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RESEARCH ARTICLE

Some Egg Quality Characteristics and Hatching Performances of Leghorn Hybrids

Hasan KESKİN[1*], Emre ARSLAN[2], Mustafa GARİP[2], Cahit ÖZCAN[3]

[1]*Provincial Directorate of Agriculture and Forestry, 42040, Konya, Türkiye*
[2]*Selçuk University, Faculty of Veterinary Medicine, Department of Animal Science, 42250, Konya, Türkiye*
[3]*Siirt University, Faculty of Veterinary Medicine, Department of Animal Nutrition and Nutritional Diseases, 56100, Siirt, Türkiye*

ABSTRACT

This study examined the hatchability performance of the offspring and some egg quality characteristics, which will be obtained from crossing Leghorn breed chickens and five different genotypes. The study's experiment was carried out in the Prof. Dr. Hümeyra Özgen Research and Application Farm in Selcuk University. In the present study, which was designed to have one male and twelve females belonging to each genotype, a total of 186 eggs from each flock were examined. No adverse results were found in the incubation results of the crosses made with our local breed Denizli and Araucana, Brahma, and Cornish breeds, whose breeders increased locally. When egg quality characteristics were examined, the difference in egg weight between F_1 genotypes was insignificant and ranged between 46.91-51.54 g on average. When the F2 generation was investigated, egg weight differed between genotype groups, and the average weights ranged between 57.6-67.14 g. In addition, the effect of genotype on egg shell strength values were found to be significant. In addition, the effect of genotype on egg shell strength and shell weight values were found to be significant. However, the effect on the Haugh Unit and yellow height were insignificant in the same generation. As a result, hybridizing genotypes with low yield performance with commercially important genotypes could provide a genotype for alternative production systems for future generations.

Keywords: Egg quality, genotype, hatching efficiency, hybridization, Leghorn.

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Leghorn Melezlerine Ait Bazı Yumurta Kalite Özellikleri Ve Kuluçka Performansları

ÖZ

Bu çalışma Leghorn ırkı tavuklar ile beş farklı genotipin melezlemesi sonucunda elde edilecek yavruların kuluçka performansı ve bazı yumurta kalite özelliklerini incelemek için yapılmıştır. Çalışmanın deneyi Selçuk Üniversitesi Prof. Dr. Hümeyra Özgen Çiftliğinde gerçekleştirildi. Her bir genotipe ait bir erkek yirmi dişi hayvan olacak şekilde planlanan çalışmada toplamda her sürüden 186 yumurta incelendi. Yerli ırkımız olan Denizli ve lokal olarak yetiştiriciği artan Aracuana, Brahma, Cornish ırkları ile yapılan birleştirmelerde kuluçka sonuçlarında olumsuzluk bulunmamıştır. Yumurta kalite özellikleri incelendiğinde ise F_1 genotipler arasında yumurta ağırlığı bakımından farkın önemsiz olduğu ve ortalama 46.91-51.54 g arasında değiştiği tespit edildi. F_2 kuşağı incelendiğinde ise yumurta ağırlığının genotip grupları arasında farklılık gösterdiği ve ağırlık ortalamalarının 57.6-67.14 g arasında değiştiği tespit edildi. Ayrıca aynı kuşakta genotipin kabuk mukavemeti ve kabuk ağırlığı değerlerine etkisi önemli, Haugh Unit ve sarı yüksekliğine etkisi ise önemsiz bulundu. Sonuç olarak, düşük verim performansına sahip genotiplerin ticari önemi olan genotiplerle melezlemeleri gelecek nesiller için alternatif üretim sistemlerine bir genotip kazandırılabileceği sonucuna varıldı.

Anahtar Kelimeler: Genotip, kuluçka randımanı, Leghorn, melezleme, yumurta kalitesi.

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ORCID ID; *HK: 0000-0001-7390-3444, EA: 0000-0002-4609-8395, MG: 0000-0002-1429-2724, CÖ: 0000-0002-1047-5347*

*Corresponding author e-mail: keskin.hasan@tarimorman.gov.tr

INTRODUCTION

Rapid population growth in the world has increased the need for animal products, and intensive system breeding has become widespread to meet this demand. Cracked, broken, defective, and unshelled eggs in poultry farms cause severe damage to the national economy. The rate of broken shells in the eggs produced varies between 6-20% (Çetin and Gürcan 2006). In addition to the shell defects, this situation may impair the quality characteristics of the egg in general. Egg quality, which is examined in two areas as internal and external quality characteristics, significantly affects hatchability. For the chickens we obtain from hatching eggs to have a high life force and achieve high hatching efficiency, the necessary hatching conditions must be provided, and the quality of hatching eggs must be high. External quality of the egg; egg weight, shell thickness, breaking strength, and shape index parameters determine the internal quality, white and yellow appearance, flesh-blood stain, Haugh Unit, and nutrient composition parameters. The optimum level of all these features is a good start for chick hatching. Any abnormality in the quality characteristics of the egg leads to the deterioration of the primary functions that will provide the best conditions for embryo development. Egg production at a level to meet the hatching requirements is not at the desired level despite the efforts of breeding establishments. The lack of chick hatching between 20-40% in chicken eggs indicates this situation. Studies have reported that some parameters in eggs cause embryonic mortality (Narushin and Ramanov 2002). It has been stated that the parameters that make up the egg quality characteristics have a more positive effect on the hatching yield rather than having very high or low values (Wolc and Olori 2009).

The hatching yield is usually 82-85%. It is impossible to interpret hatching results without knowing the problems that cause low hatchability. Moreover, there is a loss of 15-18% may be caused by egg storage conditions, bacterial and fungal contamination, eggshell quality, mechanical errors, feed used, diseases and genetic structure of animals, breeding flock, egg processing, and hatchery errors (Wilson 1991).

Hatching efficiency is an essential parameter for the continuity of production of generations in poultry. It can vary with the effect of factors such as the age of the breeder flock, health status, maintenance feeding procedure, transportation of hatching eggs, disinfection, storage conditions and duration, hatchery and incubation conditions (Burton and Tullett 1983, Peebles and Brake 1985, Peebles et al. 2001, Reis et al. 1997). incubation conditions in the hatchery practice and the shell characteristics of hatching eggs cause weight loss in eggs, which can affect hatching results. Burton and Tullet (1983) reported that the eggs' weight loss (as water vapour) during hatching affects the hatching results. Reis et al. (1997) reported an of 11.22-11.64% weight loss in eggs until the end of hatching in chickens. Peebles et al. (2001) reported that there would be a lower weight loss in infertile eggs and eggs with early embryo mortality compared to other egg types. Peebles and Marks (1991) reported that gas exchange was affected by an increase in shell thickness, and thus, early embryonic mortality were formed. In addition, Padhi et al. (2013) reported that the average shell thickness was between 0.34 mm and 0.38 mm.

MATERIAL AND METHODS

This study was carried out at Prof. Dr. Hümeyra Özgen Research and Application Farm in Selcuk University. Three roosters from each breed and 30 chickens from each breed were used for five breeds (Brahma, Denizli, Araucana, Leghorn, Cornish) to form the breeder flock to be grown as material. Leghorn parent breeder chickens were obtained from Poultry Research Institute, Ankara. Ankara Poultry Research Institute. After adaptation feeding, 20 females will be placed in the mating chamber made with fencing wire for mating so that one male has 20 females (F_0). In order to determine which animal the fertile eggs belonged to, the breeder chickens were given wing numbers, and their wing and family numbers were given on the cages. After all the females were kept in the mating chamber with the roosters for ten days, they were placed in the egg-laying cages and placed in individual cages of 30x45x50 cm (width × length × height). Fertile eggs were obtained from cage cells, and hen and rooster numbers were recorded at regular intervals. 40 randomly selected eggs from each flock were examined in terms of quality characteristics. During the examination, cracks etc. eggs were not evaluated. Before the eggs were transferred to the incubator, the eggs stored in the holding rooms at room temperature 22 ^{o}C and 75% relative humidity for one week were transferred to the incubator at 37.5 ^{o}C and 65% humidity conditions after fumigation. At the end of the 18th day of incubation, the egg records were written in gauze bags and on small papers, and the transfer process was carried out. The egg were weighted at the end of storage, and recorded before ıncubation. The eggs were transferred to the brooder machine at 37.2 °C and 70% relative humidity and kept for 3 days. As a result, crossbred F_1 chickenof Brahma x Leghorn (BxL), Denizli x Leghorn (DxL), Araucana x Leghorn (AxL), Leghorn x Leghorn (LxL), and Cornish x Leghorn (CxL) were obtained in female line with Leghorn breed, respectively. The wing numbers of the hatched chickens were given by writing the parent number. The healthy hatched chickens were raised in the brooder machine, where they will be kept for three weeks. Initially, 2.5%

sugary water was given, and after 3-4 hours of fasting, feeding was started. The vaccination program for poultry (Marek, Gumboro, Newcastle) was implemented in the The vaccination program for chicken (Marek, Gumboro, Newcastle) was implemented in the Prof. Dr. Hümeyra Özgen Research and Application Farm Alternative Poultry Unit in Selcuk University. 300 (F_1) animals were obtained from five families, and members of five families with sufficient male females from the herd were separated as breeders to obtain the F_2 herd. In order to obtain F_2, the same procedure was applied in the F_0 generation for each breed (15 males and 300 females F_1 individuals). As a result, the quality characteristics and hatchability of the eggs of F_1 and F_2 genotypes were evaluated.

Early embryonic mortality rate, storage period and temperatures of eggs below or above average, errors due to fumigation, temperature shock in eggs during transport, high-temperature values in the first week of embryo development, very young or very old breeders, the health status of the flock, chromosomal abnormalities affected by many factors. The middle embryonic mortality rate (7-17st days) is shaped by improper temperature, humidity, turning and ventilation in the machine, contamination of eggs, nutritional deficiencies in breeder houses, and lethal genes. Late embryonic mortality rate (18-21st days); It may occur in situations such as unsuitable temperature, humidity and ventilation, fumigation, excessive cooling of the eggs during transfer, contamination, nutritional deficiencies, and the inability of the embryo to take the normal hatching position in the hatching machines (Wilson 1991).

In this study were used to below formulas;

Hatching efficiency rate (%): (Number of live chicks hatched/Number of eggs laid in hatching)*100

Hatching rate (%): (Number of live chicks hatching/Number of fertile eggs hatched)*100

Specific Gravity (g/cm3)=Egg weight in air (g)/(Egg weight in air(g)-weight in pure water (g))

Early embryonic mortality rate (%): (Number of embryos mortality 0-6st days incubation/Number of fertile eggs)*100

Middle embryonic mortality rate (%): (number of embryos mortality 7-17st days of incubation/Number of fertile eggs)*100

Late embryonic mortality rate (%): (Number of embryos mortality 18-21st days of incubation/Number of fertile eggs)*100

Table 1. The rations contents used in the experiment

Week Nutritional Contents	1-3 Starter ration	4-10 Growth raiton	11-16 Growth raiton-II	17-40 Breeder hen ration I	40-64 Breeder hen ration II
Dry matter %	88	88	88	88	88
Crude Ash %	8	8	8	8	8
Crude Protein %	19	18	16	18	17
Energy kkal/kg	2900	2800	2700	2800	2700
Crude cellulose %	4-5	5-6	6	6	6
Ca %	1.0-1.2	1.0-1.1	0.9-11	4.0-4.2	3.5.0-4.5
P %	0.45	0.42	0.40	0.40	0.35
Metionin %	0.55	0.45	0.35	0.50	0.40
Lysine %	1.15	1.0	0.75	0.75	0.75
Salt %	0.50	0.50	0.40	0.40	0.35
Vit A IU	13 000	13 000	13 000	13 000	13 000

The data of the study were evaluated using the IBM SPSS 21 package program licensed by XX. The normal distribution of the data was analyzed using the Shapiro-Wilk test. Multiple analysis of variance (ANOVA) was used for parametric tests and Duncan test was used for comparisons between groups. In addition, Kruskal Wallis-H test was used from non parametric tests. Intergroup significance was evaluated on the basis of $P<0.05$.

RESULTS

Eggs obtained from the F_0 flock were placed in the incubator as 300 from each genotype group. At the end of the incubation, as a result of the embryonic mortality evaluation made at the end of the 22nd day, the incubation machine efficiency and embryonic mortality percentages were calculated and presented in Table 2.

In the study carried out with an equal number of eggs, hatchability characteristics and embryonic mortality are given in Table 2. The group with the highest hatchability of set/total eggs was the LL_1 cross (93.67). When infertility rates are examined, while the highest rate was found in the CL group, the lowest rate was 3.3% in the LL group. It was calculated that embryonic mortality, which were examined in as early, late middle, and sub-crustacean periods, ranged from 0.3% to 4% in the groups.

Table 2. Fertility, hatchability and embriyonic mortality rate of F1 (%)

Genotype		Hatchability	HSE	Fertility	EEM	MEM	LEM
(Brahma x Leghorn)	BL	88.33	92.98	95.0	1.7	1.0	4
(Denizli x Leghorn)	DL	86.00	92.81	92.7	2.0	2.3	2.3
(Aracuana x Leghorn)	AL	88.67	93.99	94.3	2.7	0.3	2.6
(Leghorn x Leghorn)	LL	93.67	96.90	96.7	1.0	0.3	1.7
(Cornish x Leghorn)	CL	82.67	89.86	92.0	3.3	2.7	3.3

HSE: Hatchability of set/total eggs, EEM: Early Embryonic Mortality, MEM: Mid Embryonic Mortality, LEM: Late Embryonic Mortality

Cornish x Leghorn F_2 (CL_2) was the lowest hatchability with 79.0%, while the highest hatchability was obtained from Leghorn x Leghorn F_2 (LL_2) crosses with 90.5%, belonging to the F_2 genotype groups.

Table 3. Fertility, hatchability and embriyonic mortality rate of F1 (%)

Genotype		Fertility	HSE	İnfertile	EEM	MEM	LEM
(Brahma x Leghorn)	BL	87.5	92.1	5.0	2.5	1.5	3.5
(Denizli x Leghorn)	DL	83.5	88.4	5.5	3.0	3.5	4.5
(Aracuana x Leghorn)	AL	86.0	90.5	5.0	3.0	2.5	3.5
(Leghorn x Leghorn)	LL	90.5	95.3	5.0	1.5	0.5	2.5
(Cornish x Leghorn)	CL	79.0	84.0	6.0	5.5	4.0	5.5

HSE: Hatchability of set/total eggs, EEM: Early Embryonic Mortality, MEM: Mid Embryonic Mortality, LEM: Late Embryonic Mortality

Egg weights of F_1 genotype groups were found to be 46.91-51.54 g, and the difference between the groups was insignificant ($P>0.05$).

Table 4. Egg weights and specific gravity values of the F1 generation

Genotypes	DL	AL	LL	BL	CL	Mean±SE	P
Egg weight (g)	48.61±0.63	46.91±0.63	47.97±1.08	49.66±1.17	51.54±2.28	48.94±0.59	**0.128**
Specific gravity (gr/cm³)	1.077±0.01	1.098±0.02	1.076±0.01	1.074±0.01	1.075±0.01	1.080±0.01	**0.297**
n	37	37	37	38	37	186	

In the F_2 generation, which was obtained by combining the F_1 genotype groups among themselves, the egg weights were found to be the highest in BL_2 and were determined as 67.14 g. The lowest egg weight was found in CL_2 with 57.6 g. In addition, the mean egg weight of the study groups was determined as 62.0 g, and it was determined that there were statistically significant differences between the genotypes in terms of egg weight ($P<0.05$).

Table 5. Egg weights and some egg quality characteristics of the F2 generation

	LL	CL	DL	BL	AL	P	Total
Egg weight (g)	63.24±0.71[b]	57.6±0.86[d]	61.95±0.97[bc]	67.14±0.66[a]	60.21±0.81[c]	0.001	62.00±0.44
Haught Unıt*	73.52±2.86	62.73±2.29	65.52±3.03	70.69±2.65	69.1±2.57	0.073	68.39±1.23
Egg height (mm)	5.44±0.43	6.79±2.36	5.06±0.37	5.82±0.3	5.41±0.26	0.796	5.68±0.43
Egg shell strength (mm/kg)	33.79±1.76[c]	47.52±1.53[a]	37.69±1.92[bc]	40.86±1.7[b]	40.79±1.82[b]	0.001	40.24±0.86
Shell weight (g)	6.2±0.11[b]	10.97±3.22[a]	6.12±0.13[b]	6.6±0.09[b]	6.11±0.09[b]	0.042	7.08±0.58

The difference between groups carrying different letters on the same line is statistically significant.

DISCUSSION

Economic sustainability in commercial breeding hatcheries depends on success in hatching. One of the factors affecting hatching performance is genetic factors. Hatching performance and machine yield values of F_1 genotypes are presented in Table 2. The hatchability values obtained in the study ranged from 82.67 to 93.67. When this difference was examined, ıt was higher especially in the Leghorn breed than other breeds. It could be because this breed was more bred. Likewise, the lowest yield in Cornish Leghorn (CL) hybrids can be expressed in this situation. Due to the higher embryonic mortality in CL crosses, the hatchery efficiency is lower than in other crosses. Ledur et al. (2000) obtained 94-97% fertility and 86.65-90.60% hatchability in their crosses in White Leghorn lines of different ages. The fact that it was found to be lower than the findings of this study may be due to the age factor as well as the difference in care and feeding conditions.

Alewi and Melesse (2013) and Bamidele et al. (2020) reported that the hatching performance of eggs obtained from hybrids is between 67.9-89%. Alabi et al. (2012) and Wondmeneh et al. (2011) stated that this value varies between 52.4-87% in domestic chicken breeds and crosses. In this study, as indicated in Table 3, the hatchability of F_2 genotypes was found to vary between 79-90.5%. Detection of a higher value than the values were reported in the literature; may have resulted from genotype, male-female ratio, or differences in care and feeding.

The difference between the F_1 genotype groups was insignificant in terms of egg weight. However, significant differences were found between the F_2 genotype groups regarding egg weight. The main reason for this difference may be due to age, feeding, and seasonal changes between generations. It was concluded that due to the decrease in the variation in egg weight in the F_2 generation.

Putra et al. (2021) calculated the egg weights in three Turkish layer genotypes as 59.7, 53.7, and 55.86 g in White Leghorn, Lohman Brown, and Atak-S chickens, respectively. These values were higher than the egg weights of the F_1 genotype groups in this study and lower than those obtained from the F_2s. Ewa et al. (2005), on the other hand, reported the egg weights of four inbred domestic chicken genotypes as 56.30, 56.72, 39.45, and 39.21 g in Black Olimpia (ESA), Brown Nick (ESB), LTA, and LTB genotypes, respectively. When the egg weights stated in Table 4 were compared with the values of Ewa et al. (2005), it was determined that the egg weights were similar to the commercial chicken lines and higher than the local lines. In addition, egg weights obtained from F_2s were higher than the values of the four genotypes reported by Ewa et al. (2005). Sirri et al. (2018) calculated the egg weight as 64.5 g in commercial chickens and 52.9 g in domestic genotypes, stating that the statistical difference is very significant ($p=0.01$). Regarding the similarity of egg weight, it was found that the commercial line was closer to the F_2s specified in our study, and the egg weight obtained from the local line was closer to the F_1 generation. Drabik et al. (2021), on the other hand, found 47.24, 60.93, and 66.32 g in their study on Araucana, Marans, and Leghorn breed chickens, and they found the effect of genotype on egg weight to be very important ($P<0.001$). The study evaluated that the findings of 46.91 g in AL_1 and 63.24 g in LL_2 were close to the values of Drabik et al. (2021).

The egg-specific gravity values of the F_1 generation are given in Table 4, and the average specific gravity value was found to be 1.080 g/ml (1.074-1.098) ($p=0.297$). Putra et al. (2021), on the other hand, reported 1.017, 1.07, and 1.11 and found the difference statistically significant ($P<0.05$). Drabik et al (2021) found 1.078 g/ml in Aracuana, 1.078 in Marans, and 1.081 g/ml in Leghorn ($p=0.299$).

The Haugh Unit value of the F_2 generation presented in Table 5, and the difference between genotypes found no significant ($p=0.073$). The highest Haugh Unit value was found in LL_2 with 73.52, and the lowest Haugh Unit value with 62.73 in CL_2. Drabik et al. (2021), on the other hand, reported that the Haugh Unit value was 80.53 in Araucana, 84.01 in Marans, and 84.82 in Leghorn ($p=0.215$). Sirri et al. (2018) found the Haugh Unit value to be 81.8 in commercial chickens and 76.4 in local chickens ($p>0.05$). On the other hand, Yaman et al. (2020) examined egg Haugh Unit values in 6 different genotypes and found a statistical difference in subtypes ($p<0.05$). The bark weight value of the F_2 generation presented in Table 5, and the difference between genotypes found significant ($p=0.042$). Although the CL_2 genotype had the lowest egg weight, the highest eggshell weight was determined. In addition, it determined that this value, 10.97 g in CL_2, was different from other genotype groups. It was concluded that this situation might be a genotype-specific situation. Putra et al. (2021), on the other hand, determined the eggshell weight value obtained from the White Leghorn as 8.76 g and stated that this value was higher than the other study groups. This study determined that eggshell weight values of LL_2 were higher than all other genotype groups lower than CL_2.

CONCLUSION

It was concluded that obtaining offspring without significant brood losses in the offspring generation was obtained using Leghorn in the main line. No adverse results founded in the incubation results of the crosses made with our local breed Denizli and the green layer Araucana, Brahma, and Cornish breeds, whose breeders increased locally.

It is necessary to develop local chicken breeds with low production performance, to increase their production performance, create disease-resistant local breeds, and search for alternative feeding opportunities, to introduce and protect traditional flavors. Moreover, further studies are needed in this context to bring new types from local breeds to the next generations and contribute to the protection of the gene resources of the countries.

ETHICS STATEMENT

Approval was obtained from the Selcuk University Experimental Research and Application Center, Animal Experiments Ethics Committee with the decision number 2014/61 dated 29.09.2014.

Conflict of interest: The authors have no conflicts of interest to report.

Ethical approval: This study was carried out at Selçuk University Faculty of Veterinary Medicine Hümeyra Özgen Research and Application Center Farm Poultry Unit. This research was approved by The Ethics Committee of the Faculty of Veterinary Medicine, University of Selçuk (report no: 2014/61).

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