ISSN 1682-8356
ansinet.org/ijps

INTERNATIONAL JOURNAL OF

POULTRY SCIENCE

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

International Journal of Poultry Science 15 (5): 188-191, 2016
ISSN 1682-8356

Impact of Egg Shape on Hatchability in Pekin Ducks

Zachary S. Lowman[1,2], Carmen R. Parkhurst[1] and McCaide T. Wooten[1]
[1]Prestage Department of Poultry Science, North Carolina State University, Raleigh, NC, 27606, USA
[2]Joe Jurgielewicz and Son, Ltd. Hamburg, PA, 19554, USA

Abstract: Hatchability and duckling quality are of the utmost importance for commercial hatcheries. Many factors can affect hatchability and quality of the newly hatched ducklings. The importance of egg shell quality has been studied extensively in both turkey and chickens, however very little research has been directed toward ducks. This trial explored the effect that the overall shape of a duck egg plays on the moisture loss, hatchability, shell thickness, and pore concentration of eggs.

Key words: Abnormal eggs, pekin duck, hatchability

INTRODUCTION

Optimal hatchability is the goal of all chicken and turkey hatcheries and duck hatcheries are no exception. Many factors can impact optimal hatchability; some of these factors are easier for the hatchery to control such as disinfection, temperature and humidity. However, many problems can occur long before the egg arrives to the hatchery, including, bacterial contamination, egg breakage and malformation.

The importance of egg shell quality has been studied in both turkey and chickens (Rahn *et al*., 1981; Brunson and Godfrey, 1953). However, very little research has focused on egg shell characteristics in ducks. It is well known that ducks have a great affinity for water (Rodenburg *et al*., 2005). The natural attraction to water results in duck eggs being dirtier than typical commercial poultry eggs. Since duck eggs are prone to being dirty, shell quality is of great importance to prevent bacteria from entering yet maintaining optimal gas and moisture exchange.

There are studies in turkeys (Brunson and Godfrey, 1953) and chickens (Landauer, 1951) that examine the effect that egg shape has on the hatchability of the egg. These reports noted little to no difference in the hatchability of abnormally shaped eggs compared to normal eggs, excluding grossly misshapen eggs that are very long and narrow, or very short and round. These grossly abnormal eggs have been reported to have poor hatch rates. Brunson and Godfrey (1953) reported no differences in hatchability between abnormal and normal eggs, but found egg weight to be correlated with hatchability in turkey eggs.

Egg shell quality is an important factor to the poultry industry, there are countless losses due to poor shell quality including increased numbers of eggs cracked in the nesting box, eggs cracked during shipment and increased bacterial penetration (Sauter and Petersen, 1974). Several factors can influence shell quality: flock age (Peebles and Brake, 1987), diet and genetics (Christensen and McCorkle, 1982). A balance between pore concentration and shell thickness must be achieved to achieve optimal hatchability (Soliman *et al*., 1994). The relationship between shell thickness and pore concentration is likely to influence respiration across the shell for the developing embryo (Rahn *et al*., 1979). Shell thickness has been shown to greatly influence hatch rates, younger flocks tend to have thicker shells that gradually thin as the flock ages (Peebles and Brake, 1987; Roland, 1976). Eggs with thin shells typically have decreased hatch rates (Godfrey and Jaap, 1949) increased moisture loss (Christensen, 1983) and increased shell malformation (Britton, 1977). Shell thickness can be equated to pore length (Brake, 1988) and changes in pore length have been shown to significantly change gas diffusion (Wagensteen and Rahn, 1970). Peebles and Brake (1985) demonstrated that increased pore length or shell thickness and decreased pore concentration is associated with embryonic mortality. In addition, eggs with thicker shells have been shown to be more resistant to salmonella contamination than eggs with thinner shells (Sauter and Petersen, 1974). Thicker shelled eggs have also been reported to be more resistant to penetration by Pseudomonas (Sauter and Petersen, 1969).

For respiration, the shell must be permeable to gases and moisture in order for the developing embryo to maintain homeostasis (Christensen, 1983; Rahn, 1981). Conductance is the measurement of gas exchange in the egg and is dependent on several factors including pore length and concentration as well as humidity in the incubator (Rahn, 1981; Paganelli, 1980). The conductance of an egg is considered a significant indicator of shell quality (Rahn *et al*., 1979).

MATERIALS AND METHODS

For this trial 2,304 Pekin duck eggs were collected from a 41 week old breeder flock. All eggs were collected on the same day. All eggs were washed using a warm 400

Corresponding Author: Zachary S. Lowman, Prestage Department of Poultry Science, North Carolina State University, Raleigh, NC, 27606, USA

ppm chlorine rinse, allowed to dry for 30 min, then sorted by the hatchery staff. Eggs were sorted in to two groups based solely on shape (8 trays of 144 eggs per group, for a total of 1152 eggs per group). The eggs were classified as either normal or abnormal. Abnormal meaning slightly more round or pointed than desired (Fig. 1). Eggs that were grossly misshapen, visibly cracked, or with obvious shell deformities were discarded (soft shell, wrinkled, body checks, slab sided etc.). Each tray of eggs was weighed prior to incubation and were weighed again at 10 days of incubation. All eggs were placed in the same Natureform S-14 incubator (Natureform Hatchery Systems, Jacksonville, FL) at candling eggs that were black (contaminated) or infertile were counted and removed. A sample of the black and infertile eggs from each tray was saved for further analysis. The eggs were transfer to a Natureform H-14 hatcher (Natureform Hatchery Systems, Jacksonsville, FL) on day 24. At hatch all ducklings and unhatched eggs were counted and recorded.

Pore concentration and shell thickness: Eggs collected at candling were carefully broken in half. The contents of the eggs were emptied and the shell was rinsed with tap water. The shells were allowed to dry for 24 h. Shell thickness was measured using a caliper to (.01 mm) in 4 different locations at the large end of the egg, measurements were averaged for analysis. The pores of the eggs were stained so that they were visible, following the procedures of Peebles and Brake (1985). Briefly, the eggs were filled with a solution consisting of 70% ethanol and 0.5 g of methylene blue. The stain was allowed to sit in the eggs for 30 min, then the solution was emptied and the eggs were allowed to dry for 24 h. Then three equally spaced squares (0.25 cm^2) were drawn on the outside surface of the shells. The pores were then counted and the three numbers averaged for each egg.

Data analysis: All data was analyzed with the JMP 10 program (SAS Institute, Cary, NC) utilizing one-way ANOVA, comparisons were made with Tukey HSD comparisons and Student's t test.

RESULTS AND DISCUSSION

Shell quality plays an important role in the protection of the egg. Bacteria can easily penetrate the shell of an egg when there is moisture present, due to the porosity and "breathing" of the egg (Berrang *et al*., 1999). Previous reports suggest the actual thickness of the shell does not prevent bacterial contamination, that the plugging of the cuticle plays more of a protective role than actual shell thickness (Williams *et al*., 1968). No significant differences were found between egg shape and infertility or the percentage of black eggs found at candling (Table 1). There was a significant difference observed in the number of black eggs at transfer (24 d) ($p<0.0063$). The abnormal eggs had a slightly higher average number of black eggs than did the control group (Table 1). No significant difference was observed in shell thickness, nor pore count between the contaminated, infertile and

Table 1: Mean infertile and black eggs at candling and transfer

Treatment	# Infertile	# Black	Black (%)	# black at transfer	n
Control	5.75	1.63	1.13	0^{B}	8
Abnormal	7	2	1.39	1.12^{A}	8

^{A,B}Denotes significant differences within columns at $p\leq0.05$. Lack of superscript denotes no significant difference

Table 2: Mean shell Thickness (mm) and pore count

	Pore count	SE	Shell thickness	SE	n
Control (Contaminated eggs)	24.67	5.28	0.436	0.01	10
Abnormal (Contaminated eggs)	23.78	6.81	0.447	0.01	6
Control (Early dead)	29.2	3.31	0.441	0.01	18
Abnormal (Early dead)	28.2	4.43	0.464	0.009	10
Control (Infertile)	30.57	3.13	0.444	0.01	21
Abnormal (Infertile)	23.37	2.99	0.469	0.01	23

^{A,B}Denotes significant differences within columns at $p\leq0.05$. Lack of superscript denotes no significant difference

Table 3: Average egg weight loss by treatment (per tray)

Treatment	(g)	SE	%	SE	n
Control	1266.63^{B}	118.8	10.45^{B}	0.17	8
Abnormal	1358.13^{A}	118.8	11.21^{A}	0.17	8

^{A,B}Denotes significant differences within columns at $p\leq0.05$. Lack of superscript denotes no significant difference

Table 4: Mean hatch percentage and number of ducklings by tray

Treatment	# hatched	% hatched of set	% fertile hatch	% Cull	n
Control	127.1^{A}	88.28^{A}	93.0^{A}	0.009	8
Abnormal	119.87^{B}	83.25^{B}	88.8^{B}	0.003	8

^{A,B}Denotes significant differences within columns at $p\leq0.05$. Lack of superscript denotes no significant difference

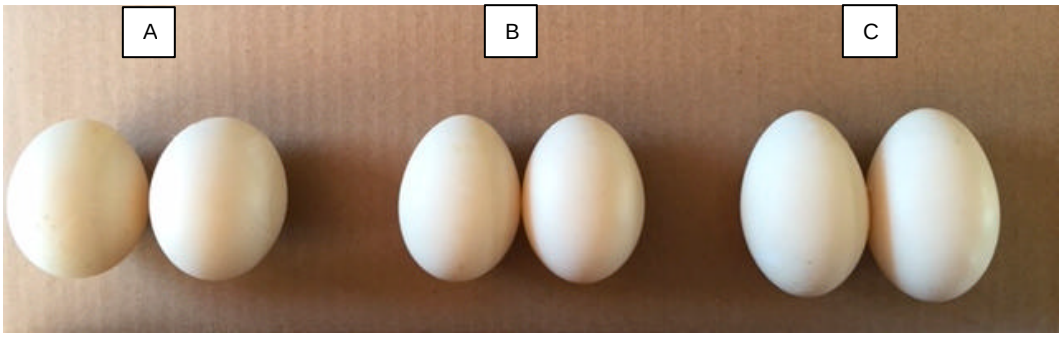

Fig. 1: Classification of eggs used for comparison. (A) Abnormal eggs (Round), (B) Normal (Control) and (C) Abnormal eggs (Long/Pointed)

early dead eggs from either group (Table 2). Significant differences ($p<0.006$) were observed in the percent moisture loss and actual moisture loss ($p<0.011$) with the abnormal eggs losing more moisture than the control eggs (Table 3). Significant differences ($p<0.0073$) were also observed in the average number of ducklings hatched by group. The control group hatched on average 7.23 more ducklings per tray than did the abnormal group. Similar results were observed in % hatched ($p<0.0073$) with a 5.03% difference in hatch rate between groups, as well as % fertile hatch ($p<0.0098$) having a 4.2% difference in hatch rate between the control and abnormal groups (Table 4). These data differ from similar experiments in turkeys (Brunson and Godfrey, 1953; Byerly and Marsden, 1938) and in chickens (Landauer, 1951). These trials all reported that the egg shape has little if any effect on the hatchability, weight loss, or specific gravity of the egg. Additionally, there was no difference observed in 7 d bird weights between ducklings hatched from abnormal or control eggs (data not listed).

There are numerous reasons why differences were observed in this trial than previous trials in other species. The main reason could be our selection criteria for the eggs, Brunson and Godfrey (1953) did note that very long narrow and very short round eggs do show decreased hatchability, compared to normal eggs. The eggs selected for this trial could have been more "abnormally" shaped than eggs used in previous trials. A second factor that could contribute to the difference in previous data in chickens and turkeys could be how duck eggs are cleaned. These eggs were washed in a chlorine solution and since chlorine removes the cuticle of eggs and can cause changes in moisture loss and gas exchange.

REFERENCES

Berrang, M.E., N.A. Cox, J.F. Frank and R.J. Buhr, 1999. Bacterial penetration of the eggshell and shell membranes of the chicken hatching egg: A Review. J. Appl. Poult. Res., 8: 499-504.

Brake, J., 1988. Relationship of time of feeding and strain to egg shell quality and hatchability in broiler breeders. Poult. Sci. 67: 538-543.

Britton, W.M., 1977. Shell membranes of eggs differing in shell quality from young and old hens. Poult. Sci. 56: 647-653.

Brunson, C.C. and G.F. Godfrey, 1953. The relationship of egg shape, egg weight, specific gravity and 21-day incubation weight-loss to hatchability of broad-breasted bronze Turkey eggs. Poult. Sci., 32: 846-849.

Byerly, T.C. and S.J. Marsden, 1938. Weight and hatchability of turkey eggs. Poult. Sci., 17: 298-300.

Christensen, V.L. and F.M. McCorkle, 1982. Turkey egg weight losses and embryonic mortality during incubation. Poult. Sci., 61: 1209-1213.

Christensen, V.L., 1983. Distribution of pores on hatching and non-hatching turkey eggs. Poult. Sci., 62: 1312-1316.

Godfrey, G.F. and R.G. Jaap. 1949. The relationship of specific gravity, 14-day incubation weight loss and eggshell color to hatchability and eggshell quality. Poult. Sci., 28: 874-889.

Landauer, W., 1951. The hatchability of chicken eggs as influenced by environment and heredity. Storrs (Connecticut) Agric. Exp. Sta. Bull., 449.

Paganelli, C.V., 1980. They physics of gas exchange across the avian eggshell. Am. Zool., 20: 329-338.

Peebles, E.D. and J. Brake, 1985. Relationship of eggshell porosity to stage of embryonic development in broiler breeders. Poult. Sci., 64: 2388-2391.

Peebles, E.D. and J. Brake, 1987. Eggshell quality and hatchability in broiler breeder eggs. Poult. Sci., 66: 596-604.

Rahn, H., A. Ar and C.V. Paganelli, 1979. How bird eggs breathe. Sci. Am., 240: 46-55.

Rahn, H., 1981. Gas exchange of avian eggs with special reference to Turkey eggs. Poult. Sci., 60: 1971-1980.

Rahn, H., V.L. Christensen and F.W. Edens, 1981. Changes in shell conductance, pores and physical dimensions of egg and shell during the first breeding cycle of Turkey hens. Poult. Sci., 60: 2536-2541.

Rodenburg, T.B., M.B.M. Bracke, J. Berk, J. Cooper, J.M. Faure, D. Guemene, G. Guy, A. Harlander, T. Jones, U. Knierim, K. Kuhnt, H. Pingel, K. Reiter, J. Serviere and M.A.W. Ruis, 2005. Welfare of Ducks in European duck husbandry systems. Worlds Poult. Sci., 61: 633-646.

Roland, D.A., Sr., 1976. Recent developments in eggshell quality. Feedstuffs, 48: 31-32.

Sauter, E.A. and C.F. Petersen, 1969. The effect of egg shell quality on penetration by *Pseudomonas fluorescens*. Poult. Sci., 48: 1525-1528.

Sauter, E.A. and C.F. Petersen, 1974. The Effect of egg shell quality on penetration by various Salmonellae. Poult. Sci., 53: 2159-2162.

Soliman, F.N.K., R.E. Rizk and J. Brake, 1994. Relationship between shell porosity, shell thickness, egg weight loss and embryonic development in Japanese quail eggs. Poult. Sci., 73: 1607-1611.

Wagensteen, D. and H. Rahn, 1970. Respiratory gas exchange by the avian embryo. Respir. Physiol., 11: 31-45.

Williams, J.E., L.H. Dillard and G.O. Hall, 1968. The Penetration patterns of Salmonella typhimurium through the outer structures of chicken eggs. Avian Dis., 12: 445-466.