Egg Morphology, Quality and Chemical Characteristics of Ostrich *Struthio camelus camelus*

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Abstract

The objective of this first native study was to determined morphology, quality and chemical characteristics of ostrich *Struthio camelus* eggs. A total of 97 eggs were collected from ostrich flocks (6 females and 3 males) domestic subspecies *Struthio camelus camelus* reared in the zoo of Baghdad city during the period from June 14th of 2010 to October 15th of 2011. The data obtained revealed that egg breadth, egg length and egg shape index were 12.6 cm, 16.9 cm and 74.6 respectively, egg weight, egg volume, egg specific gravity were 1576 gm, 1368.3 cm3, 1.15 gm/cm3 respectively, albumen height, yolk height, yolk diameter and yolk index were 12.7 mm, 13.6 mm, 30.8 mm and 0.44 respectively. This survey showed that ostrich egg components were 20.23% shell, 31.12% yolk and 48.65% albumen during the third year of production. Chemical composition of ostrich eggs showed that moisture were 87.69 and 48.04%, ash 1.05 and 1.10%, protein 11.84 and 17.76%, carbohydrates 0.71 and 0.95% of albumen and yolk materials respectively, lipids and cholesterol were 29.87% and 11.21 mg/gm of yolk materials. Minerals contents in egg albumen and yolk were; calcium (26 and 133 ppm), phosphorous (13 and 375 ppm), magnesium (8 and 17 ppm), iron (1 and 8 ppm), potassium (150 and 114 ppm), copper (0.5 and 2 ppm), zinc (0.5 and 1 ppm), manganese (1 and 2 ppm) respectively. In conclusion, compared with the henôs egg, the ostrich egg has similar chemical and nutritive characteristics, but a lower cholesterol content.

الصفات الشكلية والنوعية والكيميائية لبيض النعامة *Struthio camelus camelus*

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الخلاصة

استهدف البحث ولأول مرة محليا دراسة الصفات الشكلية والنوعية والكيميائية لبيض النعامة *Struthio camelus*. تم جمع 97 بيضة من قطيع النعام (6 إناث و3 ذكور) تحت النوع المدجن *Struthio camelus camelus* والمربى في حديقة حيوانات بغداد خلال المدة من 14/ 7/ 2010 ولغاية 15/ 10/ 2011. وقد بينت النتائج إن معدلات قيم المحور العرضي والطولي ومعامل الشكل لبيض النعامة قد بلغ 12.6 سم و16.9 سم و74.6 على التوالي، وبلغت معدلات قيم وزن البيضة وحجمها والوزن النوعي لها 1576 غم و1368.3 سم3 و1.15 غم/ سم3 على التوالي، وبلغت معدلات قيم ارتفاع البياض والصفار وقطر الصفار ودليل الصفار 12.7 ملم و13.6 ملم و30.8 ملم و0.44 على التوالي، وبينت النتائج أيضا إن البيض يتكون من 20.23% قشرة و31.12% صفار و48.56% بياض خلال الموسم الثالث لإنتاج البيض. التحليل الكيميائي لبيض النعامة

أشار إلى إن الرطوبة تشكل 87.69 و48.04% والرماد 1.05 و1.10% والبـــروتين 11.84 و17.76% والكربوهيدرات 0.71 و0.95 لكل من البياض والصفار على التوالي وبلغ تركيـــز الـــدهون والكولســـترول 29.87% و11.21 ملغم/ غم من الصفار على التوالي. بلغ محتوى البياض والصفار من العناصر المعدنيـــة: 26 و133 جزء بالمليون كالسيوم و13 و375 جزء بالمليون فسفور و8 و17 جزء بالمليون مغنيسيوم و1 و8 جزء بالمليون حديد و150 و114 جزء بالمليون بوتاسيوم و0.5 و2 جزء بالمليون نحـــاس و0.5 و1 جـــزء بالمليون زنك و1 و2 جزء بالمليون منغنيز على التوالي. نستنتج ان بيض النعام مشابه في تركيبـــه الكيميـــائي لبيض الدجاج إلا إن محتواه منخفض من الكولسترول.

Introduction

The ostrich *Struthio camelus*, is the largest living species of any living birds, its a large flightless bird native to Africa. It is the only living species of its family, Struthionidae. Ostrich share the order Struthioniformes with the kiwi, emu and other ratites. It is distinctive in its appearance, with a long neck and legs (1). Five subspecies of ostrich are recognized: *S.c.australis*, Southern ostrich, southern Africa. It is wild, found in the south of the Zambezi and Cunene rivers. *S. c. camelus*, North African ostrich or Red-necked ostrich, it was the most widespread domestic subspecies, ranging from Ethiopia and Sudan in the east throughout the Sahel to Senegal and Mauritania in the west, and north to Egypt and southern Morocco, respectively. *S. c. massaicus*, Masai ostrich, East Africa. It has some small feathers on its head, and its neck and thighs are pink, their range is essentially limited to southern Kenya and eastern Tanzania and Ethiopia and parts of Southern Somalia. *S. c. syriacus*, Arabian ostrich or Middle Eastern ostrich, was formerly very common in the Arabian Peninsula, Syria and Iraq, it became extinct around 1966. *S. c. molybdophanes*, Somali ostrich, southern Ethiopia, northeastern Kenya, and Somalia, the neck and thighs are grey-blue, the females are more brown than those of other subspecies (2, 3). Since the mid-1980s, there has been worldwide farming of ratites, particularly with ostriches for feathers, meat, eggs, skin and oil (4). The farming of ostriches is well established in South Africa and is gaining in popularity in agriculture around the world (5). The production of ostriches has been widely discussed in countries other than in their preferred and natural environment the desert (6, 7, 8, 9). Ostriches have evolved in desert environments and then have developed adaptations to successfully cope with challenges therein (10, 11). 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 (12, 13). The objective of this first native study was to determined egg morphology, quality and chemical characteristics of domestic subspecies of ostrich *Struthio camelus camelus* during the third year of production.

Materials and Methods

- **Eggs collection:** During the third year of production, 97 eggs were collected from domestic subspecies of ostrich *Struthio camelus camelus* flocks (6 females and 3 males) reared in the zoo of Baghdad city during the period from June 14th of 2010 to October 15th of 2011.
- **Eggs quality:** Freshly laid eggs were subjected to determined the egg morphology and quality parameters according to the methods revealed by Stadelman and Cotterill (14), egg shape index was determined using a vernier caliper device according to the equation:

$$\text{Egg shape index} = \frac{\text{egg breadth (short circumference) mm}}{\text{egg length (long circumference) mm}} \times 100$$

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

Egg volume (cm^3)= 0.51 LB2, L: egg length, B: egg breadth.

Egg specific gravity determined according to Stadelman and Cotterill (14), using the equation:

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

At the Iraq Natural History Research Center and Museum laboratory, all eggs weighed using Sartorius digital balance (Sweden) 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 using large spoon. Percentages of egg components (shell, yolk and albumen materials) as a ratio to total egg weight were determined according to Stadelman and Cotterill, (14) using the equation:

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

- **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 (15), all these measurements were done in triplicates. Moisture determined by drying samples in conventional oven at 98 Co for 24 hr. Ash determined by ashing samples using muffle furnace oven at 600 Co for 6 hr. Lipid analysis was conducted on all samples using mixture of chloroform: methanol (1: 1) and stirred for 20 min. 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. Cholesterol was determined by ethanol-ferric chloride colorimetric methods using spectrophotometer (LKB Ultra spectronic) of Franey and Elias (16). Minerals were determined according to AOAC (15), 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).
- **Statistical analysis:** Data were analyzed by using the General Linear Model Procedure of SAS (17). Means were compared by the Duncan's Multiple Range test at 5% probability (18).

Results

Table (1) shows that ostrich egg breadth, egg length and egg shape index were 12.6 cm, 16.9 cm and 74.6 respectively, egg weight, egg volume, egg specific gravity were 1576 gm, 1368.3 cm^3 and 1.15 gm/cm^3 respectively, albumen height, yolk height, yolk diameter and yolk index were 12.7 mm, 13.6 mm, 30.8 mm and 0.44 respectively. This survey showed that Ostrich egg components were 318.8 gm (20.23%) of shell, 490.5 gm (31.12%) of yolk and 766.7 gm (48.65%) of albumen during the third year of production.

Table (2) shows chemical composition of ostrich eggs showed that moisture were 87.69 and 48.04%, ash 1.05 and 1.10%, protein 11.84 and 17.76%, carbohydrates 0.71 and 0.95% of albumen and yolk materials respectively, lipids and cholesterol were 29.87% and 11.21 mg/gm of yolk materials. Table (3) shows that minerals contents in albumen and yolk were, calcium (26 and 133 ppm), phosphorous (13 and 375 ppm),

magnesium (8 and 17 ppm), iron (1 and 8 ppm), potassium (150 and 114 ppm), copper (0.5 and 2 ppm), zinc (0.5 and 1 ppm), manganese (1 and 2 ppm).

Table (1) Egg morphology and interior quality characteristics of ostrich eggs (Mean± SE)

Parameters	Mean ±SE
Egg weight (gm)	1576 ±26.41
Egg breadth (cm)	12.6 ±1.63
Egg length (cm)	16.9 ±1.42
Egg shape index	74.6 ±0.73
Egg volume (cm^3)	1368.3 ±21.37
Egg specific gravity (gm/cm^3)	1.15 ±0.84
Albumen high (mm)	12.7 ±0.25
Yolk high (mm)	13.6 ±0.41
Yolk diameter (mm)	30.8 ±0.63
Yolk index	0.44 ±0.03
Shell weight (gm)	318.8 ±17.50
Shell (%)	20.23 ±0.67
Yolk weight (gm)	490.5 ±29.44
Yolk (%)	31.12 ±1.24
Albumen weight (gm)	766.7 ±72.83
Albumen (%)	48.65 ±1.74

Values are the mean of 97 replicates.

Table (2) Albumen and yolk chemical composition of ostrich eggs (Mean± SE)

Parameters	Egg	
	Albumen	Yolk
Moisture (%)	87.50 ±0.88	49.02 ±0.73
Ash (%)	1.05 ±0.03	1.40 ±0.10
Protein (%)	10.84 ±0.66	18.76 ±0.68
Lipid (%)	-	29.87 ±0.81
Carbohydrate (%)	0.71 ±0.08	0.95 ±0.05
Cholesterol (mg/gm)	-	11.20 ±0.74

Values are the mean of three replicates.

Table (3) Minerals content in albumen and yolk of ostrich eggs (Mean± SE)

Minerals (ppm)	Egg	
	Albumen	Yolk
Calcium (Ca)	26 ±1.86	133 ±1.90
Phosphorous (P)	19 ±1.14	375 ±1.30
Magnesium (Mg)	8 ±0.92	17 ±0.87
Iron (Fe)	1 ±0.06	8 ±0.06
Potassium (K)	150 ±2.48	114 ±2.47
Copper (Cu)	0.5 ±0.10	2 ±0.10
Zinc (Zn)	0.5 ±0.10	1 ±0.10
Manganese (Mn)	1 ±0.11	2 ±0.11

Values are the mean of three replicates.

Discussion

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 1.5 kilograms, over 25 times the weight of a chicken egg. They are glossy cream-colored, with thick shells marked by small pits (19). At the third productive life of the ostriches, 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 (20, 21) because of its third season of production, which eggs became larger as birds advanced in age (14). It can worthy be noted that the ostrich egg is not in oval shaped like chicken eggs, it is also very difficult to define visually the round end from the sharp one (22). However, the values of the length and width are

affected by egg weight (23). 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, where as laying progresses, there is a lower percentage of albumen and higher percentage of yolk. Amer (24) 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. 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 white part of the egg, known as albumen or egg white, 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% in the albumen (14). Ostrich eggs are also fully equivalent to chicken eggs in taste and practical properties (25). 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 are similar, it is clear that both of total proteins and lipids are almost the same, but there are obvious differences in some mineral salts such as magnesium, selenium and iron, which are higher in ostrich eggs while manganese, zinc and copper are lower in ostrich than chicken eggs. Total cholesterol value recorded 11.2 mg/ g egg yolk of ostrich compared with 15 mg/ g egg yolk of chicken eggs (14). Di Meo *et al.* (23) recorded that the content of cholesterol /g of ostrich eggs yolk was between 10.6 and 10.9 mg. In conclusion, compared with the henôs egg, the ostrich egg has similar chemical and nutritive characteristics, but a higher un-saturated/ saturated fatty acid ratio and lower cholesterol content (25, 26). With respect to albumen and yolk trait of the eggs studied, it could be seen that the ostrich egg was acceptable for consumers, if ostrich's eggs were used as table eggs. (27). Generally, it is therefore stated that both age and prevailing environmental conditions may be affected the internal and external egg quality traits of ostrich during the third year of production. In conclusion, ostrich eggs are similar to chicken eggs, both of total proteins and lipids are almost the same, but there are obvious differences in some mineral salts but a lower cholesterol content.

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