International Journal of Food Science and Nutrition Engineering 2015, 5(1): 59-67
DOI: 10.5923/j.food.20150501.08

Proximate Composition and Physical Characteristics of Eggs from Laying Chickens Fed Different Proprietary Vitamin-Mineral Premixes Under Two Rearing Systems During Storage

Olugbenga Adeniran Ogunwole*, Akinola Yinka Paul Ojelade, Mutiu Oyeyemi Oyewo, Emem Aquawo Essien

Agricultural Biochemistry & Nutrition Unit, Department of Animal Science, University of Ibadan, Ibadan, Nigeria

Abstract The proximate composition and physical characteristics of eggs from laying chickens fed diets supplemented with five different proprietary vitamin-mineral premixes (VMP) under two rearing systems (RS) in the duration of storage (DOS) were assessed. A 240 twenty week-old black Bovan nera chickens at the point of lay were randomly allotted equally to two RS in the deep litter (DL) and battery cages (BC)., Pullets were further allocated in each RS to five dietary treatments of 24 birds per treatment each in triplicate of eight birds per replicate. Five isocaloric and isonitrogenous diets formulated were each supplemented with 0.25% of the different VMP 1, 2, 3, 4 and 5 to obtain treatments T1, T2, T3, T4 and T5 respectively. Experimental diets and water were offered to respective birds *ad libitum.* At week 36, 75 eggs were sampled from each RS, stored at room temperature and thereafter assayed at days 0, 7, 14, 21 and 28. The experiment was a 2 X 6 X 5 factorial arrangement in completely randomized design. Crude protein (11.63%) and ether extract (7.67%) were significantly higher (P<0.05) in eggs from hens fed T1 compared to others. Crude protein (11.45 to 11.59), and ash (1.24 to 1.34) increased significantly (P<0.05) with decreased moisture content during storage. Shell thickness, weight loss, albumen height, and Haugh unit were significantly affected (P<0.05) by the DL. Egg albumen heights from birds fed diets T1 (3.69), T4 (3.67) and T5 (3.72) were significantly higher (P<0.05) compared to that fed T3. Haugh unit (83.08 to 15.38), albumen height (6.99 to 1.62), yolk height (15.52 to 5.41) and yolk index (41.94 to 11.38) decreased while albumen pH (8.77 to 9.39) and weight loss (0.0 to 3.2) increased significantly (P<0.05) with DOS. Interaction among RS, VMP type and DOS were not significantly different (P>0.05) for all parameters measured. Haugh unit and yolk index relative to DOS both gave negative and highly significant (P<0.01) regression equations: $y = 0.000x^4-0.044x^3+0.864x^2-7.915x+83.08$ (R^2 =0.874) and $y = -0.000x^3+0.050x^2-1.861x+41.89$ (R^2=0.935) respectively. Conclusively, extent of reduction in egg quality in the DOS was influenced by the different dietary VMP employed in the feeding as well as the hens RS.

Keywords Duration of storage, Haugh unit, Chemical composition, Egg quality indices, Yolk index

1. Introduction

Vitamin and mineral supplementations in layer diet remained indispensable due to their participation in all biochemical processes and chicken gut flora provide very little vitamin synthesis but compete with the host for dietary vitamins [1]. Chicken eggs contain high-quality proteins, carbohydrates, easily digestible fats and minerals, as well as valuable vitamins [2]. The use of quality premix is an important feature of a successful poultry production leading to improved safety, reliability and performance [3] of laying birds and quality of eggs produced. However, in Nigeria like some other developing countries, refrigeration of eggs is seldom practiced and eggs produced are temporarily stored at room temperature until sold to final consumers.

Apart from direct human consumption, eggs are valuable raw materials for the pharmaceutical and cosmetic industries due to their multifunctional properties like foaming, gelling and emulsifying [4] which are highly dependent on interior and exterior characteristics reflected both in the quality and size [5]. The quality is composed of those characteristics of egg that affects its acceptability to consumers such as cleanliness, freshness, weight, shell quality; yolk index, albumen index, Haugh unit and chemical composition [6]. As reported [7-9], egg quality is influenced by management,

* Corresponding author:
droaogunwole@gmail.com (Olugbenga Adeniran Ogunwole)
Published online at http://journal.sapub.org/food

climatic factors, nutrition, breed and post-lay handling practice. Eggs are highly susceptible to internal quality deterioration during storage [10] depending on shell and internal content [11, 12]. Factors associated with the level of quality loss are time, temperature, humidity, air movement and handling [13]. There is therefore the need for further documentation of the effects of dietary VMP vis a vis possible interaction of RS on DOS of eggs in the hot humid tropical environment. Therefore, this study was aimed at evaluating the proximate composition and physical characteristics of eggs from hens fed different commercial VMP under two RS as affected by the DOS.

2. Materials and Methods

The study was carried out at the Poultry Unit, Teaching and Research Farm, University of Ibadan, Ibadan, Nigeria. 240 twenty weeks old black Bovan nera at the point of lay were allotted to two RS (i.e. BC and DL systems) with 120 birds per RS. In each RS, birds were randomly allotted to six dietary treatments in triplicate of eight birds per replicate making 24 birds per treatment. Five isonitrogenous and isocaloric layer diets were formulated. The composition of the experimental diets is shown in the Table 1. The feed were each supplemented respectively with 0.25% Nutripoult (T1), Hinutrients (T2), Agrimix (T3), Daramvita (T4) and Micromix (T5). The experimental diets and water were given to the birds *ad libitum* for fifteen weeks. Table 2 shows the composition of the test VMP as shown on the respective labels.

At week 36, a total of 75 eggs were sampled from each RS, they were stored at room temperature for 28 days and were subsequently withdrawn serially for analyses on days 0, 7, 14, 21 and 28. Recorded minimum and maximum ambient temperature in the DOS of eggs were 23.4 and 27.9℃ respectively while the relative humidity ranged between 73 to 87%. Proximate compositions and physical characteristics (external and internal) of the eggs were measured at days 0, 7, 14, 21 and 28 DOS. Each egg was homogenized and the proximate composition determined [14]. Egg length and diameter were measured with electronic venier caliper. Eggs were weighed and broken on a flat surface, and the height of thick albumen was measured with a tripod micrometer. The albumen and yolk were separated, and only yolk was weighed. Shell thickness was measured with micrometer screw gauge after air drying at room temperature. Egg weight loss was determined as the difference between successive weights of eggs at different weighing days. Albumen weight was determined by the difference between egg weight, yolk weight and shell weight while albumen pH was measured with pH meter. Yolk index was estimated from the ratio of yolk height to yolk width. Haugh unit was determined from albumen height and egg weight using the equation as described [15]; $HU= 100\log (h + 7.6 - 1.7W^{0.37})$ where HU is Haugh unit, h is albumen height (mm), W= egg weight (g).

Table 1. Gross Composition (%) of Experimental Diets Fed to Layers

Ingredients	T1	T2	T3	T4	T5
Maize	59.00	59.00	59.00	59.00	59.00
Soybean meal	24.37	24.37	24.37	24.37	24.37
Wheat Bran	3.00	3.00	3.00	3.00	3.00
Palm Kernel Cake	3.00	3.00	3.00	3.00	3.00
Salt	0.30	0.30	0.30	0.30	0.30
Di-calcium Phosphate	0.11	0.11	0.11	0.11	0.11
Limestone	9.30	9.30	9.30	9.30	9.30
Biotronics	0.30	0.30	0.30	0.30	0.30
Mycofix	0.10	0.10	0.10	0.10	0.10
Methionine	0.15	0.15	0.15	0.15	0.15
Lysine	0.12	0.12	0.12	0.12	0.12
VMP 1	0.25	-	-	-	-
VMP 2	-	0.25	-	-	-
VMP 3	-	-	0.25	-	-
VMP 4	-	-	-	0.25	-
VMP 5	-	-	-	-	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated Nutrients					
ME (Kcal/kg)	2687.56	2687.56	2687.56	2687.56	2687.56
Crude Protein %	17.00	17.00	17.00	17.00	17.00
Crude Fiber %	3.80	3.80	3.80	3.80	3.80
Fat %	3.59	3.59	3.59	3.59	3.59
Lysine %	0.97	0.97	0.97	0.97	0.97
Meth + Cyst %	0.71	0.71	0.71	0.71	0.71
Calcium %	3.68	3.68	3.68	3.68	3.68
Phosphorous %	0.40	0.40	0.40	0.40	0.40

Table 2. Composition per 2.5 kg of Test Vitamin-mineral premixes as shown on the labels

Vitamins and Minerals	Test Ingredient 1	Test Ingredient 2	Test Ingredient 3	Test Ingredient 4	Test Ingredient 5
Vitamin A (IU)	10,000,000	10,000,000	10,000,000	12,000,000	10,000,000
Vitamin D3 (IU)	2,000,000	2,000,000	2,000,000	2,400,000	2,000,000
Vitamin E (IU)	12,000	12,000	12,000	12,000	23,000
Vitamin K3 (mg)	2,000	2,000	2,000	2,000	2,000
Vitamin B1 (mg)	1,500	1,500	1,500	1,500	3,000
Vitamin B2 (mg)	5,000	4,000	5,000	4,000	6,000
Vitamin B6 (mg)	1,500	1,500	1,500	1,800	5,000
Vitamin B12 (mcg)	10	10	10	10	25
Niacin (mg)	15,000	15,000	15,000	25,000	50,000
Calcium Panthotenate (mg)	5,000	5,000	5,000	5,000	10,000
Folic acid (mg)	600	500	600	500	1,000
Biotin (mcg)	20	20	20	25	50
Choline chloride (mg)	150,000	100,000	150,000	240,000	400,000
Manganese (mg)	80,000	75,000	75,000	80,000	120,000
Zinc (mg)	60,000	50,000	50,000	50,000	80,000
Iron (mg)	40,000	20,000	25,000	20,000	100,000
Copper (mg)	8,000	5,000	5,000	5,000	8,500
Iodine (mg)	1,000	1,000	1,000	1,200	1,500
Selenium (mg)	150	200	100	200	120
Cobalt (mg)	250	500	400	200	300
Antioxidant (mg)	100,000	125,000	125,000	125,000	120,000

2.1. Statistical Analysis

Data were analyzed using three way analysis of variance [16] while significant means were separated by least squares method.

3. Results and Discussion

Effect of RS and VMP in the DOS on proximate composition of chicken eggs is shown in Table 3. The crude protein (CP) varied only numerically (P>0.05) among treatments and was not affected by RS. This observation conformed to the documented opinion [17] that egg displayed very consistent composition with regard to its content of total proteins, essential amino acids, total lipids, phospholipids, phosphorus, and iron. Also, protein and total lipid content of eggs were noted [18] not to be affected by the diet of the hen but the types of lipids (fatty acid composition) which in a way contradicted other proximate values of ether extracts (EE), total ash and nitrogen free extracts in Table 3. It was observed that dietary VMP type altered the moisture, CP and EE composition of eggs in this study highly significantly (P<0.01). The CP and EE (11.63 and 7.67 respectively) were significantly higher (P<0.01) in eggs from hen fed diets containing T1 compared to others. In the DOS, CP (11.45 to 11.59), and ash (1.24 to 1.34) increased very significantly (P<0.01) with decreased moisture content. Aside from EE composition, the DOS altered other proximate values highly significantly (P<0.01). The interactions of DOS X VMP only resulted in significantly different (P<0.05) EE values. Also, the interactions of the RS X VMP altered all eggs proximate values highly significantly (P<0.01). However, the interactions of RS X DOS and the RS X VMP type X DOS on egg proximate parameters were all not significantly different (P>0.05).

Effect of RS, VMP and the DOS on external characteristics of chicken eggs is shown in Table 4. The net weight loss in eggs from DL was 1.7% which was significantly higher (P<0.05) when compared with those from BC (1.6%). The weight losses significantly (P<0.05) increased with the DOS. Weight losses in eggs during storage were 0, 0.9, 1.7, 2.5 and 3.2% for days 0, 7, 14, 21, and 28 respectively which varied significantly (P<0.05) from one another. Weight losses from eggs of hens fed T1, T2 and T3 were not significantly different (P>0.05) during storage, however, they were significantly higher (P<0.05) when compared with stored eggs from hens on diets T4 and T5. The consistent increased weight loss in egg with advancing DOS agreed with the earlier report [19]. However, authors [20] opined that egg weight did not change in the first 10 days of storage. According to reports [21-24], the losses could be ascribed to the release of carbon dioxide, ammonia, nitrogen, hydrogen sulphide gas and water from eggs. Another report [25] also suggested that reduction in egg weight could be attributed to the loss of humidity from inside the egg due to evaporation effects.

Eggs from hens on DL and those fed diets containing VMP 2 were observed to lose more weight compared to others and this could be attributed to the lowered egg shell thickness. It was also noted [26] that thin-shelled eggs lost more moisture compared to when the shell was thick. Also, shell weight and shell thickness of eggs from hen fed supplemental VMP 2 and 3 were observed to be lower in both RS which thus resulted in higher weight losses during storage compared with those fed VMP 5 which recorded lower weight loss. Dietary vitamin D determines the level of calcium metabolism for egg shell formation and vitamin D deficiency has been observed to lead to poor eggshell quality, mainly due to decreased eggshell weight [27].

The effect of RS, VMP type and the DOS on albumen characteristics of chicken eggs is shown in Table 5. The overall albumen height of stored eggs from hens fed T1, T2, and T4 were similar (P>0.05) but differed significantly (P<0.05) from those fed T3. However, albumen height of stored eggs from hens on T3 was similar (P>0.05) to those of T2 though, the overall Haugh unit of all stored eggs on the different dietary VMP were similar (P>0.05). The overall albumen heights were 6.99, 3.92, 3.22, 2.22 and 1.62mm for days 0, 7, 14, 21 and 28 respectively. Also, the Haugh unit values were 83.08, 56.52, 48.03, 30.63 and 15.34 for the corresponding 0, 7, 14, 21 and 28 days respectively of storage. These values significantly decreased (P<0.05) as the DOS increased irrespective of the RS and the VMP used. Much deterioration was observed in overall values of albumen heights (6.99mm to 1.62mm) and Haugh unit (83.08 to 15.38) with the DOS. These results agreed with those in literature [19, 20] on significant decrease in albumen height and Haugh unit with increased DOS.

Table 3. Effect of Rearing Systems, Vitamin-mineral Premixes and the Duration of Storage on Proximate Composition of Chickens Egg

		% Proximate Composition				
	Factors	Moisture content	Crude Protein	Ether Extract	Ash	Nitrogen Free Extract
Rearing Systems	Deep litter	78.43	11.54	7.64^{a}	1.30^{a}	1.08^{b}
	Battery Cage	78.42	11.56	7.59^{b}	1.28^{b}	1.15^{a}
	SEM	0.01	0.01	0.01	0.01	0.02
Vitamin-mineral Premix	1	78.32^{d}	11.63^{a}	7.67^{a}	1.28	1.09
	2	78.45^{b}	11.55^{b}	7.57^{c}	1.29	1.14
	3	78.50^{a}	11.44^{c}	7.65^{ab}	1.28	1.12
	4	78.48^{ab}	11.54^{b}	7.62^{b}	1.30	1.04
	5	78.37^{c}	11.59^{b}	7.56^{c}	1.29	1.18
	SEM	0.02	0.021	0.02	0.01	0.04
Storage time	0	78.51^{a}	11.45^{b}	7.61^{a}	1.24^{c}	1.15
	7	78.49^{a}	11.54^{a}	7.60^{ab}	1.23^{c}	1.12
	14	78.41^{b}	11.60^{a}	7.61^{ab}	1.29^{b}	1.13
	21	78.36^{c}	11.55^{a}	7.62^{a}	1.35^{a}	1.10
	28	78.35^{c}	11.59^{a}	7.59^{b}	1.34^{a}	1.06
	SEM	0.02	0.02	0.02	0.01	0.04
	Source Of Variation (P-Value)					
	Rearing system	0.3260^{NS}	0.6550^{NS}	0.0004^{*}	0.0412^{*}	0.0186^{*}
	Storage time	$<0.0001^{**}$	$<0.0001^{**}$	0.0816^{NS}	$<0.0001^{**}$	0.4494^{NS}
	Vitamin-mineral premix	$<0.0001^{**}$	$<0.0001^{**}$	$<0.0001^{**}$	0.4152^{NS}	0.0615^{NS}
	Storage time X Vitamin-mineral Premix	0.2090^{NS}	0.9237^{NS}	0.0071^{*}	0.7047^{NS}	0.0116^{*}
	Rearing system X vitamin-mineral premix	$<0.0001^{**}$	$<0.0001^{**}$	$<0.0001^{**}$	$<0.0001^{**}$	$<0.0001^{**}$
	Rearing system X Storage time	0.1860^{NS}	0.1983^{NS}	0.9652^{NS}	0.8000^{NS}	0.9323^{NS}
	Rearing System X Storage time X Vitamin-mineral Premix	0.4210^{NS}	0.8890^{NS}	0.6826^{NS}	0.2026^{NS}	0.6230^{NS}

$^{a–d}$Means of values with different superscripts are different significantly. SEM -Standard error of mean.
NS- not significant. *P< 0.05. **P< 0.001.

Table 4. Effect of Rearing Systems, Vitamin-Mineral Premixes and Storage Time on External Characteristics of Chicken Egg

	Factors	Egg Weight (g)	Shell Weight (g)	Shell Thickness (mm)	Shape Index	Weight Loss (%)
Rearing system	Deep litter	59.74	5.58[b]	0.33[b]	1.37	1.7[a]
	Battery cage	60.65	5.89[a]	0.35[a]	1.34	1.6[b]
	SEM	0.56	0.58	0.00	0.14	0.0
Vitamin-mineral Premix	1	60.96	5.89[a]	0.34	1.29	1.7[a]
	2	60.09	5.59[b]	0.33	1.37	1.8[a]
	3	59.81	5.61[b]	0.33	1.35	1.7[a]
	4	59.04	5.73[ab]	0.34	1.39	1.5[b]
	5	61.08	5.84[ab]	0.34	1.37	1.5[b]
	SEM	0.89	0.92	0.00	0.02	0.1
Storage Time	0	60.63	5.54[c]	0.35[a]	1.32	0.0[e]
	7	59.23	5.60[bc]	0.32[b]	1.36	0.9[d]
	14	60.33	5.81[ab]	0.33[b]	1.34	1.7[c]
	21	60.47	5.76[abc]	0.35[a]	1.38	2.5[b]
	28	60.31	5.95[a]	0.35[a]	1.38	3.2[a]
	SEM	0.89	0.09	0.00	0.02	0.1
	Rearing System					
	Vitamin-Mineral premix	0.8170[NS]	0.0855[NS]	0.7262[NS]	0.0568[NS]	0.0001[*]
	Storage Time	0.4690[NS]	0.0169[*]	< 0.0001[**]	0.2053[NS]	< 0.0001[**]
	Rearing system X Vitamin-mineral Premix	0.0550[NS]	0.4137[NS]	0.4448[NS]	0.5325[NS]	0.6123[NS]
	Rearing System X Storage Time	0.6110[NS]	0.0403[NS]	0.1227[NS]	0.0642[NS]	0.1685[NS]
	Vitamin-mineral Premix X Storage Time	0.6560[NS]	0.0769[NS]	0.0001[**]	0.4698[NS]	0.0844[NS]
	Rearing System X Storage Time X Vitamin-mineral Premix	0.8830[NS]	0.7889[NS]	0.0007[**]	0.3572[NS]	0.7168[NS]

[a–e]Means of values with different superscripts are different significantly. SEM -Standard error of mean. NS- not significant. *P< 0.05. **P< 0.001.

During storage, some physical and chemical modifications take place in albumen. These are the thinning of the albumen thickness [28], main increase of albumen pH caused by the loss of carbon dioxide from the egg through the pores in the shell [29] and changes occurring in ovomucin [28, 30]. A rapid loss of CO_2 leads to a decrease in quality until the state of gas balance is reached between the inside and outside of the egg [25]. Haugh unit (56.52) was observed to fall in the grade of B (59-30) at days 7 of storage (Table 4) as against the desired grade AA (100-72) or A (71-60). This showed that decline in egg quality was sharp at room temperature in line with the documented report [31].

Also, Haugh unit was related to the DOS (Fig. 1) and the regresion equation was

$$y = 0.000x^4 - 0.044x^3 + 0.864x^2 - 7.915x + 83.08 \ (R^2 = 0.874) \quad (1)$$

This indicated a strong negative and highly significant relationships (P<0.01).

Effects of RS and VMP on albumen pH were not significant (P>0.05). However, albumen pH values significantly increased (P<0.05) with DOS, although there was no significant difference (P>0.05) in the albumen pH obtained at days 21 and 28. The values for these days were statistically higher (P<0.05) compared with the albumen pH at days 0, 7 and 14. Also albumen pH obtained at days 0, 7 and 14 were significantly different (P<0.05). A rapid upsurge in alkalinity of albumen was observed which increased from

8.77 to 9.39 (Table 5). This observation conformed to those reported [19] on increased albumen pH from 7.47 to 9.11 in 10 days of storage.

Effect of RS, VMP and DOS on yolk characteristics of chicken eggs are shown in Table 6. Yolk height, yolk index, and yolk weight values were similar (P>0.05) among the different VMP and the RS. The changes in yolk weight were observed not to be significantly altered (P>0.05) during storage which conformed to earlier findings [20] that yolk and shell weights were not changed by storage. Yolk height and yolk index was observed to decrease significantly (P<0.05) from 15.52mm and 41.94 to 5.41mm and 11.38 respectively with increased DOS. Tabidi [25] reported that reduction rate of yolk index was sharp at room storage. Flattening of yolk was primarily due to increased water content caused by osmotic migration from albumen through the vitelline membrane [28].

Yolk index was related to the DOS (Fig. 2) and the regresion equation was:

$$y=-0.000x^3+0.050x^2-1.861x+41 \quad (R^2=0.935) \tag{2}$$

which also indicated a strong negative and highly significant relationships (P<0.01).

Table 5. Effect of Rearing Systems, Vitamin-mineral Premixes and the Duration of Storage on Albumen Characteristics of Chickens egg

	Factors	Albumen Height (mm)	Albumen Weight (g)	Haugh Unit	Albumen pH
Rearing system	Deep litter	3.69^a	40.26	48.68^a	9.23
	Battery cage	3.50^b	40.63	44.78^b	9.21
	SEM	0.07	0.72	1.03	0.01
Vitamin-mineral Premix	1	3.69^a	42.23	46.13	9.22
	2	3.57^{ab}	40.04	46.09	9.22
	3	3.33^b	40.65	46.08	9.23
	4	3.67^a	38.71	48.64	9.23
	5	3.72^a	40.58	48.03	9.21
	SEM	0.10	1.14	1.64	0.01
Days of Storage	0	6.99^a	40.21	83.08^a	8.77^d
	7	3.92^b	39.12	56.52^b	9.24^c
	14	3.22^c	41.55	48.03^c	9.33^b
	21	2.22^d	41.64	30.63^d	9.39^a
	28	1.62^e	39.69	15.38^e	9.39^a
	SEM	0.10	1.14	1.64	0.01
	Source of Variation (P-value)				
	Rearing System	0.0480*	0.7150^{NS}	0.0090*	0.0660^{NS}
	Storage Time	< 0.0001**	0.4330^{NS}	< 0.0001**	< 0.0001**
	Vitamin-Mineral premix	0.0490*	0.3010^{NS}	0.4470^{NS}	0.7280^{NS}
	Rearing System X Storage Time	0.2570^{NS}	0.2480^{NS}	0.4060^{NS}	0.2200^{NS}
	Rearing system X Vitamin-mineral Premix	0.9110^{NS}	0.2830^{NS}	0.8220^{NS}	0.7430^{NS}
	Vitamin-mineral Premix X Storage Time	0.0360*	0.8400^{NS}	0.2740^{NS}	0.4690^{NS}
	Rearing System X Storage Time X Vitamin-mineral Premix	0.7740^{NS}	0.6390^{NS}	0.2590^{NS}	0.6870^{NS}

$^{a–e}$Means of values with different superscripts are different significantly. SEM -Standard error of mean. NS- not significant. *P< 0.05. **P< 0.001.

Table 6. Effect of Rearing Systems, Vitamin-mineral Premixes and Duration of Storage on Yolk Characteristics of Chickens Egg

	Factors	Yolk Weight (g)	Yolk height (mm)	Yolk index (%)	Yolk Ratio	Yolk/Albumen Ratio
Rearing System						
	Deep litter	13.91	9.67	22.9	23.31	0.36
	Battery Cage	14.13	9.30	22.9	23.32	0.36
	SEM	0.65	0.44	1.1	1.06	0.02
Vitamin-mineral premix						
	1	12.85	9.61	22.3	21.03	0.37
	2	14.46	9.78	22.9	24.13	0.38
	3	13.55	8.72	21.4	22.64	0.35
	4	14.61	9.51	23.6	24.89	0.36
	5	14.65	9.83	24.2	23.89	0.37
	SEM	1.03	0.69	1.7	1.68	0.03
Storage Time						
	0	14.88	15.52^{a}	41.9^{a}	24.61	0.37
	7	14.50	11.09^{b}	26.8^{b}	24.39	0.38
	14	12.96	8.37^{c}	19.5^{c}	21.31	0.34
	21	13.08	7.03^{cd}	14.8^{cd}	21.89	0.35
	28	14.68	5.41^{d}	11.4^{d}	24.39	0.39
	SEM	1.03	0.69	1.7	1.68	0.03
	Source of variation (P value)					
	Rearing System	0.8060^{NS}	0.5490^{NS}	0.9940^{NS}	0.9930^{NS}	1.0000^{NS}
	Storage Time	0.5240^{NS}	$< 0.0001^{**}$	$< 0.0001^{**}$	0.4740^{NS}	0.6260^{NS}
	Vitamin-mineral premix	0.6550^{NS}	0.7920^{NS}	0.7990^{NS}	0.5180^{NS}	0.5180^{NS}
	Rearing system X Storage Time	0.8630^{NS}	0.5950^{NS}	0.7380^{NS}	0.7810^{NS}	0.7720^{NS}
	Rearing System X Vitamin-mineral Premix	0.7390^{NS}	0.7220^{NS}	0.8240^{NS}	0.4940^{NS}	0.4540^{NS}
	Vitamin-mineral Premix X Storage Time	0.9440^{NS}	0.9860^{NS}	0.9840^{NS}	0.9330^{NS}	0.9430^{NS}
	Rearing System X Storage Time X Vitamin-mineral Premix	0.9250^{NS}	0.6610^{NS}	0.6930^{NS}	0.8530^{NS}	0.8220^{NS}

[a–d]Means of values with different superscripts are different significantly. SEM -Standard error of mean. NS- not significant. *P< 0.05. **P< 0.001.

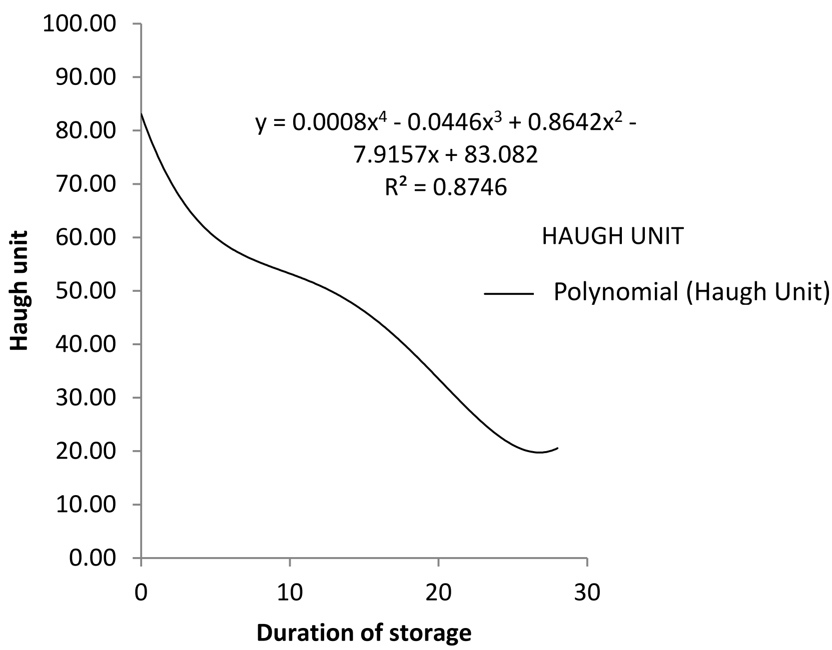

Figure 1. Effects of Duration of Storage on Haugh Unit of chickens Egg

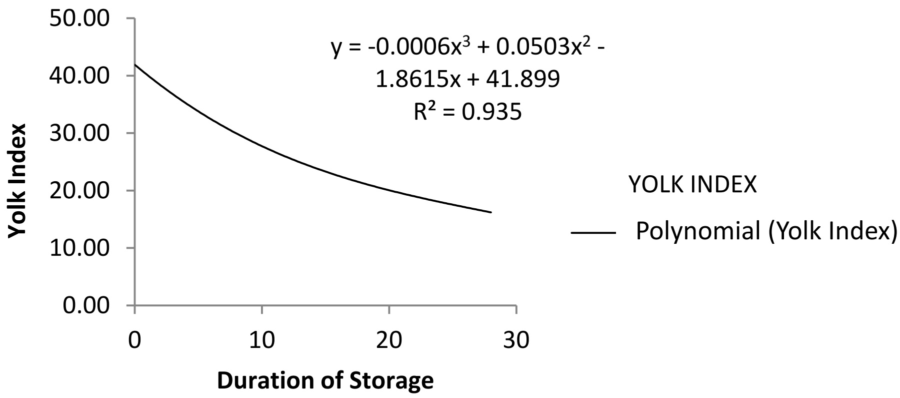

Figure 2. Effect of Duration of Storage on Yolk Index of Chickens Egg

4. Conclusions and Recommendations

The RS and the type of dietary VMP both affected the composition and egg quality characteristics in the DOS. The VMP 1 and 5 would be preferred in both RS as they both tend to ensure good albumen height, Haugh unit, yolk height, yolk index, higher shell thickness and lowered weight loss. Quality of eggs was observed to decrease when stored at room temperature. Eggs qualities deteriorated bellow desirable grade before day 7 of storage at room temperature in the hot humid tropics. Thus, alternative methods should be considered for storing excess eggs produced to enhance retention of freshness.

REFERENCES

[1] Asaduzzman, M., M. S. Jahan, M. R. Mondol, M. A. Islam and A.K. Sarkar. 2005. Efficacy of different commercial vitamin-mineral premixes on productive performance of caged laying pullets. Int. J. Poult. Sci., 4: 589-595.

[2] Huopalahti, R., López F., R., Anton, M. and Schade, R. (eds). 2007. Bioactive Egg Compounds. Springer-Verlag, Heidelberg, pp. 298.

[3] Raven, P. and G. Walker. 1980. Food and Agricultural Organization of United Nation. Reitman, S. and S Frankel. Am. J. Clin. Path., 1957, 28: 56.

[4] Matt, D., E. Veromann and A. Luik. 2009. Effect of housing systems on biochemical composition of chicken eggs. Agronomy Research 7(Special issue II), 662–667.

[5] Koelkebeck. K. W. 1999. What Is Egg Quality and Conserving It? University of Illinois.http://www.traill.uiuc.edu/poultrynet/paperDisplay.cfm?ContentID=522.

[6] Song K. T, Choil S. C., Oh H. R. 2002. A comparison of egg quality of pheasant, chukar, quail and guinea fowl. Asian-Australian J. Anim. Sci., 13(7): 986-990.

[7] Ternes, W., S. Leitsch. 1997. Chemistry of egg yolk. In: Proceedings of the VII European Symposium on the Quality of Eggs and Egg Products. Poznan, Poland. WPSA Polish branch, Poznan, Poland, pp. 127–144.

[8] Zemková, L. J. Simeonovová, M. Lichovníková, K. Somerlíková. 2007. The effects of housing systems and age of hens on the weight and cholesterol concentration of the egg. Czech J. Anim. Sci., 52(4): 110–115.

[9] King'ori, A. M. 2012. Poultry egg external characteristics: egg weight, shape and shell colour. Res.J.Poult.Sci. 5:14-17.

[10] Wong Y. C., Herald T. J., Hachmeister K. A., 1996. Evaluation of mechanical and barrier properties of protein coatings on shell eggs. Poult Sci 75: 417–22.

[11] Adeogun, I. O., Amole, F. O. 2004. Some Quality Parameters of Exotic Chicken eggs Under Different Storage Conditions. Bulletin for Animal Health and Production in Africa (Kenya), Vol. 52 (1):43 – 47.

[12] Kul, S., Seker I. 2004. Phenotypic correlations between some external and internal egg quality traits in the Japanese quail (Coturnix coturnix japonica). Int. J. Poult. Sci., 3(6): 400-405.

[13] Stadelman, W. J. and O. J. Cotterill. 1995. Egg Science and Technology. 4th Edition. New York, Food Product Press.

[14] AOAC. 2000. Official methods of analysis, 15th edition. Association of Official Analytical Chemists, Washington, DC.

[15] Haugh, R. R. 1937. The Haugh unit for measuring egg quality. In: US Egg Poult. Mag. 43:522–555, 572–573.

[16] SAS. 1999. SAS/STAT User's guide Version 8 for Windows SAS Institute Inc. SAS.

[17] Nys, Y, Gautron J. Garcia-Ruiz JM, Hincke MT. 2004. Avian eggshell mineralization: biochemical and functional characterization of matrix proteins. Comptes Rendus Palevol 3: 549–62.

[18] Froning, G. W. 1998. Recent advances in egg products research and development. Presented at the University of California Riverside and Modesto egg processing workshop. June 2-3, 1998.

[19] Samli H. E, A Agma and N Senkoylu. 2005. Effect of storage time and temperature on egg quality in old laying hens. J Appl Poult Res, 14: 548-553.

[20] Scott, T. A. and F. G. Silversides. 2000. The effect of storage and strain of hen on egg quality. Poult. Sci. 79:1725-1729.

[21] Dudusola, I. O. 2009. Effects of Storage Methods and Length of Storage on some Quality Parameters of Japanese Quail Eggs. Tropicultura, 27 (1): 45-48.

[22] Alsobayel, A. A. and M. A. Albadry. 2011. Effect of storage period and strain of layer on internal and external quality characteristics of eggs marketed in Riyadh area. J Saudi Soc Agri Sci, 10: 41-45.

[23] Jin Y. H, K. T Lee, W. I. Lee and Y. K. Han. 2011. Effects of Storage Temperature and Time on the Quality of Eggs from Laying Hens at Peak Production. Asian Aust J Anim Sci, 24 (2): 279-284.

[24] Siyar H. S. A., H. Aliarabi, A. Ahmadi and N. Ashori. 2007. Effect of different storage conditions and hen age on egg quality parameters. Aust Poult Sci Symp. 19: 106-109.

[25] Tabidi, M. H. 2011. Impact of storage period and quality on composition of Table egg. Adv Environ Biol, 5(5): 856-861.

[26] Roque, L. and M. C. Soares. 1994. Effects of eggshell quality and broiler breeder age on hatchability. Poultry Sci. 73:1838-1845.

[27] Galea, F. 2011. Nutrition and food management and their influence on egg quality. xlviii simposio científico de avicultura. Santiago de Compostela | 5 al 7 de octubre.

[28] Kato, S., T. Kawamura., T. Goto, H. ohduchi and K. Toyolima. 1994. Effect of storing condition on interior quality of quail (coturnix coturnix Japonica) egg. Research Bulletin of the Aichi-Ken Agricultural Research center, 26: 37.

[29] Hill, A. T., and J. W. Hall. 1980. Effects of various combinations of oil spraying, washing, sanitizing, storage time, strain, and age upon albumen quality changes in storage and minimum sample sizes required for their measurement. Poultry Science, 59: 2237-2242.

[30] Toussant, M. J. and Latshaw, J. D. 1999. Ovomucin content and composition in chicken eggs with different interior. J. Sci. Food Aric. (79): 1666-1670.

[31] USDA. 2000. United States standards, grades, and weight classes for shell eggs. United States Department of Agriculture. Agricultural Research note. RN 23 12/99.