ISSN: 3062-3235
I-CRAFT AGRICULTURAL and FOOD TECHNOLOGIES

The Effect of Hatching Egg Disinfection on Egg Weight, Hatching Traits, and Chick Quality in Pekin Ducks

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Abstract. This study investigated the effect of egg disinfection before incubation on egg weight, hatching traits, and chick quality in pekin ducks. The egg weight loss (Ew-L) between embryonic day (ED) 0-25 was 9.31±0.42% and 8.70±0.24% in groups A and B, respectively (P=0.333). The hatchability of fertile eggs (HFE) was 51.65±5.22% in Group A and 55.77±5.22% in Group B (P=0.633), while the embryonic mortality (EM) was 51.29±6.71% and 44.23±6.71% in Groups A and B, respectively (P=0.535). The chick weight at hatch (CWH) was 47.69±0.90 g in Group A and 47.99±1.07 g in Group B (P=0.833), while the chick yield (CY) was 63.26±1.35% in Group A and 64.65±0.78% in Group B (P=0.467). The chick length was significantly higher in Group B than in Group A (P=0.050). The current study suggests that the disinfection of soiled hatching eggs of ducks could improve hatchability, chick length, chick weight, and chick yield at hatch and reduce embryonic mortality without any negative effect on egg weight loss.

Keywords: Ducks, Disinfection, Eggs, Egg Weight Loss, Hatchability, Incubation

1 Introduction

Due to increasing levels of income and standard of living, the demand for poultry products, especially eggs, has improved tremendously [1], which has increased the search for the production of other alternative poultry species to support the total poultry egg [2] and meat consumption. Pekin ducks have been identified as one of the alternative poultry species with low production and maintenance costs but a high egg and meat nutritive value [3]. Ducks as an alternative poultry species are reared in many parts of the world however, production is mostly concentrated in Asia [4] and in deed [5] reported that in Southeast Asia, duck meat is the second most consumed poultry meat. Compared to chicken eggs, duck eggs have been reported to have higher protein, energy, carbohydrate, vitamins, iron, and sodium content [6]. Several authors have also reported duck eggs as a good source of protein and other nutrients, and are regarded as food with high nutritional quality [7, 8]. Moreover, a higher amount of total essential and non-essential amino acids in duck meat compared to chicken meat was reported [5].

In many parts of the world, duck breeders are mostly reared in free-range/litter or non-cage housing systems due to their high space and welfare requirements, with female ducks mostly laying eggs on the floor. Additionally, ducks are waterfowl and turn to perform different highly motivated water-related behaviors, including preening, dabbling, head dipping, and sieving. In free-range/litter systems with water pools, ducks mostly wet/soil the litter materials with water droppings from their bodies, and eggs end up being soiled with mud, leading to several microbial contaminations of the eggshells and the internal constituents of the eggs. Indeed, in our farm (Çukurova University Poultry Research Unit, Adana, Türkiye), we realized that ducks reared in a litter

https://doi.org/10.65888/icraft.3.1.21

ISSN: 3062-3235
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system with nipple drinkers still exhibited severe bathing behavior, causing the research unit (pens) to be flooded with water.

In the current study, the eggs were collected in a free-range system, with the majority soiled with mud. Because of the nature of ducks and their breeding environments, the disinfection of duck hatching eggs before incubation is very crucial for embryonic development, hatching, and post-hatch performance, and indeed [9] reported that duck eggs have lower hatchability due to the higher number of soiled eggs. The disinfection of hatching eggs is crucial for the reduction of the bacterial load in order to prevent hatching problems and issues associated with chick performance [10].

Therefore, this study investigated the effect of egg disinfection before incubation on egg weight, hatching traits, and chick quality in Pekin ducks.

2 Materials and Methods

Ethical Statement

This study was conducted under the guidelines for animal experiments of the Ministry of Food, Agriculture and Livestock, Türkiye. Approval was granted by the animal experiments local ethics committee.

Animal Material, Experimental Groups and Incubation Conditions

A total of 120 hatching eggs of Pekin duck breeders at 60 week of age (wk) were used in this study. The eggs were first weighed using a scale of 0.1g precision and divided into 2 groups. The groups consisted Group A (undisinfected eggs) and Group B (Eggs disinfected prior to incubation). The fumigation process was carried out by mixing 14 ml of formaldehyde with 7 g of potassium permanganate which later spread through diffusion in gaseous form. The eggs remained in the chamber of containment with the diffused gas for approximately 25 minutes.

The eggs were incubated under standard conditions (37.8 ºC and 70% humidity) between embryonic age (ED) 0 and 24. At ED 25, candling was conducted and fertile eggs were transferred to the hatcher with a temperature and humidity of 37.5 ºC and 70%, respectively.

Evaluation of Egg Weight Loss, Hatchability, Embryonic Mortality, Chick weight, Chick Yield, and Chick Quality

At ED 7, 14, 20, and 25 all the eggs were weighed again using a scale with a precision of 0.1g. The egg weight loss (EwL%) at different ED was evaluated by subtracting the weight of the eggs at a specific ED from the weight of the eggs before incubation, dividing it by the weight of the eggs before incubation, and multiplying by 100%. The egg EwL% was evaluated using the formula below.

$$\text{EwL\%}=\frac{Egg\ weight\ before\ incubation-Egg\ weight\ at\ a\ specific\ ED}{Egg\ weight\ before\ incubation}\times 100 \quad (1)$$

At hatch, all the ducklings were weighed using a scale with 0.1 g precision, and all the unhatched eggs were broken to actually confirm embryos died. The hatchability of fertile eggs (HFE), embryonic mortality (EM), and chick yield (CY) were evaluated using the formula below. Selected chick quality traits (activity, eyes, legs, and appearance) from Tona et al. (2003) were evaluated using 17 and 15 ducklings from Group A and B,

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respectively. The duckling length was measured from the beak to the finger of the middle toe of the chicks using a ruler/rule placed on a square table. The egg HFE, EM, and CY were evaluated using the formula below.

$$HFE\% = \frac{Number\ of\ hatched\ chicks}{Total\ number\ of\ fertile\ eggs} \times 100 \quad (1)$$

$$EM\% = \frac{Number\ of\ dead\ embryos}{Total\ number\ of\ fertile\ eggs} \times 100 \quad (3) \quad (2)$$

$$CY\% = \frac{Average\ weight\ of\ hatched\ chicks\ in\ a\ specific\ group}{Average\ weight\ of\ eggs\ before\ incubation\ for\ that\ group} \times 100 \quad (3)$$

Statistical Analysis

The normality test and test of homogeneity of the data were conducted using Shapiro-Wilk and Levene's tests, respectively. It was confirmed that the data showed normal distribution. After confirming the normality of the data, the analysis of variance, Student t-test, was applied to the data. The *p-value* was set at $P \leq 0.05$. The statistical software package JMP 18 (SAS, 2017) was used for data analysis.

3 Results and Discussion

The effect of egg disinfection before incubation on EW (g) and Ew-L (%) is presented in Tables 1 and 2, respectively. The EW and the Ew-L at different ED did not significantly vary between the two experimental groups (P>0.05) and it could be possible that the disinfection of eggs with formaldehyde did not influence the eggshell conductance, the mechanism involved in the control of moisture loss between the egg and its environment. Our findings confirm the results of previous studies [11, 12] that have also reported that eggs disinfected before incubation did not significantly differ in terms of moisture loss or Ew-L compared to the control eggs (undisinfected). Other authors [13] also reported that while different disinfectants had no effect on EW at ED 18, the Ew-L after incubation was lowest in eggs disinfected with propolis. The differences in results could be related to the type of disinfectant used, the method of disinfection, or the degree of egg contamination.

Table 1. The effect of egg disinfection before incubation on egg weight (g) Group A (undisinfected eggs, control), Group B (Disinfected eggs), EWBI (Egg weight before incubation), EW (Egg weight), ED (Embryonic day).

Group	Ew-L (%)			
	ED0-7	ED0-14	ED0-20	ED0-25
A	2.99±0.13	5.74±1.05	7.73±0.74	9.31±0.42
B	3.07±0.07	5.59±0.61	7.79±0.42	8.70±0.24
P-value	0.620	0.910	0.953	0.333

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Table 2. The effect of egg disinfection before incubation on egg weight loss (%)

Group	Ew-L (%)			
	ED0-7	ED0-14	ED0-20	ED0-25
A	2.99±0.13	5.74±1.05	7.73±0.74	9.31±0.42
B	3.07±0.07	5.59±0.61	7.79±0.42	8.70±0.24
P-value	0.620	0.910	0.953	0.333

Group A (undisinfected eggs, control), Group B (Disinfected eggs), Ew-L (Egg weight loss), ED (Embryonic day).

The effect of egg disinfection before incubation on HFE, EM, CWH, and CY is given in Table 3. The HFE, EM, CWH, and CY did not significantly vary between the two experimental groups in the present study (P>0.05), and it could be possible the degree of pathogenic contamination of eggs was not detrimental enough to influence embryonic growth and development and the mechanisms involved in hatching processes of chicks. Our findings agree with the results of [14], who reported no significant effect of duck egg disinfection on hatchability, EM, and CWH. It was also reported lower EM and higher HFE in duck eggs disinfected before incubation compared to undisinfected eggs; however, the CWH did not significantly vary among the groups [11]. Clean duck eggs disinfected before incubation did not significantly vary in terms of hatchability compared to the control eggs; however, soiled eggs disinfected before incubation had higher hatchability compared to soiled undisinfected eggs [9]. In geese, significantly higher EM and lower hatchability in dirty eggs compared to treated eggs before incubation were identified [15]. In addition, higher CY in chicken eggs disinfected with propolis was reported by [16]. The differences in results could be related to the type of disinfectant used, the method of disinfection, or the degree of egg contamination.

Table 3. The effect of egg disinfection before incubation on HFE, EM, CWH, and CY

Group	Hatching traits			
	HFE	EM	CWH	CY
A	51.65±5.22	51.29±6.71	47.69±0.90	63.26±1.35
B	55.77±5.22	44.23±6.71	47.99±1.07	64.65±0.78
P-value	0.633	0.535	0.833	0.467

Group A (undisinfected eggs, control), Group B (Disinfected eggs), HFE (Hatchability of fertile eggs), EM (Embryonic mortality), CWH (Chick weight at hatch), CY (Chick yield).

The effect of egg disinfection before incubation on chick quality score is presented in Table 4. The duckling activity, appearance, eyes, and leg scores did not significantly vary between the experimental groups (P>0.05), and our findings agree with the results of [17], who also reported that the number of saleable chicks from disinfected eggs did not significantly differ from the number of saleable chicks from undisinfected eggs. Our findings contradict the results of [18], who identified the highest number of saleable chicks from eggs disinfected using 30% hydrogen peroxide vapor.

However, in the present study, the duckling length at hatch was significantly higher in Group B than in Group A (P=0.05), and we speculated that the disinfection of eggs with formaldehyde might have prevented the negative effect of microorganisms/pathogens on progenitor cell specification, cell migration, epithelial-to-mesenchymal transition, and differentiation and maturation of chondrocytes, the mechanism involved in bone development in poultry, leading to higher skeletal or body length in ducklings from the disinfected eggs.

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Table 4. The effect of egg disinfection before incubation on chick quality score

Group	Chick length (cm)	Activity	Appearance	Eyes	Legs
A	20.17±0.26[b]	2.47±0.71	9.18±0.73	15.53±0.34	16.00
B	20.94±0.28[a]	1.60±0.75	8.53±0.77	16.00±0.37	16.00
P-value	0.050*	0.405	0.548	0.356	-

Group A (undisinfected eggs, control), Group B (Disinfected eggs).

4 Conclusion

The current study suggests that the disinfection of soiled hatching eggs of ducks could improve hatchability, chick length, chick weight, and chick yield at hatch and reduce embryonic mortality without any negative effect on egg weight loss.

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