



Blood Profile, Productivity, and Carcass Characteristics of Super Superior Kampung Chickens Supplemented with Vitamin C, Vitamin E, and Selenium and Infected with *Escherichia coli*

Roisu Eny Mudawaroch^{1*}, Faruq Iskandar¹, Fayza Maya Azzahra¹, Ushonahito Muhammad Rizquna Akbar¹

¹ Faculty of Agriculture, Universitas Muhammadiyah Purworejo, Purworejo, Indonesia.

Received: December 17, 2025

Revised: January 18, 2026

Accepted: February 13, 2026

Published: February 28, 2026

Corresponding Author:

Roisu Eny Mudawaroch

roisueny@umpwr.ac.id

DOI: [10.29303/jppipa.v12i2.14308](https://doi.org/10.29303/jppipa.v12i2.14308)

 Open Access

© 2026 The Authors. This article is distributed under a (CC-BY License)



Abstract: Balitbangtan's superior native chicken (KUB) is a local chicken produced from genetic crossbreeding of native chickens that are susceptible to heat stress. Heat stress was reduced by adding vitamin C, vitamin E, and Se to the feed. The purpose of this study was to determine the effect of supplementation of Vitamin E, Vitamin C, and Se in KUB chickens on blood profiles, productivity, and carcass cuts. The materials used were KUB chickens, Vitamin C, Vitamin E, and selenium. This study used a completely randomized design with 6 treatments and 5 replications. The results showed that supplementation of vitamin E, Vitamin C, and selenium in chickens infected with *Escherichia coli* did not show significant differences in drinking consumption and body weight but showed differences in feed consumption. Meanwhile, long-term maintenance had a significant effect. Supplementation of vitamin E, Vitamin C, and selenium in chickens infected with *Escherichia coli* did not show significant differences in carcass and carcass cuts. Blood protein, hemoglobin, red blood cells, hematocrit, monocytes, basophils, neutrophils, and lymphocytes did not show any differences, while eosinophils showed significant differences with the treatment of supplementation of vitamin E, Vitamin C, and selenium in chickens infected with *Escherichia coli*. The conclusion of this study is that supplementation of vitamin E, Vitamin C, and selenium in chickens infected with *Escherichia coli* did not show any differences in productivity, carcass, and blood profile, but had a significant effect on feed consumption and eosinophils.

Keywords: Blood profile; Carcasses; KUB chicken; Productivity

Introduction

The poultry industry is currently growing rapidly in Indonesia. Not only have broilers and laying hens developed, but also the super Javanese chicken (joper), which is a cross between a male native chicken (Bangkok) and a female laying hen (layer). At this time, the KUB chicken has begun to be developed. KUB chicken is an original chicken developed by Balitbangtan and named KUB chicken. KUB chicken is a local chicken resulting from genetic crossbreeding of various native chickens in Indonesia carried out by the Ciawi Animal

Husbandry Research Institute. KUB chicken has better genetic traits when compared to ordinary native chickens. The KUB-1 chicken strain is based on the Decree of the Minister of Agriculture of the Republic of Indonesia No: 274 / Kpts / SR.120 / 2/2014. KUB chickens produce 160-180 eggs per year, with a henday egg production of 65-70%, and a first-laying age of around 20-22 weeks. Fermented tomato extract supplemented to IAARD KUB chickens has beneficial effects on maintenance. KUB chickens have also been introduced to farmer groups for cultivation. KUB chickens have high productivity capabilities, but the

How to Cite:

Mudawaroch, R. E., Iskandar, F., Azzahra, F. M., & Rizquna, U. M. Blood Profile, Productivity, and Carcass Characteristics of Super Superior Kampung Chickens Supplemented with Vitamin C, Vitamin E, and Selenium and Infected with *Escherichia coli*. *Jurnal Penelitian Pendidikan IPA*, 12(2), 144-153. <https://doi.org/10.29303/jppipa.v12i2.14308>

relatively high temperatures in Indonesia affect their metabolism. High environmental temperature is one of the most important factors related to the profitability of meat and egg production. High environmental temperatures (31–34°C) cause economic losses, namely high-water consumption and low feed intake, which lead to weight loss, low egg production, low egg quality, and low feed efficiency.

High temperatures not only negatively impact production performance but also inhibit immune function (Imberti et al., 2025). Heat stress can be managed through feed manipulation, namely optimizing feed to reduce heat stress. Temperatures above 30°C cause feed consumption to decrease with increasing temperature (Ahmad et al., 2022). Heat stress causes a decrease in plasma concentrations of ascorbic acid and α -tocopherol (Alberghina et al., 2024). Heat stress also interferes with the absorption of vitamins E, C, and Se, necessitating the addition of vitamins C, E, and Se to the feed. Vitamin E, vitamin C and selenium are added to poultry feed to reduce heat stress (Horváth & Babinszky, 2018). Vitamin E contains antioxidants to protect cells and tissues from lipoperoxidative lipid damage caused by free radicals (Shakeri et al., 2020). Vitamin E reduces the negative effects of corticosteroids induced by stress, providing protection against oxidative damage, and enhancing the proliferation and function of these cells. Optimal responses in feed intake, weight gain, and feed efficiency in broilers under heat stress appear to occur with vitamin E supplementation at 360–600 mg/kg body weight. Vitamin C enhances antioxidant activity by reducing tocopherol radicals back to the active form of vitamin C.

Vitamin C requirements are higher during stress, and several reports have documented the beneficial effects of supplementing poultry feed with ascorbic acid. Vitamin C supplementation limits and reduces metabolic markers of stress and improves performance, immunological status, and behavior of birds. The productivity of broiler chickens exposed to heat can be maintained by supplementing with vitamin C up to 400 mg/kg body weight (Biswas et al., 2024). Selenium (Se) holds a special place among naturally occurring dietary antioxidants, being an integral part of glutathione peroxidase (GSH-Px), which acts as a protective antioxidant in cells. Se improves antioxidant status in broiler chickens. Vitamin E and Se supplementation significantly improved broiler growth performance and carcass composition, and reduced heat-related mortality and Core Body Temperature (at 30°C) without affecting intestinal mRNA abundance.

The addition of higher levels of vitamins E, C, and Se to broiler diets had no adverse effects on carcass properties, oxidative stability, or meat quality

parameters when added alone or in combination. Selenium supplementation of 0.46 mg/kg BW in broiler chickens has also been reported. Most of the addition of vitamin E, Vitamin C and selenium is applied to broiler chickens and laying hens, while KUB chickens which are Indonesian germplasm have not been widely studied. The purpose of this study was to study the effects of Vitamin E, Vitamin C and Se supplementation of KUB chickens on blood profiles, productivity, meat chemical quality, and carcass cuts.

Method

The research was conducted in the Field Laboratory of the Animal Husbandry Study Program, Faculty of Agriculture, Muhammadiyah University of Purworejo. The materials used in this study were 100 two-week-old KUB chickens. The commercial feed used by PT. Japfa Comfeed Indonesia was 250 kg (5 sacks) consisting of two sacks of BR1 and one sack of BR2. The feed was supplemented with 100 g of vitamin C, 100 g of vitamin E, and 100 g of selenium. The facilities used were a cage with a total of 25 compartments, each measuring 60 cm long, 50 cm wide, and 50 cm high, with a capacity of 4 chickens. A 200 g feed container and 25 nipple drinking water dispensers were provided, along with one scale with a 3 kg capacity and an accuracy of 0.1 g, and one scale with a 10 kg capacity and an accuracy of 10 g for weighing the chickens and feed.

Research Design

This study used a completely randomized design with a factorial pattern for productivity parameters. The first factor was feed supplementation, and the second was the length of rearing. There were 6 treatments, each treatment replicated 5 times. Each replicate consisted of 4 KUB chickens. Carcass parameters, carcass cuts, and blood profiles were analyzed using a completely randomized design. KUB chickens were randomly selected, treated, and placed in cages. The treatment in this study was the level of feed supplementation in the drinking water. The treatments were:

- P1 = KUB chickens (control);
- P2 = KUB chickens + *Escherichia coli*;
- P3 = KUB chickens + vitamin E 300 mg/kg feed; vitamin C 200 mg/kg feed; selenium 23 mg/kg feed;
- P4 = KUB chickens + vitamin E 600 mg/kg feed; vitamin C 400 mg/kg feed; selenium 46 mg/kg feed + *Escherichia coli*;
- P5 = KUB chickens + vitamin E 300 mg/kg feed; vitamin C 200 mg/kg feed; Selenium 23 mg/kg feed,
- P6 = KUB chicken + vitamin E 600 mg/kg feed; vitamin C 400 mg/kg feed; selenium 46 mg/kg feed + *Escherichia coli*

The KUB chickens were raised in this study for 11 weeks, starting after the DOC was 1 week old. The study was divided into three stages: the first stage was a 2-week adaptation period with basal feeding. The second stage was an initial period of 1 week with rations and treatment. The third stage was an 8-week treatment period after the initial stage, with lysine and methionine supplemented according to the treatment dosages. Drinking water was provided ad libitum using a teat. During the rearing period, the daily consumption of each chicken was recorded by weighing the remaining daily feed. Weights were recorded weekly.

Research Parameters

The parameters to be observed in this study were as follows: Chicken productivity: Feed consumption (g/bird/day) obtained by subtracting remaining feed. Drinking water consumption and weight. Carcass and carcass cuts: including: carcass weight and carcass cuts including: breast, thigh, back, and wings. Blood profile including: blood protein, hemoglobin, red blood cells, hematocrit, monocytes, ND antibodies, basophils, eosinophils, neutrophils, lymphocytes, erythrocyte count, hematocrit, and hemoglobin levels.

Statistical Analysis

The data obtained were analyzed using analysis of variance. If differences between treatments were found, the Duncan Multiple Distance Test (DMRT) was used.

Results and Discussion

*KUB Chicken Productivity
Drinking Water Consumption*

Drinking water consumption of KUB chickens is shown in Table 1. Treatments supplemented with vitamin C, vitamin E, and selenium for Escherichia coli infection showed no significant difference in drinking water consumption. Treatments supplemented with vitamin C, vitamin E, and selenium for Escherichia coli infection showed no significant difference in drinking water consumption. This indicates that supplementation did not directly influence water intake. Supplementation with vitamin E at 600 mg/kg of feed, vitamin C at 400 mg/kg of feed, and selenium at 46 mg/kg of feed did not differ from the control. This is because these feed supplementations do not directly trigger excessive water consumption, resulting in normal water intake. Treatments P2, P4, and P6 for Escherichia coli infection did not experience diarrhea and therefore did not cause dehydration. Supplementation with vitamin C, vitamin E, and selenium functions as antioxidants and promotes metabolic health and did not affect drinking water consumption (Barnhart et al., 2024).

The length of rearing showed significant differences in drinking water consumption for KUB chickens. Drinking water consumption increases linearly with age. The older the chicken, the greater the volume of water consumed per day. This increase in drinking water consumption is based on the mechanisms of digestion and excretion, as well as the physiological development of the bird. Drinking water consumption increases significantly with age (Dang et al., 2024). Because feed consumption increases with age (Table 2), the body's water requirements also increase for nutrition, digestion, excretion, and metabolism. Water consumption of KUB chickens in a study administered fermented tomato extract increased during growth (Cuvas-Limón et al., 2022).

Table 1. Drinking Water Consumption of KUB chickens (ml/bird/day)

Week to	P1	P2	P3	P4	P5	P6	Mean
3	206.7±9.78	198.7±11.07	227.95±10.98	238.75±18.21	207.25±9.41	213.85±4.38	269.41±6.26a
4	514.65±5.22	506.55±7.89	509.4±5.73	513.4±3.84	505.2±14.8	501.65±8.55	635.59±3.99b
5	717.15±1.68	704.05±7.29	695.9±8.81	712.95±6.09	693.5±26.5	677.45±14.26	875.20±6.95c
6	836.15±20.30	840.25±17.12	837.45±12.58	841.3±15.68	838.65±21.35	810.55±28.57	1042.57±9.41d
7	1046±36.27	1048.55±25.51	993.75±53.37	1086.7±17.72	1052.95±60.46	988.15±61.84	1295.02±22.57e
8	909.05±118.84	872.25±40.40	795±37.37	931.25±55.36	912.35±89.76	818.6±41.65	1091.35±34.53d
9	1000.8±61.49	1061.8±27.07	1039±70.51	1086.05±9.96	1031.4±54.19	1030.65±51.75	1302.02±23.76e
10	1302.05±88.23	1421.15±14.58	1311.15±80.97	1402.7±34.41	1374.2±62.77	1364.8±51.49	1703.34±29.81f
11	1375.25±131.86	1586.7±21.84	1358.1±90.03	1513.6±79.28	1487.4±124.21	1414.25±116.79	1819.85±50.27g
Mean ns	1098.31±77.67	1144.44±86.01	1078.84±74.81	1156.48±81.94	1125.40±83.31	1086.10±79.28	

Note: ns = non-significant; a, b, c, d, e, f different notations indicate significant differences.

Feed Consumption

The addition of vitamin C, vitamin E, and selenium to Escherichia coli-infected chickens showed significant differences in feed consumption. The length of rearing showed significant differences in drinking water consumption for KUB chickens. Feed consumption by

age of KUB chickens is presented in Table 2. The addition of vitamin C, vitamin E, and selenium to Escherichia coli-infected chickens showed significant differences in feed consumption. In the Escherichia coli-infected chickens, feed consumption increased significantly compared to the uninfected chickens (P2 >

P1, P4 > P3, and P6 > P5). This high consumption is due to the high nutritional requirements of the infected body, resulting in increased consumption. *Escherichia coli* infection causes damage to the digestive tract and other organs, reducing the chicken's ability to absorb feed (Ye et al., 2025). Chickens tend to consume more feed to promote normal growth. Poultry infected with *Campylobacter jejuni* prefer high-protein diets and exhibit increased consumption compared to uninfected birds. Pathogenic bacterial infection can alter poultry's

eating behavior. Infection with pathogenic bacteria in poultry causes the body to produce inflammatory substances (cytokines and oxidative stress molecules) that can affect the appetite-regulating center in the bird's brain (Visscher et al., 2018). Infection triggers an immunological response, resulting in increased appetite, a compensatory mechanism to meet the increased energy needs caused by this immune response (Lacourt et al., 2018).

Table 2. Feed Consumption of KUB Chickens (g/bird/day)

Week to	P1	P2	P3	P4	P5	P6	Rerata
3	166.62±16.25	158.75 ± 2.87	146.75±3.14	177.25±5.69	157.12±6.36	163.62±12.41	161.68±3.85a
4	252.43±8.24	273.06 ± 4.13	236.62±16.27	283.81±10.12	260.68±15.37	273.93±8.48	263.42±5.21b
5	321.93±9.97	317.75±9.52	294.25±4.91	361.5±11.07	307.5±17.28	318.5±12.65	320.23±5.98c
6	398.87±6.27	393.25±7.31	380.62±12.82	416.62±7.84	400.81±7.66	405.06±4.41	399.21±3.72d
7	471.68±23.90	506.12±17.21	496.06±8.34	479.43±17.13	510.93±11.69	498.62±6.86	493.81±6.26e
8	466.62±34.61	515.37±10.32	484.68±13.15	513.93±11.88	502.06±14.84	512.12±10.06	499.13±7.49e
9	597.43±44.27	648.5±2.73	644.68±5.27	643.25±5.24	646.43±2.83	649.93 ± 1.85	638.37±7.68f
10	596.56±33.35	663.87±11.87	644±10.01	669.31±8.99	641.25±20.47	662±15.34	646.16±8.45f
11	617.87±39.99	647.37±16.61	622.81±18.31	621.06±40.01	634.43±22.52	629.31 ± 29.17	628.81±10.80f
Mean ns	432.22±26.92p	458.22±29.31r	438.94±29.69 pq	462.91±27.40r	451.25±29.04qr	457.01±28.73r	

Note: ns = non-significant; a, b, c, d, e, f different notations indicate significant differences.

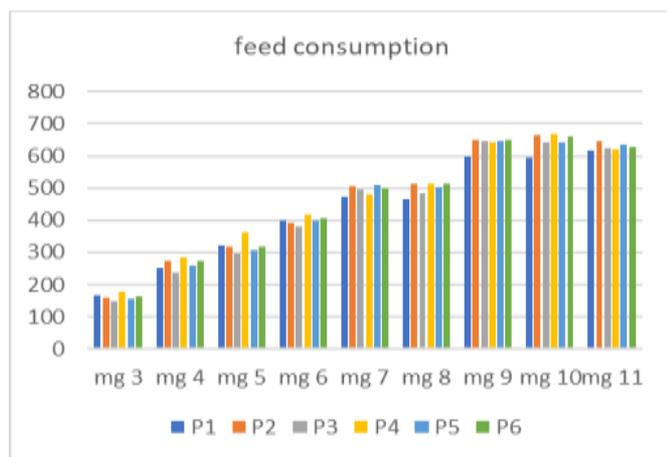


Figure 1. Feed consumption requirements tend to increase with the age of the chicken

Feed consumption in the treatment with vitamin C, vitamin E, and selenium supplements was higher than in the treatment without supplementation. Vitamin C, vitamin E, and selenium are beneficial antioxidants. Vitamin E, vitamin C, and selenium act as antioxidants in poultry, protecting cells from free radical damage, ensuring healthy, active feed intake, and optimal metabolism. Vitamin C helps reduce metabolic stress and improves nutrient absorption from feed (Alberts et al., 2025; Soetedjo, 2025). Vitamin C supplementation (±200–300 mg/kg feed) increased feed intake compared to unsupplemented feed (Righi et al., 2021). The combination of vitamin C and selenium has been shown to reduce oxidative tissue damage and stabilize the

physiological condition of poultry, which in turn can maintain or increase feed intake compared to poultry without supplementation (Pečjak et al., 2022). Length of rearing affects feed consumption. Feed consumption increases linearly with chicken age (Table 2) and also with water consumption (Table 1). As chickens grow larger, they require more energy and nutrients to maintain basic life functions and grow. Birds consume more feed as they age because their energy and nutrient requirements for growth also increase. Feed consumption tends to increase with age (Mekonnen, 2024; Ahiwe et al., 2018).

Weight

The body weight of KUB chickens is presented in Table 3. Supplementation with vitamins C, E, and selenium in *Escherichia coli*-infected chickens did not show significant differences in weight. The addition of vitamin C, E, and selenium supplements does not function as growth promoters, but rather as antioxidants that help poultry reduce oxidative stress, especially under environmental conditions, and promote cell and tissue health. Antioxidants in poultry improve the chicken's physiology, but do not always have an effect on final body weight (Chen et al., 2024; Shakeri et al., 2018). Vitamin C is an antioxidant that plays a role in cellular immune function, collagen synthesis, and aids in body metabolism. Vitamin E is also a fat-soluble antioxidant that protects cell membranes from oxidative damage. Selenium is an essential mineral that plays a role in antioxidant enzymes such as glutathione

peroxidase (Yuan et al., 2024; Bai et al., 2024). Vitamin E supplementation over a specific period of time does not affect the body weight of broiler chickens, although there are differences in immune responses (Sadiq et al.,

2023). The feed provided serves to meet basic needs, while antioxidant supplementation does not increase body weight despite increased feed consumption (Dalia et al., 2018).

Table 3. KUB Chicken Body Weight (g/bird)

Week 3	P1	P2	P3	P4	P5	P6	Average *
4	250.9±5.63	247.1±1.63	247.3±4.71	249.5±28.65	243.3±4.78	246.2±7.86	121.2±3.9a
5	316.3±14.33	189.3±1.88	177.5±4.31	193.7±34.01	180.1±7.76	188.3±3.22	247.4±2.1b
6	250.9±5.66	247.1±1.63	246.8±4.74	250.3±28.43	235.3±7.01	257.1±10.16	302.2±3.9c
7	299.1±16.26	294.7±7.70	311.8±6.66	314.7±43.45	291.2±7.025	306.7±10.27	394.6±4.9d
8	395.2±14.47	402.9±0.81	399.6±19.51	401.9±58.58	376.2±11.77	396.4±8.10	539.7±6.3e
9	531.7±10.86	559.1±10.29	535.5±17.25	545.5±101.98	523±17.83	548.7±16.08	688.2±7.3f
10	697±5.71	695.7±2.20	674.7±14.46	704.1±132.12	670±22.62	683.7±30.99	821.6±7.0g
11	835.8±11.41	839.1±1.61	794.7±20.19	834.3±93.35	786.8±27.12	827.7±27.13	972.4±8.2h
Averages	981.3±8.83	998.7±3.15	957.6±21.18	977.6±114.76	928.8±30.22	971.7±37.93	1105.2±11.3i
Week 3	578.7±54.60	589.7±56.60	580.0±55.20	574.8±53.90	571.8±54.20	566.6±53.70	576.9±22.10

Information: ns = non-significant; *different notations indicate significant differences.

The length of rearing significantly affected the body weight of KUB chickens. During the early growth phase, the need for certain nutrients, such as protein, is high, while in the later phase, energy requirements increase, so the chickens consume more feed to meet their energy needs (Hidayat et al., 2020). With increasing age, feed consumption increases (Table 2), resulting in an increase in the body weight of KUB chickens. Feed was provided ad libitum, ensuring the chickens continued to consume it to support their metabolism, especially during growth.

Older chickens consume more feed than younger chickens (Cherian, 2015; Noetzold & Zuidhof, 2025; Zampiga et al., 2021).

Carcass and Carcass Cuts

The treatment of supplementing vitamin C, vitamin E, and selenium in Escherichia coli-infected chickens showed no significant difference in the percentage of carcass and carcass parts. The carcass and carcass parts of KUB chickens are presented in Table 4.

Table 4. Carcass and Carcass Cuts of KUB Chickens

Treatment	P1	P2	P3	P4	P5	P6	Average
Carcass (g)	800.00±50.10	745.50±47.10	685.00±52.50	786.00±28.30	807.25±31.20	731.50±50.50	800.00±50.10ns
Carcass (%)	60.17±0.90	60.45±0.70	58.45±0.90	61.70±0.30	61.25±1.00	60.23±0.90	60.37±0.40ns
Thigh (g)	131±5.80	121.25±6.20	111.5±9.40	134.75±6.70	120±4.4	97.5±13.8	119.33±3.90ns
Thigh (%)	9.57±0.40	9.86±0.20	9.49±0.20	9.04±0.4	9.12±0.30	9.06±0.30	9.34±0.10ns
Thigh (g)	141.5±6.90	126.25±9.60	118±8.9	129.75±5.10	149±5.70	130.25±13.40	132.46±3.80ns
Thigh (%)	10.32±0.20	10.24±0.40	10.09±0.30	10.19±0.30	11.34±0.50	10.73±0.90	10.48±0.20ns
Wing (g)	122.25±5.40	109.00±3.4	108.75±1.40	112.50±3.40	115.00±5.1	110.75±3.30	113.05±1.70ns
Wing (%)	8.93±0.30	8.02±0.10	8.21±0.20	8.84±0.2	8.72±0.20	8.32±0.3	8.51±0.10 ns
Breast (g)	190.25±11.70	178.5±15.40	156±17.70	190±8.830	192.5±8.10	182±14.80	181.54±5.40ns
Breast (%)	13.85±0.40	14.41±0.60	13.19±0.70	14.90±0.20	14.61±0.40	14.96±0.40	14.32±0.20ns
Back (g)	208.75±9.90	179.5±10.50	168.25±8.90	184.25±6.20	209.5±12.50	196±11.20	191.04±4.80 ns
Back (%)	14.52±0.30	14.01±0.40	14.46±0.50	14.48±0.40	14.78±0.30	14.79±0.30	14.51±0.20 ns

ns = non-significant

The carcass weight of KUB chickens ranged from 58.45 to 60.45 (%). This carcass weight is still equivalent to the carcass weight according to Nadaf Fahmideh et al. (2023), Akinmoladun et al. (2020), which is 61.75%. The lack of difference in carcass weight between treatments with vitamin C, vitamin E, and selenium supplementation in Escherichia coli-infected chickens was also due to the similar body weight (Table 3). Similar body weight results in similar carcasses and carcass parts. Vitamin C supplementation did not significantly affect carcass characteristics or meat

quality, although it did affect blood and blood lipid parameters (Tavakolinasab & Hashemi, 2025). The combination of vitamin E and selenium in broiler chicken feed did not significantly affect carcass percentage and carcass parts (breast, thigh, and fat) (Tallentire et al., 2016), Vitamin C, vitamin E, and selenium supplements did not affect carcass and carcass parts, although they increased the antioxidant content of meat (Yang et al., 2016). Variations in vitamin E and selenium supplementation did not produce statistical differences in carcass percentage (Murawska, 2017).

Antioxidant feed supplements often impact meat quality (e.g., reduced lipid oxidation or changes in physiochemical parameters), but do not always statistically affect carcass size or carcass percentage (Ebrahimi et al., 2024).

*KUB Chicken Blood Profile
Blood Protein and Hemoglobin*

The treatment of vitamin C, vitamin E, and selenium supplementation in *Escherichia coli*-infected chicken is presented in Table 5. The treatment of vitamin C, vitamin E, and selenium supplementation in *Escherichia coli*-infected water did not show significant differences in blood protein and hemoglobin levels.

Total blood protein in this study ranged from 3.5 to 4.10 (g/dl). This result is within the normal range of 3-5 g/ml. In this study, the addition of moderate and high doses of vitamin C did not show significant differences. This is because vitamin C does not directly correlate with blood protein. The addition of vitamin C and

vitamin E can reduce protein oxidation in red blood cells and strengthen antioxidant capacity, which indirectly helps maintain overall blood protein stability. In treatments P2, P4, and P6 infected with *E. coli*, there were no significant differences in blood protein levels. This is because the doses administered were relatively small and the KUB chickens did not experience diarrhea. If an *E. coli* infection causes diarrhea, it can trigger an immune response by increasing the production of acute-phase proteins such as CRP and fibrinogen, thereby increasing total plasma protein. In severe infections such as sepsis caused by *E. coli*, leukocyte counts and CRP increase significantly as the body responds to the pathogen. Hemoglobin levels in this study ranged from 13.75-15.50 (g/ml), which is within the normal range of 7-13 g/ml. Vitamin C helps increase iron absorption and aids hemoglobin synthesis through collagen and transferrin, which are important proteins in iron transport. Supplementing vitamin C to broiler chickens did not affect blood hemoglobin.

Table 5. Blood Protein and Hemoglobin Levels

Treatment	P1	P2	P3	P4	P5	P6	Average
Blood Protein (g/ml) ns	3.50±0.13	3.95±0.35	3.90±0.13	4.00±0.00	3.85±0.95	4.10±0.26	3.88±0.08
Hemoglobins (g/ml) ns	14.00±1.50	15.25±0.70	14.00±0.40	14.75±0.50	13.75±1.50	15.50±0.60	14.58±0.40

Information: Ns = non-significant.

Red Blood Cells and White Blood Cells

Red blood cells and white blood cells supplemented with vitamin C, vitamin E, and selenium in *Escherichia coli*-infected chickens are presented in Table 6. The vitamin C, vitamin E, and selenium supplementation treatments for *Escherichia coli* infection showed significant differences in eosinophils and no significant differences in basophils, monocytes, neutrophils, and lymphocytes. However, there were no significant differences in red blood cells and hematocrit.

Red blood cell levels in treatments P1, P3, P5, and P6 were normal, while P2 and P4 were high. The normal range for red blood cell levels is 2.5-3.5 10⁶/μL. Vitamin

C, vitamin E, and selenium supplementation treatments for *Escherichia coli* infection did not show significant differences in red blood cells in KUB chickens. Although red blood cells increased in the treatment with *Escherichia coli* infection, there was no significant difference. Previous studies reported that supplementation with vitamin E (100-150 IU/kg) and selenium (<0.45 mg/kg) increased red blood cell counts and hematocrit in broiler chickens under heat stress. Meanwhile, this study used KUB chickens, which are relatively resistant to disease and heat stress.

Table 6. Red Blood Cells and White Blood Cell Derivatives

Treatment	P1	P2	P3	P4	P5	P6	Average
Red blood cells (10 ⁶ /μL)	3.23 ± 0.81	5.03 ± 0.86	2.92 ± 0.16	4.21 ± 0.66	3.23 ± 0.32	2.82 ± 0.54	3.57±0.27
Hematocrit (%)	26.75±3.80	27.50 ± 0.60	25.50±0.90	22.50±1.20	25.00±1.40	27.66 ± 1.80	25.73±0.80
Basophils (%)	0.00±0.0	0.25±0.20	1.75±0.70	1.50±0.90	0.25±0.20	0.25±0.25	0.69±0.20
Eosinophils (%) *	2.33 ± 0.80a	0.00±0.00a	7.50±2.30ab	13.00±4.80b	2.75±1.90a	2.00±1.10a	4.90±1.30
Monocytes (%)	1.00±0.60	1.50±0.90	4.00±2.00	5.75±0	2.50±0.0	2.25±0.0	2.91±0.30
Neutrophils (%)	19.67±4.90	11.25±4.50	9.75±2.90	18.75±2.30	16.00±4.50	15.25±1.70	15.11±1.50
Lymphocytes (%)	73.00±0	87.00±0	73.00±0.0	65.00±0	78.50±0.00	80.25±0.0	76.26±0.10

Information: ns = non-significant; *Different notations on the same line indicate a noticeable difference.

The hematocrit levels in the treatments were 22.50-27.66%, still within the normal range. The normal range for hematocrit levels is 22-35%. Supplementation with vitamin C, vitamin E, and selenium in *Escherichia coli*-

infected chickens showed no significant difference in hematocrit. Hematocrit is the percentage of red blood volume to total blood volume. Vitamin C (Antosiak-Cyrak et al., 2025). Vitamin E and selenium are not the

main limiting nutrients in erythropoiesis (erythrocyte formation). The nutrients that play the most direct role in erythrocyte formation are iron, protein, vitamin B12, folic acid, and vitamin B6. Therefore, supplementation with vitamins C, E, and selenium does not automatically increase the number of red blood cells or hematocrit if the basic needs for blood-forming nutrients are met (Abudabos et al., 2018). Supplementing vitamin C to broiler chickens did not affect hematocrit.

The basophil count in this treatment was 0.0-1.7%, still within the normal range. The normal range for basophil counts is 1-4%. KUB chickens infected with *Escherichia coli* were in good condition because they were nutritionally adequate and disease-free. Treatment with the addition of vitamins C, E, and selenium to the *Escherichia coli*-infected chickens showed no difference in basophil counts. Although statistically similar, the control treatment had the lowest basophil count, while the *Escherichia coli*-infected treatment showed an increase. Basophils often increase in response to mild chronic allergens or inflammation from supplementation and exposure to bacteria, which play a key role in immunity against allergies (Shekhu, 2025).

Eosinophil levels in treatments P1, P2, P3, P5, and P6 remained normal, while those in P4 were high. The normal hematocrit level is 2-10% (Nurhadi & Sudana, 1988). Supplementation with vitamin C, vitamin E, and selenium during *Escherichia coli* infection showed a significant difference in eosinophil levels in KUB chickens. Basophil levels were lowest in the *Escherichia coli* infection treatment. The increase in eosinophils may be related to a response to *Escherichia coli* bacteria or certain immune pressures. Eosinophils are blood granulocytes formed in the bone marrow by cytokine signals in response to allergies or infections (Gaur et al., 2022). Eosinophils play a role in the response to chronic stress, parasites, or foreign substances, and the regulation of inflammatory mediators. Vitamin C and vitamin E supplementation can improve immune balance, increasing eosinophil activity and increasing eosinophil counts in response to the body's physiological needs to cope with stress (Ajakaiye et al., 2010).

Monocyte levels in this study, particularly in treatments P1, P2, P3, P5, and P6, ranged from 1.0% to 4.0%, which is still normal, while in P4, they were high. The normal range for basophil levels is 1.0% to 4%. Treatment with the addition of vitamins C, E, and selenium in *Escherichia coli*-infected chickens showed no significant differences in monocytes. Monocytes play a crucial role in maintaining homeostasis and defense against pathogens, both parasites and pathogenic bacteria. Monocytes are highly effective in combating parasitic infections, particularly those requiring tissue immunity and Th2-mediated immunity. Neutrophil

levels in this study, P1, P2, P3, P5, and P6, ranged from 1.0 to 4.0%, still normal, while P4 was high. The normal limit for neutrophil levels is 1-4%. The combination of Vitamin E + selenium + zinc feed supplement maintained total leukocyte and leukocyte differential (including lymphocytes) within the normal range, but did not show a significant increase in lymphocyte counts compared to the control; all treatments remained within the normal range for chicken blood.

Neutrophil levels in this study, P1, P2, P3, P5, and P6, ranged from 1.0 to 4.0%, still normal, while P4 was high. The normal limit for neutrophil levels is 1-4%. The addition of vitamin C, vitamin E, and selenium to *Escherichia coli*-infected chickens showed no significant difference in neutrophils. Vitamin C, vitamin E, and selenium act as antioxidants to inhibit free radicals. Lymphocyte levels in the study ranged from 65-80.25%, which is still within the normal range. The normal range for lymphocyte levels is 55-95%. Supplementation of vitamin C, vitamin E, and selenium with *Escherichia coli* infection showed no significant difference in the lymphocytes of KUB chickens. The addition of vitamins and minerals was within normal limits and did not cause stress or disease in the birds (Saleh et al., 2023).

Conclusion

Supplementation of vitamin E, vitamin C, and selenium in *Escherichia coli*-infected chickens showed no significant differences in productivity, carcass characteristics, and blood profile, but had a significant effect on feed consumption and eosinophil levels. Suggestion: Further testing with different levels of bacterial exposure (challenge tests) is needed to evaluate the protective effectiveness of this supplementation under more clinical or chronic infection conditions.

Acknowledgments

Thanks to all parties who have supported the implementation of this research. I hope this research can be useful.

Author Contributions

Conceptualization; R. E. M.; methodology; F. I.; validation.; F. M. A.; formal analysis; U. M. R. A.; investigation; R. E. M.; resources; F. I.; data curation.; F. M. A.; writing – original draft preparation; U. M. R. A.; writing – review and editing; R. E. M.; visualization: F. I. All authors have read and approved the published version of the manuscript.

Funding

Researchers independently funded this research.

Conflicts of Interest

The authors declare no conflict of interest.

References

- Abudabos, A. M., Al-Owaimer, A. N., Hussein, E. O. S., & Ali, M. H. (2018). Effect of Natural Vitamin C on Performance and Certain Haemato-Biochemical Values in Broiler Chickens Exposed to Heat Stress. *Pakistan Journal of Zoology*, 50(3). <https://doi.org/10.17582/journal.pjz/2018.50.3.951.955>
- Ahiwe, E. U., Omede, A. A., Abdallah, M. B., & Iji, P. A. (2018). Managing Dietary Energy Intake by Broiler Chickens to Reduce Production Costs and Improve Product Quality. In *Animal Husbandry and Nutrition*. InTech. <https://doi.org/10.5772/intechopen.76972>
- Ahmad, R., Yu, Y.-H., Hsiao, F. S.-H., Su, C.-H., Liu, H.-C., Tobin, L., Zhang, G., & Cheng, Y.-H. (2022). Influence of Heat Stress on Poultry Growth Performance, Intestinal Inflammation, and Immune Function and Potential Mitigation by Probiotics. *Animals*, 12(17), 2297. <https://doi.org/10.3390/ani12172297>
- Ajakaiye, J. J., Perez-Bello, A., & Mollineda-Trujillo, A. (2010). Impact of Vitamins C and E Dietary Supplementation on Leukocyte Profile of Layer Hens Exposed to High Ambient Temperature and Humidity. *Acta Veterinaria Brno*, 79(3), 377–383. <https://doi.org/10.2754/avb201079030377>
- Akinmoladun, O. F., Fon, F. N., & Mpendulo, C. T. (2020). Stress indicators, carcass characteristics and meat quality of Xhosa goats subjected to different watering regimen and vitamin C supplementation. *Livestock Science*, 238, 104083. <https://doi.org/10.1016/j.livsci.2020.104083>
- Alberghina, D., Amato, A., Brancato, G., Cavallo, C., Liotta, L., & Lopreato, V. (2024). Impact of Heat Stress on the Balance between Oxidative Markers and the Antioxidant Defence System in the Plasma of Mid-Lactating Modicana Dairy Cows. *Animals*, 14(14), 2034. <https://doi.org/10.3390/ani14142034>
- Alberts, A., Moldoveanu, E.-T., Niculescu, A.-G., & Grumezescu, A. M. (2025). Vitamin C: A Comprehensive Review of Its Role in Health, Disease Prevention, and Therapeutic Potential. *Molecules*, 30(3), 748. <https://doi.org/10.3390/molecules30030748>
- Antosiak-Cyrak, K., Demuth, A., Czerniak, U., Ratajczak, J., Bryl, E., Kowalski, P., Wochna, K., Lewandowska, M., & Domaszewska, K. (2025). The Impact of Dietary Nutrient Intake on Red Blood Cell Distribution Width-Coefficient of Variation in Pregnant Women: A Cross-Sectional Observational Pilot Study. *Nutrients*, 17(21), 3396. <https://doi.org/10.3390/nu17213396>
- Bai, S., Zhang, M., Tang, S., Li, M., Wu, R., Wan, S., Chen, L., Wei, X., & Feng, S. (2024). Effects and Impact of Selenium on Human Health, A Review. *Molecules*, 30(1), 50. <https://doi.org/10.3390/molecules30010050>
- Barnhart, A., Anthony, A., Conaway, K., Sibbitt, B., Delaney, E., Haluschak, J., Kathula, S., & Chen, A. (2024). Safety and efficacy of Vitamin C, Vitamin E, and selenium supplementation in the oncology setting: A systematic review. *Journal of Oncology Pharmacy Practice*, 30(4), 678–696. <https://doi.org/10.1177/10781552231182362>
- Biswas, A., Deo, C., Sharma, D., Matin, A., & Tiwari, A. K. (2024). Production performance, haematological parameters, serum biochemistry, and expression of HSP-70 in broiler chickens fed dietary ascorbic acid during heat stress. *International Journal of Biometeorology*, 68(1), 33–43. <https://doi.org/10.1007/s00484-023-02568-3>
- Chen, X., Zeng, D., Zeng, X., & Zeng, Q. (2024). Effects of Complex Antioxidants Added to Chicken Diet on Growth Performance, Serum Biochemical Indices, Meat Quality, and Antioxidant Capacity. *Animals*, 14(3), 360. <https://doi.org/10.3390/ani14030360>
- Cherian, G. (2015). Nutrition and metabolism in poultry: Role of lipids in early diet. *Journal of Animal Science and Biotechnology*, 6(1), 28. <https://doi.org/10.1186/s40104-015-0029-9>
- Cuvas-Limón, R. B., Ferreira-Santos, P., Cruz, M., Teixeira, J. A., Belmares, R., & Nobre, C. (2022). Novel Bio-Functional Aloe vera Beverages Fermented by Probiotic *Enterococcus faecium* and *Lactobacillus lactis*. *Molecules*, 27(8), 2473. <https://doi.org/10.3390/molecules27082473>
- Dalia, A. M., Loh, T. C., Sazili, A. Q., Jahromi, M. F., & Samsudin, A. A. (2018). Effects of vitamin E, inorganic selenium, bacterial organic selenium, and their combinations on immunity response in broiler chickens. *BMC Veterinary Research*, 14(1), 249. <https://doi.org/10.1186/s12917-018-1578-x>
- Dang, X., Li, A., Fan, L., & Cui, J. (2024). Resident water conservation behaviors among different age groups in rural areas of the Weibei arid belt, China. *Journal of Cleaner Production*, 456, 142389. <https://doi.org/10.1016/j.jclepro.2024.142389>
- Ebrahimi, N. A., Nobakht, A., İnci, H., Palangi, V., Suplata, M., & Lackner, M. (2024). Drinking Water Quality Management for Broiler Performance and Carcass Characteristics. *World*, 5(4), 952–961. <https://doi.org/10.3390/world5040048>
- Gaur, P., Zaffran, I., George, T., Rahimli Alekberli, F., Ben-Zimra, M., & Levi-Schaffer, F. (2022). The regulatory role of eosinophils in viral, bacterial, and fungal infections. *Clinical and Experimental*

- Immunology*, 209(1), 72–82. <https://doi.org/10.1093/cei/uxac038>
- Hidayat, D. F., Widodo, A., Diyantoro, D., & Yuliani, M. G. A. (2020). The Effect of Providing Fermented Milk on The Performance of *Gallus domesticus*. *Journal of Applied Veterinary Science And Technology*, 1(2), 43. <https://doi.org/10.20473/javest.V1.I2.2020.43-47>
- Horváth, M., & Babinszky, L. (2018). Impact of selected antioxidant vitamins (Vitamin A, E and C) and micro minerals (Zn, Se) on the antioxidant status and performance under high environmental temperature in poultry. A review. *Acta Agriculturae Scandinavica, Section A – Animal Science*, 68(3), 152–160. <https://doi.org/10.1080/09064702.2019.1611913>
- Imberti, L., Tiecco, G., Logiudice, J., Castelli, F., & Quiros-Roldan, E. (2025). Effects of Climate Change on the Immune System: A Narrative Review. *Health Science Reports*, 8(4), e70627. <https://doi.org/10.1002/hsr2.70627>
- Lacourt, T. E., Vichaya, E. G., Chiu, G. S., Dantzer, R., & Heijnen, C. J. (2018). The High Costs of Low-Grade Inflammation: Persistent Fatigue as a Consequence of Reduced Cellular-Energy Availability and Non-adaptive Energy Expenditure. *Frontiers in Behavioral Neuroscience*, 12, 78. <https://doi.org/10.3389/fnbeh.2018.00078>
- Mekonnen, D. A. (2024). Does household's food and nutrient acquisition capacity predict linear growth in children? Analysis of longitudinal data from rural and small towns in Ethiopia. *Food Security*, 16(2), 533–550. <https://doi.org/10.1007/s12571-024-01430-7>
- Murawska, D. (2017). The Effect of Age on Growth Performance and Carcass Quality Parameters in Different Poultry Species. In M. Manafi (Ed.), *Poultry Science*. InTech. <https://doi.org/10.5772/64860>
- Nadaf Fahmideh, M., Seidavi, A., & Bouyeh, M. (2023). The effect of different levels of vitamin C and chromium on growth performance, carcass characteristics, digestive organs, immunity, blood constituents, liver enzymes, cecal microflora, meat sensory taste and fatty acid profile of breast meat in broilers. *Veterinary Medicine and Science*, 9(6), 2763–2780. <https://doi.org/10.1002/vms3.1300>
- Noetzold, T. L., & Zuidhof, M. J. (2025). Role of nutritional and metabolic status on the pullet to hen transition and lifetime productivity. *Frontiers in Physiology*, 16, 1585645. <https://doi.org/10.3389/fphys.2025.1585645>
- Pečjak, M., Leskovec, J., Levart, A., Salobir, J., & Rezar, V. (2022). Effects of Dietary Vitamin E, Vitamin C, Selenium and Their Combination on Carcass Characteristics, Oxidative Stability and Breast Meat Quality of Broiler Chickens Exposed to Cyclic Heat Stress. *Animals*, 12(14), 1789. <https://doi.org/10.3390/ani12141789>
- Righi, F., Pitino, R., Manuelian, C. L., Simoni, M., Quarantelli, A., De Marchi, M., & Tsiplakou, E. (2021). Plant Feed Additives as Natural Alternatives to the Use of Synthetic Antioxidant Vitamins on Poultry Performances, Health, and Oxidative Status: A Review of the Literature in the Last 20 Years. *Antioxidants*, 10(5), 659. <https://doi.org/10.3390/antiox10050659>
- Sadiq, R. K., Abrahamkhal, M. A., Rahimi, N., Banuree, S. Z., & Banuree, S. A. H. (2023). Effects of Dietary Supplementation of Vitamin E on Growth Performance and Immune System of Broiler Chickens. *Journal of World's Poultry Research*, 1. <https://doi.org/10.36380/jwpr.2023.13>
- Saleh, A. A., El-Tahan, H. M., Shaban, M., Morsy, W. A., Genedy, S., Alzawqari, M. H., El-Tahan, H. M., Shukry, M., Ebeid, T. A., El-Keredy, A., Alwutayd, K., Alhotan, R. A., Al-Badwi, M. A. A., Sewlim Hussein, E. O., Kim, I. H., Cho, S., & Eid Abdel-Moneim, A.-M. (2023). Effect of dietary supplementation of betaine and organic minerals on growth performance, serum biochemical parameters, nutrients digestibility, and growth-related genes in broilers under heat stress. *Poultry Science*, 102(11), 103051. <https://doi.org/10.1016/j.psj.2023.103051>
- Shakeri, M., Cottrell, J., Wilkinson, S., Ringuet, M., Furness, J., & Dunshea, F. (2018). Betaine and Antioxidants Improve Growth Performance, Breast Muscle Development and Ameliorate Thermoregulatory Responses to Cyclic Heat Exposure in Broiler Chickens. *Animals*, 8(10), 162. <https://doi.org/10.3390/ani8100162>
- Shakeri, M., Oskoueian, E., Le, H., & Shakeri, M. (2020). Strategies to Combat Heat Stress in Broiler Chickens: Unveiling the Roles of Selenium, Vitamin E and Vitamin C. *Veterinary Sciences*, 7(2), 71. <https://doi.org/10.3390/vetsci7020071>
- Shekhu, N. A. (2025). Impact of Pathogenic Bacterial Challenges on Growth Performance, Gut Morphology, Serum Biochemistry, and Meat Quality in Broiler Chickens. *Pakistan Journal of Life and Social Sciences (PJLSS)*, 23(1). <https://doi.org/10.57239/PJLSS-2025-23.1.00561>
- Soetedjo, N. N. M. (2025). The role of nutrition in various endocrine and metabolic diseases. *Clinical Nutrition Open Science*, 62, 164–188. <https://doi.org/10.1016/j.nutos.2025.05.015>
- Tallentire, C. W., Leinonen, I., & Kyriazakis, I. (2016). Breeding for efficiency in the broiler chicken: A review. *Agronomy for Sustainable Development*, 152

- 36(4), 66. <https://doi.org/10.1007/s13593-016-0398-2>
- Tavakolinasab, F., & Hashemi, M. (2025). Effect of Using Vitamin C Supplementation on Performance, Blood Parameters, Carcass Characteristics and Meat Quality of Broiler Chickens Under Heat Stress Condition: A Meta-Analysis. *Journal of Animal Physiology and Animal Nutrition*, 109(3), 753–765. <https://doi.org/10.1111/jpn.14091>
- Visscher, C., Klingenberg, L., Hankel, J., Brehm, R., Langeheine, M., & Helmbrecht, A. (2018). Feed Choice Led to Higher Protein Intake in Broiler Chickens Experimentally Infected With *Campylobacter jejuni*. *Frontiers in Nutrition*, 5, 79. <https://doi.org/10.3389/fnut.2018.00079>
- Yang, Y., Yu, Y., Pan, J., Ying, Y., & Zhou, H. (2016). A new method to manipulate broiler chicken growth and metabolism: Response to mixed LED light system. *Scientific Reports*, 6(1), 25972. <https://doi.org/10.1038/srep25972>
- Yuan, S., Zhang, Y., Dong, P.-Y., Chen Yan, Y.-M., Liu, J., Zhang, B.-Q., Chen, M.-M., Zhang, S.-E., & Zhang, X.-F. (2024). A comprehensive review on potential role of selenium, selenoproteins and selenium nanoparticles in male fertility. *Heliyon*, 10(15), e34975. <https://doi.org/10.1016/j.heliyon.2024.e34975>
- Zampiga, M., Calini, F., & Sirri, F. (2021). Importance of feed efficiency for sustainable intensification of chicken meat production: Implications and role for amino acids, feed enzymes and organic trace minerals. *World's Poultry Science Journal*, 77(3), 639–659. <https://doi.org/10.1080/00439339.2021.1959277>