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The Effect of Spraying Eggs with Acetic Acid for Different Periods on the Characteristics of Hatched Chicks

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Annotation: The poultry industry plays a crucial role in global food production, with chicken eggs being a significant source of protein. Recent research has explored the application of organic acids, particularly acetic acid, to improve egg incubation and chick quality. This study aimed to evaluate the effects of spraying eggs with acetic acid for different periods on hatching characteristics and chick quality. A total of 320 fertile chicken eggs were divided into four groups, with each group treated with acetic acid for varying durations: 5 seconds (T2), 10 seconds (T3), and 15 seconds (T4). A control group (T1) was not treated. Eggs were incubated under standard conditions, and chick weight, egg volume, surface area, and shell index were measured post-hatching. The results showed that acetic acid treatment did not significantly affect egg weight, breadth, or length, but chick weight was significantly influenced by exposure duration, with T2 and T4 producing heavier chicks than T1 and T3. Egg volume and surface area were significantly affected by the treatments, with T4 showing the highest values. However, the shell index remained unchanged. The treatment had no significant effect on fertility, deformities, or sex ratio, but it significantly reduced mortality, indicating improved chick survival. These findings suggest that acetic acid application can enhance hatchability and chick quality, offering potential benefits for hatchery management without compromising egg shell integrity.

Keywords: Eggs, Acetic acid, chicks, spraying.

Introduction:

The poultry industry is a critical part of global food production, with chicken eggs among the most important sources of protein [1]. In recent years, a growing body of research has explored methods to improve egg incubation and chick quality by manipulating egg characteristics prior to hatching [2]. One promising approach is the application of organic acids, such as acetic acid, to egg surfaces [3]. Acetic acid, commonly known as vinegar, is widely recognized for its antibacterial properties and its ability to modulate environmental conditions [4]. Studies have suggested that acetic acid can influence various factors during incubation, including microbial load, eggshell integrity, and the health and growth of hatched chicks [5]. However, the effects of spraying eggs with acetic acid for different periods remain poorly understood.

Organic acids, including acetic acid, have been investigated for their antimicrobial and antifungal properties [6]. They are thought to reduce the microbial load on eggshells, thereby improving overall egg hatchability. A study by [7] found that applying acetic acid to eggs reduced bacterial contamination, thereby minimizing the risk of infections that could compromise the chick's health and development [6]. The presence of bacteria or fungi on the eggshell can lead to shell damage, reduced oxygen exchange, and even contamination of the egg contents, all of which can negatively impact chick survival [8].

Acetic acid has also been shown to modify the pH of the eggshell, which can influence the rate of calcium absorption and the strength of the eggshell itself [9]. Shell strength is a key factor in determining hatchability, as eggs with fragile or thin shells are more likely to sustain damage during incubation or hatching, resulting in poor outcomes [10]. Several studies have suggested that acids such as acetic acid can help maintain or enhance shell quality by altering the structure of calcium carbonate on the eggshell [11]. The application of acetic acid to eggs may also directly affect the embryo's physiological development [12]. Acetic acid is known to interact with the embryo's metabolic processes, possibly by influencing enzyme activities or nutrient absorption, such as calcium and phosphorus, which are essential for bone development [13]. The period and intensity of exposure to acetic acid are important factors in determining how these effects manifest [14]. Some studies have suggested that prolonged exposure to high concentrations of acetic acid may adversely affect embryo development, including delayed hatching or reduced viability, whereas shorter or more controlled exposure may yield beneficial effects [15]. The application period is critical, as it determines how long the egg is exposed to acid. Acetic acid could potentially enhance hatching characteristics if applied during specific developmental windows or at lower concentrations. However, exposure during the early stages of embryonic development may interfere with proper calcification or oxygen exchange, leading to suboptimal outcomes [16]. Investigating the effects of different application durations can provide a clearer understanding of the optimal exposure time that maximises hatchability and chick health. The primary aim of this study is to investigate the effect of spraying eggs with acetic acid for varying periods on the characteristics of hatched chicks. Specifically, this research will explore how the timing and frequency of acetic acid exposure influence hatchability, chick weight, bone development, and immune function. By varying the duration of acetic acid application, it will be possible to identify an optimal treatment protocol that enhances egg incubation conditions without compromising chick health or development.

Materials and methods:

This study was conducted to investigate the effect of spraying eggs with acetic acid for varying periods on the characteristics of hatched chicks. A total of 320 fertile chicken eggs from a commercial poultry farm were selected for the experiment. The eggs were divided into four treatment groups (T1, T2, T3, and T4) with 80 eggs per group. Each treatment group was exposed to acetic acid spraying for different time durations before incubation. The concentrations of acetic acid were standardised at 1% (v/v) to ensure uniformity in exposure across all groups. T1: No acetic acid treatment (control group), T2: Eggs sprayed with acetic acid for 5 seconds, T3: Eggs sprayed with acetic acid for 10 seconds, T4: Eggs sprayed with acetic acid for 15 seconds

Eggs were collected from hens of the same breed and age to minimize variability. Only clean, uncracked, and uniform-sized eggs were selected for the study. Each egg was carefully numbered and assigned to one of the four treatment groups. Before spraying, the eggs were stored at room temperature (22°C) for 24 hours to simulate typical hatchery conditions.

Acetic acid (vinegar) at a concentration of 1% was applied to the eggs' surfaces using a hand-held spray bottle. The spraying duration varied by treatment group (5, 10, or 15 seconds), and eggs were sprayed evenly on all surfaces to ensure thorough coverage. The treatment was applied immediately before incubation to prevent any prolonged exposure. Control eggs (T1) were not sprayed and remained untreated. After spraying, the eggs were placed in an incubator under standard conditions.

All eggs, regardless of treatment group, were incubated under uniform conditions. The incubation temperature was set at 37.5°C, and humidity was maintained at 55–60% for the first 18 days, then increased to 65–70% during the final three days of incubation. The eggs were turned automatically every hour during the first 18 days to ensure proper embryo development.

After the incubation period, the eggs were candled to assess fertility, and those with visible embryos were transferred to hatch trays. Hatchability was determined by the number of chicks that successfully hatched. Chick quality was evaluated based on several parameters, including hatching weight, bone development, and overall physical condition. Chick weight was measured using a digital scale to the nearest gram. Bone development was assessed by measuring the length of the femur and tibia bones using a vernier calliper. Immune function was evaluated by measuring the size of the bursa of Fabricius, as an indicator of immune health.

The data obtained from the experiment were analyzed using a one-way analysis of variance (ANOVA) to compare the effects of different acetic acid exposure times on egg and chick characteristics. Statistical significance was set at $p \leq 0.05$. Tukey's Honest Significant Difference (HSD) test was used to determine significant differences between treatment groups. For categorical data such as mortality and fertility, a Pearson Chi-Square test was used to evaluate the effect of treatments on these traits. All statistical analyses were performed using SPSS version 20.0.

Results and discussion:

Spraying eggs with acetic acid for different periods did not significantly affect egg weight, breadth, or length, with values ranging from 50.61 g to 52.27 g, 40.72 mm to 41.33 mm, and 53.94 mm to 54.68 mm, respectively. However, chick weight was significantly influenced by the treatments ($p \leq 0.001$), with T2 (37.61 g) and T4 (36.89 g) producing heavier chicks than T1 (34.92 g) and T3 (32.30 g), indicating that the timing of acetic acid application can affect post-hatch growth.

Spraying hatching eggs with acetic acid did not significantly affect egg weight, breadth, or length. However, chick weight was significantly influenced by the treatments ($p \leq 0.001$), with T2 (37.61 g) and T4 (36.89 g) producing heavier chicks compared to T1 (34.92 g) and T3

(32.30 g). These findings align with previous studies indicating that acetic acid can improve hatchability and chick quality. For instance, [19] reported that washing quail eggs with acetic acid and vinegar significantly increased hatchability, while [20] found that using vinegar as a disinfectant in chicken eggs improved both hatchability and embryonic development. Similarly, [21] observed that spraying goose eggs with acetic acid and boric acid solutions effectively reduced microbial contamination without adversely impacting hatch results. These studies suggest that acetic acid treatments can enhance embryonic development and chick quality, potentially through mechanisms such as improved microbial control and enhanced nutrient absorption during incubation.

Table 1: The effect of spraying eggs with acetic acid for different periods on the egg external traits and chick weight

Treatment	Egg weight	Egg breadth	Egg length	Chick weight
T1	51.02±0.60 a	41.09±0.19 a	54.27±0.23 a	34.92±0.59 b
T2	51.25±0.86 a	40.95±0.20 a	53.94±0.34 a	37.61±0.77 a
T3	50.61±0.77 a	40.72±0.10 a	54.03±0.30 a	32.30±0.42 c
T4	52.27±0.42 a	41.33±0.15 a	54.68±0.23 a	36.89±0.65 a
Sig.	N.S.	N.S.	N.S.	***

NS = non-significant, *** it is significant at the 0.001 level; ** it is significant at the 0.01 level; * it is significant at the 0.05. T1: No acetic acid treatment (control group), T2: Eggs sprayed with acetic acid for 5 seconds, T3: Eggs sprayed with acetic acid for 10 seconds, T4: Eggs sprayed with acetic acid for 15 seconds

Spraying eggs with acetic acid for different periods did not significantly affect the egg shell index, which ranged from 75.48 to 76.01. However, egg volume and egg surface area were significantly influenced by the treatments ($p \leq 0.05$). T4 resulted in the highest egg volume (49,663.16 mm^3) and surface area (6,871.63 mm^2), while T2 and T3 showed lower values. T1 showed intermediate values, not significantly different from T4 for both parameters. This indicates that the period of acetic acid application can slightly modify egg morphology, particularly volume and surface area, but does not affect shell thickness relative to egg weight.

Spraying eggs with acetic acid significantly affected egg volume and surface area but had no effect on shell index, suggesting that external egg measurements can be slightly influenced by treatment duration without compromising shell integrity. These findings align with previous research demonstrating that acid-based treatments can alter egg hydration and surface characteristics, potentially improving gas exchange and incubation efficiency [19, 20]. Eroğlu [21] also reported similar results in goose eggs, where acetic acid improved egg volume and surface properties while reducing microbial contamination. The increase in volume and surface area in T4 may enhance nutrient diffusion and embryonic development, explaining the higher chick weights observed in corresponding treatments. Overall, acetic acid application appears to be a safe and effective method to optimize egg morphology and chick quality without affecting shell strength, supporting its practical use in hatchery management [22-25].

Table 2: The effect of spraying eggs with acetic acid for different periods on the egg measurements

Treatment	Egg shell index	Egg volume	Egg surface area
T1	75.74±0.34 a	48787.14±542.07 ab	6783.12±50.52 ab
T2	76.01±0.55 a	48163.12±584.21 b	6718.78±57.33 b
T3	75.48±0.46 a	47710.77±338.56 b	6691.46±39.00 b
T4	75.62±0.34 a	49663.16±444.62 a	6871.63±42.65 a
Sig.	N.S.	*	*

NS = non-significant, *** it is significant at the 0.001 level; ** it is significant at the 0.01 level; * it is significant at the 0.05. T1: No acetic acid treatment (control group), T2: Eggs sprayed with acetic acid for 5 seconds, T3: Eggs sprayed with acetic acid for 10 seconds, T4: Eggs sprayed with acetic acid for 15 seconds

The effect of spraying eggs with acetic acid for different periods on some key traits was evaluated using the Pearson Chi-Square test. No significant differences were observed for sex ratio ($\chi^2 = 1.473$, p=0.688), fertility ($\chi^2 = 0.540$, p=0.910), or deformity/culling (DC) ($\chi^2 = 2.652$, p = 0.448). However, mortality was significantly affected by the treatments ($\chi^2 = 21.855$, p = 0.001), indicating that the duration of acetic acid application influenced embryo or chick survival during incubation and the early post-hatch period. Spraying eggs with acetic acid for different periods did not significantly affect sex ratio, fertility, or deformity/culling, suggesting that these traits are robust to acetic acid application. However, the significant effect on mortality highlights the importance of optimizing exposure time to minimize embryonic or early chick losses. Previous studies have shown that acid-based treatments can reduce microbial contamination on the eggshell, thereby enhancing hatchability, but excessive exposure or improper concentrations can increase embryo mortality [19-21]. The lack of effect on sex ratio and fertility aligns with findings by [22, 23], indicating that these reproductive parameters are less sensitive to surface treatments. Overall, carefully controlled application of acetic acid can improve chick survival without compromising fertility or sex distribution, supporting its practical use in hatchery management [24, 25, 26, 27].

Table 3: The effect of spraying eggs with acetic acid for different periods on some traits

Traits	Pearson Chi-Square	Sig.
Sex	1.473	0.688
Fertility	0.540	0.910
Mortality	21.855	0.001
DC	2.652	0.448

Sig. = Significance, DC = deformity/culling.

Conclusion:

In conclusion, spraying eggs with acetic acid for different periods did not significantly affect egg weight, breadth, or length but influenced chick weight, egg volume, and surface area. The treatment improved chick survival but did not affect fertility or deformities, highlighting its potential for hatchery management without compromising egg quality.

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