EFFECTS OF RAISING WEST AFRICAN DWARF GOATS WITH GRADED LEVELS OF *PROSOPIS AFRICANA* POD MEAL IN MUBI, ADAMAWA STATE

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DOI: https://doi.org/10.70382/caijaat.v11i1.013

Supported by Tertiary Education Trust Fund

ABSTRACT

A study was conducted to determine the effects of raising West African dwarf goats (WAD) using graded levels of Prosopis africana pod meal. Thirty (30) WAD goats with an average weight of 8.70 kg were used. The experiment was conducted in a completely randomized design of six treatment replicated five times (6x5). Six diets were formulated to contain 0%, 5%, 10%, 15%, 20%, and 25% levels of Prosopis africana pod meal and designated as TI, TII, TIII, TIV, TV and TVI, respectively. Data were taken on growth performance (initial live weight-ILW, final body weight- FBW, total body weight- TWG, average daily wight gain- ADG, daily feed intake- DFI and feed conversion ratio- FCR), nutrient digestibility (dry matter digestibility- DMD, crude protein digestibility-CPD, crude fibre digestibility-CFD, ether extract digestibility-EED and nitrogen free extract digestibility - NFD) and thermos-physiological responses (rectal temperature- RT, respiratory rate- RR, pulse rate- PR and skin temperature-ST). The trial lasted for a period of 82 days. Data collected were analyzed using SPSS 25.0 for windows. Significant means were separated using Duncan multiple range comparison test. Result of growth performance revealed that FBW, ADG, TWG, DFI and FCR were highly significantly ($P<0.001$) different among the various levels of Prosopis africana pod meal, while ILW was not affected. Results of nutrient digestibility of the WAD goats showed that, DMD, CPD, CFD, EED and NFD were highly significantly ($P<0.001$) different among the various levels. Result of thermos-physiological responses of the goats depicted that RR and PR were ($P<0.001$) highly affected by the levels of Prosopis africana pod meal, while RT and ST were not significantly different. It could be concluded and recommended that; since 5%–15% inclusion range gave better results in terms of growth performance, nutrient digestibility and thermos-physiological responses than higher inclusion levels (20% and 25%) which resulted in decline of these parameters be recommended as feed resource for enhancing small ruminant production.

Key words: Prosopis africana, WAD goats, Levels, Performance, Nutrient Digestibility

INTRODUCTION

Goat production is a vital component of livestock farming in Nigeria, particularly in Adamawa State (Idowu *et al*., 2023; Shua *et al.,* 2024). West African Dwarf (WAD) goats are a popular breed in the region due to their adaptability to tropical environments and ability to thrive on low-quality feed (Adeyinka & Ahmed, 2007). However, one of the major constraints facing goat production in Nigeria is the scarcity and high cost of conventional feed resources (Njidda *et al.,* 2013). The high cost of feed is a significant challenge for smallholder farmers, who are the primary producers of goats in the country.

Prosopis africana is a leguminous tree that is widely distributed in tropical Africa (Aregheore, 2007; Oluwafemi *et al*., 2021)). The pods of the tree are rich in protein (with about 25.27 % to 32.27 %) and can be used as a valuable feed resource for livestock (Adeosun & Omotayo, 2023). According to Njidda *et al*., 2013), *Prosopis africana* pods can be used to improve the nutritional status of grazing animals.

Evaluating growth performance of WAD goat helps determine the effectiveness of *Prosopis africana* pod meal as a feed supplement in promoting animal growth and productivity (Adeyinka & Ahmed, 2007). Growth performance is a key indicator of animal health and productivity, and measuring it can help identify optimal feeding strategies (McDonald *et al.*, 2011). Nutrient digestibility helps determine the nutritional value of *Prosopis africana* pod meal and its potential to meet the nutritional needs of West African Dwarf goats (Njidda *et al*., 2013). Nutrient digestibility is essential for evaluating the efficiency of feed utilization and minimizing waste (Aregheore, 2007). Thermo-physiological response is an important indicator of animal welfare, and measuring it can help evaluate the impact of *Prosopis africana* pod meal on heat stress and overall animal comfort (Aregheore, 2007). Heat stress can significantly impact animal productivity and health, and measuring thermo-physiological response can help identify strategies to mitigate its effects (Jiwuba & Ikwunze, 2023).

Statement of the Problem

Smallholder goat production is a vital component of livestock farming in Nigeria, particularly in Adamawa State (Devendra, 2010). However, one of the major constraints facing goat production in the region is the scarcity and high cost of conventional feed resources (Njidda *et al.,* 2013). *Prosopis africana* pod meal has been identified as a potential feed resource for livestock in tropical regions due to its high nutritional value (Aregheore, 2007).

Despite its potential benefits, there is limited information on the optimal levels of *Prosopis africana* pod meal supplementation and its effects on the performance, nutrient digestibility, and thermo-physiological response of West African Dwarf (WAD) goats in Mubi, Adamawa State. This knowledge gap hinders the adoption of *Prosopis africana* pod meal as a feed supplement in goat production, potentially limiting the productivity and welfare of goats in the region.

Objectives of the Study

The study was designed to archive the following objectives:

i. To evaluate the effects of feeding graded levels of *Prosopis africana* pod meal on the performance (Daily weight gain, final weight gain, total weight gain, daily feed intake, total feed intake and feed conversion ratio) of WAD goats in Mubi, Adamawa State.

ii. To determine the nutrient digestibility (Organic matter, dry matter, crude protein, neutral detergent fibre, acid detergent fibre, crude fibre, either extract, ash) of WAD goats fed graded levels of *Prosopis africana* pod meal.

iii. To assess the thermo-physiological response (Temperature, pulse rate and respiratory rate) of WAD goats raised with graded levels of *Prosopis africana* pod meal.

iv. To determine the optimal level of *Prosopis africana* supplementation in WAD goats

The study area

The study was conducted at the Federal Polytechnic Mubi Teaching and Research Farm Mubi, Adamawa State. Adamawa State is located in the North Eastern part of Nigeria, lying between latitudes 7^0 and 11^0N of the equator and between longitudes 11^0 and 14^0E of the Greenwich Meridian. The state shares border with Taraba State in the South and West, Gombe State in the Northwest and Borno State to the North. It has an international border with Cameroon Republic along its Eastern border. Adamawa State covers a land mass of 38,741 km^2 with a population of 3,166,101 inhabitants based on the 2006 census (Ajawara, 2007). Mubi lies on latitude 10^0 16′ 8″ N and and longitude 13^0 16′ 14″ E of Greenwich meridian (Anonymous, 2015). Mubi region is bordered to the North by Borno State to the West by Hong and Song LGAs and to the South and East by the Republic of Cameroon. It has a land area of 4,728,77 km^2 and human population of 151,000 going by 2006 census figure (Adebayo, 2004; Ajawara, 2007).

Animals and their Management

Thirty (30) West African Dwarf goats approximately seven to nine months old were used for the trial. The animals were purchased from Mubi cattle market and neighbouring villages. The animals were quarantined for a period of two weeks during which they were given prophylactic treatment. The animals were treated against ecto and endo parasites using Diazinon and Albendazol (2.5 % oral suspension) respectively. Whilst in quarantine, the animals were vaccinated against *Pestes des Petits Ruminants* (PPR), 0.5 mls/animal were administered subcutaneous at the neck region. Oxytetracycline LA (broad spectrum antibiotics) was administered. Rectal temperatures, respiratory rates and pulse rate were taken during the quarantine. They were provided with clean drinking water *ad libitum.* Animals were housed in individual pens (4 x 6 feet or 1.22 x 1.83 m) made up of concrete floors and with sufficient ventilation. At the end of the quarantine, animals were identified with plastic ear tags carrying threedigit numbers (Shua *et al.*, 2011). The experiment lasted for a period of 82 days between May/June to August.

Experimental Diets and Animal Feeding

Six diets were formulated using maize bran and *Prosopis africana* pod meal at graded levels with other fixed ingredients. The supplements are designated as TI (0% PPM- control), TII (5 % PPM), TIII (10 % PPM), TIV (15% PPM), TV (20 % PPM) and TVI (25 % PPM). The supplement was offered to the goats based on their body weight. The supplement was offered in the morning around 7:00 am. They were allowed to consume the feed for one and half hour (7:00 to 8: 30 am). By 10:00 am, left-over feed was collected and weighed to determine supplement intake. The basal diets were offered to the animal until another day. Clean drinking water was provided *ad libitum* throughout the duration of the experiment. Ingredient composition of the experimental diets is shown in Table 1.

Experimental Design

The experiment was conducted in a completely randomized design of six (6) treatments replicated five (5) times -6 x 5 (Steel and Torrie, 1980).

Data collection

Data was collected on the following parameters:

Growth performance

The animals and the left-over feed were weight using hanging 200kg and digital scale, respectively. Live weight changes were determined by subtracting initial weight from the final weight of the experimental animals on weekly basis. Voluntary feed intake of the animals was determined by subtracting left-over feed from the quantity offered per day. Feed consumption and weight gained were used to compute the Feed Conversion Ratio (FCR).

Thermo-physiological Indices

The thermo-physiological indices were determined according to the methods described by Okoruwa *et al*. (2013). Rectal temperatures, respiratory rate and pulse rate of the animals was measured at the onset of the experiment and weekly thereafter in the morning (before feeding) and four hours after feeding throughout the experimental period. Rectal temperature was taken on each animal using a digital thermometer. The sensory tip was disinfected and inserted into the rectum, at the display of L^0C by the thermometer (indicating that the thermometer is set for temperature reading). This was removed after the sound of alarm signal. The displayed body temperature will then be recorded. Respiratory rate was determined by counting the number of abdominal movements per minute, while pulse rate was determined for each animal by placing the finger tips on the femoral arteries of the hind limb for one minute and read from the stop watch

Digestibility studies

At the end of the feeding trial animals were allotted to individual metabolic cages designed for separate collection of faeces. The animals were allowed ten days adjustment period to the conditions of the metabolic crates before commencement of the digestibility study which lasted for seven days. Known weights of the experimental diets were offered daily and water was given *ad libitum*. Daily feacal outputs was collected and weighed and 5% of each day's collection was stored. This was later bulked and taken to the laboratory for proximate (AOAC, 2010), neutral detergent fibre and acid detergent fibre analysis (Van Soest, 1994).

Chemical analysis

All samples of feeds and faeces were analyzed for proximate composition using the procedures described by (AOAC, 2010). The fibre fractions were determined according to (Van Soest 1994).

IJAAT: **E-ISSN 3027-2521 P-ISSN 3027-026X**

Data Analysis

Data collected was subjected to standard ANOVA procedures using the software package SPSS 25.0 (2017) for Windows. Treatment means were separated using Duncan multiple range test at 5% level of significance (DUNCAN, 1955).

RESULTS AND DISCUSSION

Growth Performance of West African Dwarf Goats Fed Diets Containing *Prosopis africana* Pod Meal

The growth performance of West African Dwarf goat fed graded levels of *Prosopis africana* pod meal is shown in Table 2. The result showed that all the performance parameters measured were significantly ($P<0.001$) different among the various levels of *Prosopis africana* pod meal except for initial live weight that was not affected. The significant means for the parameters were recorded by 5-15% level of inclusion. Goats on diets containing 5–15% inclusion recorded higher weight gain and average daily gain compared with the control diet. The highest final body weight and average daily gain were observed in goats fed the 10% inclusion level (TIII). This suggests that moderate inclusion of *Prosopis africana* pod meal improved nutrient utilization and feed palatability. However, goats fed higher levels (20–25%) recorded reduced growth performance and poorer feed conversion ratio, possibly due to increased fibre and the presence of anti-nutritional factors such as tannins in the pods (Shua *et al.,* 2024).

The improvement in weight gain at moderate inclusion levels agrees with the findings of. Akinmutimi (2004), who reported that moderate inclusion of alternative plant feed resources can improve growth performance of small ruminants when they replace conventional ingredients at optimum levels. Similarly, Adu & Akinsoyinu (1990), reported that the inclusion of browse legumes and pods in goat diets can enhance feed intake and growth due to improved nutrient diversity.

The reduction in performance at higher inclusion levels is consistent with the report of Ayuk (2009), observed that excessive inclusion of fibrous pods in ruminant diets may decrease growth performance due to reduced digestibility and the presence of anti-nutritional compounds. The feed conversion ratio values obtained in this study also fall within the normal range reported for growing West African Dwarf goats under tropical feeding conditions.

Nutrient Digestibility of West African Dwarf Goats Fed Diets Containing *Prosopis africana* Pod Meal

The nutrient digestibility of the goats is presented in Table 3. The results revealed that all the digestibility parameters measured were significantly ($P<0.001$) affected by the levels of *Prosopis africana* pod meal. Goats fed diets containing 10% *Prosopis africana* pod meal recorded the highest digestibility coefficients for dry matter, crude protein, and nitrogen-free extract. This indicates that moderate inclusion levels enhanced nutrient utilization in the animals. The improvement in digestibility could be attributed to the ability of goats to efficiently digest fibrous feed materials through microbial fermentation in the rumen.

However, digestibility values declined slightly as the inclusion level increased beyond 15%. This may be associated with higher levels of fibre and secondary plant metabolites, particularly tannins, which can interfere with protein digestibility and microbial activity in the rumen. These findings agree with the

work of Makkar (2003), who reported that moderate levels of tannin-containing feed resources may improve rumen efficiency but excessive levels can reduce nutrient digestibility. Similarly, Van Soest (1994) noted that high dietary fibre concentration often reduces digestibility due to limitations in rumen microbial breakdown of structural carbohydrates.The digestibility values obtained in this study fall within the range previously reported for goats fed agro-industrial by-products and browse plants in tropical environments (Aregheore, 2000).

Thermo-Physiological Responses of West African Dwarf Goats Fed Diets Containing *Prosopis africana* Pod Meal

The thermo-physiological response of the West African Dwarf goats is shown in Table 4. The result revealed that, respirator rate and pulse rate were highly significantly ($P<0.001$) affected, while rectal temperature and skin temperature were not affected. All the thermos-physiological parameters measured remained within the normal physiological ranges for goats. This suggests that the experimental diets did not impose severe physiological stress on the animals. Goats fed diets containing 10–15% inclusion levels showed slightly lower respiratory and pulse rates, indicating better metabolic comfort and adaptation to the diet (Akinmutimi, 2004).

However, goats fed higher inclusion levels (20–25%) showed slight increases in rectal temperature and respiratory rate. This could be attributed to increased metabolic effort required to digest higher fibre diets or the possible effects of anti-nutritional factors present in the pods (Marai *et al.,* 2007).

These findings are consistent with the observations of Ayo (1998), who reported that thermo-physiological parameters in goats are influenced by diet composition and environmental conditions. Likewise, Brown-Brandl (2005) noted that goats are well adapted to tropical climates and can maintain stable body temperature when fed appropriate diets, provided that the feed does not significantly impair metabolic processes. The physiological parameters recorded in this study indicate that the inclusion of *Prosopis africana* pod meal up to 15% in the diet is safe and does not adversely affect the health status of West African Dwarf goats (Marai *et al.,* 2007).

CONCLUSION

This study evaluated the effects of graded levels of *Prosopis africana* pod meal in the diets of West African Dwarf goats. The results obtained from growth performance, nutrient digestibility, and thermo-physiological responses indicated that the inclusion of *Prosopis africana* pod meal influenced animal performance. The results demonstrate that *Prosopis africana* pod meal can serve as a viable alternative feed ingredient in goat diets when included at moderate levels. The study therefore concludes that 10–15% inclusion of *Prosopis africana* pod meal in goat diets optimizes growth performance, nutrient digestibility, and physiological stability in West African Dwarf goats.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made:

i. *Prosopis africana* pod meal can be included in the diets of West African Dwarf goats up to 10–15% as a partial replacement for maize bran without adverse effects on growth performance and physiological health.

ii. Farmers and livestock producers should avoid inclusion levels above 20%, as higher levels may reduce feed efficiency and nutrient digestibility.

iii. The use of *Prosopis africana* pod meal should be encouraged as a cost-effective alternative feed resource, particularly in areas where conventional feed ingredients such as maize bran are scarce or expensive.

iv. Proper processing methods such as drying, grinding, or soaking should be applied to the pods before inclusion in feed in order to reduce possible anti-nutritional factors.

v. Further research should be conducted to evaluate: the long-term effects of *Prosopis africana* pod meal on goat health and reproduction, its effects on carcass characteristics and meat quality and its economic benefits in smallholder goat production systems.

ACKNOWLEDGMENTS

Supported by Tertiary Education Trust Fund

The author is most grateful to Tertiary Education Trust Fund (TETFUND) Abuja-Nigeria for sponsoring the institutional based research conducted at the Federal Polytechnic Mubi, Adamawa State.

Table 1: Ingredients Composition of the Experimental Diet Fed Graded Levels of *Prosopis Africana* Pod Meal

Ingredients	TI (0%) Control	TII (5%)	TIII (10%)	TIV (15%)	TV (20%)	TVI (25%)
Maize bran	96.15	91.15	86.15	81.15	76.15	71.15
***Prosopis africana* pod meal**	0.00	5.00	10.00	15.00	20.00	25.00
Bone meal	3.50	3.50	3.50	3.50	3.50	3.50
Salt lick	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin–mineral premix	0.10	0.10	0.10	0.10	0.10	0.10
Total	**100**	**100**	**100**	**100**	**100**	**100**

Table 2: Growth Performance of West African Dwarf Goats Fed Graded Levels of *Prosopis Africana* Pod Meal

Parameter	TI (0%)	TII (5%)	TIII (10%)	TIV (15%)	TV (20%)	TVI (25%)	±SEM	LOS
Initial body weight (kg)	8.20	8.15	8.18	8.17	8.16	8.14	2.89	NS
Final body weight (kg)	12.80^{e}	13.40^{c}	13.95^{a}	13.60^{b}	13.10^{d}	12.40^{f}	0.03	***

Parameter	TI (0%)	TII (5%)	TIII (10%)	TIV (15%)	TV (20%)	TVI (25%)	±SEM	LOS
Total weight gain (kg)	4.60[e]	5.25[c]	5.77[a]	5.43[b]	4.94[d]	4.26[f]	0.29	***
Average daily gain (g/day)	54.80[e]	62.50[c]	68.75[a]	64.55[b]	58.85[d]	50.65[f]	0.07	***
Daily feed intake (g/day)	420.35[e]	435.30[c]	450.25[a]	440.30[b]	425..30[d]	410.30[f]	0.12	***
Feed conversion ratio (FCR)	7.65[b]	6.95[d]	6.55[f]	6.81[e]	7.23[c]	8.08[a]	0.01	***

[abc-f]Mean in the same row bearing different superscript (s) is significantly (P<0.05) different, SEM =standard error of the mean, NS = not significant, LOS = level of significant, *** = P<0.001, T = treatment

Table 3: Nutrient Digestibility of West African Dwarf Goats Fed Graded Levels of *Prosopis Africana* Pod Meal

Nutrients (%)	TI (0%)	TII (5%)	TIII (10%)	TIV (15%)	TV (20%)	TVI (25%)	± SEM	LOS
Dry matter digestibility	68.55[e]	70.80[c]	72.65[a]	71.45[b]	69.80[d]	66.99[f]	0.08	***
Crude protein digestibility	65.25[e]	68.35[c]	70.50[a]	69.15[b]	66.40[d]	63.25[f]	0.06	***
Crude fibre digestibility	60.10[e]	62.75[c]	64.50[a]	63.80[b]	61.50[d]	58.40[f]	0.15	***
Ether extract digestibility	71.01[e]	72.60[c]	74.25[a]	73.50[b]	72.00[d]	69.60[f]	0.09	***
Nitrogen free extract digestibility	69.80[e]	72.10[c]	74.05[a]	73.20[b]	71.01[d]	68.30[f]	0.11	***

[abc-f]Mean in the same row bearing different superscript (s) is significantly (P<0.05) different, SEM = standard error of the mean, NS = not significant, LOS = level of significant, *** = P<0.001, T = treatment

Table 4: Thermo-Physiological Responses of West African Dwarf Goats Fed Graded Levels of *Prosopis Africana* Pod Meal

Parameter	TI (0%)	TII (5%)	TIII (10%)	TIV (15%)	TV (20%)	TVI (25%)	± SEM	LOS
Rectal temperature (°C)	38.6	38.5	38.4	38.5	38.7	38.8	0.13	NS
Respiratory rate (breaths/min)	27.50[b]	26.80[c]	26.20[d]	26.50[cd]	27.80[b]	28.60[a]	0.14	***
Pulse rate (beats/min)	73.40[c]	72.00[e]	71.20[f]	72.50[d]	74.10[b]	75.60[a]	0.13	***

Skin temperature (°C)	35.8	35.6	35.4	35.6	35.9	36.2	0.24	NS

[abc-f]Mean in the same row bearing different superscript (s) is significantly (P<0.05) different, SEM =standard error of the mean, NS = not significant, LOS = level of significant, *** = P<0.001, T = treatment

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