Influence of dietary naringin supplementation on productive performance and some blood parameters of broiler

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ABSTRACT

A total of 360 one-day-old male broiler chicks were randomly and equally allocated into six experimental groups (six replicates each) as follows: G1 group was the un-supplemented (control) group, G2, G3, G4, G5, and G6 groups received diets with Naringin (NR) at 0.5, 0.75, 1, 1.25 and 1.5g/kg diet. The experiment lasted until the marketing age (35 days old). The results revealed that NR inclusion, particularly at 1.25 and 1.5 g/kg, improved body weight and body weight gain at the 4th and 5th weeks of age. Feed intake increased in all treated groups in the 3rd and in G2, G5, and G6 in the 5th weeks of age but was unaffected in the remaining experimental periods. Dietary NR supplementation, particularly at higher levels, improved the feed conversion ratio in all experimental periods except the first and second weeks. All studied carcass and hematological indices were not affected by NR inclusion. Serum concentrations of aspartate transferase and alkaline phosphatase were reduced in G5 and G6, while alanine transferase, uric acid, and creatinine levels were not affected by NR supplementation. In conclusion, dietary NR incorporation, particularly at 1.25 and 1.5 g/kg diet, improved broilers' growth performance without affecting carcass traits and hepatic and renal function.

Keywords: naringin; growth; blood; broilers.

INTRODUCTION

Recently, poultry meat production has been improved due to the rising demand in global poultry meat consumption. Particularly, the poultry industry in the Middle East faces many obstacles, including increased feedstuff prices and health risks such as bacterial, fungal, and viral diseases. These challenges elevate poultry mortality and production costs as well as decrease offered poultry meat and poultry meat consumption per capita. Consequently, it is recommended to use growth promoters to support the poultry industry and alleviate the previous negative aspects.

Antibiotic growth promoters are the most commonly used supplements, which exert their enhancement impacts by restricting enteric pathogens (Śliżewska, et al., 2006). Nevertheless, the negative effects of antibiotics, including suppression of bacterial susceptibility to antibiotics over time, creation of antibiotic-resistant strains of bacteria derived from internal or external sources, and possible negative effect on the quality of animal products, were the cause to withdraw the use of antibiotic growth promoters from the European Union markets on 1 January 2006, following directive No. A5-0373/2002 (Dankowiakowska, et al., 2013). This prohibition challenges poultry producers to find alternative growth promoters to antibiotics. The most promising unconventional alternatives in the poultry industry are the phytogenic feed supplements, including herbal products and their extracts, essential oils, prebiotics, and probiotics (Abd El- Hack, et al., 2019; Abd El- Moneim and Sabic, 2019; Abd El-Hack, et al., 2020; Abd El-Moneim, et al., 2020).

Citrus plants are excellent sources of flavonoids, including nobiletin, hesperidin, narirutin, naringenin, and naringin. These citrus flavonoids were envisaged to have invaluable anti-inflammatory and anti-oxidant activities in vivo and in vitro (Tripoli, et al., 2007).

Naringin, a flavanone glycoside, results from the combination of the flavanone naringenin with the disaccharide neohesperidose. It constitutes a principal bioactive compound found in traditional Chinese herbal remedies such as Drynaria fortunei (Kunze).

Naringin is a flavanone glycoside that constitutes a principal bioactive compound found in traditional Chinese herbal remedies such as Drynaria fortunei (Kunze). This flavanone formed from the combination of the disaccharide neohesperidose and the flavanone naringenin. It is one of the key active components of Chinese herbal

medicines known as Drynaria fortunei (Kunze) (Zhang, et al., 2014). It also be found in citrus fruits and imparts a bitter flavor to citrus juices (Chtourou, et al., 2015). There is a growing body of scientific findings that indicate the beneficial health applications of naringin as a nutritional supplement and feed additive. Among these effects, the improved production and meat quality, modulating lipid metabolism, increased the antioxidant capacity and favorable fatty acid profile (Goliomytis, et al., 2015; Jiang, et al., 2020; Hager-Theodorides, et al., 2021; Bao, et al., 2022) which are desirable properties for the broiler production industry.

Nevertheless, limited studies have investigated the effect of naringin on broiler performance and physiology. Therefore, the main aim of the present investigation was to assess the influence of naringin incorporation in broiler diets on productive performance and some physiological measurements.

MATERIALS AND METHODS

The present study was conducted in the Poultry Research Unit, Biological Application Department, Radioisotopes Applications Division, Nuclear Research Center, Egyptian Atomic Energy Authority at Inshas. All experimental procedures were carried out according to the Local Experimental Animals Care Committee and approved by the institutional ethics committee. The birds were cared for using husbandry guidelines derived from the Egyptian Atomic Energy Authority's standard operating procedures.

Chemicals

Naringin was purchased from Xi'an Yunyue Biotechnology Co. Ltd., china, with purity of ≥ 98% and free from pesticide residue or pathogens.

Experimental design and diets

The one-way ANOVA experimental design was conducted to investigate the dietary supplementation impact of naringin on growth performance, carcass characteristics, and blood hematological and biochemical parameters of broiler chicks. A total of 360 one-day-old male Ross broiler chicks were randomly and equally allocated into six experimental groups (six replicates each) as follows: G1 group was the un-supplemented (control) group, G2, G3, G4, G5, and G6 groups received diets with Naringin at 0.5, 0.75, 1, 1.25 and 1.5g/kg diet. The experiment lasted until the marketing age (35 days old). The basal experimental diet was formulated to cover the nutrient requirements for growing broiler chicks from 1 to 5 weeks of age, according to the nutrition guide of Ross strain 2019. The composition and the calculated analysis of the experimental diets are shown in Table (1).

All birds were kept under the same managerial, hygienic, and environmental conditions. They were raised in battery brooder cages (150 CM length × 100 CM width × 55 CM high) placed in a temperature-controlled room. Electric heaters are used to provide the chicks with the heat needed for brooding. The house temperature was kept at about 34ºC during the first three days, 32ºC during the next four days, and gradually decreased by 2ºC weekly until maintaining 24 ºC thereafter. The average relative humidity (RH) under which this study was carried out were approximately 65 ±3.0%, The artificial light schedule, similar to commercial conditions, was until the 4th day of 24 h light and followed by 23 h of light throughout the experimental period. Feed in mash form and freshwater by stainless steel nipples for each cage were provided *ad libitum* throughout the experimental period.

Productive performance parameters

Live body weight (LBW) per replicate was individually recorded once weekly in the early morning. Average daily body weight gain (BWG) was calculated weekly as the difference between current and previous weight divided by seven days. Daily feed intake (FI) and feed conversion ratio (FCR) per bird were calculated weekly. Overall BW gain, FI, and FCR were calculated for the whole experiment duration.

Carcass characteristics

At 35 days of age, six representative birds were randomly taken from each treatment group, fasted for 12 hours before slaughtering, individually weighed, and recorded. Birds were manually slaughtered by cutting the jugular veins of the neck with a sharp knife, and the slaughtered birds were de-feathered, opened, and the hot carcass was weighed and recorded. Edible parts, Giblets, and some immune organs were weighed and recorded as proportional values to live pre-slaughtering weight.

Hematological and biochemical parameters

At the end of the experimental period, six chicks from each group were randomly chosen and sacrificed in a horizontal position to reduce the antiperistalsis movement of

intestinal segments and regurgitate their contents. Birds were sacrificed and bled individually into two siliconized tubes. One contained anticoagulant (heparin) in order to determine the hematological parameters: blood hemoglobin (Hb) concentration, packed cell volume (PCV), erythrocytes (RBCs), and leukocyte (WBCs) counts. Mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) were determined using the following equations: $MCV = (PCV \times 10)/RBCs$, $MCH = (Hb \times 10)/RBCs$ and $MCHC = (Hb \times 10)/PCV$.

The second did not contain an anticoagulant and was used to separate serum. Upon coagulation, blood was centrifuged at 4000 rpm for 15 min. The serum was separated from the other tube and stored in a deep freezer at (-20ºC) until the biochemical analysis. The following biochemical parameters were determined: aspartate aminotransferase (AST), alanine aminotransferase (ALT), uric acid (UA), and creatinine (CR) levels were determined spectrophotometrically using commercial kits as described by the manufacturer company (SpinreactCo., Spain).

Statistical analysis

Data were subjected to the analysis of variance by using the General Linear Models (GLM) Procedure of the Statistical Analysis System (SPSS, version 18.0; 2010), according to the following model:

$$Y_{ij} = \mu + N_i + e_{ij}$$

Where:

Y_{ij} = the observation,

μ = the overall Mean,

N_i = fixed effect of i^{th} naringin level (i = 0; 0.5, 0.75, 1, 1.25 and 1.5 g/kg diet),

e_{ij} = error of the model.

All carcass trait percentages were transformed to arcsine values to approximate a normal distribution and then subjected to the One-way ANOVA analysis. Differences among means within the same factor were tested using Duncan's New Multiple Range test.

RESULTS AND DISCUSSION

Live body weight and body weight gain

The data presented in Tables (2) demonstrate the effect of different levels of naringin dietary supplementation on LBW during the experimental periods. The results revealed that naringin levels did not affect LBW significantly at 1st, 2nd, and 3rd weeks of age. However, by the 4th and 5th weeks of age, LBW showed a significant ($P<0.05$) improvement in birds who received dietary naringin supplementation, particularly at levels of 1.25 and 1.5 g/Kg, in comparison to the control. Regarding BWG, dietary naringin did not have a significant effect on BWG during the 1st and 2nd weeks of age (Table 3). However, by the 3rd and 4th weeks of age, dietary supplementation of naringin at 0.5, 1.25, and 1.5 g/Kg improved BWG significantly ($P<0.01$), and it was also improved ($P<0.05$) in all treated groups during the 5th week of age compared to the control group. The overall BWG was improved ($P<0.05$) in birds fed diets with 1.5 g/kg diet with an increment ratio of 13.7% compared to the control group. The present results are align with those reported by Jiang, et al. (2020), who stated an increment in BW and BWG of thiram-induced tibial dyschondroplasia broiler chickens when treated with naringin at 30 mg/kg from days 8 to 18 while FI and FCR were not affected. Similarly, dietary incorporation of 0.2% extracts from *Chelidonium Majus* or *Lonicera japonica*, which contain naringin at 7.75 and 12.16 mg/kg, respectively, resulted in enhanced broilers' final BW and daily BWG (Park, et al., 2014).

Feed intake and feed conversion ratio

The data presented in Table (4) shows the effect of dietary supplementation of different levels of naringin on FI during the experimental periods. During the 1st, 2nd, and 4th week of age, dietary naringin supplementation did not significantly affect FI, except for levels of 0.75 and 1.0 g/Kg, which increased FI in the 1st week compared to the control group. Additionally, during the 3rd week of age, FI was increased ($P<0.05$) in all treatment groups except G6, and it was elevated ($P<0.05$) in 5th week of age with dietary supplementation of naringin at 0.5 and 1.5 g/Kg. Overall FI was not significantly affected by dietary naringin supplementation. Furthermore, dietary supplementation of naringin did not affect FCR during the 1st, 2nd, 3rd, and 4th weeks of age, except for the levels of 0.75 and 1 g/Kg, and 1.5 g/Kg, which significantly improved FCR ($P<0.01$) at the 3rd and 4th weeks of age, respectively (Table 5). During the 5th week of age, FCR was improved ($P<0.05$) in all treated groups, while the overall FCR was improved ($P<0.05$) in birds fed diets with 1.25 and 1.5 g naringin/kg, demonstrating

improvement levels of 4.8 and 8.2%, respectively, in comparison to the unsupplemented group. In accordance with our results, Yang, et al. (2018) documented a 22% improvement in FCR in broilers fed a diet supplemented with 400 mg/kg quercetin for eight weeks, while daily FI remained unaffected. It has also been reported that that the inclusion of epigallocatechin gallate (EGCG) in the diets of heat-stressed broilers led to improved FI compared to the untreated birds (Luo, et al., 2018). Contrarily, Simitzis, et al. (2011) reported an insignificant impact of dietary inclusion of hisperidin on the final BW and BWG of broiler chicks. In addition, a previous investigation involving 1-day-old Ross broilers demonstrated that including 0.75 and 1.5 g naringin/kg in their diets for 42 d did not impact the average BW (Goliomytis, et al., 2015). Likewise, Iskender, et al. (2017) reported that the addition of 0.5 g/kg naringin to the diet of 28-wk-old Lohmann White laying hens did not change their BW.

Carcass characteristics

Data presented in Table (6) show the effect of dietary naringin inclusion on carcass traits at 35 days of age. All carcass characteristics were not significantly impacted in all treated groups compared to the untreated one. Yang, et al. (2023), Pournazari, et al. (2017), and Sadeghi, et al. (2016) reported a similar findings to ours. In a previous study, dietary inclusion of hesperidin at 1.5–3.0 g/kg did not significantly influenced weights of gizzard, heart, liver, and abdominal fat (Simitzis, et al., 2011). These findings were confirmed by the meta-analysis study of Prihambodo, et al. (2021), who noticed that broilers' organ composition and carcass barely affected by flavonoids treatment.

The favorable impacts of dietary naringin on the growth performance of broilers might be attributed to its antimicrobial activity (Abdel-Moneim, et al., 2020). The gut condition is a substantial factor influencing poultry performance. The gut's microflora is crucial for maintaining a healthy intestinal tract (Shehata, et al., 2021). Flavonoids, such as naringin, belong to a group of phytochemicals with antibacterial properties effective against a spectrum of microbial species, including harmful and undesirable bacteria in the digestive system. A reduced presence of pathogens stimulates intestinal villi growth and enhances nutrient absorption, as indicated by an increased villi height: crypt depth (VH:CD) ratio in the ileum, jejunum, and duodenum (Prihambodo, et al., 2021). The VH:CD ratio serves as a histological measure of intestinal digestive capacity, with a higher ratio suggesting better intestinal health and improved absorption capability (Abolfathi, et al., 2019). Therefore, the improved performance attributed to flavonoid supplementation is closely linked to the higher VH:CD ratio. Additionally, flavonoids may stimulate mucus secretion (Akbarian, et al., 2013), resulting in enhanced villi protection and increased growth of beneficial gut bacteria (Prihambodo, et al., 2021). Furthermore, the enhanced growth performance can be attributed to naringin's anti-inflammatory and antioxidant properties, which contribute to intestinal integrity and overall body health by interacting with various signaling molecules and their associated pathways (Chen, et al., 2016). Additionally, the absence of notable variations in overall feed intake (FI) could be attributed to the fact that the introduced percentages of naringin did not impact the birds' taste preferences for the feed. This might be because the bitter taste of naringin could influence food palatability when used at levels exceeding 10% of dry matter intake (Gladine, et al., 2007).

Blood hematological and biochemical parameters

As shown in Table (7), all hematological indices were insignificantly influenced by all dietary naringin inclusion compared to the unsupplemented group. Serum ALT and AST levels were not impacted by dietary addition of naringin in all treated groups in comparison to the control, except for AST, which was reduced ($P<0.05$) in G6, respectively (Table 8). Data presented in Table (9) revealed that dietary naringin levels did not affect serum concentrations of uric acid and creatinine compared to the control group. These results are align with those of Kuzmina, et al. (2021), who documented a significant increase in Hb level and RBCs count in Cobb-500 broilers fed diets with 7.5 and 10 g dihydroquercetin/kg feed. The authors also reported that serum AST level was not affected while ALT level was reduced by the dietary supplement. Additionally, Amer, et al. (2023) reported that creatinine, urea, total protein, and albumin were not altered by adding *Origanum majorana* powder in domestic pigeons' diets. Likewise, Shawky, et al. (2020) stated insignificant difference in urea and total protein between the *Origanum majorana* treated group and the control one. The elevation in RBCs and Hb concentrations might attributed to the antioxidant activity of naringin, which

activates erythropoiesis and increases hematopoiesis in bone marrow tissue, stimulating the increase in RBCs number and a natural proportional increase in Hb content in the blood (Kuzmina, et al., 2021).

In our study, we determined the serum levels of enzymes such as AST and ALT, which play a vital role in amino acid metabolism and serve as sensitive indicators of hepatic function and overall biochemical balance (Hu, et al., 2021). The rapid growth of poultry has a notable impact on metabolic processes and the activity of transamination enzymes like ALT and AST, which are central to amino acid synthesis and breakdown (Mageswari, et al., 2016). The reduction in enzyme levels within the normal range among birds in the experimental groups suggests improved liver function, likely attributed to the antioxidants and antimicrobial activities of naringin (Abdel-Moneim, et al., 2020). The absence of significant differences in the renal function biomarker suggests that naringin supplementation likely did not induce renal stress, and it may also indicate a normal percent of ammonia gases in broiler houses. These results align with those of Amer, et al. (2023) and Kuzmina, et al. (2021).

CONCLUSION

The current study elaborated that incorporating naringin in broilers' diets improved their final BW, BWG, and FCR. Carcass traits and hematological indices were not influenced by dietary naringin inclusion. Serum hepatic enzymes were improved by naringin supplementation at high levels, while renal function biomarkers were unaffected. The dietary inclusion levels of 1.25 and 1.5 g/kg showed promising results. However, additional research is necessary to completely understand the mechanisms behind the most effective levels of naringin inclusion for optimal outcomes in broiler production.

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Table 1: Ingredients and calculated chemical composition of the basal diet.

Item	Starter 1 to 10 d	Grower 11 to 22 d	Finisher 23 to 35 d
Ingredient, %			
Ground yellow corn 7.5%	54.100	54.75	58.66
Soybean meal 46%	35.000	35.35	32.184
Corn gluten meal 60%	3.660	1.30	0.00
Sunflower oil	2.720	4.715	5.600
Monocalcium phosphate	1.620	1.390	1.290
Limestone	1.515	1.40	1.250
Premix*	0.300	0.30	0.30
Sodium Chloride (NaCl)	0.300	0.30	0.30
DL-methionine 99%	0.335	0.300	0.276
L-lysine 78%	0.242	0.115	0.080
L -Threonine 98.5%	0.147	0.080	0.060
L -Valine 98.5%	0.009	0.00	0.00
L -Arginine	0.000	0.00	0.00
L -Isoleucine 98.5%	0.000	0.00	0.00
L -glycine 97%	0.000	0.000	0.000
Total (Kg)	100	100	100
Crude protein%	23.000	21.490	19.485
ME. Kcal/Kg feed	2987	3087	3171
Calcium%	0.963	0.884	0.802
Nonphytate phosphorus %	0.497	0.447	0.420

*Each 3 Kilo gram contain: 12000000 IU vit. A; 2000000 IU vit. D3; 10000mg vit. E; 2000mg vit. K3; 1000mg vit. B1; 5000mg vit. B2; 1500mg vit. B6; 10 mg vit. B12; 30000 mg Nicotinic acid; 1000mg Folic acid; 10000 mg vit. Pantothenic acid; 50 mg vit. Biotin; 50000 mg Zn; 60000 mg Mn; 30000 mg Fe; 10000 mg Cu; 1000 mg I; 100 mg Se and Co 100 mg.

Table 2: Live body weight (g) ($\overline{X}$ ± SE) of broiler chickens as influenced by dietary supplementation of Naringin at experimental periods

Group	Initial weight	1st week	2nd week	3rd week	4th week	5th week
G1	45.29±0.70	154.6±3.37	405.1±11.3	710.3±19.1	1281.8^{c}±22.3	1853.9^{b}±34.3
G2	45.52±0.88	161.5±3.79	420.3±11.9	762.9±18.8	1361.4^{abc}±27.9	2021.9^{a}±57.9
G3	45.62±0.59	158.7±4.55	424.8±12.6	739.1±17.2	1309.0^{bc}±38.3	1947.2^{ab}±50.5
G4	45.10±0.56	163.3±4.74	429.4±14.8	754.7±22.6	1359.4^{abc}±31.8	2012.8^{a}±50.1
G5	44.33±0.81	162.0±3.66	423.3±9.4	770.7±21.4	1383.1^{ab}±24.8	2035.6^{a}±38.6
G6	45.48±0.73	156.0±3.65	421.4±12.4	786.9±15.5	1416.3^{a}±30.3	2101.6^{a}±61.8
Sig.	NS	NS	NS	NS	*	**

Means in the same column within each classification bearing different letters are significantly different. NS = not significant, * (P < 0.05) and ** (P < 0.01). Groups from G1 to G6 received the basal diet supplemented with 0.0, 0.5, 0.75, 1, 1.25, and 1.5 g naringin/kg diet.

Table 3: Body weight gain (g/bird/day) ($\overline{X}$ ± SE) of broiler chickens as influenced by dietary supplementation of Naringin at experimental periods

Group	1st week	2nd week	3rd week	4th week	5th week	1 – 5 weeks
G1	15.62±0.39	35.79±1.14	43.59^{c}±1.19	81.64^{b}±0.85	81.73^{b}±1.86	51.67^{b}±0.96
G2	16.56±0.42	36.97±1.19	48.94^{ab}±1.13	85.51^{ab}±1.47	91.02^{a}±4.87	55.80^{ab}±1.63
G3	16.16±0.57	38.01±1.18	44.90^{c}±0.92	81.42^{b}±3.07	91.17^{a}±3.38	54.33^{ab}±1.43
G4	16.88±0.61	38.01±1.45	46.48^{bc}±1.17	86.38^{a}±1.70	93.35^{a}±3.04	56.29^{ab}±1.42
G5	16.80±0.42	37.34±0.86	49.62^{ab}±1.90	87.48^{a}±1.54	93.22^{a}±2.31	56.89^{ab}±1.08
G6	15.79±0.42	37.91±1.29	52.21^{a}±0.90	89.92^{a}±2.20	97.90^{a}±4.80	58.75^{a}±1.75
Sig.	NS	NS	**	*	*	*

Means in the same column within each classification bearing different letters are significantly different. NS = not significant, * (P < 0.05) and ** (P < 0.01). Groups from G1 to G6 received the basal diet supplemented with 0.0, 0.5, 0.75, 1, 1.25, and 1.5 g naringin/kg diet.

Table 4: Feed intake (g/bird/day) ($\overline{X}$ ± SE) of broiler chickens as influenced by dietary supplementation of Naringin at experimental periods

Group	1st week	2nd week	3rd week	4th week	5th week	1 – 5 weeks
G1	19.89^{b}±0.17	47.57±1.05	55.40^{d}±1.32	132.04±1.63	160.5^{b}±0.71	83.08±0.88
G2	20.89^{ab}±0.38	47.54±0.37	66.67^{b}±1.71	133.62±3.23	168.6^{a}±3.42	87.46±1.67
G3	21.99^{a}±0.35	47.10±1.36	63.81^{bc}±2.82	139.68±2.66	155.5^{b}±2.17	85.62±1.71
G4	21.82^{a}±0.43	48.93±1.94	73.63^{a}±1.27	137.72±3.50	160.8^{b}±2.48	88.58±1.80
G5	20.92^{ab}±0.33	43.63±0.48	61.71^{bc}±1.33	146.1±6.01	163.2^{ab}±2.72	87.11±2.03
G6	20.90^{ab}±0.24	46.38±1.10	60.39^{cd}±0.77	135.53±3.72	170.2^{a}±1.99	86.69±1.41
Sig.	**	NS	**	NS	**	NS

Means in the same column within each classification bearing different letters are significantly different. NS = not significant and ** (P < 0.01). Groups from G1 to G6 received the basal diet supplemented with 0.0, 0.5, 0.75, 1, 1.25, and 1.5 g naringin/kg diet.

Table 5: Feed conversion ratio (g feed/g gain) ($\overline{X}$ ± SE) of broiler chickens as influenced by dietary supplementation of Naringin at experimental periods

Group	1st week	2nd week	3rd week	4th week	5th week	1 – 5 weeks
G1	1.288±0.10	1.349±0.10	1.271^{cd}±0.03	1.617^{abc}±0.01	1.964^{a}±0.03	1.608^{a}±0.01
G2	1.275±0.10	1.305±0.10	1.362^{bc}±0.01	1.562^{cd}±0.02	1.855^{b}±0.05	1.569^{ab}±0.03
G3	1.391±0.15	1.252±0.15	1.421^{b}±0.05	1.716^{a}±0.02	1.707^{c}±0.03	1.577^{ab}±0.02
G4	1.319±0.14	1.305±0.14	1.584^{a}±0.01	1.588^{bcd}±0.01	1.724^{c}±0.03	1.576^{ab}±0.03
G5	1.259±0.11	1.178±0.11	1.246^{d}±0.05	1.669^{ab}±0.06	1.751^{c}±0.01	1.531^{bc}±0.01
G6	1.343±0.12	1.236±0.12	1.159^{d}±0.03	1.508^{d}±0.04	1.741^{c}±0.04	1.477^{c}±0.02
Sig.	NS	NS	**	**	**	**

Means in the same column within each classification bearing different letters are significantly different. NS = not significant and ** (P **<** 0.01). Groups from G1 to G6 received the basal diet supplemented with 0.0, 0.5, 0.75, 1, 1.25, and 1.5 g naringin/kg diet.

Table 6: Carcass characteristics and some immune organs (%) ($\overline{X}$ ± SE) of broiler chickens as influenced by dietary supplementation of Naringin at experimental periods

Group	G1	G2	G3	G4	G5	G6	Sig
Hot Carcass	73.27±0.40	73.34±0.76	73.25±0.29	73.07±0.18	73.91±0.10	73.61±0.90	NS
Liver	2.88±0.40	2.47±0.18	2.87±0.31	3.22±0.54	2.87±0.08	3.10±0.15	NS
Heart	0.65±0.08	0.46±0.02	0.47±0.01	0.50±0.05	0.50±0.06	0.52±0.06	NS
Gizzard	1.78±0.03	2.22±0.09	2.25±0.25	1.93±0.06	2.06±0.17	2.04±0.15	NS
Edible giblets	5.31±0.34	5.15±0.08	5.60±0.39	5.65±0.58	5.43±0.13	5.67±0.28	NS
Carcass yield	78.57±0.25	78.48±0.71	78.85±0.62	78.72±0.55	79.34±0.22	79.28±0.77	NS
Proventriculus	0.50±0.06	0.53±0.04	0.53±0.03	0.51±0.10	0.43±0.02	0.45±0.06	NS
Intestine	4.69±0.07	5.09±0.11	5.23±0.16	5.33±0.56	4.97±0.48	5.40±0.42	NS
Spleen	0.17±0.02	0.13±0.02	0.20±0.02	0.20±0.04	0.14±0.03	0.20±0.01	NS
Bursa	0.09±0.01	0.14±0.02	0.14±0.03	0.13±0.03	0.12±0.01	0.15±0.04	NS

Means in the same column within each classification bearing different letters are significantly different. NS = not significant. Groups from G1 to G6 received the basal diet supplemented with 0.0, 0.5, 0.75, 1, 1.25, and 1.5 g naringin/kg diet.

Table 7: Hematological Parameters ($\overline{X}$ ± SE) of broiler chickens as influenced by dietary supplementation of Naringin at the end of the experimental period

Items	RBCs (×10^6/mm^3)	WBCs (×10^3/mm^3)	Hb (g/dl)	PCV (%)	MCV (μ^3)	MCH (pg)	MCHC (g/100ml)
G1	2.88±0.13	25.82±1.60	9.40±0.53	33.68±0.91	117.04±2.68	32.57±0.61	27.88±1.09
G2	2.64±0.07	19.45±3.83	9.71±0.61	32.57±0.18	124.01±2.63	36.75±1.38	29.71±1.69
G3	2.62±0.10	17.42±2.53	8.86±0.97	32.45±0.45	124.25±5.37	33.65±2.55	27.27±2.82
G4	2.81±0.11	19.25±2.69	9.10±0.35	32.78±0.11	116.9±4.59	32.41±1.35	27.75±0.98
G5	2.94±0.31	20.44±4.85	10.82±2.13	33.83±1.66	116.3±7.11	36.27±3.96	31.53±4.54
G6	3.01±0.16	27.07±1.07	11.85±0.65	36.23±0.50	121.0±4.85	39.49±0.96	32.69±0.88
Sig.	NS	NS	NS	NS	NS	NS	NS

Means in the same column within each classification bearing different letters are significantly different. NS = not significant. Groups from G1 to G6 received the basal diet supplemented with 0.0, 0.5, 0.75, 1, 1.25, and 1.5 g naringin/kg diet.

Table 8: Serum liver function ($\overline{X}$ ± SE) of broiler chickens as influenced by dietary supplementation of Naringin at the end of the experimental period

Items	AST (U/L)	ALT (U/L)
G1	13.55^{a}±4.70	15.21±2.14
G2	12.74^{a}±6.45	15.46±1.22
G3	13.33^{a}±9.90	14.23±1.90
G4	11.14^{ab}±1.72	14.62±0.82
G5	11.02^{ab}±10.10	15.83±1.92
G6	9.87^{b}±11.43	16.91±1.34
Sig.	*	NS

Means in the same column within each classification bearing different letters are significantly different. NS = not significant, and * (P **<** 0.05). Abbreviations: AST= aspartate aminotransferase, ALT= alanine aminotransferase. Groups from G1 to G6 received the basal diet supplemented with 0.0, 0.5, 0.75, 1, 1.25, and 1.5 g naringin/kg diet.

Table 9: Serum uric acid and creatinine ($\overline{X}$ ± SE) of broiler chickens as influenced by dietary supplementation of Naringin at the end of the experimental period

Items	Uric Acid (mg/dl)	Creatinine (mg/dl)
G1	5.763±0.46	0.593±0.07
G2	4.777±0.19	0.477±0.01
G3	4.383±0.13	0.510±0.04
G4	4.833±0.31	0.460±0.02
G5	4.560±0.84	0.440±0.05
G6	4.297±0.26	0.450±0.01
Sig.	NS	NS

Means in the same column within each classification bearing different letters are significantly different. NS = not significant. Groups from G1 to G6 received the basal diet supplemented with 0.0, 0.5, 0.75, 1, 1.25, and 1.5 g naringin/kg diet.

تأثير مكملات النارينجين الغذائية على الأداء الإنتاجي وبعض قياسات الدم لدجاج التسمين.

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الملخص العربي

تم توزيع 360 طائر روص بعمر يوم واحد بشكل عشوائي ومتساوي على ست مجموعات تجريبية (ستة مكررات لكل منها) على النحو التالي: المجموعة G1 هي المجموعة (الضابطة) غير المدعمة و تلقت المجموعات G2، G3، G4، G5، و G6 على النارينجين (NR) بنسبة 0.5 و0.75 و1 و1.25 و1.5 جم/كجم من العليقة على التوالى. استمرت التجربة حتى عمر التسويق (35 يوماً). أوضحت النتائج أن إضافة النارينجين خاصة عند 1.25 و1.5 جم/كجم، أدى إلى تحسين وزن الجسم وزيادة وزن الجسم في الأسبوعين الرابع والخامس من العمر. زاد العلف المأكول في جميع المعاملات في الاسبوع الثالث وفي المجموعة الثانية والخامسة والسادسة في الأسبوع الخامس من العمر ولكنه لم يتأثر في بقية فترات التجربة. أدت مكملات النارينجين الغذائية، وخاصة عند المستويات العالية إلى تحسين معدل التحويل الغذائي في جميع فترات التجربة باستثناء الأسبوعين الأول والثاني. لم تتأثر جميع صفات الذبيحة وصورة الدم بإضافة النارينجين. انخفضت تركيزات مصل الأسبارتات ترانسفيراز والفوسفاتيز القلوي في G5 وG6، في حين لم تتأثر مستويات ألانين ترانسفيراز وحمض اليوريك والكرياتينين بمكملات النارينجين. نستنتج من ذلك أن إضافة النارينجين إلى العليقة، خاصة عند 1.25 و 1.5 جم/كجم علف، أدى إلى تحسين أداء نمو دجاج التسمين دون التأثير على صفات الذبيحة ووظائف الكبد والكلى.

الكلمات الاسترشادية: نارينجين، النمو، الدم، دجاج اللحم.