**An Evaluation of Different Quail Varieties for the Heat Stress Resistance**

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**ABSTRACT**

The aim of this study was to evaluate some biochemical variables under heat-stressed Japanese quail that have different plumage colors for detecting that variety of quail better adapted to heat stress. A total of 100 birds were used in this study. The 25 birds that belong to each four plumage color group were placed in 5-tiered including 3 compartments in each tier plastic cages with subdivided 5 repetitions according to their initial body weights. The statistical significance occurred in LDH (P<0.01). The highest LDH level was found in the Recessive white variety (25.43 mmol/L), followed by Wild type (23.78 mmol/L), Golden (12.87 mmol/L), and Tuxedo (12.71 mmol/L), respectively. The Recessive white group was different from the Golden and Tuxedo groups. According to the results of the current study, there was no significant difference was observed between the four different color varieties of Japanese quail regarding heat stress. However, when LDH is taken into account, it can be thought that the white color may be more sensitive to stress. In order to clarify exactly this situation, more studies that are detailed such as yield performance can be conducted on different quail species.

**Keywords:** Biochemical analysis, heat stress, plumage color, quail.

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**I. INTRODUCTION**

High ambient temperature is one of the most important problems for poultry production. Heat stress begins when the ambient temperature raises the thermo-neutral zone, which ranges between 16-25 °C for many poultry species. Recent studies found that poultry flocks subjected to chronic heat stress environment (over 30 °C) had poor production performance as well as high morbidity and mortality, causing substantial economic losses in poultry farms [1]. In addition to affecting reproduction, numerous studies have pointed out that physiological and biochemical characteristics change during heat stress [2]. With global warming fact, thermal stress (hyperthermia) is thought that will take place a more crucial phenomenon in affecting animal performance. However, avian species can utilize a variety of physiological mechanisms to regulate their body temperature [3]. Quail is a bird species that belongs to the Phasianidae family. They are reared primarily for meat and egg production [4], [5]. Quail meat is renowned for its dietary properties like high-quality protein and low-caloric content, and its valuable taste to consumers [1]. On the other hand, it provides beneficial substances such as conjugated linoleic acid, vitamins, antioxidants, omega 6, and omega 3 polyunsaturated fatty acids. The most common domesticated type is the Coturnix quail also known as the Japanese quail (Coturnix japonica) is considered an ideal biological and experimental specimen due to its rapid development. Quail reach sexual maturity at 6-7 wk of age [6], [7]. There are 18 different plumage color mutants that were previously described for the Japanese quail. The Wild type (Pharaoh) is the most common one which has grey plumage color amongst them. The other common varieties are Manchurian Golden, Recessive White (English White), and Tuxedo plumage color [8]. In animal husbandry, the main purpose is profitability. In this context, efforts about livestock are driving into rearing strategies more efficiently. One of these strategies could be the rearing of animal material that is well-adapted to heat stress. Biochemical analyses of the serum may give some hints about the metabolic status of the organism. Some enzymes, immune substances are evaluated under this circumstance. Frequently, the alanine aminotransferase (ALT), aspartate aminotransferase (AST) enzymes are examined for liver damage cases. On the other hand, serum glucose or blood sugar level is considered for diabetes. When glucose is released into the bloodstream it dissolves in this serum. Once the glucose is dissolved, the pancreas releases insulin to help move the glucose out of the blood and into cells that will store the glucose as energy. Ease degradable energy sources such as glucose are firstly consumed when an organism faces any stress conditions [9].

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**Table 1: Biochemical analysis under heat stress in four different color varieties of Japanese quail**

| Plumeage Color Group       | LDH (mmol/L) | ALT (U/L) | AST (U/L) | ALT/AST Ratio |
|----------------------------|-------------|-----------|-----------|---------------|
| Recessive white            | 25.43       | 2.56      | 0.88      | 2.88          |
| Wild type                  | 23.78       | 2.78      | 1.12      | 2.42          |
| Golden                     | 12.87       | 1.87      | 0.76      | 2.46          |
| Tuxedo                     | 12.71       | 1.71      | 0.67      | 2.55          |

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Lactate dehydrogenase (LDH) is an enzyme that turns sugar into energy when required. LDH is found in many tissues and organs, including the muscles, liver, heart, pancreas, kidneys, brain, and blood cells. In any stress conditions, low-density lipoprotein (LDL) tends to be higher in organisms. Stress encourages the body to produce more energy in the form of metabolic fuels, which cause the liver to secrete more of the LDL.

The aim of this study was to evaluate some biochemical variables under heat-stressed Japanese quail that have different plumage colors for detecting that variety of quail better adapted to heat stress.

II. MATERIALS AND METHODS

A. Animal Material and Experimental Design

The trial protocol was approved by the Institutional Animal Care and Use Committee of Elazig Veterinary Control Institution of Agriculture and Forestry Ministry (approval number 2020/01). A total of 100 birds were used in this study. The 25 birds that belong to each four-plumage color group were placed in 5-tiered including 3 compartments in each tier plastic cages with subdivided 5 repetitions according to their initial body weights. The five birds were kept in each cage compartment with a stocking density was 0.02 m²/5 birds. The birds were reared for 42 days in an environmentally controlled room at 39 °C and relative humidity of 60-65%. Soybean meal and maize-based standard mixture feed and freshwater were provided on an ad libitum basis [10]. Feed ingredients are presented in Table I. The lighting program was implemented as 23L:1D for the first 7 days, 21L:3D for 7-14 days, 19L:5D for 14-21 days, 16L:8D for 21-42 days. Manure was removed weekly from the cages and other optimum rearing conditions were provided considerably.

B. Biochemical Analysis

At the end of 42 days, a total of 10 birds were slaughtered from each group based on similar body weights. The blood was sampled to measure the levels of ALT (μkat/L), AST (μkat/L), glucose (mmol/L), LDH (μkat/L), and LDL (μkat/L). The activities of ALT and AST were measured. Glucose concentration, ALT, AST, LDH, and LDL activities were determined in serum by Olympus AU 2700 autoanalyzer (Beckman-Coulter, Inc., Fullerton, CA).

C. Statistical Analysis

All data were subjected to One-Way ANOVA test by IBM SPSS 21 software after the normality test (Kolmogorov-Smirnov). Tukey test was chosen as post-hoc for determining the differences between the groups. Statistically, the significance was accepted when p≤0.05 [11].

### Table I: Feed Ingredients and Nutritional Composition

| Ingredients                  | %  | Nutritional Composition  |
|------------------------------|----|--------------------------|
| Maize                        | 51.40 | Dry matter 90.40         |
| Wheat barn                   | 9.00 | Crude protein 18.00       |
| Soy bean meal                | 22.00 | Crude cellulose 4.40     |
| Corn extract meal            | 2.00 | Crude fat 5.35           |
| Sunflower meal (45% CP)      | 4.30 | Crude ash 10.19          |
| Sunflower oil                | 3.50 | Calcium 1.26             |
| Phosphate of lime            | 0.88 | Phosphorus 0.35          |
| Calcium carbonate            | 4.50 | Natrium 0.18             |
| Limestone                    | 1.43 | Lysine 1.00              |
| L-Lysine hydrochloride       | 0.16 | Methionine 0.59          |
| L-Threonine                  | 0.12 | Cystine 0.76             |
| Natrium bicarbonate          | 0.16 | Triptophane 0.25         |
| Salt                         | 0.20 | Me, kcal/kg 2800         |
| Vitamin-mineral premix*      | 0.35 |                          |

*Vitamin-mineral premix (per 1 kg): Vitamin A 15.500 IU; Vitamin D3 3.500 IU; manganase 120 mg; ferrous 40 mg; zinc 100 mg; copper 16 mg; cobalt 200 mg; iodine1.25 mg; selenium 0.30 mg. Calculated CP: Crude Protein.

### Table II: ALT, AST, Glucose, LDH, and LDL Levels of the Groups

| Traits     | Tuxedo (Black) | Golden (Yellow) | Wild-type (Grey) | Recessive White | P-value |
|------------|----------------|-----------------|------------------|-----------------|---------|
| ALT (μkat/L)| 0.071±0.013    | 0.053±0.006     | 0.054±0.005      | 0.066±0.005     | >0.05   |
| AST (μkat/L)| 3.49±0.35      | 3.63±0.21       | 3.74±0.26        | 3.96±0.18       | >0.05   |
| Glucose (mmol/L)| 15.62±0.91 | 16.07±0.67 | 16.53±0.85 | 17.86±0.89 | <0.01   |
| LDH (mmol/L)| 12.72±1.37    | 12.87±1.15      | 23.78±3.10       | 25.43±4.96      | >0.05   |
| LDL (μkat/L) | 1.53±0.36     | 1.59±0.22       | 1.42±0.28        | 1.26±0.26       | >0.05   |

Data are presented mean standard error. Statistical significance considered when p≤0.05.
III. DISCUSSION

Factors affecting the choice of animal material by farmers in livestock include availability, yield capacity, strength, and cost. In farm animals, there may be different varieties and types within the same species and breed, and these types may have different characteristics. Varieties generally differ in color, appearance, and some body parts. Biochemical analyzes of blood help to identify many physiological processes in the organism. Every component needed to tissue and cells in the organism is transported through the blood flow. In any physiological phenomenon, differences in blood composition may occur. The serum is the liquid and soluble part of the blood that does not play a role in coagulation. A number of chemical elements such as hormones and fatty acids, which are effective on most of the cells, are transported through the serum. ALT and AST are transaminase enzymes found in many organs, mainly the liver, kidney, heart, and muscle. They catalyze a reaction between amino acids, aspartate, and glutamates. They were first discovered in the mid-1950s. If they are high concentration, cases that cause damage to the liver and pancreas (side effects of some drugs, inflammatory condition, diabetes, etc.) are considered. In this case, these enzymes are transported from the liver to the blood and the negativity is tried to be eliminated. The response of the organism in heat stress is to activate emergency energy reserves such as glucose first. The adrenal glands trigger the release of glucose stored in various organs, which often leads to elevated levels of glucose in the bloodstream. On the other hand, stress stimulates the release of various hormones, which can result in elevated blood glucose levels [12]. If stress cannot be dealt with, glucose is attempted to be obtained from non-carbohydrate sources through gluconeogenesis. Chronic or long-term stress can cause high blood cholesterol due to high levels of cortisol as a result of adrenal gland triggering. LDH is an oxidoreductase that takes part in the process of the carbon hydrates glycolysis [13]. It takes an important role in producing an organism's energy. If there is a malfunction caused by oxidative stress, the LDH level may increase. On the other hand, LDH amplifies reactive oxygen species in response to oxidative stimuli [14]. In this study, no difference was found between the groups in terms of glucose, ALT, AST, and LDL values, except for LDH, between different varieties. Although the response to stress may be the same in animals belonging to the same species, there may be partial differences in different varieties of the species. The right choice of animal material in livestock has a direct impact on profitability. For this reason, the selection of animal material that is resistant to stress and diseases is an issue that should be considered for farmers.

According to the results of the study, no significant difference was observed between the four different color varieties of Japanese quail regarding heat stress. However, when LDH is taken into account, it can be thought that the white color may be more sensitive to stress. In order to clarify exactly this situation, more studies that are detailed such as yield performance can be conducted on different quail species.

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