



Amol University of Special  
Modern Technologies

Caspian Journal of Veterinary Sciences

doi: 10.22034/CJVS.2025.537515.1041

Journal homepage: <https://Cjvs.ausmt.ac.ir/>

## A survey on the causes of egg rejection and hatchability analysis in a hatchery in Amol, Mazandaran province

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Article Info	Abstract
<p><b>Article history:</b> Submit Date: 27 July 2025 Accept Date: 14 August 2025 Online Date: 4 December 2025</p>	<p>Studying the indicators associated with eggs sent to hatcheries, as well as the outcomes of the incubation process, is crucial for producing high-quality day-old chicks and, ultimately, desirable broilers. In this six-month study, eggs delivered to a hatchery in Amol, Iran, were examined to identify various reasons for egg rejection. Additionally, unhatched eggs were analyzed at the end of the incubation period to determine the causes of hatch failure. Out of 319,110 eggs submitted to the hatchery, 4,926 were rejected. Among the reasons for rejection, cracked shells accounted for the highest proportion (29.4%), followed by malformed and oversized eggs. A significant difference was observed in the mean percentage of rejected eggs across different breeder age groups. The lowest rejection rate occurred in the 31-40-week age group, while the highest was recorded in breeders older than 51 weeks. Furthermore, hatch residue analysis conducted at the end of the incubation period revealed that infertility was the most prevalent cause of hatch failure. According to the findings, the season can influence the overall hatchability rate and egg hatchability was higher in the spring compared to the summer.</p> <p>©2025 Published by Amol University of Special Modern Technologies Press. This is an open-access article under the CC-BY4.0 license (<a href="https://creativecommons.org/licenses/by/4.0/">https://creativecommons.org/licenses/by/4.0/</a>).</p>
<p><b>Keywords:</b> Amol Embryo mortality Hatch analysis Hatchery</p>	

## Introduction

Edible eggs are considered a highly valuable food source to meet human nutritional needs, while fertile eggs, by providing a suitable environment for embryo development, enable bird reproduction, and support the extensive poultry breeding industry (Lesson and Summers, 2000). Various factors, including genetic and managerial ones, affect eggs, causing increased embryonic mortality and ultimately impacting hatchability rates (Tona *et al.*, 2004; Hamidu *et al.*, 2007; Azizpour, 2019). Annually, about 2–12% of eggs are not selected for incubation due to unsuitable conditions and are sold cheaply for industrial and other uses (Dhawale, 2008). Additionally, at the end of each incubation period, some of the selected eggs do not hatch. By analyzing these unhatched eggs, factors causing hatch failures, such as genetic factors, nutrition of broiler breeder flocks, and management and hygiene conditions in hatcheries can be identified and addressed to improve hatchability rates in subsequent cycles (Azizpour, 2019; Assersohn *et al.*, 2021). Recent studies have emphasized the use of embryodiagnosis, candling, and microbiological analysis as effective tools for investigating hatch failures and categorizing early, mid, and late embryonic mortality (Assersohn *et al.*, 2021). Amol County, with 12 hatchery factories, 23 broiler breeder farms, and more than 250 broiler farms, holds a significant position in the poultry industry of the Mazandaran province. To the best of our knowledge, no research has yet been conducted on the causes of discarded fertile eggs in this county. The aim of this study was to determine the causes of discarded fertile eggs at the hatchery factory in Amol, Mazandaran province. By identifying the rate of discarded fertile eggs and their causes, significant measures can be taken to improve the conditions of contributing factors in poultry breeding centers and hatchery factories, ultimately reducing economic losses.

## Materials and Methods

Over a six-month period, data were systematically collected from seven active broiler breeder flocks located in various regions of Mazandaran province, whose embryonated eggs were delivered to a commercial hatchery in Amol. The total number of settable (hatchable) eggs and the number of rejected eggs were recorded.

Rejected eggs were examined for external abnormalities, including bloody shells, broken shells, soiled shells, cracked shells, oversized eggs, undersized eggs, and misshapen eggs. The frequency of each abnormality was calculated as a percentage of both the total number of settable eggs and the total number of rejected eggs. Upon completion of each incubation cycle, hatchability was assessed, and all unhatched eggs were opened and evaluated to determine the cause of hatch failure. This post-hatch analysis enabled the differentiation between infertile eggs and those exhibiting embryonic mortality at early, mid, or late developmental stages, with each category quantified as a proportion of the total hatch failures.

## Statistical analysis

The collected data were analyzed using a completely randomized design with SAS software according to the general linear model (GLM). Mean comparisons were performed using Duncan's Multiple Range Test. The significance level was set at 0.05.

## Results

Out of 319,110 eggs sent to the hatchery and examined, a total of 4,926 eggs (1.54%) were rejected. Seven indicators of egg rejection were evaluated in this study, and based on the results; the highest proportion of rejected eggs was due to cracked shells (29.4%). Additionally, misshapen eggs, very large eggs, and very small eggs accounted for 24.3%, 18.9%, and 16.8% of rejected eggs, respectively (Fig. 1). The average number of eggs sent, rejected eggs, and the percentage of rejected eggs based on the age of the broiler breeder flock were presented in Table 1. The analysis of rejected eggs across different age groups of breeder hens indicated a statistically significant increase in egg rejection percentage in birds older than 40 weeks ( $p < 0.05$ ). While hens aged between 24 and 40 weeks had lower and statistically similar rejection rates (1.35% and 0.90%, respectively), those in the 41–50 and >51-week groups showed a sharp increase (2.60% and 3.34%). These results suggest that advancing breeder age is associated with a notable decline in egg quality and hatchery suitability.

The average percentages of embryo mortality at various incubation stages in spring and summer were shown in Table 2. The percentage of infertile

eggs did not significantly differ between spring (8.5%) and summer (8.1%) ( $P = 0.15$ ). Similarly, early embryonic mortality at 24-48 hours was 1.9% in spring and 2.1% in summer, with no significant difference ( $P = 0.11$ ). Mortality between days 3-5 was slightly higher in summer (3.3%) than spring (2.5%) ( $P = 0.21$ ), though the difference was not significant. Mid-incubation mortality (days 6-11 and 12-17) was also comparable across seasons, with no significant differences observed ( $P = 0.12$  and  $P = 0.16$ , respectively). However, late embryonic mortality at days 18-19 showed a statistically significant increase in the summer group (2.4%) compared to spring (1.7%) ( $P = 0.04$ ). Mortality during the final two days (days 20-21) was higher in summer (1.7%) than in spring (1.1%), but this difference was not statistically significant ( $P = 0.11$ ). Total hatchability was significantly higher in spring (83.1%) than in summer (77.2%) ( $P = 0.02$ ), indicating a seasonal impact on overall hatching success.

**Table 1.** Percentage of rejected eggs based on the age of the breeder flocks.

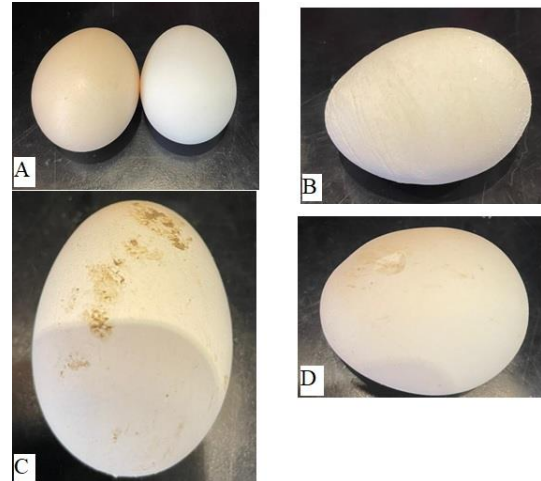
Breeder age (weeks)	Total eggs	Rejected eggs (n)	Rejected eggs (%)	p-value
24-30	112360	1520	1.35 <sup>a</sup>	0.08
31-40	125030	1130	0.9 <sup>a</sup>	0.06
41-50	62100	1620	2.6 <sup>b</sup>	0.02
>51 week	19620	656	3.34 <sup>b</sup>	0.01

\* Different letters in each column show significant differences ( $P < 0.05$ )

**Table 2.** Average percentage of embryo mortality at different ages of the incubation period in spring and summer.

Mortality before hatch (%)	Season		p-value
	Spring	Summer	
Infertile egg (%)	8.5 ± 0.52	8.1 ± 0.3	0.15
Mortality at 24-48 hours (%)	1.9 ± 0.37	2.1 ± 0.05	0.11
Mortality at day 3-5 (%)	2.5 ± 0.2	3.3 ± 0.02	0.21
Mortality at day 6-11 (%)	1.1 ± 0.3	1.4 ± 0.05	0.12
Mortality at day 12-17 (%)	2 ± 0.12	2.4 ± 0.2	0.16
Mortality at day 18-19 (%)	1.7 ± 0.02 <sup>b</sup>	2.4 ± 0.05 <sup>a</sup>	0.04
Mortality at day 20-21 (%)	1.1 ± 0.42	1.7 ± 0.3	0.11
Total hatch (%)	83.1 ± 0.71 <sup>a</sup>	77.2 ± 0.3 <sup>b</sup>	0.02

\*Different letters in each row show significant differences ( $P < 0.05$ )



**Fig. 1.** Different conditions of discarded eggs: A) Undersized egg; B) Misshapen egg; C) Shell with fecal contamination; D) Cracked shell.

## Discussion

The findings of this study indicated a significant increase in the percentage of rejected eggs as the age of the broiler breeder flocks increases, particularly beyond 40 weeks of age. This trend was consistent with prior research showing that egg quality deteriorates with advancing flock age due to physiological changes in the reproductive tract, shell formation processes, and nutrient absorption efficiency (Peebles and Brake, 1987). Older hens often produce eggs with weaker shells, irregular shapes, or thinner membranes, which are more prone to rejection during quality control (Roberts, 2004). In contrast, younger flocks (24-40 weeks) are at their peak reproductive performance, with optimal shell quality and egg uniformity (Tona *et al.*, 2004). The highest rejection rate (3.34%) in flocks over 51 weeks may be attributed to cumulative physiological wear and tear, decreased calcium metabolism, and increased prevalence of shell defects, such as cracks and translucency (Safaa *et al.*, 2008). Furthermore, egg rejection in older hens may also increase due to higher rates of contamination, internal defects (e.g., blood spots), and microcracks, which are harder to detect externally (Nys *et al.*, 2011; Ketta and Tůmová, 2016).

In the current study, the highest rejection rate (3.34%) was observed in flocks older than 51 weeks, consistent with research by Safaa *et al.* (2008) which suggested that extended laying periods contribute to cumulative shell damage

and rising incidence of internal abnormalities, such as blood spots and yolk mottling. Moreover, the proportion of misshapen and oversized eggs also increases significantly with flock age, likely due to dysregulated follicular development and declining efficiency of ovulation control (Bar *et al.*, 1998). These results were reinforced by findings from Azizpour (2018) and updated by Cheng and Ning (2023), indicating that cracked and malformed eggs remain among the most prevalent reasons for egg condemnation, accounting for over 50% of rejected fertile eggs. Notably, the trend of increased egg rejection in older hens has significant economic implications and calls for targeted age-specific interventions. Nutritional strategies, such as increasing dietary calcium bioavailability, supplementing vitamin D<sub>3</sub> metabolites, and incorporating organic trace minerals (e.g., Zn, Mn, Se), have shown promise in improving shell strength and egg uniformity in aged flocks (Gao *et al.*, 2024; Yang *et al.*, 2024). Additionally, the adoption of automated egg collection and gentle handling systems can further reduce shell damage and microbial contamination, especially in older flocks with structurally fragile eggs.

The findings of this study revealed a clear seasonal effect on late embryonic mortality and total hatchability, with summer conditions adversely affecting both parameters. The significantly higher mortality during days 18-19 of incubation and the reduced hatchability observed in the summer group suggest that elevated environmental temperatures during this period may have a detrimental impact on embryonic development and hatching success. Late incubation stages, particularly after day 18, were physiologically critical for the embryo. At this point, the embryo transitions from chorioallantoic to pulmonary respiration, and any imbalance in temperature or oxygen availability can lead to metabolic disturbances and mortality (Surai *et al.*, 2016). High ambient temperatures in summer can elevate internal egg temperatures, even with controlled incubator settings, leading to excessive embryonic heat production and insufficient cooling capacity (Lourens *et al.*, 2005). This thermal stress can result in increased oxygen demand, reduced gas exchange efficiency, and cardiovascular strain in the embryo (Pokhrel *et al.*, 2021). Moreover, high humidity levels often associated with summer can impair moisture loss from the egg, leading to oversized embryos, inadequate air cell development, and difficulties in

pipping or hatching (Tona *et al.*, 2005). Suboptimal gas exchange combined with delayed or weak pipping may further explain the rise in mortality observed during the final days of incubation. The observed reduction in total hatchability in summer (77.2%) compared to spring (83.1%) underscores the cumulative impact of seasonal heat stress. Under heat stress, feed intake decreases, and panting in birds leads to respiratory alkalosis. This physiological response is associated with an increase in blood pH and a reduction in blood calcium and bicarbonate levels, both of which are essential for proper eggshell strength. As a result, eggshell quality deteriorates, which in turn contributes to reduced hatchability.

In summary, the findings of this study demonstrated that breeder flock age plays a critical role in the occurrence of egg abnormalities. A significant increase in the proportion of rejected eggs was observed as flock age advanced. Additionally, seasonal variations appeared to influence total hatchability rates.

## Acknowledgement

The author wishes to acknowledge the Research Deputy of Amol University of Special Modern Technologies.

## Conflict of Interest

There are no conflicts to declare.

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