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EFFECT OF DIETARY INCLUSION OF GALANGAL (*ALPINIA GALANGA*) ON GROWTH PERFORMANCE AND SOME PHYSIOLOGICAL PARAMETERS OF BROILER CHICKS

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ABSTRACT: This study aimed to evaluate the impact of different levels of galangal (*Alpinia galanga*) supplemented diet on productive performance, lipid profile, biomarkers of antioxidant status, carcass traits, economical efficiency, and production index of broiler chicks. A total of 180 unsexed broiler chicks (*Arbor Acres*) at an age of seven-day-old chicks were randomly divided into 5 treatments (36 chicks each) divided into 6 replicates (each replicate of 6 chicks). The first group fed the basal diet (control); while the 2nd, 3rd, 4th, and 5th groups were fed the basal diet supplemented with 0.25, 0.50, 0.75, and 1.00 % galangal, respectively. Data revealed that treatments groups with supplemented different levels of galangal had greater productive performance, economical efficiency, and production index compared to the control group. All treatments with different levels of galangal were decreased total lipids, triglycerides, cholesterol, low-density lipoprotein (LDL), malondialdehyde (MAD), and increased glucose, thyroid hormones (T3-T4), high-density lipoprotein (HDL), total antioxidant capacity (TAC), glutathione peroxidase (GSH-Px), and superoxide dismutase (SOD) compared to the control group (within normal range). In conclusion, it can be considered that galangal supplementation at 0.25% of diet improved the growth performance and physiological status of broiler without any adverse effects on blood parameters of broiler chicks.

Key words: Galangal, Broilers, Performance, Blood biochemical, Antioxidative status.

INTRODUCTION

Diet plays a critical role in the health and productivity of poultry. A large variety of food additives in feed for broiler chickens are used to improve performance. In developing countries, medicinal plants and/or their preparation-derived forms as dietary supplements have become more widely accepted. Spices and herbs can boost broiler health by providing anti-oxidant properties (Hui, 1996), antibacterial action (Dorman & Deans, 2000), and improving digestion by stimulating endogenous enzymes (Brugalli, 2003). As a result, it's critical to assess the negative effects of those plants and their preparations in order to boost human confidence in their safety. Around 6000 plants have been found to have anti-diabetic, and antioxidant properties (Sharma *et al*., 2015). Galangal was native to southeast Asia, where it has been an important part of many Asian cultures. Traditionally, galangal is used as a flavoring spice in the cuisines of Thailand, Indonesia, Malaysia, and China (Trakranringgsie *et al*., 2014). It is a plant in the ginger family (*Zingiber officinale*), has a long history of medicinal and culinary uses. The entire plant contains many beneficial properties. But the most commonly used portion is the rhizome or mass of roots. It is rich in phenolic compounds such as flavonoids and phenolic acids (Pahwa *et al*., 2016).

Galangal is reported to be rich in essential oils such as cineole, methyl cinnamate, myrecene, and methyl eugneol and is also said to contain various flavones such as galangin, alpinin, kampferide and 3-dioxy-4-methoxy flavone (Cui, 2003). The galangal rhizome is effectively used as a therapeutic treatment for various diseases, because it contains anti-bacterial, anti-fungal, anti-inflammatory, anti-hepatotoxic, antioxidants (Khare, 2007). Some studies have revealed that galangal has antibacterial capabilities due to its lipophilic component, according to some researchers (Valenzuela-Grijalva *et al*., 2017). It may contain antibiotic metabolites, such as carboxylic acid, 2, 4-diacetyl phloroglucinol, and cell wall-degrading enzymes and chattiness (Cheah and Abu Hasim, 2000). The antioxidant action of galangal, according to Zhao *et al*. (2010), is attributable to the presence of polyphenols, anthocyanin, glycosides, and thiocarbamates, which scavenge free radicals. Galangal also has a strong antioxidant capacity due to a combination of polyphenolic components (Ibrahim *et al*., 2011; Das & Santhy, 2015; Pahwa *et al*., 2016 and Abdel-Azeem and Basyony, 2019). The objective of this investigation was to study the impacts of galangal supplementary in broiler diet on productive performance, blood biochemical parameters, antioxidant status, carcass traits, economic efficiency and production index.

MATERIAL AND METHODS

During the months of June to August 2020, the current experiment was conducted at the Animal and Poultry Research Centre (El-Bostan Farm), which is part of the Animal and Poultry Production Department, Faculty of Agriculture, Damanhour University. All treatments and birds care procedures were approved by the Institutional Animal Care and Use Committee in Damanhour University, Egypt. Authors declare that the procedures imposed on the birds were carried out to meet the Directive 2010/63/EU of the European Parliament and of the Council of 22 September 2010 on the protection of animals and birds used for scientific purposes.

Birds and experimental design

A total of 180 unsexed broiler chicks (*Arbor Acres*) were randomly divided into five experimental treatments when they were one week old and weighed an average of 178.8 g body weight (BW) with (36 chicks each) for 42 days of age. Each treatment was subdivided into 6 replicates (6 chicks each). The first treatment was fed the basal diet without any supplementation (control), while the 2^{nd}, 3^{rd}, 4^{th} and 5^{th} treatments were supplied with different levels (0.25, 0.50, 0.75, and 1.00 %) of galangal, respectively. Ad libitum feed and freshwater were provided. The galangal material used in the experiment was obtained in powder form from a commercial source in Damanhour City, Beheira Governorate, and analyzed in the laboratory, the most important major compounds are shown in Table (1). The experimental diets were formulated according to NRC (1994). During the starter (7-21 d) and grower stages (22-42d), chicks were fed a basal diet comprising (22.9and 21.4%) of crude protein and (3042 and 3103 kcal/kg) of metabolizable energy, respectively.

Housing and management

In an open system house, chicks were housed in breeding pens. They were given a conventional light regimen that was suggested for commercial broiler chick-rearing, with 23 hours of light during the first week and 20 hours of light from the second week until the end of the fattening period. All chicks were incubated at 33°C upon arrival, then gradually decreased to 30-27°C during the second week and with the use of fans, an average temperature of 24 -26°C was maintained from 3 to 6 weeks of age.

Data collection

Performance parameters including individual live body weight (LBW, g), body weight gain (BWG, g), and feed consumption (FC, g) were recorded throughout the trial period (1-6 wk of age). For each replicate within treatment groups, feed conversion ratio (feed/gain ratio, FCR) was calculated according to the formula:

FCR = FC (g) /BWG (g).

The economic efficiency of experimental diets was estimated by (Zeweil, 1996) as the ratio between income and total feed cost during the experimental growth period. The price of the diets and galangal supplements was calculated according to the local market price at the same time as the experiment in 2020 by the Egyptian pound (L.E.).

Economic efficiency = (Net revenue/ Total feed cost) * 100

$$\text{Economic } efficiency = \frac{\text{Total revenue} - \text{Total cost}}{\text{Total cost}} \times \mathbf{100}$$

Net revenue = Total revenue - Total feed cost.

Total revenue: the selling price of the obtained live weight

*= live body weight of broiler chicks * Price per kg (20.0 LE).*

Total feed cost: the feed cost

= Total feed consumption x feed Price per kg (6.00 LE).

European Production Efficiency Index (EPEI) was calculated by guide (1999).

$$\mathbf{EPEI} = \frac{\mathbf{BW\ (kg)}\,x\ \mathbf{SR}}{\mathbf{PP}\ x\ \mathbf{FCR}}\ x\ \mathbf{100}$$

Where:

BW = Body weight (kg), SR = Survival rate (100% - Mortality), PP = Production period (days), FCR = Feed conversion ratio (kg feed / kg gain).

Six chicks from each treatment were chosen at random for slaughter after 12-hour fastening at the end of the trial (42 days of age). Before slaughter, 3 mL of blood was drawn from the wing vein and placed in un-heparinized vacuum tubes. Coagulated blood samples were centrifuged for 15 minutes at 4000 rpm, and the clear serum was extracted and stored at -20°C until biochemical analysis. According to Fossati & Prencipe's (1982), serum total lipids and serum triglycerides concentrations were tested using specific kits from CAL-TECH Diagnostics, INC, (CAL) Chino, California, U.S.A. According to the recommendations of Bogin & Keller (1987), serum total cholesterol was estimated using the specific kits, high-density lipoprotein (HDL) was measured according to the method outlined by Lopez-Virella (1977), and low-density lipoprotein (LDL) was calculated by the formula of Friedewald *et al*. (1972). Serum glucose concentration was measured by the method of Trinder (1969). Serum concentration of total tri-iodothyronine (T_3) and thyroxin (T_4) was assayed by radioimmunoassay technique using the kit from Diagnostic Products Corporation, Los Angeles, USA. The activity of malondialdehyde (MDA) in the blood was measured using the method reported by Placer *et al*. (1966). The calorimetric method of Koracevic *et al*. (2001) was used to assess blood total antioxidant capacity (TAC). Serum glutathione peroxidase activity was determined according to the colorimetric method of Bauer (1982). Misra & Fridovich (1972) method for measuring serum superoxide dismutase (SOD) was used.

Six chicks from each treatment were chosen at random at the end of the experiment and slaughtered after a 12-hour fastening period to determine carcass characteristics. Abdominal fat was removed from the gizzard and abdominal region, and each carcass was individually weighed and estimated relative to the pre-slaughtered weight. Individual lymphoid organs (spleen, thymus, and bursa) were removed, weighed, and the weight of each organ was estimated relative to the pre-slaughtered weight.

Statistical analysis

Data were subjected to the one-way ANOVA procedure using statistical analysis system (SAS, 2002) with the following model:

$$Yij = \mu + Ti + eij$$

Where Yij = is the dependent variable; μ= the general mean; T= the fixed effect of treatment and eij = random error. The difference among means was determined using Duncan's new multiple range test (Duncan, 1955) at $P<0.05$.

RESULTS AND DISCUSSION

Productive performance traits

Data from Table (2) shows that varying levels of galangal supplementation resulted in a significant ($P\leq0.05$) increase in body weight (BW) at 6 weeks of age and body weight gain (BWG) from 1-6 weeks of age. Overall, galangal treatments raised BW by 13.4, 9.2, 8.6, and 13.0 % of the control value with the 0.25, 0.50, 0.75, and 1.00 % treatments, respectively, with the best BW being at the levels of 0.25 and 1.00 %. BWG was increased in a level-dependent way ($P=0.001$), and a similar trend was seen with BW, which reached 114.5, 109.9, 109.3, and 114.0 % of the control group, respectively. It is clear from the data analysis of variance that different levels of galangal, overall chick feed consumption was lowered significantly ($P=0.0001$), reaching 93.6, 93.0, 92.1, and 93.7 % of control chicks, respectively. The improvement in weight gain associated with the reduction in feed consumption resulted in a significantly (P=0.001) improved FCR (Table 2), the 0.25, 0.50, 0.75, and 1.00 % treatments enhanced FCR by 17.9, 15.3, 15.8, and 17.4%, respectively, compared to control group, with the best FCR observed at the 0.25 and 1.00 % levels. The results obtained in this study corresponded with the results of Viveros *et al*. (2011) found that these components present in the galangal rhizomes stimulate digestive enzymes and improve overall digestion and thus lead to increased body weight. Also, Srividya *et al*. (2010) suggested that this positive effect on the performance traits of laying chickens due to galangal supplementation may be because it improves intestinal enzymes (glucase, oxidase, catalase, and peroxidase) that may be associated with better digestibility of different nutrients. Ibrahim *et al*. (2011) reported that galangal has strong antioxidants and stimulates the body's immunity process; this may increase the growth performance and health status of laying hens that are reared under heat stress conditions.

Blood constituents

Data from Table (3) shows the chick's blood analysis, where it is noted that when compared to the control group, serum glucose levels were increased significantly (P=0.001) with galangal treatments, reaching 115.5, 117.4, 118.7, and 118.1 %, respectively. The energy source of the cell is glucose, which is absorbed in the intestine and transferred to different tissues. The interaction of multiple hormones, including glucagon, pancreatic polypeptide, insulin, and thyroxine, is responsible for most of this regulation. These hormones have the ability to regulate glucose metabolism (Lovita, 2013). With galangal treatments, both triiodothyronine (T3) and thyroxin (T4) levels increased significantly while keeping a stable ratio (P =0.004 and 0.002, respectively). With the four galangal levels, the increase was by 24.6, 23.6, 13.1, and 26.1 % in T3 and by 25.3, 17.5, 11.3, and 27.2 % in T4. This finding is in harmony with the findings of Tao *et al*. (2006) reported that thyroid hormones influence nearly all major metabolic pathways. Thyroid hormones stimulate lipid substrates' utilization due to an increased mobilization of triglycerides stored in adipose tissue that can explain the lower lipids profile observed in this study with different levels of galangal.

Significant differences were observed in Table (4) shows the data of the impact of galangal different levels on the lipid profile of chicks. Different levels of galangal inclusion in the diets appeared to considerably reduce serum concentrations of total lipids, cholesterol, triglycerides, and low-density lipoprotein (LDL). The level of high-density lipoprotein (HDL) was unaffected by any of the treatments. Galangal treatments significantly (P=0.002) reduced serum total lipids by 9.5, 9.8, 10.3, and 9.5 % compared with the control group. A similar trend was observed with cholesterol, triglycerides, and LDL (P=0.002, 0.001, and 0.003 respectively) as they were reduced by 14.0, 12.5, 14.7, and 13.2 % and by 9.4, 10.4, 8.3, and 15.6 %, and also 11.3, 7.0, 15.5, and 7.0 % compared with the control group. These findings back up those of Teissedre & Waterhouse (2000) galangal rhizomes extracts have been shown that the phenolic components inhibit LDL oxidation very effectively. He *et al*. (2009) reported that adding *Alpinia galanga* rhizomes extracts to a broiler's diet reduced blood triglyceride levels by dampening the formation of triglyceride compounds in the early work of glycerol-3-phosphate derived from glycerol, dihydroxyacetone phosphate (GPDH), and NADH to assist in the production of triglyceride-3-phosphate and decreased glycerol-3-phosphate (GPDH) activity in triglyceride biosynthesis. Moreover, Akbari & Torki (2014) indicated that high antioxidant concentrations could reduce lipid peroxidation and thus decrease the serum triglyceride concentration. Galangal has a wide range of active compounds including alkaloids, flavonoids, saponins, atsiri oils, terpenoids, and quinone. By inhibiting the enzyme 3-hydroxy-3-Metilglutaril-CoA (HMG-CoA reductase), which plays a role in cholesterol synthesis, as well as the LDL receptor through SERBP, flavonoids and essential oils can decrease cholesterol biosynthesis and absorption (Sunarto, 2012; Lovita, 2013 and Abdel-Azeem & Basyony, 2019). Saponins and tannins also have a role in cholesterol uptake suppression by inhibiting lipase activity, binding cholesterol, and lowering surface tension by the action of saponin binding cholesterol in the gut lumen, which influences fat metabolism in the body (Morehouse *et al*., 1999).

Table (5) shows the effect of galangal supplements on antioxidant levels in the blood serum of treated broiler chicks. Galangal treatments enhanced blood total antioxidant capacity (TAC) by 11.0, 8.3, 9.8, and 7.3 % with the four levels, respectively compared with the control group. Glutathione peroxidase activity (GSH-Px) and superoxide dismutase (SOD) (P=0.001 and 0.001, respectively) increased by 9.1, 11.6, 12.3, and 11.2 % and 23.9, 22.9, 25.4, and 18.9 % compared with the control group with the four levels of galangal, respectively. On the other hand, Galangal therapies had a substantial (P=0.001) effect on blood malondialdehyde (MDA) levels. When compared to the control group with the four levels of galangal, blood malondialdehyde was reduced by 14.7, 21.8, 12.4, and 21.2 %, respectively. These findings corroborate those of Chudiwal *et al*. (2010) reported that flavonoids have been found in the galangal rhizome. As a result, it's thought to have a higher concentration of anti-oxidant compounds than other herbal plants. Furthermore, the polyphenolic composites can clean up free radicals and reduce membrane lipid peroxidation, lowering the risk of free radical-related disorders (Surveswaran *et al*., 2007). Abdulmajeed (2011) findings, which showed that rats fed aqueous extracts containing galangal rhizomes had lower serum MDA levels. As a result, galangal rhizome extract may be appealing antioxidants as well as new antioxidant supplies in animal nutrition (Valenzuela-Grijalva *et al*., 2017). Al-Snafi (2015), Sharma *et al*. (2015), and Abdel-Azeem & Basyony (2019) found that total phenols, carotenoids, flavonoids, tannins, and saponins are well-known antioxidants. Furthermore, the subsequent authors added that polyphenols from galangal rhizomes are effective components in modulating redox homeostasis in chickens.

Table (6) summarizes the effects of galangal treatment on carcass characteristics in broiler chicks at the end of the study period. Overall, galangal treatments enhanced the percentage of the carcass by 7.7, 6.8, 3.8, and 3.2 % of the control group with 0.25, 0.50, 0.75, and 1.00 % treatments, respectively, with 0.25 % treatment having the best percentage of the carcass.

With the 0.25, 0.50, 0.75, and 1.00 % treatments, overall chick abdominal fat (%) was considerably reduced (P=0.001), reaching 37, 8, 56.1, 47.6, and 39.0 % of control group chicks, respectively. The percentage of lymphoid organs (spleen, thymus, and bursa) increased non-significantly (P=0.066, P=0.099, and 0.077, respectively), indicating that immune characteristics have improved. These findings are consistent with those of Lovita (2013) found that a dietary galangal rhizome supplement of 0.5 and 1.0 % increased dressing percentages, carcass pieces, and carcass weight among each studied carcass characteristic of rabbits. Furthermore, the obtained results are consistent with the broiler study. Valenzuela-Grijalva *et al*. (2017) found that the addition of extracted galangal in broiler diets affects the percentage of abdominal fat compared to the control group.

Results of economic efficiency in Table (7) shows the total revenue, net revenue (NR), economic efficiency, relative economic efficiency (%), and European Production Efficiency Index (EPEI) that were used to assess the economic viability of various levels of galangal. Supplementing with galangal in the nutritional programs altered net revenue, which is represented by the equation NR = total revenue - total feed cost, indicating that net revenue increased as dietary nutrient levels increased by supplementing with galangal. The lower level galangal 0.25 % produced the best economic efficiency and relative economic efficiency (%) compared to the other treatments. Therefore, this level seems to be economically viable to increase galangal levels in the diet of broilers.

However, this depends on the market price of corn, soybean meal, and soybean oil at the time of feed formulation, as these were the feedstuffs which levels were most increased in the diets and that most affected the economic indices, but the addition of galangal has improved total revenue, NR, economic efficiency, relative economic efficiency (%) and EPEI. Therefore, it is advised to include these ingredients in the poultry diet to improve performance and health status, which will benefit the owners of commercial farms to raise the economic value.

CONCLUSION

It may be concluded that feeding galangal to broiler chicks, especially at 0.25 %, improves their physiological status and performance, as seen by increased body weight gain and feed utilization. This enhancement was also seen in the blood biochemical parameters of the chicks, indicating improved antioxidative status. Furthermore, greater thyroid hormone levels can be expected to result in improved metabolic functions.

Table (1): The most important major compounds of powder galangal

Proximate analysis of galangal	**%**
Crude protein	8.26
Carbohydrate	55.51
Ash	8.51
Crude fiber	6.98
Oils	13.3
Antioxidant fractions content of galangal	
Total phenols	9.52
Carotenoids	0.53
Total flavonoids	5.70

Table (2): Effect of dietary inclusion with different levels of galangal on productive performance of broiler chicks

Dietary supplementations	**BW 1 Wk.**	**BW 6 Wks**	**BWG (1 – 6 Wks)**	**FC (1 – 6 Wks)**	**FCR (1 – 6 Wks)**
Control	177.10	2107.10[b]	1930.20[b]	3676.87[a]	1.90[a]
Galangal 0.25%	180.10	2390.11[a]	2210.90[a]	3441.54[b]	1.56[b]
Galangal 0.50%	179.20	2300.10[a]	2121.77[a]	3420.90[b]	1.61[b]
Galangal 0.75%	178.10	2288.23[a]	2110.67[a]	3385.12[b]	1.60[b]
Galangal 1.00%	180.10	2360.40[a]	2180.90[a]	3443.34[b]	1.57[b]
SEM	3.57	119.81	88.91	83.21	0.637
P value	0. 188	0.002	0.001	0.0001	0.001

[a,b] Means in the same column followed by different letters are significantly different at $p \leq 0.05$.
SEM; Standard error of mean.
BW: Body weight, BWG: Body weight gain, FC: Feed consumption, FCR: Feed conversion ratio.

Table (3): Effect of dietary inclusion with different levels of galangal on some blood biochemical parameters of broiler chicks

Dietary supplementations	Glucose (mg/dl)	Thyroid hormones	
		T3 (ng/dl)	T4 (ng/dl)
Control 0 %	155.11[b]	1.99[b]	3.71[b]
Galangal 0.25%	179.23[a]	2.98[a]	4.86[a]
Galangal 0.50%	182.89[a]	2.96[a]	5.76[a]
Galangal 0.75%	184.90[a]	3.06[a]	5.83[a]
Galangal 1.00%	183.89[a]	2.25[a]	5.89[a]
SEM	1.15	1.91	0.46
P value	0.001	0.004	0. 002

[a,b] Means in the same column followed by different letters are significantly different at $p \leq 0.05$.
SEM; Standard error of mean. T3: Triiodothyronine, T4: Thyroxine.

Table (4): Effect of dietary inclusion with different levels of galangal on serum lipids profile of broiler chicks

Dietary supplementations	Lipids profile				
	Total lipids (mg/ dl)	Cholesterol (mg/ dl)	Triglycerides (mg/ dl)	HDL (mg/ dl)	LDL (mg/ dl)
Control	448.09[a]	236.22[a]	166.11[b]	60.90	141.90[a]
Galangal 0.25%	342.00[b]	207.07[b]	187.90[a]	56.62	113.01[b]
Galangal 0.50%	341.01[b]	208.09[b]	186.88[a]	54.91	116.09[b]
Galangal 0.75%	339.12[b]	206.09[b]	188.12[a]	57.52	110.00[b]
Galangal 1.00%	342.10[b]	208.01[b]	181.09[a]	55.83	116.02[b]
SEM	93.91	20.31	88.71	0.68	29.17
P value	0.002	0.002	0.001	0.062	0.003

[a,b] Means in the same column followed by different letters are significantly different at $p \leq 0.05$.
SEM; Standard error of mean. HDL: High-density lipoprotein, LDL: Low-density lipoprotein

Table (5): Effect of dietary inclusion with different levels of galangal on indicators of antioxidative status in serum blood of broiler chicks

Dietary supplementations	Indicators of antioxidative status in blood			
	MDA (мg/ml)	TAC (nmol/L)	GSH-Px (mmol/L)	SOD (U/ml)
Control	170.98[a]	400.01[b]	881.01[b]	201.10[b]
Galangal 0.25%	145.01[b]	444.09[a]	961.11[a]	249.22[a]
Galangal 0.50%	133.31[b]	433.03[a]	983.09[a]	247.31[a]
Galangal 0.75%	149.09[b]	439.10[a]	989.20[a]	252.10[a]
Galangal 1.00%	134.11[b]	429.11[a]	980.87[a]	239[.65a]
SEM	5.981	3.34	2.86	1.59
P value	0.001	0.001	0.001	0.001

[a,b] Means in the same column followed by different letters are significantly different at $p \leq 0.05$.
SEM; Standard error of mean. MDA: Malondialdehyde, TAC: Total antioxidant capacity, GSH-Px; glutathione peroxidase

Table (6): Effect of dietary inclusion with different levels of galangal on carcass traits and lymphoid organs of broiler chicks.

Dietary supplementations	Carcass traits		Lymphoid organs		
	Carcass (%)	Abdominal fat (%)	Spleen (%)	Thymus (%)	Bursa (%)
Control	68.71[b]	0.817[a]	0.373	0.427	0.257
Galangal 0.25%	74.10[a]	0.307[b]	0.383	0.530	0.303
Galangal 0.50%	73.24[a]	0.463[b]	0.322	0.627	0.263
Galangal 0.75%	71.33[a]	0.387[b]	0.400	0.547	0.240
Galangal 1.00%	70.89[a]	0.320[b]	0.390	0.521	0.266
SEM	2.98	0.091	0.780	0.041	0.031
P value	0.001	0.001	0.066	0.099	0077

[a,b] Means in the same column followed by different letters are significantly different at $p \leq 0.05$.
SEM; Standard error of mean.

Table (7): Effect of dietary inclusion with different levels of galangal on the economic efficiency of broiler chicks

Items	Galangal levels					SEM	*P value*
	0.0 %	**0.25%**	**0.50%**	**0.75%**	**1.00%**		
Chicks price (L.E)	5.00	5.00	5.00	5.00	5.00	--	--
FC (kg/chick)	3.67	3.44	3.42	3.35	3.44	83.21	0.0001
Price/kg (L.E)	6.00	6.00	6.00	6.00	6.00	--	--
Feed cost L.E/Kg + feed additive	22.02	21.15	21.52	21.23	22.64	--	--
Body weight gain (kg/chick)	1.93^{b}	2.21^{a}	2.12^{a}	2.11^{a}	2.18^{a}	1.05	0.001
Price/kg (L.E)	20.00	20.00	20.00	20.00	20.00	--	--
Total Revenue (L.E)	38.60^{b}	44.20^{a}	42.40^{a}	42.20^{a}	43.60^{a}	0.07	0.087
Net Revenue (LE)	16.58^{c}	23.05^{a}	20.88^{b}	20.97^{b}	20.96^{b}	2.98	0.001
Economic efficiency	75.45^{c}	108.93^{a}	97.02^{b}	98.77^{b}	92.57^{b}	11.91	0.001
Relative economic efficiency (%)	100	144.37	128.58	130.12	122.77	--	--
Production index	269.23^{c}	396.83^{a}	370.30^{b}	373.38^{b}	368.70^{b}	22.91	0.001

^{a,b} Means in the same column followed by different letters are significantly different at $p \leq 0.05$
SEM; Standard error of mean.

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الملخص العربي

تأثير الاضافة العلفية لنبات الخولنجان على أداء النمو وبعض الصفات الفسيولوجية لكتاكيت التسمين

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أجريت هذه الدراسة في وحدة بحوث الدواجن بمزرعه البستان، قسم الانتاج الحيواني والداجني، كلية الزراعة - جامعة دمنهور خلال الفترة من يونيو حتي أغسطس ٢٠٢٠ وكان الهدف منها تقييم التأثيرات الناتجة عن إضافة مستويات مختلفة من نبات الخولنجان علي الصفات الانتاجيه وخصائص الدم وميتابولزم الدهون والخصائص المضادة للأكسدة لكتاكيت اللحم تم استخدام ١٨٠ من كتاكيت اللحم عشوائيا بداية من عمر أسبوع وحتى عمر ٦ اسابيع واستخدمت خمسه معاملات تجريبيه بكل معاملة ٣٦ طائر في سته مكررات بكل منها ٦ كتاكيت علي النحو التالي: المجموعة الاولى هى الضابطة (الكنترول) وكانت بدون إضافات؛ والمعاملات الاربعه الاخري تغذت على العليقه الأساسيه مع اضافه الخولنجان بمستويات ٠,٢٥- ٠,٥٠- ٠,٧٥ – ١% علي التوالي. أظهرت النتائج حدوث زيادة معنوية في وزن الجسم الحي ومعدل الزيادة في وزن الجسم مع انخفاض معدلات استهلاك العلف مع تحسن في الكفاءة الغذائية والكفاءة الاقتصادية في المجموعات التي غذيت علي المستويات المختلفة من الخولنجان بالمقارنة بمجموعة الكنترول. كما أظهرت النتائج انخفاض معنوي في مستوي الدهون الكلية في الدم و الكوليسترول وكذلك انخفاض في مستوي LDL في المجموعات المغذاة علي مستويات الخولنجان المختلفة. لوحظ أيضا وجود زيادة في مستوي جلوكوز الدم وفي تركيز هرمونات الغدة الدرقية وأيضا تحسن في مستوي انزيمات الاكسدة المختلفة في سيرم الدم في المجموعات المغذاة علي الخولنجان بالمستويات المختلفة. وبالمثل تحسنت حالة مضادات التأكسد للطيور من واقع زيادة مستوى انزيم (SOD) والجلوتاثيون (GSH) والجلوتاثيون بيروكسيديز والقدرة الكلية المضادة للأكسدة وتم تقدير الكفاءة الاقتصادية.

وقد خلصت نتائج الدراسة إلي أن إضافة المستويات المختلفة من الخولنجان كان لها تأثير ايجابي ومعنوي على الأداء الإنتاجي وقياسات الدم والخصائص المضادة للأكسدة لدجاج اللحم وكانت افضل معامله هي ٠,٢٥% افضل نسبة اضافة من الناحية الاقتصادية.