

**SERUM BIOCHEMICAL PARAMETERS OF LAYING JAPANESE  
QUAILS (*Coturnix coturnix japonica*) FED DIETS CONTAINING  
FERMENTED TARO COCOYAM (*Colocasia esculenta* var . *esculenta*)  
MEAL**

**Abstract**

The study was conducted to evaluate the effect of fermented taro cocoyam meal on the serum biochemical parameters of 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  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{CL}^-$ ,  $\text{HCO}_3^-$ , Creatinine, ALT, AST and Total bilirubin were determined on the 70th day. The results of serum biochemistry showed that,  $\text{CL}^-$ ,  $\text{HCO}_3^-$ , Creatinine, ALT and AST were within normal range. However, it was observed that serum  $\text{K}^+$  increased above the upper limit whereas serum  $\text{Na}^+$  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, maize can be replaced totally by fermented taro cocoyam meal without adverse effect on most serum biochemical parameters of laying Japanese quails. However, for optimum performance supplementation should not exceed 25%.

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

**Introduction**

There has been a call for substantial increase in protein intake of animal origin in developing countries. Ogbonna (1997), 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

pig 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 (Votti 2004). It is one of the most widely spread root crop grown throughout the humid tropics (Votti, 2004). About 60% of world production is grown in Africa and the remaining 40% in Asia and Pacific Island. 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 (kelsely,1985) . Some of the non-starchy nutrients such as proteins, minerals and vitamins are concentrated in the outer peels of the corms (Ohtsuka, 1989). Most varieties are acid and some contain anti-nutritional factors such as Trypsin inhibitors, Phytates, Tannins, Saponins as well as Raphides (Wills,1983) 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.(Obi, 2010) (Table one and two). Cocoyam corms and its by- products have not received enough attention in terms of utilization as a livestock feed: Abdulrashid et al. (2006) use taro cocoyam to replace all the maize in diets for broilers. Agwunobi et al.,(2008) 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. Okon et al (2008) fed boiled taro cocoyam meal to growing Japanese quails and observed a depressive growth beyond 50% inclusion. Abang et al.,(2013) fed fermented taro cocoyam meal to growing Japanese quails and observed no depressive growth at 100% replacement with maize(Table three). 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 (Obi et al.2013)(Table four). 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 (EL-Dean et al., 2009). 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 (Obi, 2010) whereas, the negative effect includes spoilage of food products and contamination by pathogenic micro-organism (Ojokoh, 2007).

## 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 133g to 163g 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°C- 29°C) 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 AOAC (2000) and metabolizable energy was calculated using the method of Ponzenga (1985). 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 0.75m × 0.38m. Litter materials (wood shavings) were used on the wooden floor. Each tier was equipped with adequate drinker and feeding troughs. A floor space 0.007m to 0.009m 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 2kg serving to ensure a uniform amount across treatments .Quail were served 300gms of feed for the first week at about 8am on a daily basis, the quantity was increased by 50gms 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 (70<sup>th</sup> day/10<sup>th</sup> 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 Feteris (1965). The Standard Flame Photometer (Gallen Clamp) was used to determine HCO<sub>3</sub><sup>-</sup>, Na<sup>+</sup>, K<sup>+</sup> and CL<sup>-</sup>. Liver function test was also conducted (ALT (IU/L), AST (IU/L)) according to the methods of Evans (1996) and Meyer et al. (1972).

118 **Table 1: Percentage** composition of experimental diets for laying Japanese quails.

| Ingredients                 | 0%            | 25%           | 50%        | 75%        | 100%       |
|-----------------------------|---------------|---------------|------------|------------|------------|
| 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 offals                | 10.00         | 10.00         | 9.75       | 9.10       | 8.30       |
| 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       |
| Vit./min.premix             | 0.50          | 0.50          | 0.50       | 0.50       | 0.50       |
| <b>Total</b>                | <b>100.00</b> | <b>100.00</b> | <b>100</b> | <b>100</b> | <b>100</b> |
| <b>Calculated nutrient:</b> |               |               |            |            |            |
| Crude protein%              | 20.35         | 20.39         | 20.40      | 20.35      | 20.37      |
| ME (MJ/kg)                  | 2.674         | 2.670         | 2.585      | 2.554      | 2.538      |

119 **Analyzed nutrients:**

|     |                   |              |              |              |              |              |
|-----|-------------------|--------------|--------------|--------------|--------------|--------------|
| 120 | Crude protein (%) | 21.20        | 20.89        | 20.78        | 20.63        | 20.59        |
| 121 | <b>ME (MJ/kg)</b> | <b>2.690</b> | <b>2.680</b> | <b>2.593</b> | <b>2.562</b> | <b>2.553</b> |

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**Proximate analysis:**

Proximate analysis was carried out according to AOAC (2000) methods.

Metabolisable energy (MJ/Kg) was calculated using the method of Ponzenga(1985).

**Statistical analysis:**

The result of serum biochemical parameters were analyzed using the Standard Error of Mean (SEM).

Table 2: Proximate composition of differently processed taro cocoyam.

| PARAMETERS               | RAW (SUN-DRIED) | 15 MINUTES BOILED | 48HRS<br>FERMENTATION |
|--------------------------|-----------------|-------------------|-----------------------|
| ETHER<br>EXTRACT(E.E.)   | 0.50            | 0.50              | 0.50                  |
| CRUDE PROTIEN            | 5.25            | 4.81              | 8.75                  |
| ASH                      | 2.50            | 2.50              | 2.00                  |
| CRUDE FIBER              | 2.75            | 2.50              | 1.50                  |
| NITROGEN FREE<br>EXTRACT | 89.00           | 89.96             | 87.25                 |
| MOISTURE                 | 68.00           | 50.29             | 55.89                 |

SOURCE :Obi(2010)

Table 3:The effect of processing methods on anti-nutritional factors..

| Parameter        | Raw(sun-dried)           | 48 hrs fermentation     | 15 minutes boiled        |
|------------------|--------------------------|-------------------------|--------------------------|
| Hydrogen cyanide | 1.24±.010 <sup>a</sup>   | 0.89±0.076 <sup>a</sup> | 0.47±0.013 <sup>b</sup>  |
| Oxalate          | 35.75±0.030 <sup>a</sup> | 9.72±0.043 <sup>c</sup> | 21.85±0.023 <sup>b</sup> |
| Phytate          | 0.41±0.010 <sup>a</sup>  | 0.25±0.043 <sup>b</sup> | 0.25±0.043 <sup>b</sup>  |
| Saponin          | 5.50±0.200 <sup>a</sup>  | 2.15±0.043 <sup>c</sup> | 3.30±0.043 <sup>b</sup>  |
| Tannins          | 0.26±0.010 <sup>a</sup>  | 0.09±0.043 <sup>b</sup> | 0.10±0.067 <sup>b</sup>  |

Mean of 3 determinations ± SD.

SOURCE :Obi(2010)

**Table 4: Summarized table of performance characteristics of growing Japanese quails fed fermented taro cocoyam.**

| Parameters                 | 0%                       | 25%                       | 50%                     | 75%                       | 100%                     |
|----------------------------|--------------------------|---------------------------|-------------------------|---------------------------|--------------------------|
| Ave. weekly feed intake(g) | 86.24±4.10 <sup>d</sup>  | 89.50±2.40 <sup>c</sup>   | 93.68±2.88 <sup>b</sup> | 97.34±3.03 <sup>a</sup>   | 97.58±3.03 <sup>a</sup>  |
| Ave. Weekly body weight(g) | 102.85±20.2 <sup>a</sup> | 104.14±20.18 <sup>a</sup> | 96.85±8.65 <sup>b</sup> | 91.59±17.53 <sup>bc</sup> | 86.93±17.96 <sup>c</sup> |
| Ave .term. Body weight(g)  | 155.13±2.89 <sup>a</sup> | 153.02±0.53 <sup>a</sup>  | 143.09±1.1 <sup>b</sup> | 135.96±1.53 <sup>c</sup>  | 130.53±1.60 <sup>d</sup> |
| Ave. Weekly weight gain(g) | 26.78± 5.23              | 26.31±6.52                | 23.77±7.43              | 22.67±7.73                | 20.63±5.53               |
| Feed efficiency            | 3.68±1.76                | 4.26±1.26                 | 5.74±2.04               | 6.51±2.18                 | 6.40±2.15                |
| Feed conversion ratio      | 0.31±0.06                | 0.30±0.07                 | 0.25±0.08               | 0.23±0.15                 | 0.21±0.06                |
| Protein efficiency ration  | 0.17±0.03                | 0.17±0.04                 | 0.15±0.05               | 0.14±0.04                 | 0.13±0.04                |

Different superscript(a,b,c and d)within the same row indicates significance(P<0.05)differences.  
Source: Abang *et al*(2013)

**Table 5: Summarized table of performance characteristics of laying quails fed fermented taro cocoyam .**

| Parameters                 | 0%                                         | 25%                                        | 50%                                        | 75%                                        | 100%                                      |
|----------------------------|--------------------------------------------|--------------------------------------------|--------------------------------------------|--------------------------------------------|-------------------------------------------|
| Ave. weekly feed intake(g) | 128.34±6.33 <sup>c</sup>                   | 134.84±6.83 <sup>b</sup>                   | 141.27±7.30 <sup>b</sup>                   | 149.12±15.77 <sup>a</sup>                  | 149.53±8.07 <sup>a</sup>                  |
| Ave. Final body weight(g)  | 187.61±3.61 <sup>a</sup>                   | 185.44±3.78 <sup>a</sup>                   | 169.48±2.20 <sup>c</sup>                   | 160.12±1.84 <sup>c</sup>                   | 155.25±2.79 <sup>d</sup>                  |
| Feed efficiency            | 1.54±0.64 <sup>c</sup>                     | 1.13±0.27 <sup>c</sup>                     | 7.30±5.11 <sup>b</sup>                     | 11.58±6.13 <sup>c</sup>                    | 11.97±3.49 <sup>a</sup>                   |
| Production/day             | 20.37±2.45 <sup>a</sup>                    | 21.31±2.45 <sup>a</sup>                    | 8.94±1.53 <sup>b</sup>                     | 4.62±1.18 <sup>b</sup>                     | 0.16±0.39 <sup>c</sup>                    |
| Hen day production (%)     | 47.72±6.02 <sup>a</sup>                    | 48.43±5.50 <sup>a</sup>                    | 20.51±3.54 <sup>b</sup>                    | 10.92±2.65 <sup>c</sup>                    | 3.71±0.85 <sup>c</sup>                    |
| Time of lay.               | 42 days of age(at the 6 <sup>th</sup> wk.) | 39 days of age(end of 5 <sup>th</sup> wk.) | 46 days of age(end of 6 <sup>th</sup> wk.) | 51 day of age (at the 7 <sup>th</sup> wk.) | 54days of age(at the 8 <sup>th</sup> wk.) |

Different superscript(a,b,c and d)within the same row indicates significance(P<0.05)differences.  
Source: Obi *et al*(2013.)

## 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 6.

A condition of hyponatremia was observed across the treatments(126-133µmol/L) when compared with the established reference interval for 16weeks old female Japanese quails by Scholtz *et al*, 2009 (135-155µmol/L). This result was in contrast with that of Nwani (2014) who reported that the serum sodium (Na<sup>+</sup>) 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  $\mu\text{m/L}$ ) when compared with the normal reference range by Scholtz *et al*; 2009 (3.6-5.0  $\mu\text{m/L}$ ). Serum potassium tells us about the heart condition. It controls the heart beat rate and the blood pressure (El-boushy *et al* 2004; Diarra *et al*; 2008) 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  $\mu\text{m/L}$ ) when compared with the normal reference range by Scholtz *et al*; 2009 (98-106  $\mu\text{m/L}$ ).

This finding were different from that of Nwani (2014) who observed slight increase in serum chloride above upper limit in quails fed control diet and 50% SMK. Hyperchloremia is sometimes associated with excessive fluid loss, Such as diarrhea. Hyperchloremia can be symptomatic with signs of weakness and intense thirst (Cambier, *et al*.1998).

Serum bicarbonate ( $\text{HCO}_3^-$ ) was within normal range (22-24  $\mu\text{m/L}$ ) as established by Scholtz *et al.*, 2009 (22-30  $\mu\text{m/L}$ ). This result was in agreement with the report of Nwani (2014) who observed that serum  $\text{HCO}_3^-$  of quails fed SMK was within normal range. This implies that, the acid-base ratio was balanced. Low levels of serum  $\text{HCO}_3^-$  results in metabolic acidosis (Kesimatis *et al.*, 2005).  $\text{HCO}_3^-$  of less than 22 $\mu\text{mol/L}$  is compatible with metabolic acidosis.

Serum Creatinine was within normal range (4.0 - 6.2  $\mu\text{m/L}$ ) comparing with the established reference range by Scholtz *et al*; 2009 (1.2 – 6.7  $\mu\text{m/L}$ ).

The report of Creatinine agrees with that of Nwani (2014) who had similar results but was in contrast with the reports of Sobayo *et al.*, 2013 who observed values below the lower limit across treatments. Serum AST and ALT were within normal ranges (242 - 538  $\text{IU/L}$ ; 4.5 - 8.0  $\text{IU/L}$  respectively) when compared with the established reference range by Scholtz *et al.*, 2009 and Robin, 2013 (243-562  $\text{IU/L}$  (AST); 4.5-8.5  $\text{IU/L}$  (ALT). These results were in agreement with those of Nwani (2014) and Sobayo *et al.*(2013) who fed SMK to laying quails and Garcinia kola to broilers respectively. This implies 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 $\mu\text{m/L}$ ) beyond 25% replacement of maize in the diet when compared with the normal reference range by Scholtz *et al.*, 2009 (3.6 -14.2  $\mu\text{m/L}$ ). High value 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 (Robin, 2013). The deviations observed could be associated with diagnose conditions that would have caused increased destruction of the red blood cells as the birds were intermittently treated with pentheryl (antibiotic) as serum ALT and AST which are equally used to ascertain the condition of the liver were within normal ranges.

**Table 6:** Serum biochemical parameters of laying quails fed varying levels of 48 – hours fermented taro cocoyam meal (*Colocasia esculenta var. esculenta*).

| Parameter                            | 0%    | 25%   | 50%    | 75%   | 100%  | Mean  | SEM  |
|--------------------------------------|-------|-------|--------|-------|-------|-------|------|
| Na <sup>+</sup> (μmol/L)             | 28.0  | 126.0 | 132.0  | 130.0 | 133.0 | 109.8 | 2.86 |
| K <sup>+</sup> (μmol/L)              | 12.80 | 12.90 | 13.00  | 13.10 | 13.20 | 13    | 0.16 |
| CL <sup>-</sup> (μm/L)               | 98.00 | 96.00 | 100.00 | 97.00 | 98.00 | 97.8  | 0.48 |
| HCO <sub>3</sub> <sup>-</sup> (μm/L) | 23.0  | 22.0  | 24.0   | 24.0  | 24.0  | 23.4  | 0.89 |
| Creatinine(μm/L)                     | 4.00  | 6.20  | 4.00   | 4.80  | 4.60  | 4.72  | 0.90 |
| ALT(IU/L)                            | 4.50  | 5.00  | 4.50   | 4.80  | 8.00  | 5.36  | 0.67 |
| AST(IU/L)                            | 242.0 | 253.0 | 262.0  | 332.0 | 538.0 | 325.4 | 124  |
| Total bilirubin(μm/L)                | 13.0  | 14.0  | 15.0   | 16.0  | 17.0  | 15    | 1.58 |

## Conclusion

This study revealed that, maize can be replaced totally by fermented taro cocoyam meal without adverse effect on most serum biochemical parameters of laying Japanese quails. However, for optimum performance supplementation should not exceed 25%.

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