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Egg Quality Characteristics of Japanese Quails *(Coturnix coturnix japonica*) Fed Varying Levels of 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 FBPA and BIO designed the study, wrote the protocol and wrote the first draft of the manuscript. Author FBPA reviewed the experimental design and all drafts of the manuscript. Authors AAA and FBPA managed the analyses of the study. Author FBPA identified the plants. Authors FBPA and AAA performed the statistical analysis. All authors read and approved the final manuscript.

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ABSTRACT

A study was conducted to investigate the effect of FTCM on the egg quality parameters of Japanese quails. Two hundred and twenty five Japanese quails were randomly allotted to five dietary treatments (1-V) of 36 hens and 9 cockerels each. Each treatment was replicated thrice with 12 hens and three cockerels per replicate. In each of the five diets, FTCM was used to replace maize at 0%, 25%, 50%, 75% and 100% for treatments i, ii, iii, iv and v respectively. Quails in this study were fed over a period of 70 days. Feed intake was measured daily and quails were weighed weekly .Eggs were collected on weekly basis for egg quality analysis. Results showed that, mean weekly egg weight, shell weight, yolk weight, albumen weight, yolk index and egg breaking strength

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of quails fed treatments i and ii were significantly(P<0.05) higher than those fed other treatments. Quails fed diets i, ii and iii recorded highest values of shell thickness. However, there were no significant (P>0.05) differences in relative yolk and relative albumen weights across treatments. The results suggest that FTCM could replace maize up to 100% without adverse effect, but for premium egg quality, replacement should not exceed 25%.

Keywords: Quails; FTCM; maize and egg quality.

1. INTRODUCTION

Poultry production offers the greatest potential for bridging the gap of protein deficiency existing in Nigeria. The poor performance of non-ruminants (poultry, rabbits and pigs) is due to high cost of conventional ingredients such as maize, sorghum, millet, soybeans, groundnut etc. These conventional feedstuffs are expensive and are gravely faced by the problems of seasonality. This all year round unavailability has led to stiff competition between man and livestock industries as demand outstrips supplies. The need to search for alternative feed stuffs that are cheap and readily available cannot be over emphasized. A lot of Researchers have been able to use supplemental levels of non-conventional feed stuffs to reduce cost of production such as: Cocoyam [1,2], Cassava [3], Rubber seed [4], Mango kernel [5,6], Sweet orange peels [7] and *Prosopis* [8].Taro cocoyam is one of the most widely spread root crop grown in humid tropics. About 60% of the world production is grown in Africa and 40% in Asia [9]. Fresh taro root is high in energy and contains about 25% starch and 1% protein. Taro has highest contents of P, Mg and Zn of all root/tuber crops and rich in all vitamins except for nicotinic acid [10]. Protein of taro cocoyam is well supplied with the essential amino acid but somehow low in histidine and lysine [11]. Cocoyam is cheaper and yields better than maize [12] and as such stands a better chance of replacing maize. However, the presence of anti-nutrients constitute a problem. Anti - nutrients are known to interfere with the bio availability of nutrients and render them un-available. Processing techniques such as; boiling, fermentation, toasting, sun drying etc. could take care of its limitation [13]. This study was designed to investigate the effect of fermented taro cocoyam on egg quality parameters of Japanese quails.

2. MATERIALS AND METHODS

The study was carried out in Cross River University of Technology Teaching and Research Farms Calabar, Calabar- Nigeria.

2.1 Experimental Diets

Unpeeled taro cocoyam corms were bought from Bendeghe village, Etung, Cross River State, Nigeria. Corms were peeled and chopped into sizeable chips of about 14 g each. These chips were submerged in a big plastic pot-like container with a tight lid and fermented in water at room temperature (28℃ to 29℃) for 48hrs. Sun- drying lasted for a week (7days) and this reduced the moisture content to less than 10% for longer keeping. The 48hrs fermented taro cocoyam corms (FTCC) and other ingredients were milled separately and used to formulate experimental diets. The diets had varying protein (%) and energy (ME/Kcal/kg) levels of 21.20, 20.89, 20.78, 20.68, 20.59, and 2690.30, 2679.58, 2593.20, 2562.20 and 2552.90 for protein and energy respectively. These levels were for treatments 1, 2, 3, 4 and5 respectively. The diets were analyzed according to the methods of [14]. Energy was calculated according to the methods of [15]. The percentage composition of the experimental diets is presented in Table 1.

2.2 Design and Management

The birds (quails) used in this study were twelve (12) hens and three (3) cockerels per replicate. In summary, a total of 225 quails (180 hens and 45 cockerels) were studied over a period of ten weeks (70 days). Birds were randomly allotted to five dietary treatments 1, 2, 3, 4 and 5 formulated with 48hrs fermented taro cocoyam meal (FTCM) at 0%, 25%, 50%, 75% and 100% replacement levels respectively (Table 1). Quails were housed in three tier cages of dimension 0.75 m^2 x0. 38 m^2. The cages were made up of wood and wire mesh. Same quantity of feed was weighed and served to the quails on weekly basis, the feed was increased by 50 g weekly. Fresh, clean water was supplied *ad libitum* daily. Adequate bio-security and bio- sanitary measures were strictly adhered to. Records of feed intake were kept daily, initial body weight was taken on commencement and subsequently on weekly basis. Total number of eggs laid per

Table 1. Percentage composition of diet with fermented taro cocoyam (*Colocasia esculenta var esculenta*) meal for laying Japanese quails (*Coturnix coturnix japonica*)

Ingredients	Levels of inclusion				
	0%	25%	50%	75%	100%
Maize	46.00	34.50	23.00	11.50	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
P.K.C	10.90	10.00	10.00	10.00	10.00
Wheat offal	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	0.50	0.50	0.50	0.50	0.50
Vita/ min premix	0.10	0.40	7.50	1.00	1.20
Total	100.00	100.00	100.00	100.00	100.00
Analyzed nutrients:					
Crude protein (%)	21.20	20.89	20.78	20.63	20.59
ME/kcals/kg	690.30	2679.58	2593.20	2562.20	2552.90

replicate group were collected twice daily (8 am and 4 pm) and recorded. At the end of every week fresh eggs were collected for egg quality analysis.

2.3 Determination of Egg Quality Parameters

Nine fresh eggs (large, medium and small) were separated from each treatment (3 eggs from each replicate) and used at weekly interval to determine egg quality parameters throughout the experimental period. The eggs were weighed using a sensitive electronic weighing balance (JJ560 USA) citizen scale to the nearest 0.01 g. Each egg was weighed and broken around the equator with care being taken to keep the yolk intact. Yolk was separated from the albumen using an egg separator and weighed separately. Relative yolk and relative albumen weights were calculated in percentage by relating the yolk or albumen weights measured to the nearest gram to the whole weight of the particular egg and multiply by 100.

Relative yolk weight =Yolk/Egg wt. x 100

Relative albumen weight=Albumen/Egg wt. x 100

Egg shells were sun- dried for three days and their weights taken with the aid of a sensitive electronic balance. Shell thickness was measured using micrometer screw gauge. The measurement were taken from the pointed, middle and broad part of the egg and the mean thus obtained and measured to the nearest 0.01 mm. Yolk height was taken with the aid of a Spherometer at the highest point of its surface and yolk width was measured at long and short axis using vernier caliper. The values obtained were used to calculate yolk index. Egg breaking strength (EBS) was calculated using the formular suggested by [16] and represented as;

Yolk Index = mean height/mean width

EBS =50.86 x (EW) 0.915, where EW =Egg weight.

Data obtained were subjected to analysis of variance using the completely randomized design (CRD) as described by [17]. Least significant difference method was used to separate means that differed significantly [17].

3. RESULTS AND DISCUSSION

The egg weights (EW) of quails fed control diets and 25% inclusion levels of cocoyam had significantly ($P<0.05$) better egg weights as compared to quails on other dietary treatments. [18] indicated that egg mass or weight can be used as a criteria in assessment of nutritional status. Similar results were reported in which egg weights increased significantly ($P<0.05$) at higher levels of dietary protein inclusion [19,20]. The weight ranged between 9.40 to10.80 g. This range was higher than the 8.92 to 10.13 g reported by [20] and the 7.89 to 9.30 g reported by [21]. [22] indicated that a good quail egg should weigh about 9.30 g and above. Quails fed various diets met this requirement. The egg shell weights (ESW) of quails placed on treatments I and II were significantly (P<0.05) heavier than those of other treatments. It was observed that beyond 25% inclusion levels the egg shell weights decreased with increased supplementation. This could be attributed to decrease in dietary protein across the treatments. The egg shell weights ranged from 1.12 to 1.30 g. This range was higher than 0.90 to 0.93g reported by [19] and the 0.91 to 0.95 reported by [23]. It could be as a result of the varying Ca:P ratio in the experimental diets of the various experiments. Results showed that shell thickness (ST) of quails fed control diets and 25% inclusion levels of cocoyam had significantly (P<0.05) thicker shells than quails fed other diets. Shell thickness ranged from 0.203 to 0.217 mm. The result was lower than that reported by [19] (0.24 to 0.26 mm). The result contradicts with the report of [24] who asserted that, shell thickness declines with age due to increase in egg size which forces the constant amount of shell to spread thinner and thus reducing the thickness and quality. However, it was in agreement with the report of [25] who asserted that, the amount of shell materials deposited per egg does not change with age and size. Otherwise, treatments V and IV should have had significantly (P<0.05) thicker shells according to [24]. Egg breaking strength (EBS) followed similar trend with quails placed on diets I and II having significantly (P<0.05) higher values compared with others. The result ranged from 442.1 to 502.77. This implies that eggs of quails placed on treatments I and II will not easily get cracked or broken when compared with eggs of other treatments. Generally, egg breaking strength (EBS) of quails is lower than that of chickens which could be as high as 2322±55.60 g [26,27]. By implication, the higher the EBS the better the egg quality. Yolk weight and albumen weights of quails fed control and 25% inclusion levels of cocoyam had significantly (P<0.05) higher weights than those of other treatments. Yolk and albumen weights ranged from 3.28 to 3.60 g and from 5.00 to 5.91 g respectively. The result of the yolk weight was in agreement with the report of [25] who noted that, albumen weight (AW) is negatively correlated with the yolk weight (YW). This infers that eggs with higher values of AW will have lower yolk weights. The values recorded for AW in this finding were different from those recorded by [23] (4.42 to 4.60 g). This result was in agreement with the reports of [28] who indicated that AW was highly correlated with egg weight. It was observed that treatments I and II with highest values of egg weights (EW) had highest values of albumen weights (AW). The AW is sufficient to measure egg quality [29]. There were no significant (P>0.05) differences recorded in relative yolk weights (RYW) and relative albumen weights (RAW) across the treatments. RYW and RAW ranged from 33.33 to 34.89 and from 52.75 to 54.72 respectively. The results of RYW and RAW are in agreement with the observation of [28] who observed that as the egg size (ES) increases, the RYW decreases and the RAW increases. This result also agrees with the findings of [25] who asserted that although the age of a layer has positive relationship with ES it exerts a negative influence on the yolk properties. Results showed significant (P<0.05) difference in yolk index (YI) with treatments.

Table 2. Summarized table of egg quality characteristics of laying quails fed vary levels of fermented taro cocoyam meal

	Treatments levels (%)				
Parameter	**0%**	**25%**	**50%**	**75%**	**100%**
External characteristics:					
EW (g)	7.516 ± 0.52^c	8.636 ± 0.41^a	8.633 ± 0.40^a	8.128 ± 0.32^b	7.757 ± 0.41^c
ESW (g)	1.12 ± 0.10^d	1.29 ± 0.08^a	1.30 ± 0.08^a	1.19 ± 0.09^b	1.15 ± 0.08^c
EBS	442.21 ± 23.77^c	502.36 ± 19.11^a	502.77 ± 18.58^a	472.68 ± 14.87^b	451.23 ± 19.00^c
ST(mm)	0.205 ± 0.006^b	0.216 ± 0.004^a	0.216 ± 0.005^a	0.217 ± 0.005^a	0.203 ± 0.006^b
Internal characteristics:					
YW (g)	3.60 ± 0.10^a	3.45 ± 0.07^b	3.34 ± 0.07^c	3.28 ± 0.10^c	3.28 ± 0.10^c
AW (g)	5.90 ± 0.25^a	5.91 ± 0.24^a	5.56 ± 0.16^b	5.21 ± 0.62^c	5.00 ± 0.35^c
RYW (%)	35.32± 1.29	33.47±0.43	33.40±0.41	34.05±0.49	34.73±1.00
RAW (%)	52.75 ±1.19	54.61±0.39	54.65±0.35	54.73±0.34	53.52±0.84
YI	0.488 ± 0.06^a	0.489 ± 0.06^a	0.475 ± 0.005^b	0.472 ± 0.002^b	0.468 ± 0.002^b

Different superscripts (a, b, c and d) within the row indicates significant (P<0.05) difference

I and II having the highest values. The YI ranged from 0.468 to 0.489. This range varied from the 0.35 reported by [19]. YI is the measure of the standing up quality of the yolk. Average values for fresh eggs usually fall between 0.40 to 0.42 [29]. The authors further stated that, the YI of 0.25 or lower indicates the weakness of the yolk and extreme difficulties in handling it for measurement without breaking. In this findings, one could deduce that the YI of all the treatments were within the range and could be handled for measurement without scattering easily.

4. CONCLUSION

The results of this study suggested that fermented taro cocoyam meal could replace maize up to 100% without compromising egg quality. Nevertheless, for premium egg quality, replacement of maize with fermented taro cocoyam meal should not exceed 25%.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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