Research Article

Effect of Spraying Japanese Quail Eggs with Garlic Oil on Hatching Performance and Hatch Weight

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Abstract | Garlic oil is a strong natural disinfectant. Previous studies documented the effectiveness of pre-incubation application of garlic oil on hatching efficiency. This study was conducted to evaluate the effect of spraying garlic oil solution before incubation and for the first 10 days of incubation on hatching performance of fertile Japanese quail eggs including; weight loss, hatchability, embryonic mortalities and hatch weight. A total of 2100 Japanese quail eggs were divided into three treatments (Each treatment represented with four replicates). T1 (control group); non-treated group, T2 group sprayed with distilled water and T3 group that sprayed with garlic oil solution (2%). The results showed that T3 group had the lowest egg weight loss percentage during different incubation stages as well as less early, intermediate and late mortalities. Furthermore, hatchability percentages of T3 remarkably exceeded than T1 and T2. Significant differences were observed for hatch weight among treatments (P<0.05) where, T3 group had the heaviest chick weight. We concluded that spraying garlic oil solution 2% as pre-incubation disinfectant and during first 10 days of eggs incubation could improve the hatchability, embryonic development and hatch weight of Japanese quail.

Keywords | Egg weight loss, Embryonic mortalities, Garlic oil, hatchability, Hatch weight, Quail

Received | October 14, 2020; **Accepted** | December 12, 2020; **Published** | January 01, 2021
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Citation | Abo-Samaha MI, Basha HA (2021). Effect of spraying Japanese quail eggs with garlic oil on hatching performance and hatch weight. Adv. Anim. Vet. Sci. 9(2): 156-161.
DOI | http://dx.doi.org/10.17582/journal.aavs/2021/9.2.156.161
ISSN (Online) | 2307-8316; **ISSN (Print)** | 2309-3331

INTRODUCTION

Hatchability is one of the most important factors in hatchery industry. Improving hatchability and chick quality is a crucial step for optimizing poultry production efficiency. Hence, eggs exposed to multiple microbial contaminations as *Salmonella, Escherichia coli, enterobacteria*, molds, and yeasts, at pre and post egg laying that can penetrate the egg shell causing poor hatchability as well as the reduction in the incubation efficiency (de Faria et al., 2014). Fertile eggs may be contaminated by microorganisms during its pass in an infected oviduct, laying in dirty nest or contaminated cage. So, an effective hatching sanitation program is essential before incubation in order to improve the hatchability. Sanitizers used to prevent the growth and decrease content of the microorganisms on the eggshell surface (De Reu et al., 2006). Usually; Fumigation of hatching eggs using paraformaldehyde is commercially used (Kusstatscher et al., 2017). This technique effectively reduces the potential pathogenic microorganisms (Rui et al., 2011) but has adverse effects on the embryo as well as the human (Zeweil et al., 2015; Kusstatscher et al., 2017). Therefore, alternative products are needed to provide safe satisfactory sanitization on the incubation efficiency and human health.

Natural products have been used as alternatives to formaldehyde in many studies, such as etheric thyme oil (*Origanum vulgare L*), which has antimicrobial properties (Yildirim et al., 2003; Baydar et al., 2004; Copur et al., 2010; Debes and Basyony, 2011), propolis (a resin-like material made by bees) (Aygun et al., 2013), allicin (Copur et al., 2011) and garlic oil (Fouad et al., 2018). Garlic (*Allium sativum*) is a bulbous vegetable belongs to the family *Liliaceae* and genus *Allium* (Simon and Jenderek, 2003). The organic sulphurous compounds (aliin, ajoene, allicin

and allylpropyl disulphide, sallilcisteine, diallyl trisulphide and others) are the main components of garlic (Freeman and Kodera, 1995; Kemper, 2000; Mansoub, 2011). Allicin and garlicin are potent antibiotics (Makaklı, 1980), they are effective against both gram-positive and gram-negative bacteria (Farbman et al., 1993).

The antiseptic properties of garlic against *Helicobacter pylori* have been established *in vitro* (Salih and Abasıyanık, 2003). In the study of Astal and Younis (2003), garlic extract at a concentration of 750-1000 µg/ ml showed very high antibacterial effect against gram-positive bacteria, such as *Staphylococcus aureus*, *Staphylococcus saprophyticus*, *Streptococcus pneumonia* and *Streptococcus faecalis*, as well as against gram-negative bacteria, including *Escherichia coli*, *Enterobacter cloacae*, *Klebsiella pneumonia*, *Proteus mirabilis*, *Pseudomonas aeruginosa* and *Acinetobacter haemolyticus*. Copur et al., 2011 showed that treatment of breeder broiler eggs with allicin (3600 mg/l and 7200 mg/l) is a safe substitute for formaldehyde fumigation improves the hatchability and decreases the contamination rate, and mortality percentages. Similarly, Baylan et al., 2018 indicated that immersion quail eggs in garlic extract in concentration (2.5 and 5.0%) is an alternative method for formaldehyde fumigation. Furthermore, Fouad et al., 2018 reported that spraying garlic oil solution (1ml/l or 2ml/l) on Japanese quail eggs before incubation improved embryonic development, hatchability, hatch weight and chick performance.

Whereas, previous studies had been limited to the use of garlic oil or other natural alternatives as disinfectant for hatching eggs only before setting into incubator. Therefore, the objective of this study was to evaluate spraying of quail eggs with garlic oil solution pre-incubation and during first 10 days of the incubation period, to evaluate its effect on egg weight loss, hatchability, embryonic mortalities, and hatch weight.

MATERIALS AND METHODS

The current experiment was carried out at Department of Animal Husbandry and Animal Wealth Development, Faculty of Veterinary Medicine, Alexandria University, Egypt. In this study, a total of 2100 hatching eggs were obtained from a private breeder flock farm of Japanese quails (*Coturnix coturnix japonica*). Eggs were allotted to three treatments with 700 eggs/ treatment (Each treatment represented with four replicates with 175 eggs / replicate). T1 (control group) where eggs are non-treated, T2: eggs were sprayed with distilled water and T3: eggs were sprayed with 2 % garlic oil (Fouad et al., 2018). Spraying distilled water or garlic oil was applied just before setting of eggs into incubator and once every day until 10th day of setting. During incubation of first 10 days, the three experimental groups were getting out the incubator, then the spraying of treated eggs with water (T2) or garlic oil 2% (T3) at the same temperature of the incubator. Eggs allowed to be dry and returned back to the incubator. Eggs were incubated vertically with broad end up in the setting trays in automatic incubator at 37.5°C (dry bulb temperature), with 65% relative humidity. Automatic egg turning with angle ± 45 degree eight times daily. On day 15 of incubation, the eggs were transferred to the hatchery at 36.5°C (dry bulb temperature), with 75-80% relative humidity.

Preparation of solution

Garlic oil can be diluted with water for preparation of spray (Ellis et al., 1996). Garlic oil solution 2% was prepared by diluting 20 ml garlic oil in 1000 ml distilled water using a magnetic stirrer. Garlic oil was obtained from El-masrayia company, Egypt.

Egg weight loss

Eggs (50 eggs/ replicate) were weighed before setting in the incubator, then on 7th and 15th day of incubation. The differences between two successive weights of incubated eggs were estimated in grams and percentage from initial egg weight. Egg weight loss (%) = [(egg weight at setting– egg weight at different days of incubation)/ initial egg weight at setting] ×100

Embryonic mortalities

Unhatched eggs were submitted to embryo diagnosis and the infertile eggs were excluded. Then only the number of fertile unhatched eggs were used to determine the percent of early mortality (EM, 0-7 days), intermediate mortality (IM, 8-14 days), and late mortality (LM, 15-18 days).

Hatchability percentage

Hatchability of total eggs % = (Number of hatched chicks)/ (Total number of total eggs) × 100

Hatchability of fertile eggs % = (Number of hatched chicks)/ (Number of fertile eggs) × 100

Hatch weight

A total of 400 chicks / treatment were weighed at hatch for obtaining the average weight.

Statistical analysis

Data were analyzed with GLM using the SAS statistical package (SAS, 2014). In case of significant differences ($P<0.05$), means were compared by Duncan's test.

$$\textit{Statistical model: } X_{ij}=\mu + T_i + eij$$

Where;

Xij= the observation record; µ= Overall mean; T_i= Effect of treatment; e_{ij}= random error.

RESULTS AND DISCUSSION

The effect of spraying water or garlic oil on egg weight loss during the incubation period of Japanese quail is presented in Table 1. Weight loss during incubation period was significantly different among treatments (P<0.05). First 7 days of incubation, the egg weight loss was significant with highest rate in T1 (control) group, while the lowest was recorded in T3. However, no significant differences were observed between water and garlic oil treated group at first 7 days of incubation. Weight loss during the period from 7th day until 15th day as well as, total weight loss took the same pattern but values were varied significantly between the three groups. The total weight loss ranged from 8.95 in T3 to 10.65% in T1 with a difference of 1.7% between control group and group sprayed with garlic oil solution during the entire period of incubation.

Results of embryonic mortalities and hatch weight are presented in Table 2. The highest percentage of early embryonic mortalities was recorded in T1 (15.55%) and T2 (15.41%), while, this percentage was the lowest in T3 (9.25%). Intermediate embryonic mortalities were higher in T1 but decreased in T2 and T3. Late embryonic mortality was observed as the same in T1 and T2 but differed significantly with T3 that had the least percentage.

Results of fertility, hatchability and hatch weight are shown in Table 3. Fertility percentages did not show any differences among groups (P>0.05). Hatchability percentages of total or fertile eggs were significantly affected with spraying of water or garlic oil, where high hatchability percentage was recorded in T3 (76.43%, 84.38%, respectively) followed by T2 (68.86%, 75.79%, respectively) and the least percentage was observed in T1 (66.43%, 73.8%, respectively).

Table 1: Effect of spraying hatching quail eggs with garlic oil solution (2%) before incubation and during first 10 days of incubation on egg weight loss.

	Treatment			
Variable	**T1 (Control)**	**T2 (Water)**	**T3 (Garlic)**	**P value**
Egg weight	12.26±0.06	12.27±0.10	12.28±0.15	0.26
Weight loss 0-7 days (gm)	0.66±0.03^{a}	0.57±0.01^{b}	0.54±0.01^{b}	<.0001
Weight loss 0-7 days (%)	5.39±0.23^{a}	4.64±0.07^{b}	4.39±0.06^{b}	<.0001
Weight loss7-15 days (gm)	0.65±0.02^{a}	0.61±0.01^{b}	0.56±0.01^{c}	<.0001
Weight loss7-15 days (%)	5.26±0.11^{a}	4.97±0.08^{b}	4.56±0.06^{c}	<.0001
Weight loss 0-15 days (gm)	1.31±0.03^{a}	1.18±0.01^{b}	1.10±0.02^{c}	<.0001
Weight loss 0-15 days (%)	10.65±0.26^{a}	9.61±0.10^{b}	8.95±0.09^{c}	<.0001

Means bearing different letters within the same row are significantly different (P<0.05). Data presented as means± SE. N=200 for each treatment.

Table 2: Effect of spraying hatching quail eggs with garlic oil solution (2%) before incubation and during first 10 days of incubation on embryonic mortalities percentage during incubation.

	Treatment			
Variable	**T1 (Control)**	**T2 (Water)**	**T3 (Garlic)**	**P value**
EM (%)	15.55±0.36^{a}	15.41±0.39^{a}	9.25±0.47^{b}	<.0001
IM (%)	3.34±0.40^{a}	2.05±0.30^{b}	2.04±0.30^{b}	0.03
LM (%)	6.98±0.43^{a}	6.76±0.16^{a}	4.86±0.15^{b}	0.0008

Means bearing different letters within the same row are significantly different (P<0.05). Data presented as mean ±SE. EM: Early embryonic mortalities, IM: Intermediate embryonic mortalities, LM: Late embryonic mortalities.

Table 3: Effect of spraying hatching quail eggs with garlic oil solution (2%) before incubation and during first 10 days of incubation on fertility, hatchability and hatch weight.

	Treatment			
Variable	T1 (Control)	T2 (Water)	T3 (Garlic)	P value
Fertility (%)	90.00±0.37	90.86±0.23	90.57±0.28	0.18
Hatchability of total egg (%)	66.43±0.63^{c}	68.86±0.37^{b}	76.43±0.79^{a}	<.0001
Hatchability of fertile egg (%)	73.81±0.68^{b}	75.79±0.51^{b}	84.38±0.79^{a}	<.0001
Hatch weight (gm)	9.10±0.04^{c}	9.31±0.03^{b}	9.51±0.04^{a}	<.0001

Means bearing different letters within the same row are significantly different (P<0.05). Data presented as mean ±SE.

Also, the average hatch weight was significantly (P<0.05) higher in T3 (9.51 gm) followed by T2 (9.31 gm) and T1 (9.10 gm). Where the heaviest chick obtained from group treated with garlic oil solution

In hatching eggs, disinfection of egg shell surface is an essential control practice to obtain high quality hatching performance and consequently disease prevention in the farm (Dvorak, 2005). Conventional chemical sanitation method causing impaired the physiology of developing chick embryo (Zeweil et al., 2015). So, natural sanitizers had been recently developed. Garlic oil (Fouad et al., 2018) or its extract (Baylan et al., 2018) were used for decontamination of egg surface before incubation. Results from current study revealed that egg weight loss at different stages and at the entire period of the incubation were decreased by spraying of garlic oil on quail eggs for first 10 days of incubation. The interesting results obtained from garlic oil spraying that the reduction in egg weight loss to 8.95 % compared to 10.65 % from non-treated eggs. This was similar to results obtained by Fouad et al. (2018) who reported that eggs sprayed with garlic oil before incubation had less weight compared with those sprayed with water or non-treated eggs. The decrease in water loss could be attributed to that egg pores coated with garlic oil (Fouad et al., 2018) that diminished the evaporation of water vapor (Shahein and Sedeek, 2014).

Additionally, the significant decrease in early, intermediate and late embryonic mortalities in quail eggs treated by garlic oil (Table 2) could be as a result of the antimicrobial effect of garlic oil (Iwalokun et al., 2004; Gbenga et al., 2009). Spraying of eggs with garlic oil for 10 days of incubation enhanced the embryo development with reducing the embryonic mortalities and this could be attributed to the fact that garlic has antibiotic, antioxidant, anti-inflammatory and cardiovascular-protecting effects (Reuter et al., 1996). This result was in agreement with Fouad et al. (2018) who reported that embryonic mortalities lowered in hatching eggs disinfected with garlic oil solution. Also, garlic extract used for disinfection of eggs before incubation resulted in decreased embryonic mortalities than fumigated eggs or non-treated eggs (Baylan et al., 2018). As the same trend, using of allicin as an alternative disinfectant for hatching eggs lowered the early and late embryonic mortalities compared to formaldehyde or non-treated group (Copur et al., 2011).

Additionally, spraying of hatching eggs with garlic oil for first 10 days of the incubation led to incredible improvement of hatchability of total or fertile eggs as compared to eggs sprayed with water or non-treated eggs. This could be attributed to the fact that eggs with the lower weight loss had higher hatchability and eggs with greatest weight loss had the lowest hatchability (McDaniel et al., 1979). Moreover, poor eggshell quality has been related with a higher percentage of egg moisture loss during incubation (Peebles et al., 2001) and low hatchability (Narushin and Romanov, 2002). Besides, the low percentage of embryonic mortalities (Table 2) recorded in garlic oil group compared to other groups is another explanation for the improved hatchability. Also, the better hatchability may be a direct result of decreased microbial contamination of the eggs treated with garlic oil. These results were in harmony with other studies that used natural product alternatives for eggs disinfection as allicin (Copur et al., 2011), propolis (Shahein and Sedeek, 2014), garlic extract (Baylan et al., 2018) and garlic oil (Fouad et al., 2018) that resulted in improved hatchability.

Furthermore, our results showed that hatched chicks of T3 group were the heaviest chicks (P<0.05). This could be attributed to T3 group recorded the lowest egg weight loss during incubation (Table 1). This was confirmed by a study revealed that chick weight is reduced by increasing incubation egg weight loss (Peebles et al., 1987). Also, excess water evaporation from eggs is incorporated into new tissues that affect the chick weight (Davis et al., 1988). As the same trend, the heaviest chick body weight at hatch were recorded for chicks produced from group treated with propolis 14% compared with those produced from other egg treatments (Shahein and Sedeek, 2014). On the other hand, spraying of eggs with allicin had no significant effect either on hatching or chick growth and their development after hatching (Copur et al., 2011). Also, using of garlic extract as alternative disinfectant for hatching egg did not affect the hatch weight but improved the final body weight in Japanese quail (Baylan et al., 2018). Spraying of garlic oil as alternative disinfectant for hatching eggs had no significant effect on the hatch weight but improved 14 days body weight of Japanese quail (Fouad et al., 2018).

CONCLUSIONS AND RECOMMENDATIONS

Combined spraying garlic oil solution 2% as a natural sanitizer for Japanese quail eggs before incubation and during first 10 days of incubation could be a good practice to improve egg weight loss, decrease embryonic mortalities percentage and improve the hatchability as well as the hatch weight.

AUTHOR'S CONTRIBUTION

Magda I. Abo-Samaha developed the experimental plan and carried out the experimental work. Heba A. Basha analyzed the data. Both of authors wrote the main draft of manuscript, revised the manuscript and approved the final

version.

CONFLICT OF INTEREST

The authors have declared no conflict of interest.

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