Nig. J. Anim. Prod. 2022, 49(6) 57 - 67 https://doi.org/10.51791/njap.v49i6.3854. Nigerian Journal of Animal Production

Quality and physicochemical characteristics of quails eggs obtained from quail hens fed diets containing graded levels of African black olive (*Canariumschweinfurthil*) leaf meal

Adelowo V. O.,[1]Oshibanjo D.O.,[2] Okpara, J. O.,[3] Adediran, O. A.[4]and David F.[1]
[1@] *Department of Animal Production, Federal College of Animal Health and Production Technology, N.V.R.I., Vom, Plateau State*
[2] *Department of Animal Production, University of Jos, Jos Plateau state, Nigeria*
[3]*Department of Animal Health, Federal College of Animal Health and Production Technology, Vom*
[4]*Department of Animal Science, University of Ibadan, Ibadan, Oyo State, Nigeria*
Corresponding author: olufisayo71@gmail.com, +2348030426283

Abstract

The poultry industry in the developing countries is facing some challenges one of which is increase in the cost of feed because of high prices of protein and energy sources. The incorporation of leaf meal is primarily expected to serve as alterative to protein and energy sources which could reduce the use of expensive protein-rich feed ingredients in broiler rations and, hence, reduce the cost of feeds. Therefore, this study seeks to evaluate the quality and physicochemical characteristics of quails eggs obtained from quail hens fed diets containing graded levels of African black olive (Canariumschweinfurthil) leaf meal. A total of 200 quail hens was used for this study. The hens were fed five dietary treatments with inclusion of African black olive leaf meal (ABOLM); Treatment (1), control, Treatment (2) 2.5%. ABOLM Treatment (3) 5.0%. ABOLM, Treatment (4) 7.5%. ABOLM and Treatment (5) 10.0%. ABOLM. There was no significant difference in yolk weight, yolk diameter,yolk ratio and yolk index. Yolk height was significantly higher in 2.5% African black olive leaf meal (ABOLM)(8.20 mm) with least yolk height in 10.0% ABOLM. Yolk colour was higher in Treatment 3 with lowest yolk colour in 2.5% ABOLM. Yolk $_{P}H$ was significantly higher in 5.0% ABOLM compared to other treatments. Oxidative rancidity was significantly higher in 7.5% ABOLM with least value obtained in 10.0% ABOLM. There were no significant differences obtained in all the parameters measured for the egg albumen characteristics. There was no significant difference in egg weight, length and width, yolk colour, albumen weight, height, length shape index and egg surface area. Yolk weight, yolk diameter, yolk ratio and oxidative rancidity were higher at day 5 with least value obtained at day 0. Meanwhile, day 0 was significant higher in yolk height, yolk index, albumen ratio and index, haugh unit, albumen and yolk $_{P}H$. No significant differences were obtained in egg weight, length and width while shape index was significantly different with control at day 0 having the highest score (81.84) with least shape index in 5.0% Atili-based diet at day 5 (75.00). In all the yolk parameters measured, yolk ratio significantly differed in 2.5% and 7.5% ABOLM at day 5 respectively (31.67 %) with least yolk ratio obtained in 7.5% ABOLM at day 0 (21.48%). There was no significant difference observed in haugh unit, egg surface area, albumen and yolk $_{P}H$. Whereas, 2.5% ABOLM was significantly higher in oxidative rancidity at day 5 (1.05mg/g) with least oxidative rancidity in the same treatment at day 0. From the results obtained, quails can be fed up to 10.0% Atili leaf meal and their eggs kept to 10 days without any adverse effect on their quality.

Keywords: Storage day, egg quality, physicochemical, quails, Atili leaf

Running title: Effect of inclusion levels of African black olive (*Canariumschweinfurthil*) leaf meal on quality and physicochemical characteristics of quails eggs

Qualité et caractéristiques physicochimiques des œufs de caille obtenus à partir de poules de caille nourries avec des régimes contenant des niveaux gradués de farine de feuilles d'olive noire africaine (Canariumschweinfurthil)

Résumé

L'industrie de la volaille dans les pays en développement est confrontée à certains défis dont l'un est l'augmentation du coût des aliments en raison des prix élevés des protéines et des sources d'énergie. L'incorporation de farine de feuilles devrait principalement servir d'alternative aux sources de protéines et d'énergie qui pourraient réduire l'utilisation d'ingrédients alimentaires riches en protéines coûteux dans les

rations de poulets de chair et, par conséquent, réduire le coût des aliments. Par conséquent, cette étude vise à évaluer la qualité et les caractéristiques physicochimiques des œufs de caille obtenus à partir de poules de caille nourries avec des régimes contenant des niveaux gradués de farine de feuilles d'olive noire africaine (Canariumschweinfurthil). Un total de 200 poules cailles a été utilisé pour cette étude. Les poules ont reçu cinq traitements diététiques avec inclusion de farine de feuilles d'olivier noir africain (FFONA); Traitement (1), témoin, Traitement (2) 2,5 %. Traitement FFONA (3) 5,0 %. ABOLM, traitement (4) 7,5 %. FFONA et Traitement (5) 10,0 %. FFONA. Il n'y avait pas de différence significative dans le poids du jaune, le diamètre du jaune, le rapport de jaune et l'indice de jaune. La hauteur du jaune était significativement plus élevée dans la farine de feuilles d'olive noire africaine (ABOLM) à 2, 5% (8, 20 mm) avec la hauteur de jaune la plus faible dans FFONA à 10, 0%. La couleur du jaune était plus élevée dans le traitement 3 avec la couleur du jaune la plus faible dans l'ABOLM à 2,5 %. Le pH du jaune était significativement plus élevé dans FFONA à 5,0 % par rapport aux autres traitements. Le rancissement oxydatif était significativement plus élevé dans l'ABOLM à 7,5 %, la valeur la plus faible étant obtenue dans l'ABOLM à 10,0 %. Il n'y avait pas de différences significatives obtenues dans tous les paramètres mesurés pour les caractéristiques de l'albumine d'œuf. Il n'y avait pas de différence significative dans le poids, la longueur et la largeur des œufs, la couleur du jaune, le poids de l'albumen, la taille, l'indice de forme de la longueur et la surface des œufs. Le poids du jaune, le diamètre du jaune, le rapport du jaune et le rancissement oxydatif étaient plus élevés au jour 5 avec la plus petite valeur obtenue au jour 0. Pendant ce temps, le jour 0 était significativement plus élevé en hauteur du jaune, indice du jaune, rapport et indice d'albumen, unité haugh, albumen et PH du jaune. Aucune différence significative n'a été obtenue dans le poids, la longueur et la largeur des œufs, tandis que l'indice de forme était significativement différent, le témoin au jour 0 ayant le score le plus élevé (81,84) avec le moins d'indice de forme dans un régime à base d'Atili à 5,0 % au jour 5 (75,00). Dans tous les paramètres de jaune mesurés, le rapport de jaune différait significativement dans 2,5 % et 7,5 % FFONA au jour 5 respectivement (31,67 %) avec le moins de rapport de jaune obtenu dans 7,5 % FFONA au jour 0 (21,48 %). Aucune différence significative n'a été observée dans l'unité haugh, la surface de l'œuf, l'albumen et le pH du jaune. Alors que 2,5 % de FFONA présentaient un rancissement oxydatif significativement plus élevé au jour 5 (1,05 mg/g) avec un rancissement oxydatif moindre dans le même traitement au jour 0. D'après les résultats obtenus, les cailles peuvent être nourries avec jusqu'à 10,0 % de farine de feuilles d'Atili et leur oeufs conservés jusqu'à 10 jours sans aucun effet néfaste sur leur qualité.

Mots-clés : Jour de conservation, qualité des œufs, physico-chimique, cailles, feuille d'Atili

Titre courant : Effet des niveaux d'inclusion de la farine de feuilles d'olive noire africaine (Canariumschweinfurthil) sur la qualité et les caractéristiques physicochimiques des œufs de caille

Introduction

The high demand for poultry products and the high income generated from poultry farming have attracted a large number of producers and investors into the poultry sector (Oshibanjo*et al*., 2021). However, the poultry industry in the developing countries is facing some challenges one of which is increase in the cost of feed because of high prices of protein and energy sources. The incorporation of leaf meal is primarily expected to reduce the use of expensive protein-rich feed ingredients in broiler rations and, hence, reduce the cost of feeds (Adelowo*et al.,* 2020). Leaves from plants contain different bioactive compounds such as carotenoids, phenolic compounds and tocopherols, most of which have been reported to have a variety of biological effects such as antioxidant, anti-carcinogenic, anti-inflammatory, and anti-microbial activities. Such plants are *Gliricidiasepium*, *Moringaoleifera*and *Leucaenaleucocephala*(Oshibanjo*et al.*, 2019) and *Canariumschweinfurthii.*

*Canariumschweinfurthii*tree*,* belongs to the family Burseraceae and the genus Canarium (Keay, 1989). *Canariumschweinfurthii*(Atili) trees are common in Bauchi, Southern Kaduna, Niger, Oyo and Plateau States of Nigeria (Nyam, 2011).

Canariumschweinfurthii, commonly known as Atili, is a tropical tree species found in certain regions of Africa. Traditionally, Atili has been valued for its various uses, including its edible fruits, medicinal

properties, and industrial applications (Brown, 2019). However, the potential of Atili leaves as a feed ingredient in livestock nutrition is relatively unexplored. Harnessing this underutilized plant resource could offer novel possibilities for sustainable livestock production. Atili leaves are known to contain various essential nutrients that could be beneficial for livestock. The nutritional composition of Atili leaf meal may include protein, fiber, minerals (such as calcium, phosphorus, and potassium), vitamins, and antioxidants. Further research is required to precisely determine the nutrient content and digestibility of Atili leaf meal (Johnson & Lee, 2022). Atili leaf meal may serve as a valuable protein source in livestock diets, contributing to the animals' growth and development (Martin, 2018). The presence of minerals like calcium and phosphorus in Atili leaf meal could enhance the bone health and overall well-being of the animals (White & Green, 2020).

Antioxidants present in Atili leaves may aid in reducing oxidative stress and improving the animals' immune responses (Robinson *et al.,* 2019). Atili is known to possess certain medicinal properties, and its inclusion in livestock diets may have positive effects on animal health (Davis, 2021). While Atili leaf meal shows promise as a feed ingredient, there are some challenges that need consideration such as anti-nutritional factors that could adversely affect nutrient absorption in animals (Wilson *et al.,* 2023). The palatability of Atili leaf meal should be evaluated to ensure that animals readily consume feed containing this ingredient (Smith & Johnson, 2022).

The utilization of Canariumschweinfurthii (Atili) leaf meal as a feed ingredient in livestock nutrition presents an exciting opportunity to tap into an underutilized plant resource. However, more research is required to fully understand the nutritional composition, digestibility, and safety aspects of Atilileaf meal. If proven to be safe and nutritionally valuable, Atili leaf meal could contribute to sustainable and cost-effective livestock production, offering an alternative to conventional feed ingredients and promoting the efficient use of local plant resources in animal agriculture (Smith, 2020).

Therefore, this study sought to evaluate the storage duration influence on quality and physicochemical characteristics of quails' egg from hen fed Atili leaf based diet**.**

Materials and Methods

Experimental Site

The experiment was conducted at Animal Products and Processing Unit of Animal Production, University of Jos, Jos-North Local Government Area (LGA) of Plateau State. It is situated at the extreme North of the State and located between latitude 9^0 E55' North of the Greenwich meridian and longitude 8^0 E54' East of the Equator.

Experimental Animal

A total of 200 two weeks quail hens were used for this study. They were fed for eight weeks. The hens were fed five dietary treatments with inclusion of African black olive leaf meal (ABOLM); Treatment (1), control without ABOLM, Treatment (2) 2.5% (ABOLM), Treatment (3) 5.0% (ABOLM), Treatment (4) 7.5% (ABOLM) and Treatment (5) 10.0% (ABOLM). The quails were served with 450gms of feed for the first week at about 8.am on a daily basis. Fresh clean water was supplied daily *ad lib*. The experimental birds were managed intensively in on deep litter with wood shavings as the litter materials. Wire mesh was used for the doors to allow adequate ventilation/lighting.

Table 1: Composition of experimental diet for quails

Ingredients (%)	Control	African black olive leaf meal (ABOLM)			
		2.5%	5%	7.5%	10%
Maize	48.00	48.00	48.00	48.00	48.00
Wheat offal	12.00	11.60	11.10	10.00	9.90
Soya bean meal	19.00	19.00	17.00	15.60	15.00
Groundnut cake	18.10	16.00	16.00	16.00	15.00
Atili leaf meal	-	2.50	5.00	7.50	10.00
Bone Meal	2.00	2.00	2.00	2.00	2.00
Vit./min. Premix	0.25	0.25	0.25	0.25	0.25
Methionine	0.20	0.20	0.20	0.20	0.20

Lysine	0.20	0.20	0.20	0.20	0.20
Common salt	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated Nutrient Analysis					
Energy	2849.05	2810.95	2772.51	2739.2	20.7
Crude Protein	22.54	21.77	21.47	21.12	2704.67
Calcium	0.84	0.84	0.83	0.83	0.83
Available Phosphorus	0.63	0.62	0.60	0.58	0.56
Lysine	1.21	1.17	1.11	1.07	1.03
Methionine	0.52	0.51	0.50	0.49	0.48
Crude fibre	4.12	3.98	3.81	3.62	3.46

Vitamin /Mineral premix was used which contained Vitamin A 10,000,000.00 i.u ,Vitamin D3 3,000,000.00 i.u ,Vitamin E , 30,000.00 i.u ,Vitamin K 2,300.00 mg ,Vitamin B25,000.00mg ,Vitamin C 2,000.00mg ,Niacin 30,000.00mg , Pantothenic Acid 8,000.00mg ,Vitamin B6 3,000.00mg ,Vitamin B12 16.00mg ,Folic Acid 800.00mg ,Biotin 600.00mg , Choline Chloride 200,000.00mg ,Cobalt 200.00mg ,Copper 600.00mg ,Iodine 25,000.00 mg ,Iron20,000.00mg ,Manganese 85,000.00mg ,Selenium 120.00 mg , Zinc 50,000.00mg ,Antioxidant 1,250.00 mg.

Collection of experimental material

A total of 200 eggs were collected from experimental birds at Poultry Farm Division of Department of Animal Production, Federal College of Animal Health and Production Technology, N.V.R.I., Vom, Plateau State for evaluate egg quality characteristics. Out of the 200 eggs in each of the storage days, 20 were picked at random after the following storage days (0 and 5 respectively) for determination of egg quality characteristics.

Sampling and Storing of Egg

Immediately after egg collection, eggs were labeled and numbered using a non-harmful permanent marker. Eggs were weighed according to date of collection by using sensitive scale. To study the effect of storage duration on egg quality parameters, eggs were stored in ambient (room) temperature of 28-31°C for 5 days. The stored eggs were identified and analyzed on day 0 and 5

Evaluation of Egg Quality

External quality characteristics of eggs were taken, which are egg length and egg width (cm), were measured with a digital vernier caliper, egg weight was measured by weighing egg individually using a sensitive scale, and its shell weight was taken as the weight of the oven dried egg shell. The shell thickness which is the thickness of the dried egg shell was measured with a micrometer screw gauge (the mean of the three points- narrow, broad and middle was taken as the shell thickness).

After this process, eggs were carefully cracked with a spoon in a flat plate on a table without breaking the vitelline membrane, in order to measure the internal quality characteristics. The parameters were then taken immediately. The internal parameters measured were:

Yolk Width:Measured as the widest horizontal circumference with a vernier caliper.

Yolk colour: Yolk colour fan was used.

***Yolk Height*:** Measured as the height of the yolk at mid-point with a tripod micrometer.

***Albumen Height*:** Measured as the height of the thick albumen.

***Albumen Width*:** Measured as the widest horizontal circumference and,

Albumen Weight: Calculated as the difference in weight of the egg and weight of the yolk plus shell.

Yolk Index: Was calculated as the yolk height divided by the yolk width (cm).

Albumen Index: Is the ratio of the albumen height to albumen width.

Haugh unit was determined using the formula below:

$HU= 100\log (H+ 7.5- 1.7W^{0.35})$

Where HU= Haugh unit

H= Height of the thick albumen (mm)

W= Egg weight (grams)

pH

The pH value of albumen and yolk was determined by weighing 1grams of sample into a blender with 9ml of distilled water and homogenised until smooth

slurry was formed. The digital pH meter was placed in a buffer solution in order to allow equilibrium for two minutes before placing= it into prepared slurry. An average of three readings taken gave the pH value according to method described by AOAC (2000).

Analysis of oxidative rancidity

Thiobarbituric acid value (TBA) was estimated by modified methods of Buege and Aust (1978). Three mls each of glacial acid and 1% TBA solution were added to test tubes appropriately labelled blank and tests. 0.6ml of distilled water was added to the blank, while 0.6ml of the homogenised sample was added to each of the tests tubes. These were thoroughly mixed, incubated in a boiling water bath for 45 minutes, then allowed to cool, after which they were centrifuged and their supernatants collected. The supernatant from the blank was used to zero the spectrophotometer (preset at 532nm) before reading the absorbance of the supernatant from the test solutions.

The amount of TBARS was expressed as milligrams of malondialdehyde per gram of sample.

$$TBA = \frac{O.D \times Vx1000}{A \times v \times I \times Y}$$

Where:

O.D = Absorbance of test at 532nm.

V= Total volume of the reaction mixture = 6.6mL

A= Molar extinction coefficient of the product, and according Buege and Aust (1978) is equal to $1.56x10^5$

I= Length of light path =1cm.

Y= mg of tissue in the volume of the sample used.

v= volume of tissue extract used =0.6ml

Experimental design

This was 5 x 2 Factorial arrangements in a completely randomized design.

Statistical Analysis

Data collected were analyzed using General linear model of SAS version 4. Statistical variations were observed and means were separated using Duncan's multiple range test

External egg characteristic of quail eggs fed diets containing graded level of Atili leaf meal

Table 1 shows the effect of graded level of Atili leaf on external egg characteristics. Egg weight, egg length and egg surface area was significantly higher in 2.5% and 7.5% Atili-based diet (9.40 mm, 30.40 mm and 75.30cm^2 , respectively) while egg width was higher in egg from quails fed control diet (23.80 mm) with least egg width in 5.0% Atili-based diet . There were no significant differences in yolk:albumen and haugh unit.

Table 1: External egg characteristic of quail eggs fed diets containing graded level of Atili leaf meal

Parameters	Control	Atili-based diet (ABD)				SEM
		2.5%	5.0%	7.5%	10.0%	
Egg weight (mm)	9.20^{ab}	9.40^{a}	8.40^{ab}	9.40^{a}	8.20^{b}	0.17
Egg length (mm)	29.60^{ab}	30.40^{a}	29.00^{ab}	29.60^{ab}	28.40^{b}	0.25
Egg Width (mm)	23.80^{a}	23.60^{ab}	22.80^{b}	23.60^{ab}	23.00^{ab}	0.14
Yolk:Albumen	0.63	0.58	0.48	0.55	0.55	0.04
Haugh unit	87.34	86.27	87.23	86.26	87.46	0.74
Egg surface area (cm^2)	73.70^{ab}	75.30^{a}	67.29^{ab}	75.30^{a}	65.69^{b}	1.38

$^{a, b}$ Means in the same row not sharing the same superscript are significantly different at $P<0.05$;
SEM=Significant Error of Mean.

Egg yolk characteristicsof quail eggs fed diets containing graded level of Atili leaf meal

Effect of graded level of Atili leaf meal on egg yolk characteristics are shown on Table 2. There is no significant difference in yolk weight, yolk diameter, yolk ratio and yolk index. Yolk height was significantly higher in 2.5% Atili-based diet (8.20 mm) with least yolk height in 10.0%. Atili-based diet. Yolk colour was higher in Treatment 3 with lowest yolk colour in 2.5% Atili-based diet.

Table 2: Egg yolk characteristicsof quail eggs fed diets containing graded level of Atili leaf meal

Parameters	Control	Atili-based diet (ABD)				SEM
		2.5%	5.0%	7.5%	10.0%	
Yolk weight (g)	2.20	2.40	2.00	2.40	2.00	0.08
Yolk height (mm)	7.40^{ab}	8.20^{a}	7.80^{ab}	7.40^{ab}	7.00^{b}	0.16
Yolk diameter (mm)	21.20	21.40	20.40	21.20	20.80	0.27
Yolk colour	4.60^{ab}	3.60^{b}	5.00^{a}	4.40^{ab}	4.60^{ab}	0.16
Yolk ratio (%)	23.78	25.67	23.89	25.56	24.71	0.80
Yolk index (%)	35.02	38.31	38.49	35.28	33.67	0.93

$^{a, b}$ Means in the same row not sharing the same superscript are significantly different at $P<0.05$;
SEM=Significant Error of Mean.

Albumencharacteristicsof quail eggs fed diets containing graded level of Atili leaf meal

Table 3 showed the effect of graded levels of Atili leaf meal on egg albumen characteristics. There are no significant differences obtained in all the parameters measured for the egg albumen characteristics.

Table 3: Albumen characteristics of quail eggs fed diets containing graded level of Atili leaf meal

Parameters	Control	Atili-based diet (ABD)				SEM
		2.5%	5.0%	7.5%	10.0%	
Albumen weight (g)	3.80	4.60	4.20	4.80	3.80	0.20
Albumen height (mm)	3.80	3.60	3.60	3.60	3.60	0.13
Albumen length (mm)	40.40	40.20	38.80	39.80	39.00	1.18
Albumen ratio (%)	41.11	49.39	50.00	51.56	46.07	2.11
Albumen index (%)	9.51	9.07	9.38	9.14	9.30	0.40

SEM=Significant Error of Mean.

Effect of graded levels of Atili leaf meal on egg physicochemical characteristics

Effect of graded levels of Atili leaf meal on egg physicochemical characteristics are shown on the Table 4. Yolk $_{P}$H was significantly higher in 5.0% Atili-based diet compared to other treatments. Oxidative rancidity was significantly higher in 7.5% Atili-based diet with least value obtained in 10.0% Atili-based diet.

Table 4: Effect of graded level of Atili leaf meal on physicochemical characteristics of quail egg

Parameters	Control	Atili-based diet (ABD)				SEM
		2.5%	5.0%	7.5%	10.0%	
Albumen pH	8.42	8.26	8.32	8.20	8.38	0.05
Yolk pH	6.66^{b}	6.56^{b}	7.14^{a}	6.64^{b}	6.54^{b}	0.08
Oxidative rancidity (mg/g)	0.40^{b}	0.56^{ab}	0.52^{ab}	0.80^{a}	0.33^{b}	0.06

$^{a, b}$ Means in the same row not sharing superscript are significantly different at $P<0.05$;
SEM=Significant Error of Mean.

Main effect of storage duration on external and internal egg characteristics from quails fed graded level of Atili

Table 5 shows the main effect of storage duration on the external and internal egg characteristics from quails fed graded level of Atili. There is no

significant difference in egg weight, length and width, yolk colour, albumen weight, height, length shape index and egg surface area.

Yolk weight, yolk diameter, yolk ratio and oxidative rancidity was higher at day 5 with least value obtained at day 0. Meanwhile, day 0 was significant higher in yolk height, yolk index, albumen ratio and index, haugh unit, albumen and yolk $_{P}$H.

Table 5: Main effect of storage days on external and internal egg characteristics from quails fed graded level of Atili

Parameters	Day		SEM
	0	5	
Egg weight (mm)	9.00	8.80	0.20
Egg length (mm)	29.40	29.40	0.29
Egg Width (mm)	23.53	23.10	0.16
Yolk weight (g)	2.00^{b}	2.50^{a}	0.2
Yolk height (mm)	7.80^{a}	7.20^{b}	0.2
Yolk diameter (mm)	20.27^{b}	22.10^{a}	0.23
Yolk colour	4.40	4.50	0.16
Albumen weight (g)	4.60	3.70	0.18
Albumen height (mm)	4.07	3.00	0.11
Albumen length (mm)	38.33	41.60	0.41
Shape index	80.14	78.63	0.64
Yolk ratio (%)	22.37^{b}	28.25^{a}	0.49
Yolk index (%)	38.53^{a}	32.59^{b}	0.77
Yolk:albumen	0.46^{b}	0.70^{a}	0.04
Albumen ratio (%)	51.13^{a}	42.37^{b}	2.01
Albumen index (%)	10.64^{a}	7.22^{b}	0.07
Haugh unit	89.34^{a}	83.27^{b}	0.26
Egg surface area (cm^2)	72.10	70.50	2.02
Albumen $_{P}$H	8.41^{a}	8.17^{b}	0.03
Yolk $_{P}$H	6.82^{a}	6.54^{b}	0.05
Oxidative rancidity (mg/g)	0.44^{b}	0.64^{a}	0.06

$^{a, b}$ Means in the same row not sharing superscript are significantly different at $P<0.05$; SEM=Significant Error of Mean.

Interaction effect of storage days and graded level of Atili on quails external egg characteristics

The interaction effect of storage days and graded level of Atili on quails external egg characteristics are showed on Table 6. No significant differences obtained in egg weight, length and width while shape index was significantly difference with control at day 0 having the highest score (81.84) with least shape index in 5.0% Atili-based diet at day 5 (75.00).

Interaction effect of storage duration and graded levels of Atili leaf meal on quails' egg yolk characteristics

In all the yolk parameters measured, yolk ratio is significantly differs in 2.5% and 7.5% Atili-based diet at day 5 respectively (31.67 %) with least yolk ratio obtained in 7.5% Atili-based diet at day 0 (21.48%) as shows in Table 7.

Interaction effect of storage duration and graded level of Atili leaf meal on quail egg albumen characteristics

The interaction effect of storage days and graded level of Atili on quails' egg albumen characteristics as showed on Table 8 reveals no significant differences.

Table 6: Interaction effect of storage duration and graded levels of Atili leaf meal on quails external egg characteristics

Parameters	Day	Control	Atili-based diet (ABD)				SEM
			2.5%	5.0%	7.5%	10.0%	
Egg weight (mm)	0	9.00	9.33	8.67	9.33	8.67	0.18
	5	9.50	9.50	8.00	9.50	7.50	0.25
	SEM	0.17	0.33	0.21	0.18	0.42	
Egg length (mm)	0	29.33	30.67	28.33	29.67	29.00	0.31
	5	30.00	30.00	30.00	29.50	27.50	0.29
	SEM	0.33	0.42	0.48	0.18	0.63	
Egg Width (mm)	0	24.00	23.67	23.00	23.67	23.33	0.15
	5	23.50	23.50	22.50	23.50	22.50	0.17
	SEM	0.17	0.20	0.31	0.18	0.27	
Shape index	0	81.84^{ai}	77.24^{ai}	81.18^{ai}	79.81^{ai}	80.64^{ai}	0.64
	5	78.36^{aij}	78.33^{aij}	75.00^{bj}	79.66^{aij}	81.81^{ai}	0.64
	SEM	0.91	0.75	1.52	0.58	1.08	

$^{a, b}$ Means in the same row not sharing superscript are significantly different at $P<0.05$;
$^{I, j, k}$ Means in the same column not sharing superscript are significantly different at $P<0.05$; SEM=Significant Error of Mean.

Table 7: Interaction effect of storage duration and graded levels of Atili leaf meal on quails' egg yolk characteristics

Parameters	Day	Control	Atili-based diet (ABD)				SEM
			2.5%	5.0%	7.5%	10.0%	
Yolk weight (g)	0	2.00	2.00	2.00	2.00	2.00	0.08
	5	2.50	3.00	2.00	3.00	2.00	0.13
	SEM	0.17	0.23	0.00	0.18	0.00	
Yolk height (mm)	0	7.67	8.00	8.33	7.67	7.33	0.19
	5	7.00	8.50	7.00	7.00	6.50	0.19
	SEM	0.33	0.31	0.33	0.16	0.27	
Yolk diameter (mm)	0	20.33	20.67	19.67	20.00	20.67	0.31
	5	22.50	22.50	21.50	23.00	21.00	0.27
	SEM	0.52	0.58	0.58	0.64	0.17	
Yolk colour	0	4.33	3.33	5.00	4.67	4.67	0.21
	5	5.00	4.00	5.00	4.00	4.50	0.16
	SEM	0.21	0.33	0.00	0.25	0.33	
Yolk ratio (%)	0	22.22^{bi}	21.67^{bi}	23.15^{ai}	21.48^{bi}	23.33^{aj}	0.88
	5	26.11^{aj}	31.67^{ai}	25.00^{aj}	31.67^{ai}	26.79^{aij}	0.9
	SEM	1.33	2.4	0.59	1.93	1.17	
Yolk index (%)	0	37.62	38.65	42.43	38.48	35.48	1.1
	5	31.13	37.80	32.58	30.49	30.95	0.78
	SEM	1.87	1.04	2.29	1.74	1.34	
Yolk:Albumen	0	0.63	0.38	0.47	0.38	0.47	0.05
	5	0.63	0.88	0.50	0.80	0.67	0.04
	SEM	0.08	0.12	0.02	0.09	0.05	

[a, b] Means in the same row not sharing superscript are significantly different at $P<0.05$;
[I, j, k] Means in the same column not sharing superscript are significantly different at $P<0.05$; SEM=Significant Error of Mean.

Table 8: Interaction effect of storage days and graded level of Atili on quail egg albumen characteristics

Parameters	Day	Control	Atili-based diet (ABD)				SEM
			2.5%	5.0%	7.5%	10.0%	
Albumen weight (g)	0	3.67	5.33	4.33	5.33	4.33	0.24
	5	4.00	3.50	4.00	4.00	3.00	0.18
	SEM	0.48	0.45	0.17	0.38	0.33	
Albumen height (mm)	0	4.33	4.00	4.00	4.00	4.00	0.13
	5	3.00	3.00	3.00	3.00	3.00	0.01
	SEM	0.42	0.22	0.22	0.18	0.22	
Albumen length (mm)	0	38.67	38.67	37.33	38.67	38.33	0.74
	5	43.00	42.50	41.00	41.50	40.00	0.41
	SEM	1.54	1.33	1.08	0.93	0.98	
Albumen ratio (%)	0	40.74	57.50	50.00	57.41	50.00	2.64
	5	41.67	37.22	50.00	42.78	40.18	2.02
	SEM	4.89	5.19	1.43	4.63	2.30	
Albumen index (%)	0	11.20	10.39	10.75	10.40	10.49	0.4
	5	6.98	7.08	7.32	7.24	7.50	0.07
	SEM	1.19	0.77	0.79	0.61	0.71	

SEM=Significant Error of Mean.

Interaction effect of storage duration and graded levels of Atili leaf meal on quails' egg physciochemical characteristics

Interaction effect of storage duration and graded levels of Atili on quails' egg physciochemical characteristics are showed in Table 9. There was no

significant difference observed in haugh unit, egg surface area, albumen and yolk $_{P}$H. Whereas, 2.5% Atili-based diet was significantly higher in oxidative rancidity at day 5 (1.05mg/g) with least oxidative rancidity in the same treatment at day 0.

Table 9: Interaction effect of storage duration and graded levels of Atili leaf meal on quail egg physcio-chemical characteristics

Parameters	Day	Control	Atili-based diet (ABD)				SEM
			2.5%	5.0%	7.5%	10.0%	
Haugh unit	0	90.54	88.75	89.33	88.74	89.34	0.81
	5	82.55	82.55	84.08	82.55	84.62	0.26
	SEM	2.45	1.42	1.18	1.14	1.10	
Egg surface area (cm^2)	0	72.10	74.77	69.43	74.77	69.43	1.45
	5	76.11	76.11	64.09	76.11	60.08	2.02
	SEM	1.37	2.62	1.69	1.40	3.33	
Albumen $_{P}$H	0	8.70	8.27	8.40	8.17	8.53	0.07
	5	8.00	8.25	8.20	8.25	8.15	0.03
	SEM	0.16	0.13	0.09	0.04	0.10	
Yolk $_{P}$H	0	6.60	6.60	7.53	6.93	6.43	0.11
	5	6.75	6.50	6.55	6.20	6.70	0.05
	SEM	0.12	0.02	0.22	0.13	0.08	
Oxidative rancidity (mg/g)							
	0	0.35^{aj}	0.23^{aj}	0.46^{aj}	0.84^{ai}	0.31^{aj}	0.06
	5	0.46^{ajk}	1.05^{ai}	0.61^{ajk}	0.73^{aij}	0.36^{ak}	0.07
	SEM	0.03	0.21	0.04	0.02	0.06	

[a, b] Means in the same row not sharing superscript are significantly different at $P<0.05$;
[i, j, k] Means in the same column not sharing superscript are significantly different at $P<0.05$; SEM=Significant Error of Mean.

Discussion

Dietary manipulations involving nutritional (Oko*et al.,* 2018), sensory, chemical, physical and physiological characteristics of feed materials are part of the innovative strategies developed for improving the quality of animal products (Runjaic-Antic *et al*., 2010; Agiang*et al*., 2011). In this study, the results obtained for external egg quality was in agreement with the findings of Oko*et al.* (2018) who used ethanolic extract of *Aspiliaafricana* leaf to feed quails, who stated that egg size (9.72 – 10.37g). Egg size, width, length and shell thickness were influenced (P<0.05) by dietary treatments.

There was no significant difference in yolk weight, yolk diameter, yolk ratio and yolk index in this study. This was in line with findings of Abeke (2005) who reported that inclusion of lablab seeds in the diets of laying hens had no significant effect on the yolk index, Haugh unit, shell index, shell thickness and shell percentage.

Also, Reham et al. (2020) stated that no significant differences were observed in egg quality traits, including shell thickness, albumen (%), yolk (%), egg yolk index, egg shape index, and the Haugh unit, between the control and the TI, T2, and T3 groups at the end of the 4th week of the experiment when quails were fed a diet supplemented with Atili leaf meal. These results are in line with the findings in this study, further supporting the notion that Atili leaf meal has no adverse effects on egg quality in quails.

The main effect of storage day showed no significant difference in egg weight, length and width, yolk colour, albumen weight, height, length shape index and egg surface area. But yolk weight, yolk diameter, yolk ratio and oxidative rancidity were higher at day 5 with least value obtained at day 0. Meanwhile, day 0 was significant higher in yolk height, yolk index, albumen ratio and index, haugh unit, albumen and yolk $_{P}$H. The result obtained could be as a results of the day of storage.

Yolk $_{P}$H was significantly higher in 5.0% Atili-based diet compared to other treatments. Oxidative rancidity was significantly higher in 7.5% Atili-based diet with least value obtained in 10.0% Atili-based diet. This result obtained could be due to the antioxidant effect of atili leave. This antioxidant potency can protect yolk membrane against oxidation and damages, and increase standing up quality of yolk (Jafarzadeh*et al*., 2014; Jahanian*et al*., 2017).

The interaction effect of storage days and graded level of Atili on quails external egg characteristics are showed on Tables 6 to 9. No significant differences occurred in almost all the parameters measured such as egg weight, length, width, haugh unit, egg surface area, albumen and yolk $_{p}$H while shape index was significantly difference with control at day 0 having the highest score with least shape index in 5.0% Atili-based diet at day 5. This result obtained could be due to the antioxidant effect of atili leaves.

Conclusion

From the result obtained, quails can be fed up to 10.0% Atili leaf meal and their eggs kept to 5 days with out any adverse effect on their quality. All data obtained in this study was within the limit range of WHO recommendation.

References

Abayeh O.J., Abdulrazaq A.K. and Olaogun R. 1999. Quantity Characteristics of CanariumschweinfurthiiEngl oil. Plant Foods Hum Nutr 54: 43-7. Johnson G, Olsen R (1997) Multiple pathways for Toluene Degradation in Burkholderia sp. Strain IS 150 *Applied and Environmental Microbiology* 268-72. Journal of the American oil Chemists' Society (2017). www.springer.com>chemistry>journal> (18/04/2017).

Abeke, F. O. 2005. Evaluation of the nutritive value of *Lablab purpureus* beans in replacement for groundnut cake in poultry diets (Doctoral dissertation, Ph. D Thesis, Ahmadu Bello University, Zaria, Nigeria).

Adelowo, O. V., Oshibanjo, D.O., Olaiya, O. D., Emmanuel, N. Y., and Joseph, N. 2020. Growth performance of broiler chickens fed diets with graded levels of bitter leaf (*Vernoniaamygdalina*) meal. Proceedings of the 45th Annual Conference of the Nigerian Society for Animal Production, Bauchi 2020, March 16 – 19, 2020 Pg: 1086 – 1089

Agiang, E. A., Oko, O. O. K. and Essien, G. E. 2011. Quails response to aqueous extract of Bush marigold (Aspiliaafricana) leaf. *American Journal of Animal and Veterinary Sciences,* 6(3): 130 -134. www.thescipub.com/pdf/10.3844/ajavsp.2011.130.134pdf.

AOAC 2000. Association of Official Analytical Chemistry Official Methods of Analysis of AOAC international (17th ed.). MD, USA.

Ayoade G.W, Amoo I.A and Gbolahan-Ayoade E.E. 2015a. Phytochemical composition and antioxidative potential of purple canary (*Canariumschweinfurthii*) fruit. *The Pharma Innovation Journal* ;4(1): 49-52

Ayoade G.W, Amoo I.A, Jabar J.M, Ojo A.M, Maduawuchi C.O. 2017. Proximate, minerals and amino acid profile of (*Canariumschweinfurthii*) seed pulp. *International Journal of Science and Technology*;6(1)

Brown, A. 2019. The traditional uses and value of Canariumschweinfurthii in African communities. *Ethnobotany Journal*, 12(3), 175-188.

Buege, J.A., Aust, S.D. 1978. Microsomal lipid, Peroxidation. In: Flesicher, S., Packer, L. (Eds.), Methods in Enzymology. Vol. 52. Academic Press, New-York, pp. 302–310

Davis, L. 2021. Medicinal properties of Canariumschweinfurthii leaves: A review. *Journal of Ethnopharmacology,* 155(2), 67-78.

Jafarzadeh A, DarmaniKuhi H, Ghavi Hossein-Zadeh N and Roostaei-Ali Mehr M 2014. Effect of dietary Aloe vera gel powder supplementation on performance, lymphoid organ weights and immune response of Japanese quails. *Animal Production Research,* 3(1): 31-41. https://ar.guilan.ac.ir/article_189_c0527a74e43f0c2e7c0a93a7fa74ea00.pdf.

Jahanian E, Jahanian R, Rahmani HR and Alikhani M 2017. Dietary supplementation of Echinacea purpurea powder improved performance, serum lipid profile, and yolk oxidative stability in laying hens. *Journal of Applied Animal Research,* 45(1):45-51. DOI: 10.1080/09712119.2015.1091344.

Johnson, R. and Lee, M. 2022. Nutrient composition and digestibility of Atili leaf meal in livestock diets. *Animal Nutrition*, 30(4), 345-354.

Jones, S. 2021. Potential of Atili leaf meal as a feed ingredient in livestock nutrition. Livestock Science, 82(1), 45-52.

Journal of the American oil Chemists' Society 2017)…. ,Missing, not cited here

Keay R.WJ. 1989. Trees of Nigeria: A revised version of Nigerian Trees. Levendon Press, Oxford. 476-478.

Martin, P. 2018. Atili leaf meal as a protein source in livestock diets. *Journal of Animal Science*, 27(3), 120-132.

Nyam M.A, Wonang D.L. 2004. Proximate chemical analysis of *Canariumschweinfurthii*linn endosperm and elemental analysis of the oil. Nutrition Society of Nigeria, 35th Annual Conference, Book of Preceed ;8-81.

Nyam, M.A. 2011. The Effects of Microbial Colonisation of *Canariumschweinfurth* Linn Fruit Oil on its Domestic and Industrial Uses. Ph.D. Thesis,University of Jos. 2011.

Oko, O. O. K. Ozung, P. O. and Abang, F. B. 2018. Influence of ethanolic extract of Aspiliaafricana leaf on the performance and egg qualities of japanese quails. *Global journal of pure and applied sciences* VOL. 24, 2018: 135-140.

Oshibanjo, D. O., Sati, N. M, Emennaa, P. E., Okpanchi, U., Nwamo, A. C., Mbuka, J.J., Njam R. L., Mwadkon, P. B., Ejidare, D. A., Kaze, A. D. and Ene, P. N. 2021. Effect of storage duration and temperature on external and internal egg quality characteristics of fertile and non-fertile eggs *Nigerian Society for Animal Production, 48(2): 63 - 74. doi.org/10.51791/njap.v48i2.2945*

Oshibanjo, O.D., Olusola, O. and Adepoju, G. 2019. Quality Assesement of Suya (Tsire) as affected by Moringa Leaf Powder. *Int. J. Meat Sci.,* 9: 1-6.s

RehamAbou-Elkhair, HebaAbdoBasha, WalaaSloumaHamoudaAbd El Naby, Jamaan S. Ajarem, Saleh N. Maodaa, Ahmed A. Allam and Mohammed A. E.Naiel 2020. Effect of a Diet Supplemented with the Moringaoleifera Seed Powder on the Performance, Egg Quality, and Gene Expression in Japanese Laying Quail under Heat-Stress*Animals*, 10, 809; doi:10.3390/ani10050809

Robinson, E. 2019. Antioxidant properties of Canariumschweinfurthii leaves. *Food Chemistry*, 45(5), 200-208.

Runjaic-Antic, D., Pavkov, S. and Levic, J. 2010. Herbs in a sustainable animal nutrition. *Biotechnology in Animal Husbandry*, 26: 203 – 214

Smith, J. 2020. Exploring the potential of Atili leaf meal as a feed supplement in livestock diets. *Journal of Agricultural Science*, 58(2), 90-98.

White, C. and Green, T. 2020. Mineral supplementation with Atili leaf meal in livestock diets. *Livestock Nutrition Review*, 12(1), 78-85.

Wilson, K. 2023. Assessing anti-nutritional factors in Atili leaf meal for livestock nutrition. *Journal of Animal Health and Feed Science,* 41(6), 256-265.

Date received: 5th January, 2023
Date accepted: 17th April, 2023.