Carcass quality and economic benefit of New Zealand White rabbit bucks fed processed *mucuna pruriens*

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Abstract

The concern of people about nutritional quality and healthy eating make them to reduce meat consumption due to the fear of hypercholesterolemia. Against this background, there is need to incorporate cholesterol-reducing feed stuff into diets of meat producing animals. This study was therefore carried out to evaluate the performance as well as carcass quality of rabbits fed diets containing processed *Mucuna* seed meal (MSM) for 84 days. A total of 45 rabbit bucks (New Zealand White) of six weeks old were divided into three treatment groups of 15 rabbits each. Each treatment group was replicated thrice with five rabbits per replicate. The rabbit groups were randomly assigned to three treatment diets in a completely randomized design: The three experimental diets were formulated such that *Mucuna pruriens* seed (processed by soaking and boiling) replaced maize at 0, 20 and 30% as T_1 , T_2 and T_3 respectively. T_1 served as the control without *Mucuna Pruriens*. Data were collected on feed intake, weight gain, feed conversion ratio, carcass traits and meat lipid profile viz: total cholesterol (TC), triglyceride (TG), low density lipoprotein (LDL), very low density lipoprotein (VLDL) and high density lipoprotein (HDL). Result obtained revealed that rabbits on mucuna-based diets (T_2 and T_3) had significant ($P<0.05$) increase in feed intake and weight gain than rabbits on diet T_1 (control). Similarly, carcass characteristics of the animals fed mucuna-based diets showed significant ($P<0.05$) increase in dressed weight, dressing percentage, cut parts (fore leg, hind leg, loin, thoracic cage) except organ (liver, kidney, heart, lungs) weights which were comparable to rabbits fed control diet. Significant ($P<0.05$) improvement in meat quality in terms of increase in HDL, protein, muscle, meat to bone ratio and reduction in TC, TG, LDL, VLDL and fat were obtained for the rabbit fed the mucuna-based diets. Economy of production indicated that cost of feed consumed and cost per weight gain reduced for rabbits fed MSM compared to those fed control diet. The results of the trial have shown that processed MSM can be used to substitute maize in diet up to 30% for improved performance, carcass traits and meat quality of rabbit bucks.

Keywords: Carcass quality, rabbit buck, *Mucuna pruriens*, economic benefit

La Qualité de carcasse et l'avantage économique des mâles blancs de lapin de Nouvelle-Zélande alimentés pruriens transformés de mucuna

Résumé

Les préoccupations des gens au sujet de la qualité nutritionnelle et d'une alimentation saine les font réduire la consommation de viande en raison de la crainte de l'hypercholestérolémie. Dans ce contexte, il est nécessaire d'incorporer des aliments pour animaux réducteurs de cholestérol dans les régimes alimentaires des animaux producteurs de viande. Cette étude a donc été réalisée pour évaluer la performance ainsi que la qualité de carcasse des lapins nourris à des régimes contenant des farines de graines de *Mucuna* transformées (le 'MSM') pendant 84 jours. Un total de 45 mâles de lapin (New Zealand White) de six semaines ont été divisés en trois groupes de traitement de 15 lapins chacun. Chaque groupe de traitement a été répliqué trois fois avec cinq lapins par réplique. Les groupes de lapins ont été assignés au

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hasard à trois régimes de traitement dans une conception complètement randomisée : Les trois régimes expérimentaux ont été formulés de telle sorte que les graines pruriens de Mucuna (traitées par trempage et ébullition) ont remplacé le maïs à 0, 20 et 30% comme T1, T2 et T3 respectivement. T1 a servi de contrôle sans Mucuna Pruriens. Des données ont été recueillies sur la consommation d'aliments pour animaux, le gain de poids, le rapport de conversion des aliments pour animaux, les traits de carcasse et le profil lipidique de la viande viz : cholestérol total (le 'TC'), triglycérider (le 'TG'), lipoprotéine de basse densité (le 'LDL'), lipoprotéine de très faible densité (le 'VLDL') et lipoprotéine de haute densité (le 'HDL'). Le résultat obtenu a révélé que les lapins qui suivraient un régime à base de mucuna (T2 et T3) avaient une augmentation significative ($P<0,05$) de la consommation d'aliments pour animaux et du gain de poids que les lapins au régime T1 (contrôle). De même, les caractéristiques de carcasse des animaux nourris à base de mucuna ont montré une augmentation significative ($P<0,05$) du poids habillé, du pourcentage d'habillage, des parties coupées (jambe avant, patte arrière, longe, cage thoracique) à l'exception des poids des organes (foie, rein, cœur, poumons) comparables aux lapins nourris au régime de contrôle. Une amélioration significative ($P<0,05$) de la qualité de la viande en termes d'augmentation de la HDL, des protéines, des muscles, du rapport viande/os et de la réduction du TC, du TG, du LDL, du VLDL et de la graisse a été obtenue pour le lapin nourri aux régimes à base de mucuna. L'économie de production a indiqué que le coût des aliments consommés et le coût par gain de poids réduit pour les lapins nourris aux 'MSM' par rapport à ceux nourris régime de contrôle. Les résultats de l'essai ont montré que les 'MSM' transformés peuvent être utilisés pour remplacer le maïs dans l'alimentation jusqu'à 30 % par une meilleure performance, des caractéristiques de carcasse et la qualité de la viande des mâles lapins.

Mots-clés: Qualité carcasse, mâle lapin, Pruriens Mucuna, avantage économique

Introduction

Rabbit industry is gradually growing in many African countries including Nigeria due to increased awareness of rabbit meat consumption by the populace as the most nutritious meat, lowest in percentage of fat and highest in protein percentage than chicken, turkey, beef and pork (Fielding, 1991). However, success in rabbit production would be difficult if producers do not give enough attention to the diet and provide wholesome feeds in adequate quantity and quality for domestic animals like rabbits. Forage given to the animal depends on what is available. In order to increase the scale of production, adopting an alternative and cheaper source of feed to replace or supplement cereals would be an important strategy. The concern of people about nutritional quality and healthy eating make them to reduce meat consumption due to the fear of hypercholesterolemia (Abey-

Wardena, 2003). Therefore, there is the need to adopt measures to produce meat with low cholesterol level. One way of lowering meat cholesterol level is to incorporate cholesterol-reducing factors into the diets of meat producing animals (Jayaweera *et al.*, 2007; Asaolu *et al.*, 2010). Dietary inclusion of certain crops residues, seeds and leaves which are locally available and suspected to have therapeutic values in diets of fast growing animals such as rabbits may achieve these purposes. One of such plant is *Mucuna pruriens* (velvet bean). This could be described as lesser-known legume which grows in the wild but is native to Africa and Nigeria in particular. It can be fed to rabbits either as seed or leaves (Aboh *et al.*, 2002; Taiwo *et al.*, 2006). The seeds of velvet bean are high in protein, carbohydrates, lipids, fiber and minerals. They are also rich in antioxidants such as flavonoids, saponins and L-dopa

(Herbal Powers 2007; Widowati *et al.*, 2007) although studies have shown that if processed, these anti-oxidants get reduced but often help in improving feed and weight gain while reducing cholesterol in **hypercholesterolemic rats**. (Pugalenthi *et al.*, 2005; Vadivel *et al.*, 2007). This study was therefore carried out to evaluate the effect of processed mucuna seed meal on carcass quality as well as performance of New Zealand White rabbit bucks.

Materials and methods

This study was conducted in teaching and research farm of Akwa Ibom State University, Nigeria. Uyo is in the South-South geo-political zone of Nigeria and lies 70m above sea level, located on latitude 4°58' and 5°08'N and longitude 8°02' and 9°47'E, temperature range between 25.0°C and 26.0°C with average relative humidity of 75-80% while mean annual rainfall vary from 2250mm to 2926mm with 3 months duration of dry season in a year (https://en.wikipedia.org/wiki/Akwa_Ibom_State). The test material, *Mucuna pruriens* seeds were handpicked in Uyo,

Nigeria. Processing of the *Mucuna pruriens* seeds was carried out based on procedures outlined by Emenalom *et al.* (2005). The seeds were soaked in water for 48 hours then boiled in maize-cob ash solution for 1 hour, drained and air-dried before ground to form meal. 100g of the meal sample was analyzed for proximate composition, mineral elements and anti-nutritional compounds using standard procedures by AOAC, (2003) and Raina & Khatri (2011). Experimental diets were later formulated such that the *Mucuna pruriens* seed meal (MSM) constituted 0, 20 and 30% of the diets and designated as T1, T2 and T3, respectively. Forty-five (45) New Zealand White rabbit bucks aged 6-7 weeks were acquired from private research farm in Uyo. The rabbits were pre-conditioned within two weeks with medications given before divided into three groups of 15 rabbits each and allotted randomly to the three treatment diets. Each treatment group subdivided into 3 replicates comprising 5 rabbits per replicate and each replicate housed in a hutch measuring 70cm x 70cm. The entire hutch system was of the three-tier model.

Table 1: Composition of experimental diets

Ingredients	Level of <i>Mucuna pruriens</i> meal in the diet (%)		
	0.00(T1)	20.00(T2)	30.00(T3)
Maize	45.00	35.00	27.00
Whole soybean	15.00	5.00	3.00
<i>Mucuna pruriens</i> meal	0.00	20.00	30.00
Fish meal	1.00	1.00	1.00
Wheat offal	37.00	37.00	37.00
Bone meal	1.50	1.50	1.50
Vit/min. Premix*	0.25	0.25	0.25
Salt	0.25	0.25	0.25
Total	100.00	100.00	100.00
Calculated Composition of Experimental Diets			
Crude protein	17.10	17.90	18.07
Crude fibre	5.50	6.07	6.65
Ether extract	3.98	4.10	4.22
Ash	3.86	3.98	4.10
ME(Kcal/ kg)	2530	2750	2830

*Hi Nutrient International Premix providing the following per 25kg; Vit.A, 8,000,000iu; Vit.D3,16,000,000iu; Vit.E, 20,000mg; Vit.K,2000mg; Vit.B1,1500mg; vit. B2,4,000mg, vit. B6,2,000mg; vit. B12,10mg; Niacin, 15,000mg; Choline chloride, 200, 000mg; pantothenic acid,5000mg;

Data collection

Each rabbits were weighed at the beginning of the feeding trial and subsequently on weekly basis. Feed intake was determined by obtaining the difference between the quantity of feed offered and quantity left over the following morning. Total weight gain was determined by the difference between initial weight and final weight. Daily weight gain was obtained by dividing the weekly weight gain by 7 days of the week. Feed conversion ratio was computed by dividing the average daily feed intake by the average daily weight. The economic analysis was based on the method by Ekpo *et al.* (2009). The cost of dietary ingredients (N/kg) was used to calculate the feed cost per kg of each diet. Cost of total feed consumed was calculated by multiplying feed intake by cost per kg feed. While cost per kg body weight gain was calculated by multiplying cost per kg feed by feed conversion ratio. At day 84 of the feeding trial, 6 rabbits per treatment (2 per replicate) making a total of 18 rabbits were randomly selected, starved of feed but not water for 12 hours, weighed to obtain pre-slaughter weight then slaughtered after stunning. The carcasses were immediately skinned, eviscerated and the gut emptied to obtain the dressed weight which was also used in calculating dressing percentage as the ratio of dressed weight to pre-slaughter weight multiplied by 100. Each of the organs (heart, liver, kidney and lungs) were removed, weighed and expressed as percentages of live weight. The whole Carcass was cut into different cut-parts after abdominal fat had been removed and weighed using electronic scale (AS3101). The carcass evaluation was carried out as described by Ekpo *et al.* (2009). Meat crude protein content was measured by Kjeldahl's method (AOAC, 2003). Meat total lipid was determined using the methanol: chloroform (2:1) extraction and estimation method of Folch as described by Rahman *et al.* (2011).

After measuring the meat total lipid, 1ml of total solution was used to measure the total cholesterol content by the cholesterol oxidase assay (NCEP, 2001) using commercially available reagent kits

Statistical Analysis: Data on live weights, carcass quality and organ characteristics were subjected to one-way analysis of variance in a completely randomized design. Significant differences were observed at 0.05 levels, means were separated using Duncan's new multiple range test as outlined by Obi (1990). The SAS computer software package (SAS, 2000) was used for all statistical analysis.

Results and discussion

The proximate composition of the processed *mucuna P. seed* are shown in Table 2. Result indicated that crude protein content, 25.45%; ether extract, 6.98%; crude fibre, 9.56% and ash (6.16%) obtained in this study were within the ranges of 23-35% for protein, 6.3-7.4% for ether extract, 8.7-10.5% for crude fibre, as well as 3.3-5.5% for ash reported by Gurumoorthi *et al.* (2003); Pugalenth *et al.* (2005) and Vadivel *et al.* (2007). The value of phytochemical constituents of the processed *Mucuna* seed obtained in this study reduced significantly in comparison with the raw seeds value. For instance, L-Dopa value (1.88%) obtained was lower than the value (7%) reported by Cook *et al.*, (2005). Same trend was observed for HCN, Phytate and flavonoid (Pugalenth *et al.*, 2005; Ogudoro *et al.*, 2014). This shows impact of heat processing method used. Diallo and Berhe (2003) had earlier reported that Processing reduce anti-nutrient compounds in legumes as well as increase in biological benefits and ease of digestion. The result of proximate composition of the experimental diets is presented in Table 3. It indicated higher values in terms of protein, ether extract, ash and fiber for mucuna-based diets.

Table 2 Proximate and Phytochemical Composition of processed *mucuna pruriens* seed

Component	% Dry matter
Dry matter	90.40
Crude protein	25.45
Crude fibre	10.06
Ether extract	6.98
Ash	6.16
Nitrogen free extract	51.35
ME (Kcal/kg)	3330.65
L-dopa (%)	1.88
HCN (mg/100g)	4.80
Phytate (g/100g)	3.08
Flavonoid (g/100g)	3.01
Saponins (g/100g)	2.80

Table 3: Proximate composition of the experimental diets

Parameters	Dietary inclusion levels of <i>Mucuna</i> seed meal		
	T ₁ (0%)	T ₂ (20%)	T ₃ (30%)
Dry matter	91.51	89.37	90.47
Crude protein	16.85	17.30	18.40
Ether extract	3.42	5.46	6.47
Ash	6.00	5.37	6.08
Crude fibre	6.43	7.85	8.04
Nitrogen free extract	67.30	64.02	61.01
ME(Kcal/kg)	3289.96	3355.62	3371.37

Table 4 shows that the highest significant ($P<0.05$) daily feed intake was obtained for rabbits fed diet in T₃ followed by the rabbits fed diet in T₂ while the rabbits fed diet in T₁ had lowest intake. The significant increase in feed intake for rabbits on diets T₂ and T₃ show palatability of the test diets as well as effect of the dietary antioxidants might have contributed to the higher feed intake observed. This corroborates Aboh *et al.* (2002) and Selim *et al.* (2008) who linked higher voluntary feed intake in rabbit fed mucuna-based diet to dietary antioxidant such as flavonoid. The increased dietary fibre content of the diets T₂ and T₃ (Table 3) could contribute to the increasing feed intake. This agrees with Olorunsanya *et al.*

(2007) who reported increase in dietary crude fibre stimulated voluntary feed intake in rabbits fed sun-dried cassava waste meal. This invariably resulted in the higher body weight gain of the rabbits fed mucuna-based diets (T₂ and T₃) compared to T₁. The increased weight gain might also be made possible by the antioxidant, flavonoids present in the MSM which is known to ease digestion as well as improve weight gain in rabbits and broiler chickens (Adenkola *et al.*, 2010). Higher growth rates for rabbits fed MSM had earlier been attributed to the rich vitamins, essential amino acids and unsaturated fatty acids such as linoleic and linolenic of mucuna seed meal by Aboh *et al.* (2002) and Emenalom *et al.* (2005).

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Table 4: Effect of *Mucuna* seed meal (MSM) on growth performance of Rabbits

MP level	Initial wt (g)	Final wt (g)	Total wt (g)	Daily wt gain (g)	feed intake (g)	FCR
0% (T ₁)	452.50	1332.00c	879.00c	10.55c	70.65c	6.69
20% (T ₂)	446.50	1506.50b	1060.00b	12.62b	80.68b	6.39
30% (T ₃)	430.00	1606.00a	1176.00a	14.00a	89.52a	6.39
SEM	10.54	26.46	11.49	0.40	2.63	0.35

^{a,b,c} Means in the same column bearing different superscripts differ significantly (P<0.05); NS =

Not significant. wt =weight

Result presented in table 5 indicated that for rabbits offered mucuna-based diets, pre-slaughter weight, dressed weight, dressing percentage and prime cuts increased significantly (P<0.05) due to higher weight gain earlier observed for rabbits on mucuna diets. There could be a synergistic interactive effect of the increased dietary protein and energy content of mucuna-based diets (Table 5) thereby contributing to the slaughter yield. Pla (2004), Obinne and Mmereole (2010) had reported that slaughter yield in rabbits could be influenced by nutrition especially dietary protein and energy due to synergistic interactive effect of protein and energy level. For the organs; heart, lungs, liver, kidneys whose weights did not differ significantly (P>0.05) among the treatment groups reflects non- toxic effects of the phytochemicals present in the *Mucuna* which could be attributable to processing method used. This corroborates Ekpo *et al.* (2016) who stated that abnormal increase in organ weights is mostly a reflection of toxicity in diets.

Results of the meat lipid profile presented in Table 6 show significant (P<0.05) decrease in total cholesterol (TC), low density lipoprotein (LDL), triglyceride (TG), very low density lipoprotein(VLDL) and increased in high density lipoprotein (HDL) for the rabbits on *mucuna* diets. The hypolipidaemic activity observed in the

rabbit meat is not unconnected with the presence of saponins and antioxidants such as flavonoid in the *mucuna* (Table 2). Herbal powers (2007) had earlier asserted that saponins and **Flavonoid, an antioxidant in mucuna seed significantly decrease total cholesterol, LDL, triglyceride and increase HDL-cholesterol in hypercholesterolemic rats. In addition, the authors asserted that L-Dopa in mucuna seed also contributes to reduction of cholesterol and blood sugar levels in rats. Saponins are plant compounds that have surfactant properties to bind to cholesterol and bile acids.**

Results on muscle, bone and their ratio (Table 6) indicate significant (P<0.05) increase in muscle as the dietary level of MSM increased. However, bone percentage showed no significant (P>0.05) increase. The significant (P<0.05) increase in muscle suggest that MSM could promote muscularity while reducing fat. The increased muscle could be a reflection of the higher weight gain earlier observed (Table 4), due to higher dietary protein and energy content of MSM (Table 3). This corroborates both Pesti (2009) who reported that increase in dietary protein directly promote muscle weight in broiler birds and Xicatto (1999) who reported that protein content in meat increase as fat content reduce and vice versa.

Table 5: Effect of *mucuna seed meal (MSM)* on carcass characteristics of rabbits

MSM % in diet	Pre- slaughter weight (g)	Dressed weight (g)	Dressing %	Liver (%l.w)	Heart (%l.w)	Lungs (%l.w)	Kidney (%l.w)	Fore- leg (g)	Thoracic cage (g)	Loin (g)	Hind- leg (g)	Breast (g)
0% (T ₁)	1322.00 ^c	680.00 ^c	51.43 ^b	2.81	0.32	0.62	1.01	137.00 ^b	120.00 ^b	227.00 ^b	250.00 ^b	5.50
20% (T ₂)	1501.00 ^b	839.41 ^b	55.92 ^a	3.22	0.36	0.70	0.81	164.00 ^a	142.00 ^a	258.90 ^a	275.00 ^a	5.52
30% (T ₃)	1589.00 ^a	917.00 ^a	57.70 ^a	4.09	0.37	0.64	0.91	168.00 ^a	159.00 ^a	269.00 ^a	293.00 ^a	6.43
SEM	12.55	19.45	1.31	0.88	0.34	0.07	0.08	8.54	7.05	10.01	8.02	0.57

^{a,b,c} Means in the same column bearing different superscripts differ significantly (P< 0.05); l.w = Liveweight MPM = *Mucuna pruriens* meal

Table 6: Effect of MSM on rabbit meat lipids profile

Dietary level of velvet bean	Total cholesterol (TC) (mg/100g)	Triglyceride (TG)(mg/100g)	High density lipo protein(HD) (mg/100g)	Low density protein (LDL) (mg/100g)	lipo- protein(VLDL) (mg/100g)	-
0% (T ₁)	57.72 ^a	103.24 ^a	11.31 ^c	37.44 ^a	9.36 ^a	
20% (T ₂)	54.21 ^b	98.79 ^b	14.82 ^b	29.64 ^b	8.97 ^b	
30% (T ₃)	51.87 ^c	92.56 ^c	17.55 ^a	25.74 ^c	7.80 ^c	
SEM	0.01	0.01	0.02	0.02	0.10	

^{a,b,c} Means in the same column bearing different superscripts differ significantly (P<0.05); NS =

Not significant.

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Table 6: Effect of MSM on abdominal fat, protein, muscle to bone ratio

Dietary level	Protein (g/100g)	Abdominal fat (%)	Muscle (%)	Bone (%)	Muscle/bone ratio
0% (T ₁)	21.07 ^c	10.96 ^a	66.06 ^c	22.98	2.87 ^c
20% (T ₂)	22.82 ^b	5.93 ^b	71.00 ^b	23.06	3.08 ^{ab}
30% (T ₃)	23.97 ^a	3.00 ^c	73.68 ^a	23.30	3.16 ^a
SEM	0.30	0.11	0.65	1.26	0.17

^{a,b,c} Means in the same column bearing different superscripts differ significantly (P<0.05).

Table 7 shows the result of economic benefit of incorporating *mucuna seed* meal in rabbit diets. Cost of feed per kg reduced as the level of *mucuna seed* meal increased. This reflect the lower cost of *mucuna seed* meal relative to maize. Cost of feed consumed significantly (P<0.05) differed among the treatment groups even as it ranged from N962.34 to N1059.75 with rabbits fed the control diet incurred the highest cost of feed while rabbits fed MSM attracted the least cost of feed consumed. This is a reflection of

the lowest cost per kg feed in diet 3 earlier observed. In the same vein, highest feed cost per kg body weight gain was obtained for rabbits in diet T₁ while the lowest value was recorded for rabbits on diet3. This implies that inclusion of MSM in rabbit diets reduced the cost of feed consumed as well as cost per kg body weight gain significantly relative to the rabbit fed the control diet. Hence, inclusion of *mucuna pruriens* seed meal in rabbit diet is economically profitable.

Table 7: Economics of rabbits fed processed *mucuna seed* meal

Dietary level	Cost/kg feed (₦/kg)	Cost of feed consumed (₦/kg)	Cost/kg weight gain (₦/kg)
0% (T ₁)	15.00 ^a	1059.75 ^a	100.35 ^a
20% (T ₂)	11.75 ^b	1002.04 ^b	79.31 ^b
30% (T ₃)	10.75 ^{bc}	962.34 ^c	68.69 ^c
SEM	1.03	10.38	2.14

^{a,b,c} Means in the same column bearing different superscripts differ significantly (p<0.05); NS = Not significant.

Conclusion

Processed *mucuna pruriens* seed meal can be used in the diets of rabbit-bucks up to 30% for optimum improvement in performance, carcass yield and meat quality of rabbit bucks. This is coupled with the reduction in the cost per kg, cost of feed consumed and cost of feed per kilogram weight gain, the lowest being at 30% level of substitution of the *mucuna Pruriens seed* meal.

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