EFFECT OF VARYING PROTEIN LEVELS AND PRESERVATION METHODS ON EGG PRODUCTION PERFORMANCE AND INTERNAL EGG QUALITIES OF JAPANESE QUAILS IN A SEMI-ARID ENVIRONMENT

[*1]N. Muhammad
[1]Department of Animal Science, Usmanu Danfodiyo University, Sokoto, Nigeria

[1]S. Altine;
[1]Department of Animal Science, Usmanu Danfodiyo University, Sokoto, Nigeria

[1]A. Abubakar
[1]Department of Animal Science, Usmanu Danfodiyo University, Sokoto, Nigeria

[2]U.M. Chafe
[2]Faculty of veterinary medicine, Usmanu Danfodiyo University, Sokoto, Nigeria

L.A. Saulawa
[3]Department of Animal Production and Health, Federal university, Dutsima, Katsina State, Nigeria

M.G. Garba
[3]Department of Animal Production and Health, Federal university, Dutsima, Katsina State Nigeria

A. Yusuf
[3]Department of Animal Production and Health, Federal university, Dutsima, Katsina State, Nigeria

ABSTRACT

The study was conducted to determine the effect of varying protein levels and preservation method on internal egg qualities of Japanese quails. A total of 180 birds were randomly allotted into three dietary treatments in a completely randomized design (CRD) replicated six times. A factorial arrangement of 3x4x4 which involves 3 protein levels, 4 storage method and 4 time intervals was designed to determine the effect of storage methods on internal egg quality characteristics The birds were fed diets containing 15, 20 and 25% crude protein respectively. The trial lasted for 10 weeks during which egg production, egg weight and egg quality characteristics were monitored. Results indicated that egg weight, hen day egg production and hen house egg production were significantly higher (P<0.05) for quails fed diet containing 25% CP. Internal egg quality characteristics were significant (P<0.05) between treatment means except for albumin weight, yolk weight, yolk height, yolk width, yolk colour and yolk index. The effects of storage method was found to be significant (P<0.05) for all traits except for albumen weight, yolk weight, yolk index and yolk colour. Storage time was found to be significant (P<0.05) for all the traits observed. However, lower egg quality was recorded with increased storage time (P<0.05). Refrigeration and immersion in oil and stored at room temperature provide significant (P<0.05) value for Haugh unit, indicating a minimal loss in quality. It was concluded that increasing dietary protein level of 25% will increase the production performance and internal egg quality of Japanese quails. Refrigeration and immersion in oil were best rated for preserving internal egg qualities of the Japanese quails.

Keywords: Protein level; preservation method, egg quality, Quails and Semi-arid environment.

INTRODUCTION

The significance of protein from animal protein sources such as poultry in providing sufficient and balanced nourishment is considerable for the human physical and mental health (Stadelman, 1994; Jacob, *et al*., 1998). Eggs provide means through which animal protein requirement of the populace are met (Stadelman, 1994). Egg has various uses and contains many essential nutrients that supports life during embryonic growth and is one of the nutritious and complete foods known to man (Scott and Silversides, 2001). Egg quality is composed of those characteristics of egg that affect its quality, acceptability and marketing (Adeogun and Amole, 2004). Among many quality characteristics, external factors including cleanliness, freshness, egg weight and shell weight are important in consumer's acceptability of shelled eggs. On the other hand, interior characteristics such as yolk index, Haugh unit, and chemical composition are considered in egg product industry as the demand for liquid egg, frozen egg, egg powder and yolk oil (Scott and Silversides, 2001). Eggs deteriorate in internal quality with time depending on the shell and internal content (Adeogun and Amole, 2004; Kul and Seeker, 2004). Adeogun and Amole (2004) reported that poor storage conditions may result in deterioration of egg quality and consequently loss and waste of eggs. Their report further showed that prevention of loss of water through pores, inhibition of micro organism invasion and lower storage temperature are major considerations in retarding quality degradation. Since storage environment influence quality of eggs, methods like lower temperature and modified atmosphere packaging such as refrigeration have been recommended (Chang and Chen, 2000). This makes it important to pay attention to the problems of preservation and marketing of eggs in order to maintain the quality (Adeogun and Amole, 2004). It has been reported that egg quality characteristics, its utilization for food, storage and other purposes have been studied mostly for chicken eggs. In addition, little information is available on the nutrient requirements of domestic quail (NRC, 1994). Although Japanese quail, do not constitute a major share of the poultry industry, there is an increasing demand for their products especially meat and eggs (NRC, 1994). This study was therefore designed to investigate the effect of varying protein levels and preservation method on internal egg qualities.

MATERIALS AND METHODS

Experimental Location

The study was conducted at the poultry research unit of the Department of Animal Science, Usmanu Danfodiyo University, Sokoto situated at the Sokoto veterinary centre, Aliyu Jodi in Sokoto North Local Government area of Sokoto State. Sokoto State is located within Sudan Savannah zone in the North western part of Nigeria and lies within longitudes 3-6°E and latitudes 8-13°N (Mamman *et al.,* 2000). Sokoto has a semi-arid climatic condition, characterized by low rainfall varying widely in amount from year to year (500-1300mm) and long dry season. Diurnal and seasonal temperature fluctuations are very wide. Maximum temperature of 41°C is attained in April while minimum temperature of 13.2°C occurs in January (Mamman *et al.*, 2000). Humidity is very low during most part of the year and solar radiation is relatively high due to dry atmosphere and clear skies (Mamman *et al.*, 2000).

Sources of experimental materials

The feed ingredients used for the formulation of the experimental diets (groundnut cake, soybeans meal, maize, sorghum, wheat offal, mineral and vitamin premixes) were obtained from Sokoto Central Market.

Experimental birds and their management

A total of 180 four weeks old, female Japanese quail chicks (Brown strain) were randomly allotted to three (3) dietary treatments with six (6) replicates of ten (10) chicks each in a completely randomized design. The chicks were allowed to adapt to the experimental diet for seven (7) days. The pens were cleaned and disinfected using detergent and CID 20 solution, (alkyldimethlbenzylammonium chloride). The pens were allowed to dry for two days. Fresh wood shaving was served as litter material. The animals were subjected to the same management practice (lighting, feeding, and watering) throughout the experimental period.

Data collection

The chicks were weighed on arrival; they were also weighed at the beginning and at the end of the experiment. Data were collected daily on feed intake and number of eggs. Weight of eggs laid was also determined daily. Minimum and maximum temperature was monitored on daily basis using minimum and maximum thermometer. Cost of feed, cost of feed consumed and cost of feed/egg were determined. Mortality was also recorded throughout the period of the study.

Preparation of experimental diets

A single diet of 2700kcal/kg and 27% protein was formulated and fed to the birds for the growing period. Three diets containing three (3) different protein levels (15, 20, and 25%) were formulated as dietary treatments. All the diets were iso-caloric (2600kcal/kg). Composition of experimental diets is shown in tables 1 and 2.

Table 1: Gross and chemical composition of quails grower diets used in the (Pre-laying) experiment

Ingredients	**Protein level % 20**
Maize	29.00
Sorghum	9.00
Soy Bean Meal	8.00
Ground Nut Cake	13.00
Wheat offal	33.70
Blood Meal	3.00
Limestone	2.00
Bone Meal	2.00
Premix*	0.25
Salt	0.25
Methionine	0.25
Lysine	0.25
Total	**100**
Calculated analysis	
Energy ME (Kcal/kg)	2700
CP (%)	20.0
CF (%)	4.8
Available P (%)	0.6
Lysine (%)	1.0
Methionine. (%)	0.5
Ether Extract (%)	4.5
Calcium (%)	1.3
Cost **(₦/kg)**	**102.2**

Table 2: Gross and chemical composition of layer experimental diets

Ingredient (%)	**Treatments (Protein levels %)** 15	20	25
Maize	33.00	24.00	15.00
G/nut cake	6.00	14.00	20.00
Soya bean	1.00	8.00	17.00
Wheat offal	38.00	34.00	30.00
Sorghum	12.00	10.00	8.00
Blood meal	3.00	3.00	3.00
Bone meal	3.00	3.00	3.00
Limestone	3.00	3.00	3.00
Salt	0.25	0.25	0.25
Premix*	0.25	0.25	0.25
Methionine	0.25	0.25	0.25
Lysine	0.25	0.25	0.25
Total	**100**	**100**	**100**
Calculated analysis			
Energy ME (Kcal/kg)	2607	2616	2615
CP (%)	15.0	20.2	25.3
CF (%)	4.6	4.9	5.2
Available P (%)	0.7	0.7	0.8
Lysine (%)	0.9	1.0	1.2
Methionine. (%)	0.5	0.5	0.5
Ether Extract (%)	3.9	4.5	4.9
Calcium (%)	1.9	2.0	2.0
Cost (₦/kg)	**94.1**	**103.6**	**108.8**

Egg preservation trial of Japanese quails

A 3x4x4 that includes 3 protein levels 4 storage methods and 4 time interval of factorial experiment was designed for egg preservation trial. A total of 144 non defective eggs were randomly divided into four preservation treatments, each treatment consisting of 48 eggs, (each replicate consisting of 12 eggs). These include storage at room temperature 32^{o}C (P1), storage in refrigerator 4^{o}C (P2), immersion in vegetable oil, and stored at room temperature (P3), and immersion in vegetable oil, and refrigerated (P4). Each egg was subjected to weekly weight loss determination, and external and internal egg quality assessment. The parameters determined include; egg weight, egg shape index, weight and proportion of shell, yolk and albumen, shell thickness and the height and width of albumen and yolk.

Albumen index was obtained by dividing albumen height by its diameter. Yolk index was obtained by dividing yolk height by its diameter and egg shape index was calculated as egg diameter divided by its length. Egg shell surface area was calculated as described by Haugh (1937) using the mathematical relationship:

$$\text{Shell surface area} = w0.667*4.67$$

Yolk pigmentation was evaluated using egg colour chart. Egg mass was computed according to the procedure of North and Bell (1990). Haugh unit was calculated using the mathematical expression:

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$Hu = 100 \log (H7.57-1.7w^{0.37})$.

Where;
Hu = Haugh unit
H = Albumen height
W = Observed weight of egg

Table 3: Egg storage methods

	T1(15% CP)				T2 (20% CP)				T3(25% CP)			
	P1	**P2**	**P3**	**P4**	**P1**	**P2**	**P3**	**P4**	**P1**	**P2**	**P3**	**P4**
W0	3	3	3	3	3	3	3	3	3	3	3	3
W1	3	3	3	3	3	3	3	3	3	3	3	3
W2	3	3	3	3	3	3	3	3	3	3	3	3
W3	3	3	3	3	3	3	3	3	3	3	3	3

P1= storage at room temperature **P2**= storage in refrigerator **P3**= immersion in vegetable oil, and storage at room temperature **P4**=immersion in vegetable oil, storage in a refrigerator **W1**= week one **W2**= week two **W3**= week three

Each egg was subjected to weekly weight loss determination, and external and internal egg quality assessment. The parameters determined include; egg weight, yolk and albumen and the height and width of albumen and yolk.

Albumen index was obtained by dividing albumen height by its diameter. Yolk index was obtained by dividing yolk height by its diameter. Yolk pigmentation was evaluated using egg colour chart. Egg mass was computed according to the procedure of North and Bell (1990). Haugh unit was calculated using the mathematical expression:

$Hu = 100 \log (H7.57-1.7w^{0.37})$.

Where;
Hu = Haugh unit
H = Albumen height
W = Observed weight of egg

Statistical analysis

Data collected were subjected to analysis of variance (ANOVA) using start view statistical package (SAS, 2002). Where significant differences exist, least significant difference (LSD) was used to separate the means. As described by Steel and Torrie (1980).

RESULTS AND DISCUSSION

Results of the experiment are presented on table 4 and 5. The per cent egg production, Hen day and Hen house egg production recorded similar significant response with one another where quails fed 25% CP had significantly better levels of these two parameters ($P<0.05$). Mean egg weight of quails for all treatment groups followed the same pattern with hen day and hen house egg production where quails fed 25% CP had heavier egg weight compared to 15 and 20% CP levels (Table 4).

Results (Table 5) indicated that protein level had no significant effect on albumin weight, yolk height, yolk width, yolk weight, yolk index, yolk colour and Haugh unit ($P>0.05$). Albumin height and index were significantly higher ($P<0.05$) for birds fed diets containing 15% CP while birds fed diets containing 20% and 25% CP were similar ($P>0.05$) in terms of the parameters mentioned. However albumin width was significantly higher for birds fed diet containing 25% CP (P<0.05) and lower for those fed 15% and 20% CP (P>0.05).

Results revealed that preservation method had no significant effect on albumin weight, yolk weight, yolk colour and yolk index (P>0.05). Albumin height for eggs that were refrigerated and stored at room temperature and those immersed in oil and stored at room temperature were significantly (P<0.05) higher compared to those eggs immersed in oil and then stored in refrigerator. Albumin width and albumen index were higher (P<0.05) for eggs stored at room temperature and in refrigerator compared to other treatments. Yolk height and Haugh unit were higher for treatment P2, P3, and P4 (P<0.05) while yolk width was higher for P1 compared to other treatments (P<0.05).

Results (Table 5) showed that albumen height, albumen index, yolk height and Haugh unit were significantly higher at W0 (week 0) whereas albumen width, yolk height yolk width and yolk weight were significantly at higher W3 (week 3) (P<0.05) compared to other storage sessions. No significant differences was recorded for albumen width (at W1 and W2) albumen weight (at W0 and W1) and Haugh unit (at W1 and W2) (P>0.05).

Table 4: Performance characteristics of Japanese quails fed varying protein levels

Parameter	**Treatments (protein levels %)**			
	T1 (15)	**T2 (20)**	**T3 (25)**	**SEM ±**
Initial body weight (g/b)	137.77	139.44	137.22	4.249
Final body weight (g/b)	157.14^{b}	153.57^{b}	173.81^{ab}	5.897
Weight gain (g/b)	19.36^{b}	19.12^{b}	38.25^{a}	5.118
Daily weight Gain (g/day)	0.30^{b}	0.30^{b}	0.60^{a}	0.729
Feed intake (g/b/d)	29.36	30.47	29.80	0.741
F.C.R	18.98^{a}	12.41^{b}	5.03^{c}	4.004
Egg production (%)	75.49^{b}	82.50^{a}	85.86^{a}	1.784
Hen day egg production	42.63^{b}	46.53^{ab}	49.94^{a}	1.350
Hen house egg production	42.63^{b}	43.91^{b}	48.25^{a}	1.200
Weight/egg (g)	7.25^{b}	8.00^{b}	8.95^{a}	0.249
live weight (g)	158.76^{c}	174.69^{b}	183.84^{a}	2.836
Mortality (%)	0.000	3.33	5.55	2.283

^{abc}Means with different superscript along the same row differ significantly (P<0.05)

Table 5: Internal egg quality characteristics of Japanese quails as affected by protein level and Preservation method

Factor	Albumen height (cm)	Albumen width (cm)	Albumen weight (g)	Albumen index (cm)	Yolk height (cm)	Yolk width (cm)	Yolk weight (g)	Yolk index (cm)	Yolk colour	Haugh unit (gmm)
Protein Level										
15%	0.350^{a}	3.225^{b}	5.495	0.123^{a}	0.815	2.641	3.238	0.339	1.083	131.766
20%	0.330^{ab}	3.400^{ab}	5.920	0.109^{b}	0.962	2.554	3.293	0.705	1.123	126.937
25%	0.315^{b}	3.744^{a}	5.494	0.096^{b}	0.921	2.816	3.477	0.344	1.051	126.918
SEM	0.011	0.162	0.181	0.004	0.021	0.109	0.087	0.14	0.042	2.382
Preservation										
P1	0.331^{ab}	3.986^{a}	5.313	0.100^{b}	0.797^{b}	3.024^{a}	3.328	0.288	1.056	128.864^{ab}
P2	0.346^{a}	2.775^{c}	5.726	0.127^{a}	0.962^{ab}	2.447^{b}	3.254	0.397	1.000	131.463^{a}
P3	0.347^{a}	3.558^{b}	5.895	0.112^{ab}	1.000^{a}	2.630^{b}	3.470	0.814	1.000	132.125^{a}
P4	0.302^{b}	3.506^{b}	5.611	0.101^{b}	0.838^{ab}	2.579^{b}	3.291	0.350	1.306	121.708^{b}
SEM	0.013	0.136	0.126	0.005	0.095	0.098	0.095	0.142	0.043	2.476
Storage session										
WO	0.418^{a}	3.075^{b}	5.573^{b}	0.137^{a}	0.985^{a}	2.424^{c}	3.258^{b}	0.408	1.000^{c}	142.544^{a}
W1	0.338^{a}	2.714^{c}	5.951^{a}	0.126^{b}	0.892^{a}	2.453^{c}	3.197^{b}	0.375	1.000^{c}	128.906^{b}
W2	0.303^{b}	2.872^{c}	5.622^{b}	0.118^{c}	0.724^{b}	2.715^{b}	3.311^{b}	0.287	1.222^{a}	127.180^{b}
W3	0.267^{C}	5.164^{a}	5.398^{b}	0.058^{c}	0.997^{a}	3.088^{a}	3.577^{a}	0.779	1.139^{b}	117.117^{c}
Interaction effect										
Dietary and preservation method	**	*	NS	*	NS	NS	NS	NS	**	NS
SEM	0.016	0.177	0.211	0.006	0.115	0.115	0.089	0.248	0.046	2.959

^{abc} Means with different superscript along the same Coolum differ significantly (P<0.05)

* P<0.05 **P<0.01

P1= storage at room temperature **P2**= storage in refrigerator **P3**= immersion in vegetable oil, and storage at room temperature **P4**=immersion in vegetable oil, storage in a refrigerator **W1**= week one **W2**= week two **W3**= week three

The highest egg production was recorded for quails on treatment T3 (25% CP). This was higher than the 70-80% reported by Pigareva (1989) and Anonymous (2010). The high egg laying intensity of the hens combined with the high egg mass produced was attributed to protein level increases from treatments T1 to T3.

The hen day egg production reported in this study (42.64-49.94%) was higher than the values obtained by Babangida and Ubosi, 2006; (30.28-36.39%) but lower than those reported (57%) for with Shika brown layer hens by Abdullahi, (2004); (58-64%) by Abubakar (2005) with layer chicken. This variation could be attributed to the difference in crude protein levels of the diets fed to the birds and age as well as specie of the birds. sHen house egg production for all the treatments were almost similar to the hen-day values, which could be due to very low mortality (Table 4).

The mean egg weight obtained was lower than the 9.5g reported by Babangida and Ubosi (2006) when coturnix Japanese quails were fed diet containing 20% CP. This could be attributed to the differences in energy content of the diets used, environmental location probably or breed differences. Result indicated that the range of egg weight obtained in the present study conform with the findings of Li *et al.* (2011) who reported non-significant differences in the egg weight of birds fed varying protein levels. Shrivastav *et al.* (1993) also found that quails egg was unaffected by varying protein levels in diets. When comparisons were made among dietary protein levels from 14 to 20% (Yamagami and Kobayashi, 1983), reported non-significant differences in the egg composition.

Egg quality comprises a number of aspects related to the shell, albumin and yolk (Kul and Seker, 2004). Keener *et al.* (2006) report that Haugh unit is a measure of albumen quality, however Silversides *et al.* (1993) showed that albumen height is used to determine egg quality. Scott and Silversides (2000); Jones and Musgroove (2005) observed a decrease in albumen height with storage leading to decreased egg weight. Williams (1992) and ACIAR (1998) observed that oiling of eggs within 24 hours of lay is effective in retarding albumin deterioration but does not replace the need for storage under low temperature. According to Samli *et al.* (2005), storage time and temperature appear to be the most crucial factors affecting albumin quality. In some parts of Nigeria, most of the available eggs are usually stored at room temperature until they are completely sold or consumed because facilities for refrigeration are almost non-existent. Room temperature in the semi-arid region of Nigeria could be as high as 35^{0C} in the dry hot season when ambient temperature reaches 40 -45^{0C} (SERC, 1992).

The non-significant effect of protein levels on albumin weight, yolk weight, yolk height, yolk width, yolk colour and yolk index was contrary to the report of Garcia *et al.* (2005) who reported significant effect of protein levels on yolk percentage and that of Akbar *et al.* (1983) who showed increased yolk percentage and reduced albumen percentage of eggs with increased protein levels. Novak *et al.* (2008) also reported decrease in albumin percentage and increase yolk percentage, when they fed laying chickens low protein diets. Gardner and Young (1972) reported that increasing the dietary protein level from 12 to18% produced a significant increase in the relative proportion of egg yolk, Gunawardana *et al.* (2008) reported significant effect of protein levels on egg yolk colour contrary to what was obtained in the present study.

Albumen height significantly decreases with increase in length of preservation. The decline in albumen height (from 0.42cm to 0.27cm) and HU (from 142.544 to 117.12) is closer to those reported by Silversides and Villeneuve (1994). Silversides and Scott (2001) also found that albumen height decreased as eggs aged. The decrease in yolk index and albumen width with increase in length of storage may be due to breakdown of the fibrous glycoprotein ovomucin (Haugh, 1937). The general decline in albumen and yolk quality as eggs aged is in agreement with the findings of Fasenko *et al.* (2001); Monira *et al.* (2004) and Miles and Henry (2004). Who observed a decline in albumen and yolk indices with increase in storage time, the increase in albumen and yolk width observed in this study has also been reported by Keener *et al.* (2006).

Egg yolk size increased with storage time due to movement of water from the albumen to the yolk as a result of osmotic pressure differences (Haugh, 1937). Increase in yolk weight with increase in storage time conform with the report of Heath (1977) who showed that increase in yolk weight with a longer period of storage may be due to amino acids movement through the vitelline membrane from the albumen. A decrease in yolk viscosity during storage reported by Hidalgo *et al*. (1996) follows the same trend as observed in our result. Similarly Samli *et al.* (2005) also reported significant increase in yolk index within 10 days of storage.

Haugh unit and yolk indices are generally considered as good indicators of egg quality evaluation (Chang and Chen, 2000). The higher the yolk index (Ayorinde, 1987) and the haugh unit (Haugh, 1937), the more desirable the egg quality. The HU was initially 142.54 at week 0 and subsequently decrease to 117.12 at week 3. The values however contradicted the report of Trava *et al.* (2009), which indicated that Haugh unit and yolk index from quail eggs do not change during storage periods of between 0 and 20 days at room and refrigerated temperature with supplementation of organic zinc in diet.

CONCLUSION

It was concluded that increasing dietary protein level of 25% will increase the egg production performance of Japanese quails. Refrigeration and immersion in oil were proved as the best methods for preserving internal egg qualities of Japanese quails.

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