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EFFECTS OF PRE-HATCH THERMAL PROGRAMMING ON INTERNAL ORGAN DEVELOPMENT OF CROSSBRED CHICKENS IN THE FIRST WEEK POST-HATCH

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ABSTRACT

This study evaluated the effects of pre-hatch thermal programming on internal organ development of crossbred chickens in the first week post-hatch. A total of 200 fertile eggs from a crossbreed of male local chickens and commercial laying hens were used in this study. The average egg weight was 62.76 ± 4.40 g with a coefficient of variation was 7.01%. The eggs were randomly distributed into four treatment groups, each with five replicates (10 eggs per replicate). The treatments were T0: standard incubation maintained at 37.50°C throughout the entire incubation period (control); T1: standard incubation with a 6-hour daily increase to 38.50°C from days 10-18, T2: standard incubation with a 6-hour daily increase to 39.50°C from days 10-18, and T3: standard incubation with a 6-hour daily increase to 40.50°C from days 10-18. After hatch, the chicks were reared for a week and evaluated for internal organ development. The results showed that there were no significant differences among treatments (P>0.05) for all measured variables, including the absolute weights (g) and relative percentages (%) of the internal organ. The absolute weight of the heart, liver, proventriculus, gizzard, and intestine were ranged from 0.69 to 0.84, 2.68 to 2.93, 0.74 to 0.87, 6.48 to 7.05, and 7.94 to 8.42 g, respectively. Whereas, the relative weight of the heart, liver, proventriculus, gizzard, and intestine were ranged from 0.89 to 1.12, 3.46 to 3.79, 0.95 to 1.13, 8.29 to 9.11, 10.24 to 10.82%, respectively. It could be concluded that pre-hatch thermal programming can be considered a safe strategy without compromising internal organ development of crossbred chickens in the early post-hatch period.

Keywords: heat stress; heart; incubation temperature; liver; poultry.

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INTRODUCTION

Climate change has substantially intensified heat stress in poultry production. This stressor hampers growth performance, reduces feed intake, and compromises overall health, resulting in considerable economic losses for poultry producers (Rocchi et al., 2023; Kim et al., 2024). Poultry are especially vulnerable due to their high metabolic rates and lack of sweat glands, limiting their capacity to dissipate heat effectively (Dung et al., 2024). Chronic heat stress also disrupts gut integrity and immune responses, thereby elevating disease susceptibility (Yang et al., 2024; Zhang et al., 2024). These challenges jeopardize farm profitability and animal welfare, highlighting the urgent need for more robust interventions.

Climate control technologies, such as closed-house systems, have been developed to moderate temperature and humidity, thereby mitigating heat stress (Mangan & Siwek, 2023). Although these systems can create stable environments that support optimal poultry growth and production, high costs and technical requirements often restrict their implementation among smallholder farmers in developing regions. Limited financial resources and technology access further complicate the adoption of closed-house systems in these areas, emphasizing the necessity of more accessible, cost-effective alternatives.

Recent studies indicate that pre-hatch thermal programming offer a promising avenue for bolstering heat tolerance in poultry. By exposing embryos to precise temperature conditions during embryonic development, this intervention can induce physiological adaptations that enhance resilience against high ambient temperatures (Costa et al., 2020). These adaptations often involve changes in the expression of heat shock proteins and other stress-related genes, thereby increasing the capacity of chicks to withstand heat stress post-hatch (Goel et al., 2023). Hatchery protocols play a crucial role in shaping post-hatch performance of poultry (Abdel-Fattah et al., 2024; Andri et al., 2023; Yulianti et al., 2023). Evidence comparing various physiological parameters suggests that pre-hatch thermal programming significantly affects internal organ development, which is crucial for subsequent productivity. In particular, it has been shown to influence liver development as a key factor in metabolic efficiency (Iraqi et al., 2024). Additionally, the intervention has been linked to improved muscle development, survival rates, and overall performance (Al Amaz et al., 2024). Understanding the development of internal organ is crucial for optimizing poultry production and ensuring animal welfare. Therefore, this study was conducted to evaluate the effects of pre-hatch thermal programming on internal organ development of crossbred chickens in the first week post-hatch.

MATERIALS AND METHODS

A total of 200 fertile eggs from a crossbreed of male local chickens and commercial laying hens (Berline Farm, Malang, Indonesia) were used in this study. The average egg weight was 62.76 ± 4.40 g with a coefficient of variation was 7.01%. The eggs were randomly distributed into four treatment groups, each with five replicates (10 eggs per replicate). The treatments in this study were pre-hatch thermal programming as follows: T0 served as the control, with standard incubation maintained at 37.50°C throughout the entire incubation period; T1 involved standard incubation but with the temperature increased to 38.50°C for 6 hours daily from day 10-18 of incubation; T2 involved standard incubation but with the temperature increased to 39.50°C for 6 hours daily from day 10-18 of incubation; while T3 involved standard incubation but with the temperature increased to 40.50°C for 6 hours daily from day 10-18 of incubation.

All eggs were incubated for 21.5 days in separate forced-air incubators according to the treatments. A total of 100 DOC (five chicks per replicate) were randomly chosen and reared for 1 week in the temperaturecontrolled chambers. The average temperature and relative humidity during the study were 31.78 ± 0.56ºC and 58.50 ± 4.45%, respectively. The chicks received ad libitum feed and drinking water throughout the study.

The type of feed used in this study was Broiler I commercial feed (PT. Japfa Comfeed Indonesia, Sidoarjo, Indonesia), with minimum metabolizable energy and crude protein contents were 3,000 kcal/kg and 21.00%, respectively. After a week of rearing, one chick per replicate was chosen for evaluation of internal organ development including heart, liver, proventriculus, gizzard, and intestine. Data of internal organ were expressed as absolute weight (g) and relative percentage to the body weight (%). Data were analyzed using analysis of variance, with P<0.05 considered as a significant difference. Data analysis was performed using IBM SPSS Statistics Version 25.

RESULTS AND DISCUSSION

Absolute weight of internal organ of crossbred chickens during the first week post-hatch following pre-hatch thermal programming is summarized in Table 1. There was no significant difference (P>0.05) for all absolute weight of internal organ. The absolute weight of heart ranged from 0.69 to 0.84 g, while the liver varied between 2.68 and 2.93 g. The absolute weight of proventriculus was recorded within the range of 0.74 to 0.87 g, and the gizzard ranged from 6.48 to 7.05 g. The absolute weight of intestine was observed to range from 7.94 to 8.42 g. These findings indicate consistent development patterns in absolute weight of internal organ across the treatments.

Table 1. Absolute Weight of Internal Organ of Crossbred Chickens in the First Week Post-Hatch Following Pre-Hatch Thermal Programming

Variables	T0	T1	T2	T3
Heart (g)	0.84 ± 0.07	0.76 ± 0.12	0.71 ± 0.02	0.69 ± 0.13
Liver (g)	2.68 ± 0.24	2.72 ± 0.15	2.93 ± 0.44	2.81 ± 0.06
Proventriculus (g)	0.74 ± 0.15	0.83 ± 0.08	0.87 ± 0.07	0.80 ± 0.11
Gizzard (g)	6.48 ± 1.17	6.81 ± 0.29	7.05 ± 0.56	6.72 ± 0.48
Intestine (g)	7.94 ± 0.43	8.16 ± 0.68	8.42 ± 1.26	8.21 ± 0.65

Data were expressed as mean ± standard deviation from five replicates in each treatment

The relative weight of internal organ of crossbred chickens during the first week post-hatch following pre-hatch thermal programming is presented in Table 2. It was observed that there was no significant effect (P>0.05) of pre-hatch thermal programming on relative weight of internal organ. The relative weight of heart ranged from 0.89 to 1.12%, while the liver varied between 3.46 and 3.79%. The relative weight of proventriculus was recorded within the range of 0.95 to 1.13%, and the gizzard ranged from 8.29 to 9.11%. The relative weight of intestine was observed to range from 10.24 to 10.82%. These results suggest consistent development of internal organ in relation to body weight across all pre-hatch thermal programming conditions.

Table 2. Relative Weight of Internal Organ of Crossbred Chickens in the First Week Post-Hatch Following Pre-Hatch Thermal Programming

Variables	T0	T1	T2	T3
Heart (%)	1.12 ± 0.15	0.98 ± 0.16	0.93 ± 0.10	0.89 ± 0.17
Liver (%)	3.46 ± 0.40	3.51 ± 0.29	3.79 ± 0.52	3.64 ± 0.24
Proventriculus (%)	0.95 ± 0.15	1.07 ± 0.10	1.13 ± 0.10	1.02 ± 0.09
Gizzard (%)	8.29 ± 0.91	8.82 ± 0.89	9.11 ± 0.28	8.73 ± 0.99
Intestine (%)	10.24 ± 0.41	10.59 ± 1.60	10.82 ± 1.00	10.61 ± 0.46

Data were expressed as mean ± standard deviation from five replicates in each treatment

Absolute and relative weight of internal organ were presented in this study to provide a comprehensive understanding of organ development. Absolute data allow for direct comparison of organ growth between treatments. On the other hand, relative data adjust for body weight variations ensuring a proportional assessment of organ development. This approach highlights whether changes in organ size are due to treatment effects or merely reflect variations in overall growth. The results of this study show that pre-hatch thermal programming had no significant effect on internal organ development, including the heart, liver, proventriculus, gizzard, and intestine. This finding suggests that thermal manipulations applied during embryonic development were within the adaptive capacity of the embryos, allowing them to maintain normal physiological growth. The heart as a critical organ for circulating oxygen and nutrients (Chen et al., 2017) exhibited consistent development across all treatments. Similarly, the liver as a central role in metabolism and detoxification (Wang et al., 2023) maintained normal growth patterns on all treatments. The proventriculus and gizzard as vital organ for food digestion and nutrient availability (Scholey et al., 2020; Kim et al., 2022) also showed no significant variations. Likewise, the intestine as nutrient absorption site (Ravindran & Abdollahi, 2021) remained unaffected by the temperature variations during incubation.

A potential explanation for this resilience is the genetic composition of the crossbred chickens used in this study. The male parent of these crossbred chickens is a local chicken breed, which is well-documented for its adaptability to thermal variations in tropical regions (Tamzil et al., 2013; Sumantri et al., 2020). This genetic trait may have contributed to the ability of embryo to tolerate the applied thermal programming without compromising post-hatch organ development. The absence of adverse effects on the internal organ suggest that pre-hatch thermal programming is a safe practice and potentially offering other benefits such as enhanced thermotolerance capability in crossbred chickens.

CONCLUSION

It could be concluded that pre-hatch thermal programming can be considered a safe strategy without compromising the development of internal organ (heart, liver, proventriculus, gizzard, and intestine) in the early post-hatch period of crossbred chickens.

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