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PERFORMANCE AND NUTRIENT DIGESTIBILITY BY GROWING JAPANESE QUAILS FED FERMENTED MANGO KERNEL

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Supporting information

ABSTRACT: A growth study was conducted to determine the effect of feeding varying levels of FMKCM on the growth performance and serum biochemical indices of growing Japanese quails (*Coturnix coturnix japonica*). A total of one hundred and ninety five (195) two weeks old unsexed Japanese quail chicks with initial mean live body weight of 33.60g were randomly allotted to five dietary treatments designated T_1-T_5 containing 0%, 10%, 15%, 20%, and 25% FMKCM respectively. Each treatment comprised of 39 quails which was replicated thrice with 13 quails per replicate in a completely randomized design (CRD). The parameters measured were; feed intake, body weight, weight gain, feed conversion ratio and nutrient digestibility. The results of performance showed no significant differences in all the parameters measured but feed intake: it was observed that feed intake decreased with increased supplementation with FMKCM probably because of the energy content of the feed. FMKCM had no adverse effect on nutrient digestibility. The study concluded that FMKCM could replace maize without compromising growing quail's performance and digestibility of nutrients.

Keywords: Maize, Fermented Mango Kernel, Quail, Performance and Nutrient Digestibility

INTRODUCTION

The cost of feeding non- ruminant is about 60-70% of the total cost of production (*Abang et al.*, 2013; 2016, 2017[a]). This stems out of increased cost of cereal grains due to stiff competition between animals, humans and industries. The resultant effect is increased cost of animals' products and low protein intake (Abang et al., 2017[a]; Bishop et al., 2021).The way forward is that: non-ruminants with short gestation periods that consume less feed be sourced for (example quails) also, potential non-conventional feedstuffs that are available in commercial quantities, less competed for or not competed for at all be scouted and incorporated into livestock feed (Abang et al., 2021; Ogana et al., 2020).

Mango kernel, a by-product of mango fruit meets this demand. Mango kernel is a very good source of soluble carbohydrates. The protein of the kernel (7.80 - 8.00%) is comparable to maize but higher in fats (7.8 – 9.00%) than maize (Abang et al., 2017[b]). The feeding value of mango kernel could be comparable to rice if tannin free; tannins interfere with the bio availability of protein (Abang et al., 2015; 2018). Apart from tannins, other anti- nutrients like; trypsin inhibitors, phytate, saponin, oxalate are also contained in mango kernel. Processing methods such as autoclaving, boiling, sun-drying, toasting, fermentation has been reported to be effective in reducing these anti- nutrients (Abang et al., 2018; Abang and Shittu, 2015; Odey et al., 2020; Bishop et al., 2021; Gyang et al., 2021).

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This paper seeks to evaluate the feed value of fermented mango kernel composite meal on the performance and nutrient digestibility by broiler Japanese quails.

METHODS

Experiment site

This experiment was conducted at the Poultry Unit of the Teaching and Research Farm of the Federal University of Agriculture, Makurdi, Benue state. Makurdi is located at the longitude 6º 10' East and latitude 6º8' North. The area is warm with a minimum temperature range of 29.8-35.6ºC. Rainfall is between 508-1016mm and relative humidity is 47%-87% (Anon, 2004). One important geographical features of this area is the river Benue which divides Makurdi into the Northern and Southern parts. Makurdi local Government has an area of 16km radius. It lies within the Guinea savannah region of the Nigeria vegetative belt located in the Benue valley. Makurdi experiences a typical tropical climate with two distinct seasons (dry and wet). The dry season begins in November and ends in March while the wet season starts in April and ends in October. Harmathan with cool weather is experienced from December to early February (Anon, 2004).

Preparation of Experimental Materials

Different cultivars of both indigenous and improved mango were collected during the month of May (peak of the mango season) in Gboko and Makurdi area of Benue state, Nigeria. Mango kernel was removed by cracking manually with the aid of hammer. The fresh kernels were soaked in water at room temperature to allow it ferment for a period of 2 days (48hrs) in order to reduce the anti-nutrients to a more tolerable level and rinsed thoroughly with clean cool water. The fermented kernel was sundried in order to reduce the moisture content to less than 10% to prevent microbial build up and for prolonged storage. The ingredients were crushed separately into fine grit and were later mixed at varying inclusion levels with other ingredients to formulate the various diets.

Chemical Analysis

Chemical analysis of fermented mango kernel and experimental diets were analyzed using (AOAC, 2000).

Formulation of Diets

Feeds were formulated to meet the nutritional requirements for quails during the growing phase. Fermented mango kernel composite meal replaced maize at 0% (control diet was compounded using 100% maize and 0% FMKCM), 10% (diet was compounded with 90% and 10% FMKCM), 15% (diets was compounded with 85% maize and 15% FMKCM), 20% (diet was compounded with 80% maize and 20% FMKCM) and, 25% (diet was compounded with 75% maize and 25% FMKCM) in treatments I, II, III, IV, V respectively.

Table 2: Composition of experimental diets with varying levels of fermented mango kernel composite (FMKCM) meal for growing quails (%)

INGREDIENTS	T1 (0%)	T2 (10%)	T3 (15%)	T4 (20)	T5 (25)
Maize	45.00	40.50	38.25	36.00	33.75
FMKCM	0.00	4.50	6.75	9.00	11.25
Soybean meal	21.00	21.00	21.00	21.00	21.00
Groundnut cake	15.95	15.95	15.95	15.95	15.95
Maize offal	9.00	9.00	9.00	9.00	9.00
Bone meal	4.00	4.00	4.00	4.00	4.00
Blood meal	2.50	2.50	2.50	2.50	2.50
Fish meal	2.00	2.00	2.00	2.00	2.00
Vita/min premix	0.30	0.30	0.30	0.30	0.30
Salt	0.25	0.25	0.25	0.25	0.25
TOTAL	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Nutrients	**Nutrients**	**(%)**			
ME(Kcal/kg)	2968.03	2995.84	3006.95	3018.05	3029.16
Crude protein	24.46	24.53	24.59	24.64	24.70
Crude fiber	4.38	4.36	4.35	4.34	4.33
Lysine	1.05	1.18	1.25	1.31	1.38
Methionine	0.36	0.40	0.42	0.44	0.46
Calcium	1.89	1.90	1.90	1.90	1.90
Phosphorus	0.38	0.39	0.39	0.31	0.32

Each 1kg of Vitamin/mineral premix is expected to contain; Vitamin A (220,000iu), Vitamin D (66,000iu), Vitamin E (44,014iu), Vitamin K (88mg), Vitamin B12 (0.76mg), Niacin (1122mg), Calcium 27%, Phosphorus 10%, Iron 0.6%, Zinc 0.35%, Manganese 0.25%, Copper 0.06%, Iodine 0.002%, Cobalt 26ppm, Selenium 4ppm.

Animal Grouping

A total of one hundred and ninety five two weeks old un-sexed Japanese quails of about 33.60g of weight purchased with the national veterinary research institute Vom –Jos, Nigeria. At the start of the feeding trial, three groups were allotted to five dietary treatments of 39 quails each. Each treatment was replicated thrice with 13 quails per replicate.

Housing

The birds were managed intensively in cages of three tiers. Each tier was separated with wood. Wire mesh was used for the walls and doors to allow adequate ventilation/lighting. The dimension of each tier was ($1.0m^2$ x $0.78m^2$). Litter materials (wood shaving) were used on the wooden floors. Each tier was equipped with adequate drinkers and feeding troughs. A floor space of about 0.007 m^2 to 0.009 m^2 per quail was provided. Artificial lighting was provided with the use of one battery lantern for each tier to ensure adequate feed intake.

Routine Operations

Feeds were weighed with a micro scale balance of 5kg before serving to ensure a uniform amount across treatments. Quails were served with 250grams of feeds for the first week at about 8 am daily, the quantity was increased by 50grams on weekly basis. Fresh clean water was Supplied ad-libitum. Drinkers and feeders were washed and disinfected using izal when appropriate. Litter materials were changed when due and replaced accordingly.

Performance indices

Average daily feed intake (ADFI)

The experimental birds were provided feed and water liberally in the course of the experiments. Left over feed was collected and weighed daily. This was then subtracted from the quantity of feed served daily to obtain the daily feed intake. To obtain the average weekly feed intake per bird (AWFI / bird), feed consumed daily was multiplied by 7 (seven) and divided by the number of birds/replicate.

Average daily weight gain (ADWG)

Body weights of birds were taken at the on-set of the study and then weekly until the expiration of the study. The difference between the initial weight and the final weight showed the weight gain/bird. ADWG was obtained by dividing the final weight gain/bird/replicate by the number of days the study lasted.

Feed conversion ratio (FCR)

The records of feed consumed and that of the weight gain by birds in each treatment group were used to compute feed conversion ratio (FCR) according to the following formula.

$$FCR = \frac{\text{Feed intake}}{\text{Body weight gain}}$$

Protein efficiency ratio (PER)

This was obtained as

$$PER = \frac{\text{Weight gain}}{\text{Protein intake}}$$

Mortality

Mortality was determined by dividing the total number of dead birds by the total number of birds brought at the beginning of the study and expressed as a percentage.

$$\text{Mortality} = \frac{\text{Number of dead birds}}{\text{Number of birds housed}} \times 100$$

Nutrient digestibility study

At the beginning of the last week of the finisher phase, 2 (two) birds, male and female with average body weight were picked from each replicate and placed in metabolism cages. The birds were allowed 2 days to get adapted to the cage environment and were served their respective treatment diets liberally. In the course of the adaptation period, the actual feed intake of each bird in the metabolism cage was determined and served to the birds for the remaining 5 days along with constant supply of water. For the collection of faecal droppings, polyethene sheets were spread beneath the cages. The voided faecal droppings were collected daily by 1800 hours from each replicate. The faecal samples were weighed, enveloped, labeled and oven-dried at 105° C to obtain constant weight. At the end of the 7th day, all the dried faecal samples were bulked together according to replicate to obtain a homogenous mixture from which representative samples were subjected to proximate analysis according to AOAC (2000). Similarly, the experimental diets were analyzed using the same method – at the Animal Nutrition Laboratory, University of Agriculture, Makurdi, Benue State.

From the results of the proximate analysis, the digestibility coefficient was calculated using the formular illustrated by McDonald et al. (1995).

$$\text{Digestibility coefficient} = \frac{\text{Nutrient in-take in feed} - \text{Nutrient in faeces}}{\text{Nutrient in-take in feed}} \times \frac{100}{1}$$

Design and Analysis

The data obtained on all the parameters studied were subjected to one-way analysis of variance (ANOVA) using Minitab statistical software version 14 (Minitab, 2014) and least significant method was used to separate means that differed significantly (Steel and Torrie, 1980).

RESULTS

Performance indices of growing quail is presented in Table 2. Result revealed that daily feed intake was affected significantly ($P<0.05$) across the treatments. Quail fed 0% and 10% fermented mango kernel composite meal (FMKCM) consumed more feed than quails fed 15%, 20% and, 25% probably because of the lower energy content of the diets; this is so because birds eat to meet up their energy demands (Olubamiwa et al., 1999; Odunsi, 2005; Abang et al., 2013). This observation corroborate the reports of Abang et al., 2015 who observed a decreased intake with increased supplementation with sun- dried mango kernel meal (SMKM) across treatments in growing quails. A non- significant ($P>0.05$) increase in FBW, TWG and, DWG was observed across the treatment groups. However, numerically, a progressive increase was observed in the aforementioned parameters with increased levels of supplementation across treatments, probably, because of the processing method employed; soaking has been proven to effectively reduced tannins and other anti- nutrients (Abang et al., 2013; Abang and Shittu, 2015). This assertion was in disagreement with the reports of Dairra et al. (2010); Oyaraga et al. (2015) and Abang et al., 2015 who replaced maize with boiled mango kernel in broiler chicks diets; mango fruit reject composite meal in finisher diets and sun- dried mango kernel meal in quails diets respectively, and observed depressed weight gain across treatments. This could be due to the varying processing methods adopted.

The result obtained on feed conversion ratio did not differ significantly ($P>0.05$) among the treatments. However, FCR numerically, improves with heavy supplementation across treatment groups: birds fed

diets containing 25% FMKCM had the best feed conversion ratio (FCR). This contradicts the reports of Dairra et al. (2010); Oyaraga et al. (2015) but was in line with the findings of Abang et al., 2015. Feed conversion ratio depends on two major factors; growth rate and feed intake and, both are affected by the quality of the diet (Sadeghi et al., 2004). The trend of response observed in this present study could be as a result of efficient nutrient utilization by birds fed 25% FMKCM. This was achievable due to the processing method employed; fermentation. Fermentation would have reduced the anti-nutrients to a more tolerable state and thereby increasing the palatability of the feed, also, the inclusion level was lower in this study.

The digestibility coefficient obtained for proximate components in the growth phase showed no significant (P>0.05) differences among the various treatments. This agrees with the reports of Faniyi (1997) who investigate the effect of replacing maize with mango seed kernel meal in the diet of broiler chickens. The result in this study showed a decline in amount of crude fibre digested. This is similar to the report of Njidda et al. (2006) who asserted that crude fibre and phytic acid found in most plant do not only resist digestibility by monogastric endogenous enzymes but are also two common organic compounds known to sequester feed nutrient, rendering them unavailable for animal use. Similar depression (in fiber) in nutrients digestibility by broiler chicken has been reported by Abdelsamie et al. (1983) and Odey et al. (2020). Kass et al. (1980) and Fielding (1991) attributed such depression in apparent digestion to higher rate of passage of digester in animals fed on high diets. Beside fibre, anti-nutritional factors such as trypsin and tannin could also cause depression in crude fibre (Bishop et al., 2021). However, in this study the control experiment observed a decline in the amount of fibre as well; indicating that treatments were not responsible for the results: It could have been technical.

Table 2: Performance of Growing Japanese Quails fed fermented Mango kernel composite Meal.

Parameters	**T_1 (0%)**	**T_2 (10%)**	**T_3 (15%)**	**T_4 (20%)**	**T_5 (25%)**	**SEM**	**P-Value**
Initial weight (g/ bird)	33.60	33.60	33.60	33.60	33.60	0.31	-
Average daily feed intake (g)	15.35[a]	15.07[b]	14.09[c]	13.97[d]			
Final weight (g/bird)	131.67	136.00	142.09	148.13	153.02	3.31	0.12
Daily weight gain (g)	3.50	3.65	3.87	4.09	4.27	0.09	0.07
Average daily feed intake (g)	15.35[a]	15.07[b]	14.09[c]	13.97[d]	13.07[e]	0.28	0.03
Feed Conversion Ratio (g)	4.39	4.13	3.64	3.42	3.06	0.17	0.16

abc Means within the same row bearing different superscripts are significantly different

SEM= Standard error mean.

Table 3: Nutrient digestibility by Japanese Quails fed fermented mango kernel composite meal (FMKCM)

Parameters	T_1 (0%)	T_2 (10%)	T_3 (15%)	T_4 (20%)	T_5 (25%)	SEM	P-Value
Dry matter	92.55	92.40	91.22	91.00	89.37	1.69	0.38
Crude protein	77.00	78.00	79.67	80.00	82.00	2.83	0.14
Ether extract	79.67	71.67	70.67	67.00	66.67	1.03	0.12
Crude fibre	27.25	25.25	24.38	23.14	21.38	10.64	0.85
N.F.E	86.45	86.25	84.15	83.12	81.15	1.72	0.07

N.F.E – Nitrogen free extract
SEM – Standard error mean

CONCLUSION:

The study concluded that fermentation could be used to improve nutritive value of mango seed kernel, thereby improving quail's performance and digestibility of nutrients.

DECLARATIONS

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Authors' contribution

F. B. P. ABANG performed conceptualization, writing, original draft preparation, review and editing. E.E.NSA performed conceptualization and evaluation of manuscript before submission. T.N. KPERUN performed conceptualization and evaluation of manuscript before submission. E. E. Archibong performed conceptualization and evaluation of manuscript before submission. Y. S.KOLO performed conceptualization and evaluation of manuscript before submission.

Ethical Approval

All authors hereby declared that "Principles of laboratory animal care" (NIH publication No. 85-23, revised 1985) were followed as well as specific national laws where applicable. All experiment have been examined and approved by the appropriate ethics committee.

Conflict of Interests

The authors declare that there is no conflict of interest.

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