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Evaluation of Sun Dried Mango (*Mangifera spp*) Kernel as a Feed` Resource on the Serological Parameters of Laying Japanese Quails (*Coturnix coturnix japonica*)

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Authors' contributions

This work was carried out in collaboration between all authors. Author FBA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors OJN and YCS managed the analyses of the study. Authors OJN and FBA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted using one hundred and fourty four unsexed laying Japanese quails of about two weeks old to investigate the effect of varying levels of SMKM on the health status of quails. The results for serum biochemical composition showed that serum sodium (Na^+), serum potassium (K^+), serum bicarbonate (HCO_3^-) and creatinine were within normal ranges. However, ALT, AST, total bilirubin and serum chloride were not within the normal reference ranges. It is concluded that SMKM could replace maize up to 50% without any nutritional disorder as the parameters that were not within the normal reference ranges did not follow a regular pattern and these observations were applicable to the control experiment as well, revealing that diets would not have accounted for these anomalies.

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1. INTRODUCTION

The protein of high biological value (BV) especially that of animal origin is limited in supply particularly in developing countries like Nigeria. This emanates from a stiff competition of cereals grains (especially maize) between man, animals and industries due to seasonal availability, which leads to unavailability and consequently high cost of production which is translated into the high cost of animal products. The incorporation of agro-industrial by-products and non-conventional feedstuff that are available, cheap, safe and nutritionally adequate is now been encouraged and explored to sustain poultry industry. The situation has necessitated the need to source for an alternative or partial replacement of one of the most highly competitive feed ingredients such as maize, which contributes about 60 – 80% of most formulated diets [1,2]. Some of the unconventional feed resources that have been experimented includes: Taro cocoyam cormel meal (*Colocasia esculenta*), cassava root meal (*Manihot spp.*), Sweet potato meal (*Ipomea batata*), coffee pulp meal (*Coffee arabica*), *Prosopis africana* seed coat meal (Iron tree) and mango seed kernel meal (*Mangifera indica)* [3;4]. However, most of these feeds contain anti-nutrients and toxic components such as saponins, lectins, tannins, trypsin inhibitors and cyanogenic glycosides which make them unsafe as carbohydrate sources in livestock production [3]. These anti-nutrients chelate divalent ions like Ca^{2+}, Mg^{2+}, Fe^{2+}, and Zn^{2+} also react with the charged groups of protein and polysaccharides thereby forming indigestible complexes while the toxic substances interfere with nutrient bioavailability and utilization [5,6]. Processing methods such as: boiling, oven drying, autoclaving, fermentation etc could reduce these anti-nutrients to a more tolerable state [5,6].

Mango kernel is a good source of soluble carbohydrates [7]. The protein of the kernel (7.80 – 8.00%) is comparable to that of maize but it has higher fats (7.80 – 9.00%) than maize [8].

Mango kernel flour is reported to be equal to rice in food if tannin free [9]. Tannin is known to interfere with protein digestibility and rendering it unavailable. There are other anti-nutrients contained in mango kernel such as; phytate, hydrogen cyanide, trypsin inhibitor, oxalate, saponin etc. Processing methods such as; boiling, fermentation, drying has been reported to be effective in reducing these anti-nutrients [10,7]. Research in the past have indicated the suitability of mango seed kernel in livestock feeding but the level of inclusion in poultry diets has been low because of the presence of tannins which have been reported to inhibit chicks' growth [10,7]. The need to assay for blood parameters which are good indicator of the health status of an animal becomes necessary [11].

Japanese quails are hardy birds that thrive in small cages. It is this attribute of hardiness, ability to withstand diversified agro-climatic conditions and inexpensive to keep that makes it viable commercial poultry enterprise. Japanese quails mature in about 6 weeks and are usually into full egg production by 50 days of age. With proper care, hens should lay 200 eggs in their first year of lay. Life expectancy is only 2 to 2½ years [12]. These attributes makes it an ideal experimental bird for the provision of supplemental income and protein. The objective of this study is to determine the effect of sun dried mango kernel meal (SMKM) on serum biochemical composition of laying Japanese quail (*Coturnix coturnix japonica*).

2. MATERIALS AND METHODS

2.1 Experimental 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 longitude 6°10' East and latitude 6°8' North. The area is warm with a minimum temperature range of 29.8-35.6°C. Rain fall is between 508-1016mm and relative humidity is 47%-87% [13]. 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 radium. 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. Hama than with cool weather is experienced from December to early February [13].

2.2 Preparation of Experimental Materials

Mango seeds 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 kernel was sun-dried for 7 days in order to reduce the moisture content to less than 10% for prolonged storage. Soybean was well toasted to a dark brown colour to reduce the level of anti- nutrients such as tannin, oxalate, trypsin inhibitors, saponin, phytate, flavonoid, cyanides etc. The ingredients were crushed separately into fine grit (maize and soybean) and were later mixed at varying inclusion levels with other ingredients to formulate the various diets.

2.3 Chemical Analysts

Chemical analysis of sun-dried mango kernel and experimental diets were analysed using [14] methods.

2.4 Formulation of Diets

Feeds were formulated to meet the nutritional requirements for quails during the growing phase. Sun- dried mango kernel meal replaced maize at 0% (control diet was formulated with 100% maize and 0% SMKM), 25% (diet was compounded with 75% maize and 25% SMKM) and 50% (diet was formulated with 50% maize and 50% SMKM) in treatments I, II and III respectively.

2.5 Animal Grouping

A total of one hundred and forty four two weeks old un-sexed Japanese quails of about 26.56±0.02 g of weight purchased with the National Veterinary Research Institute Vom- Jos, Nigeria was studied over a period of four weeks (19th June-18th July). The birds were randomly selected at the expiration of one week acclimatization and allotted to three dietary treatments (I- III) of 48 quails each. Each treatment was replicated thrice with 16 quails per replicate. The experiment lasted for seven weeks by this time quails were ten weeks old.

2.6 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 (1.0 m^2 x 0.78 m^2). Litter materials (wood shavings) 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 kerosene lantern for each tier to ensure adequate feed intake.

2.7 Routine Operations

Feeds were weighed with a micro scale balance of 2kg before serving to ensure a uniform amount across treatments. Quails were served with 200gms of feed for the first week at about 8.am on a daily basis, the quantity was increased by 50gms on weekly basis. Fresh clean water was supplied daily *ad-lib*. Drinkers and feeders were washed and disinfected using izal when appropriate. Litter materials were changed when due and replaced accordingly. Manure was sold to generate revenue whenever litter materials were changed.

Table 1. Composition of diet with sun-dried mango (*Mangifera spp*) kernel meal (SMKM) for laying Japanese quails (*coturnix coturrnix japonica*)

Ingredients	Control (0%)	25%	50%
Maize	53.20	39.90	26.60
SMKM	-	13.30	26.60
Full- fat soybean	26.67	25.85	25.35
Fish meal	5.20	6.00	6.50
Wheat offal	6.93	6.93	6.93
Bone ash	7.00	7.00	7.00
Salt	0.50	0.50	0.50
Vita/Min Premix	0.50	0.50	0.50
Total	100.00	100.00	100.00
Analysed nutrients:			
Crude protein (%)	22.02	21.75	21.70
M.E (Kcal/kg)	2845.01	2900.00	2950.00

Key: ME= Metabolisable energy; SMKM= Sun dried mango kernel meal

2.8 Design and Analysis

At the end of the experiment (by this time the quails were 10 weeks of age), two (2) laying quails per replicate (amounting to 6 quail per treatment) were randomly selected and weighed. Quails were slaughtered by cutting the jugular vein with sharp knife. The blood samples were collected at slaughter into sterile vacutainers and the Serum was separated by centrifuge at 750g for 15 minutes and stored in a deep freezer until time of use for Serum biochemical analysis. Serum biochemical indices were carried out using routine standard clinical chemistry procedures [15]. The data obtained on all the parameters studied were subjected to one-way analysis of variance (ANOVA) using minitab statistical software version 14 [16] and least significant method was used to separate means that differed significantly [17]. Results were presented as Mean± Standard Error of Mean (SEM).

3. RESULTS AND DISCUSSION

The results for serum biochemical composition of growing quails are presented in Table 2. The result for serum sodium (Na^+) ranged from 141.83 to 151.07 µm/L. Serum Na^+ was significantly ($p<0.05$) different among treatment groups, least values were recorded with quails served 25% SMKM. These values were within the normal reference range (135-155 µm/L) by [18]. The result was in agreement with the report of [19] who observed a similar trend when growing quails were fed fermented mango kernel composite meal (FMKCM). Serum Na^+ is a major component of the cations of the extracellular fluid and is largely associated with chloride and bicarbonate in regulation of acid- base equilibrium, it's important in the maintenance of osmotic pressure of body fluid, thus protecting the body against excess fluid loss (dehydration). Low levels of Na^+ affects growth in animals and reduce digested protein and energy utilization. The result for serum potassium (K^+) ranged from 3.88 to 5.40 µm/L. Serum potassium (K^+) of quails fed 25% inclusion levels of SMKM was significantly ($p<0.05$) higher than quails served 0 % and 50% SMKM. However, these values were within the normal reference range (3.6 – 5.5 µm/L) as established by [18]. This report was in contrast with the findings of [19] who observed a slight increase in serum potassium above the upper limit of the normal range by [18]. Serum potassium gives a true picture of the heart condition, it controls the heart beat rate and blood pressure and also assist in the regulation of acid – base balance of cellular exchange within hydrogen [20]. The result for serum chloride (CL^-) ranged from 105.97 to 125.97 µm/L. Quails served 25% SMKM had significantly ($p<0.05$) higher values compared with quails placed on 0% and 50% SMKM. Result showed that only serum chloride (CL^-) of quails fed 50% SMKM was within normal range (98-106 µm/L) by [18]. There was a slight and marked increase in the serum chloride (CL^-) (hyperchloremia) above the upper limit of quails served 0% and 25% SMKM respectively. [19] observed values below the lower limit (hypochloremia) of the normal reference range across treatments with quails fed FMKCM. [21] recorded values within the normal reference range with broiler chicks fed boiled mango kernel composite meal (BMKCM) across treatments. Hyperchloremia is sometimes associated with excessive fluid loss due to diarrhoea. Hyperchloremia can be symptomatic with signs of weakness and intense thirst [22]. The result for serum bicarbonate ($HC0_3^-$) ranged from 29.93 to 30.30µm/L. A non -significant ($p>0.05$) difference was recorded across the treatment groups. Serum bicarbonate ($HC0_3^-$) was within normal range (22-30 µm/L) as established by [18]. This result disagrees with the report of [23] who observed an increase in serum bicarbonate ($HC0_3^-$) above the upper limit of the normal reference range across treatment groups with broiler chicks fed FMKCM. The result of this present study revealed that the acid-base ratio was balanced. Serum bicarbonate of less than 22µmol/L is compatible with metabolic acidosis [24]. The result for serum creatinine ranged from 2.40 to 3.11. Serum creatinine decreased across the treatments with high inclusion levels. Quails fed 50% SMKM had significantly ($p<0.05$) lowest values when compared with others. These values were within the normal reference range (1.6-6.7 µm/L) as established by [18]. This result contradicts the reports of [19] and [21] who observed values above the upper limit of the normal reference range across treatments with quails fed FMKCM, and broiler chicks fed BMKCM respectively. Creatinine content depends on both the quantity and quality of protein supplied in the diet. A major source of excess creatinine in the blood of the animals is from the muscles when wasting occurs, and creatinine phosphate is catabolized [25]. The result for *alanine aminotransferase (ALT)* ranged from 16.95 to 25.83 IU/L. *ALT* was significantly ($p<0.05$) different across treatments. These values were above the upper limit of the normal

Table 2. Serum biochemical composition of laying quails fed varying levels of sun-dried mango (*Mangifera spp*) kernel meal (SMKM)

Parameters	0%	25%	50%	P STD	P value
Na+ µm/L	151.07±0.07a	141.83±0.17c	148.03±0.04b	0.18	0.00
K+ µm/L	3.88± 0.02c	5.40± 0.00a	4.69 ± 0.00b	0.12	0.00
CL- µm/L	109.67± 0.33b	125.97± 0.03a	105.97± 0.03b	0.34	0.00
HC03- µm/L	26.93 ± 0.07	33.30 ± 3.50	27.79± 0.00	3.30	0.11
Creatinine µm/L	3.11± 0.01a	2.69± 0.00b	2.40 ± 0.00b	0.01	0.00
ALT	25.83± 0.69a	16.93± 0.03c	22.33± 0.33bc	0.37	0.00
AST	18.97± 0.02c	29.83± 0.16b	36.95± 0.04a	0.17	0.00
Total bilirubin	4.68± 0.02a	2.47± 0.02c	3.60± 0.00b	0.02	0.00

Different superscripts (a, b and c) within the same row differed significantly (p<0.05)
Key: STD=Standard Deviation

reference range (4.5 to 8.5 IU/L) by [18]. A similar trend was observed by [19] and [21] when quails were fed with FMKCM and broiler chicks with BMKCM respectively. Treatments would not have accounted for these results as the quails in the control experiment were not left out. Slightly elevated alanine aminotransferase levels can indicate any liver disease or may be normal for that particular bird [26]. The result for serum *aspartate aminotransferase (AST*) ranged from 18.97 to 36.95 IU/L. *AST* was significantly ($p<0.05$) different across treatment groups. Results revealed that values increased with high inclusion levels. However, these values were far below the lower limit of the normal reference range (243 to 562 IU/L) by [18]. These low values were not peculiar to quails served the test diets (control was not left out), indicating that treatments would not have influenced the results. The values recorded in this study were lower than those reported by [19,21] when quails were fed FMKCM and broiler chicks served BMKCM respectively. The enzyme *AST* gives a true picture of the liver condition. High values mostly signify liver damage by: drugs, urinary tract infection, hepatitis, toxins etc. Low *AST* value could be as a result of age effect as *AST* value also depends on the age of the bird [25]. The result for total bilirubin ranged from 2.47 to 4.68 µmol/ L. Total bilirubin was significantly ($p<0.05$) different across treatments. Quails placed on 0% and 50% SMKM had values within the normal reference range (3.6 – 5.5 µm/L) as established by [18]. However, quails fed 25% SMKM had values slightly below the lower limit of the reference range [19]. Also recorded similar low values on most treatments when fed FMKCM, [21] observed low values across treatment groups when BMKCM was served to broiler chicks. Total and conjugated bilirubin are indicators of protein adequacy [26]. A high value of bilirubin signifies liver disease such as; hepatitis or blockage of tubes (bile duct) or diagnose conditions that cause increased destruction of red blood cells [27] as well as protein inadequacy [11]. Again the results did not follow a regular pattern, and so one cannot infer that nutrients supplied were inadequate for basic maintenance and metabolic functions of quails as creatinine which equally depends on quantity and quality of protein supplied in the diet was within the normal reference range. It could be that there were not enough old red blood cells to be broken down by the liver as at the time of blood collection. SMKM could probably be a rich source of iron (Fe^{2+}) and folic acid which would have helped in the building up of blood.

4. CONCLUSION

It is concluded that SMKM could replace maize up to 50% without any nutritional disorder as most of the parameters measured that were not within the normal reference ranges were applicable to the control experiment, thereby, revealing that diets would not have accounted for these anomalies.

5. RECOMMENDATIONS

It was recommended that up to 50% of SMKM be included in quails' diets to reduce the cost of production and subsequently cost of animals' products, thereby, increasing the consumption of animal protein in Nigeria.

CONSENT

It is not applicable.

ETHICAL DISCLAIMER

As per international standard or university standard written ethical permission has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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