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SOME BLOOD BIOCHEMICAL, ANTIOXIDANT BIOMARKERS, LIPID PEROXIDATION, PRODUCTIVE PERFORMANCE AND CARCASS TRAITS OF BROILER CHICKS SUPPLEMENTED WITH ALPINIA GALANGAL RHIZOMES EXTRACT DURING HEAT STRESS

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ABSTRACT: One thousand one-day-old Cobb broilers were randomly allotted to four dietary groups to study the influences of various levels of nutritional supplementation of *Alpinia* galangal rhizomes extracts (AGRE) on blood biochemical components, antioxidant status biomarkers, lipid peroxidation, productive performance, and carcass traits of broilers beneath summer circumstances. The control set was fed a standard diet free of AGRE; the trial groups obtained the standard diet besides 250, 500, and 750 mg AGRE /kg. The trial time continued for six weeks. The obtain results showed that, in groups, 500 AGRE and 750 AGRE, plasma globulin, albumin, and total protein were significantly augmented. However, all levels of AGRE supplementary diets revealed significantly decreased in the plasma total cholesterol, triglycerides, low-density lipoproteins, and total lipids. Total antioxidant capacity, glutathione S -transferase, superoxide dismutase, catalase, and glutathione peroxidase were significantly augmented by supplementing nutritional AGRE, respectively. In contrast, malondialdehyde was lowered with rising AGRE levels. Chickens of group 750 AGRE had the lowest mortality and also, the most effective feed conversion ratio and body weight gain. Percentage of dressing, breast, and thigh significantly augmented for chicks consumed different levels of AGRE. Also, the group fed on AGRE recorded the highest abdominal fat compared with control group. Additional, liver, heart and gizzard weights were increased significantly in the group of chickens that received different levels of AGRE as compared with the control group. Ascending levels of AGRE supplementary in broiler diet affected the carcass meat, which was noticed an increase in crude protein, moisture and ether extract in breast meat compared to the control group. However, ascending levels of AGRE supplementary caused downward in crude protein contents of thigh meat compared to the control group. The present findings revealed that all tested levels of AGRE supplementations were useful against heat stress to downgrade the adverse effects of heat stress in broilers.

Key words: Alpinia galangal-Antioxidant-blood- broiler performance- carcass- heat stress.

INTRODUCTION

In Egypt, summer temperature increases to more than 40 C^{o}, broiler chickens are confronted with heat stress, which has harmful influences on their homeostasis and affects their production and growth rate. Heat stress is additionally mirrored in numerous physiological traits and leads to large economic harms (Kapetanov *et al.*, 2015). The negative impact of heat stress influences the performance of broiler and leads to an increment in oxidative stress (Quinteiro-Filho *et al.*, 2012, 2010), which may inhibit illness impedance and damages antioxidant status. Lately, it appeared that phenolic compounds in broilers have useful effects associated with antimicrobial, antioxidant, and anti-inflammatory activities (Eumkeb, *et al.*, 2011).

These compounds are found in herbal plants Galanga (*Alpinia* Officinarum) is one of the most important herbal plants in Egypt. The plant cultivates from rhizomes in bunches of rigid stems up to 2 m in height with plentiful lengthy leaves that tolerate red fruit. It is native to Indonesia and South Asia, and cultivated in Malaysia, Laos, Thailand, and Egypt.

Alpinia Officinarum is the galanga consumed the majority in cooking. *Alpinia* galanga rhizome comprises the flavonol galangin (Al-Adhroey *et al.*, 2010). The rhizome comprises oil, called galangol that upon partial percolation produces cineol, which has therapeutic properties, eugenol and pinene (Ali *et al.*, 2017). Galanga rhizome contains approximately 50% carbohydrates, 3-6% crude fiber, and ash, 9% protein and free amino acids, and 6-8 % fatty acids and triglycerides (on dry matter basis) depending on variety, geography, and climatic conditions (Tang and Eisenbrand, 1992). Galanga rhizome extract (AGRE) contains a number of volatile oil ranged about 48% methyl cinnamate, 20-30% cineole, α-pinene, β-pinene and camphor (Jirovetz, *et al.*, 2017 and Charles *et al.*, 1992) diarylheptanoids, and Flavonoids (Zhao *et al.*, 2010 and Tao *et al.*, 2006), phenylpropanoids (Ly *et al.*, 2002), have been stated so far. In contrast, jointly of the necessary secondary metabolites and bioactive substances within the plant, total polyphenols from galanga rhizomes was up to 13.43 mg/g beneath this condition as ethanol concentration sixtieth percentage, extraction time one hour, extraction temperature thirty C^{o} and ratio of liquid to material 15:1 (Li and Xu, 2015).

These components are considered powerful free radical scavengers (Kambar *et al.*, 2014). Galanga rhizome extract is rich in β-Sitostero, l Diarabinoside (Fuloria and Fuloria, 2012), β-sitosterol diglucosyl caprate, (Jaju *et al.*, 2010). Galangoflavonoside, and 1-Acetoxychavicol acetate (Jaju, *et al.*, 2009). The rhizome also contains flavonoids, some of which have been identified as kaemperol, kaempferide, galangin, and alpinin. Hence, it is thought as a better supply of anti-oxidative ingredients than other herbs plant (Chudiwal *et al.*, 2010). Therefore, Galanga rhizome extract may be enticing antioxidants and also, in animal nutrition as new antioxidant supplies (Valenzuela-Grijalva *et al.*, 2017).

The objective of this investigation was to study the impacts of AGRE supplementary in broiler diet on biochemical components of the blood, biomarkers of antioxidant status, lipid peroxidation, some productive performance (growth performance and mortality rate), and carcass traits of broilers under heat stress conditions.

MATERIALS AND METHODS

Experimental design

In a simple randomized design experiment, a thousand unsexed one - day Cobb commercial broilers were weighed, wing-banded, and randomly allotted into four trial groups (n = 250 in every group). The control group was fed a diet free AGRE; the trial groups were fed the same diet besides 250, 500 and 750 mg AGRE/Kg (groups 250 AGRE, 500 AGRE, and 750 AGRE, respectively). The trial time continued for six weeks (between one day and the age of 42 days).

Birds management

Chickens were raised in a well - ventilated building; stainless steel nipples fixed in each cage automatically made fresh water available all the time. In accordance with the traditional program used for broilers, the chicks were vaccinated versus prevalent broiler diseases. In the house, the minimum and maximum temperatures, relative humidity, and temperature-humidity index ranged from 26.5 to 33.5 C°, 62 to 75% and 87.5 to 93.5, respectively, during the experimental period (June to July 2018). That means the broilers were under severe heat stress throughout the trial period as described in the LPHSI (1990).

Preparation of *Alpinia galangal* rhizome extract

Galanga plants were obtained from different regions which were grown in El-Wahat El-Bahariya, Egypt. The humidity of Galanga rhizome was reduced by sun-drying to 9-10%, and then ground by a hammer mill and kept for subsequent processing. A hammer mill grounded the seeds to get a fine powder. Dry rhizome powder was extracted at room temperature for 24 h in lots of 10 g with 100 ml ethanol (70 percent). The extract was centrifuged for 20 min at 1500 g and filtered, and GSE was then obtained by freezing as a lyophilized powder and stored at 4 C° until the test was performed (Macedonia, 2005). Chemical analysis of galanga (*Alpinia* Officinarum) rhizome extract was detected in Table 2.

Blood samples and biochemical param eters determination

Blood samples (5 ml of each chick) were collected during slaughter to determine biochemical components of the blood (fifty chicks from each pen). By centrifugation at 1000 x g for 20 min, plasma was separated from the blood and stored at−20 ° C until it was tested. A spectrophotometer (Spectronic 21 DUSA) was used to measure total plasma protein, albumin, glucose, total cholesterol, low - density lipoprotein (LDL) and high - density lipoprotein (HDL), triglycerides and total lipids using commercial diagnostic kits (Combination, Pasteur Lap.) as instructed by the manufacturers. According to (Orsonneau, *et al.*, 1989) and (Doumas *et al.*, 1971), total protein and albumin were determined, respectively. The concentration of plasma globulin was calculated by the difference between total protein and albumin, calculating the albumin / globulin ratio. According to Trinder (1969) and Wahlefeld (1974), glucose and triglycerides were determined, respectively. Plasma cholesterol, LDL - and HDL - cholesterol based on the Lopez - Virella et al, (1977) method to determine the previous traits. Total lipids were determined by the described method (Frings and Dunn, 1970).

Biomarkers of antioxidant status and lipid peroxidation

Activities of blood plasma malondialdehyde (MDA) and glutathione peroxidase (GPx) were tested using the Chiu *et al.* (1976) method. According to Misra and Fridovich (1972), the activity of superoxide dismutase (SOD) was tested. Based on (Koracevic *et al.*, 2001) method total antioxidant capacity (TAC) was determined, also, activities of glutathione S-transferase (GST) and catalase (CAT) were measured according to by (Habig *et al.*, 1974) and (Aebi, 1984), respectively.

Slaughtering and carcass traits

On day 42, fifty chicks from each pen were randomly selected, fasted 12 hours before being slaughtered, weighed and slaughtered manually. A percentage of live body weight was calculated as carcass weight (dressing, breast, thigh, empty gizzard, liver, abdominal fat, heart). Chemical meat analyzes were performed in accordance with (AOAC, 2005) and DM values were expressed.

Chemical analysis

Chemical feed analysis was carried out in accordance with AOAC recommendation (2005). The fractions of phenolic compounds, flavonoid compounds and 2, 2-diphenyl-1-picrylhydrazyl (DPPH) scavenging activity of galanga (*Alpinia* officinarum) rhizome extract have been identified in the Micro Analysis Lab., Food Technology Research Institute, Egypt by A high-performance liquid chromatographic (HPLC). HPLC determined flavonoid compounds using the method of (Mattila *et al.*, 2000), while HPLC determined phenolic compounds (Goupy *et al.*, 1999) as shown in Table 2.

Red AGRE's antioxidant activity was based on its scavenging activity to the stable free radical DPPH, which was primarily determined by the method described (Lee *et al.*, 2004). Table 2 shows the contents of flavonoid and phenolic compounds used in the AGRE in this study. In addition, AGRE contained 13.6% of total flavonoids and 35.39% of total phenols. At concentrations of 25, 50 and 75 mg / kg, respectively, DPPH's scavenging activities in AGRE amounted to 51.4%, 62.2%, and 68.4%..

Statistical analysis

Data were statistically analyzed as a completely randomized design using the general linear model of SAS SAS (2001). Differences between treatment methods were estimated by Duncan (1955) test. The statistical meaning statement was based on ($p<0.05$).

RESULTS AND DISCUSSIONS

Biochemical plasma components

Data of biochemical plasma components indicated that the concentration of total plasma protein, albumin, and globulin in groups 500 AGRE and 750 AGRE were higher (P=0.0001) than in the control group and group 250 AGRE (Table 3). However, there were no significant differences in albumin/globulin ratio and plasma glucose concentration among the experimental groups. Total levels of plasma lipids, cholesterol, and triglycerides (P=0.022, 0.0001 and 0.007) decreased as dietary levels of AGRE increased. Plasma HDL level was ascertained to decrease numerically by adding various levels of AGRE to broiler diet, but this effect was not significant. However, the concentration of LDL (P=0.0024) decreased with increased levels of dietary AGRE.

Plasma proteins are a fraction of the immune response where antibodies are formulated from albumin that is the serum's main protein component. The total protein, albumin, and globulin values found here are similar to those quoted by Ganong (2005). Total plasma protein and globulin of broiler which used 1.0% polyherbal feed premix were significantly higher than those fed synthetic vitamin C 0.1% and control diets as shown (Sujatha, *et al.*, 2010).

In the present work, blood plasma glucose has been witnessed to constantly decrease with increased dietary levels of AGRE. A control blood glucose level (free of *Alpinia* galanga L.) is nearly the same with AGRE 250, AGRE 500, and AGRE 750. Blood glucose will distribute in the blood and steady in the bird, irrespective of diverse dietary levels, according to Lovita (2013). This regulation is largely due to the interaction of many hormone varieties, including thyroxine, insulin, pancreatic polypeptide, and glucagon. These hormones may organize the glucose metabolism. Usually, in the intestinal wall, over a third of glucose is absorbed during a meal and converted to lactate, cushioning the peak inflow.

Blood triglyceride levels on control (free AGRE) are higher than 250 AGRE, 500 AGRE, and 750 AGRE groups. Blood triglyceride level is 35.20 mg/dL, according to Lovita (2013), while the content of triglyceride is 27 mg/dL according to (Sunarto, 2012). Blood triglyceride levels in broiler reduced by adding AGRE to broiler diet for dampening the creation of triglyceride compounds in the early work of glycerol-3-phosphate originated from glycerol, dihydroxyacetone phosphate (GPDH) and NADH to assistance make triglyceride-3-phosphate and decreased glycerol-3-phosphate (GPDH) activity in triglyceride biosynthesis (He *et al.*, 2009). The active component of antioxidant flavonoids is 0.21%; by unleash one hydrogen atom forming and reducing related to one free radical, it will inhibit the first stages of the reaction. This bond can stabilize the radical peroxy that will reduce energy activity and ultimately decrease the triglyceride content (Reynertson, 2007). Declining blood triglycerides also influenced by the content of saponins to retard the absorption of fat in the small intestine by inhibiting lipase activity through the binding mechanism of triglycerides- and saponins in the intestinal lumen and influences the body's fat metabolism (Morehouse *et al.*, 1999).

Alpinia galangal rhizomes extract significantly reduced elevated LDL levels ($p \leq 0.01$) and decreased total lipid levels ($p \leq 0.05$), where HDL levels did not decline significantly. Sujatha, *et al.* (2010) has shown comparable results.

Agreed with Mohamed *et al.*, (2012) stated low cholesterol, triglyceride (TG) and glucose in the ginger diet levels. It has been shown that the phenolic components in AGRE inhibit LDL oxidation very effectively (Teissedre and Waterhouse, 2000). Moreover, Akbari and Torki (2014) indicated that high antioxidant concentrations could reduce lipid peroxidation and thus decrease the serum triglyceride concentration.

In this regard, in a study, Zhang, *et al.* (2009) showed that utilizing the 0.5% extracted ginger rhizome significantly reduced total cholesterol in broilers consistent with these results.

Antioxidant biomarkers

Table 4 presents the effects of different levels of dietary AGRE on chickens' blood antioxidant constituents. In broilers fed diets supplemented with AGRE, a significant dose-dependent decrease ($P=0.001$) in plasma MDA was observed. In TAC, SOD, CAT, GPx, and GST, where the values were (P=0.0005, 0.05, 0.03, 0.02 and 0.0001) increased with increasing AGRE levels, respectively, an opposite effect was noted. As MDA is present in lipoproteins, this blood constituent, like other lipids, cholesterol, and triglycerides, decreased with increased dietary AGRE levels. This result agrees with the conclusion of Abdulmajeed, (2011) who indicated that serum MDA levels were decreased when rats were given aqueous extracts including

Alpinia galangal rhizomes. The opposite effect was observed in the present study with respect to TAC, where the values were augmented significantly with rising levels of AGRE. These results endorse that in *Alpinia* galangal rhizomes the antioxidant activity of flavonoid compounds is primarily due to their chemical structure and reduction-oxidation reactions (Al-Snafi, 2015).

The antioxidant enzymes (SOD, CAT, GPx, and GST) presented in this study are consistent with those of Sujatha *et al.* (2010), which declared that the supplementation of polyherbal feed premix at 1.0g/kg diet significantly augmented antioxidant enzyme activity (such as SOD, GPx, and CAT) in broilers. Furthermore, Habibi, *et al.*, (2014) noticed that adding ginger essential oil in diets of broilers at 150 mg/kg the activity of total superoxide dismutase (TSOD) augmented in the liver, concentrations of malondialdehyde (MDA) vice versa reduced compared to control group concentrations, followed by those results which showed that in the stress of heat, there was no significant difference between experimental groups of glutathione catalase (CAT), peroxidase (Gpx), and TSOD enzymes in the cells of red blood. In addition, the later authors supplementary that *Alpinia* galangal rhizomes polyphenols are effective components that are participating in controlling redox homeostasis in chickens. The antioxidant enzymes importance in supporting the structure and biological membranes function is due to their participation in superoxide clearance and H_2O_2 (McCord, 2000). In the antioxidant defense system, SOD acts a role (Khan, 1999). Costa *et al.* (2007) reported that *Alpinia* galangal was active in transforming oxidized glutathione into downgraded glutathione and elimination oxidative stress-caused H_2O_2. Flavonoids contribute greatly to AGRE's antioxidant activity because of their influence on the removal of free radicals (Suo, *et al.*, 2009). It appears that AGRE flavonoids have an important antioxidant activity. AGRE's antioxidant constituents consist chiefly of components with phenolic hydroxyl groups and dual bonds involving flavonoids, unsaturated fatty acids, and tannins in addition to phenolic contents, including that phenolics are AGRE's leading antioxidant constituents. Additionally, the polyphenolic composites can clean up free radicals and decrease membrane lipid peroxidation so free radical-related diseases can be lowered (Surveswaran *et al.*, 2007).

Productive performance

Table 5 summarizes the effect of dietary AGRE on the growth performance of chickens raised under conditions of heat stress. At 3 and 6 weeks of age, chicks receiving 750 mg AGRE / Kg diet had the highest body weights. Nevertheless, there was no significant increase in body weight in groups 250 AGRE and 500 AGRE. Group 750 AGRE chicks had the highest body weight gain in all experimental periods (P=0.047, P=0.039, and P=0.044) followed by group 500 AGRE. The feed intake of groups 250 AGRE and 500 AGRE did not increase significantly (by 0.38%, 2.91%, and 4.15%, respectively) compared with the control group. The FCR of group 750 AGRE has been significantly improved (P=0. 0001) compared to all other groups. High ambient temperature declines growth performing, maybe due to extreme reactive oxygen species oxidizing, devastate cellular biological molecules and impede some ATPase activities ultimately causing a variety of intestinal tissue harms (Liu *et al.*, 2011). Additionally, a decrease in body weight, feed intake and general feed efficiency results in stress in broilers. But, supplementing antioxidants with the main diet has been shown to enhance bird performance and growth scientifically well (Sahin *et al.*, 2003). In the current study, a gradual improvement in body weight was detected with augmented levels of AGRE. The enhancements in body weight at 6 weeks old for groups 250 AGRE, 500 AGRE, and 750 AGRE were 2.48%, 5.2%, and 12.35%, respectively. The current findings are in line with trials in rabbits stated by Ibrahim *et al.* (2011), where AGRE addition has been integrated with up to 1.0 g / kg diet without performance harm. In addition, Das and Santhy (2015) confirmed that polyphenols in *Alpinia* galanga (L.) have been absorbed in adequate quantities to participate and modify the activity of antioxidant in broiler chickens. Ali *et al.* (2017), demonstrated that antioxidant activity, total flavonoid, and total phenolic, phthalic acid, octadecanoic acid, palmitic acid, 2-propenoic acid, oleic acid, 2-[2-(4-nonylphenoxy) ethanol, sandaracopimaradiene, and glycidylstearate were the main components of Kaempferia galanga rhizome methanol extract. This consequence is harmonious with results of Viveros *et al.* (2011) in broilers, wherever no growth decline was detected after grape polyphenols supplemented diets. These components present in the AGRE stimulate digestive enzymes and improves overall digestion and thus leads to increased body weight. It has been established that ginger in the diet stimulates lactic acid bacteria and reduces pathogenic bacteria such as coliforms, mesophilic aerobics, and Escherichia coli, thereby improving the absorption of nutrients leading to better bird weight (Srividya *et al.*, 2010). Or perhaps because of a galangal's lower capability to enhance insulin sensitivity (Talpur, *et al.*, 2005). In the study of Karangiya *et al.* (2016), indicated that the morphometry of the jejunum as length and width of villi was improved by an additional 1 percent ginger in the broiler diet, which increases the absorbent surface area of the intestine and thus increases the absorption capacity, resulting in a higher gain in body weight. The findings are harmonious with those of Karangiya *et al.* (2016), who stated that body weight gain (g / bird) was found to be higher in the group supplemented with garlic and ginger compared to control and the group supplemented with garlic and ginger mixture. The same results were found by Sethy, *et al.* (2016) when testing addition turmeric (Curcuma longa) to broiler chickens diets. In the study of Sahin *et al.* (2003), found an increased gain in body weight in polyherbal feed premix (O. Sanctum (leaves), Terminalia chebula (fruit), P. emblica (fruit and leaves), W. Somenifera (root), and Shilajit) complemented group paralleled to the control group broilers below stress of heat. Also, Pradhan (1995) and Mujeeb Ather (1995) detected that birds supplemented by Stresroak (polyherbal formulation) appeared augmented gain of body weight compared to the control group. It has shown that the smell and/or taste of AGRE do not adversely affect the palatability of feed in broiler diets. In the else report, Cabuk *et al.* (2006) stated significantly decreased the intake of broiler feed compared to the control cluster when using a mixture of medical plant extracts. In this connection, Barazesh, *et al.* (2013) revealed that ginger extract 1% at the entire trial period appeared the best feed conversion ratio so it was the lowest numeral. Kamel (2001) stated that the feed conversion ratio enhanced with the addition of plant extracts. Mehala and Moorthy (2008) found that the addition of turmeric and Aloro had a significant impact on FCR. Durrani *et al.* (2006) reported significant conversion factor with turmeric and between treatments.

Mortality results revealed that increased dietary supplementation with AGRE resulted in a dose-dependent reduction in mortality during all experimental periods (P=0.0001).

Carcass traits

Table 6 shows the results of carcass traits. Generally, the groups fed on different levels of

(AGRE) showed (P=0.045, 0.005 and 0.0001) the highest dressing, breast, and thigh percentages, respectively, while the control group had the lowest percentages. Liver, heart, gizzard and abdominal; fat percentages were (P=0.041, 0.039, 0.41and 0.006) increased for the broiler fed on levels of (AGRE) as compared to those fed on the control diet. There have been significant differences between the different groups in the content of moisture, protein and ether extract. Results indicated that additional diets of 500 and 750 mg AGRE / Kg significantly increased (P=0.0013, 0.004 and 0.004) the content of moisture, protein and ether extracts in breast meat compared to those fed under control and 250 mg AGRE / Kg diet, respectively. Moisture and ether extract contents of thigh meat were (P=0.004 and 0.003) increased in broiler fed on diets containing 500 and 750 mg AGRE/Kg diet as when compared with control and 250 mg AGRE/Kg diet, respectively. There was a contradictory effect on the protein content of thigh meat, where the values were ($p \leq 0.05$) decreased with 500 and 750 mg AGRE/Kg diet.

In the study of Srividya, *et al.* (2010), reported that under oxidative stress conditions (where free radical production increases dramatically) AGRE supplementary diets as a natural antioxidants source avoids harm to systems and the main body parts and is economically acceptable hence our trial weights of dressing in groups 250 AGRE, 500 AGRE and 750 AGRE increased significantly by 1.61%, 3.26%, and 5.6%, respectively. The findings are harmonious with those of Lovita (2013), where dressing percentages, carcass pieces and carcass weight augmented among each evaluated carcass characteristics of rabbits a dietary AGRE supplement of 0.5% and 1.0%. In addition, the conferred findings are harmonious with broiler research.

For example, Valenzuela-Grijalva, *et al.*, (2017) found that in broiler below stress of heat AGRE supplementation affects the characteristics of carcass and proportional lengths of large intestine and caecum. These findings, however, were contrary to Barazesh, *et al.* (2013) reported that, compared to control group, the addition of 1.5% of extracted ginger in broiler diets would affect the percentage of the thigh and abdominal fat. In the study, Emadi *et al.* (2006) stated that a significant reduction in the abdominal fat relative weight was caused by the addition of 0.5% of turmeric root extract to diet. The present results disagree with those reported by Mehala and Moorthy (2008).

CONCLUSION

The results from this study showed that 250, 500 and 750 mg / kg dietary supplementation of AGRE enhanced performance of growth, antioxidant biomarkers, crude protein and ether extract in breast meat, and decreased broiler mortality. In addition, AGRE features a high antioxidant capability, a combination of polyphenolic compounds with good antioxidant properties and may be used in heat-stress for broilers. Also, the better findings were achieved in addition to the diet of 750 mg AGRE / kg.

Table (1): Feed ingredients and chemical composition of the experimental diet (% DM basis).

Ingredients	**Diets Composition %**	
	Starter Diets (0-21 d)	**Grower Diets (22-42 d)**
Yellow corn	62.9	67
Wheat bran	2.2	2.31
Soybean meal (48%)	15.5	12
Corn gluten (60%)	13.3	12.5
Fish meal (72%)	0.8	0.8
Meat meal (50%)	2.1	2.1
Calcium Carbonate	1.1	1.3
Dicalcium Phosphate	1	1
Premix*	0.3	0.3
Alpinia galangal	0	0
Table Salt (NaCl)	0.3	0.24
D L.Methionine	0.1	0.04
L. Lysine	0.3	0.31
Coxistate	0.1	0.1
Total	100	100
Calculated chemical composition		
Crude protein %	22.65	20.00
ME k cal / kg	3070	3150
Ether Extract %	3.42	3.61
Crude fiber %	2.53	2.69
Calcium %	1.09	1.10
P. (available) %	0.46	0.47
Lysine %	1.06	1.00
Methionine+cysteine%	0.82	0.77

Provided the following per kg of diet: Vit. D. 3000 IU; Vit. E, 100 IU; Vit. A, 1200 IU; Vit B12, 0.03 mg; Vit. C, 3 mg; VitB1, 3 mg; Vit B2, 3 mg; Vit. K, 4 mg; Vit B6, 5 mg; Folic acid, 2 mg; Biotin, 0.20 mg; Bantothinic acid, 15 mg; Copper, 10 mg; Cobalt, 0.05 mg; Manganese, 90 mg; Iodin, 50 mg; Zinc, 70 mg and Selenium, 0.20 mg.

Table (2): Phenolic and flavonoids compounds of *Alpinia galangal* rhizomes extract.

Phenolic Compounds[a]	Contents (MG/100G)	%	Flavonoid Compounds[b]	Contents (MG/100G)	%
1,8-cineole	15.3	34.7	Rutin	141.1	2.3
α-fenchyl acetate	5.71	12.5	Rosmarinic acid	196.1	3.79
α-terpineol	20.02	4.24	Quercitrin	553.5	23.58
Catechin	5.9	3.81	Quercetin	679.5	32.6
p-Coumaric acid	0.21	0.29	Naringinin	921.5	34.8
Myricetin	1.5	2.16	Hespertin	131.2	0.87
Chavicol llylphenol	25.74	30.02	Kaempferol	239.7	1.01
Methyl eugenol	8.76	1.68	Apigenin	44.9	1.05
Eugenol	4.35	3.5	Total flavonoid	13.6	100
β-pinene	1	7.1			
Total phenolic	35.39	100			

Notes: [a] analyzed according to (Goupy et al., 1999); [b] analyzed according to (Mattila et al., 2000).

Table (3): Effect of *Alpinia galanga* rhizome extract on plasma biochemical components of broiler.

Items	Experimental diet				SEM[4]	*P*-value
	Control	**250 AGRE[1]**	**500 AGRE[2]**	**750 AGRE[3]**		
Total protein (g/dl)	2.71^{b}	2.79^{b}	3.35^{a}	3.47^{a}	0.16	0.0001
Albumin (g/dl)	1.48^{b}	1.54^{b}	1.97^{a}	2.0^{a}	0.10	0.0001
Globulin (g/dl)	1.23^{b}	1.25^{b}	1.38^{a}	1.47^{a}	0.05	0.0001
Albumin/globulin ratio	1.2	1.23	1.42	1.36	0.09	0.147
Glucose (mg/dl)	178.23	177.12	177.26	176.2	3.56	0.439
Total lipids (mg/dl)	4.233^{a}	3.865^{ab}	3.714^{b}	3.677^{b}	0.13	0.022
Total cholesterol (mg/dl)	88.47^{a}	83.01^{b}	81.91^{bc}	80.84^{c}	1.57	0.0001
Triglycerides (mg/dl)	23.78^{a}	20.19^{b}	20.17^{b}	20.19^{b}	0.16	0.007
High-density lipoprotein (mg/dl)	91.1	89.07	90.19	87.45	3.24	0.842
Low-density lipoprotein (mg/dl)	50.09^{a}	45.31^{b}	45.26^{b}	43.12^{c}	0.001	0.0024

Notes[1]250 AGRE, 250 mg AGRE/Kg diet; [2]500 AGRE, 500 mg AGRE/Kg diet; [3]750 AGRE, 750 mg AGRE/Kg diet; [4]SEM, standard error of the mean.
[a–c] Means in a row not sharing the same superscript differ significantly ($p \leq 0.05$).

Table (4): Effect of *Alpinia galanga* rhizome extract on plasma biochemical components of broiler.

Items	**Experimental diet**				**SEM[4]**	**P-value**
	Control	**250 AGRE[1]**	**500 AGRE[2]**	**750 AGRE[3]**		
Malondialdehyde (mmol/l)	12.44^{a}	11.25^{b}	8.67^{c}	6.58^{d}	0.27	0.0001
Total antioxidant capacity (mmol/l)	0.61^{d}	0.92^{c}	1.15^{b}	2.12^{a}	0.08	0.0005
Superoxide dismutase (U/l)	27.10^{b}	32.01^{ab}	36.95^{a}	38.40^{a}	3.43	0.05
Catalase (U/g)	490^{b}	561^{ab}	610^{a}	630^{a}	27.9	0.03
Glutathione peroxidase (U/l)	0.78^{c}	1.07^{bc}	1.14^{b}	2.12^{a}	0.06	0.02
Glutathione S-transferase (U/l)	85.1^{d}	120.4^{c}	179.1^{b}	210.15^{a}	14.37	0.0001

Notes[1]250 AGRE, 250 mg AGRE/Kg diet; [2]500 AGRE, 500 mg AGRE/Kg diet;
[3]750 AGRE, 750 mg AGRE/Kg diet; [4]SEM, standard error of the mean.
$^{a-d}$ Means in a row not sharing the same superscript differ significantly ($p \leq 0.05$).

Table (5): Growth performance and mortality of broiler chicks fed experimental diets containing different levels of *Alpinia galanga* rhizome extract.

Items	Experimental diet				SEM[4]	*P*-value
	Control	250 AGRE[1]	500 AGRE[2]	750 AGRE[3]		
Body weight (g)						
Initial BW	43.2	46.41	44.77	43.95	0.41	0.457
Week 3	1059.5^{b}	1081.7^{b}	1154.8^{ab}	1200.3^{a}	43.2	0.005
Week 6	2029.1^{b}	2079.4^{b}	2134.6^{ab}	2279.7^{a}	52.3	0.0001
Body weight gain (g)						
Week 1-3	1016.3^{b}	1035.29^{b}	1110.03^{a}	1156.35^{a}	41.2	0.047
Week 3-6	969.6^{b}	997.7^{b}	1039.8^{ab}	1079.4^{a}	45.7	0.039
Week 1-6	1985.9^{b}	2032.99^{b}	2149.83^{ab}	2235.75^{a}	37.8	0.044
Feed intake (g)						
Week 1-3	1075	1080	1105	1120	23.3	0.654
Week 3-6	2319	2327	2388	2415	22.1	0.713
Week 1-6	3394	3407	3493	3535	37.3	0.842
Feed conversion ratio (g/g)						
Week 1-3	1.06^{a}	1.04^{a}	1.00^{ab}	0.97^{b}	0.001	0.0024
Week 3-6	1.17^{a}	1.14^{a}	1.11^{ab}	1.08^{b}	0.013	0.0013
Week 1-6	1.71^{a}	1.68^{a}	1.62^{ab}	1.58^{b}	0.004	0.004
Mortality (%)						
Week 1-3	3.06^{a}	2.51^{b}	2.12^{c}	1.79^{d}	0.13	0.0001
Week 3-6	3.84^{a}	2.37^{b}	2.00^{c}	1.12^{d}	0.10	0.0001
Week 1-6	7.11^{a}	5.12^{b}	4.46^{c}	3.15^{d}	0.75	0.0001

Notes[1]250 AGRE, 250 mg AGRE/Kg diet; [2]500 AGRE, 500 mg AGRE/Kg diet; [3]750 AGRE, 750 mg AGRE/Kg diet; [4]SEM, standard error of the mean.

$^{a-b}$ Means in a row not sharing the same superscript differ significantly ($p \leq 0.05$).

Table (6): Carcass traits of broiler chicks fed experimental diets containing different levels of *Alpinia galanga* rhizome extract.

Items	Experimental diet				SEM[4]	*P*-value
	Control	250 AGRE[1]	500 AGRE[2]	750 AGRE[3]		
Carcass characteristics and body organs (%)						
Dressing	63.40[b]	64.42[a]	65.47[a]	66.95[a]	0.51	0.045
Breast	30.97[b]	34.25[a]	35.97[a]	36.91[a]	0.15	0.005
Thigh	25.33[b]	26.15[a]	26.97[a]	27.98[a]	0.53	0.0001
Liver	2.55[b]	2.97[b]	3.23[a]	3.27[a]	0.08	0.041
Heart	0.62[b]	0.64[ab]	0.66[a]	0.67[a]	0.05	0.039
Gizzard	1.98[b]	2.29[a]	2.14[a]	2.25[a]	0.02	0.041
Abdominal fat	1.99[b]	2.23[a]	2.37[a]	2.39[a]	0.07	0.006
Chemical composition of meat on DM basis (%)						
Breast						
Moisture	67.17[b]	67.49[b]	68.15[a]	69.01[a]	0.24	0.0013
Protein	22.71[b]	22.97[b]	23.26[a]	23.81[a]	0.21	0.004
Ether extract	1.71[b]	1.98[b]	2.09[a]	2.11[a]	0.10	0.004
Thigh						
Moisture	73.10[b]	73.12[b]	74.21[a]	74.87[a]	0.58	0.004
Protein	20.18[a]	20.07[a]	19.71[b]	19.0[b]	0.25	0.004
Ether extract	2.11[b]	2.31[b]	2.54[a]	2.7[a]	0.13	0.003

Notes[1]250 AGRE, 250 mg AGRE/Kg diet; [2]500 AGRE, 500 mg AGRE/Kg diet; [3]750 AGRE, 750 mg AGRE/Kg diet; [4]SEM, standard error of the mean.

[a–b]Means in a row not sharing the same superscript differ significantly ($p \leq 0.05$).

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الملخص العربي

بعض المكونات البيوكيميائية بالدم، والمؤشرات الحيوية لمضادات الأكسدة وأكسدة الدهون والأداء الإنتاجي وسمات الذبيحة ببداري التسمين المدعمة بمستخلص ريزومات الجولنجان اثناء ظروف الإجهاد الحراري

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اجريت التجربة باستخدام عدد ألف كتكوت غير مجنس سلالة الكوب Cobb عمر يوم واحد قسمت بشكل عشوائي لأربع مجموعات غذائية لدراسة آثار المستويات المختلفة من المكملات الغذائية لمستخلص ريزومات ألبينيا جالانجال على المكونات الكيميائية الحيوية بالدم، والمؤشرات الحيوية لمضادات الأكسدة وأكسدة الدهون والأداء الإنتاجي وصفات الذبيحة ببداري التسمين تحت ظروف الاجهاد الحراري. مجموعة الكنترول الضابطة تغذت علي علف بدون اي اضافة و المجموعات التجريبية تغذت علي علف الكنترول مع اضافة مستويات 250 و 500 و 750 ملجم من مستخلص ريزومات الجولنجان / كجم علف. الفترة التجريبية استمرت لمدة 6 أسابيع. سجلت المجموعات التي تناولت علف مضاف اليه مستويات 500 و 750 ملجم من مستخلص ريزومات الجولنجان / كجم علف زيادة معنوية في بروتين البلازما الكلي والالبيومين والجلوبيولين. في المقابل جميع مستويات اضافة مستخلص ريزومات الجولنجان خفضت بشكل معنوي تركيزات بلازما الدهون الكلية والكوليسترول الكلي والدهون الثلاثية والكوليسترول منخفض الكثافة. بزيادة مستويات مستخلص ريزومات الجولنجان حدث زيادة معنوية فى المؤشرات الحيوية لمضادات الأكسدة كـ انزيم دِيسمُوت الفائق و الكاتلاز والجلوتاثيون بيروكسيديز و انزيم اس ناقل الجلوتاثيون و القدرة الاجمالية لمضادات الأكسدة في الدم مع حدوث انخفاض في مستوي انزيم اكسدة الدهون المالونالدهيد. أفضل نسبة زيادة وزن الجسم و معدل التحويل الغذائي وأقل معدل وفيات كانت للمجموعة التي تم تغذيتها بـ 750 ملجم من مستخلص ريزومات الجولنجان. النسبة المئوية لــ (تصافي الذبيحة وزن الصدر ووزن الفخذ) زادت بشكل معنوي بالنسبة للكتاكيت التي تغذت علي مستويات مختلفة من مستخلص ريزومات الجولنجان، كما سجلت أعلى نسبة دهون في البطن مقارنة بمجموعة الكنترول. بالإضافة الي زيادة وزن الكبد والقلب والقانصة بشكل معنوي في مجموعة الدجاج التي تغذت علي مستويات مختلفة من مستخلص ريزومات الجولنجان مقارنة مع المجموعة الضابطة. أثرت المستويات الصاعدة من مستخلص ريزومات الجولنجان على لحوم الذبيحة حيث لوحظ زيادة في البروتين الخام والرطوبة والدهن في لحم الصدر مقارنة بمجموعة المقارنة. بالرغم من أن المستويات التصاعدية من مستخلص ريزومات الجولنجان تسببت بانخفاض البروتين الخام بلحم الفخذ مقارنة مع المجموعة الكنترول. كشفت النتائج الحالية أن جميع مستويات اختبار مستخلص ريزومات الجولنجان كانت مفيدة ضد الإجهاد الحراري لتقليل الآثار السلبية للإجهاد الحراري في بداري التسمين.