INFLUENCE OF OVIPOSITION TIME ON SOME FUNCTIONAL PROPERTIES OF EGG SHELL OF THE DOMESTIC FOWL KEPT IN WARM HUMID TROPICS

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Received 28 June, 1994; Accepted 28 August, 1994.

ABSTRACT

Investigations on the influence of oviposition time on the functional properties of egg shell of the domestic fowl were conducted. The eggs used for the study were laid by commercial Lohmann pullets - a temperate hybrid. The laying birds were managed singly in battery cages, fed a layer's diet of about 17% crude protein and supplied water. The results showed the mean shell thickness was 0.31, 0.33, 0.34 and 0.35 mm for eggs laid between 0600 - 0900, 0900 - 1200, 1200 - 1500 and 1500 - 1800 hours, respectively. Shell conductance was 11.93, 11.67, 11.72 and 11.33 mg day⁻¹ torr⁻¹, respectively. The respective moisture losses were 3.80, 3.75, 3.80, 3.72 mg cm⁻² for 0600 - 0900, 0900 - 1200, 1200 - 1500 and 1500 - 1800 hours, respectively. In the same order, the pore counts were 15,096, 15,280, 14,668 and 14,927 egg⁻¹ while the respective pore diameters were 21.76, 21.17, 22.35 and 23.49 μ at the different oviposition times. Significant differences ($P < 0.05$) were observed at the different oviposition times in these shell properties except for shell conductance and moisture loss. Shell conductance and moisture loss were found to be highly correlated ($P < 0.01$). Eggs laid between 1500 - 1800 hours appeared to exhibit better shell functional properties.

Key Words: Oviposition, shell thickness, Pore area, Shell conductance

INTRODUCTION

There have been reports that variations exist in some shell properties due to time of oviposition. Investigations by Roland *et al* (1973), Roland and Harms (1974) and Roland *et al* (1977) all confirmed variations in egg weight, specific gravity of eggs, shell weight and shell thickness at different times of

oviposition. However, not much has been reported on the effect of oviposition time on such egg shell characteristics as shell conductance, moisture loss, pore count, pore area and pore diameter. These shell characteristics together with shell thickness constitute the functional properties of the egg shell as they play vital roles during the early embryonic stage of the avian species with regard to respiration. It is expected, however, that these egg shell characteristics remain vital for successful development of the avian embryo irrespective of oviposition time.

The aim of this study, was to evaluate the extent of variation in these functional characteristics as a result of oviposition time of the domestic fowl kept in warm humid tropics.

MATERIALS AND METHODS

320 eggs selected from eggs laid by 135 commercial Lohmann pullets were used for the study. Eggs were collected at different times of oviposition divided into 0600 - 0900, 0900 - 1200, 1200 - 1500 and 1500 - 1800 hours designated as periods 1, 2, 3 and 4, respectively. Periods 1 and 2 fell within the morning hours while periods 3 and 4 fell within the afternoon hours. 80 eggs were randomly selected and analysed at each period making a total of 320 eggs from all the periods during the one year of study. The experimental eggs were analysed within 24 hours of egg collection. During the period of study, birds were fed commercial feed containing about 17% crude protein, 6.20% crude fibre, 4.5% ether extract, 14.55% ash, 10.45% moisture, 47.23% NFE, 3.16% calcium and 0.56% phosphorus.

Shell thickness was determined using a micrometer screw gauge (Ames Series 25 M).

Two random pieces of shell samples broken from each zone of the egg (broad, equatorial and narrow ends) were used for determining shell thickness. The mean of these randomly selected samples were calculated for the shell thickness. Shell conductance and moisture loss were determined by adapting the methods of Rahn *et al* (1981). Pore area was calculated using the methods of Rahn *et al* (1976). Pore count was determined using the microscope. Before counting the pores the following procedures were adopted:

The removal of shell membrane was as outlined by Britton and Hale (1977). The shell was then etched in concentrated nitric acid (HNO₃) for about 10 seconds, washed thoroughly in cold water to stop further action of the acid and to make the pores visible on the microscope. The shell samples were reduced to an area of 0.25 cm² using a ruler to measure out the length and width. Two random samples of 0.25 cm² were taken from each zone of the egg for counting the pores with the microscope. The total pore count for an egg was calculated by dividing the mean pore count of the samples by 0.25 cm² and then multiplying the results by the surface area of the egg. Pore diameter was determined

while counting the pores using calibrated eye piece-micrometer.

Analysis of variance, correlation, regression and means were calculated by the methods of Snedecor and Cochran (1973).

RESULTS

The mean characteristics of the functional properties of the shell at the different oviposition times are shown in Table 1.

Thus shell thickness of 0.35 ± 0.004 mm obtained in period 4 was significantly higher than the shell thickness recorded in periods 1, 2 and 3 ($P < 0.05$). There were no significant differences in shell conductance and moisture loss during the different oviposition times. Eggs laid during the morning hours had significantly smaller pore area and pore diameter than those laid during the afternoon hours. The relationship between shell thickness versus shell conductance and shell thickness versus moisture loss are graphically represented in Figures 1 and 2, respectively. The regression of shell conductance on moisture loss is shown by the equation;

$$Y = 0.27 + 3.03x$$

where Y is shell conductance, X is moisture loss. The equation $Y = 0.38 + 2.01 X$ shows

Table 1: FUNCTIONAL PROPERTIES OF THE EGG SHELL AT THE DIFFERENT OVIPOSITION TIMES.

Shell functional Properties	OVIPOSITION TIME (PERIODS)			
	1	2	3	4
Shell thickness (mm)	0.31 ± 0.004^a	0.33 ± 0.003^b	0.34 ± 0.005^b	0.35 ± 0.004^c
Shell conductance (mg day ⁻¹ torr ⁻¹)	11.93 ± 0.340	11.67 ± 0.410	11.72 ± 0.400	11.63 ± 0.370
Moisture loss (mg cm ⁻² day ⁻¹)	3.80 ± 0.120	3.75 ± 0.130	3.80 ± 0.130	3.72 ± 0.110
Pore count (egg ⁻¹)	15096 ± 471.320^b	15280 ± 486.270^b	14668 ± 461.540^a	14927 ± 441.830^a
Pore area (mm ²)	1.65 ± 0.044^a	1.65 ± 0.036^a	1.72 ± 0.043^b	1.73 ± 0.050^b
Pore diameter (μ)	21.76 ± 0.900^a	21.17 ± 0.780^a	22.35 ± 0.790^b	23.40 ± 0.900^b

Table 2: CORRELATION BETWEEN SHELL FUNCTIONAL PROPERTIES.

	ML	ST	SC	PA	PD	PC
ML	-					
ST		-0.42 **				
SC			0.97 **			
PA			-0.43 **			
PD				0.75 **		
PC				0.02	0.08	
				0.80 **	0.11 *	0.08
					0.09	0.02
					0.14 **	0.10
						0.14 **
						0.19 **

Key: ML = Moisture loss; ST = Shell thickness; SC = Shell conductance; PA = Pore area; PD = Pore diameter; PC = Pore count.
 = 320; r = 0.11; P < 0.05; r = 0.14, P < 0.01.

Fig.1: Relationship between egg shell conductance and egg shell thickness

Fig.2: Relationship between egg moisture loss and egg shell thickness

the regression of moisture loss on pore area, where Y is moisture loss and X is pore area. The correlation between the shell functional properties is presented in Table 2.

Shell conductance (mg/day/torr)

Shell thickness (mm)

DISCUSSION

Normal eggs usually perform certain functions towards the development of the avian embryo. Some of these functions are made possible only through the integration of the functional properties of the egg shell. The significant variations in shell thickness observed during the different oviposition times are in agreement with the finding of Roland *et al* (1977) which also reported that eggs laid between 0800 - 1100 hours have lower shell thickness than those laid between 1400 - 1700 hours. It also confirms the reports of Arafa *et al* (1982) that egg shell thickness increases for eggs laid after 1200 hours. Shell conductance and moisture loss were observed to show no significant differences during the different oviposition times. It was found that shell conductance and moisture loss were negatively correlated with shell thickness and positively correlated with pore area. This corroborates the reports of Ar *et al* (1974) that shell conductance is directly proportional to pore area and inversely proportional to shell thickness. The reports of Christensen *et al* (1982) that increase in pore diameter led to increase in shell conductance was not observed in this study. Instead, it was found that pore diameter and shell conductance have no significant correlation. It was observed that there were no significant differences in pore count, pore area and pore diameter between eggs laid during two periods of morning hours. Similar observations were made on eggs laid during two periods of the evening hours. However, there were significant differences between the morning and evening periods in these shell properties.

Generally eggs laid during the evening hours appeared to have better shell functional properties than those laid during the morning hours. This could be explained by the fact that

evening eggs stayed longer in the shell gland for greater part of the photoperiod. Roland *et al*. (1977) suggested that the relationship between oviposition time and shell quality could be as a result of variation in the rate of shell calcification throughout the 24-hour period. However, there could be other unknown factors in the relationship between oviposition time and shell functional characteristics.

ACKNOWLEDGEMENT

I acknowledge the help rendered by Mr. M. Duru and Mr. I.N., Ntuen the laboratory technologists of the Departments of Animal Science and Soil Science respectively, University of Nigeria, Nsukka. I also express our sincere gratitude to Rev. Mother Chilota Elochukwu, The Mother General of the Daughters of Divine Love Congregation for her encouragement and financial support during the study period.

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