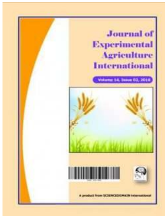

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Serum Biochemical Parameters of Laying Japanese Quails (*Coturnix coturnix japonica*) Fed Diets Containing Fermented Taro Cocoyam (*Colocasia esculenta var. esculenta*) Meal

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Authors' contributions

This work was carried out in collaboration between all authors. Authors FBA and BIO designed the study, wrote the protocol and wrote the first draft of the manuscript. Author FBA reviewed the experimental design and all drafts of the manuscript. Authors AAA and BIO managed the analyses of the study. Author FBA dentified the plants. Authors FBA and AAA performed the statistical analysis. All authors read and approved the final manuscript.

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ABSTRACT

The study was conducted to examine the size of the damage in tissue, especially the liver by fermented taro cocoyam meal on laying Japanese quails. Two hundred and twenty five Japanese quails (*Coturnix coturnix japonica*) were randomly allotted to five dietary treatments (I–V) of 36 hens and 9 cockerels each. Each treatment was replicated thrice with 12 hens and 3 cockerels per replicate. In each of the five diets, 48 hours fermented taro cocoyam meal (*Colocasia esculenta var. esculenta*) was used to replace maize at 0%, 25%, 50%, 75%, and 100% respectively. Serum Na^+, K^+, Cl^-, HCO_3^-, Creatinine, ALT, AST and Total bilirubin were determined on the 70th day. The

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results of serum biochemistry showed that, Cl^-, HCO_3^-, Creatinine, ALT and AST were within normal range. However, it was observed that serum K^+ increased above the upper limit whereas serum Na^+ was slightly below the lower limit in all the treatments. Total bilirubin was above normal range beyond 25% replacement of maize in the diets. It was concluded that, beyond 25% inclusion levels of cocoyam in quails' diets, nutrients supplied were insufficient for basic maintenance and metabolic functions for laying quails.

Keywords: Serum biochemistry; fermented taro cocoyam meal; maize and laying Japanese quails.

1. INTRODUCTION

There has been a call for substantial increase in protein intake of animal origin in developing countries. [1], observed that there is gross shortage of protein of animal origin in the diet of an average Nigeria. Strategies have been suggested to address the problem of shortage of animal protein in developing countries as human population continue to grow. These includes: increasing the production of short production cycle animals such as poultry (quails), rabbits and pigs as well as reduction in the cost of production of livestock .Feeding cost constitutes the largest cost in raising livestock (about 60-70% of total cost of production) . The above can be achieved by the use of less-expensive and non- conventional feed stuffs such as cocoyam, cassava, mango kernel, *Prosopis africana* seed coat etc. Taro cocoyam originated from Asia [2]. It is one of the most widely spread root crop grown throughout the humid tropics; about 60% of world production is grown in Africa and the remaining 40% in Asia and Pacific Island [2]. In Nigeria, the mature corms are roasted, baked or boiled and eaten. The corms of taro cocoyam provides easily digestible starch. Taro cocoyam is low in protein (1.1% fresh weight), has high content of P, Mg, Zn of any root and tuber crop and less in all the vitamins (except for nicotinic acid) and fairly rich in carotene [3]. Some of the non- starchy nutrients such as proteins, minerals and vitamins are concentrated in the outer peels of the corms [4]. Most varieties are acrid and some contain anti-nutritional factors such as trypsin inhibitors, phytates, tannins, saponins as well as Raphides [5]. Raphides are .minutes bundles of crystals of calcium oxalates (0.1-0.4% fresh weight) which accounts for the irritating effect of the taro corms. Tannins interfere with protein digestibility, phytate and oxalate interferes with minerals availability, trypsin causes depressive growth and pancreatic hypertrophy and saponin causes permeability of the intestine. These effects could be removed or reduced by processing methods such as; boiling, fermentation, toasting and sun-drying etc. [6]. Cocoyam corms and its by- products have not received enough attention in terms of utilization as a livestock feed: [7] used taro cocoyam to replace all the maize in diets for broilers. [8] fed fresh(sun-dried) and boiled taro cocoyam meal to weaned pigs and observed that, the weaned pigs fed boiled taro cocoyam meal competed favorably with those fed maize only. A depressive growth was observed beyond 50% replacement with those fed sun-dried cocoyam meals. [9] fed boiled taro cocoyam meal to growing Japanese quails and observed a depressive growth beyond 50% inclusion. [10] fed fermented taro cocoyam meal to growing Japanese quails and observed no depressive growth at 100% replacement with maize. However, when fermented taro cocoyam meal was tried on laying quails, the time of lay was delayed beyond 50% inclusions. Egg production was significantly (P<0.05) reduced beyond 25% replacement with maize [11]. These findings necessitated the need to assay the serum biochemical parameters of these laying quails as results have shown that, there is a positive correlation between body weight at six weeks and egg production in Japanese quails with some blood constituents [12]. Also because during fermentation a number of roles are played by micro- organisms in food processing: it could be positive or negative. Fermentation enhances the nutrients- vitamins and essential amino- acid by improving protein and fiber digestibility [6] whereas, the negative effect includes spoilage of food products and contamination by pathogenic micro-organism [13].

1.1 Objective

To examine the size of the damage in tissue, especially the liver by fermented taro cocoyam meal on laying Japanese quails.

2. MATERIALS AND METHODS

The study was carried out in Cross River University of Technology Teaching and Research

Farm, Calabar, Nigeria. A total of two hundred and twenty five Japanese quails (180 hens (females) and 45 cockerels (males) of about 7 weeks of age with average weekly weights ranging from 133 g to 163 g were studied over a period of ten weeks. Quails were randomly allotted to five dietary treatments (I-V) of 36 hens and cockerels each. Each treatment was replicated thrice with 12 hens and 3 cockerels per replicate. In each of the five diets, 48-hours fermented taro cocoyam meal (FTCM) replaced maize at 0%, 25%, 50%, 75% and 100% as treatments I, II, III, IV and V respectively.

Unpeeled taro cocoyam corms were bought from Bendeghe village, Etung, Cross River, Nigeria. Corms were peeled and then chopped into sizeable chips of about 14g each. These chips were put into a big black plastic pot- like container with a tight lid and fermented in water at room temperature (28℃- 29℃) for 48 hours. Sun drying lasted for a week (7 days) and thus reduced moisture content to less than 10%. The 48 hours fermented taro cocoyam corms and other ingredients were milled separately and used to formulate the experimental diets (Table 1). The experimental diets were analyzed according to the procedure of [14] and metabolizable energy was calculated using the method of [15]. 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 0.75 m^2 × 0.38 m^2. Litter materials (wood shavings) were used on the wooden floor. Each tier was equipped with adequate drinker and feeding troughs. A floor space 0.007 m^2 to 0.009 m^2 per quail was provided. Artificial lighting was provided with the use of one (200 watts) bulb for each tier to ensure adequate feed intake. Feeds were weighed with a micro scale balance of 2 kg serving to ensure a uniform amount across treatments .Quail were served 300 g of feed for the first week at about 8 am on a daily basis, the quantity was increased by 50 g on weekly intervals. Fresh clean water was supplied ad-lib. Drinkers and feeders were washed and disinfected using izal when appropriate. At the end of the experiment (70th day/10th week), three (3) laying quails per treatment (one from each replicate) were randomly selected and weighed. Quails were slaughtered by cutting their jugular vein with a sharp knife. The blood samples were collected at slaughter into sterile vacutainers and the serum was separated by centrifugation at 750 g for 15 minutes and stored in a deep freezer until use for serum biochemical analysis. Creatinine was analyzed using SIGMA Kits according to [16]. The Standard Flame Photometer (Gallen Clamp) was used to determine HCO_3^-, Na^+, K^+ and Cl^-. Liver function test was also conducted : ALT (IU/L), AST (IU/L) according to the methods of [17] and [18].

Table 1. Percentage composition of experimental diets with fermented taro cocoyam meal as a replacement for maize in the diets of laying Japanese quails

	Treatment levels				
Ingredients	**0/100**	**25/75**	**50/50**	**75/25**	**100/0**
Maize	46.00	34.50	23.00	11.60	0.00
Cocoyam	0.00	11.50	23.00	34.50	46.00
Soybean	20.80	21.00	19.70	19.90	20.00
Fish meal	4.20	4.60	5.80	6.00	6.00
Palm kernel cake	10.90	10.00	10.00	10.00	10.00
Wheat offal	10.00	10.00	9.75	9.00	8.80
Bone meal	7.00	7.00	7.00	7.00	7.00
Salt	0.50	0.50	0.50	0.50	0.50
Palm oil	0.10	0.40	0.75	1.00	1.20
Vita./mineral premix	0.50	0.50	0.50	0.50	0.50
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated nutrients:					
Crude protein (%)	20.35	20.39	20.40	20.35	20.37
ME (kcal/kg)	2674	2670	2585	2554	2548
Analyzed nutrients:					
Crude protein (%)	21.20	20.89	20.78	20.63	20.59
ME (Kcal/kg)	2690	2680	2593	2562	2553

2.1 Statistical Analysis

The result of serum biochemical parameters were subject to a one-way analysis of variance (ANOVA). Means that differed significantly ($P<0.05$) were separated using least significant dIfference (LSD) method. Results were presented in mean ± standard error of mean (X±SEM).

3. RESULTS AND DISCUSSION

The results of the serum biochemical composition of laying Japanese quails fed diets containing 48-hour fermented taro cocoyam are presented in Table 2.

A condition of hyponatremia was observed across the treatments (126-133 µmol/L) when compared with the established reference interval for 16 weeks old female Japanese quails by [19] (135-155 µmol/L). This result was in contrast with that of [20] who reported that the serum sodium (Na^+) of quails fed sun-dried mango kernel meal (SMKM) was within normal range across treatments. These low levels could not be attributed to the experimental diets as quails fed control diet also showed similar result. It could be attributed to syndrome of inappropriate anti-diuretic hormone.

The serum potassium (K^+) of quails rose slightly above the upper limit (hyperkalemia) (6.8-7.2 µm/L) when compared with the normal reference range by [19] (3.6-5.0 µm/L). Serum potassium tells us about the heart condition. It controls the heart beat rate and the blood pressure [21,22] the fact that the diversions from the normal range were not outrageous, the heart would not have manifested any symptom of disorder. Serum chloride was within normal range in all the treatments (98-100 µm/L) when compared with the normal reference range by [19] (98-106 µm/L) This finding were different from that of [20] who observed slight increase in serum chloride above upper limit in quails fed control diet and 50% SMKM. Hyperchloremia is sometimes associated with excessive fluid loss, Such as diarrhea. Hyperchloremia can be symptomatic with signs of weakness and intense thirst [23].

Serum bicarbonate (HCO_3^-) was within normal range (22-24 µm/L) as established by [19] (22-30 µm/L). This result was in agreement with the report of [20] who observed that serum HCO_3^- of quails fed SMKM was within normal range. This implies that, the acid-base ratio was balanced. Low levels of serum HCO_3^- results in metabolic acidosis [24]. HO_3^- of less than 22µmol/L is compatible with metabolic acidosis.

Serum creatinine was within normal range (4.0 - 6.2 µm/L) comparing with the established reference range by [19] (1.2 – 6.7 µm/L). The report of creatinine agrees with that of [20] who had similar results but was in contrast with the reports of [25] who observed values below the lower limit across treatments. Serum AST and ALT were within normal ranges (242 - 538 IU/L; 4.5 - 8.0 IU/L respectively) when compared with the established reference range by [19] and [25] (243-562 IU/L (AST); 4.5-8.5 IU/L (ALT). These results were in agreement with those of [20] and [25] who fed SMKM to laying quails and Garcinia kola to broilers respectively. Results for AST showed significant ($P<0.05$) differences across treatments with diets containing100% cocoyam having highest values. It was observed that the values increased with heavy supplementation across treatments. These values may have increased as a result of increasing doses of oxalates present in cocoyam diets. Large doses of oxalates crystals of about 780 mg/100 g are known to cause renal damage, kidney stone, low-plasma and corrosive gastro-enteritis [3]. However, the doses were not high enough (8.58 mg/100 g) to cause necrotic effects on the liver, implying that, the liver of quails fed fermented cocoyam were normal and healthy as high values usually represent liver damage. Total bilirubin was slightly above the upper limit (15.17 µm/L) beyond 25% replacement of maize in the diet when compared with the normal reference range by [19] (3.6 -14.2 µm/L). Total and conjugated bilirubin are indicators of protein adequacy [26]. The result of total bilirubin investigation revealed significant ($P<0.05$) differences. The findings showed that beyond 25% inclusion levels of cocoyam in quails' diets, nutrients supplied were insufficient for basic maintenance and metabolic functions of quails probably because of the presence of anti-nutrients such as: tannins, protease inhibitors (trypsin), phytates in cocoyam diets. Tannins are known to form complexes with proteins and limit their availability whereas phytates affects the bio availability of minerals. High values of bilirubin signifies liver disease such as hepatitis or blockage of tubes (bile ducts) or diagnose conditions that cause increased destruction of red blood cell [27]. Heavy supplementation of maize with cocoyam has the tendency of damaging the liver over prolonged usage. It is concluded that cocoyam meals should not be included in layers' diets beyond 25%.

Table 2. Serum biochemical parameters of laying quails fed varying levels of 48–hours fermented taro cocoyam (*Colocasia esculenta var. esculenta*) meal

	Treatment levels						
Parameters	**0/100**	**25/75**	**50/50**	**75/25**	**100/100**	**Mean**	**+SEM**
Na^+ (µmol/L)	1 28.0	126.0	132.0	130.0	133.0	109.8	2.86N
K^+ (µmol/L)	12.80	12.90	13.00	13.10	13.20	13.00	0.16N
Cl^- (µm/L)	98.00	96.00	100.00	97.00	98.00	97.8	0.48N
HCO_3^- (µm/L)	23.0	22.0	24.0	24.0	24.0	23.4	0.89N
Creatinine (µm/L)	4.00	6.20	4.00	4.80	4.60	4.72	0.90N
ALT (IU/L)	4.50	5.00	4.50	4.80	8.00	5.36	0.67N
AST (IU/L)	242.00^c	253.00^c	262.00^c	332.00^b	538.00^a	325.4	124 S*
Total bilirubin (µm/L)	13.00^b	14.00^b	15.00^a	16.00^a	17.00^a	15.00	1.58S*

**Different superscripts (a, b and c) within the same row differed significantly (P<0.05)*

4. CONCLUSION

This study revealed that, heavy supplementation of maize with cocoyam has the tendency of damaging the liver over prolonged usage. It is concluded that cocoyam meals should not be included in layers' diets beyond 25%.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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