Neo Science Peer Reviewed Journal
Volume 43, February - 2026 ISSN (E): 2949-7701
www.neojournals.com

THE EFFECT OF MODIFYING THE TEMPERATURE REGIME DURING INCUBATION ON EMBRYONIC DEVELOPMENT

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Abstract:

This study investigated the effect of incubation temperature regime modification on embryonic development, viability, and hatchability of chicken embryos. A total of 90 chicken eggs of the same breed, with an average weight of 58–60 g and without external defects, were divided into three groups: control, progressive temperature regime, and regressive temperature regime. Embryonic development was monitored using the ovoscopy method on days 7, 14, and 18 of incubation. Hatchability, embryonic mortality, and chick quality were evaluated at the end of incubation. The results showed that the progressive temperature regime provided the highest embryonic survival and hatchability rate, reaching 93.3%, while embryonic mortality was the lowest at 6.7%. In contrast, the regressive temperature regime resulted in higher embryonic mortality (26.7%) and lower hatchability (73.3%). The findings indicate that the progressive incubation temperature regime improves embryonic development, reduces mortality, and increases hatchability efficiency.

Keywords:

Incubation, chicken egg, embryonic development, temperature regime, progressive incubation, embryonic mortality, hatchability, ovoscopy, incubator, poultry science.

Introduction

The poultry industry in the Central Asian region is developing under the influence of global trends while simultaneously facing a number of regional challenges. Differences in infrastructure between rural and urban areas, limited availability of veterinary services, disparities in disease prevention strategies, and the underdevelopment of market infrastructure complicate poultry production in the region. In particular, there is a shortage of knowledge and resources related to technological factors such as maintaining consistent control of temperature and humidity during incubation, improving the quality of breeding materials, and implementing evidence-based management systems. These issues contribute to lower hatchability rates and increased losses during the incubation process, ultimately reducing overall poultry productivity. Research is ongoing to mitigate these challenges through regional cooperation and the introduction of scientifically grounded technological solutions.

In the study, chicken eggs of the same breed, with an average weight of 58–60 g and without external defects, were used. Each group consisted of 30 eggs set for incubation. The eggs were divided into three groups: a control group, Experimental Group I, and Experimental Group II. The study was conducted using automatic incubators designed for poultry incubation. The incubation period lasted 21 days. The experiments were carried out under laboratory conditions with continuous monitoring of temperature and humidity.

Objective of the Study:

To evaluate the effects of temperature, humidity regimes, and egg-turning frequency during poultry egg incubation on embryonic development, hatchability, and embryo viability.

Tasks of the Study:

1. Analyze the biological basis of the incubation process;
2. Compare the stages of embryonic development in control and experimental groups;
3. Determine the effects of deviations from standard temperature on embryo morphology.

Research Methods:

Ovoscopy (on days 7, 14, and 18): Ovoscopy is performed at the following stages: Preparation: Eggs are examined in a dark place to clearly observe internal structures. Examination with light: A light source is directed at the top or bottom of the egg. The light passes through the egg, revealing the contours of internal structures.

- **Evaluation of results:** In a healthy egg, blood vessels are clearly visible; if the embryo is developing, it moves or its contour is distinct. Dead embryos or unfertilized eggs appear fully illuminated under light as a uniform mass.

Ovoscopy is an important diagnostic method that allows careful monitoring of embryo development during incubation, early identification, and removal of defective eggs, thereby increasing hatchability. This method provides a solid scientific basis for effective incubation management.

Determination of Embryo Mortality; Evaluation of Hatchability and Chick Quality:

- **Purpose:** To assess the outcome of incubation.
- **Indicators:** Hatchability percentage, average weight, activity level.
- **Procedure:**

1. After incubation ends, hatched chicks are counted.
2. Hatchability is calculated as:

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

Each chick's weight is measured, and activity is assessed (high, medium, low).

3. Results are compared between groups.

This structured methodology ensures accurate assessment of incubation outcomes and the effects of experimental conditions on embryonic development.

Table 1.Control group incubation (standard incubation)

Daily	Temperature, °C	Humidity, %	Rotation, times/day
1-18	37,6-37,8	55-60	4-6
19-21	37,2	65-70	No

Table 2. Experimental Group 1 (Dynamic Incubation)

Stage	Daily	Temperature, °C	Humidity, %	Rotation, times/day
I	1-7	37,8-38,0	60-62	7-8
II	8-14	37,6	55-57	6-7
III	15-18	37,4-37,5	52-55	5-6
IV	19-21	37,1-37,2	70-75	Stopped

Experimental Group 2 (Regressive Incubation)

Daily	Temperature, °C	Humidity, %	Rotation, times/day
1-18	35,6-35,8	50	2-3
19-21	36,8	60	No

In artificial incubation of poultry eggs, temperature is considered the primary regulatory factor of embryonic ontogenesis. For chicken eggs, the optimal incubation temperature ranges between 37.5-37.8 °C, and deviations from this range directly affect metabolic processes, gas exchange, enzymatic activity, and cellular differentiation.

Temperature influences the following aspects of embryonic development:

- Metabolic energy expenditure and O_2 consumption
- Heart rate and blood circulation
- Protein synthesis and tissue differentiation
- Duration of the incubation period
- Hatchability and chick quality

Even deviations of ±0.5–1.0 °C from the physiological norm can increase embryonic mortality. Research by Romanoff A.L. demonstrated that incubation at 36.5 °C reduced embryonic body mass by 3-5% and decreased hatchability. [1]

According to Lundy H., prolonged low temperatures caused leg deformities and internal organ malformations in chicks.[2]

Studies by Decuypere E. and Bruggeman V. reported that incubation at 39.5 °C increased early embryonic mortality by 10–15%. [3]

French N.A. (1997) observed that high temperatures reduced chick body weight and prolonged the post-hatch adaptation period.[4]

Tullett S.G. demonstrated that from the 15th day of incubation, embryos start producing heat independently, necessitating a reduction in incubator temperature. [5]

In recent years, research has focused on short-term temperature variations during incubation to enhance heat tolerance in chicks.

Experiments conducted by Piestun Y. showed that applying thermal exposure at 39 °C for 3–6 hours on days 16–18 increased the chicks' subsequent resistance to heat stress. [6]

Table 4. Effect of temperature regime alteration during incubation on embryonic development and hatchability

Indicators	Unit of measurement	Control group (standard), n = 30	1st experimental group (progressive), n = 30	2nd experimental group (regressive), n = 30
Number of fertilized eggs	pcs	30	30	30
Fertilization rate	%	100	100	100
Live embryos on day 7	pcs	28	29	25
Embryo survival on day 7	%	93,3	96,6	83,3
Live embryos on day 14	pcs	27	29	24
Embryo survival on day 14	%	96,6	100	96,6
Live embryos on day 18	pcs	26	29	22
Healthy chicks at the end of incubation	pcs	25	28	22
Hatchability (relative to fertilized eggs)	%	83,3	93,3	73,3
Embryonic mortality	%	16,7	6,7	26,7
Proportion of weak chicks	%	3,8	3,4	0

According to the data presented in Table 4, altering the temperature regime during incubation had a significant effect on embryonic development, survival, and hatchability. During the study, the number of eggs set for incubation was the same in all groups, 30 eggs per group, and the

fertilization rate was 100% in all groups. This indicates the biological completeness of the eggs used and confirms that the initial conditions were equal across the experimental groups.

At the initial stage of incubation (day 7), analysis of embryonic survival showed that the 1st experimental group (progressive temperature regime) achieved the highest results, with 29 live embryos (96.6%). This was 1 embryo (3.3%) higher than the control group and 4 embryos (13.3%) higher than the 2nd experimental group (regressive regime). The survival rate in the control group was 93.3%, and in the regressive group, it was 83.3%, indicating that the regressive temperature regime negatively affected early embryonic development.

At the mid-incubation stage (day 14), the progressive regime maintained the highest embryo survival rate, reaching 100%, while the control and regressive groups showed 96.6%. This demonstrates that the progressive temperature regime provides optimal conditions for physiological embryonic development and ensures stable metabolic processes.

At the later stage of incubation (day 18), the superiority of the progressive regime persisted. The number of live embryos was 29 in the progressive group, compared to 26 in the control group and 22 in the regressive group, indicating that the regressive temperature regime increases the risk of embryonic mortality in later developmental stages.

Final incubation results also confirmed the effectiveness of the progressive temperature regime. The number of healthy chicks was 28 (93.3%) in the 1st experimental group, which was 3 chicks (10.0%) higher than the control group and 6 chicks (20.0%) higher than the regressive group. In the control group, the hatchability was 83.3%, while the regressive group showed the lowest value of 73.3%.

Analysis of embryonic mortality further highlighted the importance of temperature regime. The lowest mortality rate was observed in the progressive group at 6.7%, which was 10.0% lower than the control group and 20.0% lower than the regressive group. The highest embryonic mortality (26.7%) occurred under the regressive regime.

Chick quality was also higher under the progressive temperature regime. The proportion of weak chicks was 3.4% in the progressive group, compared to 3.8% in the control group. In the regressive regime, low hatchability resulted in poorer chick quality. These results indicate that applying a progressive temperature regime during incubation ensures high survival at all stages of embryonic development, reduces embryonic mortality, and significantly increases the proportion of healthy chicks. This effect is explained by the creation of optimal thermal conditions that correspond to the physiological needs of the developing embryo. In conclusion, the study demonstrates that the application of a progressive temperature regime during incubation is biologically and practically effective and confirms its suitability for obtaining high-quality, viable chicks in poultry production.

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