Journal of Genetic and Environmental Resources Conservation, 2015, 3(2):132-137.
www.jgerc.com

Comparison study of egg morphology, component and chemical composition of ostrich, emu and native chickens

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Abstract

The objective of this first native study was to determined egg morphology, quality and chemical characteristics of tow Ratites; ostrich (*Struthio camelus*) and emu (*Dromaius novaehollandiae*) eggs and compared with native chickens (*Gallus domesticus*). A total of 12 eggs of ostrich, 7 eggs of emu and 35 eggs of native chicken were collected from flocks reared in open condition in Baghdad. The data obtained revealed that significant differences (P<0.05) were appeared in the morphological structure and components of eggs among ostrich, emu and native chicken. Although, some significant differences (P<0.05) in chemical composition were noticed, ostrich and emu eggs are equivalent to native chicken eggs in chemical composition, so its eggs were acceptable for consumers as table eggs.

Keywords: Ostrich, Emu, Native chickens, Morphology, Quality, Chemical composition.

Introduction

Ostrich (*Struthio camelus*) and emu (*Dromaius novaehollandiae*), are belong to one group of largest living species of living birds called Ratites. These birds are distinctive in their appearance, with a long neck and legs (Hermes, 2006).

Since the mid-1980s, there has been worldwide farming of Ratites, particularly with ostrich for feathers, meat, eggs, skin and oil (Glatz and Miao 2008). The farming of ostrich is well established in South Africa and is gaining in popularity in agriculture around the world (Deeming, 1997). The production of ostrich has been widely discussed in countries other than in their preferred and natural environment (Mahrose, 2002 and 2007; Al-Nasser *et al*., 2003; Horbanczuk, 2005 and Cooper *et al*., 2007 and 2008). Ostrich have evolved in desert environments and then have developed adaptations to successfully cope with challenges therein (Cooper *et al*., 2007). Recent interest in ostrich farming has led to an increasing demand for information about this bird and how to manage it in a commercial environment (Deeming, 1999 and Minka, 2003).

Numerous ovological studies referring to egg structure and its morphological and chemical composition, egg shell thickness and strength, and even its ultrastructure were carried out for many poultry species (Burton and Tullett, 1983; Solomon, 1997; Mróz *et al.*, 2008; Szczerbińska and Wiercińska, 2010). However, such a scope of knowledge has not been achieved with respect to evaluation of eggs in birds of the superorder Palaeognathae. It includes ostrich and emu, the aim of this study was to comparison between egg morphology, Component and chemical composition of ostrich (*Struthio camelus*), emus (*Dromaius novaehollandiae*) and native chicken (*Gallus domesticus*)

Materials and Methods

Eggs collection: A total of 12 eggs of ostrich (*Struthio camelus*), 7 eggs of emu (*Dromaius novaehollandiae*) and 35 eggs of native chicken (*Gallus domesticus*) were collected from flocks reared in open condition in Baghdad.

Eggs quality: All eggs were subjected to determine the egg morphology and quality parameters according to the methods revealed by Stadelman and Cotterill (1995), egg shape index was determined using a vernier caliper device according to the equation :

$$\text{Egg shape index} = \frac{\text{egg breadth (mm)}}{\text{egg length (mm)}} \; 100$$

Egg volume determined according to Hoyt, (1979) using the equation :

Egg volume (cm^3) = 0.51 LB^2 , L: egg length, B: egg breadth.

Egg specific gravity determined according to Stadelman and Cotterill (1995), using the equation:

$$\text{Egg specific gravity (gm/cm}^3) = \frac{\text{egg weight (gm)}}{\text{egg volume (cm}^3)}$$

All eggs weighed using Sartorius digital balance and broken onto a flat surface where the height of the inner thick albumen and the upper point of yolk were measured with a height gauge (Ames micrometer, USA), yolk diameter measured with a vernier caliper device. Yolk index values were determined by division yolk high values to yolk diameter values, weights of the egg shell, yolk and albumen materials were determined using a very sensitive digital Sartorius balance after cracking the shell and separating the yolk from albumen materials. Percentages of egg components (shell, yolk and albumen materials) as a ratio to total egg weight were determined according to Stadelman and Cotterill, (1995) using the equation :

$$\text{Egg components (\%)} = \frac{\text{component weight (gm)}}{\text{egg weight (gm)}} \; 100$$

Chemical analyses: The yolk was separated from the albumen and both were distributed into three replicates of glass beakers. Egg albumen and yolk pH values, moisture, ash, protein, lipid and carbohydrates contents in albumen and yolk were carried out according to AOAC (1980), all these measurements were done in triplicates, the pH of the albumen and the yolk were measured immediately with a pH meter (Electronic Instruments LTD, England) (Scott and Silversides, 2000). Moisture determined by drying samples in conventional oven at 98°C for 24hrs. Ash determined by ashing samples using muffle furnace oven at 600°C for 6hrs. Lipid analysis was conducted on all samples using mixture of chloroform : methanol (1 : 1) and stirred for 20min using magnetic stirrer for several rinsing times. Protein determined by the method of semi-microkjeldal determination of N% and the values obtained multiplied with 6.25 to calculate protein%. Carbohydrate was determined by subtracking moisture, ash, lipid and protein percentages from 100. Minerals were determined according to AOAC (1980), K, Ca, and B were determined by automatic flame photometer PGI 2000, which give the concentration in ppm, Mg, P, Fe, Cu and Zn were determined by colorimetric methods using spectrophotometer (LKB Ultra spectronic). Lipid profile; cholesterol, high density lipoprotein, low density lipoprotein, very low density lipoprotein, triglyceride and free fatty acids were determined by using BioAssay Systems (EnzyChrom Cholersterol, HDL and LDL/VLDL Kite) and according to AOAC (1980).

Statistical analysis: Data were analyzed by using the general linear model procedure of SAS (2001). Means were compared by the Duncan's multiple range test at 5% probability (Steel and Torrie, 1980).

Results and Discussion

Egg breadth, egg length, egg shape index egg weight, egg volume, egg specific gravity, albumen height, yolk height, yolk diameter and yolk index of ostrich, emus and native chicken were shown in Table (1). Ostrich egg is spherical shaped not in oval shaped like native chicken egg, whereas emu egg is longitudinal, also ostrich egg had the largest percentage of egg shell (20.1%) compared with emu (16.2%) and native chicken (10.4%) in the same time ostrich egg had the lowest percentage of yolk (29.2%) compared with emu (34.7%) and native chicken (32.4%).

Chemical composition of ostrich, emu and native chicken eggs shown in Table (2), no statistical differences in moisture, ash, and carbohydrates in egg albumen were appeared among studied birds whereas, native chicken egg albumen predominant in protein percentage (11.03%). Native chicken egg yolk significantly ($P<0.05$) predominant ostrich and emu in protein and lipid percentages (17.27 and 31.88% respectively).

Table (3) shows that minerals contents in albumen and yolk of ostrich, emus and native chicken, minerals were high concentration in yolk compared with albumen for all studied bird and Ca and P were the main elements in the egg components (albumen and yolk). Elements; Mg, Fe and K were in good concentration in ostrich, emu and native chicken eggs whereas, Cu, Zn and Mn concentration were less than 1 ppm.

Lipid profile of ostrich, emu and native chicken eggs shown in Table (4), ostrich egg had low concentration of cholesterol, LDL and VLDL which were 10.3mg/g, 41.2mg/100gm and 127.0mg/100mg respectively, compared with emu which were 15.7mg/g, 50.9mg/100gm and 165.3mg/100mg respectively, and native chicken which were 13.6mg/g, 45.4mg/100gm and 142.2mg/100mg respectively, in the same time HDL and triglycerides were high in ostrich egg (70.4mg/100mg and 75.8mg/100mg) compared with emu egg (52.4mg/100mg and 50.6mg/100mg) and native chicken egg (67.6mg/100mg and 71.7mg/100mg). No statistical differences were appeared in FFA among studied birds.

Ostrich eggs are the largest of all eggs though they are actually the smallest eggs relative to the size of the adult bird, on average they are 15 centimeters long, 13 centimeters wide, and weigh 1.4kgm, over

20 times the weight of a chicken egg. They are glossy cream-colored, with thick shells marked by small pits (Romanoff and Romanoff, 1949).

All values of egg quality traits (internal and external) reported in the present work and showed in Table (1) were high than those found by some investigators (Mahrose, 2007; Mushi *et al.*, 2007) this may due to the year of production (Al-Obaidi *et al.*, 2012), which eggs became larger as birds advanced in age (Stadelman and Cotterill, 1995). It can worthy be noted that the ostrich egg is not in oval shaped (Spherical shaped) like chicken eggs, it is also very difficult to define visually the round end from the sharp one (Zaharchenko, 2005) whereas emu eggs is longitudinal (Szczerbińska and Wiercińska, 2010). However, the values of the length and width are affected by egg weight (Di Meo *et al.,* 2003). The same author added that shell weight percentage averaged 19% and the higher shell percentage caused a decrease in the percentage of albumin and yolk. They also stated that these components did not affect by laying period, unlike the chicken hen, whereas laying progresses, there is a lower percentage of albumen and higher percentage of yolk. Amer (2005) reported the following values of ostrich egg characteristics for hatched and unhatched eggs, respectively; egg length was 15.12 and 15.31 cm; egg width was 12.23 and 12.25 cm, egg shell weight was 237 and 249 g and egg shell thickness was 1.835 and 1.8 mm.

Table (1): Egg morphology and interior quality characteristics of ostrich, emu and native chicken eggs (Mean ±SE).

Parameters	Ostrich	Emu	Native chicken
Egg Weight (gm)	1529 $\pm 33.16^{a}$	603 $\pm 15.39^{b}$	49 $\pm 2.62^{c}$
Egg breadth (cm)	12.2 $\pm 1.38^{a}$	7.9 $\pm 1.25^{b}$	3.3 $\pm 0.74^{c}$
Egg length (cm)	16.1 $\pm 1.36^{a}$	15.6 $\pm 1.27^{a}$	4.6 $\pm 0.63^{b}$
Egg shape index	75.8 $\pm 1.97^{a}$	50.6 $\pm 1.85^{c}$	71.7 $\pm 1.84^{b}$
Egg volume (cm^3)	1222.1 $\pm 22.46^{a}$	496.5 $\pm 11.41^{b}$	25.6 $\pm 1.72^{c}$
Egg specific gravity (gm/cm^3)	1.25 $\pm 0.52^{a}$	1.21 $\pm 0.60^{a}$	1.91 $\pm 0.54^{a}$
Albumen High (mm)	12.5 $\pm 1.21^{a}$	7.8 $\pm 0.85^{b}$	1.8 $\pm 0.36^{c}$
Yolk High (mm)	17.3 $\pm 1.32^{a}$	10.6 $\pm 1.33^{b}$	2.4 $\pm 0.47^{c}$
Yolk Diameter (mm)	49.4 $\pm 1.78^{a}$	28.6 $\pm 1.41^{b}$	3.1 $\pm 0.55^{c}$
Yolk index	0.35 $\pm 0.23^{b}$	0.37 $\pm 0.21^{b}$	0.47 $\pm 0.21^{a}$
Shell (%)	20.1 $\pm 0.75^{a}$	16.2 $\pm 0.71^{a}$	10.4 $\pm 0.63^{b}$
Yolk (%)	29.2 $\pm 2.18^{c}$	34.7 $\pm 2.23^{a}$	32.4 $\pm 1.41^{b}$
Albumen (%)	50.7 $\pm 2.79^{b}$	49.1 $\pm 2.33^{b}$	57.2 $\pm 2.15^{a}$

Table (2): Albumen and yolk chemical composition of ostrich, emu and native chicken eggs (Mean ±SE).

Parameters	Ostrich		Emu		Native chicken	
	Albumen	Yolk	Albumen	Yolk	Albumen	Yolk
Moisture (%)	87.54 ±0.45^{a}	52.26 ±1.22^{a}	87.50 ±0.38^{a}	52.20 ±1.23^{a}	87.23 ±0.41^{a}	48.45 ±1.25^{b}
Ash (%)	0.97 ±0.03^{a}	1.08 ±0.31^{a}	0.95 ±0.05^{a}	1.11 ±0.33^{a}	1.02 ±0.05^{a}	1.12 ±1.31^{a}
Protein (%)	10.79 ±0.62^{b}	16.34 ±0.85^{b}	10.86 ±0.58^{b}	16.52 ±0.88^{b}	11.03 ±0.62^{a}	17.27 ±0.86^{a}
Lipid (%)	-	28.91 ±1.05^{b}	-	28.95 ±1.11^{b}	-	31.88 ±1.06^{a}
Carbohydrate (%)	0.70 ±0.20^{a}	1.41 ±0.34^{a}	0.69 ±0.24^{a}	1.22 ±0.33^{a}	0.72 ±0.21^{a}	1.28 ±0.33^{a}

Table (3): Minerals content in albumen and yolk of ostrich, emu and native chicken eggs (Mean ±SE).

Minerals	Ostrich		Emu		Native chicken	
	Albumen	Yolk	Albumen	Yolk	Albumen	Yolk
Calcium (Ca)	27 ±0.54^{a}	145 ±1.72^{b}	28 ±0.55^{a}	139 ±1.66^{b}	32 ±0.52^{a}	165 ±1.68^{a}
Phosphorous (P)	18 ±0.72^{a}	334 ±3.99^{b}	19 ±0.81^{a}	343 ±4.13^{b}	22 ±0.70^{a}	380 ±4.15^{a}
Magnesium (Mg)	10 ±0.40^{a}	15 ±0.38^{a}	8 ±0.37^{a}	17 ±0.39^{a}	13 ±0.37^{a}	19 ±0.37^{a}
Iron (Fe)	2 ±0.52^{b}	7 ±0.56^{b}	1.8 ±0.51^{b}	8 ±0.51^{b}	3 ±0.53^{a}	14 ±0.55^{a}
Potassium (K)	142 ±1.73^{a}	108 ±1.77^{a}	144 ±1.80^{a}	100 ±1.79^{a}	167 ±1.78^{a}	125 ±1.79^{a}
Copper (Cu)	<1 ±0.00	<1 ±0.00	<1 ±0.00	<1 ±0.00	<1 ±0.00	<1 ±0.00
Zinc (Zn)	<1 ±0.00	<1 ±0.00	<1 ±0.00	<1 ±0.00	<1 ±0.00	<1 ±0.00
Manganese (Mn)	<1 ±0.00	<1 ±0.00	<1 ±0.00	<1 ±0.00	<1 ±0.00	<1 ±0.00

Table (4): Lipid profile of ostrich, emu and native chicken eggs (Mean ±SE).

Parameters	Ostrich	Emu	Native chicken
Cholesterol (mg/gm)	10.3 ±1.09	15.7 ±1.12^{a}	13.6 ±1.13^{b}
High density lipoprotein (mg/100g)	70.4 ±1.46^{a}	52.4 ±1.47^{a}	67.6 ±1.45^{b}
Low density lipoprotein (mg/100g)	41.2 ±1.65^{a}	50.9 ±1.52^{b}	45.4 ±1.57^{c}
Very low density lipoprotein (mg/100g)	127.0 ±3.46^{a}	165.3 ±3.39^{b}	142.2 ±3.34^{c}
Triglycerides (mg/100g)	75.8 ±1.97^{a}	50.6 ±1.85^{c}	71.7 ±1.84^{b}
Free fatty acids (mg/100mg)	0.62 ±0.27^{a}	0.74 ±0.22^{a}	0.49 ±0.14^{a}

Avian egg is one of most complex and highly differentiated reproductive cell, germinal cell accumulated relatively enormous amounts of food substances (yolk and albumen material) and all are enclosed in protective structures (shell), birds egg diverge widely in shape, volume, weight and the amount of yolk and albumen material due to species characteristic and bird age. Avian eggs contain protein and fat, but merely a trace of carbohydrate, and no fiber. An egg is composed of about 11% proteins and 11.2% is fat. Most of the proteins are concentrated in the albumen part of the egg, the egg albumen mostly contains water and proteins. The yolk is surrounded by the albumen and contains about 80% of the calories and almost all fats present in the egg, also it contains minerals such as iron, calcium, and phosphorus. The fat of an egg is found almost entirely in the yolk; there is less than 0.05% (Trace) in the albumen (Stadelman and Cotterill, 1995).

Ostrich and emu eggs are also fully equivalent to chicken eggs in taste and practical properties (El-Safty and Mahrose, 2008). They can be cooked in similar ways. Ostrich eggs are impressive by their sheer size and one ostrich egg (about 1600 g) is equivalent to 24 chicken eggs. The chemical composition of ostrich and chicken eggs. It is clear that both of total proteins and lipids are almost the same, but there were obvious differences in some mineral, elements such as calcium, phosphorus and iron were higher in native chicken eggs. Total cholesterol value recorded 11.2 mg/g egg yolk of ostrich compared with 15mg/g egg yolk of chicken eggs (Stadelman and Cotterill, 1995). Di Meo *et al.* (2003) recorded that the content of cholesterol /g of ostrich eggs yolk was between 10.6 and 10.9mg, compared with the native chicken eggs, the ostrich and emu eggs have similar chemical and nutritive characteristics, but a higher un-saturated/ saturated fatty acid ratio and lower cholesterol content (El-Safty and Mahrose, 2008; Shahin *et al.*, 2006). With respect to albumen and yolk trait of the eggs studied, it could be seen that the ostrich and emu eggs were acceptable for consumers as table eggs (Chowdhury *et al.*, 2008).

Conclusions

Ostrich egg is spherical shaped not in oval shaped like chicken eggs, it is also very difficult to define visually the round end from the sharp one, whereas Emu eggs is longitudinal. Ostrich and Emu eggs are fully equivalent to Native chicken eggs in chemical composition, so its eggs were acceptable for consumers as table eggs.

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