International Journal of Veterinary Science and Agriculture Research
Volume 6 Issue 2, May-june 2024
ISSN: 2582-4112, Available at www.ijvsar.com

Effect of Egg Storage Duration and Turning during Storage on Hatchability

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ABSTRACT: Commercial hatcheries often store eggs before incubation, and one method used to enhance hatchability is egg turning during this storage period. This study focuses on exploring how egg storage affects egg weight changes and how turning during storage can impact chick hatching. The experiment involved assessing the influence of storage duration and egg turning on egg quality, hatchability, and residual analysis. Researchers gathered 420 hatching eggs from a 55-week-old commercial Cobb500 breeder flock and stored them according to different treatment conditions. The experiment was designed using a completely randomized 3×2 factorial design, incorporating three different storage periods (3, 8, and 13 days) and the practice of egg turning (180° rotations once daily) or no turning during storage. This design resulted in six distinct treatment groups. The stored eggs were then incubated to hatch, and various parameters such as chick weights were recorded, along with calculating the hatchability rate. The association between weight changes across different storage periods was determined using a paired t-test, while categorical variables and the difference in hatchability outcomes were assessed using the Pearson chi-square test at a 95% confidence level, using SPSS version 23.0. The results showed a significant difference in egg weight between the different storage durations, both with egg turning and without ($P<0.001$). During the incubation period, there was a significant difference in egg weight among all treatments ($P<0.001$). Fertile hatchability was highest (92%) for eggs stored for 3 days with turning, while it was slightly lower in the non-turning condition and in eggs stored for 8 days, under both turning and non-turning conditions. As the storage period increased to 13 days without turning, hatchability decreased to 72%, accompanied by an increase in embryonic death. However, when turning was implemented, the results were similar to those of the 8-day storage period. Additionally, there were no significant differences in chick weights among eggs from the three different storage periods ($P>0.05$).

Key words: egg storage, egg quality, embryonic death, fertile hatchability

I. Introduction

1.1.1 Background

The poultry industry has experienced rapid growth globally, with significant adjustments contributing to its expansion over recent decades (Gerber et al., 2008). In Nepal, where approximately two-thirds of the population is involved in agriculture either directly or indirectly (FAO, 2020b), the poultry sector has also seen notable development. The agriculture sector makes up 27.1% of Nepal's national gross domestic product (GDP), with the poultry subsector alone contributing an estimated 4% to the GDP (MoALD, 2020). Nepal has around 320 poultry hatcheries, producing approximately 2.5 million broilers each week (MoALD, 2020). Commercial chicken farming plays a crucial role in providing livelihoods. To maximize returns on investments in poultry farming, it's essential for farmers to achieve efficient outputs at every stage of production, ranging from breeding to hatchery operations (Davey, 1948).In the past, eggs were hatched by placing them under broody hens. However, this method proved to be highly unsuitable for large-scale production of baby chicks. As a result, modern incubators that mimic the natural environment provided by broody hens but in a more efficient manner are now commonly used for hatching eggs.

The incubation process starts with the introduction of fertile eggs and continues as they undergo biological changes, eventually becoming 1-day-old chicks. Throughout this journey, the setter creates ideal conditions including temperature, relative humidity (RH), ventilation, and egg turning, all of which are conducive to the embryonic development from the laying of the egg to the hatching stage (Araújo et al., 2016). Pre-incubation factors like storage conditions (humidity and temperature) and duration significantly influence egg quality, subsequently affecting hatchability and the quality of hatchlings (Nasri et al., 2020). Commercial hatcheries often store eggs for several days to achieve a high volume of chicks hatching simultaneously, which is essential for their operations (Damaziak et al., 2018). Some management practices can be used during storage to reduce the negative effects that storage has on incubation yield, such as storing eggs with the thin tip down, egg turning during storage, and pre-storage incubation(Rocha et al., 2013). Research on egg turning during storage has shown promising results. Studies have indicated a decrease in embryonic mortality, leading to improvements in hatching rates and an increase in the number of healthy, saleable chicks (Elibol et al., 2002).

1.1.2 Statement of Problem

In the poultry production, the hatchability of eggs stands as amain factor that significantly influences the efficiency and productivity of the industry. The successful conversion of eggs into robust and viable chicks plays a crucial role in economic sustainability. Investigating the duration of egg storage and the practice of turning them during storage are essential variables, as they greatly influence hatchability rates and overall success. It's common practice to store hatching eggs for a few days before starting the incubation process. This approach allows for setting batches of eggs once or twice a week, leading to groups of chicks hatching together. Eggs are perishable and their quality declines over time, potentially reducing hatchability rates.The quality of eggs can be compromised by the length of time they are stored, potentially resulting in a decrease in hatchability. Longer storage periods can disrupt embryonic development, impacting hatchability due to possible metabolic disruptions and alterations in yolk composition (Hulet et al., 2007). Extended storage times can lead to increased microbial growth on the eggshell, which may hinder embryo viability (Miles et al., 2017). Hatchability of stored eggs can be influenced by various factors. As eggs are stored, their internal quality can deteriorate, impacting the development and viability of the embryo. This decline may involve changes in eggshell permeability, moisture loss, and gas exchange rates, all of which can contribute to reduced hatchability. Furthermore, alterations in the nutritional content of the egg, including yolk nutrients, can affect the growth and survival of the developing embryo.Researching the correlation between storage duration and hatchability is crucial to identifying the ideal storage period and conditions that would optimize hatchability rates.

Turning eggs during storage mimics the natural behavior of brooding chickens and promotes uniform embryonic development. However, the frequency and degree of turning can lead to different results. Turning aids in preventing the embryo from adhering to the inner shell membrane and improves gas exchange (Lourens et al., 2005). Yet, excessive turning may disturb the embryo's orientation, impacting its developmental path and, consequently, hatchability (Al-Murrani et al., 1978; Bakst, 1987).

1.1.3 Rationale of Study

Egg storage is a common practice in the poultry industry, enabling the management and accumulation of eggs before incubation. However, during storage, several variables such as temperature, humidity, and duration can affect the quality and viability of eggs. Analyzing the impact of storage duration on hatchability is essential for optimizing storage conditions and determining the ideal storage period for maximum hatchability. This knowledge can assist poultry producers in making informed decisions regarding egg storage protocols, leading to increased hatchability rates, improved productivity, and cost-effectiveness.

Hatchability refers to the percentage of eggs that successfully reach the end of the incubation period and hatch into chicks. This metric holds significant economic value in the poultry sector as it directly influences the number of chicks produced (Elamin et al., 2014). Maintaining a high hatchability rate is crucial for ensuring a steady supply of chicks. Any fluctuations from the optimal hatchability can result in economic losses due to reduced chick availability and disruptions in production schedules. Comprehending the factors influencing hatchability, like egg storage duration and turning methods, is vital for the efficiency and sustainability of the poultry industry. Egg storage duration, the period from egg production to incubation, presents unique challenges that must be managed. With time, eggs in storage undergo a slower pace of embryonic development, potentially impacting their hatchability.The impact of storage duration on hatchability is multifaceted, involving changes in yolk composition, metabolic processes, and microbial activity within the eggshell (Hulet et al., 2007). Consequently, determining the optimal storage period for eggs is a complex task, balancing the preservation of embryonic integrity with successful hatching outcomes. To gain insight into how storage duration affects egg viability and hatching success, research on the relationship between egg storage length and hatchability is essential.

Turning eggs during storage is designed to mimic the natural behavior of brooding hens, fostering consistent embryonic development. Effective turning helps prevent the embryo from adhering to the inner shell membrane and improves gas exchange, which are crucial for the overall well-being of the developing embryo (Lourens et al., 2005).

Understanding the impact of storage duration and turning practices on hatchability is essential for optimizing egg storage conditions and enhancing the efficiency of the poultry industry. By implementing best practices based on this knowledge, such as determining the optimal storage period and frequency of turning, the industry can improve hatchability rates and overall hatchery operations. This, in turn, contributes to increased productivity and sustainability within the poultry farming sector.

1.1.4 Objectives

1.1.4.1 General objective

- To study the impact of egg storage duration and egg turning during egg storage on hatchability.

1.1.4.2 Specific objectives

- To study the possible connection between the length of egg storage on hatchability and embryonic mortality.
- To know the loss of weight during storage and during incubation period.
- To know the effect of storage period on day old chicks weight.

II. Literature Review

To inhibit embryonic development during storage, eggs need to be kept at low temperatures. For eggs stored up to 4 days, the egg room temperature should range from 20-25°C. For eggs stored between 4 to 7 days, the temperature should be maintained between 16-17°C. Eggs stored for more than 7 days require an even lower temperature, ideally kept at 10-12°C (Meijerhof, 1992).Storage indeed leads to water loss in eggs through evaporation, and this rate is influenced by factors like temperature and relative humidity. Research indicates that extended storage periods can have negative effects on both table-egg and hatching-egg quality (Samli et al., 2005). During incubation, a normal process involves water loss, typically ranging from 12 to 14% for broiler and turkey eggs (Rahn et al., 1981).Maintaining the appropriate level of water loss is crucial for optimal embryo development and egg hatchability. If water loss is either too low or too high, it can negatively impact embryo development (Meir et al., 1984). Additionally, prolonging the storage duration can lead to increased embryo mortality during both storage and incubation, raising the risk of hatch failure (Whitehead et al., 1985). It's worth noting that egg storage before incubation can have both adverse and beneficial effects, depending on various factors.Research has shown that hatchability tends to decrease when eggs are set on the same day as oviposition compared to eggs stored for 4 days (Asmundson&MacIlraith, 1948a). One hypothesis for this decline is attributed to the high viscosity of albumen (measured as albumen height) in fresh eggs, which may hinder the transport of oxygen to the developing embryo (Benton & Brake, 1996). Indeed, studies have shown significant decreases in hatchability, with reductions of up to 5% per day observed after 7 days of egg storage (Mayes &Takeballi, 1984). The detrimental effects of egg storage are often attributed to the decline in overall egg quality, particularly in terms of albumen quality (Lapão et al., 1999). Consequently, the conditions under which eggs are stored before incubation can significantly impact hatchability, making this aspect a major concern in commercial hatchery operations (Butler, 1990).

Fertility and hatchability play crucial roles in the profitability of a hatchery business (Peters et al., 2008). Nonetheless, storing eggs for over a week is recognized to raise the occurrence of abnormal development and mortality in embryos due to the decline in the consistency of egg white (albumen) (Petek&Dikmen, 2006).Prolonged egg storage leads to reduced hatchability and extended incubation periods. A widely accepted rule in the hatchery sector is that for every day beyond a 10-day storage period, hatchability decreases by around 1% (Bakst &Akuffo, 2002).In the hatchery industry, a general rule is that hatchability decreases by about 1% for each day of storage beyond 10 days (Bakst &Akuffo, 2002). There are reports indicating that storing eggs before incubation can have both negative and positive impacts (Brake et al., 1993).Prolonged storage before incubation has been shown to lower hatchability (Becker, 1964). However, there are studies suggesting that eggs stored for a short period might have better hatchability than those immediately placed in an incubator after laying (Asmundson&MacIlraith, 1948a). Factors such as temperature, relative humidity (RH), storage duration, and egg orientation have all been reported to affect embryo development during both storage and incubation (Butler, 1990).The duration of egg storage, although just one of several influencing factors, is often considered the most crucial factor in achieving an adequate quantity and quality of chicks (Narahari et al., 1988). Effective management of egg storage duration can have a significant impact on hatchability rates and the general health and quality of the hatched chicks.

The eggshell serves as a protective barrier around the yolk and albumen, allowing for the exchange of carbon dioxide, oxygen, and water through its pores during storage (Juergens&Bessei, 2016). Various environmental factors can affect egg quality and contribute to its deterioration during storage (Silversides & Villeneuve, 1994). Monitoring the pH of the albumen during storage can offer valuable insights into changes in albumen quality over time (Akyurek&AgmaOkur, 2009). The porous nature of the eggshell aids in the release of carbon dioxide and moisture (Biladeau& Keener, 2009).

III. Materials and methods

3.3.1 Experimental site

This experiment was carried out from mid of June, 2023 to the end of July, 2023 at the Hy Po Agro Pvt. Ltd. of Dang district, Lumbini province which is a Broiler Breeder Farm.

3.3.2 Birds and Management

- The breeder birds are housed in a deep litter housing system having an area of 8000 square ft. for flock of 3000 poultry.
- The breeder stocks are fed with self-made mash feed which has proper nutrition as per requirement standard guideline of the Cobb breeder management.
- The birds are placed at the proper lighting management on the farm around 17 hours as per the Cobb guideline.
- The well vaccinated birds are kept for research purpose.

3.3.3 Selection of Eggs

420 eggs of following characteristics are taken:

- Clean eggs without any blood stain and soiled
- Collected within 2 hours of laying
- Ideal shape and size
- Eggs with intact and strong shells without any cracks, deformities or thin spots.

3.3.4 Experimental design

The treatments were arranged in a completely randomized 3*2 factorial design with three storage periods (3,8 and 13 days), and with or without turning during storage, for total of six treatments. Turning involved rotating the eggs 180 degree and was performed once a day in the morning; thus, eggs with the large end up were turned so the narrow end was up, or vice versa.

3.3.5 Fumigation and sanitation

- After collection and selection of every batch of eggs, the eggs were kept in a compact room for fumigation.
- In order to fumigate, Potassium permanganate and Formaldehyde in the ratio of 1:2 are mixed in a container and left for 30 minutes.

3.3.6 Storage of Eggs

In all cases eggs were kept with the small end down at 80% RH in a storage chamber being turned 180° once a day at regular intervals at 18 ℃.

3.3.7 Egg Incubation

- Following storage, the eggs are pre-warmed before incubation by maintaining them in the room.
- All the eggs will be loaded into the incubator setting trolly at once.
- The incubator temperature is maintained at 99.5-100 °F and Relative Humidity of 85 %, and eggs turn at 45 degrees angle every hour. On the 18^{th} day the eggs are transferred into hatcher, where temperature will be 99.5-100°F and Relative Humidity 90% without turning of eggs.

3.3.8 Egg weight loss and hatchability

Weight loss was assessed by weighing eggs on the day they were collected, on the final day of storage, and on day 18 of incubation. Egg weight loss during storage was determined by subtracting the egg weight on the day of collection from the egg weight on the last day of storage. Egg weight loss during incubation was calculated by subtracting the egg weight on the storage day from the egg weight on day 18 of incubation.The hatching rate was determined by considering all the eggs that were placed in the incubator and expressed as a percentage. Each group's hatched chicks were counted, and their weight was measured to determine the chick weight.

3.3.9 Statistical Analysis

Stored eggs were incubated for hatching, and the weights of the hatched chicks were recorded to calculate the hatchability rate. The association between the weight change during different storage periods was analyzed using a paired t-test for continuous variables, while the categorical variables and their impact on hatchability differences were assessed using a Pearson chi-square test. These analyses were conducted at a 95% confidence level using SPSS version 23.0.

IV. Results

Table 1:Effect of egg storage period on wt. of egg

Storage Period	Turning		p value	Non turning		p value
	Egg wt. (Before)	Egg wt. (After)		Egg wt. (Before)	Egg wt. (After)	
3	70.98±0.53	70.47±0.53	p<0.001	71.49±0.53	71.194±0.51	0.006
8	70.3±0.60	68.7±0.59	p<0.001	72.46±0.45	71.03±0.46	p<0.001
13	69.97±0.48	68.089±0.47	p<0.001	71.85±0.53	69.96±0.54	p<0.001

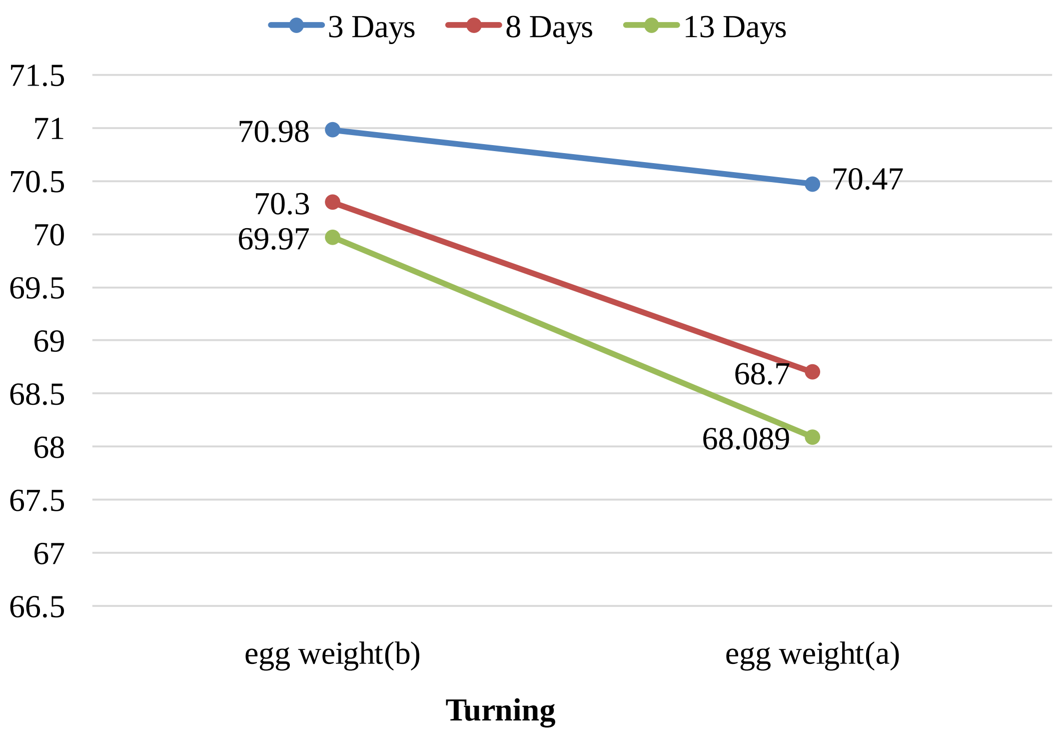

Figure 1:Line graph showing egg weight loss on Turning of egg during storage period

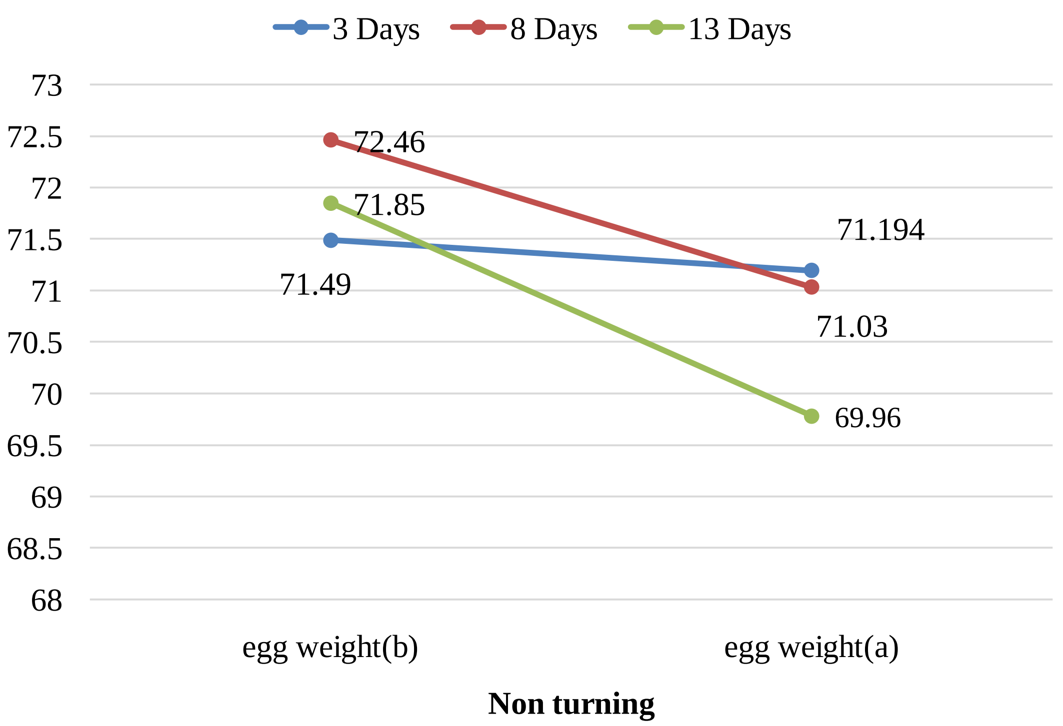

Figure 2:Line graph showing egg weight loss on Non- Turning of egg during storage period

There was a notable interaction observed between the duration of storage and egg turning in relation to egg weight. Specifically, there was a significant difference in egg weight before and after a storage period of 13 days, both in conditions where the eggs were turned and in conditions where they were not turned (P<0.001). The magnitude of the difference in average weight between after and before storage was substantial enough to be statistically significant.

The difference in egg weight before and after storage was significant for both 8-day and 13-day storage periods, irrespective of whether the eggs were turned or not (P<0.001). However, when comparing the mean difference between the two storage periods, it was observed that the 8-day storage period resulted in less weight loss compared to the 13-day storage period, in both turning and non-turning conditions.Interestingly, regardless of the storage period, turning the eggs showed a greater difference in weight loss compared to not turning them. This trend was consistent even for storage periods under 3 days. In the 8-day storage period, the mean difference in weight loss was 0.7% for turning eggs and 0.4% for non-turning eggs. For the 13-day storage period, the mean difference was 2.3% for turning eggs and 1.88% for non-turning eggs. Interestingly, in the 3-day storage period, there was a significantly smaller difference in weight loss for non-turning eggs (P = 0.006), but for turning eggs, there was a significantly larger difference in weight loss (P<0.001). This suggests that the effect of turning on weight loss may vary depending on the duration of storage.

Table 2:Egg wt. loss during incubation period

Storage Period	Turning		Non turning		p value
	Day 0	Day 18	Day 0	Day 18	
3	70.74±0.53	62.03±0.64	71.194±0.51	62.05±0.48	p < 0.001
8	68.697±0.59	60.85±0.47	71.02±0.50	62.13±0.33	p < 0.001

13	68.088±0.47	60.4±0.34	69.96±0.54	61.35±0.50	p < 0.001

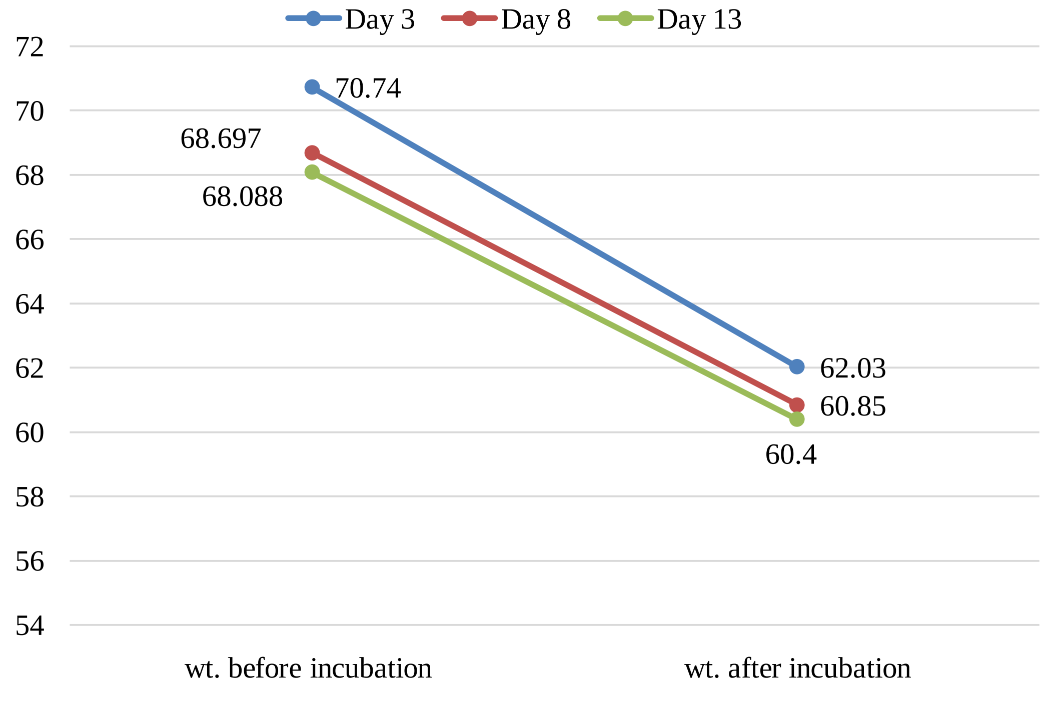

Figure 3:Line graph showing egg weight loss on Turning of egg during incubation period

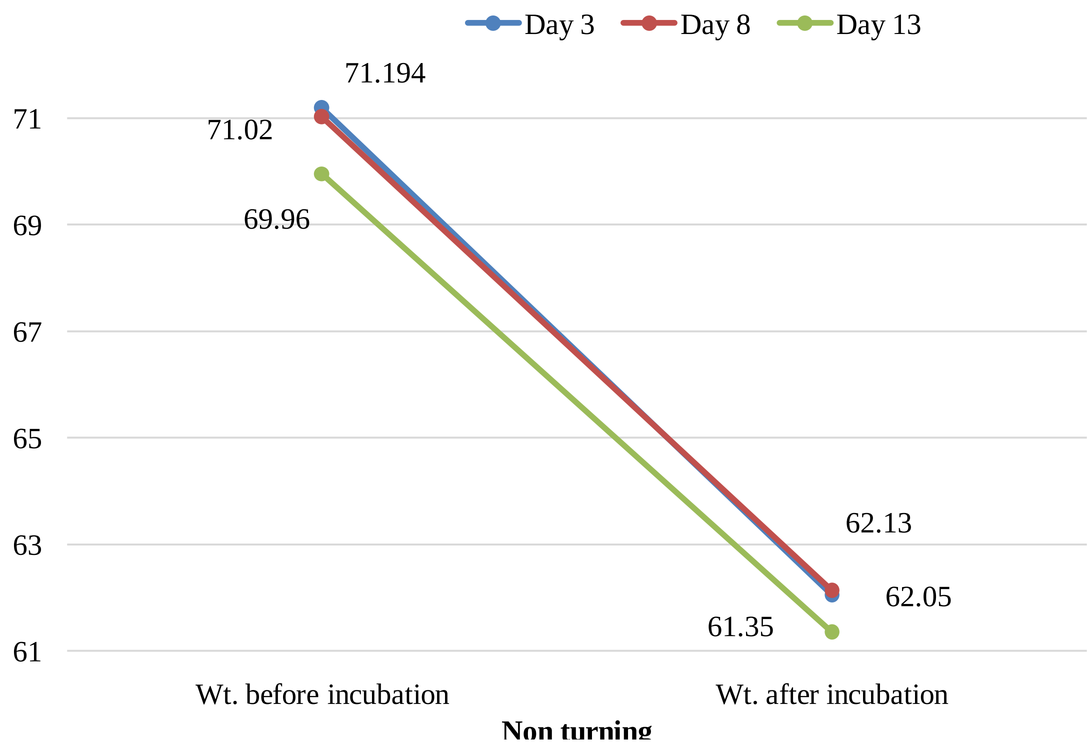

Figure 4:Line graph showing egg weight loss on Non- Turning of egg during incubation period

The average weight of the eggs significantly decreased during the incubation period across all storage duration conditions. There was a notably large difference in egg weight during incubation for all storage periods ($P < 0.001$).

The p-values being less than 0.001 for each combination of storage period and treatment indicate a highly significant difference in egg weight between Day 0 and Day 18 of incubation. This substantial decrease in egg weight is consistent across all storage periods and treatments, as indicated by the significant p-values.This implies that, regardless of the storage duration or treatment applied, there is a statistically significant decrease in egg weight over the incubation period. Interestingly, in the 3-day storage period eggs, the highest reduction in mean egg weight (indicating more water loss) was observed compared to the other storage periods. Conversely, less water loss was found in long storage periods compared to shorter storage periods.

Table 3:Results of Incubation

Day	Turning			Non turning			p value
	Hatched	Infertile	ED	Hatched	Infertile	ED	
3	58	7	5	56	6	8	0.699
8	53	10	7	51	9	10	0.896
13	52	10	8	41	13	16	0.015

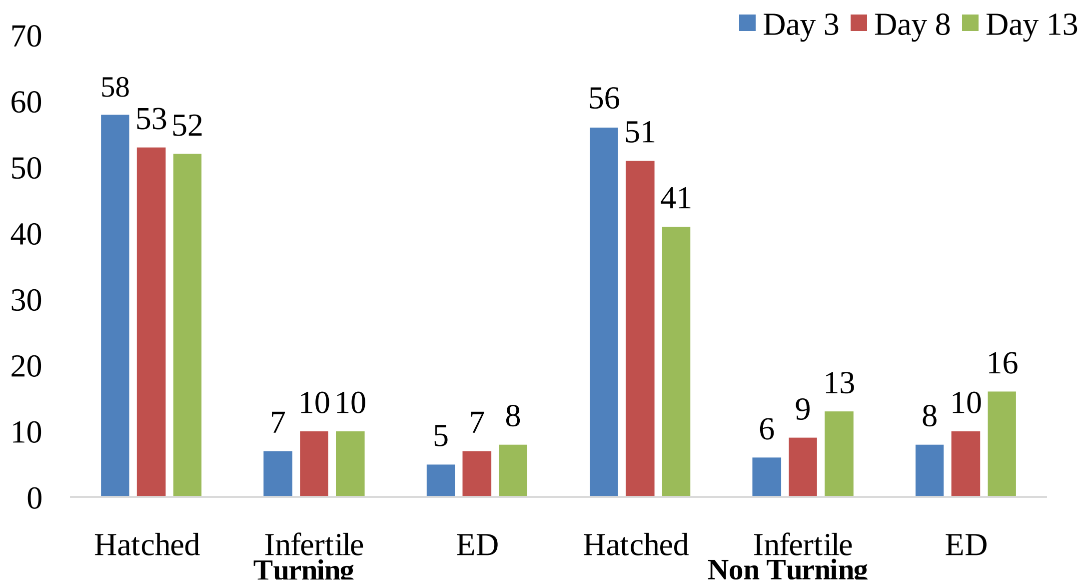

Figure 5:Bar graph showing result of incubation

As anticipated, fertile hatchability was higher in the three-day storage period, with rates of 92% for turning and 87% for non-turning cases. Interestingly, there was no significant difference in hatchability for the 3-day storage period (P>0.05). However, in the 8-day storage period, there was a slight decrease in hatchability.In this scenario, there was no significant difference between the turning and non-turning treatments in terms of hatchability (P>0.05), but there were slightly more sellable chicks in the turning condition. The poorest result was observed in the 13-day storage period non-turning condition with a hatchability rate of 72%, while the turning condition showed a satisfactory rate of 86%, which was similar to the 8-day storage period. There was a significant difference between the turning and non-turning conditions (P<0.05).
Eggs stored for 13 days without turning exhibited higher late embryonic mortality compared to non-turned eggs stored for 8 days, whereas non-turned eggs stored for 4 days showed lower mortality than the other two periods. There was a slight difference in embryonic death observed in turning conditions across the storage periods.

Table 4:Average weight of hatched chicks

Storage Period (Days)	Chicks wt.	p value
3	45.65±0.60	0.917
8	45.95±0.76	
13	46.06±0.44	

The p-value of 0.917 suggests that there is no statistically significant difference in the weight of chicks among the three different storage period eggs. The data does not provide enough evidence to conclude that the storage period of eggs has a significant effect on the weight of the chicks. The result suggests that, based on the data and the statistical test performed, there is no strong evidence to conclude that the storage period of eggs has a significant impact on the weight of the chicks.

V. Discussion

The experiments in this study revealed that advancements in artificial incubation technologies can lead to higher hatching rates. Longer storage periods were associated with increased weight loss in both turning and non-turning conditions. This increased weight loss in eggs stored for longer periods is primarily attributed to water loss but can also be influenced by transformation reactions occurring within the egg (Cherian et al., 1990).During storage, a transformation occurs in ovalbumin, converting it into S-ovalbumin, while the ovomucin-lysozyme complex dissociates, leading to the breakdown of ovomucin gel and the subsequent liquefaction of the albumen. These changes are crucial for achieving improved incubation results. Additionally, these reactions aid in the evaporation of water through the pores of the eggshell (Seibel et al., 2005).It's plausible that egg turning increased the rate of evaporation when the wider end was turned upward. The act of daily turning could have heightened eggshell conductance, which refers to the egg's gas exchange capacity. This is because the wider end of the egg contains a greater number of pores, leading to increased conductance (Araújo et al., 2016).Storing eggs before incubation is a necessary management practice to optimize embryonic development, and the associated egg weight loss is not entirely detrimental. Eggs that are incubated immediately after laying typically exhibit lower incubation yields (Benton & Brake, 1996). Moreover, higher quality albumen can make gas exchange during incubation more challenging.Therefore, before being incubated, eggs are stored to increase albumen pH about 7.6 up to between 1.6 and 2.1, which causes its liquefaction and leads to better hatching rates(Rocha et al., 2013).

The study revealed that eggs stored for 8 and 13 days experienced weight loss, although this did not affect hatching rates in eggs stored for 3 or 8 days, which still exhibited higher hatching rates. The lower hatching rates observed in non-turned eggs can be primarily attributed to the lack of movement of egg constituents. Elibol et al. (2002) proposed that storing eggs with turning helps reduce the detrimental effects of storage on eggshell membranes, which in turn promotes the normal development of the chorio-allantoic membrane during incubation. This hypothesis may explain the higher hatchability observed in turned eggs.Hatchability is influenced by increased embryo mortality, which is particularly notable on the second and third days of incubation (Mousa-Balabel&Saleem, 2004). The higher hatchability observed in eggs stored with the small end up is likely linked to the central position of the yolk, as well as the equatorial position of the blastoderm in the egg (Brake et al., 1997).The findings on eggs stored for 13 days in my study, unrelatedly of the turning, revealed higher late embryonic mortality compared to the other treatments. On the other hand, results found by (Brake et al., 1997) showed that eggs turned 4 or 24 times a day, independent of the storage time, had similar late embryonic mortality rates. The decrease in the number of hatched chicks and hatchability percentage observed with an increase in storage period beyond day 4, as recorded in the study, could possibly be attributed to water loss and albumen degradation during storage. This finding indicates that egg storage can lead to a decline in hatchability percentage from 92% to 72% if eggs are stored for up to 13 days.This result was in line with the findings of (Senbeta, 2016) who studied the effect of storage periods on egg weight loss, hatchability, and growth performance of chicks and found that there is a decline in hatchability when eggs are stored for prolonged periods. Similarly, (Yassin et al., 2008) addressed that storage duration beyond 7 days has a pronounced effect on hatchability. It has been well known in numerous domestic fowl that egg storage longer than 1 week significantly reduces hatchability(Asmundson & MacIlraith, 1948b; Becker, 1964) which was similar to my findings that eggs stored for 13 days had marked decrease in the fertile hatchability than in 8 and 3 days storage periods. A simple approach to preserve hatchability is to turn the eggs down during storage and allow normal position during incubation(Schulte-Drüggelte, n.d.). This method of turning eggs down during storage and allowing normal position during incubation was adopted in the present study and recorded an increased hatchability of 2.92 % above the normal position.

There was significance difference in the weight loss during the incubation period, and was more in short storage period than long storage period by comparing the mean difference between the variables. It was almost same to the (Stępińska et al., 2016) which performed experiment in turkeys. About 10.5% to 12.5% is considered to be ideal water loss (egg weight loss) according to(The Value of Understanding Moisture Loss in Incubation » Cobb, n.d.). If the value is less than normal it can lead to reduced hatchability, potentially malformed chicks and if the humidity is high than it can lead to increased bacterial growth, difficulty in gas exchange, which can negatively affect the developing embryo.

The negative effect of storage on embryonic mortality has been noted by researchers for some time(Sittmann & Abplanalp, 1971). It has been established that embryonic mortality even before incubation can be measured and that mortality increases as storage time lengthens(Fasenko et al., 1992). In broiler embryos, egg storage for 14 vs. 4 d increased embryonic mortality at early and late stages of incubation. Overall embryo mortality went from 10.7% in embryos of 4-d stored eggs to 27.7% in embryos from 14-d stored eggs(Fasenko et al., 1992). Likewise, in my research there was 12% embryonic mortality in 3 days storage period and 28% in 13 days stored eggs. According to (Surai et al., 2016) the effects of egg storage before incubation can reduce nutrients and antioxidant properties of yolk, and these antioxidants are essential to the hatching of chicks; thus, embryos are unable to hatch.

The relationship that exists between egg storage period and egg turning influenced chicks' hatchability percentage. The best performance in terms of chick hatched and hatchability percentage was observed in eggs turned and stored for 3 days. However, slightly lower hatchability performance was seen in 8 days storage period in both turned and non-turned condition. This result indicated that eggs stored for more than 7 days will decline hatchability percentage from 94.82 to 76.30%. This result agreed with the reports of (Onbasilar et al., n.d.) who studied the effects of egg storage period on hatching egg quality, hatchability, chick quality, and relative growth in Pekin ducks. In line with this, (Basha, 2015) reported that the main cause of low hatchability of long-stored egg was the decrease of albumen viscosity and increased pH of the albumen. According to (Scott & Silversides, 2000) and (Romao et al., 2008) a long storage period could be detrimental to hatching egg quality and can also reduce hatchability.

(Kosin & St. Pierre, 1956) examined the effect of preincubation of turkey and chicken eggs before storage. In both species, eggs that were warmed before storage of at least 7 d had higher hatchability than those not exposed to incubation before storage. In broiler breeder eggs stored for 4 d the hatchability (89.7%) was significantly lowered when the eggs were stored for 14 d (72.2%). The negative effect on hatchability was significantly reduced (78.1%) when the eggs were incubated for 6 h before storage for 14 d(Fasenko et al., 2001).

Chick weight is the most widely used indicator for day-old chick quality valuation. Previous studies proved that the hatching weight is determined by many factors such as genetic, egg weight, incubator environment, storage length, and weight loss in the incubator(Schmidt et al., 2009). Increased egg storage period could reduce chick weight and change in egg positioning as storage period increased could alter the chick weight positively(Ayeni et al., 2020), which disagreed with my finding that storage duration did not affected the chick weight ($P<0.05$). Rather, positive correlation exists between egg size and chick weight in broiler chickens. (Abiola et al. 2008) also reported that small chicks hatched from small eggs, while large chicks hatched from large eggs in Anak broiler breeder. Chick yield is one of the important factors in the incubation process and relates to the initial egg weight (Tullet 2009).

VI. Conclusion

Storage period and egg turning during storage affect the egg hatchability. It could, therefore, be inferred that storage must not exceed 8 days for optimum hatchability. However, if eggs are to be stored for more than 8 days, it could be suggested that storing of eggs with turning might enhance the hatchability.

References

[1] Akyurek, H., & Agma Okur, A. (2009). Effect of Storage Time, Temperature and Hen Age on Egg Quality in Free-Range Layer Hens. Journal of Animal and Veterinary Advances, 8, 1953–1958.

[2] Al-Murrani, W. K., Cherry, J. A., & Dziuk, P. J. (1978). Early embryonic survival and development after frequent turning of eggs during storage. Poultry Science, 57(3), 725–730.

[3] Araújo, I., Leandro, N., Mesquita, M., Café, M., Mello, H., Gonzales, E., & Federal University of Goiás, Brazil. (2016). Effect of Incubator Type and Broiler Breeder Age on Hatchability and Chick Quality. Revista Brasileira de Ciência Avícola, 18(spe2), 17–25. https://doi.org/10.1590/1806-9061-2015-0146

[4] Asmundson, V. S., & MacIlraith, J. J. (1948a). Preincubation Tests with Turkey Eggs. Poultry Science, 27(4), 394–401. https://doi.org/10.3382/ps.0270394

[5] Asmundson, V. S., & MacIlraith, J. J. (1948b). Preincubation Tests with Turkey Eggs. Poultry Science, 27(4), 394–401. https://doi.org/10.3382/ps.0270394

[6] Ayeni, A. O., Agbede, J. O., Igbasan, F. A., Onibi, G. E., & Adegbenro, M. (2020). Effects of storage periods and positioning during storage on hatchability and weight of the hatched chicks from different egg sizes. Bulletin of the National Research Centre, 44(1), 101. https://doi.org/10.1186/s42269-020-00362-4

[7] Bakst, M. R. (1987). Influence of storage and strain on early embryonic survival and development in the turkey. Poultry Science, 66(1), 30–33.

[8] Bakst, M. R., & Akuffo, V. (2002). Impact of Egg Storage on Embryo Development. Avian and Poultry Biology Reviews, 13(3), 125–131. https://doi.org/10.3184/147020602783698520

[9] Basha, H. (2015). Effect of Storage Period on Egg Weight Loss, Hatching Weight and Hatchability Percentage of Incubated Egyptian Balady Eggs. Alexandria Journal of Veterinary Sciences, 47(1), 216. https://doi.org/10.5455/ajvs.207712

[10] Becker, W. A. (1964). The Storage of White Leghorn Hatching Eggs in Plastic Bags1. Poultry Science, 43(5), 1109–1112. https://doi.org/10.3382/ps.0431109

[11] Benton, C. E., & Brake, J. (1996). The effect of broiler breeder flock age and length of egg storage on egg albumen during early incubation. Poultry Science, 75(9), 1069–1075. https://doi.org/10.3382/ps.0751069

[12] Biladeau, A. M., & Keener, K. M. (2009). The effects of edible coatings on chicken egg quality under refrigerated storage. Poultry Science, 88(6), 1266–1274. https://doi.org/10.3382/ps.2008-00295

[13] Brake, J., Walsh, T. J., Benton, C. E., Petitte, J. N., Meijerhof, R., & Penalva, G. (1997). Egg handling and storage. Poultry Science, 76(1), 144–151. https://doi.org/10.1093/ps/76.1.144

[14] Brake, J., Walsh, T. J., & Vick, S. (1993). Relationship of egg storage time, storage conditions, flock age, eggshell and albumen characteristics, incubation conditions, and machine capacity to broiler hatchability-Review and model synthesis. Zootechnia International, 16(1), 30–41.

[15] Butler, D. E. (1990). Egg handling and storage at the farm and hatchery. Avian Incubation., 195–203.

[16] Cherian, G., Langevin, C., Ajuyah, A., Lien, K., & Sim, J. S. (1990). Research Note: Effect of Storage Conditions and Hard Cooking on Peelability and Nutrient Density of White and Brown Shelled Eggs. Poultry Science, 69(9), 1614–1616. https://doi.org/10.3382/ps.0691614

[17] Damaziak, K., Pawęska, M., Gozdowski, D., & Niemiec, J. (2018). Short periods of incubation, egg turning during storage and broiler breeder hens age for early development of embryos, hatching results, chick's quality and juvenile growth. Poultry Science, 97(9), 3264–3276. https://doi.org/10.3382/ps/pey163

[18] Davey, A. (1948). "Efficiency"-A "must" in poultry production. World's Poultry Science Journal, 4(1), 36–45. https://doi.org/10.1079

[19] Elamin, K. M., Malik, H. E. E., Sakin, A. I. Y., Elagib, H. A. A., & Dousa, B. M. (2014). Effect of Egg Weight and egg Shell Thickness on Hatchability and Embryonic Mortality of Cobb Broiler Breeder Eggs. Global Journal of Animal Scientific Research, 3(1), Article 1.

[20] Elibol, O., Peak, S. D., & Brake, J. (2002). Effect of flock age, length of egg storage, and frequency of turning during storage on hatchability of broiler hatching eggs. Poultry Science, 81(7), 945–950. https://doi.org/10.1093/ps/81.7.945

[21] FAO. (2020b). Nepal at a glance | FAO in Nepal | Food and Agriculture Organization of the United Nations. https://www.fao.org/nepal/fao-in-nepal/nepal-at-a-glance/en/

[22] Fasenko, G. M., Robinson, F. E., Hardin, R. T., & Wilson, J. L. (1992). Research Note: Variability in Preincubation Embryonic Development in Domestic Fowl.: 2. Effects of Duration of Egg Storage Period. Poultry Science, 71(12), 2129–2132. https://doi.org/10.3382/ps.0712129

[23] Fasenko, G. M., Robinson, F. E., Whelan, A. I., Kremeniuk, K. M., & Walker, J. A. (2001). Prestorage incubation of long-term stored broiler breeder eggs: 1. Effects on hatchability. Poultry Science, 80(10), 1406–1411. https://doi.org/10.1093/ps/80.10.1406

[24] Gerber, P. J., Opio, C. I., & Steinfeld, H. (2008). Poultry production and the environment – a review. https://api.semanticscholar.org/CorpusID:16400395

[25] Hulet, R. M., Gladys, G. L., & Meijerhof, R. (2007). Embryonic development of broilers. Poultry Science, 86(5), 1020–1029.

[26] Juergens, C. A., & Bessei, W. (2016). Michael Grashorn, University of Hohenheim, Germany. 50.

[27] Kosin, I. L., & St. Pierre, E. (1956). Studies on Pre-Incubation Warming of Chicken and Turkey Eggs1,2. Poultry Science, 35(6), 1384–1392. https://doi.org/10.3382/ps.0351384

[28] Lapão, C., Gama, L. T., & Soares, M. C. (1999). Effects of broiler breeder age and length of egg storage on albumen characteristics and hatchability. Poultry Science, 78(5), 640–645. https://doi.org/10.1093/ps/78.5.640

[29] Lourens, A., van den Brand, H., Meijerhof, R., & Kemp, B. (2005). Effect of eggshell temperature during incubation on embryo development, hatchability, and posthatch development. Poultry Science, 84(6), 914–920. https://doi.org/10.1093/ps/84.6.914

[30] Mayes, F. J., & Takeballi, M. A. (1984). Storage of the Eggs of the Fowl (Gallus domesticus) before Incubation: A Review. World's Poultry Science Journal, 40(2), 131–140. https://doi.org/10.1079/WPS19840011

[31] Meijerhof, R. (1992). Pre-incubation holding of hatching eggs. World's Poultry Science Journal, 48(1), 57–68. https://doi.org/10.1079/WPS19920006

[32] Meir, M., Nir, A., & Ar, A. (1984). Increasing Hatchability of Turkey Eggs by Matching Incubator Humidity to Shell Conductance of Individual Eggs. Poultry Science, 63(8), 1489–1496. https://doi.org/10.3382/ps.0631489

[33] Miles, R. D., Butcher, G. D., & Henry, P. R. (2017). The effect of storage on the fertility, hatchability, and composition of eggs from broiler breeders. Poultry Science, 96(1), 45–52.

[34] MoALD. (2020). Journal | Publication Category | Ministry of Agriculture and Livestock Development. https://moald.gov.np/publication-types/journal/

[35] Mousa-Balabel, T. M., & Saleem, El. Kh. Y. (2004). EFFECT OF SELECTION AND DURATION OF STORAGE OF BROILER HATCHING EGGS ON HATCHABILITY PERCENT AND CHICK WEIGHT. Kafrelsheikh Veterinary Medical Journal, 2(2), 197–208. https://doi.org/10.21608/kvmj.2004.112436

[36] Narahari, D., Abdul Mujeer, K., Thangavel, A., Ramamurthy, N., Viswanathan, S., Mohan, B., Muruganandan, B., & Sundararasu, V. (1988). Traits influencing the hatching performance of Japanese quail eggs. British Poultry Science, 29(1), 101–112. https://doi.org/10.1080/00071668808417031

[37] Nasri, H., van den Brand, H., Najjar, T., & Bouzouaia, M. (2020). Egg storage and breeder age impact on egg quality and embryo development. Journal of Animal Physiology and Animal Nutrition, 104(1), 257–268. https://doi.org/10.1111/jpn.13240

[38] Onbasilar, E. E., Poyraz, O., & Erdem, E. (n.d.). Effects of egg storage period on hatching egg quality, hatchability, chick quality and relative growth in Pekin ducks—European Poultry Science. Retrieved

October 2, 2023, from https://www.european-poultry-science.com/effects-of-egg-storage-period-on-hatching-egg-quality-hatchability-chick-quality-and-relative-growth-in-pekin ducks,QUlEPTQyMTc5NDUmTUlEPTE2MTAxNA.html

[39] Petek, M., & Dikmen, S. (2006). The effects of prestorage incubation and length of storage of broiler breeder eggs on hatchability and subsequent growth performance of progeny. Czech Journal of Animal Science, 51(2), 73–77. https://doi.org/10.17221/3912-CJAS

[40] Peters, S. O., Shoyebo, O. D., Ilori, B. M., Ozoje, M. O., Ikeobi, C. O. N., & Adebambo, O. A. (2008). Semen Quality Traits of Seven Strain of Chickens Raised in the Humid Tropics. International Journal of Poultry Science, 7(10), 949–953. https://doi.org/10.3923/ijps.2008.949.953

[41] Rahn, H., Christensen, V. L., & Edens, F. W. (1981). Changes in Shell Conductance, Pores, and Physical Dimensions of Egg and Shell During the First Breeding Cycle of Turkey Hens1,2. Poultry Science, 60(11), 2536–2541. https://doi.org/10.3382/ps.0602536

[42] Rocha, J. S. R., Baião, N. C., Barbosa, V. M., Pompeu, M. A., Fernandes, M. N. S., Lara, L. J. C., Matias, C. F. Q., & Batista, J. V. M. S. P. (2013). Negative effects of fertile egg storage on the egg and the embryo and suggested hatchery management to minimise such problems. World's Poultry Science Journal, 69(1), 35–44. https://doi.org/10.1017/S0043933913000044

[43] Romao, J. M., Moraes, T. G. V., Teixeira, R. S. C., Cardoso, W. M., & Buxade, C. C. (2008). Effect of egg storage length on hatchability and weight loss in incubation of egg and meat type Japanese quails. Brazilian Journal of Poultry Science, 10, 143–147. https://doi.org/10.1590/S1516-635X2008000300001

[44] Samli, H. E., Agma, A., & Senkoylu, N. (2005). Effects of Storage Time and Temperature on Egg Quality in Old Laying Hens. Journal of Applied Poultry Research, 14(3), 548–553. https://doi.org/10.1093/japr/14.3.548

[45] Schmidt, G. S., Figueiredo, E. a. P., Saatkamp, M. G., & Bomm, E. R. (2009). Effect of storage period and egg weight on embryo development and incubation results. Brazilian Journal of Poultry Science, 11, 1–5. https://doi.org/10.1590/S1516-635X2009000100001

[46] Schulte-Drüggelte, R. (n.d.). Recommendations for hatching egg handling and storage.

[47] Scott, T. A., & Silversides, F. G. (2000). The effect of storage and strain of hen on egg quality1. Poultry Science, 79(12), 1725–1729. https://doi.org/10.1093/ps/79.12.1725

[48] Seibel, N. F., Barbosa, L. das N., Gonçalves, P. M., & Souza-Soares, L. A. de. (2005). Qualidade física e química de ovos de codornas alimentadas com dietas modificadas. Revista do Instituto Adolfo Lutz, 64(1), Article 1.

[49] Senbeta, E. K. (2016). Effect of Egg Storage Periods on Egg Weight Loss, Hatchability and Growth Performances of Brooder and Grower Leghorn Chicken. IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS), 9, 75–79. https://doi.org/10.9790/2380-0911017579

[50] Silversides, F. G., & Villeneuve, P. (1994). Is the Haugh Unit Correction for Egg Weight Valid for Eggs Stored at Room Temperature? Poultry Science, 73(1), 50–55. https://doi.org/10.3382/ps.0730050

[51] Sittmann, K., & Abplanalp, H. (1971). Extended Storage of Quail, Chicken, and Turkey Eggs. Poultry Science, 50(3), 722–725. https://doi.org/10.3382/ps.0500722

[52] Stępińska, M., Mróz, E., Krawczyk, M., Otowski, K., & Górska, A. (2016). Effect of hen age and storage time on egg weight loss and hatchability results in turkeys. Annals of Animal Science, 17. https://doi.org/10.1515/aoas-2016-0057

[53] Surai, P. F., Fisinin, V. I., & Karadas, F. (2016). Antioxidant systems in chick embryo development. Part 1. Vitamin E, carotenoids and selenium. Animal Nutrition, 2(1), 1–11. https://doi.org/10.1016/j.aninu.2016.01.001

[54] The value of understanding moisture loss in incubation » Cobb. (n.d.). Retrieved October 7, 2023, from https://www.cobb-vantress.com/en_US/articles/the-value-of-understanding-moisture-loss-in-incubation/

[55] Whitehead, C. C., Maxwell, M. H., Pearson, R. A., & Herron, K. M. (1985). Influence of egg storage on hatchability, embryonic development and vitamin status in hatching broiler chicks. British Poultry Science, 26(2), 221–228. https://doi.org/10.1080/00071668508416807

[56] Yassin, H., Velthuis, A. G. J., Boerjan, M., van Riel, J., & Huirne, R. B. M. (2008). Field study on broiler eggs hatchability. Poultry Science, 87(11), 2408–2417. https://doi.org/10.3382/ps.2007-00515

[57] Islam, S., & Ahmed, M. S. (2019). Knowledge, attitude, and practice toward zoonotic diseases among different professionals at selected coastal areas in Barguna district, Bangladesh. Journal of Advanced Veterinary and Animal Research, 6(3), 284–289. https://doi.org/10.5455/javar.2019.f346

[58] Kelly, T. R., Bunn, D. A., Joshi, N. P., Grooms, D., Devkota, D., Devkota, N. R., Paudel, L. N., Roug, A., Wolking, D. J., & Mazet, J. A. K. (2018). Awareness and Practices Relating to Zoonotic Diseases Among Smallholder Farmers in Nepal. EcoHealth, 15(3), 656–669. https://doi.org/10.1007/s10393-018-1343-4

[59] Niraula, A., Sharma, A., & Dahal, U. (2020). KNOWLEDGE, ATTITUDE AND PRACTICES (KAP) REGARDING ZOONOTIC DISEASES AMONG SMALLHOLDER LIVESTOCK OWNERS OF TULSIPUR SUB-METROPOLITAN CITY, NEPAL. JOURNAL OF HEALTHCARE IN DEVELOPING COUNTRIES, 1(3), 41–46. https://doi.org/10.26480/jhcdc.03.2021.41.46

[60] Singh, B. B., Kaur, R., Gill, G. S., Gill, J. P. S., Soni, R. K., & Aulakh, R. S. (2019). Knowledge, attitude and practices relating to zoonotic diseases among livestock farmers in Punjab, India. Acta Tropica, 189, 15–21. https://doi.org/10.1016/j.actatropica.2018.09.021

[61] Tebug, S. F., Kamga-Waladjo, A. R., Ema, P. J. N., Muyeneza, C., Kane, O., Seck, A., Ly, M. T., & Lo, M. (2015). Cattle Farmer Awareness and Behavior Regarding Prevention of Zoonotic Disease Transmission in Senegal. Journal of Agromedicine, 20(2), 217–224. https://doi.org/10.1080/1059924X.2015.1010068