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EFFECTS OF PROPOLIS POWDER ON GROWTH PERFORMANCE, PHYSIOLOGICAL TRAITS AND CARCASS CHARACTERISTICS OF BROILER CHICKENS

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Abstract: Assessing the effects of incorporating propolis as a natural growth enhancer of broiler chickens for growth performance, physiological traits and carcass characteristics was the aim of this study. A total of 240 one-day-old broiler chicks (Cobb 500) were individually weighed and randomly divided into four equal groups, with 60 chicks in each. Each group comprises four replicates, each containing 15 birds. Propolis powder was supplemented into broiler diets at dosages of 0, 200, 400, and 600 mg/kg diet. On day 42, two birds per replication (8 birds per treatment) were selected to evaluate blood biochemistry and carcass yield. The results showed that the group of chickens given 400 mg/kg of propolis grew better and converted feed into body weight more efficiently than the other groups. The chickens who had propolis baseline diets exhibited a significant ($P < 0.05$) reduction of total cholesterol, triglycerides, and LDL levels in comparison to the control group. The incorporation of 600 mg/kg propolis resulted in diminished broiler performance and carcass yield. In conclusion, propolis can be administered to broilers at a dosage of up to 400 mg/kg without detrimental effects on growth performance.

Key words: *propolis, broiler, carcass, quality, physiological performance*

INTRODUCTION

Concerned about the effects of antibiotics in chicken feed, Libyans are particularly worried about the inadequate preservation of processed poultry products and the emergence of antibiotic-resistant bacteria (Kairalla, Alshelmani & Imdakim, 2023; Kairalla, Alshelmani, Imdakim & Aburas, 2025). With considerable effort, poultry nutritionists revealed natural components that may improve broiler development, feed economy, and meat quality (Raheema, 2016; Aguihe, Kehinde, Ospina-Rojas & Murakami, 2017; Kairalla, Alshelmani & Aburas, 2022; Alshelmani, El-Safty, Kairalla & Humam, 2024). Natural feed additives have clear advantages and can be excellent substitutes for antibiotics for many bird species, according to several studies. Extensive research across various avian species has de-

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monstrated that natural feed additives can serve as effective alternatives to antibiotics, yielding beneficial outcomes (AL-Kahtani, Alaqil & Abbas, 2022; Aburas & Kairalla, 2025). Propolis is a resinous substance, commonly referred to as bee glue, that honeybees gather from various plants. It exhibits significant characteristics, including immunomodulatory, anti-inflammatory, hepatoprotective, antioxidative, antiviral, antibacterial, antifungal, anticancer, and cardioprotective effects (Saeed et al., 2017). The biological attributes of propolis and its prospective therapeutic benefits in poultry are presently the subject of significant study attention. Elevated levels in different polyphenols, particularly flavonoids, triterpenes, phenolic acid esters, phenolic acids, diterpenic acids, and lignans of propolis, primarily promote improved health, immune system, and gut microflora (Abd El-Ghany, 2024; Konanc & Öztürk, 2025a). The phenolic acids in propolis are t-cinnamic acid, quercetin, chrysin, pinocembrin, ferulic acid, apigenin, gallic acid, and p-coumaric acid-compounds (Juárez et al., 2024). Poultry nutriationists aim to develop natural feed additives that enhance feed efficiency, immune function, growth performance, and meat quality in broiler chickens (Phillips et al., 2023). Bee products, including propolis, royal jelly, and bee pollen, are being employed with considerable emphasis on the feeding of broilers (Petričević et al., 2022). Therefore, the objective of this study was to evaluate the impacts of propolis on growth performance, physiological traits, and carcass characteristics of broiler chickens.

MATERIALS AND METHODS

Ethical approval

The feeding study was carried out at the Poultry Research Center, Faculty of Agriculture, Sebha University, Libya. All ethical standards related to animal care and husbandries were applied in the current study and approved by the institutional animal care and use committee (IACUC)-3752-SUEC, 2025 of the University of Sebha.

Sources of experimental birds and materials

The broiler chicks (Cobb500) for this study were purchased from a local hatchery in Sebha City, Libya. Commercially tested material propolis was purchased from the Libyan local market.

Birds and diets

This study experienced a completely randomized design. A total of 240 one-day-old Cobb500 broiler chicks with comparable live body weights were utilized. The chicks were measured separately and then allocated into four equal groups, each including 60 birds per treatment. The groups were split into four replicates, each containing 15 birds.

The individually produced birds were reared in ground cages measuring 1.5 × 1.5 m, furnished with wood shavings as litter. The chicks were provided with unrestricted access to water and nutrition. All birds were subjected to uniform feeding and maintenance procedures as specified in the (Cobb500) broiler chick manual. In the first few hours after hatching, the temperature in the breeding house was maintained at 33±0.5 °C. The temperature was decreased by two degrees each week and maintained it between 25 and 27 °C.The birds were raised in open house system. All chicks received vaccines against three prevalent infectious diseases: Newcastle disease, infectious bronchitis, and Gumboro disease.

The birds were fed their initial and final diets from 1 to 21 days and 22 to 42 days of age, respectively (Table 1). Experimental diets were developed according to the calorie requirements of birds as described by the National Research Council (1994). All diets had almost iso-nutritive value according to the purpose of study. The experimental diets were determined as follows:

Diet (1): Basal diet without propolis powder, and served as control diet;

Diet (2): Basal diet with propolis powder at 200 mg/kg level;

Diet (3): Basal diet with propolis powder at 400 mg/kg level;

Diet (4): Basal diet with propolis powder at 600 mg/kg level.

Production performance

The body weight was measured individually, and the amount of food consumed was recorded every week for all replicates. Then, body weight gain (BWG) and feed conversion ratio (FCR) were recorded.

Blood samples

Two birds were randomly selected from each replicate within each feeding treatment at the end of the trial. The birds underwent a 12-hour fasting period prior to take blood samples. The blood samples were collected by inserting a sterile injector into the wing vein, and then transferred into K3EDTA vacuum tubes, which functioned as an anticoagulant.

The samples were centrifuged for 15 minutes at 3000 *g* and the plasma was kept at -20 ºC for further analysis (Alshelmani, Loh, Foo, Sazili & Lau, 2017; Abdulla, Loh, Foo, Alshelmani & Akit, 2019).

Blood hematology

An automatic blood analyzer (Huma Count 80TS Hematology Analyzer, Human Company for Biochemistry, Wiesbaden, Germany) was used to estimate the levels of white blood cells, red blood cells, packed cell volume, and lymphocytes in whole blood samples at the main laboratory.

Blood biochemistry

The concentration of total protein, albumin, globulin, total cholesterol levels, high-density lipoprotein cholesterol (HDL), low-density lipoprotein cholesterol (LDL), triglycerides, glucose, and the enzyme activity of alanine and aspartate aminotransferase were determined by automatic biochemical analyser (Spectrophotometer V 1.0; Revision for Alpha-1,101,1,102, 1,502; Laxco Inc.). The A/G ratio was calculated by dividing the albumin concentration by the globulin concentration in serum samples.

Slaughter processing and organ weights

On day 42, two birds per replication (8 birds per treatment) were randomly selected to assess the dressing percentage. Designated birds underwent a 12-hour fasting period prior to slaughter, were individually weighed to determine pre-slaughter weight, and were murdered in accordance with Islamic religious guidelines using a sharp knife.

The birds were defeathered and eviscerated, and the carcass was individually weighed. Next, the internal organs and the abdominal fat were weighed and expressed as a percentage of the final live body weight (LBW), using the methods outlined by (Kairalla et al., 2023).

Statistical analysis

The results give in the tables are represented as mean ± standard error of a number of independed measurements in each replicate, while the body weight was measured individually. Each replicate represented an experimental unit, and each bird represented an experimental unit in body weight gain. The normality test was applied to the data, and One-way ANOVA was used to assess differences among the various groups. General linear model approach was applied to analyze the data using statistical analysis system of SAS software (SAS, 2003).

The linear and quadratic effects of enhancing the increasing propolis inclusion levels in comparison to the controls were evaluated using orthogonal polynomial contrasts. Effects were considered significant at (P<0.05) using Tukey's test to separate the differences among the treatments. The statistical model used for the feeding trial was $Y_{ijk} = \mu + T_{ij} + E_{ijk}$, where Y_{ijk} = observation; μ = population mean; T_{ij} = the effect of diet (propolis powder); and E_{ijk} = experimental error.

RESULTS AND DISCUSSION

Production performance

Table 2 shows the effect of propolis incorporation on growth efficiency during the study period. In starter phase, birds that provided 400 mg/kg of propolis were linear and quadratic (P= <0.0001) gained more weight than those in other groups, and supplementing 400 mg/kg of propolis to their diet was linearly (P= 0.0023) improved FCR compared to those fed diets with 200 mg/kg or 600 mg/kg of propolis. The body weight gain (BWG) was better in birds consumed a basal diet with 400 mg/kg of propolis compared to the other groups during both the finisher phase and overall (Linear and Quadratic, P= <0.0001). The birds fed with a 600 mg/kg propolis basal diet showed a significant increase (Linear and Quadratic, P= <0.0001) in feed intake throughout the finisher period and during the whole period (Linear, P= 0.0038; Quadratic, P= 0.0077). Moreover, birds provided 600 mg/kg of propolis gained less weight and were less efficient at using their feed, This may be attributed to quantity of propolis, explaining the varying effects of propolis on growth. As a result, production decreased. The use of 400 mg/kg propolis basal diet resulted in a significant improvement in FCR during the finisher phase (Linear, P= 0.0005) and overall period (Linear and Quadratic, P= <0.0001). The better growth seen in the propolis group at moderate levels may attributed to the antibacterial and antioxidant qualities of phenolic compounds and flavonoids in propolis leading to increase BWG and improving FCR.

This enhancement may be associated with a positive effect on gut flora, which aids in digestion, nutritional absorption, and utilization (El-Sabrout, Khalifah & Ciani, 2023; El-Sabrout, Tavares Dantas & Souza-Junior, 2023). The results agree with studies by Zhijiang, Sanfeng, Ke, Hongxiang and Kaijie (2004), Shalmany and Shivazad (2006), Seven (2008), Seven, Yilmaz, Seven and Kelestemur (2012) and Abdel-Maksoud et al. (2023) showed that adding moderate amounts of propolis to broiler feed boosted productivity because of its helpful nutrients. This is likely attributed to its heightened advantageous active components.

These studies indicated that propolis significantly increases the body's capacity to absorb and utilize nutrients. The augmented nutriational properties of propolis act as significant growth boosters, consequently promoting avian health. Therefore, it is an effective nutritional feed for the poultry industry (Kadhim, Łos, Olszewski & Borsuk, 2018).

Propolis can be effectively utilized in various forms as a natural supplement to enhance broiler performance without adversely affectting the carcass qualities of the birds (Galal, Ibrahim, Osman, Abdalla & Rabie, 2025). In contrast, Dosoky, Abd El-Rahman and Al-Rumaydh (2022) observed no significant effect on growth performance indicators at 42 days of age with the inclusion of propolis (100–400 mg/kg food) in broiler diets. In accordance with the findings of Vieira et al. (2021), the carcass characteristics of broiler chickens receiving diets enriched with either whey or propolis exhibited no significant alterations.

Dressing measure

Table 3 shows the impact of propolis inclusion on dressing percentages. The inclusion of 600 mg/kg of propolis into the diet resulted in a reduction in carcass yield (Linear, P= 0.0004; Quadratic, P= <0.0001). Birds that provided a 400 mg/kg propolis basal diet showed an overall reduction in abdominal fat (Linear, P= 0.0019; Quadratic, P= 0.0030) when compared to the other groups.

These results agree with those of Dosoky et al. (2022), who indicated that the inclusion of 400 mg/kg of propolis in the feed increased carcass yield when compared with a control group. The increase in carcass production in chickens consumed 200 mg/kg or 400 mg/kg of propolis may be attributed to the improved growth performance due to its high nutritional value. Improvements in carcass characteristics are typically associated with improved growth performance and nutrient digestibility.

Investigations by Seven (2008) and Hassan and Abdulla (2011) demonstrated that incurporating propolis into the diet significantly increased the quality of meat measurements, such as dressing and carcass percentages, in broiler chickens, ducks, and quails. In contrast, Galal et al. (2025) observed no significant effect on dressing percentages at 42 days of age with the inclusion of propolis in broiler diets. The influence of propolis in production or carcass characteristics depends on its origin. It could be due to the variation and concentration of active ingredients (Juárez et al., 2024).

Blood hematology

Table 4 shows the impact of propolis inclusion on hematological indicators. No significant changes (P>0.05) were seen in white blood cells (WBC), red blood cells (RBC), hemoglobin (Hb), packed cell volume (PCV), and lymphocyte levels among the dietary treatments. However, the glucose levels were higher (Linear, P= 0.0001; Quadratic, P= 0.0005) in the birds administered propolis compared to the control group. The superior quality of the energy source in propolis may account for the increase in glucose levels in broilers fed propolis-based diets. The findings are consistent with those of Haro et al. (2000) and Shihab and Ali (2012), who revealed that the inclusion of propolis in broiler diets significantly (P<0.05) improved glucose levels. In addition, it was demonstrated that the inclusion of propolis in broiler diets did not adversely affect Hb levels, WBC, RBC count, PCV, or lymphocyte levels in broiler chicks (Shihab &

Ali, 2012). However, Eldiasty et al., (2024) claimed that nano- propolis led to a decrease in WBC and lymphocyte in broiler chickens under cyclic heat stress.

Blood biochemistry

The impact of propolis inclusion on blood biochemistry is shown in Table 5. The bird consumed propolis-enriched food showed decreased levels of total cholesterol (Linear, P= <0.0001; Quadratic, P= 0.0010) and triglycerides (Linear, P= <0.0001) compared with the control group. The reduced levels of total cholesterol, triglycerides, and LDL (Linear, P= <0.0001; Quadratic, P= 0.0061), together with the elevated HDL levels (Linear, P= <0.0001; Quadratic, P= 0.0021) in broilers feeding propolis-based diets, may be attributed to the improved antioxidant properties of propolis. Studies indicated that propolis improves biological processes, optimizes liver function, and promotes lipid metabolism (Matsui et al., 2004; Babinska, Kleczek, Makowski & Szarek, 2013). Abdel-Rahman and Mosaad (2013) found that poultry receiving 300 ppm of propolis per kilogram for 35 days demonstrated a substantial decrease in triglyceride and cholesterol levels. These findings may relate to propolis's ability to neutralize free radicals, improve lipid absorption, and affect liver morphology (Attia et al., 2014). In addition, supplementation of propolis to the diet greatly lowered triglyceride and LDL levels and raised HDL levels, indicating that propolis might help control fat levels in the body (Huang et al., 2005).

Table 1.
Chemical composition of experimental diets

Ingredients (kg)	Starter from days 0 to 21	Finisher from days 22 to 42
Yellow Corn	54.00	60.00
Soybean Meal 44%	29.50	24.00
Corn Gluten Meal	8.00	8.24
Di-calcium phosphate	2.15	2.05
Lime stone	1.10	1.00
Salt (NaCl)	0.25	0.25
Vegetable oil	4.50	4.00
L-lysine	0.15	0.15
DL-Methionine	0.05	0.01
Vitamin and mineral premix*	0.30	0.30
Total	100	100
Calculated parameters		
Crude protein (%)	22.25	18.10
M.E (kcal/ kg)	2995	3185
C/P	134.60	175.96
Fat (%)	3.75	6.25
Crude fiber (%)	2.40	2.60
Calcium (%)	1.03	0.97
Available phosphorus (%)	0.44	0.39
Methionine (%)	0.54	0.43
Lysine (%)	1.15	0.99

**Each 1 kg Premix contained: Vit. A 3350000 IU; Vit. D3 760 000 IU; Vit. E 6700 IU; Vit. K3 335 mg; Vit. B1 334 mg; Vit. B2 1670 mg; Vit. B6 500 mg; Vit. B12 3.4 mg; Niacin 10000 mg; Ca D-pantothenate 3334 mg; Biotin 16.7 mg; Folic acid 334 mg; Trace minerals: Iron 13350 mg; Copper 3335 mg; Zinc 16700 mg; Manganese 25000 mg; Iodine 500 mg; Cobalt 84 mg; Selenium 100 mg; Additives: Ethoxyquine 600 mg; and Carrier ($CaCO_3$) up to 1 kg.*

Propolis might lower triglycerides and cholesterol because its antioxidant properties boost GSH enzyme activity, or it might contain essential fatty acids that block an important enzyme needed for making cholesterol (Babinska et al., 2013).

In addition, the remarkable decrease in cholesterol and total lipid levels after the introduction of propolis and whey may be ascribed to reduced lipid absorption in the small intestine, resulting from bile acid ligation that promotes cholesterol excretion (Ashour et al., 2019).

The inclusion of propolis and whey impacts the heterophil-to-lymphocyte ratio by enhancing immune system functionality, which consequently boosts lymphatic tissue activity and macrophage efficacy (Mona, Naglaa & Hala, 2021).

The inclusion of propolis in broiler diets has not shown any significant impact on AST or ALT levels (Attia et al., 2014). The propolis diet has been associated with decreased blood triglyceride levels, perhaps due to flavonoids enhancing the body's utilization of triglycerides for energy, or may be because of bioactive compounds which play a crucial role in reducing oxidative stress in muscle tissue and preventing lipid oxidation (Konanç & Öztürk, 2025b). The results align with those of Sierra-Galicia et al., (2022) which indicated no significant variations in total blood protein and albumin levels in broilers consumed propolis-based diets. Recent studies and an expanding body of evidence suggested that the impact of propolis on avian health, performance, and welfare is contingent upon several criteria, including dosage, type, and concentrations of its active constituents.

Table 2.
Impact of propolis inclusion on broiler performance during the feeding trial

Traits	Propolis (mg/kg) 0	200	400	600	SEM*	Contrast P- values Linear	Quadratic
	0 – 21days						
Body weight gain (g/bird)**	795.27^{b}	799.09^{b}	861.36^{a}	784.36^{b}	4.4194	<0.0001	<0.0001
Feed consumption (g/bird)	942.27	958.05	961.35	968.73	7.6064	0.1471	0.5803
Feed conversion ratio (FCR)	1.18^{ab}	1.19^{a}	1.11^{b}	1.23^{a}	0.01675	0.0023	0.0563
	22 – 42 days						
Body weight gain (g/bird)	1372.35^{b}	1426.94^{a}	1450.20^{a}	1241.05^{c}	13.971	<0.0001	<0.0001
Feed consumption (g/bird)	3030.71^{b}	3011.11^{c}	2997.21^{d}	3039.17^{a}	1.9775	<0.0001	<0.0001
Feed conversion ratio (FCR)	2.20^{b}	2.11^{b}	2.06^{b}	2.44^{a}	0.04841	0.0005	0.0005
	Overall (0 – 42 days)						
Body weight gain (g/bird)	2167.62^{c}	2226.03^{b}	2311.56^{a}	2025.41^{d}	13.083	<0.0001	<0.0001
Feed consumption (g/bird)	3972.98^{b}	3969.61^{b}	3958.56^{b}	4007.90^{a}	7.6748	0.0038	0.0077
Feed conversion ratio (FCR)	1.83^{b}	1.78^{bc}	1.71^{c}	1.97^{a}	0.02096	<0.0001	<0.0001

**SEM: Pooled standard error of the mean based on individual birds in BWG, and on group otherwise. ** n=60 birds/group. Means within the same row with different superscripts differ significantly (P < 0.05).*

Table 3.
Impact of propolis incorporation on carcass characteristics

Parameters (%)	**Propolis (mg/kg)**					**Contrast P- values**	
	0	**200**	**400**	**600**	**SEM***	**Linear**	**Quadratic**
Carcass yield**	65.10[ab]	66.45 [a]	66.65[a]	63.40[b]	0.4065	0.0004	<0.0001
Abdominal fat	1.044[a]	0.982[ab]	0.917 [b]	0.989[a]	0.0171	0.0019	0.0030
Gizzard	1.790	1.794	1.792	1.804	0.0148	0.8963	0.7972
Liver	1.893	1.890	1.889	1.886	0.0081	0.9660	0.8754
Heart	0.49	0.48	0.48	0.47	0.0088	0.9729	0.8853

**SEM: Pooled standard error of the mean based on group. **n= 8. Means within the same row with different superscripts differ significantly (P < 0.05).*

Table 4.
Effect of propolis inclusion on hematological parameters

Parameters**	**Propolis (mg/kg)**					**Contrast P- values**	
	0	**200**	**400**	**600**	**SEM***	**Linear**	**Quadratic**
WBC, $10^6/mm^3$	12.15	12.21	12.64	13.55	0.3723	0.7310	0.8365
RBC, $10^6/mm^3$	2.71	2.80	2.86	2.85	0.0802	0.5654	0.5184
Hemoglobin, g/dL	10.08	10.52	10.63	10.61	0.2764	0.4768	0.3930
PCV %	32.35	32.93	32.84	32.55	0.2116	0.2456	0.0594
Lymphocytes %	74.10	74.52	74.08	74.63	0.6152	0.8582	0.8840
Glucose, mg/dl	180.28[c]	188.57[b]	192.78[a]	193.20[a]	0.8904	0.0001	0.0005

**SEM: Pooled standard error of the mean based on group. **n=8. Means within the same row with different superscripts differ significantly (P < 0.05).*

Table 5.
Impact of propolis incorporation on blood biochemistry

Parameters**	**Propolis (mg/kg)**					**Contrast P- values**	
	0	**200**	**400**	**600**	**SEM***	**Linear**	**Quadratic**
Total cholesterol (mg/dL)	221.54[a]	214.45[b]	210.30[c]	209.31[c]	0.7505	<0.0001	0.0010
Triglycerides (mg/dL)	93.34[a]	90.15[b]	85.56[c]	81.84[d]	0.5960	<0.0001	0.6468
LDL-cholesterol (mg/dL)	93.27 [a]	89.20 [b]	89.36[b]	88.87[b]	0.4747	<0.0001	0.0061
HDL-cholesterol (mg/dL)	110.05[c]	116.07[b]	119.33[a]	119.86[a]	0.7486	<0.0001	0.0021
Total protein (g/L)	2.74	2.83	2.92	2.97	0.2014	0.8622	0.9293
Albumin (g/L)	1.22	1.27	1.29	1.30	0.0206	0.0765	0.3043
Globulin	1.52	1.56	1.63	1.67	0.2042	0.9552	0.9850
A/G ratio	0.8026	0.8141	0.7914	0.7784	0.1002	0.6645	0.6007

**SEM: Pooled standard error of the mean based on group. **n=8. Means within the same row with different superscripts differ significantly (P < 0.05).*

CONCLUSIONS

Recent investigations indicate that the impact of propolis on bird health, performance, and overall well-being is influenced by multiple factors, including amount, type, and concentration of its bioactive constituents. The findings of the current study suggests that supplementation of broiler diets with propolis at a level of 400 mg/kg may promote improved growth performance.

However, higher inclusion rates appear to be unsuitable for broilers. Further studies are warranted to elucidate the role of propolis in modulating immune function and gut health in poultry.

AUTHOR CONTRIBUTIONS

Conceptualization, M.A.K. and M.I.A.; Methodology, A.A.A. and M.I.A.; Investigation, formal analysis, validation, writing-original draft preparation, M.A.K.; Writing-review and editing, M.A.K., M.M.I. and M.I.A.; Supervision, M.A.K.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the correspond-ding author.

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CONFLICT OF INTEREST

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

REFERENCES

Abd El-Ghany, W. A. (2024). Propolis (bee glue): a promising natural feed additive for poultry and rabbits – a review. *Annals of Animal Science, 24*(4). https://doi.org/10.2478/aoas-2024-0024

Abdel-Maksoud, E. M., Daha, A. A. E. F., Taha, N. M., Lebda, M. A., Sadek, K. M., Alshahrani, M. Y., Ahmed, A. E., Shukry, M., Fadl, S. E., & Elfeky, A. (2023). Effects of ginger extract and/or propolis extract on immune system parameters of vaccinated broilers. *Poultry Science, 102*(10), https://doi.org/10.1016/j.psj.2023.102903

Abdel-Rahman, M. A., & Mosaad, G. M. M. (2013). Effect of propolis as additive on some behavioral patterns, performance and blood parameters in Muscovy broiler ducks. *Journal of Advance Veterinary Research, 3*(2), 64-68. https://advetresearch.com/index.php/AVR/article/view/117

Abdulla, N. R., Loh, T. C., Foo, H. L., Alshelmani, M. I. & Akit, H. (2019). Influence of dietary ratios of n-6: n-3 fatty acid on gene expression, fatty acid profile in liver and breast muscle tissues, serum lipid profile, and immunoglobulin in broiler chickens. *The Journal of Applied Poultry Research, 28*(2)**,** 454-469. https://doi.org/10.3382/japr/pfz008

Aburas, A. A., & Kairalla, M. A. (2025). Impact of dietary supplementation with different levels of clove powder on growth performance and carcass traits of broiler chickens. *Journal of Pure & Applied Sciences, 24*(3), 79-82. https://doi.org/10.51984/jopas.v24i3.4019

Aguihe, P. C., Kehinde, A. S., Ospina-Rojas, I. C., & Murakami, A. E. (2017). Comparative effect of different detoxified rubber seed meal on haematological and serum biochemical indices of broilers. *Journal of Animal Health and Production 5*(2), 50-57. http://dx.doi.org/10.17582/journal.jahp/2017/5.2.50.57

AL-Kahtani, S. N., Alaqil, A. A., & Abbas, A. O. (2022). Modulation of antioxidant defence, immune response and growth performance by inclusion of propolis and bee pollen into broiler diets. *Animals, 12*(1658), 1-13. https://doi.org/10.3390/ani12131658

Alshelmani, M. I., El-Safty, S. A., Kairalla, M. A. & Humam, A. M. (2024). Enzymes in poultry feed. In L. Babinszky (Ed.) *Feed additives recent trends in animal nutrition.* IntechOpen. https://doi.org/10.5772/intechopen.112927

Alshelmani, M. I., Loh, T. C., Foo, H. L., Sazili, A. Q. & Lau, W. H. (2017). Effect of feeding different levels of palm kernel cake fermented by *Paenibacillus polymyxa* ATCC 842 on broiler growth performance, blood biochemistry, carcass characteristics, and meat quality. *Animal Production Science, 57*, 839-848. https://doi.org/10.1071/AN15359

Ashour, E. A., Abd El-Hack, M., Alagawany, M., Swelum, A. A., Osman, A. O., & Saadeldin, I. M. (2019). Use of whey protein concentrates in broiler diets. *The Journal of Applied Poultry Research, 28*(4), 1078-1088. https://doi.org/10.3382/japr/pfz070

Attia, Y. A., Al-Hamid, A. E. A., Ibrahim, M. S., Al-Harthi, M. A., Bovera, F., & Elnaggar, A. S. (2014). Productive performance, biochemical and hematological traits of broiler chickens supplemented with propolis, bee pollen, and mannan oligosaccharides continuously or intermittently. *Livestock Science, 164*, 87-95. https://doi.org/10.1016/j.livsci.2014.03.005

Babińska, I., Kleczek, K., Makowski, W., & Szarek, J. (2013). Effect of feed supplementation with propolis on liver and kidney morphology in broiler chickens. *Pakistan Veterinary Journal, 33*(1), 1-4.

Dosoky, W. M., Abd El-Rahman, M. H. A., & Al-Rumaydh, Z. I. K. (2022). Effect of propolis as natural supplement on productive and physiological performance of broilers. *Journal of the Advances in Agricultural Researches, 27*(4), *674-685.* https://doi.org/10.21608/jalexu.2022.167360.1089

Eldiasty, J. G., Al-Sayed, H. M., Farsi, R. M., Algothmi, K. M., Alatawi, F. S., Alghabban, A. J., Alnawwar, W. H., Alatawi, A. O. & Hamdy, H. M. (2024). The beneficial impacts of nano-propolis liposomes as an anti-stressor agent on broiler chickens kept under cyclic heat stress. *Poultry Science, 103*(6), 103695. https://doi.org/10.1016/j.psj.2024.103695

El-Sabrout, K., Khalifah, A., & Ciani, F. (2023). Current applications and trends in rabbit nutraceuticals. *Agriculture, 13*(7), 1424. https://doi.org/10.3390/agriculture13071424

El-Sabrout, K., Tavares Dantas, M. R., & Souza-Junior, J. B. F. (2023). Herbal and bee products as nutraceuticals for improving poultry health and production, *World's Poultry Science Journal, 79*(2), 223-242. https://doi.org/10.1080/00439339.2021.1960238

Galal, M., Ibrahim, A., Osman, E., Abdalla, A., & Rabie, A. (2025). Influence of adding propolis and/or whey on productive and physiological performance in broiler chicks. *Egyptian Poultry Science Journal*, *45*(2), 105-113. https://doi.org/10.21608/epsj.2025.436813

Haro, A., Lopez-Aliaga, F., Lisbona, M., Barrionuevo, M. J., Alferez, M., & Campos, M. S. (2000). Beneficial effect of pollen and propolis on the metabolism of iron, calcium, phosphorous, and magnesium in rats with nutritional ferric anemia. *Journal of Agricultural and Food Chemistry, 48*(11), 5715-5722. https://doi.org/10.1021/jf000635h

Hassan, M, & Abdulla, T. (2011). The effect of propolis feed supplementation on hygiene and performance of broiler chickens. *Iraqi Journal of Veterinary Sciences 25*(2), 77-82. https://doi.org/10.33899/ijvs.2011.5647

Huang, S. S., Liu, S. M., Lin, S. M., Liao, P. H., Lin, R. H., Chen, Y. C., Chih, C. L., & Tsai, S. K. (2005). Antiarrhythmic effect of caffeic acid phenethyl ester (CAPE) on myocardial ischemia/reperfusion injury in rats. *Clinical Biochemistry, 38*(10), 943-947. https://doi.org/10.1016/j.clinbiochem.2005.07.003

Juárez, B. G., Bautista, Y., Rodríguez, F. I., González, R. B., García, H. B. & Campos, C. Z. (2024). Productivity and meat quality of broiler chickens fed a diet supplemented with ethanolic propolis extract. *European Poultry Science, 88*, 1-18. https://doi.org/10.1399/eps.2024.393

Kadhim, M. J., Łos, A., Olszewski, K., & Borsuk, G. (2018). Propolis in livestock nutrition. *Entomology, Ornithology & Herpetology:Current Research, 7*(1), 207. https://doi.org/10.4172/2161-0983.1000207

Kairalla, M. A., Alshelmani, M. I., & Aburas, A. A., (2022). Effect of diet supplemented with graded levels of garlic (Allium sativum L.) powder on growth performance, carcass characteristics, blood hematology, and biochemistry of broilers. *Open Veterinary Journal 12*(5), 595-601. https://doi.org/10.5455/ovj.2022.v12.i5.1

Kairalla, M. A., Alshelmani, M. I., & Imdakim, M. M. (2023). Effect of diet supplemented with different levels of Moringa powder on growth performance, carcass characteristics, meat quality, hematological parameters, serum lipids, and economic efficiency of broiler chickens. *Archives of Razi Institute, 78*(5), 1647-1656. https://doi.org/10.22092/ARI.2023.78.5.1647

Kairalla, M. A., Alshelmani, M. I., Imdakim, M. M., & Aburas, A. A. (2025). Effect of inclusion corn distillers' dried grains with soluble on performance, carcass and meat quality on broiler chicken. *Zanco Journal of Pure and Applied Sciences*, *37*(4), 70-77. https://doi.org/10.21271/ZJPAS.37.4.6

Konanç, K. & Öztürk, E. (2025a). Effects of propolis extract supplementation in breeder and broiler diets and it's in ovo injection on immune status, blood parameters, vaccine-antibody response and intestinal microflora of broiler chick. *Tropical Animal Health and Production, 57*, 89. https://doi.org/10.1007/s11250-025-04329-3

Konanç, K. & Öztürk, E. (2025b). Propolis supplementation in broiler breeder chickens: Enhancing meat quality. *Black Sea Journal of Agriculture, 8*(3), 412-420. https://doi.org/10.47115/bsagriculture.1647464

Matsui, T., Ebuchi, S., Fujise, T., Abesundara, K. J., Doi, S., Yamada, H., & Matsumoto, K. (2004). Strong antihyperglycemic effects of water-soluble fraction of Brazilian propolis and its bioactive constituent, 3,4,5-tri-O-caffeoylquinic acid. *Biological and Pharmaceutical Bulletin, 27*(11), 1797-1803. https://doi.org/10.1248/bpb.27.1797

Mona, S. I., Naglaa, A., & Hala, I. (2021). Effect of propolis on the immune response and meat quality in experimentally *Escherichia coli* infected broilers. *Assiut Veterinary Medicine Journal, 76*(169), 101-135. https://doi.org/10.21608/avmj.2021.188829

National Research Council. (1994). *Nutrient requirements of poultry* (9th ed.) (p. 155). Washington, DC: National Academy Press.

Petričević, V., Lukić, M., Škrbić, Z., Rakonjac, S., Stanojković, A., Nikšić, D., & Živković, V. (2022). Production parameters, microbiological composition of intestines and slaughter performance of broilers fed with bee pollen. *Züchtungskunde, 94*(1), 36-46.

Phillips, C., Hosseintabar-Ghasemabad, B., Gorlov, I. F., Slozhenkina, M. I., Mosolov, A. A., & Seidavi, A. (2023). Immunomodulatory effects of natural feed additives for meat chickens. *Life, 13*(6), 1-16. https://doi.org/10.3390/life13061287

Raheema, R. H. (2016). Effect of pomegranate peel extract on some biochemical and histopathological parameters in experimental induced mice with *Staphylococcus aureus*. *Journal of Animal Health and Production 4*(2), 42-49. https://doi.org/10.14737/journal.jahp/2016/4.2.42.49

Saeed, M., Arain, M. A., Kamboh, A. A., Memon, S. A., Umar, M., Rashid, M., Babazadeh, D., El-Hack, M. E. A., & Alagawany, M. (2017). Raw propolis as a promising feed additive in poultry nutrition: trends and advances. *Journal of Animal Health and Production 5*(4), 132-142. http://dx.doi.org/10.17582/journal.jahp/2017/5.4.132.142

SAS. (2003). *Statistical analytical system*. Cary, NC: *SAS Institute Inc.*

Seven, P. T. (2008). The effects of dietary Turkish propolis and vitamin C on performance, digestibility, egg production and egg quality in laying hens under different environmental temperatures. *Asian-Australasian Journal of Animal Sciences, 21*(8), 1164-1170. https://doi.org/10.5713/ajas.2008.70605

Seven, P. T., Yilmaz, S., Seven, I., & Kelestemur, G. T. (2012). The effects of propolis in animals exposed oxidative stress. In V. Lushchak (Ed.), *Oxidative Stress-Environmental Induction and Dietary Antioxidants (pp.* 267-288), InTech. https://doi.org/10.5772/34850

Shalmany, S. K., & Shivazad, M. (2006). The effect of diet propolis supplementation on Ross broiler chicks performance. *International Journal of Poultry Science, 5*(1), 84-88.

https://doi.org/10.3923/ijps.2006.84.88

Shihab, I. M., & Ali, B. H. (2012). Effect of propolis in diet supplementation on the immune response against Newcastle disease and hematological picture in broiler chicks. *Al-Anbar Journal of Veterinary Sciences, 5*(2), 40-46.

Sierra-Galicia, M. I., Rodríguez-de Lara, R., Orzuna-Orzuna, J. F., Lara-Bueno, A., García-Muñiz, J. G., Fallas-López, M., & Hernández-García, P. A. (2022). Supplying bee pollen and propolis to growing rabbits: Effects on growth performance,blood metabolites, and meat quality. *Life, 12*(12), 1987. https://doi.org/10.3390/life12121987

Vieira, C., Geraldo, A., Zangerônimo, G., Gonçalves, M., Avelar, S., Costa, S., Valentim, J. K. & Garcia, G. (2021). Replacement of performance enhancers by propolis ethanol extract in broiler diets. *Acta Scientiarum Animal Science, 44*(1), 1-9. https://doi.org/10.4025/actascianimsci.v44i1.52845

Zhijiang, Z., Sanfeng, L., Ke, P., Hongxiang, W., & Kaijie, T. (2004). Effects of pollen and propolis on productive and immune performance in meat fowl. *Zhongguo Nongye Kexue, 37*(5), 751-755.

EFEKTI DODATKA PROPOLISA U PRAHU NA PROIZVODNE PERFORMANSE, FIZIOLOŠKE OSOBINE I KARAKTERISTIKE TRUPA BROJLERA

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Sažetak: Studija se bavi procenom efekata propolisa kao prirodnog stimulatora rasta, u ishrani brojlerskih pilića na nihove proizvodne performanse, fiziološke osobine i karakteristike trupa. Ukupno 240 jednodnevnih brojlerskih pilića (Cobb 500) je pojedinačno izmereno i nasumično podeljeno u četiri jednake grupe, sa po 60 pilića u svakoj. Svaka grupa se sastojala od četiri ponavljanja, sa po 15 ptica u svakoj podgrupi. Prah propolisa je dodat u obroke brojlera u dozama od 0, 200, 400 i 600 mg/kg hrane. Četrdeset drugog dana, po dve ptice iz svakog ponavljanja (8 ptica po tretmanu) su odabrane radi procene biohemijskih parametara krvi i prinosa trupa. Rezultati su pokazali da je grupa pilića koja je dobijala 400 mg/kg propolisa imala bolji rast i efikasnije pretvarala hranu u telesnu masu u poređenju sa ostalim grupama. Pilići koji su dobijali osnovnu dijetu obogaćenu propolisom pokazali su značajno ($P < 0{,}05$) smanjenje ukupnog holesterola, triglicerida i LDL nivoa u odnosu na kontrolnu grupu. Uključivanje 600 mg/kg propolisa dovelo je do smanjenih performansi brojlera i prinosa trupa. Zaključak je da se propolis može davati brojlerima u dozi do 400 mg/kg bez štetnih efekata na proizvodne performanse.

Ključne reči: *propolis, brojleri, trup, kvalitet, fiziološke performanse*

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