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NUTRITIONAL EVALUATION OF PROCESSED MANGO *(Mangifera indica* - Kent) SEED KERNEL MEAL AS REPLACEMENT FOR MAIZE IN THE DIET OF GROWING CROSSBRED RABBITS

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ABSTRACT: *A study was conducted to investigate the effect of different inclusion levels of sun-dried and parboiled mango seed kernel meal in diets of growing rabbits. Thirty crossbred male rabbits of between 6-8 weeks old with average initial weight of between 630.70g-646.36g were used. Five diets were formulated to contain 0 (control) 10 and 20% sun-dried mango seed kernel meal (SMSKM) and 10 and 20% parboiled mango seed kernel meal (PMSKM) substituted for maize of the control diet. The rabbits were randomly divided in to five groups of six rabbits each with each rabbit serving as replicate in a complete randomized block design experiment. Feed and water were offered ad libitum. The response criteria shows that the average daily feed intake ranged from 63.51 to 71.57g for all the five diets. Effects of dietary treatments on weight gain and feed conversion ratio were not significant (P>0.05). The relative weights of the organs examined (liver, spleen, heart, testis, lung, kidney) were not significantly (P>0.05) different across dietary treatments. The feed cost/ kg reduced significantly (P<0.05) as the levels of inclusion of MSKM increased. It was concluded that SMSKM and PMSKM can be included up to 20% level in growing rabbit rations without adverse effect on growth performance and carcass characteristics of growing rabbits. Mango seed kernel used in this study is of no direct value for man hence its utilization as a feed ingredient will lower feed cost and encourage increased production of meat and by implication availability of more animal protein to the populace.*

Key words: *Mango Seed Kernel Meal, Parboiled, Crossbred Rabbits, Performance, Carcass Characteristics*

ORIGINAL ARTICLE

INTRODUCTION

The World Health Organization recommended 76g protein intake of which 34.0g should be of animal origin (Akintola, 1999). This has been difficult to achieve in most developing countries due to insufficient availability, high cost of conventional feed stuffs resulting from stiff competition between man and animal for the few available feedstuffs especially cereal and legume grains. Tewe (1988) observed that under the prevailing circumstances, it is unlikely that there will be surplus from conventional cereals and pulses upon which livestock production can develop: thus his suggestion of waste-to-wealth approach to solve the animal feed crisis.

Bamgbose et al. (2004) reported that maize *(Zea mays)* as a major energy source in poultry feeds accounts for between 50 and 55% of most poultry feeds. It is equally used in human nutrition thus creating a stiff competition between man and livestock. The resulting effect is high cost translating into high feed cost. This has necessitated the search for substitutes such as agro-industrial by-products and other farm residues that can replace maize wholly or partly. Some unconventional ingredients have been investigated as partial or total substitute for maize, they include fermented cassava peel meals (Osei et al. 1990); Sugar beet pulp (Garcia et al. 1993); Mango seed kernel meal (Farinu et al. 1999); Neem leaf meal (Adeyemi and Onyimonyi, 2009. Urea-treated and fermented Brewer's dried grain (Isikwenu et al. 2011) and Pigeon pea seed; (Mathew et al. 2010).

Mango trees can be found in several locations in Nigeria in its improved and native forms. The seeds that house kernels are always discarded as waste after eating the juicy mesocarp. The gathering of the seed could constitute a serious problem but the establishment of mango fruit canning industries has led to its concentration at specific locations since the seeds are treated as waste. In addition, the availability of mango seed kernel decorticator will ease and hasten the processing or breaking of mango kernel (Morton, 1987).

Mango seed kernel meal (MSKM) has been reported to be a good non conventional ingredient. Faniyi (1997) reported its importance in poultry production while Arogba (1997) provided the physical, chemical and

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functional properties of Nigerian mango *(Mangifera indica)* kernel and it processed flour. Chemical analysis and metabolizable energy of mango seed kernel meal as determined by Arogba (1997) revealed that it contains Tannin an astringent compound, thus necessitate processing the seed before it could be safely fed to animals. The nutrient composition of Mango seed kernel on dry matter basis was estimated in Nigeria to be 6.16% crude protein, 13.63% ether extract, 2.23% ash and 73.35% nitrogen free extract (Farinu et al. 1999) while El-Alaily et al. (1976) reported that the gross energy is 4.7Kcal/g.

The under-utilization of whole mango kernel in African countries particularly Nigeria could be partly due to the limited knowledge of the toxicological status of the mango kernel, the functional properties of the kernel flour and appropriate processing technology (Arogba, 1997). Faniyi (1997) reported that broiler birds can utilize up to 30% level of mango seed kernel meal as an energy source during starter and finisher phases but that appropriate protein and ME requirements of the birds should be taken care of in the diets. However Odunsi et al. (1997) reported that the inclusion of raw mango seed kernel meal above 10% have been reported to cause a significant decrease in daily weight, feed to gain ratio as well as feed intake of broiler birds. Information on the nutritional potential of mango seed kernel meal as feed ingredient for rabbits is scarce.

This study was designed to evaluate the growth performance and carcass characteristics of growing rabbits fed diets containing processed mango seed kernel meal.

MATERIALS AND METHODS

Location

The experiment was carried out at the Rabbitry unit of the Teaching and Research Farm, Ladoke Akintola University of Technology Ogbomoso Oyo state, Nigeria. The area is located within the derived savannah zone of Nigeria.

Collection and processing of test ingredients

Mango (Cherry variety), seeds were collected from various dumping sites of major markets within Ogbomoso town. It was cut open manually and the mango kernel removed from each half of the seed. The removed kernels were divided into 2 parts for further processing.

Sun drying

One part of the mango seed kernel was sun dried for one week to attain constant weight and milled into sun dried mango seed kernel meal (SMSKM).

Parboiling

The second part was parboiled for 5 minutes in water preheated to l00°C, drained, sun dried and milled to form parboiled mango seed kernel meal (PMSKM). Other ingredients were obtained from a reputable feed mill within Ogbomoso town.

Preparation of experimental diets

Five diets were formulated. Diet 1 was the control diet with no mango seed kernel meal. Diets 2 and 3 contained sun dried mango seed kernel (SMSKM) at 10 and 20% inclusion levels while diets 4 and 5 contained parboiled mango seed kernel meal (PMSKM) at 10 and 20% inclusion levels respectively. The gross composition of the experimental diets is presented in Table 1.

Table 1 - Gross composition of the experimental diets

Ingredients		SMSKM		PMSKM	
	0%	10%	20%	10%	20%
Maize	49.80	38.88	27.94	38.88	27.94
Soybean	8.20	9.12	10.06	9.12	10.06
MSKM	0.00	10.00	20.00	10.00	20.00
Wheat offal	20.00	20.00	20.00	20.00	20.00
PKC	16.00	16.00	16.00	16.00	16.00
Dicalcium Phosphate	2.00	2.00	2.00	2.00	2.00
Fishmeal (72%)	2.00	2.00	2.00	2.00	2.00
Limestone	1.00	1.00	1.00	1.00	1.00
Salt	0.50	0.50	0.50	0.50	0.50
Premix [1]	0.50	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis					
Protein	16.00	15.89	15.78	16.02	16.04
Crude fibre	5.19	5.12	5.05	5.13	5.07
ME(Kcal/kg diet)	2709.74	2549.42	2646.14	2648.45	2644.23

[1] Vit. A 40,000 iu, Vit. D 800,000.00 iu, Vit. E 8000.00 iu, Vit $K_3$800.00mg, Vit. B, 1,200.00mg, Vit.B2 200.00mg, Niacin 18,000.00iu, calcium pantothenic 4000mg, Biotin 20mg, Vit B6 1600.00mg, Vit. B12 8.0 iu. Folic acid 400.00 mg cholin chloride 120.00 mg, manganese 48,000 mg, Iron 40,000mg, Zinc 32,000 mg, Copper 3,400mg. Iodine 600mg, Cobalt 120mg, Selenium 48mg anti-oxidant 48g

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Animals and management

Thirty 6-8 weeks old crossbred rabbit bucks were used for the experiment. They were randomly assigned to five dietary treatments of six rabbits per treatment in a complete randomized block design. The rabbit were allowed one-week adjustment period during which they were fed with the control diet and given prophylactic treatment of Ivomec (tectin) at the 0.2ml per rabbit against endo and ecto-parasites before they were placed on experimental diets.

Housing

The rabbits were housed individually in wood-wire cages equipped with earthen feeding and drinking troughs. They were housed under ambient temperature of about 27°C and natural light of about 12hours per day. The house was well ventilated. Daily routine management practices include cleaning of the hutches and surroundings, washing of the feeders and the drinkers, replacement of left over feed with fresh feed and provision of clean water.

Feeding

Weighed quantity of feed (120g) divided into two rations of 60g each was fed to the animals twice a day (8.00 am and 3.00 pm) and water was provided *ad-libitum.* The Left overs were weighed daily to determine the feed intake and the record kept for each animal. This was done throughout the experimental period which lasted for 59 days. The feed intake was determined daily as the difference between feed supplied and the orts.

Weight changes

Records of live weight changes of each animal were taken by weighing at the beginning of the experiment and at weekly intervals throughout the experiment. Weight gain was determined as the difference between the weight of the previous week and the present week.

Carcass evaluation

At the end of the experiment, four rabbits randomly selected from each treatment were tagged and fasted over night to reduce their gut contents. After weighing to determine the final live weight, the rabbits were stunned and immediately slaughtered by severing the jugular veins. After evisceration, the organs were removed and weighed. The carcasses were later scalded to remove the fur and the difference between the carcass weight before and after scalding were taken as the fur weight.

Laboratory analysis

The standard methods of AOAC (1990) was used to determine the proximate compositions of the test ingredients and the experimental diets.

Statistical analysis

All the data collected were subjected to two-way analysis of variance (ANOVA) using SPSS computer analytical software according to Field (2000). Duncan's Multiple Range test of the same software was used to separate the means.

RESULTS AND DISCUSSION

The proximate composition of the test ingredients is presented in Table 2. The SMSKM used in the study contained 5.45, 5.91, 2.25, and 0.89% for crude fat, crude protein, ash and crude fibre respectively; while the PMSKM contained 4.62% crude fat, 7.22% crude protein, 2.69% ash, and 1.0% crude fibre. The PMSKM shows a higher protein of 7.22% compared with SMSKM which had 5.95 % CP.

This is similar to values reported by Faniyi (1997) and El-Alail et al. (1976). This may be an indication that parboiling had positive effect on the protein content of MSKM which is in line with the findings of Arogba (1997) that processing brings about conformational changes of protein molecules and nutrient availability. The moisture content of both SMSKM and PMSKM were similar, an indication that either of the processing methods does not have effect on the moisture percentage and dry matter content of the processed mango seed meal. The ash contents of the test ingredients were similar to values reported by Elegbede and Achoba (1996) but less than that of Faniyi (1997) for parboiled mango seed kernel meal. The crude fibre was however lower than that reported by Faniyi (1997). This may be due to differences in varieties of mango used or the degree of ripeness before processing.

Table 2 - Proximate composition of processed mango seed kernel meal

Parameters (%)	Sun dried MSKM	Parboiled MSKM
Crude protein	5.91	7.22
Ether Extract	5.45	4.62
Crude fibre	0.89	1.00
Nitrogen free extract	85.5	84.47
Ash	2.25	2.69
Dry matter	93.75	94.06

MSKM – Mango seed kernel meal

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The performance characteristics of weaner rabbits fed processed mango seed kernel meal is presented in Table 3. There was no significant (P>0.05) difference in the feed intake, weight gain, and feed-to-gain ratio between rabbits fed with SMSKM and PMSKM implying that the pre-treatment methods did not have any effect on these parameters. This agrees with the report of Kareem (2001) who fed albino rat with mango seed kernel meal (MSKM). The results suggest that the PMSKM and SMSKM were well tolerated by the rabbits.

The daily weight gain range of between 12.85 and 14.08g obtained in this study is higher than 10.1g reported by Adama and Nma (2002) when groundnut leaves were fed to rabbits. It is also higher than the range (10.61-11.53g/day) reported by Olabanji et al.2007 who fed sunflower leaf-blood meal based diet to rabbits but similar to 12.00g reported by Omole and Ajayi (1976) who feed dried brewer's grain to rabbits. These imply that the test ingredient is as good as or better than the other non-conventional ingredients used. The weight gain range reported by Agunbiade et al. (1999) was however higher (17.65-18.80g/day) compared with the values obtained in this study. The difference may be as a result of the age of rabbit at the commencement of the experiment, feed quality and environmental factors.

Rabbits used for this study had higher feed intake than those reported by Olabanji et al. (2007). This may be because of the fact that the feeds used for this study were pelleted. The higher feed intakes consequently resulted in better weight gain. The feed-to-gain ratios of between 4.95 and 5.78 observed although higher than the range reported by Adejumo (2002) were however similar to values obtained by Iheukwuemere et al. (2002) for rabbits on rice milling waste. This implies that the test ingredients compared favourably with other unconventional ingredient such as rice milling waste, cassava leaf meal and gliricidia leaf meal. Feed cost per kilogram feed reduced significantly (P<0.05) as the inclusion level of MSKM increased implying some cost reduction on the feeds.

Table 3 - Performance characteristic of weaner rabbis fed graded levels of SMSKM and PMSKM

		SMSKM		PMSKM			
Parameters	0%	10%	20%	10%	20%	**SEM**	**SL**
IW (g)	631.33	632.63	646.36	630.70	631.72	34.49	NS
FLWt (g)	1462.00	139.50	1435.0	1430.0	1390.17	43.71	NS
ADWG (g/day)	14.08	12.91	13.37	13.35	12.85	0.63	NS
AFI (g/day)	71.57	65.37	63.51	67.69	68.64	1.68	NS
FCR	5.27	5.28	4.95	5.15	5.78	0.25	NS
FC/kg feed (₦)	67.95	62.17	53.89	63.17	54.89	0.99	*
FC/Kg wt. gain	357.97	327.96	257.20	325.13	317.20	15.62	*

*=Significant difference, NS=No Significant difference (P>0.05), FLW=final live weight, SMSKM=Sun dried mango seed kernel meal, PMSKM=Parboiled mango seed kernel meal SEM=Standard Error of means, SL = Significant level, FCR=Feed conversion ratio, FC=Feed cost, AFI=Average Feed intake, ADWG=Average daily weight gain, IW=Initial weight.

The main effects of processing methods on the performance of weaner rabbits is presented in Table 4. Sun drying or parboiling did not affect (P>0.05) the performance of rabbits in term of weight gain, feed to gain ratio and feed intake. The main effect of inclusion levels of MSKM on the performance of weaner rabbits is also presented in Table 5. The effect of inclusion levels was not significant (P<0.05). This shows that varying the inclusion levels between 10% and 20% did not have effect on the final weight, dressing percentage, feed to gain ratio and feed intake. In addition, the interactions between processing method and inclusion level were significant (P<0.05) thus indicating that the effect of processing methods on the performance of rabbits are independent of the inclusion levels and vice versa.

The carcass characteristics and relative organ weights of weaner rabbits fed graded levels of SMSKM and PMSKM is presented in Table 6. Relative weights of heart, liver, kidney and spleen as well as weights of the head, fur and abdominal fat of rabbits fed with SMSKM and PMSKV were not significantly (P>0.05) different from the control diets. The dressed weight usually expressed as dressing percentage is an indication of value of meat that could be obtained from the animal. The study shows that dressing percentage of the rabbits which ranged from 56.90 to 61.45% were not significantly (P>0.05) different from each other.

Table 4 - Main effect of processing methods on performance of rabbits fed processed MSKM

Parameters (g)	**Control**	**Sun drying**	**Parboiling**	**SEM**	**SL**
Initial wt. (g)	631.33	639.50	631.21	56.72	NS
Final wt. gain (g)	1462.00	1414.70	1410.08	71.40	NS
Total wt. gain/animal (g)	830.67	775.20	778.88	58.22	NS
Av. Gain/day/animal	14.08	13.14	13.20	0.987	NS
Total feed intake (kg)	4.22	3.80	4.02	0.155	NS
Feed gain ratio	5.27	5.11	5.46	0.402	NS
Feed cost/kg feed (₦)	67.95	58.03	59.03	0.95	NS
Av. Feed intake/day/rabbit (g)	71.57	64.44	68.16	2.635	NS
Feed cost/kg wt. gain (₦)	357.97	292.58	321.17	23.75	NS
Dressing percentage	61.45	56.91	57.35	0.68	NS

SEM = Standard Error of means

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Table 5 - Main effect of inclusion levels on performance of rabbits fed processed MSKM

Parameters	Control	10%	20%	SEM	SL
Initial wt. (g)	631.33	631.67	639.04	56.72	NS
Final wt. gain (g)	1462.00	1412.25	1412.58	71.40	NS
Total wt. gain/animal (g)	830.67	780.58	773.54	58.22	NS
Av. Gain/day/animal	14.08	13.23	13.11	0.987	NS
Total feed intake (kg)	4.22	3.93	3.90	0.155	NS
Feed gain ratio	5.27	5.21	5.36	0.402	NS
Feed cost/kg feed (₦)	67.95	62.67	54.39	0.95	NS
Av. Feed intake/day/rabbit (g)	71.57	66.53	66.07	2.635	NS
Feed cost/kg wt. gain (₦)	357.97	326.55	287.20	23.75	NS
Dressing percentage (%)	61.45	57.14	57.35	0.678	NS

SEM = Standard Error of means

Table 6 - Carcass characteristic and relative organ weights of weaner rabbits fed SMSKM and PMSKM

Parameters		SMSKM		PMSKM			
	0%	10%	20%	10%	20%	SEM	SL
Head (%live eight)	9.16	9.13	9.51	8.92	9.51	0.15	NS
Dressing percentage (%)	61.45	56.90	56.93	57.38	57.31	0.72	NS
Heart	0.40	0.44	0.44	0.40	0.40	0.01	NS
Lung	0.97	1.01	1.07	0.92	1.09	0.04	NS
Kidney	1.00	1.06	1.16	1.01	1.01	0.03	NS
Spleen	0.10	0.13	0.12	0.10	0.10	0.01	NS
Abdominal fat	2.08	1.80	2.07	2.10	2.10	0.18	NS
Liver	4.47	5.11	5.47	4.80	4.80	0.15	NS
Paired testis Wt.	0.30	0.31	0.25	0.26	0.26	0.02	NS
Fur	10.64	16.67	13.82	14.10	14.10	0.98	NS

NS=No Significant difference (P>0.05), SMSKM=Sun dried mango seed kernel meal, PMSKM=Parboiled mango seed kernel meal, SEM= Standard Error of means

Madhusadha et al. (1986) reported that presence of anti-nutritional factors is associated with enlargement of organs like liver and pancreas but Al-Dabagh and Abdulla (1963) remarked that factors like age, diet and body weight affected organ weights. However, Bamgbose et al. (2004) reported that dressed weight and internal organ weight characteristics are veritable indicators of the level of reduction or otherwise of anti-nutritional factors.

There was no enlargement or atrophy of the internal organs beyond normal thus indicating that the rabbits were able to tolerate the test ingredients. Also the higher weight of fur observed from the rabbit fed with MSKM compared to control may be a good indicator for the farmer interested in the fur production. The concern of the farmer is the production cost, the reduction in the feed cost per kilogram and total feed cost observed, showed that rabbits cost of production can be reduced using sun dried or parboiled mango seed kernel.

CONCLUSION

It could be concluded that processed mango seed kernel meal holds potential for fattening rabbits as an energy source. The fur production was favoured by the use of mango seed kernel meal. This may also be an additional advantage for those interested in fur production. Therefore SMSKM and PMSKM can be included up to 20% in growing rabbit rations without adverse effect on growth performance and carcass characteristics of growing rabbits. The use of this non-conventional feed ingredient of no direct human value will lead to lower production cost and more revenue will accrue to the farmers thus encouraging them to produce more and ultimately making more animal protein available to the populace.

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