

Effect of graded levels of teak (*Tectona grandis*) kernel meal on growth performance and carcass characteristics of rabbit (*Oryctolagus cuniculus*)

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Abstract

The study was conducted to determine the effects of graded levels of teak (*Tectona grandis*) kernel meal on rabbits. Thirty weaned rabbits aged between 4 – 5 weeks old were which lasted for 12 weeks. The rabbits were randomly allotted to five dietary treatments of two replicates consisting of three rabbits each in a completely randomized design. The calyx layer of the kernel was removed via sieving and rubbing in-between the palms, and the middle layer coupled with the innermost layer were crushed and milled using huller mill to obtain teak kernel meal. Experimental diets were compounded in such a way that Diet 1 contained no teak kernel meal (control) while Diets 2, 3, 4 and 5 contained the test ingredient at 5, 10, 15 and 20% levels of inclusion respectively. Teak kernel meal was analysed for moisture, crude fibre (CF), crude protein (CP), ether extract (EE), ash and nitrogen free extract (NFE). The results for moisture, crude fibre, crude protein, ether extract, ash and nitrogen free extract were 7.36, 54.90, 8.75, 8.50, 5.00 and 16.88% respectively. Anti-nutritional factors were also analysed for oxalate, phytate, cyanide, tannin, flavonoid and alkanoid, and the results were 28.6mg, 3.65, 0.32, 2.35, 3.12 and 0.42% respectively. Rabbits fed Diet 1 had the highest final weight of 1635.88g while those fed Diet 5 exhibited the least (1411.20g). There were significant ($P < 0.05$) differences among daily feed intake of the rabbits. The study suggests that rabbits can tolerate 20% of the test ingredient without any deleterious effect.

Keywords: rabbits, performance, teak kernel meal, proximate analysis, anti-nutrients

Introduction

The use of conventional feedstuffs in the preparation of livestock feed has put the industry into direct competition with human for the feedstuffs (Muriu *et al.*, 2002). High costs of conventional sources of energy and protein have been the major reason for the high cost of rabbit feed. The high cost of feed in turn has made livestock production an expensive venture which has caused serious animal protein deficiency among Nigerians, especially in the low income class, leading to malnutrition (Madubuike and Obidimma, 2009). Rabbit has the potential for filling the gap between demand and supply of animal protein in developing countries like Nigeria. This is because of its high genetic potential, short

generation intervals, high fecundity, rapid growth rate, high prolificacy and relative low cost of production (Akinnusi *et al.*, 2007). Rabbits are efficient converters of feed to meat, and can utilize up to 30% crude fibre as against 10% by most poultry species (Egbo *et al.*, 2001). With the above great potentials of rabbit, its production is facing the problem of high cost of feed. One of the possible options advocated to solving the present high costs of feedstuffs, according to Olorede and Longe (1999) is the substitution of the conventional feeding stuffs with non-conventional types. With the diversified uses of most of the conventional feedstuffs there is therefore, a necessity for the utilization of under-exploited farm produce as feed resources

for livestock feed. Many forest, farm produce and products, agro-industrial by-products and animal by-products had been evaluated and found as suitable replacements for some conventional feedstuffs. Rabbits may have the potential of utilizing such unconventional feedstuffs as teak (*Tectona grandis*) kernel meal. Teak kernel meal has crude protein of 8.75% from the preliminary proximate analysis carried out on the kernel. This makes it comparable to maize which is a source of energy. It is on this basis that the study was carried out to determine the growth performance and carcass evaluation of rabbits fed teak kernel meal.

Materials and methods

Experimental location

This study was carried out at the rabbit section of Ibrahim Badamasi Babangida University Teaching and Research Farm, Lapai, Niger State. Lapai is very close to Minna (State capital), which lies between Latitude 9°31' and 9°45', east of the equator (Usman, 2011). The area falls within the Southern Guinea Savannah Vegetation Zone of Nigeria with mean annual rainfall between 1100 – 1600mm and a mean temperature between 21°C and 36.5°C (Usman, 2011).

Sourcing and processing of feedstuffs

Soybean, limestone, wheat offal and bone meal were purchased from Feedtech Limited, Suleja, while maize and salt were purchased from Lapai local market. Teak kernels were sourced for at Cheche village, Lapai Local Government Area of Niger State, Nigeria. They were obtained between January and March, when they were abundant. The calyx layer of the kernel was removed via sieving and rubbing in-between the palms, and the middle layer coupled with the innermost layer were crushed and milled using huller mill to obtain teak kernel meal.

Experimental diets and management of rabbits

Thirty weaned rabbits, aged between 4 – 5 weeks, of mixed sexes were purchased from a rabbit farmer in Apata Area of Ibadan in Oyo State. They were randomly allotted into five treatment groups of six rabbits each in a completely randomised design. Each treatment has two replicates of three rabbits each. Five experimental diets were formulated with approximated crude protein level of 18%. Diet 1 (T₁) served as a control containing every other feedstuff except the test ingredient – teak kernel meal (TKM). Diets 2, 3, 4 and 5 designated as T₂, T₃, T₄ and T₅ respectively contained TKM at inclusion levels of 5, 10, 15 and 20% respectively. Table 1 shows the composition (%) of experimental diets. All diets were supplemented with equal amount of wheat offal, salt, limestone and bone meal. The rabbits were dewormed and appropriate medications were administered as at when due. The cages were equipped with feeders and drinkers. Prior to the start of the study, the animals were fed the same diet and were allowed an adjustment period of seven days to enable the animals get used to the cages. Experimental diets and water were provided *ad-libitum* throughout the experimental period of 12 weeks.

Data collection

Determination of proximate and anti-nutritional factors

Proximate analysis of teak kernel meal was determined according to A.O.A.C. (2000). NFE was calculated by subtracting the sum of crude protein, crude fibre, ether extract, and ash from 100% dry weight sample (AOAC, 1995). Metabolizable energy was calculated using the procedure of Asibey-Berko and Tayie (1999). Anti-nutritional factors: flavonoid, phytate, tannin, oxalate and cyanogenic glycoside

Table 1: Gross composition of experimental diets fed to the rabbits

Ingredient (%)	Teak kernel meal				
	0%	5%	10%	15%	20%
Maize	61.46	56.79	51.46	46.46	41.45
Soybean	24.79	24.79	24.79	24.79	24.79
Teak kernel meal	0.00	5.00	10.00	15.00	20.00
Wheat offal	10.00	10.00	10.00	10.00	10.00
Salt	0.25	0.25	0.25	0.25	0.25
Bone meal	2.00	2.00	2.00	2.00	2.00
Limestone	1.50	1.50	1.50	1.50	1.50
Total	100.00	100.00	100.00	100.00	100.00
Calculated (%)					
Crude protein	17.94	17.96	17.93	17.91	17.91
Crude fibre	4.27	6.89	9.49	12.1	14.71
Ether extract	3.98	3.94	4.02	4.11	4.21
Ash	2.92	3.12	3.30	3.30	3.67
ME (kcal/100g)	332.591	344.572	334.518	368.388	379.238

were also determined according to A.O.A.C. (2000).

Determination of performance characteristics of the rabbits

Performance parameters measured from data generated weekly in the feeding trial included feed intake, body weight change, feed conversion ratio and protein efficiency ratio. The following formulae were used for the performance parameters:

Feed intake = (Quantity of feed served – left over)g

Feed conversion ratio = (Quantity of feed consumed ÷ weight gain by the rabbits) g

Carcass evaluation

At the end of the study, four rabbits per treatment were randomly selected, final live weights taken, and then starved overnight by allowing them access to water only. The animals were killed by stunning with a wooden club at the base of the head behind the ears and were then slaughtered by cutting the jugular vein and carotid artery at the level of the atlas vertebra. Proper bleeding was allowed and the carcasses were dressed by removing their pelts and were decapitated at the atlanto-occipital

joint (head). The hind feet were cut along the joint between the tibia calcaneus while the fore feet were at carpal region and the tail cut closed to the base. Evisceration was then accomplished by removing the internal organs (heart, liver, kidneys, lung and the full gut), weighed individually, and then expressed as percentage of the carcass weight.

The hot carcass weight was recorded and the fat was collected from fat depots. The carcasses were stored in a freezer pending carcass analysis, during which they were thawed and the chilled carcass weights were recorded. They were further cut into prima cuts, and deboning was manually done according to Awosanya (1989). The fats were collected from three depots in the animal body and weighed. These are: inter-scapular fat depot (fats on the dorsal side and between the scapulars, extending to neck region and the clavicle bones), inguinal fat depot (fats deposited subcutaneously around the inguinal region prior to evisceration), and perirenal fat depot (fats on the ventral region of the carcass internally surrounding the kidneys

down to the pelvic region after evisceration). The carcass length was determined using tape rule from the anterior edge of the first rib to anterior edge of aitchbone of the pelvis. Cutting into primal parts was done by first dividing the carcasses into two symmetrical halves as much as possible by splitting the vertebral columns. Each half of the carcass was then divided into shoulder, rib, loin and leg. Shoulder was removed by cutting between 5th and 6th ribs perpendicular to the back line. The rib was thereby separated from the loin by cutting behind the 12th rib following its curvature. Loin was separated from the leg by cutting at the tip of the ilium perpendicular to the chine bone according to Awosanya (1989). Weights of the primal parts were taken and recorded. Two different symmetrical halves of carcasses were selected per treatment to make complete whole carcass. The deboning of the primal cuts were manually done and the lean and bones were weighed separately.

Data analysis

Data collected on body weight, feed intake, feed conversion ratio and protein efficiency ratio were subjected to analysis of variance (ANOVA) using statistical analysis system package (SAS, 1999).

Results and discussion

Results from proximate analysis of teak (*Tectona grandis*) kernel meal (TKM) are presented in Table 2. The TKM was found to be rich in crude fibre (54.9%), but low in crude protein (8.75%) and ash (5%). TSM dry matter, ether extract and nitrogen free extract percentages are 92.64, 8.50 and 16.88% respectively, while ME is 1618.29 kcal/kgDM. Values for crude protein and ether extract from this study were lower than what were reported by Olorunsanya *et al.* (2013) for teak seed meal. The crude protein and nitrogen free extract values

from this study were also lower than those of Ocheja *et al.* (2011) who reported 10.13 and 68.13% for teak leaf. Crude fibre value (54.9%) obtained from this study is far above what was reported by Olorunsanya *et al.* (2013) for teak seed meal. The anti-nutritional factors in teak kernel meal are presented in Table 3. Tannin in TKM did not affect the growth rate and feed intake of the rabbits because of the low value recorded from the analysis. This is contrary to the report of Makkar (2003) that tannin, the most important anti-nutritional factor in legume seeds, decreases the growth rate and feed intake of animals as a result of low palatability and decrease in various enzymatic activities. Other anti-nutrients values determined in this study are very low and as such did not pose any threat to the animals. The results on growth performance of the experimental animals are presented in Table 4. It showed that there were significant ($P < 0.05$) differences in the feed intake with the highest (422.55g) recorded in rabbits fed 10% TKM. The lowest (367.67g) weekly feed intake was recorded in rabbits fed 5% TKM. The growth performance indices, except feed intake, showed no significant ($P > 0.05$) differences among the treatment means. The highest final weight (1635.83g) was recorded in rabbits fed control diet while the lowest (1411.20g) was recorded for those fed 20% TKM. This result indicated that the more the level of inclusion of TKM the lower the final weight of the rabbits. Highest weekly feed intake was recorded for rabbits fed control diet while the lowest was the rabbits fed 15% TKM diet. Feed conversion ratio and protein efficiency ratio were at the best in the control followed by 15% and 5% TKM respectively. Final body weights recorded in this study were lower than what were reported by Jiya *et al.* (2013) who fed graded levels of processed tallow seed meal

to rabbits. This parameter is also lower than what were reported by Idowuet *al.* (2013) who fed weaned rabbits with diets containing bamboo leaf meal. Final body weight and daily weight gain of the rabbits in this study indicated higher values than what were reported by Abduet *al.* (2011) who fed acacia pod meal-charcoal based diet to growing rabbits. These, however, were lower than the results of Amaefule *et al.* (2011) who fed weaned rabbits with diets supplemented with organic acids. Results of the average daily weight gain and average daily feed intake from this study were lower than the reports of Abdu *et al.* (2012) when they fed *Ziziphus mauritiana* leaf meal to growing rabbits. However, average daily weight gain in this study is better than the reports of Adeniji *et*

al. (2012) who fed grower rabbits with *Gmelina arborea* leaf meal. Average feed intake in this study compared favourably with the reports of Orayaga and Goholshak (2014) who fed growing rabbits with different sources of groundnut meals, and results showed little disparity in the final weight of the rabbits. The differences in the final weights might be due to the difference in the levels of the test ingredients. The low feed intake recorded in this study may be attributed to the high fat and energy of TKM, which is in accordance with the report of Omole *et al.* (2007) that rabbits will consume less feed when the energy and or fat content(s) are/is high. This is because animals generally feed to meet their energy requirements.

Table 2: Chemical composition of teak kernel meal

Parameter (%)	Composition
Dry matter (DM)	92.64
Moisture	7.36
Crude protein (CP)	8.75
Ether extract (EE)	8.50
Crude fibre (CF)	54.50
Ash	5.00
Nitrogen free extract (NFE)	16.88
ME (kcal/100g)	560.52

Table 3: Anti-nutritional factors in the teak kernel meal

Parameters (%)	Composition
Flavonoid	3.12
Alkanoids	0.42
Phytate	3.65
Tannin	2.35
Cyanide	0.32
Oxalate (mg)	28.60

Table 5 shows the slaughter information and the external offal of the growing rabbit fed the test ingredient. There were no significant ($P > 0.05$) differences in all the parameters considered. However, rabbit fed

control diet had the highest (1738.73g) shrink weight, followed by rabbit on diet 4 (1453.50), while the least (1328.00g) was recorded at treatment 5. The same trend was noticed in bled weight, hot carcass, chilled

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Table 4: Performance of weaned rabbits fed teak kernel meal

Parameter	Teak kernel meal					SEM	SIG
	0%	5%	10%	15%	20%		
Initial weight (g)	370.00	420.00	400.00	362.00	358.00	5.59	NS
Final weight (g)	1635.83	1448.80	1461.40	1421.20	1411.20	96.90	NS
Av. Daily wt. gain (g)	14.06	11.43	11.78	11.77	11.39	9.36	NS
Wkly. feed intake (g)	373.98 ^c	367.67 ^d	422.55 ^a	412.80 ^b	421.47 ^a	8.07	*
Daily feed intake (g)	53.43	52.52	60.36	58.97	60.21	1.84	NS
Feed to gain ratio	3.67	5.23	5.17	4.77	5.06	3.15	NS
Mortality (%)	0.00	16.67	16.67	16.67	16.67		

^{abcd} Means in the same row with different superscripts differ significantly ($P < 0.05$), SEM = Standard Error of Means, NS = not significant

Table 5: Effect of teak kernel meal on slaughter weights and the external offal of the growing rabbits

Parameter (g)	Teak kernel meal					SEM	SIG
	0%	5%	10%	15%	20%		
Shrink weight	1738.73	1432.75	1390.50	1453.50	1328.00	78.09	NS
Bled weight	1703.50	1397.50	1350.25	1419.75	1277.00	78.59	NS
Blood loss	35.23	35.25	40.25	33.75	51.00	52.14	NS
Hot carcass	886.00	705.25	689.00	722.50	652.50	31.54	NS
Chilled carcass	876.00	691.00	679.75	706.00	640.50	31.69	NS
Chilled loss	10.00	14.25	9.25	16.50	12.00	14.43	NS
Pelt	183.25	116.25	127.50	123.00	122.00	131.8	NS
Feet	38.50	38.25	36.25	43.25	38.25	36	NS
Tail	4.50	6.50	5.00	6.00	6.00	3.87	NS
Head	166.50	137.50	137.00	152.00	136.50	343.53	NS

Table 6: Effect of teak kernel meal on visceral organs of grower rabbits

Parameter (%)	Teak kernel meal					SEM	SIG
	0%	5%	10%	15%	20%		
Heart	0.47	0.58	0.54	0.45	0.42	0.02	NS
Kidney	1.04	1.61	1.47	1.43	1.29	0.13	NS
Liver	3.89	5.03	4.39	3.92	5.23	0.69	NS
Lung	1.56	1.79	1.74	1.48	1.53	0.26	NS
Gut	29.47	32.92	36.29	36.23	38.31	246.35	NS
Perirenal fat	16.75	18.75	22.33	9.25	12.25	158.12	NS
Scapular fat	1.13	7.00	4.00	2.63	3.63	73.29	NS
Inguinal fat	15.00	15.33	19.33	11.75	6.75	11.51	NS

SEM = Standard Error of Means, NS = not significant

carcass and head. Rabbits fed control had the highest (183.25g) pelt followed by treatment 3(127.50g), while treatment 5 had the least (122.00g). Rabbit on treatment 4 recorded the heaviest (43.25g) feet followed by treatment 1 (38.50g) and the least (36.25g) from treatment 3. The highest weight (6.50g) for tail was recorded in treatment 2 followed by treatments 4 and 5 (6.00g) while the least was in the control. Table 6 shows the effect of TKM on visceral organs of the experimental rabbits. Visceral organs showed no significant

($P>0.05$) difference. Rabbits fed 5% TKM had the highest heart (0.58%), kidney (1.61%) and lung (1.79%), while those fed 20, 0 and 15% had the lowest heart, kidney and lung. Liver at 20% was at the highest (5.23%) while rabbits on control diet had the lowest liver value (3.89%). Perirenal and inguinal fats were at the highest (22.33 and 19.33% respectively) at 10%, while those fed 20% TKM had the lowest (12.25 and 6.75% respectively) for the same parameters. Scapular fat was at the lowest (1.13%) and highest (7%) at 0 and 5% respectively.

Table 7: Effect of teak kernel meal on carcass cuts and carcass measurements of grower rabbits

Parameter (%)	Teak kernel meal					SEM	SIG
	0%	5%	10%	15%	20%		
Shoulder	13.02	13.21	13.59	12.48	12.89	0.90	NS
Rib	6.38	6.91	6.79	6.15	5.89	0.37	NS
Loin	11.86 ^a	9.97 ^b	10.11 ^{ab}	11.46 ^a	11.43 ^a	0.93	*
Leg	20.09	19.74	19.31	19.34	20.00	0.74	NS
Thigh width (inch)	3.23	2.98	2.98	3.10	2.95	1.00	NS
Carcass length (inch)	9.65	9.23	9.10	9.28	8.93	0.25	NS
Lean:bone							
Shoulder	06:01	07:01	06:01	05:01	06:01		
Rib	05:01	06:01	05:01	04:01	05:01		
Loin	05:01	04:01	04:01	03:01	05:01		
Leg	02:01	03:01	03:01	03:01	03:01		

^{ad} Means in the same row with different superscripts differ significantly ($p<0.05$), SEM = Standard Error of Means, * = significant

Effect of teak kernel meal on carcass cuts and carcass measurements of grower rabbits is presented in Table 7. There were no significant ($P>0.05$) difference in all the parameters measured except in loin where the means were significantly ($P<0.05$) different. Rabbits fed control diet exhibited the highest values in all the parameters except in shoulder and rib. Values of loin obtained from this study were lower than the reports of Abu and Tanimowo (2012). The values were higher than the report of Ahmaefule *et al.* (2011) for shoulder and loin. The lean to bone ratio (Table 7) was at the best for rabbits fed 5% TSM diet for both rib and shoulder. Rabbits fed experimental

diets were better than those fed control diet as with respect to lean to bone ratio of the leg.

Conclusion

Results from this study suggested that teak kernel meal can be incorporated in the diets of rabbits for maximum performance. It is non-toxic because it showed no deleterious effects on the animals. Also, inclusion of teak kernel meal in the diets of rabbits produced better economic benefits than when using soybean meal as source of plant protein. It is concluded that teak kernel meal should be fed up to 20% level of inclusion.

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