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ARTICLE

Effects of Moringa (Moringa oleifera Lam.) Leaf Meal on Performance, Carcass, Organs, Eggs and Meat of Japanese Quails

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ABSTRACT

There are several reports on the utilisation of *Moringa oleifera* in poultry diets due to its essential bioactive compounds yet, little is known about its influence on Japanese quail eggs and meat qualities. Hence, the need to examine performance, eggs and meat qualities of Japanese quail hens fed *M. oleifera* leaf. To achieve this, 240 Japanese quail chicks were allocated to three dietary treatments: D1: control, 0.0% (without *M. oleifera* leaf meal), D2: (0.5% *M. oleifera* leaf meal) and D3: (1% *M. oleifera* leaf meal). Data on performance, carcass, organs, eggs and meat qualities were collected and subjected to ANOVA at 0.05. Results revealed that feed consumption was lowest (2,701g) in D1 and highest (2,800g) in D2, carcass weight varied from 100 - 100.67g, thigh weight (12.66 - 13.58g) and breast weight was highest (40.41g) in D3. Liver weight was lowest (3.25g) in D1, kidney was largest (0.91g) in D3 whereas, the heart, gizzard and spleen weights ranged from 1.00 - 1.16g, 3.08 - 3.50g and 0.04 - 0.08g, respectively. In the eggs, crude protein (10.94%), crude fat (6.71%), ash (1.36%), high-density lipoprotein (96.12mg/100g) and low-density lipoprotein (120.67mg/100g) were highest in D1. Total cholesterol (364.08mg/100g) and triglycerides (147.27mg/100g) were least in D1 and the caloric value varied from 1.46 - 1.47kcal/g. In the meat, crude protein (17.14%) and energy value (1.96kcal/g) were best in D2 but, crude fat (12.62%), ash (2.85%) and carbohydrates (1.31%) were superior in D3. In both eggs and meat, no crude fibre (0.0%) was detected. In any case, all the parameter values were within the normal ranges given in healthy Japanese quails at similar age. Consequently, addition of *M. oleifera* leaf meal at 1.0% to Japanese quail diets might not depress performance, affect carcass quality, cause organs dysfunctions but may improve nutritional quality of the eggs and meat.

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1. Introduction

The Japanese quail has its first history of domestication in Japan dated from the twelfth century however it was common in Egypt between 1,250 - 1,200 BC, where it was kept as a singing bird. When it was believed to have cured Japanese Emperor of tuberculosis, selected Japanese quails were extensively reared for meat and eggs [1]. In 1992, Japanese quail was brought to Nigeria by National Veterinary Research Institute, Vom, Jos, Plateau [2]. According to Kayang *et al.* [3], Japanese quail production in the recent past, became very popular as a profitable poultry bird for eggs and meat due to the unique flavour. The eggs and meat are renowned for their high quality protein, low cholesterol content but high biological and caloric values, which make it a suitable choice for hypertensive prone individuals. Japanese quail production should be encouraged due to its fecundity rate, early sexual maturity, fast growth rate, high rate of lay, shorter incubation period, requirement of less floor space, starter pack and feed. More significantly, Japanese quail is highly resistant to notorious poultry diseases hence it is often used in biomedical research [4].

Although Japanese quail feed requirement is low compared to other poultry species, it should be formulated to contain optimum nutrients concentrations for desirable growth, production and feed utilization efficiency. Apart from these conventional feed resources that will provide the essential nutrients, Grashorn [5] suggested utilisation of phytogenic feed additives in animal feed for optimum production performances. Also, inclusion of certain non-nutritive feed additives like growth promoters, antibiotics and exogenous enzymes in poultry feed has been reported [6,7]. However, it was speculated that residues of these additives in eggs and meat of poultry birds, may be harmful to human beings. This led to the restriction of these so-called performance enhancer and antibiotics to boost the poultry industry.

Based on this, plants like *Moringa oleifera* known for its essential metabolites with active bioactive compounds, could be utilized in poultry feed as phytogenic feed additives. These chemical substances have been reported to boost healthiness and production in poultry species [8, 9,10].

M. oleifera leaves were reported to be relished by ruminant and monogastric animals, even fish, fowl and several other bird species during feeding trials [11,12,13]. In each case, improved growth and production performances were recorded without significant detrimental effects. More essentially, it was reported better growth performances, carcass and organ quality with decreased feed intake vis-à-vis reduced feed cost and improved economic margin in chickens. In all the studies, there were little or no reports on the influence of moringa leaves on poultry eggs and chicken characteristics. Hence, the present study investigated the quality of eggs and meat of Japanese quail hens fed *M. oleifera* leaf meal.

2. Materials and Methods

2.1 Experimental Location

This study was carried out at the National Veterinary Research Institute, Vom, Jos, Plateau state, on latitude 9° 55' 42.56"N, longitude 8° 53' 31.63"E, altitude of 1,264.5m above sea level with about 1,400 mm of rainfall annually. Jos enjoys a more temperate climate than the rest parts of Nigeria. Average monthly variation of temperature between 21 - 25°C (70 - 77°F) with hails sometimes during the rainy season. This has made Jos a preferred vacation choice for foreigners residing in the country. Several tree species including those grown in the temperate regions of the world are found in Jos [14].

2.2 Processing of Moringa Leaf Meal

Freshly harvested moringa leaves were bought within Jos metropolis, air dried in the shade until crispy with intact green colour, ground at 3mm mesh size and stored in an air-tight container until needed. Standard finished starter and layer mash were obtained from the Feed Formulation Unit, Dagwom Farm. The Moringa leaf powder was incorporated with the finished starter and layer mash respectively, to produce the experimental diets based on daily feed requirements of the experimental chicks.

2.3 Experimental Design and Chicks' Welfare

Two hundred and forty day-old Japanese quail chicks from the Poultry Division, National Veterinary Research Institute, Vom, Jos, Plateau State were weighed and allocated based on weight in a completely randomized design to three dietary treatments designated as D1 (0.0%: without *M. oleifera* leaf meal), D2 (0.5% *M. oleifera* leaf meal) and D3 (1% *M. oleifera* leaf meal). Each of the treatments had 80 chicks with four replicates consisting of 20 chicks. The diets and clean drinking water were offered *ad libitum* to the experimental chicks for eight weeks.

2.4 Data Collection

2.4.1 Performance Indices

The birds were weighed weekly using sensitive scale to obtain body weight. The feed offered and the remnants were weighed daily using sensitive scale to obtain feed

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intake. The feed conversion ratio was derived by dividing feed intake by body weight as given by Yakubu *et al*. [15].

2.4.2 Carcass and Organ Quality Determinations

At 8 weeks of age, ten birds from each treatment group were selected randomly, fasted overnight and sacrificed by severing the jugular vein. The liver, heart, gizzard, kidney, spleen and lungs were carefully collected and weighed using sensitive scale to obtain organs weights. The carcasses were dressed according to standard procedures to obtain carcass and cuts weights [16].

2.4.3 Chemical Analysis

Carcass (meat sample) from each of the treatments was processed for chemical composition [20]. During the 8th week, eggs were collected every other day such that 5 eggs per collection day summing up to 15 eggs per treatment were processed for proximate, pH, specific gravity, cholesterol, triglycerides and lipoproteins determinations following standard procedures [17-19].

2.4.4 Statistical Analysis

Data collected were subjected to analysis of variance procedure of SPSS [20] and the means were separated using Duncan Multiple Range Test of the same software package at 5% probability.

3. Results and Discussion

Table 1 presents the performance indices, carcass and organs quality of Japanese quails fed moringa leaf meal. There were no statistical variations (P>0.05) in the carcass

Table 1. Performance, carcass and organs quality of Japanese quails fed *M. oleifera* leaf meal

Parameters	Treatments (Mean±STD)		
	T1	T2	T3
Performance indices			
Initial weight (g)	5.46±1.05a	4.81±0.27b	4.66±0.46b
Final weight (g)	157.45±2.97b	161.78±6.80ab	166.93±2.72a
Feed consumption (g)	2701.52±236b	2800.04±3543a	2722.81±661b
Feed conversion ratio	1.95±0.06a	1.88±0.10b	1.83±0.05b
Carcass characteristics (g)			
Carcass	100.17±13.28	100.67±15.61	100.08±3.56
Thigh	12.83±1.60	12.66±1.36	13.58±0.17
Wing	9.25±0.73	9.75±1.10	9.25±0.50
Back	21.91±4.62	20.50±2.21	22.66±1.55
Breast	38.86±4.60	38.08±6.41	40.41±204
Neck	8.16±0.88	8.50±2.13	9.16±0.69
Head	5.33±0.819	6.08±0.68	6.00±0.54
Shank	2.66±0.275	3.08±1.06	2.75±0.41
Organs weight (g)			
Liver	3.25±0.99	3.67±1.41	3.50±1.40
Heart	1.16±0.19	1.00±0.00	1.16±0.19
Gizzard	3.50±0.43	3.50±0.79	3.08±0.57
Kidney	0.85±0.053	0.88±0.00	0.91±0.00
Spleen	0.04±0.00	0.04±0.00	0.08±0.00
Lungs	1.58±0.28	1.08±0.16	1.49±0.33

Notes:
a,b: Means with different superscript on the same row are significantly different at 5% probability; STD: Standard deviation; T1 (Control): 0.0% moringa leaf meal inclusion; T2: 0.5% moringa leaf meal inclusion; T3: 1% moringa leaf meal inclusion.

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characteristics and organs weight values. However, all the parameters measured in the performance indices differed statistically (P<0.05). Although initial weight of the chicks was superior (5.46 g) in control, the final weight was best (166.9 g) in birds fed 1.0% *M. oleifera* leaf meal. While feed consumption was highest (2,800.04 g) in birds fed 0.5% *M. oleifera* leaf meal, the feed conversion ratio was highest (1.95g) in control birds. Carcass weight varied between 100.08 g (T3) and 100.67 g (T2) with highest thigh weight (13.58 g), back weight (22.66 g) breast weight (40.41 g) and neck weight (9.16 g) recorded in T3. Liver weight ranged from 3.25 - 3.67 g, heart (1.00 - 1.16 g), kidney (0.85 - 0.91 g) whereas, the lungs were 1.58 g, 1.49 g and 1.08 g in T1, T3 and T2, respectively.

The chicks' initial weight value was within 4 - 7 g reported to be normal in Japanese quails [21]. Also, it was similar to a range of 4.96 - 5.94 g reported in Japanese chicks exposed to different incubation temperatures [22]. Thus, the experimental chicks were probably suitable for the study. The live weight was within a range of 132.5 - 170.8 g reported in Japanese quails at similar age. The feed intake and feed conversion ratio values were similar to a range of 1,914 - 2,735 g and 1.59 - 3.80 g, respectively, reported elsewhere in Japanese quails [23-25]. This finding is similar to a significant improvement recorded in performance of broiler chickens offered selected herbal dietary supplements [26-28]. This possibly indicated that the experimental feed provided the required nutrients that were somewhat adequately utilised by the experimental birds. Therefore, addition of moringa leaf meal to diets of Japanese quail chicks, might not depress performance.

The carcass weight was less than a range of 127 - 148 g reported in different strains of Japanese quails [29] but similar to a range of 67 - 119 g reported at different ages of Japanese quails [30]. The cut parts and organs values were similar to those reported at similar age in Japanese quails [31]. This finding was somewhat similar to those recorded when broiler chickens were offered graded levels of moringa leaf meal. This apparently demonstrated that incorporation of moringa leaf meal in Japanese quails diets, might not affect the carcass quality or cause organs dysfunctions.

The nutritional quality of eggs laid by Japanese quail hens fed *M. oleifera* leaf meal is expressed in table 2. There were significant differences (P<0.05) in all the parameters determined except ash, gross energy, cholesterol, high-density and low-density lipoproteins. Meanwhile,

Table 2. Nutritional quality of eggs laid by Japanese quail hens fed *M. oleifera* leaf meal

Parameters	Treatments (Mean±STD)		
	T1	T2	T3
Crude protein (%)	10.94±0.88a	10.19±0.54b	10.05±0.44b
Crude fat (%)	6.71±0.81a	6.02±0.53b	5.83±0.41b
Crude fibre (%)	0.00±0.00	0.00±0.00	0.00±0.00
Ash (%)	1.36±0.21	1.20±0.12	1.20±0.09
Moisture (%)	70.01±0.62b	70.62±0.20a	70.58±0.20a
Gross energy (kcal/g)	1.47±0.02	1.47±0.007	1.46±0.008
pH	7.17±0.14a	7.36±0.13a	7.32±0.14a
Specific gravity (g/ml H2O)	1.06±0.01a	1.05±0.005ab	1.04±0.003b
Total cholesterol (mg/100g)	364.08±32.64	381.57±21.46	376.40±17.22
Triglycerides (mg/100g)	147.27±28.58b	170.03±13.95ab	173.93±21.93a
High-density lipoprotein (mg/100g)	96.12±3.94	92.06±8.63	89.09±13.44
Low-density lipoprotein (mg/100g)	120.67±15.89	119.48±6.51	113.38±3.69
Very-low-density lipoprotein (mg/100g)	11.07±0.91	22.95±35.2	10.52±0.89

Notes:
a,b: Means with different superscript on the same row are significantly different at 5% probability; STD: Standard deviation; T1 (Control): 0.0% moringa leaf meal inclusion; T2: 0.5% moringa leaf meal inclusion; T3: 1% moringa leaf meal inclusion.

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crude fibre was not detected in any of the treatments' eggs. While the crude protein ranged from 10.05 - 10.94%, crude fat (5.83 - 6.71%), ash (1.2 - 1.36%), the gross energy value was same (1.47 kcal/g) in control and T2, but 1.46 kcal/g was recorded in T3. The pH value ranged from 7.17 - 7.36, specific gravity was highest (1.06 g/ml H_2O) in control, followed by 1.05 g/ml H_2O (T2) and 1.04 g/ml H_2O (T3) in that order. While total cholesterol was highest 381.57 mg/100g in T2, triglycerides was highest (173.93 mg/100g) in T3.

The crude protein content of the eggs from the treated Japanese quail hens was similar to a range of 8.9 - 16.6% reported in quails, chicken and ostrich but the crude fat was less than 31.3 - 32.6% reported in that study [32]. The observed differences could be largely due to the components of the egg analysed in the studies. Although crude fibre was not detected in the present study, a range of 0.56 - 0.60% was reported in different breed lines of Japanese quail eggs in Zimbabwe [31]. This disparity could be largely due to the ingredients used in the feed formulation, metabolic efficiency of the birds and partly due to the sensitivity and efficiency of the analytical apparatus used in the studies. Ash constituent of the eggs laid by the treated Japanese quail hens were within a range of 1.0 - 1.9% reported elsewhere in some poultry species [33,34]. The energy value was similar to 1.99 kcal/kg reported in Japanese quail whole egg [35]. The pH, specific gravity, cholesterol and lipoproteins values of the Japanese quail eggs were close to the values reported in some poultry species [36-39]. This finding further lent more credence to the reports that poultry eggs provide biological, antioxidant, antimicrobial, immunomodulatory, anticancer and antihypertensive activities as well as functional lipids in human health [40]. It was speculated that moringa leave is quite rich in minerals and it contains anti-nutritional factors at various levels yet relished by livestock species. Thus, moringa leaf meal may be incorporated in Japanese quails diets to improve eggs' nutritional quality.

Expressed in table 3 is the nutritional quality of meat from Japanese quail hens fed moringa leaf meal. There were no statistical differences (P>0.05) in the crude fat, ash and energy contents whereas, the crude protein, moisture content and carbohydrate values differed statistically (P<0.05). Crude protein was highest (17.14%) in T2, but crude fat was highest (12.59%) in T3. While crude fibre was not detected in any of the birds' meat, the ash content of the meat varied between 2.73 and 2.85%. While carbohydrate level was highest (1.31%) in T3, followed by 0.96% (control) and 0.36% in T2, energy value was 1.96 kcal/g, 1.95 kcal/g and 1.94 kcal/g in T2, T3 and T1, accordingly.

Crude protein of the meat from Japanese quail hens fed *M. oleifera* leaf meal was less than a range of 21.65 - 25% reported in domesticated and wild Japanese quails' meat [41]. This could be largely due to the nature of meat samples collected, nutritional plane and age of the birds and partly due to the analytical protocols adopted in the studies. Meanwhile, the crude fat value was higher than a range of 3.57 - 3.85% and the ash and energy contents were similar to a range of 1.22 - 2.6% and 1.18 - 1.34 kcal/g given in that study. However, the crude protein content was similar to a range of 10.32 - 19.7% reported in Japanese quails raised elsewhere [42]. These findings corroborated earlier reports on the quality of Japanese quail's

Table 3. Nutritional quality of meat from Japanese quail hens fed *M. oleifera* leaf meal

Parameters	Treatments (Mean±STD)		
	T1	T2	T3
Crude protein (%)	16.84±0.11b	17.14±0.12a	16.97±0.13ab
Crude fat (%)	12.53±0.05	12.59±0.09	12.62±0.15
Crude fibre (%)	0.00±0.00	0.00±0.00	0.00±0.00
Ash (%)	2.73±0.04	2.84±0.67	2.85±0.09
Moisture (%)	68.86±0.64a	67.78±0.10b	68.85±0.11a
Carbohydrate (%)	0.96±0.23b	0.36±0.15c	1.31±0.23a
Gross energy (kcal/g)	1.94±0.03	1.96±0.004	1.95±0.003

Notes:
a,b,c: Means with different superscript on the same row are significantly different at 5% probability; STD: Standard deviation; T1 (Control): 0.0% moringa leaf meal inclusion; T2: 0.5% moringa leaf meal inclusion; T3: 1% moringa leaf meal inclusion.

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meat [43,44]. However, some factors like genotype [43-45] and slaughtering age [46] were reported to influence the quality and composition of Japanese quail meat. Essentially, in the present study, it was revealed that the nutritional values of the meat and egg samples from Japanese quails fed *M. oleifera* leaf meal, apparently competed favourably well with the values reported by Abang *et al*. [47] in Japanese quails fed mango kernel meal. Therefore, moringa leaf meal inclusion in Japanese quail ration, might not affect performance, carcass, organs, eggs and meat quality.

4. Conclusion

Final weight, feed conversion ability, thigh and breast weight were best in the treated Japanese quail hens compared to the control treatment. However, the liver and kidney were somewhat enlarged among the treated birds but the lungs of birds in control were enlarged. While the eggs from the control hens apparently contained more crude protein, crude fat, ash, high-density and low density lipoproteins, the meat of the treated hens had better crude protein, fat, ash and energy values. Since the experimental birds' performance, carcass, organs, eggs and meat qualities were seemingly not compromised moringa leaf meal may be incorporated in Japanese quail nutrition to improve nutritional quality of the eggs and meat with little or no detrimental effects.

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