Asian Journal of Advances in Agricultural Research

7(1): 1-10, 2018; Article no.AJAAR.41488
ISSN: 2456-8864

Laying Performance and Egg Characteristics of Japanese Quails (*Coturnix coturnix japonica*) Fed Diets Containing Mango Fruit Reject Meal

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Authors' contributions

This work was carried out in collaboration between both authors. Author OKT designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author SSS managed the analyses of the study and managed the literature searches. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJAAR/2018/41488
Editor(s):
(1) Rajesh Kumar, Department of Veterinary and Animal Husbandry Extension, College of Veterinary Science & A.H., Junagadh Agricultural University, Junagadh, India.
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Reviewers:
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(3) Samli, H. Ersin, Namik Kemal University, Turkey.
Complete Peer review History: http://prh.sdiarticle3.com/review-history/24936

Original Research Article

Received 13th March 2018
Accepted 22nd May 2018
Published 2nd June 2018

ABSTRACT

Aim: The experiment was carried out to investigate the effect of composite mango fruit rejects meal on the performance of laying Japanese quails.
Methodology: Mango fruit reject meal (MFRM) was included in laying Japanese quails' diets at 0.0, 40.00, 80.00, 120.00 and 160.00 g/kg respectively; 0.0 g/kg MFRM served as the control diet. One hundred and twenty (120) 51-day-old Japanese quails were randomly allocated to the five dietary treatments and replicated three times with each replicate having eight (8) quail birds in a completely randomized design and fed for 28 days.
Results: Proximate composition of MFRM showed that it has high soluble carbohydrate (810.10 g/kg); low protein (43.80 g/kg), fat and fibre. Growth in the laying phase and laying performances

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were not significantly affected. There were no significant differences among treatment groups for egg characteristics as well.

Conclusion: It was concluded that MFRM is a utilisable energy feedstuff in quail diets and should be included at 160.00 g/kg in place of maize. It was recommended that higher levels should be investigated.

Keywords: Body weight; crude protein; egg; egg production; feed intake; yolk.

1. INTRODUCTION

Diversifying poultry production, which has been chicken-centred, is one way of increasing protein supply to the less developed world, most hit by the adverse effect of the competition for conventional feedstuffs by man and his animals. Recent investigations have identified some micro-livestock species with short generation intervals, high productivity; less space requirement and easy handling that are likely to convert agro-industrial by-products to meat and or egg more efficiently than the chicken [1,2,3]. One such micro-livestock poultry is the Japanese quail (*Coturnix coturnix japanica*). The Japanese quail has the potential to serve as an excellent and cheap source of animal protein. Quails attain sexual maturity early and come into lay between 5 – 6 weeks of age, attains full egg production at 50 days of age (about seven weeks of age) and lays about 200 – 300 eggs in their first year of lay [4,5]. Quail meat and eggs are renowned for their high-quality protein, high biological value and low caloric content [6,7].

As a poultry species, the challenge of competing with humans for the source of energy; a monster in monogastric animal nutrition, is not ruled out in quail production. Agricultural by-products have been utilized in chicken diets to a greater extent, with limitations reported nonetheless [8,9,10]. Quails are reported to be hardy and likely to tolerate more agricultural by-products with relatively higher phytochemicals as energy feed resources in their diets than other poultry species, and many such by-products have been utilized in japanes quail diets. Twenty-five percent (25%) replacement of maize with mango seed kernel has been reported as safe for growth performance of quail [11]. Water soaked sweet orange peels were also used in quail feeding as a replacement for maize [12]. Yam peels [1] and sugarcane scrapping [13] have been successfully utilized in quail diets.

Mango (*Mangifera indica*) fruit is one of the common, nutritionally rich fruit with unique flavour, fragrance, taste, and health-promoting qualities. The tree originated from the Sub-Himalayan plains of the Indian sub-continent and is now widespread in tropical and sub-tropical areas of the world [14]. It is produced on a large scale around many countries of the world, with total world figure put at 39 million metric tones [15]. Nigeria is on the 9th position on the list of top-most producers of mango with a production figure of 850 000 metric tones [15]. In Nigeria, Benue state is the highest quantitative producer of Mango [16].

A large quantity of the pulp and peel of rejected fruits waste away, due to bruises, infections, improper handling, and activities of animals (especially birds) on the fruit, making them unfit for human consumption and as such rejected. Among local varieties, fruits of a whole tree stand may be considered unpalatable and as such rejected [10]. These rejected fruits litter the ground during its season; February to May, thereby constituting an environmental problem. More so, mango processing yields about 40-50% of by-products, which can be used to feed livestock [17,9]. These by-products are also a potential source of protein and phenolic compounds (antioxidants) and may include; cull (rejected) fruit, mango seed kernel, mango fruit peel and mango fruit waste [18].

Whereas the seed kernel of mango fruits have been utilized in animal feeding for more than a decade ago, the use of the pulp/peel is reported recently in poultry diets [9]; where the optimum of mango fruit reject meal in broiler diets was placed at 12%.

This study therefore determined proximate constituents of mango fruit reject (pulp and peel) and effect of its dietary inclusion on laying performance of Japanese quail.

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiments were carried out at the Poultry Unit of the Livestock Teaching and Research Farm, University of Agriculture Makurdi, Benue

State, Nigeria. Benue State is located between longitude 6° and10° E and latitude 6° and 8° N and Makurdi, town, the capital of the state is located on latitude 7° 43' and Longitude 8^0 3' E [19]. The Benue floodplain is between 0 m to 100m above sea level. The area is warm, characteristic of tropical climate with a minimum temperature of 24.20 $\pm$ 1.40°C and maximum temperature of 36.33 $\pm$ 3.70°C [20]. From February through April, temperatures may reach 35°C to 40°C in Makurdi town. Rainfall is between 508 and 1016mm, and the relative humidity is between 39.50 $\pm$ 2.20 and 64. 00 $\pm$ 4.8% and mean wind speed of 2.47 knot/second North-East [20].

2.2 Source of Mango Fruit Rejects and Preparation of Mango Fruit Reject Meal

The mango fruit rejects (test ingredient) were collected regardless of variety from mango tree stands around Makurdi town, in its season; which is between February and May. Mango fruits composite, made of locally available varieties comprising mainly of local mango, julie, peter, John and Hindi were cleaned and sliced such that the peel and pulp were together and the seed discarded. The slices were sun-dried for seven days, when the dry matter of the material was slightly more than 90%, and stored in polyethene bags until it was used. Before the mango fruit reject composite was included in quail diets, it was milled to about 500 um diameter particle size, using corn milling machine to obtain Mango Fruit Reject Meal, coded (MFRM) as reported (10). This was sub-sampled for determination of proximate composition using the procedure outlined [21].

2.3 Preparation of Diets

The mango fruit rejects meal (MFRM) was incorporated in quail diets at 0.0 (control), 40.00, 80.00, 120.00 and 160.00 g/kg; displacing maize in equal amounts, to produce five diets respectively (Table 1).

2.4 Experimental Birds and Design

One hundred and twenty (120) Japanese quails aged 51 days, were used in the experiment whose design was completely randomized design (CRD) with the following model:

$$X_{jk}=\mu+ a_j+\varepsilon_{jk}$$

Where

X_{jk} = an observation in which k is the replicate of treatment j,
μ = mean of the observation values,
a_j = effect of the treatment and
ε_{jk} =experimental error

The Japanese quails were obtained from (NVRI) VOM, Plateau State in Nigeria, and used for the study. The 120 Japanese quail birds were randomly allocated to 5 (0.0, 40.00, 80.00, 120.00 and 160.00 g/kg MFRM) dietary treatments, replicated three times and each replicate had 8 birds. Allocation of replicates to cages was also randomized using standard procedures. The birds were fed for 28 days in their laying time (from 51 days old), and the laying, as well as growth performance parameters, were evaluated.

2.5 Management of the Birds

The birds were raised and managed intensively in three-tier wooden structures; each tier was having two cages per tier and separated from the other tier with wooden floor. Wire mesh was used for the walls and doors to allow adequate ventilation and lighting. The dimension; length by breadth by height, of each cage was 0.90 m x 0.60 m x 0.45 m. This provided a floor space of 0.068 m^2 per quail. Litter materials made of wood shavings were used on the wooden floors, and each cage was equipped with a drinker and feeding trough. Quails were served fresh feeds and portable water *ad libitum* throughout the experimental period – 28 days.

2.6 Data Collection

2.6.1 <u>Growth performance of Japanese quail for the experiment</u>

The parameters measured were daily feed intake, daily weight gain, total weight gain, feed conversion ratio and final weight. Initial and final weights of birds were recorded at the start and end of the experiment using an electronic weighing scale (Mettler Toledo). Feed intake was determined by measuring the initial weight of the feed for each replicate before serving the birds and weighing the feed left over at the end of the week to determine feed intake by the difference. A summation of all the weekly feed intakes, gave total feed intake, while daily feed intake was determined by dividing total feed intake by the number of days the experiment lasted.

Table 1. Composition (g/kg) of experimental diets for laying Japanese Quail

	Experimental diets				
Ingredient	**0.0 MFRM**	**40.00 MFRM**	**80.00 MFRM**	**120.00 MFRM**	**160.00 MFRM**
Maize	420.00	380.00	340.00	300.00	260.00
MFRM	0.0	40.00	80.00	120.00	160.00
Soyabean meal	400.00	400.00	400.00	400.00	400.0
Brewers' dried grain	95.50	95.50	95.50	95.50	95.50
Fish meal	44.00	44.00	44.00	44.00	44.00
Bone ash	30.00	30.00	30.00	30.00	30.00
Salt	2.50	2.50	2.50	2.50	2.50
Prermix*	2.50	2.50	2.50	2.50	2.50
Methionine	3.00	3.00	3.00	3.00	3.00
Lysine	2.50	2.50	2.50	2.50	2.50
Total (kg)	1.00	1.00	1.00	1.00	1.00
	Calculated nutrients (g/kg)				
ME (MJ/kg)	11.13	11.06	11.00	10.93	10.87
Crude protein	274.20	271.90	269.60	267.30	264.90
Crude fibre	57.30	60.70	64.10	67.40	70.80
Crude fat	28.40	28.00	27.60	27.20	26.80
Calcium	12.40	12.50	12.60	12.70	12.80
Phosphorus	10.40	10.40	10.40	10.30	10.30
Determined nutrients (g/kg)					
Crude protein	266.80	262.50	258.90	255.30	251.70
Crude fibre	39.70	41.10	37.30	33.90	33.50
Crude fat	50.60	40.80	32.7	35.30	37.10
NFE	550.10	536.20	571.1	576.00	592.70
Ash	92.00	71.70	78.8	88.00	71.60

1. MFRM= mango fruit reject meal
2. NFE= Nutrient free extract
3. ME= Metabolizable energy
4. Premix= Animal care vitamin/mineral premix®, included at 2.50 g/kg, translating to 7.20 mg retinol, 0.15 mg cholecalciferol/ergocalciferol, 40.02 mg D-α-tocopherol, 5mg vitamin K3, 2mg folic acid, 80mg niacin, 4mg vitamin B1, 10 mg vitamin B, 7mg Vitamin B6, 0.04 mg Vitamin B12, 0.16 mg biotin and 250 mg antioxidant per kg Diet. The minerals values per kg diet were: cobalt 0.5mg, copper 16mg, selenium 0.5 mg, iodine 24 mg, iron 80 mg, manganese 140mg, zinc 120mg and chloride 400 mg*

Feed conversion efficiency (FCE) was calculated using the formula:

$$FCE = \frac{Weight\ gain(g)}{Feed\ consumed(g)} \quad (1)$$

Total weight gain was calculated by working the difference between the final and initial weights in the experiment, while daily weight gain was determined by dividing total weight gain over the number of days the experiment lasted.

2.6.2 Laying performance of Japanese quails

The performance characteristic of laying quail measured included feed consumption, weight gain, number of eggs laid, the weight of eggs, mortality, cost of feed consumed and value of eggs in USD. Laying performance indices were calculated:

a) Hen – Day egg production (HDEP) for the period

$$HDEP = \frac{Total\ No.\ of\ eggs produced\ within\ the\ period}{ontal\ No.of\ hen{-}days\ in\ the\ same\ period} X\ 100 \quad (2)$$

Note: Hen – days = number of hens for each day within the period, added together

b) Hen – Housed Egg Production (HHEP) for the period

$$HHEP = \frac{Total\ No.of\ egg\ laid\ during\ the\ period}{Total\ No.of\ hens\ housed\ at\ the\ beginning\ of\ laying\ period\ multiplied\ by\ the\ No.of\ days\ within\ the\ period} \times 100 \quad (3)$$

c) Egg mass

It was determined by first calculating the average weight from a representative sample of eggs whose weight has been measured as follows:

Average egg mass (g/hen/day) = Percentage HDEP × average egg weight (g)

d) Feed efficiency

Feed efficiency per kg egg mass; it was calculated considering feed intake, egg weight and egg production. It is the ratio between the feed consumed and the egg mass.

$$FCE\ (per\ kg\ egg\ mass) = \frac{kg\ of\ egg\ produced}{kg\ of\ feed\ consumed} \quad (4)$$

e) Feed Efficiency per Dozen Eggs

It considered the feed intake and egg production. It is the ratio between the feed consumed and the number of eggs produced.

$$FCE\ per\ dozen\ eggs = \frac{Total\ eggs\ produced}{kg\ of\ feed\ consumed\ X\ 12} \quad (5)$$

f) Net Feed Efficiency Index (NFEI)

This was based on egg production, egg weight, feed intake and body weight gain.

$$NFEI = \frac{(EM+BW)}{FCS} \quad (6)$$

Where

EM = Mean egg mass in g during a specific period
BW = Mean body weight gain or loss in g during a particular period
FC = Mean feed consumption/hen in g during a particular period

g) Egg Feed Price Ratio (EFPR):

It is used to find the ratio between the receipts from eggs and expenditure on feed.

$$EFPR = \frac{Total\ value\ (\$)\ of\ eggs\ produced}{Total\ value\ (\$)\ of\ feed\ consumed} \quad (7)$$

Economics of feed in laying Japanese quail

The cost of the feed ingredients including, services such as transportation and processing were used to arrive at a realistic cost of diets used in the study. The formulation for each diet was used to determine the cost per kg of the diet by multiplying unit cost ($) of each ingredient by its proportion in the diet to determine its cost contribution to the diet. The sum of cost contributions from all the ingredients that made up each diet gave the cost ($) per kg of the diet. Selling price ($) per crate of eggs, was used to determine the value of the eggs. Feed cost and egg value were used to calculate Egg Feed Price Ratio (EFPR).

2.6.3 Egg characteristics

A total of 30 eggs (six per treatment) of the quails were used during the experiment to examine the egg characteristics, and all measures were performed on each egg. The eggs were collected during the 6th week periods when the quails were nine weeks of age, and laying was above 0.80. The eggs were weighed using a digital weighing scale with an accuracy of 0.01 g. The length and width of the eggs were measured with venire caliper to the nearest 0.01 mm. Eggshell thickness was measured with micrometre screw gauge device. The length and width of the albumen and yolk were measured using the vernier calliper. The albumen and yolk were also weighed, while the eggshell was weighed after 24 hours to allow the rest of the albumen in eggshell to dry. The weight of each albumen, yolk and eggshell was recorded to an accuracy of 0.01 g. The proportion of yolk, albumen and eggshell were calculated about egg weight and expressed as percentages.

The egg shape index (ESI), albumen index (a), and yolk index (YI) were also computed by using the formula.

$$ESI= \frac{\text{width of egg}}{\text{Length of egg}} \times 100\% \quad (8)$$

$$AI = \frac{\text{Albumen length}}{(\text{long diameter of albumen} + \text{short diameter of albumen})/2} \times 100 \quad (9)$$

$$YI= \frac{\text{yolk lenth}}{\text{yolk diameter}} \times 100\% \quad (10)$$

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of Mango Fruit Rejects the Meal

The proximate composition of MFRM showed that it contains 43.80, CP, 27.00 CF, 16.00 EE, 39.90 ash, 810.10 NFE and 936.80 DM in g/kg. The result was in agreement with previous report (10): 88.50% dry matter, 3.24% crude protein (CP), 3.53% crude fibre (CF), 1.57% ether extract (EE), 0.97% ash and 79.19% nitrogen-free extract (NFE); though the crude protein, ash and fibre reported here were slightly higher than the report of Orayaga and others [10]. What is clear and common with both reports is that MFRM is an energy source, having low protein.

3.2 Growth Performance of Laying Phase of Japanese Quail

The result of growth performance of laying face of Japanese quail is presented in Table 2. None of the growth performance parameters was significantly affected (P>0.05). Though growth was not a priority in the laying phase, some growth took place and needed to be examined along with other growth performance parameters such as feed intake, FCR, protein intake and protein efficiency ratio. Non-significant effect of MFRM on growth performance of laying phase showed that MFRM did not exert a negative adverse effect on the performance parameters measured. Orayaga and others [10,11], reported that MFRM was safe and comparable to maize in value concerning growth performance on broiler chickens, at 10 percent inclusion in broiler chicken diets. Furthermore, the similarity in growth performance may not be unconnected to the hardy nature of Japanese quails, reputed for being tolerant to harsh environment than chickens (5); tolerating MRFM, reported [11] to contain high tannin (2.10%) and oxalate (3.35%), which were implicated for the depressed performance in broiler chickens.

Table 2. Effect of mango fruit reject meal on growth performance of Japanese quail in the laying phase

	Experimental diets						
Parameter (g)	**0.0 MFRM**	**40.00 MFRM**	**80.00 MFRM**	**120.00 MFRM**	**160.00 MFRM**	**SEM**	**LS**
Initial weight	133. 21	137.17	138.25	133.21	131.46	2.61	NS
Final weight	148.04	146.79	145.58	143.38	145.04	1.18	NS
Total weight gain	14.41	9.63	7.33	10.17	15.62	2.80	NS
Daily feed intake	22.57	22.57	22.57	22.53	22.59	0.45	NS
Feed conversion efficiency *	0.03	0.02	0.02	0.02	0.03	0.00	NS
Daily protein intake	6.09	6.09	6.09	6.08	6.10	0.00	NS
Protein efficiency	9.99	13.95	34.99	13.45	11.37	8.18	NS

SEM = Standard error of mean,
NS = no significant difference (P>0.05),
Feed conversion efficiency = feed conversion efficiency with respect to weight gain only; egg exempted*
0.0MFRM = treatment group fed diet containing 0g/kg, 40.00 MFRM = treatment group fed diet containing 40.00g/kg, 80.00MFRM= treatment group fed diet containing 80.00g/kg, 120.00MFRM = treatment group fed diet containing 120.00g/kg, 160.00MFRM = treatment group fed diet containing 160g/kg

3.3 Laying Performance of Japanese Quail

The performance of laying Japanese quail fed with the graded level of mango fruit reject meal MFRM are presented in Table 3. None of the parameters measured was significantly different among the treatment groups. This means that the test diet supported laying performance as did maize at these levels of inclusion. Feed intake (22.53 – 22.59 g/hen/day) was higher than 13.27 to 22.15g reported by Tuleun and others [3] when Japanese quail hens were fed diets having varying levels of crude protein and 14 to 18 g [5]; similar to the report of Babajide and others [22], who reported daily feed intake of 20.61–22.28 g when Japanese quails (*Coturnix coturnix japonica*) were fed diets supplemented with ascorbic acid and α- tocopherol but lower than 29.20 to 30.30 g when Japanese quail hens were fed varying protein and energy levels and 27.32 to 29.84 g, reported before [23]. It was also less than the report of Edache and others [1]. Hen-day and hen-house egg production of 63.24 to 84.14 recorded in this research were identical because there was no mortality during the experimental period and the values agreed with the recommendation of Randall and Bolla [5], who opined that 70 to 80% is good for the farmer. The result was higher than 40 to 68.28% reported by Ghazvinian and others [24], 16.19 to 30.06% [1] and 16.51 to 29.5% reported by Ijaiya and others [23]; similar to that of [3], who reported Hen-day egg production values of 69.60 to 86.33% and lower than 83.5 to 89.0 reported by [25]. Though there was no significant difference, hen-day egg production of birds on 160.00g/kg inclusion of MFRM recording the lowest value of 63.24% and the (T3) with 80.00g/kg inclusion of MFRM recorded the highest value of 84.14% (HDEP).

The non-significant difference among treatment groups was also observed with average egg weight and egg mass per hen per day. Egg weight was similar to several reports [3,24,25] but lower than about 12 g weight previously reported [25]. Variation of these very important production parameters with past reports, superior or inferior, may not be connected with diets but is likely a strain effect since the nutritional requirements of the Japanese quail were met.

Feed conversion efficiency (FCE) per kg egg, and per dozen egg, net feed efficiency index (NFEI) and egg to feed price ratio (EFPR) being similar across treatment groups means the test material did not present any substance that was intolerable to the laying Japanese quails. FCE as recorded here was similar to the report of Tuleun and others [3]. It is however not clear why there was no difference in net feed efficiency

Table 3. Effect of mango fruit reject meal on the laying performance of Japanese quail

	Experimental diets						
Parameter	**0.0 MFRM**	**40.00 MFRM**	**80.00 MFRM**	**120.00 MFRM**	**160.00 MFRM**	**SEM**	**LS**
Cost Per kg Diet ($)	0.24	0.24	0.23	0.23	0.22	-	
Daily feed intake (g/bird)	22.57	22.57	22.57	22.53	22.59	0.45	NS
No of eggs per bird in 28 days	20.96	16.62	19.33	20.64	18.34	2.70	NS
Hen day egg Production	82.36	76.31	84.16	68.18	63.24	5.83	NS
Hen house egg production	82.36	76.31	84.16	68.18	63.24	5.83	NS
Egg mass (g/hen/day)	7.33	7.63	8.17	6.74	6.11	0.70	NS
Total egg mass (kg)	0.98	1.15	1.26	0.77	0.88	0.18	NS
Feed conversion efficiency per Kg egg	0.33	0.34	0.40	0.33	0.28	0.32	NS
FCE per dozen egg (kg)	3.13	2.86	3.23	2.78	2.44	0.30	NS
Net feed efficiency index	0.43	0.47	0.46	0.52	0.47	0.28	NS
Egg-feed price ratio	6.54	6.17	7.01	6.50	5.59	0.63	NS

$= 360 Nigerian Naira
SEM = Standard error of mean,
NS = no significant difference (P>0.05),
0.0MFRM = treatment group fed diet containing 0g/kg, 40.00 MFRM = treatment group fed diet containing 40.00g/kg, 80.00MFRM= treatment group fed diet containing 80.00g/kg, 120.00MFRM = treatment group fed diet containing 120.00g/kg, 160.00MFRM = treatment group fed diet containing 160g/kg

Table 4. Effect of mango fruit reject on egg characteristics of Japanese quail

	Experimental diets						
Mean Parameter	0.0 MFRM	40.00 MFRM	80.00 MFRM	120.00 MFRM	160.00 MFRM	SEM	LS
Egg weight (g)	10.33	10.17	9.67	10.33	10.17	0.32	NS
Egg width (cm)	2.11	2.05	2.03	2.08	2.10	0.03	NS
Egg height (cm)	2.67	2.70	2.66	2.72	2.65	0.08	NS
Yolk width (cm)	1.82	1.67	1.69	1.70	1.78	0.08	NS
Yolk height (cm)	2.04	1.95	2.10	2.22	1.99	0.15	NS
Shell weight (g)	0.65	0.89	0.88	0.92	0.88	0.05	NS
Albumen weight (g)	4.51	4.70	4.62	5.00	5.09	0.40	NS
Yolk weight (g)	3.47	3.22	2.95	3.09	2.92	0.27	NS
Point end (cm)	0.77	0.80	0.83	0.72	0.78	0.40	NS
Middle end (cm)	0.74	0.77	0.76	0.71	0.76	0.40	NS
Broad end (cm)	0.74	0.73	0.73	0.74	0.75	0.30	NS

SEM = Standard error of mean,
LS = Level of significance
NS = no significant difference (P>0.05),
0MFRM = treatment group fed diet containing 0.0 g/kg, 40.00 MFRM = treatment group fed diet containing 40.00 g/kg, 80.00MFRM= treatment group fed diet containing 80.00 g/kg, 120.00MFRM = treatment group fed diet containing 120.00 g/kg, 160.00MFRM = treatment group fed diet containing 160 g/kg

index and egg to feed price index. It is expected that since the feed intake, FCE and egg production were similar, the NFEI and EFPR should be significantly better at the hens fed diets containing MFRM since the cost per kg diet was lower for the diets containing MFRM.

3.4 Egg Characteristics

The result of egg characteristics of Japanese quail is presented in Table 4. The external and internal egg characteristics were not significantly affected. This means the diets were equal in quality for egg production. Apart from the egg weight 9.67 – 10.33 g which were higher than 8.25- 9.78 reported by Tuleun and others (3) and Ijaiya and others (23), the rest of the egg characteristics namely egg length, egg width, yolk weight, yolk height, yolk width, albumin weight and egg shape index were in agreement to their reports when laying Japanese quails were fed varying levels of protein in diets and *Detarium microcarpum* based diets respectively. Egg weight was however similar to the report of Ghazvinian and others (24) when varying levels of protein to energy ratio were laying Japanese quails. A good quail egg should weight about 9.3 g or more (3). Eggs in this research agreed with this report. However, a variation of egg weight among research reports may not be tied down to nutrition alone; the age of lay and strain could also affect the egg characteristics differently. It may then be normal to have variations among reports.

4. CONCLUSION

It was concluded that mango fruit rejects meal is a feed resource in quail diets and can be included in their diets at 16% without adverse effect on laying performance and egg characteristics.

ETHICAL

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.

REFERENCES

1. Edache JA, Yisa AG, Okpala EJ. Effects of replacing maize with yam peel meal on short-term laying performance of Japanese quails (*Coturnix coturnix japonica*). Pakistan Journal of Nutrition. 2012;11(7): 614-617.
2. Caurez CL, Olo CF. Laying performance of japanese quail (*Coturnix coturnix*

Japonica) supplemented with zinc, vitamin C and E subjected to long-term heat stress. International Conference on Agriculture and Biotechnology. Singapore. 2013;60(12):58-63.

3. Tuleun CD, Adenkola AY, Yenle FG. Performance and erythrocyte osmotic membrane stability of laying Japanese quails (*Coturnix coturnix japanica*) fed varying dietary protein. Agriculture and Biology Journal of North America. 2013;4(1):6-13.
4. NRC. National research council. Quail. In: Microlivestock – Little known small animal with a promising future. National Academy Press. Washington D. C. 1991;147-155.
5. Randall M, Bolla G. Raising Japanese quail. State of new South Wales department of primary industries. Prime Fact 602 Second Edition; 2008.
   Available: http://www.dpi.nsw.gov.au/agriculture/livestock/poultry/species/japanese-quail. (Retrieved 5/14/17)
6. Haruna ES, Musa U, Lombin IH, Tat PB, Shamaki D, Okewole P, Molokwu JU. Introduction of quail production in Nigeria. Nigerian Veterinary Journal. 1997;18: 104–107.
7. Olubamiwa O, Haruna ES, Musa U, Akinade TO, Lombin LH, Longe OG. Effect of different energy levels of cocoa husk based diets on production performance of Japanese quails. Nigerian Journal of Animal Production. 1999;26:88-92.
8. Oluremi OIA, Okafor FN, Adenkola AY, orayaga KT. Effect of ensiling Sweet orange (*Citrus sinensis*) fruit peel on its Phytonutrients and the performance of broiler starter. International Journal of Poultry Science. 2010;9(6):546-549.
9. Orayaga KT, Oluremi OIA, Tuleun CD, Carew SN. The feed value of composite mango (*Mangifera indica*) fruit reject meal in the finisher broiler chickens nutrition. African Journal of Food Science and Technology. 2015;6(6):177-184.
10. Orayaga KT. Effects of composite mango (*Mangifera indica*) fruit reject meal on growth performance, digestibility and economics of production of rabbits, Nigerian Journal of Animal Science. 2016;18(1):65-75.
11. Abang FBP, Abeke M, Shittu H. Performance of quails *(Coturnix coturnix japonica)* fed graded levels of sundried mango *(Mangifera indica)* Kernel meal as replacement for maize. International Journal of Agriculture and Biosciences. 2015;4(1):5-7.
12. Guluwa LY, Madaki YA, Machido H, Dantayi RJ, Kulokom S. Growth performance and carcass evaluation of quails fed graded levels of water soaked sweet orange peel meal (SOPM). Advances in Life Science and Technology. 2014;20:1-6.
13. Kaankuka FG, Alu SE, Carew SN, Tuleun, CD. Internal and external qualities of quail (*Cortunix cortunix japonica*) eggs due to enzyme supplemented high or low fibre diets. PAT. 2012;8(2):150-158.
14. Orwa C, Mutual A, Kindt R, Jamnadass R, Anthony S. Agroforestree database: A tree reference and selection guide. version 4.0. World agroforestry Centre, Kenya; 2009.
15. FAO. Value addition of mango fruits; 2014. Available:www.fao.com/mango/value.
16. Avav T, Uza DV. Agriculture. In: Pigeonniere, A.L. (ed). Africa atlases: Nigeria las editors, Paris. 2002;92–95.
17. Soomro H, Rind MI, sanjrani SN, Magsi AS, Barham GS, Pirzada SA, Sahito HA. Effect of partial mango pulp mixing in ration on behavior and production of broiler. International Journal of plant and Animal Science. 2013;1(2):30-36.
18. Berardini N, Fezer R, Conrad J, Beifuss U, Carle R, Chieber A. Screening of mango (*Mangifera indica* L.) cultivars for their contents of flavonol and xanthone C-glycosides, anthocyanins, and pectin. Journal of Agriculture, Food and Chemistry. 2005;53(5):1563–1570.
19. Google Map. World map; Nigeria, Benue, Makurd. Microsoft Corporation; 2016.
20. TAC. Makurdi weather elements records. Makurdi Meteorological Station Nigerian Airforce, Tactical air Command, Makurdi, Nigeria; 2009.
21. AOAC. Official methods of analysis. Association of official analytical chemists. 16th Ed; 2000.
22. Babajide SE, Makinde OJ, Ibe EA, Ajibade AJ, Chukwudebe EP, Babatunde KO, Zaccheaus OS. Supplementing laying japanese quails (Coturnix Coturnix Japonica) diet with ascorbic acid and A-Tocopherol: Effect on laying performance and egg quality parameters. Journal of Advances in Agricultural Science and Technology. 2015;3(6):95-99.
23. Ijaiya AT, Aremu A, Adesiji MA, Egena SSA, Jiya EZX. Egg production and egg

quality characteristics of Japanese quails (*Coturnix cotunix japonica*) fed graded levels of cooked tallow (*Detarium microcarpum*) seed meal. Savannah Journal of Agriculture. 2015;7(2):7–11.

24. Ghazvinian K, Irani M, Jamshidi R, Mirzaei-Aghsaghali A, Siadati SA, Javaheri-Vaighan A. The effect of energy to protein ratio on production performance and characteristics of Japanese quail eggs. Annals of Biological Research. 2011; 2(2):122-128.

25. Tahan M, Bayram I. Effect of using black cumin (*Nigella sativa*) and parsley (*Petroselinum crispum*) in laying quail diets on egg yield, egg quality and hatchability. Archiva Zootechnica. 2011;14(4):39-44.

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