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## GROWTH PERFORMANCE AND COST-BENEFIT ANALYSIS OF WEST AFRICAN DWARF GOATS FED DIETS CONTAINING TOASTED *DELONIX REGIA* (FLAMBOYANT) SEED MEAL

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### Abstract

Alternative protein sources such as under-utilized leguminous seeds offer cost-effective and sustainable options for improving ruminant nutrition in developing countries. This study investigated the effect of toasted *Delonix regia* seed (TDRS) meal on growth performance and cost-benefit analysis of West African Dwarf (WAD) goats. Twenty (20) WAD goats with average weight of 8.80 kg were assigned to five dietary treatments (0%, 3.60%, 5.40%, 7.20%, and 9.00% TDRS inclusion) in a completely randomized design. Over 90 days, feed intake, weight gain and cost-effectiveness were monitored. Results showed that TDRS inclusion had a significant effect ( $p < 0.05$ ) on dry matter intake, feed conversion ratio and feed cost per kg weight gain. The best FCR (9.58) occurred at 7.20%. Economically, feed cost per kg weight gain decreased from ₦2,821.83 (control) to ₦1,651.69 at 7.20% inclusion. The study concluded that toasted *Delonix regia* seed meal up to 7.20% inclusion improves the feed conversion ratio and reduces production cost without compromising growth performance.

**Keywords:** *In vivo*, growth performance, cost-benefit, WAD goats, *Delonix regia*

## INTRODUCTION

In Nigeria, inadequate nutrition remains a key constraint to goat production (Danguguwa *et al.*, 2024). Moreover, high feed costs during the dry season greatly limit supplementation capacity (Amao and Ogunjinmi, 2023), with feed accounting for 60 - 70% of production costs. Conventional feed ingredients, aside from having competitive demands and alternative uses are costly, thereby making animal protein expensive. Sequel to this, animal nutritionists seek alternative feeds for animals. The use of *Delonix regia* as an alternative protein source for livestock has been reported in previous studies (Lamidi and Evien, 2019; Guluwa *et al.*, 2024). Generally, legumes supply essential amino acids (Olufayo and Falola, 2018) but also contain anti-nutrient compounds. Lamidi and Evien (2019) reported that raw *Delonix regia* seed contains oxalate (0.23 – 0.32 %), phytates (0.29 - 0.43 %), tannins (0.03 – 0.08 %) and saponins (0.36 – 0.49 %), which can be mitigated via processing. Processing methods such as roasting or toasting are known to improve legume nutritional quality (Guluwa *et al.*, 2024). The aim of this study is to investigate the response of West African Dwarf Goats to diets containing toasted *Delonix regia* seed meal as a replacement for palm kernel cake.

## MATERIALS AND METHODS

**Experimental site:** The experiment was conducted at the Small Ruminant Unit, Teaching and Research Farm Directorate, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. The site is in the derived savannah zone of the South - western part of Nigeria on latitude 13' 49.46"N and longitude 25' 11.98"E (Google Earth, 2024).

**Source and processing of test ingredient:** Matured *Delonix regia* pods were hand-harvested during the dry season from fully ripe trees in Igboora, Ibarapa Central, Oyo State, Nigeria. Pods were manually split using traditional wooden implements to extract the seeds. The seeds then followed a two-phase toasting process to reduce ant-nutritional compounds and enhance nutritional quality. Initially, toasted in a metal frying pan over firewood heat for one hour with continuous stirring to prevent charring, then subjected to a reduced-heat toasting for an additional 45 minutes. This gradual toasting process was monitored by observing the change in colour

from creamy beige to light brown and emergence of a nutty aroma which signify the end point of toasting. After cooling in the head pan at ambient room temperature, the seeds were milled at a local commercial feed mill.

Maize stover hay used as roughage component was sourced from post-harvest maize field at Igboora which was then sun-dried for 5 – 7 days to reduce the moisture content to a stable level suitable for storage. The dried stover was then subjected to urea treatment to improve its nutritive value, particularly its nitrogen content. The treatment involved spraying the chopped stover uniformly with a 4% urea solution at a rate of approximately 1 litre per 1 kg of dry stover. The treated stover was then packed tightly into airtight polythene bags and sealed to allow anaerobic fermentation for 21 days. After the treatment period, the stover was opened, aired for 24 hours to eliminate residual ammonia odour and stored under dry, ventilated conditions until use.

**Experimental animals and management:** Twenty (20) West African dwarf (WAD) goats with average body weight of 8.80kg were purchased from goat farmers in Abeokuta area of Ogun state. Two weeks before their arrival, the pens were thoroughly cleaned and disinfected. Upon arrival, they were acclimatized for a period of three weeks. During this period, they were fed *Panicum maximum ad libitum* and were administered prophylactic and therapeutic treatments. After acclimatization, the animals were weighed and allocated to five (5) dietary treatments in a Completely Randomised Design (CRD). The animals were raised in an intensive system of management. The experiment lasted for 90 days.

**Experimental diets:** Experimental concentrate diets were formulated by replacing palm kernel cake with toasted *Delonix regia* seed meal at graded levels of 0%, 20%, 30%, 40% and 50% (equivalent to 0%, 3.6%, 5.4%, 7.2% and 9% in the total diet, respectively) as shown in Table 1. Maize stover hay and concentrate diets in ratio 6:4.

**Experimental design:** The experiment was carried out in a completely randomized design. Twenty (20) West African Dwarf goats were allotted to five (5) treatments having four (4) animals per treatment.

**Table 1: Gross composition (%) of experimental concentrate diets for WAD goats**

Ingredients	0%TDRS	3.6%TDRS	5.4%TDRS	7.2%TDRS	9%TDRS
Cassava peel	40.00	40.00	40.00	40.00	40.00
Palm kernel cake	<b>18.00</b>	<b>14.40</b>	<b>12.60</b>	<b>10.80</b>	<b>9.00</b>
TDRS meal	<b>0.00</b>	<b>3.60</b>	<b>5.40</b>	<b>7.20</b>	<b>9.00</b>
Groundnut cake	5.00	5.00	5.00	5.00	5.00
Sawdust	35.00	35.00	35.00	35.00	35.00
Bone Meal	1.50	1.50	1.50	1.50	1.50
Salt	0.50	0.50	0.50	0.50	0.50
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>
<b>Calculated values</b>					
Crude protein (%)	11.17	11.48	11.64	11.79	11.95
Crude fiber (%)	12.86	12.92	12.95	12.98	13.02
ME(MJ/kg)	2.60	2.63	2.64	2.66	2.67

**Feed intake and dry matter intake of WAD goats:** Feed offered to each animal was weighed daily and the leftover was collected the next day and weighed before offering fresh feed. Feed intake and dry matter intake (DMI) were determined using the formulae:

Feed intake (g) = Feed offered – Feed left over

$$DMI = \frac{\% \text{ Dry matter}}{100} \times \text{Feed intake}$$

**Feed conversion ratio:** Total dry matter intake and body weight gain were used to determine the feed conversion ratio.

$$\text{Feed conversion ratio} = \frac{\text{Feed intake}}{\text{Body weight gain}}$$

**Weight gain:** The animals were weighed on weekly basis. The weekly weight gain was recorded as the difference between the weight of the previous and the current week.

**Cost-benefit analysis:** The prevailing prices per kilogram of *Delonix regia* (150 naira per kg), palm kernel cake (400 naira per kg) and other feed ingredients were taken into consideration over the entire experimental period. Milling of the test ingredients and transportation of feed were included as part of feed cost. The total cost of each experimental diet was recorded and the cost of feed consumed by each animal per weight gain was calculated.

**Feed cost/kg diet** = Quantity of each ingredient x Unit price/kg of the ingredient.

**Cost of feed consumed** = Cost/kg diet x Total feed consumed per replicate.

**Cost per kilogram weight gain** = FCR x Cost/kg diet

#### Chemical analysis

**Proximate and fibre analysis:** Samples of the diets were oven-dried at 65°C and then analyzed for proximate composition. The amount of crude protein was calculated as N x 6.25. Nitrogen free Extract (NFE) was calculated using the formula 100 – (% CP + % CF + % EE + % ash) using the methods of A.O.A.C. (2000). Neutral detergent fibre, acid detergent fibre and acid detergent lignin were analyzed for according to Van Soest *et al.* (1991).

**Statistical analysis:** All data generated in the study were subjected to one-way analysis of variance (SAS, 2002). Significant differences were accepted at  $p < 0.05$  and means were separated using Duncan Multiple Range Test (SAS, 2002).

## RESULTS AND DISCUSSION

Table 2 presents the performance of West African Dwarf goats fed diets containing toasted *Delonix regia* seed (TDRS) meal. TDRS

inclusion significantly ( $p < 0.05$ ) affected dry matter intake (DMI) and feed conversion ratio (FCR). Goats fed 7.20% TDRS had the best FCR (9.58), indicating superior feed efficiency. Daily weight gain ranged from 18.17 g/day (0%) to 22.78 g/day (5.40%), but these differences were not statistically significant, suggesting that TDRS inclusion did not adversely affect overall growth. The improvement in FCR at 5.40% and 7.20% inclusion levels may be attributed to the nutritional contribution of the processed TDRS meal, despite no significant change in final weight. This implies that the goats were able to utilize the diets more efficiently at these levels. These results align with Adebayo and Olufemi (2022) who reported that fibre-rich tropical plant inclusion improved feed efficiency in goats without necessarily increasing body weight. Although feed intake varied significantly across treatments, there was no clear pattern of suppression or stimulation due to TDRS inclusion, indicating that its presence did not deter feed consumption. The comparable weight gains further suggest that the goats accepted the diets and that TDRS meal can be used without affecting palatability.

Cost-benefit results in Table 3 show significant differences ( $p < 0.05$ ) in feed intake, feed cost per kg weight gain, and feed cost per goat. Feed cost per kg gain dropped from ₦2,821.83 (0%) to ₦1,651.69 at 7.20% inclusion. The lowest feed cost per goat occurred at 5.40% and 7.20%. These findings are consistent with reports by Ajayi *et al.* (2020) and Arowolo *et al.* (2017), who noted that replacing conventional ingredients with leguminous tree-based meals reduced feed cost while maintaining performance. Although final weight was unaffected, TDRS meal significantly reduced feed-related expenses and improved feed efficiency, demonstrating its value as a cost-effective alternative feed ingredient in goat production systems.

## CONCLUSION

It can be concluded that toasted *Delonix regia* seed meal can be included up to 7.20% in West African Dwarf goat diets to improve feed conversion efficiency and reduce production cost without negatively affecting growth performance, making it a viable alternative feed resource.

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#### Conflict of interest

There is no conflict of interest to declare.

**Table 2: Performance characteristics of West African Dwarf goats fed diets containing varying inclusion levels of toasted *Delonix regia* seed meal**

Parameters	Inclusion levels of toasted <i>Delonix regia</i> seed meal in the diets					SEM	P-value
	0%	3.60%	5.40%	7.20%	9.0%		
<b>Dry matter intake</b>							
Maize stover DMI (g/day)	159.05	150.41	139.71	121.05	128.87	9.128	0.784
Concentrate DMI (g/day)	108.19 <sup>a</sup>	101.56 <sup>b</sup>	99.83 <sup>c</sup>	75.46 <sup>e</sup>	86.69 <sup>d</sup>	8.096	0.045
Total DMI (g/day)	267.33 <sup>a</sup>	251.97 <sup>b</sup>	239.55 <sup>c</sup>	196.50 <sup>e</sup>	215.57 <sup>d</sup>	17.123	0.042
<b>Weight change</b>							

Initial weight (kg)	9.32	8.97	8.68	8.64	8.58	0.340	0.978
Final weight (kg)	10.96	10.68	10.73	10.48	10.31	0.415	0.996
Total weight gain (kg)	1.64	1.71	2.05	1.84	1.73	0.100	0.819
Daily weight gain (g/d)	18.17	18.97	22.78	20.44	19.22	1.115	0.819
Feed conversion ratio	14.54 <sup>a</sup>	13.36 <sup>ab</sup>	10.53 <sup>bc</sup>	9.58 <sup>c</sup>	11.14 <sup>bc</sup>	0.675	0.042

<sup>a, b, c</sup> means on the same row having different superscript are significantly different ( $P < 0.05$ ), SEM – Standard error of means, DMI = Dry matter intake

**Table 3: Cost benefit of the experimental diets fed to West African Dwarf goats**

Parameters	Replacement levels of toasted <i>Delonix regia</i> seed meal					SEM	P value
	0%	3.60%	5.40%	7.20%	9.0%		
Final live weight (kg)	10.96	10.68	10.73	10.48	10.31	0.415	0.996
Weight gain (kg)	1.64	1.71	2.05	1.84	1.73	0.100	0.819
Feed intake (kg)	27.67 <sup>a</sup>	26.08 <sup>b</sup>	24.78 <sup>c</sup>	20.36 <sup>e</sup>	22.32 <sup>d</sup>	1.169	0.035
Cost of feed/kg weight gain (₦)	2821.83 <sup>a</sup>	2413.73 <sup>b</sup>	1858.20 <sup>cd</sup>	1651.69 <sup>e</sup>	1867.17 <sup>c</sup>	192.94	0.021
Cost of feed/kg	167.25 <sup>a</sup>	158.25 <sup>b</sup>	153.75 <sup>c</sup>	149.25 <sup>d</sup>	144.75 <sup>e</sup>	3.460	0.042
Cost of feed/goat (₦)	4627.81 <sup>a</sup>	4127.48 <sup>b</sup>	3809.31 <sup>c</sup>	3039.10 <sup>e</sup>	3230.10 <sup>d</sup>	260.06	0.015

<sup>a, b, c, d, e</sup> means along the same row with different superscripts are significantly different ( $P < 0.05$ ), SEM: Standard error of means

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