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Dietary effects of Graded levels of Teak (T*ectona grandis*) Seed meal on the Performance Characteristics of Goats

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ABSTRACT: This experiment was conducted to evaluate the performance characteristics and haematological indices of West African dwarf goats fed diets containing graded levels of Teak (*Tectona grandis*) Seed Meal (TSM) as a replacement for Cassava wastes. Teak (*Tectona grandis*) Seed Meal was included in the diets of goats at 25 %, 50 % and 75 % to replace Cassava wastes and designated as Diet B, Diet C and Diet D respectively while Diet A was the control (P>0.05). Four dietary treatments were formulated. Twenty (20) growing goats were randomly allotted to the four treatments and replicated five times in a completely randomized design model. Feeding and watering were done *ad-libitum* for seventy (70) days. The results revealed increasing crude protein and crude fiber contents for the Teak (*Tectona grandis*) Seed Meal-based diets (B, C and D) compared to the control (A). There were significant differences in the Dry Matter Intake, Crude Fiber Intake, Ether Extract Intake and Ash Intake among all the diets (A – D) (P<0.05). However, Dry Matter Intake of Diet A was numerically higher but similar (P > 0.05) to that of Diets B and Diet C while Dry Matter Intake of Diet D was lower but similar (P > 0.05) to Diets B and C. The crude protein intake of the Teak (*Tectona grandis*) Seed Meal based diets (B – D) was comparable with the control (Diet A) (P>0.05). The crude fiber intake was highest for Diets C > D > A > B in that order. Conversely, the ether extract intake was highest for the control (Diet A) followed closely by diets D, C and the least was Diet B. The highest ash intake was recorded for Diet A and the least for Diet D. With the exception of higher crude fiber digestibility recorded for Diet D, other nutrients digestibility was higher for the control (Diet A) compared to the Teak (*Tectona grandis*) Seed Meal based diets (B – D). There was no significant difference (P>0.05) in the haematological parameters measured except eosinophil concentration. Additionally, there was no significant difference (P>0.05) in the creatinine and total protein contents of the serum of the experimental animals. While significant variations (P < 0.05) were recorded for the glucose, ALT, ALP and AST contents measured. It was concluded from the study that up to 75 % TSC could be used to replace Cassava wastes in the diets of goats without adverse effects on the health and improved feed intake, nutrient digestibility and blood metabolites of West African dwarf goats.

Keywords: Goat, Teak seed meal, dgestibility, haematological indices, performance characteristics

Introduction

The rapid increase in human population as well as the competition between man and his livestock resulted in shortage of supply of protein from livestock (meat, eggs). Most Nigerians are suffering from malnutrition due to lack of protein of animal origin (Ajala *et al*; 2004). The scarcity or high cost of conventional feedstuffs is one of the major problems facing large scale livestock production in Nigeria. Hence, there is need to search for relatively cheap, readily available unconventional feedstuff which has no competition with man and without compromising quality. One of such unconventional feedstuffs is Teak (*Tectona grandis*) Seed Cake (TSC). However, the utilization of unconventional feed resources as animal feed in Nigeria is still at the infancy stage. These feed resources was estimated to be approximately 194 x 10^6 million ton from feed and tree crops and it constitute 45% of the total available by-products from annual and perennial tropical crops (Belewu, 2001)

Teak (*Tectona grandis)* tree is widely cultivated in the Forest and Savanna areas. The fruits, leaves, root, bark and wood of the tree are used for various purposes (fodder, for animal, building materials, aesthetic, and craft and in the production of medicines and insect repellants.

Teak (*Tectona grandis*) Seed has been found to have high concentration of crude fiber of approximately 26.0 % with methionine and lysine concentrations of 4.19 g/16g N and 7.60 g/16g N respectively (Ambode and Fetuga, 1982). It was noted that the plant is used in the treatment of urinary discharge, bronchitis, cold and headache and scabies. The plant is also used as laxative and sedative, diurrrretic, anti-diabetic, analgestic and anti-inflammatory (Diallo et al., 2010).

It is interesting to note that that there is paucity of information on the feeding value of the seed cake by goats. This experiment was designed to exploit the potentials of Teak (*Tectona grandis*) Seed Cake as an unconventional feed resource for goats.

Table 1: Proximate composition of Teak (*Tectona grandis*) Seed Cake

Parameters	**%**
Crude protein	9.20
Crude fiber	26.00
Ether extract	26.50
Ash	3.40
Nitrogen free extract	34.90
Metabolizable energy (MJ/Kg)	3.80

Source: Ambode and Fetuga (1982)

Materials and Methods

Experimental Site

The experiment was carried out at the Animal Pavilion of the Teaching and Research Farm, University of Ilorin, Nigeria. The latitude and longitude of Ilorin was 80 49'N and 40 54' while the average temperature of the University of Ilorin is between 23.7 and 28.70C and humidity of between 49.2 and 90.6 (Yusuf and Akoshile, 2011).

The experiment was carried out at the paddock unit of the University of Ilorin Teaching and Research Farm, Ilorin, Kwara State, Nigeria.

Collection of Teak (*Tectona grandis*) Seed and processing

Teak Seeds were collected from the University of Ilorin Teak plantation which was established in 2009. The membranous calyxes of the fruits were removed manually after which the seeds were further sun-dried. The dried seeds were then milled and further air-dried before being used in diet formulation.

Experimental design and diets

The weights of the animals were balanced when goats were randomly allocated to 1 of 4 dietary treatments (Table 2). The experimental period was 100 days consisting of a 10 day adjustment period and a 90 day sampling and data collection period. . During the adjustment and collection periods animals were fed and water *ad-libitum*. Four (4) experimental diets were formulated in which Teak (*Tectona grandis*) Seed Meal was used to replace Cassava waste at 25 %, 50 % and 75 % in Diets B, C and D respectively while Diet A was the control Diet (without TSC inclusion). Other ingredients were of fixed proportions (Table 2).

Table 2: Composition of the Experimental Diets

	Dietary Treatments			
Ingredients (%)	**A (Control)**	**B (25 % TSC)**	**C (50 % TSC)**	**D (75 % TSC)**
Teak Seed Meal	-	13.75	27.50	41.25
Cassava wastes	55.00	41.25	27.50	13.75
Rice husk	25.00	25.00	25.00	25.00
Soya bean meal	18.00	18.00	18.00	18.00
Vitamin premix	1.00	1.00	1.00	1.00
Salt	1.00	1.00	1.00	1.00
Total	100.00	100.00	100.00	100.00

Management of the Experimental Animals

Twenty (20) growing West African Dwarf goats were used for the experiment. Before commencement of the experiment, the goats were given Ivomec against ecto-parasites and endo-parasites and long-acting oxytetracycline against cold and pneumonia. The animals were then randomly allocated into four (4) dietary treatments and in replicates of five (5) animals per treatment. There was a day-to-day record of feed intake and left-over while other daily routine activities like washing of drinkers, cleaning of the cage and its environment were also carried out.

Sample collection, analysis and measurements

The animals were weighed at the commencement, weekly and at the end of the experiment to monitor their weight gain. While the feed intake of the animals was estimated by subtracting the ort from the daily feed given. The digestibility trial was carried out during the last two week of the experiment using a Total collection technique. Three animals per treatment were kept in individual metabolic cage for quantitative collection of the faeces, and the digestibility coefficient was determined by the formula:

$$\text{Nutrient digestibility (\%)} = \frac{\text{Nutrient intake} - \text{Nutrient in faeces}}{\text{Nutrient intake}} \times 100$$

Blood Collection and Evaluation

At the 2nd, 5th and 10th weeks of the experimental feeding trial, blood samples were taken from the animals via the jugular vein with the use of disposable syringes and needles for the evaluation of haematological parameters and biochemical serum indices. The blood samples were collected into three (3) different sample bottles with one of them containing Ethylene Di-amine Tetra-Acetic acid (EDTA) to prevent coagulation of the blood samples which was stored for haematological studies. Another sample bottle free from anti-coagulants was used in order to allow the blood collected to clot at room temperature for the sera sample to be collected and stored at temperature of -20^{o}C for biochemical studies. The third sample bottle contains Fluoride Oxalate which inhibits the commencement of glycolysis in the blood collected for glucose analysis. The full blood count (Red Blood Cell and White Blood Cell, packed cell

volume, haemoglobin concentration, mean corpuscular volume, mean corpuscular heamoglobin concentration, neutrophils, lymphocytes, monocytes, eosinophils and basophils) were analysed according to the methods of Jain (1993). Biochemical constituents of the serum samples estimated include; creatinine, total protein, glucose, aspartate aminotransferase (AST), alkaline phosphatase (ALP) and alanine aminotransferase (ALT) using the procedure of Ogunsanmi *et al.*,(2002)

Chemical Analysis

Proximate analysis of the feed and faecal samples collected were analyzed using the procedure described by A.O.A.C. (2005)

Statistical Analysis

The data collected were subjected to analysis of variance of a Completely Randomized Design Model (CRD) for the evaluation of the effect of dietary teak seed cake on nutrient intake, digestibility and haematological indices and the significant differences were separated using Duncan (1955) multiple range test.

Results

The ingredients and nutrient composition of the experimental diets used in this study were presented in Tables 2 and 3. The inclusion of TSM in the experimental diets resulted in increasing Crude Protein, Crude fibre and Ether extract across the diets (Table 3)

Table 3: Proximate Composition of the Experimental Diets (DM basis)

	Dietary treatments			
Parameters (%)	**A**	**B**	**C**	**D**
Dry matter	91.98	91.57	90.20	90.60
Crude protein	10.26	11.02	11.64	10.90
Crude fibre	10.10	11.52	17.62	18.78
Ether extract	6.60	5.48	6.47	7.17
Ash	12.03	12.82	10.53	11.14

The dry matter percentage of Diet A (91.98 %) was the highest among the experimental Diets which was slightly above the dry matter contents of Diet B (91.57 %)**,** this was followed by Diet D which had 90.60 % dry matter content. Diet C had the lowest dry matter of 90.20 %. Conversely, Diet C had the highest crude protein of 11.64 % among the experimental Diets. This was followed by Diet B with crude protein content of 11.02 %. Diet D had 10.90 % crude protein while Diet A had the lowest crude protein of 10.26 %. The crude fiber in the experimental Diet D was highest followed by that in Diet C which was 17.62 %. The crude fiber of the experimental diets varied with the inclusion level of TSC.

The ether extract in Diets A and C are similar but lower than Diet D (7.17 %) > Diet A while Diet B had the lowest ether extract (5.48 %). The least Ash content was recorded in Diet C (10.53 %) followed by Diet D with 11.14 % and Diet A with 12.03 %. However, Diet B had the highest Ash content of 12.82 %.

Table 4: Feed Intake of The Experimental Animals ((g/day/goat)

	Dietary treatments				
Parameters (g/day)	**A**	**B**	**C**	**D**	**+ SEM**
Dry matter intake	198.88^{b}	162.03^{ab}	154.22^{ab}	141.18^{a}	11.94
Crude protein intake	21.95	19.89	19.49	16.98	1.38
Crude fiber intake	21.75^{a}	20.38	30.12^{b}	29.27^{b}	1.55
Ether extract intake	14.13^{b}	9.69^{a}	11.06^{ab}	11.17^{ab}	0.85
Ash intake	25.75^{b}	22.69^{ab}	18.11^{a}	17.36^{a}	1.55

Means on the same row carrying the same superscript are not significantly different (P > 0.05)

The highest dry matter intake was recorded for animals on Diet A without TSC (Control Diet). This was followed by animals on Diet B with 162.03 g/day, while animals on Diet D recorded the lowest dry matter intake of 141.18 g/day. Crude protein intake was highest for animals on Diet A (21.95 g/day) followed by animals on Diet B with Crude Protein intake of 19.89 g/day. Also, animals on Diet C had 19.49 g/day Crude Protein intake. Lowest Crude Protein intake was recorded for animals on Diet D (16.98 g/day). Crude fiber intake of animals on Diet C (30.12 g/day) was slightly higher than that of animals on Diet D (29.27 g/day), lowest crude fiber intake was recorded for animals on Diet B (20.38 g/day). The highest ether extract intake of 14.13 g/day was recorded for animal on A >D >C >B. in that order, Contractly, the least ash intake was noted for animals on diet D.

Table 5: Apparent Digestibility Coefficient of Experimental Diets (on Dry Matter Basis)

	Dietary treatment				
Parameters (%)	**A**	**B**	**C**	**D**	**+ SEM**
Dry matter	**83.75^{c}**	**75.00^{b}**	**68.20^{a}**	**75.67^{b}**	**1.33**
Crude protein	**86.75^{b}**	**80.75^{a}**	**81.00^{a}**	**82.00^{a}**	**0.98**
Crude fiber	**69.25^{b}**	**66.00^{ab}**	**59.40^{a}**	**71.67^{b}**	**2.15**
Ether extract	**88.50^{c}**	**79.25^{a}**	**84.00^{b}**	**81.67^{ab}**	**0.95**

Means on the same row carrying the same superscript are not significantly different (P > 0.05)

The dry matter digestibility was highest for animals on Diet A (83.75 %) followed by animals on Diet D (75.67 %) while animals on Diet B had dry matter digestibility of 75 %. The least dry matter digestibility was recorded for animals on Diet C (68.20 %). Crude protein digestibility was highest for animals on Diet A (86.75 %) followed by animals on Diet D with crude protein digestibility of 82 %. Next to it was that of animals on Diet C with 81 % crude protein digestibility. Lowest crude protein digestibility was recorded for animals on Diet B (80.75 %).

Crude fiber digestibility recorded for animals on Diet D was highest (71.67 %), next to this in crude fiber digestibility was animals on Diet A (69.25 %) which was followed by animals on Diet B (66 %). Lowest crude fiber digestibility was recorded for animals on Diet C (59.40 %). Animals on Diet A had the highest ether extract digestibility of 88.50 %, next to this was animals on Diet C with 84 % ether extract digestibility followed by 81.67 % recorded for animals on Diet D. Animals on Diet B had the lowest ether extract digestibility of 79.25 %.

Table 6: Haematological Indices of Experimental Animals

	Dietary treatments				
Parameters	A	B	C	D	± SEM
Packed Cell Volume (%)	31.46	31.52	31.48	28.88	1.79
Haemoglobin (g/dL)	10.49	10.51	10.49	9.62	0.50
Red Blood Cell (x 10^9/L)	2.49	2.36	2.46	1.98	0.22
White Blood Cell (x 10^9/L)	10.44	9.58	9.03	8.47	0.67
Mean Corpuscular Haemoglobin (Pg)	42.11	45.22	43.59	49.21	2.87
Mean Corpuscular Volume (FL)	13.05	13.61	13.25	14.64	0.81
MCHC (g/dL)	0.33	0.33	0.33	0.34	0.00
Lymphocytes (%)	67.36	66.41	66.90	67.47	0.97
Monocytes (%)	0.82	1.11	1.06	0.79	0.25
Neutrophils (%)	30.95	30.94	29.83	30.13	0.82
Basophils (%)	0.22	0.29	0.29	0.06	0.11
Eosinophils (%)	0.604	1.26	1.93	1.55	0.29

Means on the same row carrying the same superscript are not significantly different (P > 0.05)

MCHC – Mean Corpuscular Haemoglobin Concentration

Table 6 shows the haematological parameters of West African Dwarf goats. There was no significant differences (P > 0.05) across the treatments for the haematological parameters measured, however, numerical differences were observed.

Table 7: Serum Indices of the Experimental Animals

Parameters	A	B	C	D	± SEM
Creatinine (mg/dL)	0.93	0.85	0.82	0.75	0.08
Glucose (mg/dL)	32.88^{c}	29.76^{ab}	30.23^{b}	27.85^{a}	0.75
Total protein (g/dL)	63.40	74.57	68.43	74.57	3.74
Alkaline phosphatase (IU/L)	68.69	71.63	78.79	70.97	3.08
Alanine aminotransferase (IU/L)	7.82^{b}	7.26^{ab}	6.78^{a}	6.97^{a}	0.23
Aspartate aminotransferase (IU/L)	3.75	3.51	4.10	3.20	0.38

Means on the same row carrying the same superscript are not significantly different (P > 0.05)

Table 7 shows the results of the serum biochemistry of West African Dwarf goats. The values of craetinine, total protein and Aspartate aminotransferase parameters of the animals on Diets A, B, C and D are not significantly different (P > 0.05). Animals on Diet A had the highest glucose level of 32.88 mg/dL, followed by animals on Diet C with 30.23 mg/dL, while that of animals on Diet B (29.76 mg/dL) was slightly higher than that of animals on Diet D (27.85 mg/dL). Alkaline phosphatase of animals on Diet C was highest with 78.79 IU/L. Animals fed Diets B and D were similar (P > 0.05) with values of 71.63 IU/L and 70.97 IU/L respectively. The least value for Alkaline phosphatase was noted in animals on Diet A (68.69 IU/L). Animals on Diet A had the highest value of Alanine aminotransferase (7.82 IU/L) followed by animals fed Diet B (7.26 IU/L). Alanine aminotransferase values for animals on Diet C and D were not significantly different (P > 0.05) with values of 6.78 IU/L and 6.97 IU/L respectively.

Discussion

The dry matter intake numerically increased as the levels of inclusion of TSM increases although there was no significant difference (P > 0.05) among the intakes unless for animals on Diet D with an

intake of 141.18 g/day. Earlier work (Obioha, 1985) showed that intake in ruminant is also influenced by a taste related factor especially, palatability. Beyond nutritional composition, animals tend to consume more of palatable diet (Ibeawuchi *et al*., 2002). The reduced palatability of TSM may be due to its high fiber contents as well as to the secondary metabolites (phenolic, alkaloids, aromatic compounds and many more) present in the seed due to its stringent property (Nidavani *et al*., 2014). This was in line with the reports that inverse relationship exists between dry matter intake and crude fiber content of feed (Reid and Kloptentstein, 1983). This tends to suggest that with the decreasing levels of crude fiber contents, intake increased. There was no significant difference in the crude protein intake. However, Diet A (Control) was numerically higher compared to TSC based Diets (B – D). The higher crude fiber intake of the TSM based diets compared to Diet A (Control) could be attributed to higher crude fiber content of TSC (Ambode and Fetuga, 1983). The ether extract intake followed similar trend as the crude fiber intake except Diet B which was lower. There were significant differences in the consumption of Ash. The low ash intake could be due to the poor ash content of the TSM (Ambode and Fetuga, 1983) in this nutrient.

With the exception of the increased crude fiber digestibility reported for animals on Diet D, other parameters recorded were higher for Diet A (Control). The increased crude fiber digestibility recorded for Diet D could be attributed to the higher content of the crude fiber in TSM (Ambode and Fetuga, 1983). The higher apparent digestibility of all measured parameters obtained in Diet A may be an indication of a better utilization of the control diet. The decr ease in the digestibility with increasing levels of TSM inclusion could be attributed to the increasing levels of fiber as the levels of TSM increased. McDonald *et al.*, (2011) reported that mixed diets and those containing smaller particles recorded marked reduction in digestibility per unit increase in feeding level ranging from 0.02 – 0.03 mm and was attributed to negative associative effects which become pronounced at higher levels of feeding. This could also explain the progressive decrease in the apparent nutrient digestibility with increasing levels of TSM observed in this study. Furthermore, this author also indicated that fiber fraction of a feed as well as species of animal concerned have the greatest influence on digestibility. Crude protein and ether extract digestibility coefficients similarly followed the same trend as the dry matter digestibility, decreasing from Diets A – D. According to Ahamefule *et al.* (2006), crude protein and crude fibre components of dry matter as well as any factor that affects dry matter of a feed would simultaneously have a comparable effect on the crude protein and crude fibre components of the same feed. This may explain why the digestibility coefficients of crude protein and crude fibre decreased from Diets A – D, in the same pattern as the dry matter.

The mean packed cell volume (PCV) obtained in this study was comparable with normal range of mean values earlier reported for WAD goats and other goat breeds (Tambuwal, 2002; Daramola *et al*.,2005; Opara *et al*.,2010; Waziri *et al*., 2010). Results obtained were also higher than the range (20 – 21.67 %) reported by Oloche *et al*. (2014) who fed shea butter leaves supplemented with concentrate diets containing graded levels of sweet orange peel meal to West African Dwarf goats. The haemoglobin concentration in the present study, which is an indication of the oxygen carrying capacity of the of the blood corroborates with previous reports (Belewu *et al*., 2006; Daramola *et al*., 2005; Opara *et al*., 2010) while the Red Blood Cell values obtained are within the normal range of mean values earlier reported by Opara *et al*., (2010) for West Africa Dwarf goats. The mean total WBC count in this study agreed with the observations of Adejinmi and Akinboade (1999), Tambuwal *et al*. (2002); Waziri *et al*. (2010). Generally, goats like other animals possess more lymphocytes than neutrophils in circulation (Olusanya *et al*. 1976) and the values obtained in the present study fell within the broad range recorded for Red Sokoto goats (Tambuwwal *et al*., 2002). Thus, good health of West African Dwarf goats is ensured with a well developed immune system with such number of immune cells.

The creatinine level recorded in this study was slightly higher than those recorded (0.7 mg/dl) for WAD goats in South-eastern Nigeria by Opara *et al* ., (2010). However, the levels were within the serum creatinine ranges reported by Aiello, (2000). Mean Glucose values obtained in the present study commensurate with that reported by Opara *et al.,* (2010). The mean serum total protein values observed in this study were found to be within normal range of mean values earlier reported for WAD goats and other goat breeds Oduye (1976); Adejinmi and Akinboade, (1999); Daramola *et al.,* (2005); Waziri *et al.,* (2010). This study showed a wide variation in the concentration of both Aspartate Amino Transferase and

the Alanine Amino Transferase (AST and ALT). The mean Alkaline phosphatase (ALP) was observed to have values higher than values reported by Opara *et al.*, (2010) for WAD goats. Although ALP level can be influenced by pregnancy, blood pH and disease (Kelly, 1974) the animals in this study were apparently healthy, non-pregnant, and these parameters could not have been influenced by these factors.

Conclusion

This study indicates the potential of Teak seed meal (TSM) served as a cheap source of non-conventional feed resource (NCFR) for ruminant animal production especially during the dry season when the seeds are abundant and wasted. Hence, its utilization has no deleterious effe ct on the animals. The results of the study showed that up to 75% of TSM can be included in the diet of WAD goat to replace Cassava wastes with no deleterious effect on the health of the animals.

Recommendations

The followings are recommended for future research:

1. Research should further be carried out on how to increase the palatability of the seeds as well as their dietary nutrients for successful livestock feeding. This can be achieved by de-fatting the seed meal to increase its dietary protein.
2. Further studies should be channeled towards the knowledge of the effects of Teak seed meal (TSM) on the reproductive, urinary parameters and milk production of ruminant animals.
3. Efforts should be made to investigate the seed in Monogastric animal nutrition especially poultry to examine performance and other parameters.
4. Finally, studying the histological analysis of livestock species fed with various inclusions Teak seed meal should be encouraged, perhaps there might be accumulation of toxins in organs of animals in the long run.

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