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Carcass yield and gastro-intestinal tract morphometry of rabbits fed delinted, undecorticated raw kapok (*Ceiba pentandra*) seed meal based diets

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Abstract

The nutritive potentials of raw Ceiba pentandra (Kapok) seed, an oil seed, as a substitute for conventional oil seeds in livestock feed stuff, is tested. Twenty four rabbits of mixed breeds (New Zealand White × Chinchilla) and of both sexes, with mean initial weight of 1.25±0.25 kg, were used to investigate the effect of kapok seed meal on gastro-intestinal tract morphometry and carcass yield of growing rabbits. The diet was compounded using 0% (control diet), 10, 20 and 30% sundried raw delinted, undecorticated kapok seed meal. Each dietary treatment has six replicates. The animals were assigned to the diets in a completely randomized design (CRD). The study lasted for nine weeks. Weekly body weight changes of each rabbit were measured while gastrointestinal tract measurements and carcass yield were determined after the sacrifice of four (4) rabbits from each treatment at the end of the study. Results showed that treatment means varied significantly ($p<0.05$) with respect to weight gain, slaughter, dressed and head weights of rabbits; while relative head weights and dressing percentage were not significantly different ($p>0.05$) among treatment means. The entire relative GIT, oesophagus and caecum weight were not significantly different ($p>0.05$), while the relative stomach, small intestine and colorectum weights varied significantly ($p<0.05$) among treatment means. The GIT length, oesophagus, stomach, small intestine, colorectum and caecum (%GIT length) did not differ ($p>0.05$) among treatment means. 33.3% mortality was recorded from treatment 4 (30%, KSM). It can be concluded from this study that raw KSM may be included in the diet of rabbits up to 20% but a higher level of inclusion could be detrimental. In addition, a prolonged feeding of or making raw KSM as basal diet is not recommended.

Key words: Gastro-intestinal tract, Carcass, Growth, Kapok, Rabbits.

Running title: Carcass yield and gastro-intestinal tract of rabbits

Rendement en carcasse et morphométrie du tractus gastro-intestinal de lapins nourris avec des régimes à base de farine de graines de kapok cru (Ceiba pentandra) délintées et non décortiquées

Résumé

Le potentiel nutritif de la graine brute de Ceiba pentandra (Kapok), une graine oléagineuse, en tant que substitut des graines oléagineuses conventionnelles dans l'alimentation du bétail, est testé. Vingt-quatre lapins de races mixtes (New Zealand White × Chinchilla) et des deux sexes, avec un poids initial moyen de 1,25 ± 0,25 kg, ont été utilisés pour étudier l'effet de la farine de graines de kapok sur la morphométrie du tractus gastro-intestinal et le rendement en carcasse de lapins en croissance. . Le régime a été composé en utilisant 0 % (régime témoin), 10, 20 et 30 % de farine de graines de kapok brutes séchées au soleil, non décortiquées. Chaque traitement diététique a six répétitions. Les animaux ont été assignés aux régimes dans une conception complètement randomisée (CCR). L'étude a duré neuf semaines. Les changements de poids corporel hebdomadaires de chaque lapin ont été mesurés tandis que les mesures du tractus gastro-intestinal et le rendement en carcasse ont été déterminés après le sacrifice de quatre (4) lapins de chaque traitement à la fin de l'étude. Les résultats ont montré que les moyennes de traitement variaient significativement ($p<0,05$) en ce qui concerne le gain de poids, l'abattage, l'habillage et le poids de la tête des lapins ; tandis que les poids relatifs des têtes et le pourcentage d'habillage n'étaient pas significativement différents ($p>0,05$) entre les moyennes de traitement. Les poids relatifs totaux de l'intestin grêle, de l'œsophage et du caecum n'étaient pas

significativement différents (p>0,05), tandis que les poids relatifs de l'estomac, de l'intestin grêle et du côlon variaient significativement (p<0,05) entre les moyennes de traitement. La longueur GIT, l'œsophage, l'estomac, l'intestin grêle, le colorectum et le caecum (% longueur GIT) ne différaient pas (p> 0,05) entre les moyennes de traitement. Une mortalité de 33,3 % a été enregistrée à partir du traitement 4 (30 %, KSM). On peut conclure de cette étude que le KSM brut peut être inclus dans l'alimentation des lapins jusqu'à 20 % mais qu'un niveau d'inclusion plus élevé pourrait être préjudiciable. De plus, une alimentation prolongée ou la fabrication de KSM cru comme régime de base n'est pas recommandée.

Mots-clés : Tractus gastro-intestinal, Carcasse, Croissance, Kapok, Lapins.

Introduction

The paucity of affordable and readily available feed sources that can enhance higher livestock productivity is a fundamental issue in animal husbandry. In addition, conventional feedstuffs are expensive and competed for by humans. High feed cost has led to high production cost (Wongnaa *et al*., 2023). Ikpi (1987) noted that high profitability in animal production is certain if feed cost is low. To this earlier report Jimoh *et al*. (2023) agreed that the cost of feed and other inputs reduce the farmer's profit by half. Sourcing for adequate, affordable and readily available non-conventional feedstuff has being an area of research occupying animal scientists in Nigeria and other developing countries. In this regard, Yaakugh *et al*. (1998) found that kapok seed has nutritive potential as a feedstuff for livestock. It contains 27% crude protein, 22.73% ether extract, 21.69% crude fibre and the total ash of 5.34%. A later study (Anigo *et al*., 2013) showed that kapok seed contain 36.90% crude protein, 23.10% crude fat while ash is 5.87%. The percent amino acid contents were comparable to oil seeds such as soyabeans, cotton and groundnut seed meals (Yaakugh *et al*., 1998). Kapok seed are relatively available than many conventional protein sources in Nigeria. A preliminary feeding trial conducted by Bitto and Shidi (1999) using raw kapok seed meal did not have adverse effect on serum chemistry and visceral organs of rabbits. Ochefu *et al.* (2009) also reported no significant effects on serum biochemical and haematological parameters of rabbits on dietary raw kapok seed meal (KSM). However, relative kidney weights were observed to vary significantly among treatments of rabbits on KSM (Ochefu *et al*., 2011) Rabbits (*Oryctolagus cuniculus*) have been recommended (Cheeke *et al*., 1982; Taiwo *et al*., 2005) as having the best productive traits to bridge the protein gap. Such traits includes; rapid growth rate, low initial capital investment, small space requirement, high fecundity and short gestation length. The meat is all white, fine grained, delicately flavoured, nutritious, palatable, low in fat and caloric value but high in protein (20-22% protein) (Fielding, 1991). On this premise, this study was designed to measure gastrointestinal tract morphometry, and carcass yield of rabbits fed rations with kapok seed meal (KSM) inclusion.

Materials and methods

The feeding trial was conducted at a rabbitry in Makurdi, a town situated in the guinea savanna belt of Nigeria. Makurdi lies between latitude 7°40′ N and 7°50′N and between longitude 8°20′ E and 8°40′ E (Obiora *et al*., 2015) at a height of 73-167 meters above sea level (Chia *et al*., 2014). Twenty four (24) rabbits of mixed breeds (New Zealand white and Chinchilla) and of both sexes were used for this experiment. The animals were obtained from the University of Agriculture, Makurdi teaching and research farm. The mean initial weight of the rabbits was 1.25±0.25kg. Prophylactic treatment was administered and the animals were allowed to acclimatize for one week. The rabbits were randomized by weight into four dietary treatments of six replicates each (comprising of three males and three females). They were placed in cages and fed test diets containing delinted, undecorticated raw kapok seed meal at 0% (control diet), 10%, 20% and 30%. The diets contain basal ingredients of maize, full fat soyabeans, rice offal and dried sorghum Burukutu (local alcoholic drink made from germinated sorghum) waste. Feed and water were supplied *ad-libitum*. The feeding trial lasted for 63 days (nine weeks). Each replicate was weighed weekly and the difference from the previous week makes up the weekly gain. At the end of the feeding trials, sixteen (16) rabbits were randomly selected

(four per treatment) and sacrificed. Each animal was stunned, the carotid arteries and the jugular vein were then severed to enhance maximum bleeding (Joseph *et al*., 1994). After evisceration and evacuation of the gut contents each slaughtered rabbit was singed. The carcasses were weighed and the dressing percentages were determined according to methods reported by Aduku and Olukosi (2000) using the formula as given below.

Dressing percentage = live weight / singed weight X 100

The length and weights of the oesophagus, stomach, small intestine, colorectum, and caecum were measured according to methods described by Aduku and Olukosi (2000).

Data collected were subjected to analysis of variance (ANOVA) in a completely randomized design (CRD) and where significant differences occur the means were subjected to Duncan multiple range test (DMRT) as outlined by Steel and Torrie (1980).

Results and discussion

Proximate composition of the test ingredient (kapok seed) percent dry matter is presented in table 1. Ingredient composition of the diet and the calculated analysis of the diet are presented in table 2. The value of the calculated analysis of the ration showed that the dietary requirement of grower rabbit is met as recommended by NRC (1977). The diets were isocaloric and isonitrogenous.

Table 1: Proximate analysis of delinted, undecorticated raw kapok seed meal

Nutririent (%DM)	Composition
Dry matter	95.31±0.02
Crude protein	28.53±1.01
Crude fat	13.89±0.20
Crude fibre	21.79±0.02
Ash	4.91±3.22
Gross energy (Kcal/kg)	4132±370.58

The relative weights for the entire GIT (17.04 – 19.39% BW) presented in table 2, were higher than the values of 12.22 – 13.64 reported by Ewuola (2009). The oesophagus and caecum weight (%BW) did not vary significantly ($p>0.05$). The figures for caecum (1.14 – 1.66%) tends to agree with the report of Onifade and Tewe (1982) and Anugwa *et al*. (1998) that caecum weight increases with increased crude fibre in the diet. The percent caecum weight of rabbits on 30% KSM diet was higher than other

Table 2. Ingredient composition of experimental diets (%).

Ingredients	Dietary treatments			
	0%	10%	20%	30%
Yellow maize	34.90	32.20	29.50	26.80
Full fat Soyabeans	23.90	16.60	9.30	2.00
KSM	-	10.00	20.00	30.00
Rice offal	26.50	26.50	26.50	26.50
Sorghum BDW	10.00	10.00	10.00	10.00
Palm oil	1.00	1.00	1.00	1.00
Bone ash	2.50	2.50	2.50	2.50
Premix	0.30	0.30	0.30	0.30
Salt	0.50	0.50	0.50	0.50
Methionine	0.40	0.40	0.40	0.40
Total	100.00	100.00	100.00	100.00
Calculated analysis of diets				
Nutrients (%)				
Crude protein	16.04	16.05	16.05	16.06
Crude fibre	14.76	16.29	17.82	19.34
Calcium	0.88	0.89	0.90	0.91
Phosphorus	0.78	0.75	0.71	0.67
Lysine	0.79	0.82	0.85	0.87
Methionine	0.68	0.75	0.82	0.89
ME (Kcal/kg)	2792.25	2793.72	2795.19	2796.66

ME – Metabolizable energy

BDW - Brewer's dried waste.

Premix - Propriety premix added to supply recommend amounts of all required vitamins and minerals other than; Calcium, Phosphorus, Sodium

treatment means in this study. Mean caecum weight were lower than weights reported by Shaahu *et al*. (2014). This could be due to breed differences of experimental animals.

The mean relative stomach, small intestine, and colorectum weights vary significantly ($p<0.05$). The higher weight observed in rabbits on 30% KSM diet may be attributed to the fibre type and composition. Onifade and Tewe (1982), Anugwa *et al*. (1998) and Ochefu *et al*. (2020) noted that stomach size is directly proportional to the quantity of crude fibre intake of rabbits. Gidenne, (2015) and Vázquez *et al*. (2018) also stated that the amount and physical-chemical constituents of the dietary fibre modify the development of gastrointestinal tract. The small intestine weights (0.88 – 1.35%) were lower than the findings of Shaahu *et al*. (2014). This variation may be due to differences in age, breed and/or initial body weight of rabbits used in either experiment.

The mean relative lengths (oesophagus, stomach, small intestine, colorectum and caecum) (Table 3) were not significantly ($p>0.05$) different. When this relative values are compare with the percent weight of the GIT, it may be inferred that there have been no lateral enlargement of the intestinal tract (small intestine and colorectum), since the trend here did not show any variation. Consequently this can justify the claim that mid-section of the intestinal

tract may have been impacted by the diet as a result of indigestion or slow digestion rate.

Table 3: Effect of raw kapok seed meal on the weights (%) of gastro-intestinal tracts of rabbits (Mean ± Sem)

Parameters	Dietary treatments			
	0%	10%	20%	30%
GIT (%)	18.65±1.15	17.38±0.72	17.04±1.33	19.39±1.82
Oesophagus (%)	0.06 ±0.005	0.09±0.005	0.09±0.014	0.08±0.004
Stomach (%)	0.92^{ab}± 0.09	0.73^{b}±0.06	0.78^{b} ±0.06	1.09^{a}± 0.08
Small Intestine (%)	0.97^{b}±0.05	0.98^{b}±0.05	0.88^{b}±0.08	1.35^{a}± 0.13
Colorectum (%)	1.12^{b}±0.69	1.19^{ab}±0.07	1.32^{ab}±0.08	1.51^{a}± 0.10
Caecum (%)	1.17±0.08	1.16±0.06	1.14 ±0.11	1.66 ± 0.33

Sem - standard error of mean
^{a,b} - Means in the same row with different superscripts are significantly different while means with the same superscripts are not significant (P< 0.05)
GIT - Gastrointestinal tract
% - Percentage

Table 4: Effect of raw kapok seed meal on gastro-intestinal tract length (% GIT) of rabbits (Mean ± Sem)

Parameters	Dietary treatments				P(0.05)
	0%	10%	20%	30%	
Oesophagus (%)	2.89 ± 0.11	2.74 ± 0.17	2.96 ± 0.17	3.11 ± 0.24	ns
Stomach (%)	2.53± 0.15	2.41± 0.11	2.21± 0.14	2.85± 0.22	ns
Small intestine (%)	63.32±2.99	70.68±9.82	64.14±0.61	63.78±4.44	ns
Colorectum (%)	31.45±0.56	30.32±0.74	30.94 ± 0.89	30.54 ± 1.83	ns
Caecum (%)	12.05±0.29	11.27±0.64	11.71 ± 0.78	13.04 ± 1.08	ns

Sem - Standard error of mean
ns - Not significantly different (p> 0.05)

Data in table 4 showed final weight (g), weight gain, slaughter and head weight followed the same trend. The final weights of the rabbits on the 0% (control diet), 10% and 20% KSM were similar ($p>0.05$) while those on 30% KSM differed significantly ($p<0.05$) among treatment means. Similarly, the mean weight gain among treatment differed significantly ($p<0.05$). The mean weight gain in 30% KSM (300±0.09g) was lower than the control, 10% and 20%. It is inferred that the rabbits on 30% KSM may have had poor feed efficiency compared to the other treatments; which could imply that 30% level of KSM on a prolonged feeding could be lethal. Gidenne and Lebas (2005) noted that daily feed intake correlated with less digestible fibre (Acid detergent fibre). Gidenne and Lebas, (2002) also stated that animal on very high dietary fibre cannot increase its intake adequate to meet its energy needs; consequently, leading to lower growth rate. The mortality in this treatment (30% KSM) further justifies the assertion made in this report.

Slaughter, dressed and head weights varied significantly ($p<0.05$) among treatment means, showing that rabbits in 30% KSM with lower mean weight. The mean slaughter weights of 1350-1889g were however, higher than those reported by Igwebuike *et al*. (2001). This disparity could however be attributed to other factors such as initial weight and age differences of the animal in the two studies. But weight depression in the treatment with 30% KSM could be related to some other unknown factors in the diet which led to low feed intake by the rabbits. But Yaakugh *et al*. (1998) showed that kapok seed has nutritive potential as a feedstuff for livestock. And the percent amino acid contents were high and comparable to oil seeds such as soyabeans, cotton and groundnut seed meals. Bitto and Shidi (1999) had also conducted a preliminary feeding trial on rabbits using raw kapok seed meal.

The percent head weight (8.55-9.46) is comparable to the values obtained by Igwebuike *et al*. (2001). The dressing percentage (65.94-70.62) were similar to the values reported by Bawa *et al*. (2005) but were higher than those obtained by Igwebuike *et al*. (2001) and Dairo *et al*. (2005). This disparity could be attributed to live weight of the rabbits. Garcia *et al*. (1993) reported that the dressing percentage of rabbits slaughtered at a live weight of 2.0 and 2.5 kg were 58 and 65% respectively. It can be inferred that dietary treatment enhanced high dressing percentages. The causes of mortality (33.3%) in 30% KSM diet were not ascertained. But the rabbits were found dead during routine checks in the morning of days in the sixth and seventh week of feeding trial. They were rigor mortis when discovered, a careful examination of the body vents showed no discharge or wetness. Nonetheless, the cases of mortality could further justify the claim that there is a growth depressive and a lethal factor in 30% KSM diet.

Table 5: Growth and carcass yield of rabbits fed raw kapok seed meal (Mean ± Sem)

Parameter	Dietary treatments			
	0%	10%	20%	30%
Initial weight (g)	1330	1250	1270	1200
Final live weight (g)	1940^{a} ±0.06	1890^{a}±0.10	1910^{a}±0.04	1500^{b}±0.11
Weight gain (g)	610^{a}±0.08	640^{a}±0.14	640^{a}±0.08	300^{b}±0.09
Slaughter weight (g)	1880^{a}±0.08	1690^{a}±0.13	1760^{a}±0.07	1350^{b}±0.09
Dressed weight (g)	1150^{a}±0.05	1070^{a}±0.09	1130^{a}±0.06	800^{b}±0.06
Head weight (g)	165.12^{a}±6.78	153.82^{a}±7.55	158.73^{a}±2.31	132.68^{b}±5.13
Head (% BW)	8.55±0.05	8.84±0.27	8.76±0.32	9.46±0.32
Dressing %	68.29±3.10	69.39±0.88	70.62±0.98	65.94±1.09
Mortality %	0.00	0.00	0.00	33.30

Sem - Standard error of mean
a, b - Means in the same row with different superscripts are significantly different (p< 0.05)
BW - Body weight
% - Percentage

Conclusion

It can therefore be concluded that milled raw KSM, should not be included in rabbit diet at more than 20%. And a prolonged feeding of milled raw KSM to rabbits even at 20% level could have a cumulative effect on the animal which may be detrimental. 10%

milled raw KSM inclusion in rabbits' diets appears to be tolerated by rabbits in this study.

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