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EFFECT OF CURCUMIN AND ALLICIN ON PRODUCTIVE AND PHYSIOLOGICAL TRAITS OF MANDRA CHICKENS

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ABSTRACT

A total number of 210 hens and 21 cocks, at 28 wks old of Mandara chickens were randomly divided into seven equal treatment groups (30 hens and 3 cocks in treat) and distributed among three equal replicates of 10 females and 1 cock in each. The first group was kept as a control group, the 2nd, 3rd and 4th groups were fed a diet containing 50, 75 and 100 mg curcumin/ kg diet and the 5th, 6th and 7th groups were fed a diet containing 50, 75 and 100 mg allicin/ kg feed, respectively. Each curcumin and allicin improved significantly feed conversion ratio and increased egg mass compared to the control group. Egg production significantly increased with medium or high levels of curcumin and allicin groups compared with the other groups. Red blood cells count, packed cell volume, plasma protein, and globulin significantly increased with curcumin and allicin group compared with the control group. Total lipids, cholesterol, and low-density lipoprotein significantly decreased in all groups of curcumin and allicin compared to the control group. Curcumin groups and medium or high levels of allicin significantly increased fertility percentage compared with the low level of allicin and control groups. In addition, the hatchability percentage increased in all levels of curcumin and allicin compared with the control group. However, dead embryos significantly decreased in all groups of allicin compared with the

curcumin groups and control group. It was concluded from the present study that high level of curcumin or medium level of allicin increased the survival rate, egg production, egg mass, improved FCR, hatchability traits, and some blood parameters of Mandra chickens.

Keywords: Curcumin, Allicin, Egg production, Hatchability, Mandra Chickens

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INTRODUCTION

Laying hens are one of the best sources of high-quality protein along with important vitamins and minerals. Increased egg production and consumption could significantly improve the nutritional needs of adults and children. Eggs are also an economical source of nutrients for a healthy diet and life, playing a vital role in human nutrition (**Lei, 2021)**. Laying hen production has undergone a paradigm turnover in its primary concept and operation from an extensive backyard activity into a major commercial production. Antibiotics have been used as antimicrobial growth promoters, but their potential side effects have become a real public health concern globally **(Donoghue, 2003).** Antibiotics are used as a common method to prevent diseases and increase the production of eggs and meat, but the continuation of using antibiotics in feeds causes many problems one of which is an increase in drug resistance, nevertheless, remaining drug in tissues causes an imbalance of microflora in the digestive tract **(Awad *et al.*, 2009).** Although antibiotics are less frequently used in laying hens' chicken feeds as compared to broilers, the increase of harmful bacterial resistance to antibiotics in poultry products and its transfer to humans is a major importance. However, the European Community banned the use of antibiotics in poultry, and alternatives such as phytobiotic additives have been studied in order to maximize the growth performance of laying hens in diets without antibiotics. Compared with synthetic antibiotics or inorganic chemicals, these plant-derived products have proved to be less toxic, residue free and are thought to be ideal feed additives in food animal production (**Puvača *et al*., 2013**).

Some researchers reported that herbs have the ability to stimulate endocrine glands and the immune system **(Lee *et al*., 2004).** Curcumin is a bright yellow chemical produced by plants of the *Curcuma longa* species. It is the principal curcuminoid of turmeric (*Curcuma longa*), a member of the ginger family, Zingiberaceae. It is sold as an herbal supplement, cosmetics ingredient, food flavoring, and food coloring **(Majeed, 2015)**. Curcumin as the major compound extracted from (*Curcuma longa*) serves various therapeutic and preventive purposes **(Cheraghipour *et al*., 2018). Rathore *et al.* (2020)** showed that curcumin has been worldwide used for its complete benefits for health, which appears to act primarily through its antioxidant and anti-inflammatory mechanisms. These benefits are best achieved when curcumin is combined with agents such as carbohydrates, and piperine, which increases its bioavailability significantly. Research suggests that curcumin can help in the management of oxidative and inflammatory conditions, metabolic syndrome, ant-inflammatory, anxiety, anti-diabetic, and hyperlipidemia. **Liu *et al.* (2020)** found that supplementation with 150 mg/ kg of curcumin improved productivity, performance, egg quality, feed conversion ratio (FCR), antioxidant enzyme activity, and immune response under heat stress conditions on Hy-Line brown hens.

Natural antioxidants are important for the prevention and treatment of atherosclerosis. Garlic has been studied extensively for its cardioprotective properties with very promising results properties **(Arzanlou *et al*., 2011)**. Its primary active ingredient, 2-propene-1-sulfinothioic acid S-2-propenyl ester (also known as allicin), has been shown to alter the composition of fatty acids in animals fed a high fatty acid diet (**Abramovitz *et al*., 1999).** Allicin is an organosulfur compound extracted from garlic, a species in the family Alliaceae and allicin has a characteristically pungent smell and exhibits antibacterial, antifungal, anti-inflammatory and antioxidant properties **(Bautista *et al*., 2005; Vaidya *et***

***al*., 2009).** Overall, low levels of allicin-rich extract in the diets of laying hens improved their productivity. Allicin, rich extract can be used in birds 'production to reduce antibiotic usage in food animals **(Adjei-Mensah *et al*., 2022). Ayed *et al*. (2018)** studied the comparative effects of feed inclusion with garlic (*Allium sativum*), cloves and turmeric (*Curcuma longa*) Rhizome powder on laying hens' performance and egg quality, they found that the supplementation of garlic and turmeric powder showed an increased in double yolk egg rates, especially for the turmeric diet. Garlic incorporated at 2% reduced the rate of broken eggs. Also, they had a beneficial effect on shell and albumen weight. Yolk color was more intense in the eggs of the groups receiving turmeric and some indicators of egg freshness (yolk height and albumen diameter) were improved and dietary supplementation of 1% of garlic and turmeric seems to decrease total yolk cholesterol. Even though, more experimental trials are needed to know the antioxidant effects and the nutritive composition of these eggs, especially LDL and HDL, to conclude whether garlic and turmeric powders give a "Designer egg". This study was conducted to evaluate the effect of different levels of curcumin and allicin on productive performance, blood parameters, and hatchability percentage of the locally developed Mandara chickens.

MATERIAL AND METHODS

Chickens, experimental design and diets

A total of 210 hens and 21 cocks of Mandara chickens at 28 weeks of age the experiment period lasted for (20 wks of age) were randomly divided into seven equal treatment groups (30 hens plus 3 cocks in each) and distributed among three equal replicates of 10 females plus 1 cock each. All females and 21 cocks were housed in 21 floor pens (2m × 1.2m×2) furnished with wheat straw.

All females and males are treated as follows:
Group 1: fed diets without supplementations as the control.

Group 2: fed diets curcumin 50 mg/ kg diet.
Group 3: fed diets curcumin 75 mg/ kg diet.
Group 4: fed diets curcumin 100 mg/ kg diet.
Group 5: fed diets allicin 50 mg/ kg diet.
Group 6: fed diets allicin 75 mg/ kg diet.
Group 7: fed diets allicin 100 mg/ kg diet.

Sources of additives

The curcumin used in the present study was provided by the American company NOW Foods, and the purity detection of the same curcumin production was determined by Dr. Zhang's lab. **(Zhang *et al*., 2015).**

The allicin used in the present study was provided by the Chinese company Hebei Kangdali Pharmaceutical (Com., Ltd.). The content of allicin was 35% in this study and its color is white, allicin is chemical a thioester of sulfinic acid and is also known as allyl thiosulfinate **(Nikolic *et al.*, (2004)**.

Housing and husbandry

Environmentally controlled lightproof house (Close system) in order to start the experiment, during hot weather house was cooled using cool-cell-pads to the optimum temperature of 22-24°C, the relative humidity was adjusted automatically and ranged between 45-55%. Mash laying hen feed (Table 1) and fresh water were provided daily *ad-libitum* throughout the experimental period. Vaccination and medical programs were done according to common veterinarian care practices. Twenty-one five-watt incandescent bulbs located at the center of each pen at about were used as the source of light to illuminate the house. Birds were exposed to a photoperiod regimen 16 hrs light-8 hrs dark cycles. The experiment lasted 20 weeks. Ingredients and chemical analyses of the diet are presented in

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Table (1). Laying hens were reared according to common husbandry practice for laying hens.

Table (1). Ingredient and calculated composition (g/kg) of the experimental diet for laying hens.

Ingredients	%
Yellow corn	66.3
Soybean meal (46%CP)	24.2
Limestone	7.5
Dicalcium phosphate	1.32
Vit+Min Premix[1]	0.25
NaCl	0.25
DL-methionine	0.15
Total	100
Calculated composition, %	
ME, kcal/ Kg	2777
C/P ratio	163.6
Methionine, %	0.39
Methionine +Cysttine, %	0.67
Lysine, %	0.8
Calcium, %	3.1
Phosphorus available, %	0.37
Values (AOAC, 2000) Analyzed	
Dry matter, %	90.73
Crude protein, %	16.97
Crude fat, %	2.45
Crude fibre, %	3.96
Ash, %	6.37
Nitorgen free extract, %	60.98

[1]Vit+Min mixture provides per kilogram of diet: vitamin A, 12000IU; vitamin E, 10IU; menadione, 3mg; Vit. D_3, 2200ICU; riboflavin, 10mg; Ca pantothenate, 10mg; nicotinic acid, 20mg; choline chloride, 500mg; vitamin B_{12}, 10µg; vitamin B_6, 1.5mg; vitamin B_1, 2.2mg; folic acid, 1mg; biotin, 50µg. Trace mineral (milligrams per kilogram of diet): Mn, 55; Zn, 50; Fe, 30; Cu, 10; Se, 0.10; Antioxidant, 3mg.

Data collected

Performance traits

The live body weight (g) of each bird was recorded at the beginning (at 28 wks of age) the experiment period lasted for (20 wks of age) in the early morning before receiving any feed. The average body weight gain (BWG) was calculated as follows: BWG = (Final live BW - Initial live BW). Feed consumption was measured weekly to calculate the amount of feed consumed g/bird/day. Feed conversion ratio was calculated at the amount of feed consumed (g) required to produce a unit (g) of egg mass (FCR= g feed/g egg), FCR was recorded every 4 weeks throughout the experimental period. The mortality rate of dead birds was presented as the number of bird's dead in each treatment during the whole experimental period.

Egg production traits

Eggs were collected and recorded daily. The percentage of egg production (%) for each replicate was calculated as follows:

Egg production percentage = $\frac{Number\ of\ eggs\ produced}{number\ of\ live\ hens} x100$

Eggs were individually weighed daily for each replicate and the average egg weight was recorded. Egg mass (g/hen/day) was calculated every 4 weeks using the following equation:

Egg mass (g/hen/day) = average egg weight (g) × egg number every 4 weeks of hen.

Fertility and hatchability

All treatment groups (30 hens plus 3 cocks in each) and distributed among three equal replicates of 10 females plus 1 cock each. the females of all treatments are fertilized by the rooster who lives with her and the same treatment. At 32, 36 and 40 weeks of age are taken 3 hatchings (560 eggs per hatch), Each treatment has 80 eggs per hatch. Incubated according to the normal procedure at an automatic computerized hatchery at El-Sabahia Poultry Research Station. On day 18 of incubation, unfertile eggs were recorded. Fertility, hatchability, and embryo dead percentage were calculated. Hatching chicks were weighed to the nearest gram and the relative weight of the chicks was calculated.

Blood collection and hematobiochemical Analyses

At the end of the experiment, 9 blood samples from each treatment, blood samples were withdrawn from the bronchial vein from 9 hens having hard shells in the uterus taken randomly from each treatment, which were divided into two samples in Eppendorf tubes. One was a test tube by using Ethylenediamine tetraacetate acid (EDTA) as an anticoagulant to study blood hematological parameters immediately after blood collection. The other was non-(EDTA) to determine other biochemical constituents by using commercial kits produced by Diamond Diagnostics Company (29 Tahreer St. Dokki, Giza, Egypt). Plasma and serum samples were obtained by centrifugation of blood at 2500 rpm for 20 minutes and started in the deep freezer at approximately -20°C until used for analysis. Red blood cells count (RBCs $10^6/mm^3$) was calculated according to **(Feldman *et al.*, 2000).** Hemoglobin (Hb) concentration (g/dl) and the percentage of packed cells volume (PCV, %) were measured according to **(Drew *et al.*, 2004).** Blood mean corpuscular volume (MCV, fl), mean corpuscular hemoglobin (MCH, pg), and mean corpuscular hemoglobin concentration (MCHC, g/dl) was calculated according to **(Feldman *et al.*, 2000).**

Plasma total protein (g/dl) was measured according to the guidelines of **Henry *et al.*, (1974).** Plasma albumin (g/dl) was determined according to the method of **Doumas *et al.*, (1971).** Plasma globulin level (g/dl) was calculated by the difference between total protein and albumin since the fibrinogen usually comprises a negligible fraction **(Sturkie, 1986).** Albumin to globulin ratio was also calculated. Plasma glucose concentration (mg/dl) was measured by the method of **Trinder (1969)** using commercial kits (Diamoned Diagnostics). Plasma total lipids by the method of **(Zollner and Krisch, 1962).** Plasma triglycerides by the method of **Fasati** and **Prencipe (1982).** Plasma total cholesterol by the method of

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Stein (1986). Plasma HDL-cholesterol by the method of **Lopez-Virella (1977).** Plasma LDL-cholesterol was calculated according to **Friedewald (1972).** While, very low-density lipoprotein cholesterol (VLDL, mg/ dl) was calculated as concentrations of serum triglycerides divided by 5 [Triglycerides/5] **(Friedewald, 1972).**

Statistical analysis

An analysis of variance was done using a one-way analysis of variance as described by **SAS® (2009).** The replicate was the experimental unit. All percentages were transformed to log10 to normalize the data distribution before analysis. The statistical model for completely randomized design (CRD) with one observation per unit

$Yij = \mu + Ti + eij$
Yij= the dependent variable,
μ = overall mean effect.
Ti = true effect of curcumin and allicin treatments.
eij= error term of the jth unit receiving ith treatment.

The mean difference at $P \leq 0.05$ was calculated using the Duncan test (**Duncan, 1955**). The survival rate was analyzed using the chi-square test (**Miller *et al*., 1982**).

RESULTS

Productive performance

The effect of Curcumin and Allicin on the productive performance of Mandara chickens are presented in Table (2). There was no significance among the experimental groups in initial body weight, final body weight, body weight gain, feed consumption and mortality rate. The results showed significantly improved FCR with curcumin at 100 mg/ kg diet and allicin at 75 mg/ kg diet compared with the other groups of treatments. However, we observed that the curcumin 100 mg/ kg and allicin 75, 100 mg/ kg diet numerically improved survival rate (decreased mortality rate) compared with the other groups.

Table (2). Effect of curcumin and allicin on productive performance of Mandra chickens

Parameters / Treatments	Initial BW, g	Final BW, g	BWG, g	FC, g/bird/day	FCR, g feed/g egg	Mortality (%)
Control	1639	1912	272.7	119.5	5.14[a]	6.67
Curcumin 50 mg/kg	1641	1951	310.2	120.7	4.78[b]	6.67
Curcumin 75 mg/kg	1631	1946	314.7	122.9	4.65[bc]	6.67
Curcumin 100 mg/kg	1635	1951	314.2	123.5	4.13[c]	3.33
Allicin 50 mg/kg	1632	1925	291.6	121.1	4.83[b]	6.67
Allicin 75 mg/kg	1630	1947	317.5	123.4	4.26[c]	3.33
Allicin 100 mg/kg	1639	1923	284.3	120.1	4.56[bc]	3.33
SEM	10.55	11.98	4.221	1.332	0.047	1.223
P value	0.0871	0.0732	0.0971	0.0611	0.0131	0.0762

[a,b,c] Means in the same column with different superscripts differ significantly ($p \leq 0.05$).
FC = Feed consumption; FCR = Feed conversion rate; BW= body weight; BWG= body weight gain; SEM= standard error of mean

Egg production

The results presented in Table (3) indicated that egg production increased in the groups curcumin and allicin at 75,100 mg/ kg diet compared with the other groups. However, the levels of curcumin at 100 mg/kg diet and allicin at 75 mg/kg diet significantly increased egg mass compared with the control group and other groups.

Table (3). Effect of curcumin and allicin on egg production of Mandra chickens

Parameters / Treatments	Egg production %	Egg weight, g	Egg mass, g/hen/ day
Control	55.49[b]	49.63	28.59[c]
Curcumin 50 mg/kg	55.83[b]	50.21	30.58[b]
Curcumin75 mg/kg	59.17[a]	49.56	32.09[ab]
Curcumin 100 mg/kg	58.65[a]	51.38	33.81[a]
Allicin 50 mg/kg	55.91[b]	50.75	30.37[b]
Allicin 75 mg/kg	58.33[a]	51.45	33.32[a]

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Allicin 100 mg/kg	58.13[ab]	50.22	32.79[ab]
SEM	0.875	1.006	0.432
P value	0.0112	0.0621	0.0481

[a,b,c] Means in the same column with different superscripts differ significantly ($p \leq 0.05$). SEM = standard error of mean

Hatchability traits

The effect of curcumin and allicin on the hatchability traits of Mandra chickens is shown in Table (7). Fertility percentage significantly increased in all levels of curcumin and allicin groups at 75,100 mg/ kg diet compared with allicin at 50 mg/ kg diet and the control group. Hatchability percentage significantly increased in all levels of curcumin and allicin compared with the control group. The results indicated that dead embryos significantly decreased in all levels of curcumin and allicin groups (except high dose of curcumin) compared to the control group. There were no significant effects in egg weight, egg piped and chick weight between all experimental groups.

Table (7). Effect of curcumin and allicin on the hatchability traits of Mandra chickens

Treatments \ Parameters	**Egg weight (g)**	**Fertility (%)**	**Hatch (%)**	**Dead embryo (%)**	**Piped (%)**	**Chick. Weight (g)**
Control	50.89	90.72[b]	85.33[b]	2.12[a]	0.75	35.57
Curcumin 50 mg/kg	51.66	91.87[a]	87.33[a]	1.44[b]	0.88	35.89
Curcumin 75 mg/kg	52.03	92.52[a]	89.11[a]	1.41[b]	0.69	36.28
Curcumin 100 mg/kg	51.45	93.54[a]	88.97[a]	1.66[ab]	0.75	36.53
Allicin 50 mg/kg	51.24	90.93[b]	87.81[a]	1.13[bc]	0.68	35.69
Allicin 75 mg/kg	52.22	93.22[a]	89.31[a]	0.89[c]	0.78	36.84
Allicin 100 mg/kg	51.91	92.06[a]	87.81[a]	0.97[c]	0.83	36.46
SEM	1.005	1.001	0.831	0.071	0.015	0.148
P value	0.061	0.031	0.046	0.022	0.092	0.106

[a,b,c] Means in the same column with different superscripts differ significantly ($p \leq 0.05$). Hatch %= Hatchability of total eggs; Piped= an egg in which the chick has broken the shell in an attempt to hatch; SEM= standard error of mean.

Blood constituents

Hematological parameters

Results in Table (4**)** indicated that erythrocytic components, such as red blood cell (RBC) count significantly increased with curcumin at 100 mg/ kg diet and allicin at 75 mg/ kg diet compared with the other groups and the control group. Also, packed cell volume (PCV) significantly increased with curcumin at 75 mg/ kg diet compared with the control group and other groups. while there were no significant differences among different experimental groups in hemoglobin, mean cell volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC).

Table (4). Effect of curcumin and allicin on erythrocytic components of Mandra chickens

Parameters / Treatments	**RBC's ($10^6/mm^3$)**	**Hb (g/dl)**	**PCV (%)**	**MCV (fl)**	**MCH (pg)**	**MCHC (g/dl)**
Control	1.83^{b}	10.21	34.15^{b}	186.7	55.71	29.89
Curcumin 50 mg/kg	2.01^{ab}	11.35	37.62^{ab}	187.2	56.41	30.17
Curcumin 75 mg/kg	2.05^{ab}	11.89	39.74^{a}	193.6	58.01	29.91
Curcumin 100 mg/kg	2.22^{a}	11.75	35.97^{b}	162.1	52.92	32.66
Allicin 50 mg/kg	1.95^{b}	11.03	37.23^{ab}	190.9	56.56	29.62
Allicin 75 mg/kg	2.24^{a}	11.36	36.39^{b}	163.9	51.17	31.21
Allicin 100 mg/kg	2.09^{ab}	11.23	37.27^{ab}	178.3	53.73	30.13
SEM	0.0215	0.197	0.455	3.841	1.017	0.558
P value	0.003	0.168	0.001	0.321	0.119	0.129

[a,b,c] Means in the same column with different superscripts differ significantly ($p \leq 0.05$).
RBCs= Red blood cell count; Hb= Haemoglobin; PCV= Packed cell volume; MCV= Mean cell volume; MCH=Mean corpuscular hemoglobin; MCHC= Mean corpuscular hemoglobin concentration.

Blood biochemical parameters

The effect of curcumin and allicin on the protein profile of Mandra chickens are presented in Table (5). Total protein significantly increased in the groups of curcumin and allicin at 75,100 mg/kg diet compared with the other groups and the control group. The results showed that plasma globulin significantly increased in all levels of curcumin and allicin compared with the control group. There were no significant differences in plasma albumin and albumin/globulin ratio among different groups.

Table (5). Effect of curcumin and allicin on protein profile of Mandra chickens

Parameters / Treatments	**Total protein (g/dl)**	**Albumin (g/dl)**	**Globulin (g/dl)**	**Alb/ Glo ratio**
Control	4.85[c]	2.88	1.97[c]	1.61
Curcumin 50 mg/kg	5.46[ab]	3.15	2.31[ab]	1.36
Curcumin 75 mg/kg	5.77[a]	3.18	2.39[ab]	1.33
Curcumin 100 mg/kg	5.72[a]	3.11	2.61[a]	1.19
Allicin 50 mg/kg	5.32[ab]	3.08	2.24[b]	1.39
Allicin 75 mg/kg	5.79[a]	3.32	2.47[a]	1.34
Allicin 100 mg/kg	5.84[a]	3.28	2.56[a]	1.28
SEM	0.102	0.066	0.0407	0.034
P value	0.004	0.0713	0.001	0.0941

[a,b,c] Means in the same column with different superscripts differ significantly ($p \leq 0.05$).
SEM= standard error of mean

The influence of various levels of curcumin and allicin on plasma glucose and lipid profile is shown in Table (6). The results showed that plasma glucose significantly increased in all levels of curcumin and allicin (except the medium level of allicin) compared with the control group. All levels of curcumin and allicin significantly decreased total lipids, cholesterol and low-density lipoprotein (LDL) compared with the control group. There were no significant effects between the experimental groups on plasma triglycerides, high-density lipoprotein (HDL) and very low-density lipoprotein (VLDL).

Table (6). Effect of curcumin and allicin on serum lipid profile of Mandra

Parameters / Treatments	**Glucose mg/dl**	**TL g/dl**	**Chol mg/dl**	**TG mg/dl**	**HDL mg/dl**	**LDL mg/dl**	**VLDL mg/dl**
Control	157.8[b]	575.5[a]	202.3[a]	153.4	61.33	110.29[a]	30.68
Curcumin 50 mg/kg	176.3[a]	533.1[b]	185.7[b]	147.7	68.13	88.03[bc]	29.54
Curcumin 75 mg/kg	174.4[a]	515.2[bc]	181.7[bc]	137.3	64.24	90.00[bc]	27.46
Curcumin100mg/kg	180.7[a]	501.6[c]	176.9[c]	139.4	67.51	81.51[c]	27.88
Allicin 50 mg/kg	177.3[a]	504.7[c]	186.8[b]	149.5	59.81	93.09[b]	29.90
Allicin 75 mg/kg	169.9[ab]	505.7[c]	178.5[c]	140.4	62.74	83.68[bc]	28.08
Allicin 100 mg/kg	178.6[a]	494.5[c]	166.7[c]	141.2	58.07	76.39[c]	28.24
SEM	1.941	5.074	1.579	1.274	1.049	1.012	0.431
P value	0.0141	0.0378	0.0001	0.0911	0.081	0.0001	0.073

[a,b,c] Means in the same column with different superscripts differ significantly (p≤ 0.05).
TL= total lipids; Chol= cholesterol**;** TG**=** triglyceride HDL=high-density lipoprotein; LDL= low-density lipoprotein; VLDL= very low-density lipoprotein; SEM= standard error of mean.

DISCUSSION

Organic feed additives have the potency to provide antioxidant effects, enhance palatability, improve intestinal health, and increase the growth and development of poultry so that they can produce well **(Saki *et al*., 2014)**. Allicin, a sulfur containing and volatile compound, is found in white garlic and possesses a variety of beneficial biological effects, including antimicrobial, antioxidant, and immunomodulatory activities **(Salehi *et al*., 2019)**. Curcumin is a polyphenolic carotenoid isolated from the rhizome of turmeric (*Curcuma longa*) that has antioxidant, anti-inflammatory, antimicrobial, antiviral, and antifungal properties **(Hussain *et al*., 2017)**.

In the present study, we found that all different levels of curcumin and allicin significantly (P≤0.05) improved FCR compared with the control group. These results agree with **Liu *et al*., (2020)** who studied the effect of curcumin on laying performance under heat stress and found that supplemental curcumin at 150 mg/ kg can improve laying performance and FCR. Used allicin on broiler chicken diet at 25, 50, and 75mg allicin/ kg significantly (P≤0.05) improved final body weight, FCR, protein efficiency ratio, efficiency of energy utilization and performance index when compared with the control **(Elkatcha *et al*., 2016)**. Turmeric powder improves egg production and egg mass in chickens **(Park *et al*., 2012)**. Results indicate that all groups of curcumin and allicin significantly ($P \leq 0.05$) increased egg mass compared with the control group, also egg production significantly increased in the groups curcumin and allicin at 75,100 mg/ kg diet compared with the other groups. On the other hand, **Kosti *et al*., (2020)** showed that turmeric feed did not significantly increase egg production of Leghorn laying hens. The increased health status of chickens in the curcumin and allicin groups, as evidenced by increased survival rate, may be due to the active compounds' antibacterial, antifungal, anti-inflammatory, and antioxidant effects.

The present results showed a significant increase RBCs count and PCV in all groups of curcumin and allicin compared with the control group. Our results agree with **Elkatcha *et al*., (2016)** who reported that allicin supplementation at different levels in broiler chicken ration had increased RBCs, Hb%, PCV%, and improved broiler chicken immune response when compared with the control. In addition, **Adjei *et al*., (2015)** Recorded a significant influence on RBC, Hb, and WBC values when Cobb 500 broiler chickens' diet was enriched with allicin at 0.10 g/kg for 56 d. Curcumin and probiotic supplemented groups presented higher PCV (34.09%, 34.08%), RBCs count (2.49 106/µl, 2.50 106/µl), WBCs count (31.95 103/µl, 31.91 103/µl) and hemoglobin (8.78g/dl, 8.78g/dl) than prebiotic (32.69%, 2.40 106/µl, 31.45 103/µl, 8.48dl) and other groups at 3 weeks old **(Abd El-Samie, 2019)**. On the other hand, **Chandran *et al*., (2022)** showed that adding turmeric rhizome powder to Ross male broiler chicken feed increased hemoglobin, but RBCs were decreased.

All treatment groups of curcumin and allicin significantly increased blood glucose and globulin compared with the control group. Also, total protein increased in the groups of curcumin and allicin at 75,100 mg/kg diet compared with the other groups, but all groups of curcumin and allicin significantly decreased total lipids, cholesterol and LDL compared with the control group. Our results were similar to **Muhammad and Al-Hassani (2022)** who found that different levels of turmeric root powder on broilers exposed to heat stress had significantly increased (P>0.05) total protein, albumin, globulin and HDL, decreased cholesterol, LDL and VLDL concentrations. Bioactive compounds have played a crucial role in improving health and chronic disease prevention. These phenolic compounds including flavonoids, terpenes, curcumin, organosulfur compounds, and various other bioactive compounds present in food serve as antioxidants, anti-inflammatories, and anticancer. The phenolic compounds such as flavonoids present in small quantities in garlic suppress the synthesis of reactive oxygen species, inhibit enzymatic action, and act as chelating agents to prevent the production of free radicals **(Dhalaria *et al*., 2020)**.

The effect of curcumin and allicin on the hatchability traits of Mandra chickens' results showed that fertility percentage increased in all curcumin groups and allicin at 75,100 mg/ kg diet compared with the allicin group at 50 mg/ kg diet and the control group. Also, the hatchability percentage significantly increased in all levels of curcumin and allicin compared with the control group. Curcumin and allicin significantly decreased dead embryos in all groups of allicin compared with the curcumin groups and the control group. This result agrees with **Copur *et al.*, (2011)** indicated that allicin treatment improved the hatchability of fertile eggs and decreased the early, and late embryonic mortalities and contamination rate. The improved hatchability of fertile eggs may be a direct result of decreased microbial contamination of the eggs. Although hatching egg disinfection is often helpful in reducing contamination on the eggshell surface, it is not the only solution and special attention should be paid to producing microbe-free eggs that do not need to be disinfected, less microbial contamination could also aid in the production of cleaner and healthier chicks. The addition of curcumin and its nanoparticles to the extender can improve the fertility rate of different animal species and evaluate the biosafety of these nanoparticles in embryo, fetus, or body after fertilization **(Abd Elnour *et al*., 2020).** Turmeric powder as an additive to diet of Leghorn layers improved hatchability, chick weight, chick length, and yield percentage, compared to the control group. Further studies are suggested on turmeric powder inclusion levels in the diet of layer breeders to achieve the desired outcome in fertility, hatchability, and chick quality traits **(Wakjira *et al*., 2021).**

CONCLUSION

In conclusion, adding curcumin at 100 mg/ kg diet or allicin at 75 mg/ kg diet of laying hens increased the survival rate, egg production, egg mass, improved FCR, hatchability traits, and some blood parameters of Mandra chickens.

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الملخص العربي

تأثير إستخدام مستويات مختلفة من الكوركمين والأليسين علي بعض الصفات الإنتاجية والفسيولوجية لدجاج المندرة المحسن

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استخدم عدد 210 دجاجة وعدد 21 ديك عمر 28 أسبوع من سلالة المندرة وتم توزيعها بشكل عشوائي إلى سبع معاملات متساوية (30 فرخات +3 ديك في كل منها)، بكل معاملة ثلاثة مكررات (10 فرخات +1 ديك في كل مكررة)، المجموعة الأولى الكنترول والمجموعات 2 و3 و4 تناولت عليقة تحتوي على (50، 75، 100 ملجم كوركمين/ كجم عليقة) والمجموعات 5 و6 و7 تناولت عليقة تحتوي على 50، 75، 100 ملجم أليسين/ كجم عليقة) على التوالي، ولوحظ زيادة كتلة البيض معنوياً وتحسن معدل التحويل الغذائي في جميع مستويات الكوركمين والأليسين مقارنة بالكنترول، وزاد معدل إنتاج البيض معنوياً في مجموعات الكوركمين والأليسين المتوسطة والعالية مقارنة بباقي المعاملات بينما زادت معنوياً نسبة الخصوبة في مجموعات الكوركمين والأليسين المتوسطة والعالية مقارنة بمجموعة الأليسين 50 والكنترول، وزادت معنوياً نسبة الفقس وانخفض معنوياً نسبة الأجنة الميتة بالبيض في جميع مجموعات الكوركمين والأليسين مقارنة بالكنترول. زاد معنوياً عدد خلايا الدم الحمراء وحجم خلايا الدم الحمراء وبروتينات الدم الكلية والجلوبيولين في جمبع مجموعات الكوركمين والأليسين مقارنة بالكنترول بينما انخفضت الدهون الكلية والكوليسترول والبروتين الدهني منخفض الكثافة في جمبع مجموعات الكوركمين والأليسين مقارنة بالكنترول.

الخلاصة: يمكن إستنتاج أن إستخدام الكوركمين بمعدل 100 ملجم/ كجم علف والأليسين بمعدل 75 ملجم/ كجم علف حسن من معدل التحويل الغذائي والحيوية ومعدل إنتاج البيض وكتلة البيض ونسبة الفقس وكرات الدم الحمراء لسلالة المندرة.