value (19.67 ± 2.25) was from the control group (Table 3).

Table 3: Growth Performance of Rabbit Bucks Fed Diets Containing Soursop Leaf Meal

Parameters	T1 (0 g/kg)	T2 (100 g/kg)	T3 (200 g/kg)	T4 (300 g/kg)	T5 (400 g/kg)
Initial weight (g)	1355.56 ± 130.29	1311.11 ± 141.86	1188.89 ± 96.39	1277.78 ± 170.60	1355.56 ± 123.73
Final weight (g)	1600.00 ± 133.33^{d}	1744.44 ± 131.35^{cd}	2155.56 ± 129.22^{a}	2000.00 ± 119.02^{b}	1966.67 ± 114.26^{bc}
Weight gain (g)	244.44 ± 29.40^{d}	433.33 ± 66.67^{cd}	966.67 ± 123.60^{a}	722.22 ± 126.69^{ab}	611.11 ± 67.59^{bc}
Weekly weight gain (g/week)	30.56 ± 3.68^{d}	54.17 ± 8.33^{cd}	120.83 ± 15.45^{a}	90.28 ± 15.84^{ab}	76.39 ± 8.45^{bc}
Daily weight gain (g/day)	4.37 ± 0.53^{d}	7.74 ± 1.19^{cd}	17.26 ± 2.21^{a}	12.90 ± 2.26^{ab}	10.91 ± 1.21^{bc}
Total feed intake (g)	4480.00 ± 373.33^{c}	4884.44 ± 367.78^{bc}	6035.56 ± 361.81^{a}	5600.00 ± 333.27^{ab}	5506.67 ± 319.93^{abc}
Daily feed intake (g/day)	80.00 ± 6.67^{c}	87.22 ± 6.57^{bc}	107.78 ± 6.46^{a}	100.00 ± 5.95^{ab}	98.33 ± 5.71^{abc}
Weekly feed intake (g/week)	560.00 ± 46.67^{c}	610.56 ± 45.97^{bc}	754.44 ± 45.23^{a}	700.00 ± 41.66^{ab}	688.33 ± 39.99^{abc}
Feed conversion ratio	19.67 ± 2.25^{a}	13.94 ± 2.82^{b}	7.16 ± 0.96^{c}	8.99 ± 1.20^{bc}	9.97 ± 1.40^{bc}

a, b, c, d – Values within the same row with different superscripts differ significantly ($p < 0.05$).

Semen Characteristics

Significant differences were observed in all the parameters evaluated except semen pH, which remained constant across all treatments (8.00 ± 0.00) – Table 4. Semen volume increased significantly with increasing dietary SLM inclusion, with the highest volume recorded in rabbits fed 400 g/kg SLM (0.33 ± 0.02 ml) and the lowest from the control group (0.06 ± 0.02 ml). Sperm count followed a similar trend, increasing progressively from the control treatment rabbits with 127.78 ± 30.17 × 10^{6}/ejaculate to 544.44 ± 42.04 × 10^{6}/ejaculate, with rabbits fed 400 g/kg SLM being significantly higher than from all other treatments. Active sperm motility improved with increasing SLM inclusion, reaching the highest value from rabbits fed 400 g/kg SLM (82.22 ± 2.22%). Sluggish motility decreased progressively from control treatment (10.56 ± 0.56%) to rabbits fed 400 g/kg SLM (7.22 ± 0.88%). Sperm viability was significantly influenced by dietary treatments, increasing from 53.33 ± 3.91% in control treatment to 86.67 ± 2.04%. Sperm morphology showed a similar improvement with normal sperm morphology increasing from 53.33 ± 3.91% (control treatment) to 86.67 ± 2.04% (rabbits fed 400 g/kg SLM), while abnormal morphology decreased from 44.44 ± 2.69% in control treatment to 13.33 ± 2.04% in

rabbits fed 400 g/kg SLM. The proportion of dead sperm cells also reduced significantly, with increasing levels of SLM, from 43.89 ± 3.71% in control treatment to 10.56 ± 1.55% in rabbits fed 400 g/kg SLM (Table 4), suggesting that SLM positively affected sperm cell integrity.

Table 4. Semen Characteristics of Rabbit Bucks Fed Soursop Leaf Meal

Parameters	T_1 (0g/kg)	T_2 (100g/kg)	T_3 (200g/kg)	T_4 (300g/kg)	T_5 (400g/kg)
Semen volume (ml)	0.06 ± 0.02^{d}	0.14 ± 0.01^{c}	0.24 ± 0.01^{b}	0.30 ± 0.02^{ab}	0.33 ± 0.02^{a}
Sperm count (x 10^6 ejaculate^{-1})	127.78 ± 30.17^{d}	200.56 ± 22.74^{cd}	305.56 ± 28.19^{bc}	411.11 ± 53.86^{b}	544.44 ± 42.04^{a}
Active motile (%)	46.11 ± 3.71^{d}	58.89 ± 2.17^{c}	71.67 ± 1.67^{b}	77.22 ± 2.52^{ab}	82.22 ± 2.22^{a}
Sluggish motile (%)	10.56 ± 0.56^{a}	10.00 ± 0.00^{a}	9.44 ± 0.56^{a}	8.89 ± 0.74^{ab}	7.22 ± 0.88^{b}
Viability (%)	53.33 ± 3.91^{c}	65.00 ± 2.21^{c}	76.67 ± 1.67^{b}	81.67 ± 2.21^{ab}	86.67 ± 2.04^{a}
Normal morphology (%)	53.33 ± 3.91^{d}	65.00 ± 2.21^{c}	76.67 ± 1.67^{b}	81.67 ± 2.21^{ab}	86.67 ± 2.04^{a}
Abnormal morphology (%)	44.44 ± 2.69^{a}	33.89 ± 1.82^{b}	23.33 ± 1.67^{c}	18.33 ± 2.21^{cd}	13.33 ± 2.04^{d}
Dead sperm (%)	43.89 ± 3.71^{a}	31.11 ± 2.17^{b}	18.33 ± 1.67^{c}	13.89 ± 2.00^{cd}	10.56 ± 1.55^{d}
Semen pH	8.00±0.00	8.00±0.00	8.00±0.00	8.00±0.00	8.00±0.00

Values within each row with different superscripts differ significantly at $P<0.05$.

DISCUSSION

The proximate composition of soursop (*Annona muricata*) leaf meal in this study reveals that carbohydrates constitute the largest portion, supporting earlier findings that highlight their role as a significant energy source (Onwuka & Ehiem, 2019). The crude fibre content obtained is consistent with the report of Oduro *et al.* (2020), who emphasized the importance of fibre in digestion and nutrient regulation. The moderate protein content aligns with the observations of Ajayi *et al.* (2018), indicating that soursop leaves can serve as a valuable protein supplement in animal feed. Similarly, the ash fraction suggests adequate mineral supply, corroborating the findings of Onwuka and Ehiem (2019). Crude fat content was comparable to levels found in other leafy materials (Mensah *et al.*, 2021), and the relatively low moisture content reflects good preservation qualities, which minimizes spoilage risk (Oduro *et al.*, 2020).

Although the observed values are largely consistent with these reported studies, slight variations were noted when compared with those of Chukwu *et al.* (2017), who reported slightly higher crude fibre and lower crude protein. Such differences may be attributed to environmental factors (soil type, rainfall, sunlight), harvest stage (mature vs. young leaves), and processing methods (air-drying vs. oven-drying), all of which can influence nutrient composition. These variations, however, do not alter the overall interpretation of the findings of the soursop leaf meal which remains a rich source of energy, pro-

tein, and minerals suitable for inclusion in rabbit diets.

The growth performance of rabbits improved significantly with dietary inclusion of soursop leaf meal in this study. The best results were observed at 200 g/kg, which enhanced body weight, weight gain, feed intake, and feed conversion ratio. This finding is consistent with Oloruntola *et al.* (2018), who attributed such improvements to bioactive compounds that enhance nutrient absorption. However, performance declined at higher inclusion levels, likely due to anti-nutritional factors, as suggested by Fasuyi and Akindahunsi (2019). Similarly, Alagbe and Hassan (2019) reported that plant extracts improve growth at moderate levels but may hinder performance when used excessively. Feed intake peaked with rabbits fed 200 g/kg SLM, implying better palatability and nutrient availability (Aduku & Olukosi, 2020), although higher inclusion reduced intake, possibly due to the presence of tannins or alkaloids (Oladunjoye & Ojebiyi, 2020). The feed conversion ratio was most efficient with rabbits fed 200 g/kg SLM, reflecting optimal nutrient utilization, consistent with Oloruntola *et al.* (2019). In contrast, Akinmutimi and Onwukwe (2016) observed poor feed conversion with excessive leaf inclusion, reinforcing the importance for balanced supplementation.

This study further revealed that soursop leaf meal inclusion enhanced reproductive traits in rabbit bucks. Semen volume and sperm count increased with inclusion level, supporting earlier works that link plant antioxidants with improved reproductive outcomes (Ajao *et al.,* 2020; Yakubu *et al.,* 2017). Motility, viability, and normal morphology are also improved. This is consistent with reports by Oyeyemi *et al.* (2022), Raji *et al.* (2015), and Ajala and Lamidi (2016), respectively. These effects may be attributed to antioxidants reducing oxidative stress and promoting spermatogenesis. However, some studies (Obianime & Roberts, 2019; Agbaje *et al.,* 2018) caution against excessive supplementation, which can impair fertility. Sperm cells mortality decreased significantly, consistent with Fawole *et al.* (2019), while semen pH remained unaffected, in line with Bolarinwa *et al.* (2021).

CONCLUSION AND RECOMMENDATIONS

This study has demonstrated that soursop (*Annona muricata*) leaf meal is nutritionally valuable, containing significant amounts of carbohydrates, fibre, protein, and minerals. Moderate supplementation, up to 200 g/kg in diets of rabbit bucks significantly enhances growth indices, while inclusion at 400 g/kg improves serum quality.

Based on these findings, the following recommendations are made:

1. Moderate inclusion of soursop leaf meal at 200 g/kg in diets of rabbit bucks is recommended for optimal growth outcomes.
2. For enhanced semen quality in rabbit bucks, a dietary inclusion of 400 g/kg soursop leaf meal is recommended.

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