Special Issue:
Emerging and Re-emerging Animal Health Challenges in Low and Middle-Income Countries

Effect of Glucose and Folic Acid Injection in Egg on Hatchability of Japanese Quail

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Abstract | This research aimed to determine effects of injecting hatching eggs with nutrients, such as glucose and folic acid, in hatchery on hatching performance, growth, and health of quail chicks. A total of 300 hatching eggs were obtained from Japanese quail with an average weight ranging from 14g to 17g. These eggs were then divided into two nutritional regimens, with each treatment consisting of 75 birds. dietary treatments consisted of four groups including T1 a control group; T2, a group supplemented with 60mg of glucose; T3, a group supplemented with 0.1mg of folic acid; and T4, a group supplemented with 60mg of glucose and 0.1mg of folic acid. Folic acid treatment and combo treatment (glucose + folic acid) had the greatest hatching rate. There were no fatalities in either folic acid group or the mixed group. There was a statistically significant increase ($P \geq 0.05$) in weight for all age groups compared to birds-treated and control. A clear and statistically significant advantage ($P \geq 0.05$) was seen in a group of animals that were given a combination of glucose and folic acid in terms of their feed intake and feed conversion efficiency over 28 and 42-day periods. Our study revealed that administering a combination of nutritional solutions (consisting of 60 mg glucose and 0.1 mg folic acid) directly into the egg had a statistically significant impact ($P \geq 0.05$) on the body weight of quail birds at 28 and 42 days of age. Importantly, this intervention did not affect the amount of feed consumed or feed conversion efficiency. These finding propose consideration of a revised formulation to enhance the productivity in birds.

Keywords | Egg hatchability, Folic acid, Glucose, Quail

Received | August 18, 2025; **Accepted** | August 19, 2025; **Published** | October 14, 2025
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Citation | Nasear HA, Rahi DK, Adlan RH, Hussein BA (2025). Effect of glucose and folic acid injection in egg on hatchability of Japanese quail. J. Anim. Health Prod. 13(s1): 537-541.
DOI | https://dx.doi.org/10.17582/journal.jahp/2025/13.s1.537.541
ISSN (Online) | 2308-2801

INTRODUCTION

The practice of injecting hatching eggs with vitamins and nutrition solutions is recognized as a very successful strategy for ensuring the well-being and vitality of embryos. Glucose, with the chemical formula $C_6H_{12}O_6$, is a crucial carbohydrate and a simple monosaccharide. It serves as a vital mediator in metabolic processes and is widely recognized as a fundamental energy source for cells in most living organisms (Brady and Carson, 2023). Nevertheless, poultry eggs lack sufficient glucose, a vital energy source for enhancing embryo development. The overall carbohydrate content in eggs is believed to be a mere 1% (Sauve *et al*., 2021). Therefore, the inherent quantity of glucose in eggs is deemed inadequate and incapable of fulfilling the metabolic requirements of the baby. Research has shown that glucose levels in eggs during embryo incubation reach their minimum point on the seventh day (Baycumendur and Ergun, 2023). The study investigated different nutritional components to verify and validate their effectiveness in enhancing embryo development and increasing the hatching success rate. The research also examined these components' impact on the chicks' post-hatching performance. The study encompassed all feed compounds and nutrients (Kucharska-Gaca *et al*., 2017). Folic acid is a crucial vitamin with greater hatching demands than egg formation (Vieira, 2007). Folic acid is essential for the process of embryonic development. Irrespective of its impact on the health of the embryos inside the egg, it influences productive characteristics (Li *et al*., 2016). In a study conducted by (Amal *et al*., 2020) it was shown that injecting folic acid into chicken eggs enhanced growth and increased body weight.

This research paper seeks to improve productive performance by expediting embryo growth by injecting nutrients, specifically glucose, and folic acid, into hatching eggs. The objective is to investigate the direct impact of these nutrients on embryonic development, resulting in a reduction in embryo mortality rate and an improvement in hatching rate. Ultimately, this will lead to a substantial enhancement in embryo growth during the early incubation stage.

MATERIALS AND METHODS

A total of 300 hatching eggs were gathered from Japanese quail, with an average egg weight ranging from 14g to 17g. In the process of hatching, eggs were acquired from a private hatchery in Baghdad, Iraq. A total of 300 eggs were subjected to injections of nutritional solutions containing glucose and folic acid. Once the eggs had hatched, the resulting birds were separated into four groups, with 75 birds in each group. Each group was further split into three replicates, with 25 chicks in each duplicate. The treatments included the following: (T1) The Control group consists of chicks hatched from eggs not subjected to injection. (T2) The Experimental group consists of chicks hatched from injected eggs. The chicks hatching from eggs were treated with 60 mg of glucose, specifically T3. The subject received an injection of folic acid at a dosage of 0.1 mg (T4). The injection included a combination of glucose at 60 mg per egg and folic acid at 0.1 mg per egg.

Prior to conducting the egg injection operation, the broader end of the egg was sterilized using 70% ethyl alcohol. Subsequently, a sterile needle is used to inject the egg, taking care to avoid scratching or puncturing the outer membrane of the egg. Glucose and folic acid were injected into the egg's albumen region, reaching a depth of 12mm, using a 1 ml syringe. Subsequently, the apertures in the eggs were sealed using liquefied paraffin wax, and the eggs were given numerical labels and preserved at a temperature of 18 degrees Celsius (Akhlaghi *et al*., 2013).

The birds were provided with an initial diet from day 1 to day 21. The meal had a protein content of 23.02% and a metabolic energy of 2918.5 kg/kcal. The chicks were given this diet from the end of the third week to the sixth week of life. The diet has a protein level of 18%. The metabolic energy is 3095.8 kg/kg according to a previous study (Applegate and Angel, 2014).

The traits studied in the experiment

Hatchability

Hatching percentage of fertilized eggs = number of hatched birds/numbers of fertilized eggs x 1 (Melo *et al*., 2021).

Embryonic mortality percentage

The mortality rates in each replicate were recorded on a weekly basis and expressed as a percentage of the total number of chicks in each replicate. After the experiment, the replication and treatment were carried out in accordance with the following equation:

Percentage of deaths = number of chicks that died / number of chicks quantity × 100 (Legarreta and Hui, 2010)

Body weight (g)

Chicks of all groups were weighed collectively every week (Pandey, 2021).

Weight gain (g)

Weight Gain equals the average body weight at the end of the week subtracted from the average body weight at the beginning of the week (Pandey, 2021).

Amount of feed intake (g)

Feed intake is calculated by subtracting the quantity of feed remaining at the end of the week from the amount of feed delivered at the beginning of the week (Pandey, 2021).

Feed conversion efficiency (g) (FCE)

Feed conversion efficiency (FCE) equal Feed Intake g/ Weight Gain g (Legarreta and Hui, 2010).

Statistical analysis

The study's data were analyzed using a fully randomized design (CRD) using (Inc, 2011).

RESULTS AND DISCUSSION

Hatchability and embryonic mortality percentage

The use of egg injection technology has been recognized as a very significant approach for enhancing both the hatchability and productive performance of birds subsequent to the hatching process (Zhang *et al*., 2019). The egg injection method involves the introduction of several chemicals into the aerobic chamber of the egg, as described by (Kucharska-Gaca *et al*., 2017). I has been discussed that the administration of glucose and folic acid did not significantly impact hatchability (Amal *et al*., 2020). The injection of eggs into different groups affected the mortality rate of the embryos and their hatching success. No significant changes were seen in broiler eggs. Live body weight is a significant economic trait that poultry breeders want to enhance.

Table 1 presents the impact of including folic acid and glucose in the diet on the hatching rate of quail chicks. No notable variations were seen in the hatching rate among the various treatments during the duration of the trial. Nevertheless, the combination of folic acid and glucose and the therapy with folic acid alone exhibited a significant advantage in the hatching rate. The control and glucose treatments both saw a rise in the proportion of embryonic death in birds. In both the Folic acid and Mix groups, no mortality was reported throughout the breeding phase, which lasted for over seventy days following hatching, compared to other groups.

Table 1: Effect of injecting eggs with glucose and Folic Acid on Hatchability and Embryonic mortality percentage (mean ± standard error).

Embryonic mortality percentage	Hatchability	Group
3.63±0.26	79.27	Control
3.63 ±0.26	79.43	Glucose(60mg/egg)
-	85.32	Folic Acid(0.1mg/egg)
-	85.67	(Glucose 60 mg + Folic Acid 0.1 mg/egg)
N.S		

*Different letters vertically mean there are significant differences at the significance level (0.05).

Average of living body weight (gm) at the ages of 28 and 42 days

Table 2 shows the effects of injecting eggs with glucose and folic acid on the average live body weight of hatched Japanese quail birds at the ages of 28 and 42 days. The results showed a substantial increase (P≥0.05) in body weight at all ages compared to the control group. Liu *et al.* (2016) have performed research where they found a notable rise in the body weight of chickens at one day and four weeks of age when folic acid was injected into the eggs at 11 days of embryonic age. Separate research found that the group of chicken eggs injected with a combination of folic acid and glucose showed the greatest and most meaningful rise compared to the other groups (Liu *et al*., 2016). Folic acid may be the cause of weight gain. Injection may increase the expression of insulin-like growth factor, and a genetic link between chicken body weight and insulin-like growth factor levels in plasma has been documented. The body weight of birds in the Mix group showed a statistically significant increase after 28 days (Liu *et al*., 2016).

Table 2: Impact of injecting eggs with Glucose and folic acid on the body weight of hatched Japanese quail birds at the ages of 28 and 42 days (mean ± standard error).

Mean	Mix (glucose 60 mg +folic acid 0.1 mg)	folic acid (0.1mg)	Glucose (60mg)	Control	Period/ day
132.05 ±6.80	142.00 ±6.82	138.60 ±6.81	125.00 ±6.80	122.60 ±6.79	28
151.72 ±13.95	174.27 ±13.99	172.00 ±13.99	131.27 ±13.91	129.36 ±13.91	42

*Different letters vertically mean there are significant differences at the significance level (0.05).

Weight gain of hatched quails during the period (28-42) day

Table 3 shows the effects of injecting eggs with glucose and folic acid on weight increase from day 28 to day 42. No statistically significant difference (P≥0.05) was seen between the experimental groups throughout this time. The findings contradicted the results of research conducted by (Tarhan and Peşmen, 2023), which demonstrated that the bird's egg injected with glucose and vitamin C experienced an enhancement in Weight Gain compared to birds born from the control group.

Table 3: Impact of injecting eggs with Glucose and Folic acid on weight gain during the period between 28-42 days (mean ± standard error).

Mean	Mix (glucose 60 mg +folic acid 0.1 mg)	Folic acid (0.1mg)	Glucose (60mg)	Control	Period/ day
14.30 ±1.31	11.11±1.17	7.80 ±1.02	22.30 ±1.77	16.00 ±1.28	42 -28

*Different letters vertically mean there are significant differences at the significance level (0.05).

Amount of feed consumed by hatched quails during the period (28-42) day

Table 4 demonstrates a statistically significant advantage (P≥0.05) in a group receiving a combination of glucose and folic acid during the 28 and 42-day periods. This group closely resembled the control treatment, whereas other groups exhibited the lowest degree of significance in terms of feed consumption. The findings of this research aligned with the findings of the study performed by (Kanagaraju and Rathnapraba, 2019), which observed a rise in feed intake in the group whose eggs were injected with glucose on day 18 of incubation, as compared to the control group. In contrast, the findings of the present research aligned with those of a study conducted by (Nouri *et al*., 2018), which reported a rise in feed intake among a group of eggs that were administered folic acid by injection, as compared to the control group. Although the findings of this research diverged from those of (Liu *et al.*, 2016), no notable disparity in feed intake was seen among groups whose eggs were administered with folic acid in comparison to other groups. A study conducted by (Salmanzadeh, 2012) showed that the injection of glucose into an egg on the seventh day of incubation had no impact on feed consumption.

Table 4: Impact of injecting eggs with Glucose and folic acid on the amount of feed consumed during the period between 28-42 days (mean ± standard error).

Mean	Mix (glucose 60 mg +folic acid 0.1 mg)	folic acid (0.1mg)	Glucose (60mg)	Control	Period/ day
194.44 ±8.04	200.30 [a] ±8.92	191.60 [b] ±6.11	194.51 [b] ±8.27	199.36 [a] ±8.88	28
306.45 ±12.39	312.69 [a] ±12.31	300.60 [ab] ±12.43	302.34 [ab] ±12.60	310.17 [a] ±12.22	42

*Different letters vertically mean there are significant differences at the significance level (0.05)

Feed conversion efficiency hatched quails during the period (28-42) day

Table 5 demonstrates a statistically significant advantage (P≥0.05) in the treatment of glucose and folic acid combination, as well as the other groups, compared to the control group. The control group had the lowest degree of significance at 28 and 42 days. The current findings somewhat align with (Li *et al.*, 2016), as they demonstrated that administering folic acid to a set of eggs enhanced the feed conversion ratio (FCR). Nevertheless, according to (Nouri *et al.*, 2018), the feed conversion ratio (FCR) in broiler chickens that were administered folic acid showed a substantial improvement over the 0-42 day period compared to the control group. However, Kanagaraju and Rathnapraba (2019), Salmanzadeh (2012) discovered that chicks given glucose injections while still in their eggs had a greater conversion rate than hens that hatched naturally without any intervention.

Table 5: The impact of injecting eggs with Glucose and Folic acid on the amount of Feed conversion efficiency during the period between 28-42 days (mean ± standard error).

Mean	Mix (glucose 60 mg +folic acid 0.1 mg)	folic acid (0.1mg)	Glucose (60mg)	Control	Period/ day
2.45 ±0.03	2.39 [a] ±0.03	2.43 [a] ±0.03	2.43 [a] ±0.02	2.55 [b] ±0.07	28
3.04 ±0.10	3.48 [a] ±0.02	3.49 [a] ±0.02	3.51 [a] ±0.12	3.68 [b] ±0.27	42

*Different letters vertically mean there are significant differences at the significance level (0.05)

CONCLUSIONS AND RECOMMENDATIONS

The results of this study indicate that in-ovo injection of glucose or folic acid alone had no significant effect on hatchability in Japanese quail. However, the combined injection of both nutrients led to a marked improvement in body weight at 28 and 42 days of age, without affecting feed intake, feed conversion ratio, or mortality rate.

It is therefore recommended to consider combined in-ovo nutrient supplementation as a potential strategy to enhance post-hatch growth performance in Japanese quail, while further studies are suggested to explore its long-term effects and optimize dosage levels.

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to my academic laboratory staff, and all those who supported and guided me throughout the research work.

NOVELTY STATEMENT

This study presents a novel approach by evaluating the in-ovo injection of glucose and folic acid as a means to improve hatchability rates in Japanese quail, an area that has been rarely explored in previous avian research.

AUTHOR'S CONTRIBUTION

The author was solely responsible for designing the experiment, conducting laboratory work, data collection, analysis, and writing of the manuscript.

Generative AI and AI-assisted technology statement

The authors declare that no generative AI was used in the creation of this manuscript.

Conflict of interest

The authors have declared no conflict of interest regarding the publication of this research.

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