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CAPTIVE RED-NECKED OSTRICH (STRUTHIO CAMELUS CAMELUS) INTERNAL EGG PHYSICAL CHARACTERISTICS AND CHEMICAL VALUES

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Abstract

Purpose: This study was conducted to evaluate captive red-necked ostrich eggs.
Design/methodology/approach: Parent red-necked ostrich (*Struthio camelus camelus*) flock (5 male, 7 female) was stocked from the wild (Dindir National Park) in the second season of production. The feeding plan was 14% crude protein and 09.23 ME MJ/Kg. Internal physical egg characteristics, egg components percentage, shell thickness and egg chemical characteristics were evaluated.
Findings: Mean internal physical egg measurements were 1.32 ± 00.49 for albumen light and 19.01 ± 5.15 for yolk index. The Haugh unit was 78.58 ± 5.19. The egg chemical values showed the shell with the highest (99.50%) dry matter and ash (92.5%) and lowest (2.05%) nitrogen and nitrogen free extract. The highest CP (23.00%) and ether extract (18.90%) was in the yolk. The shell contained the highest macro and micro minerals

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cited except for potassium, which was higher (4.40%) in the yolk. The mean value of shell thickness was highest (02.00 $\pm$ 00.07) mm at the end.

Originality/value: The study evaluated the red-necked ostrich egg chemical composition and concluded that it is similar to the hen's egg. This finding is in agreement with that of Carey *et al.* (1980) who compared the hen's egg with the ostrich egg and found them to be of a similar chemical and nutritive value. Sales *et al.* (1996) reported that ostrich eggs differ little from other avian species in yolk lipid amount, but compared to poultry, the ostrich egg has a different fatty acid composition.

Keywords: Ostrich, *Struthio camelus camelus*, Egg values, Internal physical and chemical values

Paper type: Part of PhD study

INTRODUCTION

Evaluation of the red-necked ostrich egg is a very important factor contributing to incubation success. Although the ostrich egg is the biggest of all known eggs (1500 g) from the largest bird on Earth, it is also one of the smallest eggs laid by a bird in relation to body weight (1.25% compared with the average chicken at 1.7%). There are large differences in egg weight between females (Deeming, 1996d), and ostrich egg weights vary greatly with breed, season and bird weight. Many authors have reported an average weight of 1328 g from a range of 645–2296 g. (Ar *et al.*, 1979; Deeming, 1993; Jost, 1993; Sell, 1993; Ar *et al.*, 1996; Ar *et al.*, 1998; van Schalkwyk *et al.*, 1999; and Seaworld, 2004). The three principle components of the egg—the albumen, yolk and shell—make up percentages of 57.1%–59.4%, 21%–23.3% and 19.6% respectively, as showed by Kreibich and Sommer (1995), Shanawany and Dingle (1999) and Dimeo *et al.* (2003). Kreibich and Sommer (1995) and Ar and Rahn (1980) reported that the two main components of fresh eggs (the albumen and the yolk) differ considerably in their water content. The yolk from various species contains about 42–65% water, while the water content of albumen varies less among species, ranging from 85–95%. Average egg shell thickness of ostrich eggs was reported by Dimeo *et al.* (2003) to range from 2.2 mm in equatorial regions to 2.24 mm. Bowsher (1992) observed that a thinner shelled (1.81 mm) ostrich egg will hatch without assistance compared to the thicker shelled

(1.91 mm) egg, which requires assistance to hatch. She found that the mean shell thickness measurement for the assisted group in their study was 1.91 mm, which is similar to the 1.9 mm reported for an assisted group by Board and Tullet (1977).

MATERIALS AND METHODS

The commercial red-necked ostrich *S. camelus* breeding flock was maintained in EL-Rajaa Agricultural Scheme, ELGitaina Province, 70 km South of Khartoum by the White Nile, White Nile State. The parent flock consisted in the first year of a production of seven females and five males of the same age (three years old). The birds were in the second season of production. They were originally stocked in the farm from the wild (Dindir National Park, Dindir Province, Sinnar State).

Nine fresh laid eggs were randomly selected and used for evaluation of internal physical egg characteristics and chemical values. Egg weight was measured using a dial balance of maximum weight two kilograms. Internally, yolk colour determination and egg indexing was performed on a flat clean white ban. Yolk visual colour score was estimated using a standard colour fan (Hoffman, La Roche, Germany) and yolk index value (yolk diameter and centre height) by using digital vernier calipers to the nearest 0.01 cm (Sharp and Powell, 1930; Funk, 1948). Albumen height was measured by digital vernier calipers to the nearest 0.01cm as close to the periphery of the yolk as possible. The Haugh unit was calculated from the highest albumen and egg weight using the Haugh unit (HU) (Haugh, 1937) modified formula:

$HU = 100 \text{ Log } (H-1.7\ W^{0.37} + 7.57)$ (Eisen *et al.*, 1962).
Where H = height of the inner thick albumen in mm
W = weight of the egg in grams

Egg components percentage albumen, yolk and shell of each egg were separated and collected in a polythene sack and weighed fresh before drying at room temperature. Dry components were reweighed and the water content of each was determined by the difference. Percentage values of egg components were calculated.

Shell thickness was measured in the three different regions of the egg: top (air chamber), mid (equatorial) and end (opposite) region, using digital vernier calipers to the nearest 0.01 cm.

Egg chemical characteristics: three randomly selected eggs from the first season lay were subjected to approximate analysis to determine their chemical composition of albumen, yolk and shell according to AOACI (2006).

STATISTICAL ANALYSIS

Mean values were compared using the un-paired student's T-test (Snedecor and Cochran, 1978). Per cent value was utilized in expressing values of the egg nutrients.

RESULTS

INTERNAL EGG COMPONENTS

Internal egg measurements are shown in Table 1 covering mean values of egg weight (1188.33 ± 188.25 g), albumen and yolk heights, yolk diameter, index and colour. The Haugh unit was 78.58 ± 5.19.

SHELL THICKNESS

Table 2 shows average values of shell thickness in different areas of ostrich eggs. Treatment effect in shell thickness (maximum and minimum) was significant ($p < 0.05$), whereas mean values of shell thickness differed by area ($p < 0.05$), with the end of the shell being the thickest (02.00 ± 00.07 mm).

Item	Mean ± s.d.
Egg weight (g)	1188.33 ± 188.25
Albumen height (cm)	001.32 ± 00.49
Yolk height (cm)	02.57 ± 0.40
Yolk diameter (cm)	14.07 ± 2.11
Yolk index	19.01 ± 5.15
Yolk colour	09.00 ± 01.41
Haugh unit	78.58 ± 5.19

* Carried out on 9 fresh eggs randomly selected from the first year lay

Table 1. Mean (± s.d.)* internal measurements of breeding ostrich eggs

INTERNAL EGG COMPONENTS

Internal egg components absolute weights and percentages are shown in Table 3. Components yolk, albumen and shell absolute values of dry and water content weights, water percentage of fresh components (54.61 ± 06.28% yolk, 86.74 ± 04.86% albumen and 18.34 ± 05.29% shell), component fresh weight percentage of the fresh egg weight and percentage values of component water and dry weights of the fresh egg weight, which adds up to 100%.

Table 2. Analysis of variance and average (mean ± s.d.) shell thickness in different areas of breeding ostrich eggs

	F-Value#	Area mean ± s.d.		
		Top (wide end)	Side (mid region)	End (narrow)
Shell thickness (mm)	9.67*	01.95 ± 0.06**a,b**	01.85 ± 00.05**b**	02.00 ± 00.07**a**
Max. shell thickness (mm)	6.05*	02.10 ± 00.11	01.98 ± 00.11	02.14 ± 00.11
Min. shell thickness (mm)	7.00*	01.80 ± 00.07	01.73 ± 00.08	01.87 ± 00.08

Width (2,134) d.f.
* Denotes f-value significant at $p<0.05$.
NS = not significant ($p>0.05$).
Means in a row bearing the same or no letter subscript are similar ($p>0.05$)

Table 3. Mean (± s.d.)* absolute weights and percentages of internal components of breeding ostrich eggs

Item	mean ± s.d.		
	Yolk	Albumen	Shell
Fresh weight (g)	394.17 ± 56.30	843.33 ± 270.36	315.00 ± 66.46
Dry weight (g)	180.33 ± 42.87	93.55 ± 27.76	261.24 ± 46.83
Water content (g)	213.83 ± 32.48	749.62 ± 243.09	53.68 ± 21.42
Water % of fresh component	54.61 ± 06.28	86.74 ± 04.86	18.34 ± 05.29
Component fresh weight % of the fresh egg weight	26.51 ± 03.73	53.53 ± 05.11	20.83 ± 02.25
Component water % of the fresh egg weight	14.06 ± 03.61	47.79 ± 04.43	03.45 ± 00.94
Component dry weight % of the fresh egg weight	11.83 ± 00.74	06.00 ± 00.51	17.37 ± 01.72

* Carried out on 9 fresh eggs randomly selected from the first year lay

EGG CHEMICAL VALUES

Table 4 shows average percentage chemical values on a dry matter basis of the breeding ostrich eggs. The shell had the highest (99.50%) dryness, ash (92.50%) and lowest (2.05%) nitrogen-free extract. The highest crude protein (23.00%) and ether extract (18.90%) was in the yolk. The shell contained the highest macro and micro minerals cited, except for potassium, which was higher (4.40%) in the yolk.

DISCUSSION

Ostriches from various areas appear to have a characteristic average egg shape and size. This may be attributed to variations in body dimensions of the bird. Egg size is highly correlated with body size. The largest eggs measured were from the Massi *S. c. massaicus* ostrich, while the smallest were from the arid zones of the west coast of South Africa (Shanawany and Dingle, 1999).

The Haugh unit value cited in this study was 78.58 + 5.19. No values were found in the literature for comparison. This value is indicative of the egg quality and here there is no striking difference from the

Component	Percentage		
	Albumen	Yolk	Shell
Dry matter	94.80	98.51	99.50
Crude protein	19.50	23.00	04.95
Ether extract	16.50	18.90	00.00
Nitrogen-free extract	52.86	52.35	02.05
Ash	05.95	04.26	92.50
Sodium	00.65	00.75	00.85
Potassium	01.50	04.40	02.75
Calcium (mg%)	08.65	08.55	15.20
Phosphorous (mg%)	01.05	01.04	02.40
Ferrous (mg%)	26.00	32.00	69.50
Copper (mg%)	00.35	00.35	00.65

* Carried out on 3 fresh eggs randomly selected from the first year lay

Table 4. Average percentage chemical values (dry matter basis) of breeding ostrich eggs*

chicken egg Haugh unit values (i.e. weight dependant). The colour intensity of yolk probably develops as with the chicken, depending on dietary β-carotenes.

Treatment effect in shell thickness was significant with mean values of shell thickness to the side being less than the top thickness, whereas the end of the shell was the thickest (02.00 $\pm$ 00.07 mm). The mean shell thickness was (1.93 mm), which was closely similar to the value cited by Bowsher (1992) at 1.91 mm, and Brand *et al.* (1998) at 1.90 mm, but lower than the findings of Deeming (1996d) who mentioned that the ostrich egg is some 2 mm in thickness. Romanoff and Romanoff (1949) said that shell thickness varies among different avian species: 00.31 mm in the chicken; 00.31 mm in the Quail, 0.41 mm in the turkey and 4.41 mm in the ostrich, which is very thick.

Dimeo *et al.* (2003) found an average egg shell thickness value of 2.20 mm at the equatorial and 2.24 mm at the end. This was greater than the average shell thickness in this study, but nearer to the end of shell thickness (2.14$\pm$ 00.11 mm). Shell thickness to the side (at the chick pipping area) showed the least thickness.

Average percentage chemical values on a dry matter basis of the ostrich egg showed the shell to have the highest dry matter (99.5%), highest ash (92.5%) and lowest protein and nitrogen-free extract. The shell contained the highest macro (Na, K and Ca) and micro (P, Fe and Cu) minerals cited except for potassium, which was higher (4.40%) in the yolk. The highest crude protein (23.00%) and ether extract (18.90%) was in the yolk, which was greater than those found in the albumen, a situation similar to the hen's egg. In the genetic adaptation of the ostrich to desert or arid habitats, higher amounts of protein and ether extracts are stored for the hatchling chick. Dimeo *et al.* (2003), Deeming (1993), Deeming (1996d) and Carey *et al.* (1980) compared the hen's egg with the ostrich egg and found them to be of a similar chemical and nutritive value, but unlike poultry, the fatty acid profile of the ostrich yolk is not a mere reflection of the dietary fatty acids (Harigis *et al.*, 1991; Nash *et al.*, 1995; and Halle, 2000).

The egg is an important source of protein, fat and minerals and provides a well-balanced source of nutrients for people of all ages. Albumin is a protein of an excellent quality with high biological value that is often used as a standard or reference for evaluating the quality of other food proteins. The egg supports chick embryonic growth and development until hatching. The albumin completes the development of the embryo until becoming exhausted at hatching. Yolk is the storage material for the future growth of the hatching chick. Yolk represents one third of the hatching chick weight (Kreibich and Sommer, 1995), a fact that underlines the importance of yolk in the second term of development and the first two weeks of the independent chick's life. The yolk dry matter weight (180.33 ± 42.87) was twice that of the albumen (93.55 ± 27.76), whereas this relation nearly inverts (394.17: 843.33) on a fresh matter basis.

Our findings with the red-necked ostrich water percentage of the fresh egg components (yolk 54.61 + 06.28, albumen 86.74 + 04.86 and shell 18.34 + 05.29) compare fairly well with those of Ar and Rahn (1980) for values in the eggs from both altricial and precocial species in the water content of yolk 42-65% (average 53.5%) and albumen 85-95% (average 90%). Panda (1980) also found that the component percentage of albumen and yolk water content was 88.4 and 55% respectively in the chicken egg, which indicates that there are no differences between chicken and ostrich eggs in the percentage of water content. Egg shell water content in all avian species is small in amount, implying structural hardness with high dry matter and ash (99.5% and 92.5% respectively). Our findings for the fresh egg components weight percentage of the egg weight concur well with those of Dimeo *et al.* (2003) for the three principal egg components yolk (23.3%), albumen (57.1%) and shell (19.6%) respectively. Values for the three components (31, 58 and 11%) respectively in the chicken were also similar to the ostrich (Panda, 1995). Conversely, our findings on the dry egg components weight % of the egg weight support those of Reiner *et al.* (1995), who found that the African black ostrich egg has a higher proportion of shell and a lower proportion of both albumen and yolk, with no differences between the two subspecies.

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