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THE PRODUCTIVE PERFORMANCE, IMMUNOLOGICAL PARAMETERS AND THE BIOAVAILABILITY OF CALCIUM, PHOSPHORUS AND NITROGEN OF JAPANESE QUAILS FED CURCUMIN AND/OR GROUND ANISE SEEDS SUPPLEMENTATION AS A MEDICAL HERBS

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SUMMARY

This study aimed to investigate the effect of curcumin and/or anise seeds supplementation on the performance, immunological parameters and the bioavailability of calcium, phosphorus and nitrogen of Japanese quail fed graded levels of curcumin (0, 100 and 200 mg/kg feed) and ground anise seeds (0, 1%) during a 42-day feeding trial. 162 (one hundred sixty two), one-day-old quail chicks were assigned in factorial design (3×2). The results clearly that curcumin or anise seeds did not have a significant effect on body weight (BW) and body weight gain (BWG). Anise seeds supplementation improved feed conversion ratio (FCR) during the period from 3-6 wks of age. Quails fed curcumin at level of 200 mg/kg plus 1% ground anise seeds achieved significantly (P<0.05) higher feed conversion ratio (FCR) during the first 3 wks of age. Curcumin groups exhibited highly significant relative weight of spleen and bursa of fabricius , IgA, IgM, and IgG compared to the control group. Birds fed diets containing curcumin at level of 200 mg/kg and 1% anise seeds had numerically higher calcium and nitrogen bioavailability. Phosphorus bioavailability was significantly (P<0.05) higher in birds fed 200 mg/kg curcumin and 1% anise seeds. It was recommended that curcumin should be add at level of 200 mg/kg diet or with 1% anise ground seeds to achieve the best results of growth performance, immunological parameters and the bioavailability of calcium, phosphorus and nitrogen.

***Keywords*: Curcumin, Anise, Immunological parameters, Performance, Bioavailability**

INTRODUCTION

Recently, Japanese quail (Coturnix Japonica) have been considered of great economically significant as substitutional for chickens as a source of eggs and meat all-over the world including Egypt (El-Daly *et al.,* 2014). Commercial quail production in Egypt is rapidly growing, due to the new selected strains which have higher body weight, rapid growth, require little space for growing and maintenance with a very low financial input when compared to other birds (Abd El Azeem *et al*., 2019).

Many types of feed additives are being used in broiler rations to improve performance. Spices are very common additives in broiler diets (Zhang *et al.,* 2009). The supplementation of spices and herbs could have many benefits to broiler's health and performance such as having ant-oxidative potential antimicrobial activity (Doman and Deans, 2000), and enhancing digestion by stimulating endogenous enzymes (Brugalli, 2003).

Alternatively, among the potential alternatives to antibiotic growth promoters, the use of phytochemical compounds are considered to be acceptable, with more reliability and suitability among consumers, as harmles and natural additives (Hashemi and Davoodi, 2011). Under these circumstances, the use of phytochemicals in poultry feed has been closely monitored. Recently, it is important to investigate the plant material effects such as curcumin and ground anise seeds in terms of performance, immune functions and nutrients availability as the specified criteria (Metwally *et al.,* 2021), because it is well documented that some plant extracts can affect the secretion of digestive enzymes and act as antibacterial, anti-viral, and antioxidizing agents (Ertas *et al*., 2005; Cross *et al*., 2007). To date, due to the limitations of the use of antibiotics, the use of natural alternatives such as medicinal plants has been considered.

Curcumin in turmeric has a positive effect on bile production, secretion of gastrointestinal enzymes (amylase and lipase), increases the length of intestinal villi, and increases digestion and absorption of nutrients in birds. Some studies have reported the effectiveness of red pepper on digestive enzymes, and performance has been improved in various species (Parvari *et al*., 2022).

The addition of any level of nano-curcumin in the quail diet significantly improved growth, lipid profile, blood constituents, antioxidant indices, and immunity of growing quail, as well as increased counts of lactic acid bacteria and reduced pathogenic bacteria, Also, in all periods, the quails fed Nano-curcumin had better FCR ($p < 0.0001$) than the control quails, except those quails fed nano-curcumin (0.5 g/kg) did not significantly differ from the control between three and five weeks of age. Generally, the

best value of FCR was recorded for the 0.4 g nano-curcumin-treated group (Reda *et al*., 2020). Abdel-Kader *et al.* (2018) found that growth performance of quail was improved by supplementation of 1% and 3%turemeric expressing as heavier body weight at 38 days of age, statistically greater body weight gain and feed conversion ratio during the period from 10-38 days of age compared to control group. As reported by ELNaggar *et al*,. (2021), the immunoglobulins' levels were partially influenced by different treatments especially IgG. Also, It was observed that serum immunoglobulins G concentration was higher when combining turmeric and black pepper compared to other groups while, the results for IgM and IgA levels were unaffected for all the groups.

Quails fed with nano-curcumin (0.2 g/kg) exhibited the highest serum IgG and IgM concentrations and complement values compared to control. The addition of any level of nano-curcumin in the quail diet also significantly improved the lipid profile. In conclusion, supplemental Nano-curcumin had beneficial impacts on growth, lipid profile, blood constituents, antioxidant indices, and immunity of growing quail, as well as increasing counts of lactic acid bacteria and reducing pathogenic bacteria (Reda *et al*., 2020).

Anise seeds, as a medicinal plant, anise has been used as an antibacterial (Tabanca *et al*., 2003), antifungal and antiphrastic substance (Cabuk *et al*., 2003). Moreover, previous literature showed that essential oil of anise increased the digestion of protein, cellulose and fats (Jamroz and Kamel, 2002) and improved apparent whole tract and ileal digestibility of nutrients (Hernandez *et al*., 2004)

Some studies have been conducted to evaluate the use of anise seed or oil in poultry nutrition, especially to replace antibiotics as growth promoters (Al-Beitawi *et al.,* 2009). The number of studies on the physiological responses of poultry to the supplementation of anise seeds in the drinking water is limited (Al-Shammari, 2011).

Improved body weight and body weight gain and feed conversion ratio were observed in 6-week-old broiler chickens fed diets containing anise seeds (0.3% and 0.6%) compared to the control treatment (Amein *et al.,* 2019). Mohammed (2019) found an improvement in body weight and body weight gain and dressing percentage in broiler chickens fed diets containing anise seeds (0.3%, 0.6%, and 0.9%) compared to the control. Moreover, body weight gain and carcass weight was improved in broiler chickens fed diets containing anise seeds (0.5, 0.75, 1 gm/kg) in6-week-old Cobb broiler chickens compared to the control (Ramadan 2017). The results of Al-Shammari *et al.* (2017) showed that anise seeds can be considered as an effective physiological promoter in growing broilers.

This study was designed to study the effects of graded levels of curcumin or ground anise seeds and their interactions on growth performance, immunological parameters and the bioavailabilty of calcium, phosphorus and nitrogen of Japanese Quail (*Coturnix japonica*).

MATERIALS AND METHODS

The study was conducted at the Poultry Research Farm, Dep. of Poultry Production, Faculty of Agriculture, Assiut University.

Experimental Birds, Measurements and Design:

A total number of 162 (one hundred sixty two) unsexed one days old quails (*Coturnix japonica*) in a 3*2 factorial arrangement (3 levels of curcumin, 0 and 100 and 200 mg/kg feed) and 2 levels of ground anise seeds (0, 1%). Chicks were randomly divided into six equal treatments of three replicates containing 9 quails each. Experimental basal diets were containing 24% protein according to NRC (1994, recommendation). The feed raw materials (Pure Curcumin and ground anise seeds) were purchased from Sigma-Aldrich Co. in Cairo and anise seeds from different markets in Assiut Governorate.

Samples of the experimental diets (Table 1) were analyzed in the central Laboratory of Faculty of Agriculture, Assiut University according to AOAC (1990).

The experimental design was as follows:

Treatment	
T1	chicks were fed control diet without addition
T2	chicks were fed basal diet including 1% anise ground seeds
T3	chicks were fed Basel diet including 100 mg curcumin/kg feed
T4	chicks were fed basal diet including 100 mg curcumin/kg plus 1% anise ground seeds.
T5	chicks were fed basal diet including 200 mg curcumin/kg feed
T6	chicks were fed basal diet including 200 mg curcumin/kg feed plus1% anise ground seeds

Ground anise seeds was added as a replacement of yellow corn. The experimental chicks were housed in galvanized batteries composed of three tiers, equipped with cages, having the dimensions of (75*50*45 cm) and placed in a semi closed house. Quail chicks were exposed to a lighting period of 23 hr/day during the first three days of age and then decreased gradually by 1hr/day to reach 12L:12D hours/day during the remainder of the growing period.

Body weight and feed consumed were recorded at one day of age, three and six wks of age. Body weight gain and feed conversion were calculated during the same previous period at 0-3, 3-6 and 0-6 wks of age. Mortality was also recorded daily.

Lymphoid Organs and Immunological Blood Samples:

At 42 days of age, three quails from each treatment (total 18 chicks) were slaughtered, complete bleeding, scalding and lymphoid organs (spleen, bursa of fabricus and thymus gland) were removed, and then weighed to calculate the relative to weight as follow:

Relative organ weight = (organ weight/Live body weight) X 100.

At the same time of slaughter, blood samples were collected in heperanized tubes from the 3 chicks per treatment. Plasma was harvested by centrifugation blood at 3000 rpm for 10 min. The clear plasma was transferred carefully to clean and dry vials and stored at -20 C until analysis to determine the IgA, IgM and IgG at Al-Kawther Lab. Assiut, Egypt).

Calcium, Phosphorus and Nitrogen Bioavailabilty Determination:

A separate experiment was carried out during the period of 43 to 45 days of age, the three replicate (three birds/replicate) from each treatment were chosen for total collection method (Attia, 1986). Chicks were fed their corresponding experimental diets for 72 h, in which feed consumed and excreta voided, were accurately determined. The excreta was collected for each replicate, cleaned from feathers and feed then weighed, dried in a forced air oven at 70°C for 24 hours and at 105°C for 3 hours. Samples were ground and placed in screw-top glass jars until analyses. Dry matter, calcium, phosphorus and nitrogen in both feed and excreta were determined by the method of AOAC (1990) in Central Lab. of Faculty of Agriculture, Assiut University, Egypt.

The following equations were used to determine calcum and phosphorus bioavailability.

Calcium bioavailability% or retention (%) = [calcium retained (g/bird) / calcium intake (g/bird)] ×100.

Phosphorus bioavailability% Or retention = [phosphorus retained (g/bird)/ phosphorus intake (g/bird)] ×100.

Nutrient bioavailability or retention (%) indicates the percentage of nutrient retained by the bird as a function of nutrient intake (Graña *et al*., (2013) and it was calculated as follows:

Nitrogen bioavailability or retention (%) = [nitrogen retained (g/bird) / nitrogen intake (g/bird)] ×100.

Table 1. Composition and analysis of the experimental basal and treated diets

Ingredients	Control ration, %	Anise seed ration, %
Yellow corn	53.80	52.80
Soybean Meal (44%)	36.70	36.70
Corn gluten Meal (60%)	6.40	6.40
Anise ground seeds	-----	1.0
Dicalcium phosphate	1.05	1.05
Vit. Min. Premix*	0.50	0.50
Limestone	1.25	1.25
Na Cl	0.30	0.30
TOTAL	100	100
Nutrientanalysis		
Dry matter	87.82	86.88
Crude protein	24.3	24.41
Ether extract	2.6	2.53
Crude fiber[1]	2.73	2.84
Nutrient calculated analysis		
Dry matter	87.6	87.9
ME (kcal/kg)	2944	2913
Crude protein	24.3	24.8
Ether extract	2.6	2.53
Crude fiber	2.7	2.9
Calcium	0.8	0.9
Available phosphorus[2]	0.32	0.38
Lysine	1.31	1.47
Methionine	0.50	0.53
Total phosphorus	0.81	0.89

*Vitamins and minerals mixture provide per kilogram of diet: Vitamin A (as all-trans-retinyl acetate); 12000 IU; Vitamin E (all rac--tocopherol acetate); 10 IU; k3 3mg; Vit.D3, 2200 ICU; riboflavin, 10 mg; Ca pantothenate,10 mg; niacin, 20 mg; Choline chloride,

500 mg; Vitamin B12, 10g; Vitamin B6, 1.5 mg; Thiamine (as thiamine mononitrate); 2.2 mg; Folic acid, 1 mg; D-biotin, 50g. Trace mineral (milligrams per kilogram of diet) Mn, 55; Zn, 50; Fe, 30;Cu, 10; Se, 0.1 and Ethoxyquin 3mg.

Statistical Analysis:

Data were analyzed by factorial design (3x2) using the SAS procedure (Version 2006). Duncan's multiple range test (1955) was also used to determine differences among means.

The statistical model used was as follows:

$Y_{ijk}= \mu+ Cur_i+ Anis_j+ (Cur * Anis)_{ij}+ e_{ijk}$

Where; Y_{ijk} = An observation of traits. μ= The overall mean.

Cur_i= The fixed effect of the i^{th} curcumin (where i = 1, 2 and 3).

$Anis_j$= The fixed effect of the j^{th} anised (where j = 1 and 2).

$(Cur * Anis)_{ij}$= Interaction of Curcumin levels× Anise%)

e_{ijk}=The random error.

RESULTS AND DISCUSSIONS

Performance of Japanese Quails as Affected by the Main Effects of Curcumin Levels (mg/kg) and Anise Seeds %:

The results in Tables (2 and 3) revealed that dietary supplements curcumin, ground anise seeds supplementation did not significantly (P>0.05) improved live body weight, weight gain and feed conversion ratio (FCR) except FCR during the period from 3-6 wks of as compared to control group. However, FCR was improved (3.91) due to the addition of curcumin at level of 200 mg/kg compared to the level of 100 mg/kg (4.34). The main effect of anise addition also improved FCR numerically in the same previous period.

Table 2. Performance of Japanese quails as affected by curcumin and anise seeds supplementation

Parameters	Curcumin levels (mg/kg)			Ground anise seeds (1%)	
	0	100	200	0	1
BW (42) d	224.31 ± 8.39	213.89 ± 10.33	220.42 ± 1.78	217.69 ± 6.62	221.39 ± 5.85
BWG (0-3wks)	97.25 ± 1.43	96.61 ± 3.32	101.03 ± 2.53	97.77 ± 2.46	98.82 ± 1.77
BWG (3-6 wks)	119.31 ± 7.21	109.58 ± 7.19	111.67 ± 3.49	112.32 ± 4.54	114.72 ± 5.67
BWG (0-6 wks)	216.56 ± 8.29	206.19 ± 1.034	212.69 ± 1.84	210.09 ± 6.61	213.54 ± 5.84
FC (0-3 wks)	268.44± 10.8	267.5± 9.9	260.75± 6.34	259.61± 6.09	271.52± 7.44
FC (3-6 swk)	435.14 ± 3.69	481.75 ± 32.89	434.72 ± 11.35	461.72 ± 23.33	439.35 ± 9.49
FC (0-6 wks)	703.58 ± 11.94	749.25 ± 24.81	695.47 ±15.22	721.33 ± 22.02	710.87 ± 11.14
FCR (0-3 wks)	2.76 ± 0.08	2.76 ± 0.18	2.59 ± 0.09	2.67 ± 0.10	2.76 ± 0.11
FCR (3-6 wks)	3.68^{b} ± 0.2	4.43^{a} ± 0.32	3.91^{ab} ±0.19	4.15 ± 0.26	3.87 ± 0.17
FCR (0-6 wks)	3.26 ± 0.07	3.34 ± 0.41	3.27 ± 0.06	3.24 ± 0.26	3.34 ± 0.07

Means within the rows with different superscripts are significantly different (P<0.05).BW=body weight at 42 days of age; BWG=body weight gain; FC=feed consumption (g)'FCR=feed conversion ratio.

Table 3. Performance of Japanese quails as affected by the interaction between curcumin and anise seeds supplementation

Parameters	Treatments					
	T1	T2	T3	T4	T5	T6
BW (42 d)	216.11±6.1	232.5±15.8	213. 9± 23.8	213.89 ± 0.31	223.06±1.9	217.78 ± 1.11
BWG (0-3wks)	96.289±2.8	98.2±1.47	98.0± 7.73	95.21 ± 1.64	99.02 ±4.39	103.03 ± 3.31
BWG (3-6wks)	112.22±3.3	126.39±14.2	108.33±16.1	110.83 ± .94	116.39± 2.5	106.94 ± 4.72
BWG (0-6wks)	208.51±6.2	224.6±15.6	206.34± 23.8	206.04 ± 8.58	215.4± 1.89	209.98 ± 1.41
FC (0-3 wks)	256.17±7.7	280.7±18.3	256.1 ± 18.1	278.89 ± 0.89	266.56± 9.7	254.94 ± 8.83
FC (3-6 wks)	432.5^{b}±6.9	437.78^{b}± 4.4	525.7^{a}± 36.3	437.78^{a} ± 36.1	426.9^{b} ± 25	442.50^{b} ± 3.61
FC (0-6 wks)	688.7^{b}±14.6	718.50^{ab}±13	781.83^{a}± 18	716.67^{ab}±35.22	693.50^{b}± 35	697.44^{ab}±12.44
FCR (0-3 wks)	2.66±0.001	2.86 ± 0.14	2.64 ± 0.39	2.93 ± 0.06	2.69 ± 0.02	2.48 ± 0.17
FCR (3-6 wks)	3.86^{b}±0.05	3.51^{b} ± 0.43	4.91^{a}± 0.39	3.94^{ab} ± 0.08	3.67^{b} ± 0.29	4.14^{ab} ± 0.15
FCR (0-6 wks)	3.30±0.03	3.21 ± 0.16	3.19± 0.99	3.48 ± 0.03	3.22 ± 0.13	3.32 ± 0.04

Means in the rows with different superscripts are significantly different (P<0.05). BW=body weight at 42 days of age; BWG=body weight gain; FC=feed consumption (g)'FCR=feed conversion ratio. T1= control; T2=1% anise seeds; T3=100 mg/kg curcumin; T4=100 mg/kg curcumin+1%anise seeds.;T5=200 mg/kg curcumin; T6=200 mg/kg curcumin+1%anise seeds.

The interactions between curcumin and anise seeds supplementation showed significantly (P<0.05) improved in feed consumption during the period from 0-6 wks of age and feed conversion ratio during the period from 3-6 wks of age. Body weight and body weight gain during the period from 0-6 wks of age, were numerically improved compared to the other treatments. However, Treatment 2 (T2) at 42 days of age, in which chicks were fed 1% anise seeds had the highest body weight and body weight gain compared the other treatments. Also, T2 in which quails fed 1% anise seeds and T5 in which quails fed 200 mg/kg curumin (Table 3) showed improved FCR, compared to the other treatments. Our results

concerning with treatment 5 (curcumin at level of 200 mg/kg) and T2 (1% anise seeds) are in the same trends of Singh *et al.* (2017). The significant improved in FCR that was recorded for curcumin treatment is supported by the findings of Singh *et al.* (2017) and Hossen *et al*. (2018) who reported that curcumin significantly (P<0.05) increased growth performance in broiler compared to the control group. Active materials (Curcumin) causing an increase in the absorption of nutrients, enhance digestion, and greater efficiency in the utilization of feed, resulting in enhanced growth (Hussein, 2013). Similar results were recorded by Durrani *et al.* (2006) and Kumari *et al.* (2007), who reported that curcumin had a positive effects on growth performance of broiler and that might be due to effects of turmeric or curcumin flavor on the chicks' appetite and improved secretions of proteolytic enzymes, lipase enzymes and amylase (Platel & Srinivasan, 2000) and enhance antioxidants and control hyperlipidemia (Hewlings and Kalman, 2017). Badran *et al.* (2020) found a significant (P<0.05) improvement in BW and BWG in broilers (1-35 days) fed diets containing curcumin (50,100 mg / kg) compared to the control group. Arslan *et al*. (2017) showed that BWG and FCR were improved with turmeric supplementation at a higher dose (1.0 and 1.5%).It also reduced plasma total cholesterol and increasing in HDL-cholesterol without effect on triglycerides with addition turmeric levels. Attia *et al*. (2017) found that turmeric addition at 1 g/kg diet improved feed conversion ratio (FCR) compared to control groups.

Regarding with the positive effects of anise seeds on BW, BWG, FC and FCR, the current results are in agreement with Amein *et al.* (2019) who reported an improve in body weight and body weight gain in broiler chickens at 42 days when fed diets containing anise seeds. Also Jabber *et al.* (2015) found an improve in feed intake in 6-week-old broiler chickens fed diets containing anise seeds (2,4,6,8kg/ton) compared to the control.

On the other hand, Barakat *et al.* (2016) reported that there were no significant effect on BW and BWG at 5-weeks old broiler chickens fed diets containing anise seeds (0.5,0.75 gm/kg) compared to the control. Also, Amein *et al.* (2019) indicated that there was no significant effect on feed intake throughout the first 6 week of age for broiler chickens (Ross 308) fed diets containing anise seeds (0.5, 0.75 gm/kg) compared to the control group. No significant (P>0.05) differences were observed on FCR when chicks were fed diets containing anise seeds during 7-35 days of age at levels of 0.2%, 4%, and 0.6% compared to control (Mahmod, 2013).
and bursa of fabricius when feeding chicks diets containing turmeric at levels of 0.5 or 1% (Sahoo *et al*., 2019).

One of these plant materials is curcumin. Curcumin is the principle active constituent of *Curcuma longa*. Curcumin has long been used in poultry feeds, owing to its favorable effects, including antimicrobial, antioxidant, anti-inflammatory, anti-inflammatory and immunostimulant properties (Nonose *et al*., 2014 and Galli *et al*., 2018). Curcumin shows pharmacological efficacy and safety and contributes to the treatment of several diseases. It also improves the endogenous secretion of digestive enzymes (Toghyani *et al*., 2011) and reduces lipid peroxidation (Rukkumani *et al.,* 2004). Curcumin has been shown to possess antioxidant, anti-inflammatory, antimutagenic, antimicrobial, and anticancer propertie(Hewlings*et al*., 2017, Priyadarsini 2014). Badran *et al*., (2020) found that immunoglobulin m (IgM) was improved in broiler chickens fed diets containing curcumin (50,100 mg / kg) at 3 and 5 wks of age compared to the control but Immunoglobulin g (IgG) was improved at level of 50 mg/kg at the same previous age. On the other hand, there was no significant effect on relative weight of spleen and Bursa of Fabricius when chicks were fed diets containing turmeric (0.5%,1%) compared to the control at age of 35 day (Sahoo *et al.*, 2019).

These compounds of curcumin or medicinal herbs not only affect parasites directly but also indirectly

Immunological parameters

The results in Table (4) revealed that curcumin groups recorded highly significant relative weight of spleen and bursa of fabricius and immunoglobulin A, M and G (IgA, IgM, IgG) compared to control group. However, there were no significant differences due to curcumin on relative Thymus weight. On the other hand, the results showed that ground anise seeds hadn't effects on all the previous parameters.

The interactions between curcumin and ground anise seeds showed that quails in treatment 6, in which chicks were fed a mixture of curcumin at levels of 200 mg/kg and ground anise seeds at 1% had the significant highest (P<0.05) relative weight of both spleen and bursa of fabricius and improved the immune functions through the highest levels of immunoglobulin A, M and G (IgA, IgM, IgG) compared to control one. The obtained results are in agreement with that reported by Reda *et al.*, (2020) who reported that serum IgG concentrations were increased by nano-curcumin (0.1, 0.2 and 0.5 g/kg) supplementation compared to those of the control. However, serum IgM concentrations were also increased by nano-curcumin (0.1, 0.2, 0.3 and 0.4 g/kg) supplementation compared to those of the control. Badran *et al*. (2020) found that immunoglobulin M (IgM) improved in broiler chicks at 3 and 5 week of age when fed diets containing curcumin at levels of 50 or 100 mg / kg. Also, there were no significant effect on relative weight of spleen

improve efficiency and overall performance by their beneficial effects such as immunomodulation, antioxidative, and anti-inflammatory mechanism to defend against coccidian. The other functions of these natural compounds are to help in digestion and absorption of feed, flourishing beneficial gut microbiota, and maintaining healthy gut structure (Yadav and Jha, 2019).

Table 4. Relative lymphoid weight and Immunoglobulins levels of Japanese Quail as Affect by Curcumin and Anise Seed Supplementation

	Immune parameters					
Treatments	**Spleen %**	**Thymus %**	**Bursa %**	**IgG (mg/dl)**	**IgM (mg/dl)**	**IgA (mg/dl)**
Curcumin levels (mg/kg)						
0	0.072^{b}±0	0.33±0	0.118^{c}±0	615.8^{c}±9	230.5^{b}±1.5	65.5^{b}±1.8
100	0.077^{b}±0	0.38±0	0.143^{b}±0	652.7^{b}±1.9	235.3^{b}±2.3	64.8^{b}±0.6
200	0.094^{a}±0	0.49±0	0.180^{a}±0	679.0^{a}±0.9	246.8^{a}±1.4	73.5^{a}±1.5
Ground anise seeds (%)						
0	0.082±0	0.37±0.0	0.14±0	644.2±14	236.5±2.6	68.7±1.9
1	0.080±0	0.43±0.0	0.16±0	654.2±8	238.5±3.8	67.2±2.2
Interactions						
T1	0.07^{d}±0	0.33±.01	0.115^{c}±.0	600^{cd}±0	232.5^{cd}±2	68.5^{ab}±0.5
T2	0.08^{c}±0	0.34±.04	0.120^{c}±.0	631.5^{c}±2	228.5^{d}±1	62.5^{b}±1.5
T3	0.09^{b}±0	0.39±.03	0.125^{c}±.0	653.5^{b}±3	232.5^{cd}±1	64.0^{b}±1
T4	0.07^{d}±0	0.38±.02	0.160^{b}±.0	652.0^{b}±3	238.0^{bc}±4	65.6^{b}±0.5
T5	0.09^{ab}±0	0.4±.02	0.175^{ab}±.0	679.0^{a}±1	244.5^{ab}±1	73.5^{a}±3.5
T6	0.1^{a}±0	0.59±.02	0.185^{a}±.0	679.0^{a}±2	249.0^{a}±1	73.5^{a}±1.5

$^{a-d}$Means in the same column with different superscript are significantly different (P<0.05).

The Availability of Calcium, Phosphorus and Nitrogen:

Bioavailability of Calcium Retention%:

The effects of curcumin and ground anise seeds supplementation and their interactions on the bioavailability of calcium retention% of quails are presented in Table 5.

Concerning with the main effects of curcumin and anise seeds, there were no significant (P>0.05) differences in calcium retention efficiency. However, there was a numerical in increase in calcium bioavailability % in birds fed diets containing curcumin compared to control and another groups. However, the bioavailabilty of calcium as affected by the main effect of curcumin increased by about 10% than control one.

No significant (P>0.05) effects due to ground anise seeds were noticed in calcium bioavailability. But numerically, birds fed anise seeds decreased in Ca bioavailability compared to the control group. The obtained results agree with those of El Hadi *et al*. (2021), who reported that the rate of calcium retention efficiency percentage decreased in birds fed diets containing anise seeds at level of 1% in broiler chickens. There were no significant (P>0.05) differences due to interactions curcumin and anise seeds for all calcium retention efficiency traits except for calcium excreta %. Birds fed diets containing (200 mg curcumin /kg feed in treatment 5 (T5) and birds fed diets containing curcumin at level of 200 mg/kg and 1% anise seeds (T6) were numerically higher in calcium bioavailability compared to the other treatment, this due to the decrease in calcium level of excreta (Table 5).

Bioavailability of Phosphorus Retention%:

The effects of curcumin, anise seeds supplementation and their interactions on bioavailability of phosphorus retention% are presented in Table 6. Regarding the effect of curcumin, anise seeds and their interactions, there were no significant (P>0.05) differences on phosphorus retention%. The fifth group (50 mg curcumin /kg feed ×0.5% anise seeds) had the lowest phosphorus retention%, while the third treatment (1% anise seeds) had the highest phosphorus retention% compared to the other treatments at age 43-45 day.

Bioavailability of Nitrogen Retention%:

There were no significant (P>0.05) differences due to the curcumin for all nitrogen retention efficiency traits except for nitrogen in feeds and excreta. Numerically, nitrogen bioavailability in birds fed 200 mg curcumin/kg feed had the highest value compared to control and 100 mg/kg feed group. However, nitrogen bioavailability in birds fed 200 mg/kg curcumin exceed by 2 and 5 % compared to control and the100 mg/kg groups., respectively. The obtained results are similar to those of El-Hadi *et al.* (2021), who reported that birds fed 100 mg/kg curcumin had the lowest nitrogen retention% compared to control group.

There were no significant (P>0.05) differences due to the ground anise seeds for all nitrogen retention efficiency traits. Numerically, birds fed 1% anise seeds higher in nitrogen bioavailability than those of the control group. However, there was a numerical decrease in nitrogen excretion compared to

nitrogen % in feeds for birds fed diets containing ground anise seeds.

There were no significant (P>0.05) differences due to the interactions on nitrogen bioavailability%. However, nitrogen retention% was numerically increased in birds fed curcumin at a level of 200 mg/kg and in the group fed 200 mg/kg curcumin plus 1% ground anise seeds (T5 and T6) respectively compared to control and the other treatments.

The Curcuma contains curcumin for increasing digestive enzymes but was not sufficient to stimulate digestive enzymes (Makaba *et al*., 2002 and Leonel *et al.,* 2003) so, that the nitrogen retention value of super Kampong chicken was not significant. The white Curcuma in the feed has no significant effect because the protein content of the feed was the same treatment so that the resulting nitrogen retention was the same. This was following Mirnawati *et al.* (2013) who stated that by increasing feed nitrogen consumption, nitrogen retention will be positive, which means optimal protein absorption. Positive nitrogen retention indicates the treated feed protein was utilized by the body for optimal protein absorption.

GENERAL DISSCUSSIONS

According to Zhu *et al.,* (2014) and El Hadi *et al*., (2021), curcumin has properties that can improve immunity and protein metabolism and protective effects on cells through enzymetic and non-enzymetic mechanisms. Therefore, based on increase in plasma immunological parameters (IgA, IgM and IgG), we suggest that curcumin exerts beneficial effects on the host immune response, which could be associated with the presence of carotenoid compounds that contribute to modulating the immune response by inducing lymphocyte proliferation and increasing antibody production (Rajput *et al.,* 2013). Liu *et al.,* 2020) indicated that supplemental 150 mg/kg curcumin can improve productive performance, antioxidant enzyme activity and immune function in hens under heat stress. This indicates that curcumin has a certain regulatory effect on the humoral immunity in stress conditions of hens and can enhance the body's immunity by increasing the immunological parameters in plasma. Improved immunoglobulin A (IgA), immunoglobulin M (IgM) and immunoglobulin G (IgG) were observed in birds at 3 and 5 week of age fed diets containing anise seeds at 0.25, 0.50 and 0.75 g/kg (Barakat *et al*., 2016). Anise has been used over the years for its antioxidant (Gulcin*et al*., 2003), antimicrobial (Al-Kassie, 2008), antibacterial (Tabanca *et al*., 2003), antipyretic (Afifi *et al.,* 1994), and antifungal (Soliman and Badea, 2002) properties. Also, essential oil from anise seeds can stimulate immunity Yazdi *et al.* (2014), reported the role of curcumin in increasing nutrient digestibility and found that 200 mg/kg supplementation of curcumin improved performance and fat metabolism. Another study also found that curcumin improved nutrient metabolism by enhancing the production of bile acids and activity of gastric enzymes to accelerate digestion and absorption (Platel and Srinivasan, 2000).

Table 5. Calcium Bioavailability of Japanese Quails as Affected by Curcumin and Ground Anise Seeds Supplementation and their Interactions

Treatments	Calcium Bioavailability						
	Dry feed	Ca%in feed	Ca /feed	Dry Excreta	Ca% in excreta	Ca/excreta	Caavaiablity
Curcumin (g/kg)							
0	71.28±1.47	0.8	0.57±0.01	14.34±1.02	1.79	0.26^{ab}±0.02	54.94±3.3
100	83.31±2.29	0.8	0.67±0.02	19.21±2.85	1.79	0.34^{a}±0.05	55.82±2.2
200	70.11±3.55	0.8	0.56±0.03	12.61±1.39	1.79	0.23^{b}±0.02	60.43±2.9
Anise seeds %							
0	74.8±3.73	0.8	0.599±0.03	15.87±2.50	1.79	0.28±0.04	58.66±2.9
1	74.9±1.82	0.8	0.598±0.01	14.89±0.50	1.79	0.27±0.001	55.47±2.2
Interactions							
T1	72.16^{bc}±0	0.8	0.58^{bc}±0	13.89^{b}±2.06	1.79	0.25^{b}±0.04	56.9±0.38
T2	70.40^{bc}±3.17	0.8	0.56^{bc}±0.03	14.79^{b}±0.85	1.79	0.26^{b}±0.02	52.98±2.2
T3	86.24^{a}±4.16	0.8	0.69^{a}±0.03	22.61^{a}±4.97	1.79	0.41^{a}±0.09	54.66±3.1
T4	80.37^{ab}±0.59	0.8	0.62^{ab}±0	15.47^{ab}±1.37	1.79	0.28^{ab}±0.02	56.9±3.6
T5	66^{c}±6.49	0.8	0.53^{c}±0.05	10.77^{b}±2.49	1.79	0.19^{b}±0.04	64.41±5
T6	74.21^{bc}±2.05	0.8	0.59^{bc}±0.02	14.44^{b}±0.36	1.79	0.26^{b}±0.006	56.44±0.4

[a-d] Means in the same rows with different superscripts are significantly different (P<0.05); T1= control; T2=1% anise seeds; T3=100mg/kg curcumin; T4=100 mg/kg curcumin+1%anise seeds.; T5=200 mg/kg curcumin; T6=200 mg/kg curmin+1%anise seeds.

Table 6. Phosphorus Bioavailability of Japanese Quails as Affected by Curcumin and Ground Anise Seeds supplementation and their Interactions

Treatments	Phosphorus Bioavailability						
	Dry feed	P% in feed	P feed	Dry Excreta	P%inexcreta	P excreta	P avaiablity
Curcumin (g/kg)							
0	71.28±1.47	0.32	0.23^{b}±0.005	14.34±1.02	1.050	0.15^{ab}±0.01	38.77±3.75
100	83.31±2.29	0.32	0.27^{a}±0.007	19.21±2.85	1.050	0.20^{a}±0.03	41.39±1.76
200	70.11±3.55	0.32	0.22^{b}±0.01	12.61±1.39	1.050	0.13^{b}±0.01	47.58±3.46
Anise seeds %							
0	74.8±3.73	0.32	0.24±0.01	15.87±2.50	1.050	0.17±0.03	44.73±2.69
1	74.9±1.82	0.32	0.24±0.006	14.89±0.50	1.050	0.16±0.005	40.39±2.66
Interactions							
T1	72.16^{bc}±0	0.32	0.23^{bc}±0	13.89^{b}±2.06	1.050	0.15^{b}±0.02	46.39^{a}±1.11
T2	70.40^{bc} ±3.2	0.32	0.23^{bc}±0.01	14.79^{b}±0.85	1.050	0.16^{b}±0.009	31.05^{b}±3.17
T3	86.24^{a}±4.16	0.32	0.28^{a}±0.01	22.61^{a}±4.97	1.050	0.24^{a}±0.05	39.97^{ab}±3.59
T4	80.37^{ab}±0.59	0.32	0.26^{ab}±0.002	15.47^{ab}±1.37	1.050	0.16^{ab}±0.01	42.81^{ab}±0.61
T5	66^{c}±6.49	0.32	0.21^{c}±0.02	10.77^{b}±2.49	1.050	0.11^{b}±0.03	47.81^{a}±7.47
T6	74.21^{bc}±2.05	0.32	0.24^{bc}±0.007	14.44^{b}±0.36	1.050	0.15^{b}±0.004	47.33^{a}±2.03

[a-d] Means in the same row with different superscripts are significantly different (P<0.05); T1= control; T2=1% anise seeds; T3=100mg/kg curcumin; T4=100 mg/kg curcumin+1%anise seeds.; T5=200 mg/kg curcumin; T6=200 mg/kg curcumin+1%anise seeds.

Table 7. Nitrogen Bioavailability of Japanese Quails as Affected by Curcumin and Ground Anise Seeds Supplementation and their Interactions

Treatments	Nitrogen Bioavailability						
	Dry feed	N% Infeed	N/feed	Dry Excreta	N% in excreta	N/excreta	N avaiablity
Curcumin (g/kg)							
0	71.28±1.47	3.840	2.73^{b}±0.06	14.34±1.02	2.850	0.41^{ab}±0.03	85.05±1.04
100	83.31±2.29	3.840	3.13^{a}±0.09	19.21±2.85	2.850	0.55^{a}±0.08	82.72±2.82
200	70.11±3.55	3.840	2.69^{b}±0.14	12.61±1.39	2.850	0.36^{b}±0.04	86.87±0.96
Anise seeds %							
0	74.8±3.73	3.840	2.87±0.14	15.87±2.50	2.850	0.45±.07	84.54±2.16
1	74.9±1.82	3.840	2.88±0.07	14.89±0.50	2.850	0.42±.01	85.23±0.46
Interactions							
T1	72.16^{bc}±0	3.840	2.77^{bc}±0	13.89^{b}±2.06	2.850	0.39^{b}±0.06	85.70±2.12
T2	70.40^{bc} ±3.2	3.840	2.70^{bc}±0.12	14.79^{b}±0.85	2.850	0.42^{b}±0.02	84.40±0.72
T3	86.24^{a}±4.16	3.840	3.31^{a}±0.16	22.61^{a}±4.97	2.850	0.65^{a}±0.014	79.72±5.45
T4	80.37^{ab}±0.59	3.840	3.09^{ab}±0.02	15.47^{ab}±1.37	2.850	0.44^{ab}±0.04	85.73±1.20
T5	66^{c}±6.49	3.840	2.53^{c}±0.25	10.77^{b}±2.49	2.850	0.31^{b}±0.07	88.19±1.69
T6	74.21^{bc}±2.05	3.840	2.87^{bc}±0.08	14.44^{b}±0.36	2.850	0.41^{b}±0.01	85.55±0.13

[a-d] Means in the same row with different superscripts are significantly different (P<0.05); T1= control; T2=1% anise seeds; T3=100mg/kg curcumin; T4=100 mg/kg curcumin+1%anise seeds.; T5=200 mg/kg curcumin; T6=200 mg/kg curcumin+1%anise seeds.

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معدل الأداء الانتاجى والصفات المناعية والتوافر الحيوى للكالسيوم والفوسفور والنيتروجين للسمان الياباني المغذى على الكركمين و /أو بذور اليانسون المطحون كأعشاب طبية

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هدفت الدراسة إلى معرفة تأثير اضافة الكركمين و / أو بذورااليانسون المطحونة على معدل الأداء الانتاجى والصفات المناعية والتوافر الحيوي للكالسيوم والفوسفور والنيتروجين في السمان الياباني المغذى على مستويات متدرجة من الكركمين) صفر، ١٠٠ ،٢٠٠ مجم / كجم (و/ او اليانسون المطحون بمستويين) صفر، ١٪ (خلال تجربة تغذية مدتها ٤٢ يومًا. فتم اختيار ١٦٢ (مائة واثنان وستون) كتكوت سمان بعمر يوم واحد وزعت في تصميم عاملي (٢ *٣) فأظهرت النتائج أن اضافة بذور اليانسون المطحون أدت إلى تحسين معدل التحويل الغذائي (FCR) خلال الفترة من ٣- ٦ أسابيع من العمر. السمان المغذى على الكركمين بمستوى ٢٠٠ مجم / كجم و/ او بالإضافة إلى ١٪ يانسون مطحون حقق نسبة تحويل علف أعلى معنويا (P <0.05) خلال الثلاث اسابيع الاولى من العمر. وسجلت مجموعات الكركمين قيم معنوية عالية في نسبة الطحال منسوبة لوزن الجسم وكذلك نسبة غدة برسا فابريوش والجلوبولين المناعي، (IgA، IgM، IgG) مقارنة بالمجموعة الضابطه في السمان النامي.. كان التوافر الحيوي للفوسفور اعلى معنوياً (P <0.50) في الطيور التي غذيت على مخلوط من ٢٠٠ ملجم / كجم من الكرمين و١٪ من بذور اليانسون. اوصت النتائج بإضافة مخلوط الكركمين بمستوى ٢٠٠ مجم / كجم من العلف مع ١٪ بذور مطحونة من اليانسون لتحقيق النتيجة المرجوة من معدل اداء النمو والصفات المناعية والتوافر الحيوى للكالسيوم والفوسفور والنيتروجين في السمان اليابانى.