JIVS Journal of Istanbul Veterinary Sciences

The effect of egg shape index on pore number and hatching performance in Sussex hens

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Research Article

Volume: 7, Issue: 3
December 2023
Pages: 148-153

ABSTRACT

This study was carried out to investigate the effect of egg shape index on pore number and hatching performance in Sussex chickens. The material of the study consisted of 63 eggs obtained from the Sussexbreed chicken flock of a private enterprise engaged in chicken rearing in Konya. Eggs were divided into two groups as below 75 (Group-1, 75<) and above (Group-2, ≥75) according to their shape index values. Some egg external quality characteristics, regional pore numbers as well as chick weight values of the experimental groups were examined Shape index, egg width, number of pores at the equator end up, number of pores at the pointed end up and chick weight were significant (p<0.01), but egg length and number of pores at the blunt end up were similar (p>0.05). As a result, the obtained data showed that the shape index had an effect on the external egg quality and chick weight along with the number of pores in the eggs in Sussex chickens.

Article History

Received: 19.10.2023
Accepted: 29.12.2023
Available online: 31.12.2023

Keywords: chick weight, chicken, external egg quality, regional

DOI: https://doi.org/10.30704/http-www-jivs-net.1378417

To cite this article: Arslan, E., Öztürk, R., Yonar, H., Kırıkçı, K., Arslan, E. (2023). The effect of egg shape index on pore number and hatching performance in Sussex hens. ***Journal of Istanbul Veterinary Sciences, 7*(3), 148-153.** **Abbreviated Title*:* J. İstanbul vet. sci.**

Introduction

Nowadays, there are more than 200 chicken breeds in the world, which are differentiated in terms of features such as color, shape, size and yield. Sussex chickens were developed in the first half of the 19th century as a subspecies of Dorking without five toes. They are an indispensable breed of European countries that demand white skin in their parent lines in broiler production, as they are white-skinned, well-developed and also can inherit these characteristics. It is still used as a broiler line in the production of white-skinned broiler chickens (Sarıca, 2014, Dere and Guler 2022).

Poultry species provide the continuity of their generation with eggs. In addition to albumin and egg yolk, which provide nutrients to the embryos during incubation, the egg shell, which protects its weight values against external environments and is responsible for gas exchange, constitutes the three main elements of an egg (Hincke et al., 2012, Nangsuay et al., 2015). In poultry species, genotype (Tůmová et al., 2009, Lewko et al., 2021; Krawczyk et al., 2023; Tadele et al., 2023), rearing conditions (Tůmová et al., 2011), nutrition (Pérez-Bonilla et al., 2011), age (Akyurek and Okur, 2009; Zita et al., 2013; Chung and Lee, 2014; Park and Sohn, 2018) and storage (Tilki and Saatci, 2004; Demirel and Kırıkçı, 2009; Günhan and Kırıkçı, 2017; Nasri et al., 2020; Çam et al., 2022) affect the external quality of eggs.

The quality of egg shells and egg quality is determined by both genetic and environmental factors related to genotype, rearing system, parent stock age, nutrition, health, and physiological state, cage and room temperature storage of eggs (Jones and Musgrove, 2005, Banaszewska et al., 2019, Eleroğlu, 2021, Wengerska et al., 2023). The pores on the eggs; Although their number varies depending on the species, the regional (pointed, equatorial, and blunt)

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localization on the egg differs numerically (Rokitka and Rahn, 1987). Alasahan et al., (2019) reported that the egg shell contains approximately 10.000 pores, depending on the species. These pores provide gas and water exchange to the development of the chick embryo during incubation (Eddin et al., 2019).

Pores are also effective not only in gas exchange during incubation, but also in water and weight loss of the stored egg (Ar et al., 1974; Peebles and Brake, 1987).Internal and external variables can have an impa ct on the growth and development of embryos (Tong et al., 2013; van der Wagt et al., 2020).
Hatched eggs had more pores than the late embryonic death and pip groups, according to Peebles and Brake (1985), who also noted that insufficient pores may be th e cause of embryonic deaths (Peebles and Brake, 1985).

To maintain a normal overall diffusive water loss, eco logical and taxonomic heterogeneity may modify some of the linkages expected for the 'average' egg (Amos and Rahn, 1985).

The development of the embryo is associated with egg quality characteristics and the number of pores. For this reason, it is stated by Narushin & Romanov (2002) that eggs with an average egg quality value (egg weight etc.) are more suitable for hatching. One of the important egg quality characteristics affecting hatching performance is the shape index (Narushin and Romanov, 2007).

Shell structure, which is a feature that affects egg quality and hatching performance, correlates with embryonic deaths in hatching. The aim of this study was to determine the relationship of shape index with pore number and embryonic mortality in Sussex chicken eggs.

Materials and Methods

Animal materials

The material of this study consisted of 63 eggs obtained from the Sussex breed chicken flock of a private enterprise engaged in chicken breeding in Konya.

Experimental design

The Sussex eggs obtained from the brood flocks were collected daily and stored at 14 oC temperature and 70% humidity conditions for seven days. These eggs were divided into two groups as 35 eggs below 75 (Group-1, 75<) and 28 eggs above (Group-2, ≥75) according to their shape index values. The shape index of the eggs was calculated with the formula (Egg Width / Egg Length) x 100.

The eggs in the two groups were incubated at 37.7°C and 60% humidity in the incubator, and 37.6°C and 75% humidity in the hatching machine. The live weights of the hatched chicks were determined by weighing them with a digital scale (KERNPFB 100) with a precision of 0.01 g.

Determining the number of hatching performance
Egg fertilization and embryonic death of chick hatching were determined according to the method reported by Hamburger and Hamilton (1990).
Fertility rate (%) = (number of fertile eggs / number of set eggs) x 100

Hatchability of fertile eggs rate (%) = (number of hatched chicks / number of fertile eggs) x 100
Hatchability rate (%) = (number of hatched chicks / number of set eggs) x 100 Determining the number of pores

Peebles and Brake (1985) method was used to determine the number of pores in eggs with and without hatching. Eggs that were broken during pore counting or that did not have a clear image in pores were not evaluated.

The solution prepared with 89% 0.5 g of methylene blue in 1 liter of 70% ethanol was stained by the method of Board and Halls (1973).
Pores were counted with a dissection microscope by marking areas of 0.25 cm^2 from the blunt, equatorial, and pointed ends of each egg.

Egg pore counts of three regions were stained according to the same method, and photographed under the microscope, and the pore counts obtained from the counts were recorded in the Microsoft Excel program.

Statistical analysis

In the study, Kolmogorov-Smirnov and Shapiro-Wilk tests were used to examine the normality of quantitative variables. Comparison of the means of two groups, where the assumption of normality was met, was made with the Independent t test. In examining the correlations between variables, Pearson correlation coefficient was used. IBM SPSS Statistics 29.0 package program was used in statistical analysis and $p<0.05$ value was considered statistically significant.

Results

Some egg external quality characteristics and regional pore number, and chick weights according to egg shape were presented in Table 1.

Shape index values of Group-1 and Group-2 were measured 73.99 and 77.17 respectively ($p<0.001$). The traits of eggs in poultry have important indications as to which eggs were chosen for hatching. Egg length and egg width values was calculated as 55.85-41.28 and 56.59-43.61, respectively (Table 1). In this study, the number of pores in the experimental groups was

Table 1. Some egg external quality characteristics and regional pore number, and chick weights according to egg shape index on Sussex eggs.

Variables		Group-1		Group-2		p values
		n	Mean ± SE	n	Mean ± SE	
Shape Index		35	73.99±0.44	28	77.17±0.70	0.000
Egg length		35	55.85±0.30	28	56.59±0.38	0.128
Egg width		35	41.28±0.11	28	43.61±0.24	0.000
Pore number	EEU	28	34.54±2.17	20	25.05±2.15	0.004
	BEU	28	29.32±2.16	20	27.30±2.43	0.541
	PEU	27	30.70±1.74	17	19.94±1.22	0.000
Chick weight		20	30.51±0.50	15	34.86±0.67	0.000

Group-1: SI<75, Group-2: SI>75. EEU: Equator end up, BEU: Blunt end up, PEU: Pointed end up.

calculated as 34.54-25.05, 29.32-27.30-30.70-19.94 per 0,25 cm^2 at the equator, blunt and pointed ends in group-1 and group-2, respectively. Shape index, egg width, chick weight ($p<0.01$), and pore number of EEU and PEU ($p<0.01$) were found significant. On the other hand, egg length and pore number of BEU were determined no significantly ($p>0.05$) (Table 1).

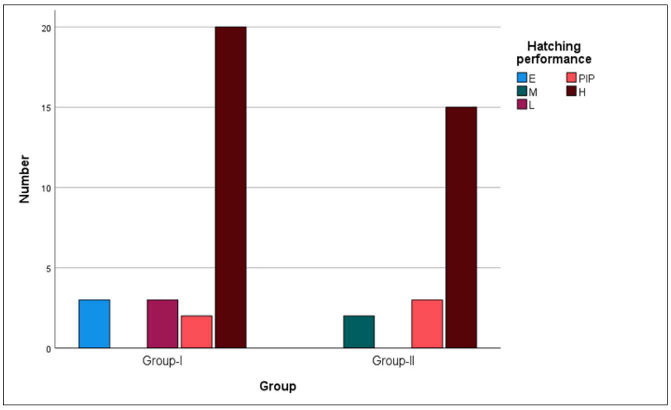

Figure 1. Hatching performance of different egg shape index in Sussex

Group-1: SI<75, Group-2: SI>75. E: Early embryonic mortality, M: Middle embryonic mortality, L: Late embryonic mortality, PIP: Pipped embryonic mortality, H: Hatching chicks.

Rate of fertility, hatchability and hatchability of fertile eggs in Sussex eggs were given in Table 2.

Table 2. Hatching performance of egg shape index groups in Sussex

	Fertility rate (%)	Hatchability of fertile eggs rate (%)	Hatchab iliy rate (%)
Group-I	80.00	71.43	57.14
Group-II	71.43	75.00	53.57
Pearson X^2	0.630	0.075	0.080
P value	0.427	0.784	0.777

Group-1: SI<75, Group-2: SI>75.

Fertility (%), hatchability of fertilized eggs (%), as well as hatchability of the shape index groups were found to be similar in Table 2.

Correlation of pore numbers in different regions of eggs were given in Table 3.

Table 3. Correlation of pore numbers in different regions of eggs

		Equator	Blunt	Point
Blunt	Pearson correlation	0.157	-	
	Sig. (2-tailed)	0.288	-	
	N	48		
Point	Pearson correlation	0.086	0.611**	-
	Sig. (2-tailed)	0.577	0.000	-
	N	44		

** Correlation is significant at the 0.01 level (2-tailed).

As seen in Table 3, it was determined that there was a significant correlation between the blunt and pointed ends of the egg ($p<0.01$).

Discussion

In this study, some egg quality characteristics, pore number and chick weight values belonging to different shape index groups were analyzed. Shape index, egg lenght, egg width, regional pore number, and chick weights were given in Table 1. The effect of egg shape index on chick weight was found to be significant. This finding is consistent with Kruenti et al. (2022), which reported that chick weight increases as egg size increases in Japanese quail.

The size of the egg yolk increases so that the old parent stock produce larger follicles. Accordingly, the size of the eggs increases with age. However, because the amount of calcium carbonate existing to form the shell remains the same, shells were examined against the growing eggs and eggs with a number of pores with a number of pore were obtained than the eggs of parent stock (Stringhini et al., 2011). According to Ancel and Girard (1992), the number of porosity is decreased from the end to pointed. This is explained as a biological condition with larger pore concentration at the wide end of the egg (Araújo et al., 2017).The average number of pores (32.5) reported in Sussex-66 line chickens by Lewko et al. (2021), who reported that different genotypes and age differences affect the number of pores in eggs, was found to be similar with the values obtained in this study. In a study examining the pore numbers of geese at different parent flock ages, it was reported that the number of pores in the blunt and equatorial regions was higher in the first year, while the total number of eggs reached the highest level in the fourth year (Kucharska-Gaca et al., 2023).

As seen as Table 1, the effect of the shape index on the equator and pointed end was significant ($p<0.01$), but the number of pores at the blunt end was found to be similar. Araújo et al., (2017), who reported that eggshell porosity showed a correlation of 0.870 with the weight of the hatched chicks, reported that the effect of age, eggshell region, and age*eggshell region on the pore number was significant ($p<0.01$). In addition, in the same study, they calculated the number of pores of eggs obtained from 29, 35, and 59-week-old broiler chickens as 125, 112, and 95 per cm2 at the blunt, equatorial, and pointed ends, respectively.

As a result, researchers (Meir and Ar, 2008; Stringhini et al., 2011; Kucharska-Gaca et al., 2023) argue that although the species are different, the number of egg pores generally varies regionally and increases with breeding age. The findings of this study, in which the effect of shape index on the number of pores was determined to be significant, are compatible with the information reported by Stringhini et al. (2011), who reported that larger eggs have a higher number of pores.

Shape index consists of the role of egg shape in the direction of turning during incubation and the determination of embryo movements for nutrient utilization (Hristakieva et al., 2017). The effect of egg shape index on hatching result evaluation parameters was not found to be statistically significant ($p>0.05$). Ascı and Durmus (2015) reported that the shape index should be between 72-76% for optimum hatching and breeding eggs, and that the shape index is a factor affecting hatching performance. In this study, it was determined that shape index did not affect hatching performance (Table 2). This finding was found to be different from the researchers who argued that egg size affects hatching and fertility rates in Koekoek chickens Molapo and Motselisi (2020) and who reported that it affects some hatching performance in Japanese quails (Khurshid et al., 2004; Alasahan and Copur, 2016; Gutiérrez et al., 2021). This may be due to genotype or age factors (Keskin et al., 2022).

Conclusion

As fertilized eggs obtained from Sussex chickens were examined, it was determined that different shape index groups had a significant effect on egg width and chick weight. The higher chick weight in the group with higher egg width can be considered as a factor affecting the shape index and chick weight. While no difference could be found in the blunt end in the shape index groups according to the number of pores, this difference occurred at a significant level ($p <0.01$) in the equator and pointed end.

The shape index value calculated based on the width and length values of the eggs showed a close relationship with the hatching performance. In this study, a high number of pores were determined in large eggs in terms of shape index. Thousands of pores on the egg prevent fluid loss during storage and incubation.

As a result, the obtained data showed that the shape index had an effect on the external egg quality and chick weight along with the number of pores in the eggs in Sussex chickens.

Authors' contributions

All authors contributed to the study conception and design. First draft writing and data collection: [EA], [RO]; general control and interpretation: [KK]; Formal and statistical analysis: [HY]; Material preparation and methodology: [EA] and [RO]; the methodology: [EA] and [KK]. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Ethics approval; This study was approved by the Animal Experiments Ethics Committee of Selçuk University Experimental Medicine Application and Research Center (SUVDAMEK) with reference number 2023/043 dated 27.04.2023.

Declarations: Consent to participate Not applicable. Consent to publish Not applicable. Code availability Not applicable.

Conflicts of interest: The authors declare that they have no competing interests.

Competing interests: The authors declare that they have no relevant financial or non-financial interests to disclose.

Funding: This research was no funded by any project, department or company.

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