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GROWTH PERFORMANCE AND SERUM BIOCHEMICAL PARAMETERS OF BROILER CHICKENS FED DIETS CONTAINING NIGELLA SEED MEAL

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ABSTRACT

A 6-wk feeding trial with 240 day-old Hubbard broiler chicks was conducted to study the effect of feeding diets containing Nigella seed meal on growth performance, some serum biochemical parameters and activities of some liver enzymes. During each feeding phase (starter, grower and finisher) isonitrogenous and isocaloric diets were formulated, where Nigella seed meal was included at three levels to supply amount of protein equal to 25, 50 or 75 % of the protein amount supplied by soybean meal in the control diet. The results showed that the use of Nigella seed meal to supply amount of protein equal to 25 % of the protein amount supplied by soybean meal in the control diet has significantly ($P < 0.01$) increased final body weight, body gain, feed conversion ratio and feed efficiency, while no significant differences were detected when Nigella seed meal was used to supply 50 or 75 % of the protein amount supplied by soybean meal in the control dies. However, inclusion of Nigella seed meal in the broiler diets did not significantly ($P > 0.01$) affect the total feed consumption, although broiler chickens tended to consume more feed as the amount of protein supplied by Nigella seed meal in the diet increased. Feed costs were relatively low when Nigella seed meal was used to supply amount of protein that would replace 25, 50 or 75 % of the protein. Compared to the control, serum concentrations of T3 and T4 were significantly ($P < 0.01$) increased when Nigella seed meal was used to supply amount of protein that replaced 25, 50 or 75 % of the protein amount supplied by soybean meal in the control diet, while glucose concentrations were significantly decreased. Serum concentrations of globulin were significantly ($P < 0.01$) elevated at all used levels of Nigella seed meal, while serum total protein concentration was significantly increased only when Nigella seed meal was used to supply 25 % of the protein. Triacylglycerol and total cholesterol concentrations were significantly reduced when Nigella seed meal was included in the diets to furnish *amount of protein substituting 25, 50 or 75 % of the protein amount provided by soybean meal in the control diet, while high density lipoproteins were significantly increased only when 75 % of the protein amount supplied by soybean meal in the control diet was replaced by equal amount of protein provided by Nigella seed meal. Vitamin C and glycogen concentrations were significantly (P < 0.01) increased in hepatic tissues of chickens fed diets contained Nigella seed meal regardless of the amount used. The activity of liver enzymes (AST, ALT and GGT) were not significantly (P > 0.01) affected when either 25 or 50 % of soybean meal protein in the control diet was replaced by equal amount of Nigella seed meal protein, while the activity of these enzymes was significantly affected when 75 % of Nigella seed meal protein was used. Under the conditions of this study, it could be concluded that Nigella seed meal could be successfully used in broiler diets to supply amount of protein that could replace 25 % the protein amount supplied by soybean meal with favorable effects on growth performance, feed efficiency and biochemical parameters.*

INTRODUCTION

As Feed expenses constitute 65 to 70% of the total poultry production costs and most, if not all, of the traditional protein supplements used in formulating poultry diets have to be imported, therefore any trials to search alternative protein supplement and to reduce feed costs are of interest. Soybean meal is one of the most widely used protein supplement, it has the highest energy and the lowest fiber content among all oil seed meals and provides the most economical quality protein available to the feed manufacturer. However, the drastic increase in price and the short supply of soybean meal, especially in recent years, are ones of the main obstacles facing poultry industry in Egypt. Therefore, nutritionists are always forced to search for other alternative cheap protein supplements.

In Egypt, there is a growing interest to cultivate Nigella seed as a medicinal plant. The seeds are traditionally used as carminative and flavoring and also exhibit antibacterial, antifungal, antidiabetic and bronchodilator effects **(Soliman et al., 1999; Aqel, 1993 and Sharobeem, 1996).** The most important nutrient of Nigella seed is its oil content (37 %), which is primarily used for medicinal purposes **(Abdel-Aal and Attia, 1993).** When the oil is removed the residue remaining behind is called Nigella seed meal (NSM). However, limited information are available concerning the use of NSM although it has a potential nutritional characteristics, the most important of which is its high protein content, 30 % or more and the relatively high energy supply, 2800 Kcal/kg ME **(Khalifah, 1995 and Zeweil, 1996).** NSM protein has been successfully and economically used as a partial substitution for sunflower meal protein **(Awadalla, 1997)** and for soybean meal protein **(El-Ayek, 1999)** in diets for growing lambs. The amino acid composition of NSM was determined for the first time by **Babayan et al. (1978)**. They found that its protein is rich in arginine, glutamic acid, leucine, phenylalanine and lysine. Nigella seeds are also a good source of some physiologically important elements such as 0.28% Na, 0.25% Mg, 0.79% K, 341.9 ppm Fe, 56.3 ppm Zn and 8.7 ppm Cu **(Soliman et al., 1999)**. There is a revived interest among producer to use NSM as immunostimulant in poultry diets. However, limited researches have been conducted to study the NSM as a source of protein in poultry diets. **Khalifah (1995)** stated that NSM contained most of the essential amino acids and could offer a fairly cheap source of protein for poultry. Moreover, the oil left in NSM is rich in oleic and linoleic acids, which are essential for poultry **(Ustun et al., 1990)**. **Zewell (1996)** found that inclusion of NSM at 6.78 and 13.54% in growing Japanese quail diets has improved performance parameters. On the other hand the use of Nigella seeds at 0.15 % and 0.30% in broiler diets has improved the immunity without any significant effect on performance parameters **(Soliman et al., 1999)**. However, the levels used in the previous studies may be not high enough to elicit a clear effect on broiler performance. Therefore, the present work was designed to study the growth performance, serum biochemical parameters and activity of some liver enzymes of broiler chicken when NSM was used to supply amount of protein that would replace 25, 50 or 75% of the protein amount supplied by soybean meal in the diet.

MATERIALS AND METHODS

Experimental diets :

Nigella seed cake was obtained from a local processing unit at Mansoura City, Dakahlia governorate. The cake was ground into meal to pass through 1-mm mesh screen for easy mixing with other ingredients. Samples of NSM and the used feedstuffs were analyzed for CP, EE and CF percentages according to **AOAC (1990)**. The chemical composition of the feedstuffs used in formulation of the diets is shown in Table 1. NSM was included at different levels in the diets (11, 22 and 33% in starter diets; 9.17, 18.33 and 27.50 % in grower diets and 6.8, 13.35 and 20% in finisher diets) to supply amount of protein that would replace 25, 50 or 75% of the protein amount supplied by soybean meal in the control diets. Four diets (one control and three experimental) were formulated at each feeding phase, accordingly a total of 12 diets were used (Table 2). The diets fed at each phase were formulated to be almost isocaloric, isonitrogenous, nearly equal in respect to other nutrients, as specified in the user's guide of Hubbard. The diets were supplemented with L-lysine hydrochloride, DL-methionine, sodium bicarbonate and choline chloride to balance for these nutrients as recommended by **NRC (1994).**

Experimental chicks :

Two hundred forty mixed sex, day-old Hubbard broiler chicks, obtained from a local commercial hatchery, were randomly distributed to four groups. Each group was replicated three times each of 20 chicks. Chicks were housed in well-disinfected houses with wheat straw as a bedding material. The groups were randomly assigned to the experimental diets. Feed and fresh clean water was provided for ad libitum consumption. The experiment was carried out on July through August, where chicks were fed the diets for 6 weeks.

Growth performance and biochemical parameters :

Throughout the experimental period, average feed consumption and body weight gains were recorded at weekly intervals, from which body gain and feed conversion were calculated. For ease of comparison, data were presented biweekly. At end of the experiment, 12 chickens per group were slaughtered for collection of blood and tissue samples. Blood samples were centrifuged and only clear sera were collected and used for analysis of triiodothyronine (T3) **(Cooper, 1982)**, thyroxine (T4) **(Schall et al., 1978)**, total proteins **(Cornel et al., 1949)**, albumin **(Doumas, 1971)**, globulin was calculated by subtracting albumin from total proteins, glucose **(Trinder, 1969)**, triacylglycerols **(Young and Postaner, 1975)**, total cholesterol **(Melattini, 1978)**, high density lipoproteins **(Clark et al., 1983)**, low density lipoproteins **(Friedwald et al., 1973)**, aspartate aminotransferase (AST), alanine aminotransferase (ALT) **(Reitmann and Frankel, 1957)** and gamma glutamyl transferase (GGT) **(Persijn and Vonderk, 1976)**. Liver tissue samples were used for analysis of vitamin C **(Roe et al., 1948)** and glycogen **(Carrol et al., 1956)**.

Statistical analysis :

Data were subjected to analysis of variance by general linear models (GLM) procedures of SAS **(SAS, 1996)**. Significant differences among main effect means were separated by Duncan's multiple range test with 1 % level of probability.

RESULTS AND DISCUSSION

Growth performance :

The main effect of NSM on body weight, body gain, feed intake and feed conversion ratio during the starter period is presented in Table 3. Data revealed that the use of NSM at 11% to provide amount of protein replacing 25% of the protein amount supplied by SBM in the control diet has significantly ($P < 0.01$) increased body weight, body gain when compared to the other dietary treatments. No significant differences were detected when 50% of the protein amount supplied by SBM in the control diet was replaced by equal amount of protein derived from NSM (22 % NSM in the diet). On the other hand, inclusion of NSM at 33% to provide amount of protein substituting 75% of the protein amount provided by SBM in the control diet has significantly (P<0.01) reduced body weight and body weight gain when compared to the other dietary treatments. Feed intake was significantly (P<0.01) decreased when 75% of the protein amount provided by SBM in the control diet was substituted with equal amount of protein derived from NSM. Use of NSM at 11% and 22% of the diet has significantly (P<0.01) improved feed conversion ratio (1.31 and 1.39, respectively) when compared to the control, while 33% of NSM in starter diet has no significant (P>0.01) effect on feed conversion ratio (1.46) compared to the control diet (1.42).

The growth performance data of broiler chicken fed the grower and finisher diets are shown in Tables 4 and 5, respectively. It is clear that the best growth performance parameters were obtained when 25% of the protein amount supplied by SBM in the control diet was substituted with equal amount of protein provided by NSM (9.17 and 6.80% NSM in the grower and finisher diets, respectively) followed in the order by 50% substitution of the protein amount (18.33 and 13.35% NSM in the grower and finisher diets, respectively), while 75% substitution of the protein amount supplied by SBM in the control diet with equal amount of protein obtained from NSM (27.5 and 20% NSM in the grower and finisher diets, respectively) has resulted in the lowest performance parameters. It is worthy to note that feed intake, during the growing and finishing periods, tended to increase as the level of NSM in the diet increased, while body weight and body gain tended to gradually decrease. The data also revealed that feed conversion ratio has been improved when 25% of the protein amount supplied by SBM in the control diet was substituted with equal amount of protein derived form NSM when compared to the other dietary treatments.

The allover growth performance data (Table 6) showed that inclusion of NSM at 11, 9.17 and 6.80% of the diet to provide amount of protein replacing 25% of the protein amount provided by SBM in the starter, grower and finisher diets, respectively has significantly (P<0.01) increased the final body weight (1650 g), the final body gain (1605.8 g) and improved the feed conversion ratio (1.98) when compared to the control diet (1525 g, 1480.8 g and 2.15, respectively). No significant differences in final body weight, final body gain were detected when either 50 or 75% of the protein amount supplied by SBM in the control diet was replaced with equal amount of protein derived from NSM. However, replacing 75% of the protein amount provided by SBM in the control diet with equal amount of protein from NSM throughout the whole feeding period has produced the lowest performance. Inclusion of NSM in broiler chicken diets has no significant effect on total feed intake, although it tended to increase as the percent of NSM in the diet increased. Broiler chickens fed diets in which NSM was used at 11, 9.17 and 6.80% to provide amount of protein replacing 25 % of the protein provided by SBM in the control diets had utilized their feed more efficiently (50.29 %) compared to those fed the control diets (46.58%), while other groups were not different from the control.

The significant higher growth performance parameters obtained when NSM protein replaced 25% of the protein amount provided by SBM in the control diets could be due to improved metabolic activity induced by the increased serum concentration of thyroxin (Table 7). Thyroxin hormone was found to increase hepatic synthesis of RNA **(Taha and Windell, 1966)** and incorporation of amino acids into protein and hence protein synthesis **(Baccari et al., 1983)**. Similarly, substitution of 25% of either wheat protein or faba meal protein with Nigella protein in diets of rat has increased growth rate and body weight **(Sharobeem, 1996 and Al-Gaby, 1998)**. **Khodary et al. (1996)** found that inclusion of Nigella seed at either 1 or 2% has increased the concentration of thyroxin hormone in blood of laying hens with consequent increase in egg production. However, the role of Nigella seed compounds as antimicrobial in treating subclinical infections and improving health status of chickens could not be neglected **(Rathee et al., 1982 and Alexander, 1985)**. The volatile oil in Nigella seed meal was found to exert antimicrobail and antifungal properties due to presence of certain active compounds such as nigellone and thymohydroquinone **(Farida and Khalid, 1987)**. There might be some sort of complementary relationship between SBM and NSM proteins. On the other hand, the decreased performance of broiler chicks when NSM protein had replaced 75% of the amount of protein supplied by SBM in the control diet, although feed intake was not decreased, could be due to low supply of some essential amino acids such as arginine and leucine or amino acid imbalance. The dietary balance of amino acids markedly influences the efficiency with which amino acids are used for growth and other physiological processes. **Austic (1994)** stated that excess or lack of some amino acids depresses the growth by mechanisms that appear largely independent of food intake. Arginine content of NSM was found to be low (0.69%) as compared to 3.14% for SBM **(Zeweil, 1996)**. The use of NSM protein to replace 75% of the protein amount provided by SBM in the control diet could have induced arginine deficiency relative to lysine. Arginine was found to stimulate growth hormone release from pituitary gland. Moreover, arginine is one of the three amino acids makeup creatine, which is well known to increase the energy ATP cycle **(Balsom et al., 1994 and Williams et al., 1999)**. **Radwan (2001)** found that growth performance of local cockerel has been reduced when Nigella seed meal replaced 60% of soybean meal in starter-grower diet. Also apparent availability of arginine and lysine in Nigella seed meal were found to be lower than that in soybean meal **(Khalifah, 1995)**. A good balance of lysine and arginine does result in release of biologically active hormone able to affect peripheral cellular receptors and thus cell growth in general **(Casey and Greenhaff, 2000)**. It is worthy to note that the final body weights obtained under condition of this experiment are evidently lower than the target body weights expected for the Hubbard breed. This was a consequence of the high environmental temperature (more than 37°C) and the relative humidity prevailing at time of the experiment.

Serum biochemical parameters ;

Serum biochemical parameters of broiler chickens fed diets containing NSM are shown in Table 7. Serum concentrations of thyroid hormones (T_3 and T_4) were significantly ($P < 0.01$) increased when NSM supplied amount of protein equal to 25, 50 or 75% of the protein amount supplied by SBM in the control diet. This increase may be due to the stimulatory effect of Nigella seed on thyroid gland either directly or through the pituitary level **(Lee and Knowles, 1965;** and **Khodary et al., 1996)**. Our results revealed a significant reduction in serum glucose level when NSM protein replaced SBM protein as compared to the control group. However, the reduction was more intense when 75% of the amount protein supplied by SBM in the control diet was substituted with equal amount of protein derived form NSM. The reduction of serum glucose could be due to the reduction of gluconeogenesis by active compounds in NSM through lowering of glucogenic enzymes **(Al-Awadi et al., 1991)**. In addition the significant increase in thyroid hormones reported in this study could be the main cause of the decline in glucose concentration through increasing the sensitivity of tissues to insulin **(Robert et al., 1996)**. This concept is supported by the findings of **Shetty et al. (1996)** and **Torrance et al. (1997)** where T3 was found to stimulate insulin responsive glucose transporter and transcription (GLUT1 and GLUT4) in rat.

Replacing 25% of the protein amount supplied by SBM in the control diet with equal amount of protein derived from NSM has significantly ($P<0.01$) increased total protein concentration in serum of broiler chicken when compared to the control ones, while no significant differences were detected when either 50 or 75% of the protein amount supplied by SBM in the control diet was replaced with equal amounts of NSM protein. On the other hand, serum albumin concentration was significantly decreased at all the replacement levels when compared to the control diet, with the lowest concentration recorded at 50% replacement level. Serum globulin concentration was significantly ($P<0.01$) increased when NSM protein has replaced SBM protein at all used levels compared to the control, with the highest concentration recorded at 25% level of replacement. The significant increase in serum globulin concentration of broiler chicken fed NSM-containing diets could have resulted from the immunostimulant effect of NSM protein **(Aqel, 1993)**. These results are in accordance with **Al-Gaby (1998)** who found that substitution of 25 % of corn or faba meal protein with Nigella cake protein has significantly increased serum total proteins and globulin concentrations in rats. In addition, higher thyroxin level, as recorded in our study, was found to stimulate protein biosynthesis **(Habeeb et al., 1989).**

Data in Table 7 showed that NSM protein has a significant effect on serum lipid profile of broiler chickens. Serum triacylglycerol (TAG) and total cholesterol concentrations were significantly (P<0.01) decreased when 25, 50 or 75% of the protein amount supplied by SBM in the control diet were replaced with equal amounts of NSM protein. On the other hand, there was a significant increase in high density lipoproteins (HDL) and a significant decrease in low density lipoprotein (LDL) when either 25 or 50% of the protein amount supplied by SBM in the control diet was substituted with equal amount of NSM protein, while 75% substitution level has significantly (P<0.01) increased serum concentration of both HDL and LDL when compared to the control. An increased serum T4 found in this study could be the plausible explanation for the significant decrease in triacylglycerol and total cholesterol. This explanation is supported by the work of **Habeeb et al. (1989)**, where thyroxin injection of rabbits reduced serum total lipids, cholesterol and glucose. **Afifi and Daghash (1999) and EL-Dakhakhny et al. (2000)** obtained relatively comparative results when inclusion of Nigella seeds at 2.5% in gestation and lactation diets of rabbits has induced hypocholesterolemic effect. The unsaturated fatty acids in Nigella seeds stimulate cholesterol excretion into the intestinal tract and its oxidation to bile acids. Also, **Zaoui et al. (2002)** found that oral dosing of Nigella seed fixed oil at rate of 1 ml/kg body weight has decreased serum cholesterol and triacylglycerol in rat. Our results support the traditional use of Nigella seed as a treatment of dyslipidemia, hyperglycemia and related abnormalities.

Vitamin C and glycogen concentrations in hepatic tissues as well as activity of serum transaminases in broiler chicken fed the experimental diets are shown in Table 8. Vitamin C and glycogen concentrations were significantly (P<0.01) higher in hepatic tissues of broiler chickens when 25, 50 or 75 % of the protein amount provided by SBM in the control diet were replaced with equal amounts of NSM protein. This may be attributed to the stimulation of T_3 and T_4 secretion, which enhance the effect of insulin **(Shetty et al., 1996)**. It appears that thyroid hormones regulate glycogen content between liver and muscles. In support of this statement, **Nabukuni et al. (1989)** found a decrease in muscle glycogen of thyroidectomized chicks, and when these chicks were given T_4 injections an apparent increase in muscle glycogen was recorded. Similarly, **Caroline (1991)** reported an increase in myocardial glycogen in hyperthyroid poults. The effect of NSM protein on the activity of serum transaminases was minor. Substituting 25 or 50% of the protein amount supplied by SBM in the control with equal amounts of NSM protein has no significant (P>0.01) effect on the serum levels of aspartate aminotransferase (AST), alanine aminotransferase (ASLT) or gama glutamyl transferase (GGT), compared to the control, while serum levels of these enzymes were significantly (P<0.01) increased when 75% of SBM protein in the control diet was replaced with equal amount of protein supplied by NSM. Our results are supported by that of **Al-Gaby (1998)** who found that substitution of 25% of both corn or faba protein with Nigella protein in the diet of rat has no significant effect on the activity of serum transaminases (AST or ALT). In accordance with this respect, **El-Dakhakhny et al. (2000)** found that oral intake of Nigella seed for 4 weeks did not adversely affect the serum AST or ALT. On the opposite side, **Tennekoon et al. (1991)** found that oral administration of aqueous extract of Nigella seeds to rat has resulted in elevation in serum concentration of GGT and ALT. Moreover, AST and ALT were elevated in serum of rabbits fed Nigella seed seeds **(Afifi and Daghash., 1999).**

Generally, from the aforementioned results it could be concluded that Nigella seed meal could be favor ly included in broiler diets to provide amount of protein that would replace 25% of the protein supplied by soybean meal. This conclusion is based on the improved growth performance parameter and serum metabolites.

Table 1. Chemical composition of feedstuffs used in formulation of the experimental diets[1]

Feedstuff	Chemical composition (% air dry basis)							
	ME Kcal/kg	CP %	EE %	CF %	Ca %	P %	Lysine %	Methionine %
Yellow corn, ground	3335	8.5[a]	3.6[a]	2.3[a]	0.05	0.28	0.30	0.18
Corn gluten meal	3720	60[a]	1.2[a]	1.8[a]	0.07	0.45	1.03	1.78
Fish meal	3185	71.5[a]	9.0[a]	0.6[a]	3.5	2.0	5.62	2.08
Soybean meal	2220	44[a]	1.5[a]	6.4[a]	0.35	0.64	2.85	0.59
Nigella seed meal	2800[b]	30[a]	10[a]	11.5[a]	0.25[b]	0.82[b]	1.46[b]	1.67[b]
Sunflower oil	8650	-	94	-	-	-	-	-

[1] Values are derived from feed composition tables, NRC (1994) unless otherwise indicated
[a] Chemically analyzed according to AOAC (1990).
[b] According to Zeweil (1996)

Table 2. Physical and chemical composition of the experimental diets

Ingredient	Experimental diets											
	Starter				Grower				Finisher			
		% SBM protein replacement				% SBM protein replacement				% SBM protein replacement		
	Control	25 %	50 %	75 %	Control	25 %	50 %	75 %	Control	25 %	50 %	75 %
Yellow corn, ground, 8.5 %	56.86	53.56	50.22	46.5	59.89	59.0	56.33	53.30	68.20	65.47	63.70	61.60
Soybean meal, 44%	*30*	*22.5*	*15*	*7.5*	*27.5*	*18.75*	*12.5*	*6.25*	*18.2*	*13.7*	*9.1*	*4.55*
***Nigella* seed meal, 30 %**	-	*11*	*22*	*33*	-	*9.17*	*18.33*	*27.5*	-	*6.8*	*13.35*	*20*
Corn glutein, 60 %	4.40	4.90	5.10	5.65	3.0	4.50	4.70	5.20	4.50	5.0	5.30	5.73
Fish meal, 71.5 %	2.50	2.50	2.70	2.70	2.0	2.0	2.20	2.20	2.50	2.50	2.50	2.50
Sunflower oil	2.60	2.0	1.50	1.0	4.0	3.0	2.50	2.10	3.20	3.0	2.60	2.35
Lime stone, ground	1.20	1.25	1.40	1.59	1.15	1.27	1.40	1.45	1.0	1.20	1.20	1.23
Dicalcium phosphate	1.26	1.15	0.90	0.80	1.35	1.20	1.0	0.90	1.30	1.25	1.17	1.13
Sodium chloride	0.26	0.26	0.26	0.26	0.24	0.23	0.24	0.24	0.20	0.21	0.21	0.21
Vitamin-mineral premix[1]	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.3	0.3	0.3
L-Lysine HCl	0.02	0.07	0.12	0.20	0.025	0.13	0.04	0.10	0.08	0.08	0.12	0.17
DL-Methionine	0.10	0.01	-	-	0.095	-	-	-	0.06	0.03	-	-
Sodium Bicarbonate	0.25	0.25	0.25	0.25	0.20	0.20	0.21	0.21	0.21	0.21	0.21	0.21
Choline chloride	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Anti-toxin	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Coccidiostate	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Cost/ton, LE[2]	885	858	844	834	865	836	810	805	837	825	813	808
Calculated composition[3]												
CP %	22.42	22.43	22.46	22.41	20.11	20.13	20.15	20.18	18.30	18.42	18.39	18.44
ME Kcal/kg	3031.5	3031.5	3028.5	3024	3128.5	3131	3131.2	3131.5	3202.5	3202.5	3201.5	3203.5
EE %	5.12	5.52	5.94	6.30	6.50	6.37	6.65	6.99	6.0	6.30	6.49	6.78
CF %	3.32	4.0	4.71	5.42	3.20	3.70	4.30	4.80	2.83	3.25	3.68	4.10
Ca %	1.0	1.0	1.0	1.0	0.99	0.99	0.99	0.99	0.93	0.97	0.95	0.96
Total P %	0.65	0.66	0.66	0.67	0.64	0.64	0.64	0.64	0.61	0.63	0.63	0.64
Na %	0.20	0.20	0.20	0.20	0.18	0.18	0.18	0.18	0.17	0.17	0.17	0.17
Cl %	0.20	0.20	0.20	0.20	0.19	0.19	0.19	0.19	0.18	0.18	0.18	0.18
Lysine %	1.23	1.22	1.21	1.23	1.12	1.12	1.0	1.0	0.98	0.95	0.95	0.96
Methionine %	0.51	0.56	0.65	0.80	0.45	0.49	0.60	0.73	0.41	0.48	0.53	0.62

1 Vitamin and mineral premix supplied the following per kilogram of the diet: vitamin A, 12000 IU; vitamin D, 2200, vitamin E, 10 mg; vitamin K3, 2 mg; vitamin B1, 1mg; vitamin B2, 5 mg; vitamin B6, 1.5 mg, vitamin B12, 0.01 mg; niacin, 30 mg; biotin, 0.05 mg; folic acid, 1 mg; pantothenic acid, 10 mg; choline, 750 mg; zinc, 50 mg; manganese, 60 mg; iron, 30 mg; copper, 4 mg; iodine, 1 mg; selenium, 0.1 mg; cobalt, 0.1 mg.

2- Based upon local feed prices prevailing at time of the experiment.

3 Calculated according to the chemical composition of feedstuffs presented in Table 1.

Table 3. Growth performance of broiler chickens fed the experimental diets (0-2 weeks)

	Experimental diets				
		% Soybean meal protein replacement			± SE[d]
	Control	25 %	50 %	75 %	
Initial weight, g	44.2	44.2[a]	43.2	43.0	0.39
Weight at 2-wk, g	361[b]	394	355[b]	331[c]	8.85
Weight gain, g	316.8[b]	349.8[a]	311.8[b]	288[c]	5.50
Feed intake, g	464[a]	460[a]	434[ab]	408[b]	10.90
Feed conversion ratio	1.46[a]	1.31[c]	1.39[b]	1.42[ab]	0.069
Feed cost, LE	0.41	0.395	0.366	0.34	

[abc] Means in the same row with different superscripts are significantly different ($P < 0.01$).
[d] Standard error of treatment means.

Table 4. Growth performance of broiler chickens fed the experimental diets (2-4 weeks)

	Experimental diets				
		% Soybean meal protein replacement			± SE[d]
	Control	25 %	50 %	75 %	
Initial weight, g	361	394	355	331	8.85
Weight at 4-wk, g	994[bc]	1050[a]	1000[ab]	946[c]	16.68
Weight gain, g	633[b]	656[a]	645[ab]	615[c]	3.24
Feed intake, g	1240[ab]	1213[b]	1242[ab]	1275[a]	15.7
Feed conversion ratio	1.96[ab]	1.85[b]	1.92[ab]	2.07[a]	0.11
Feed cost, LE	1.07	1.01	1.0	1.02	

[abc] Means in the same row with different superscripts are significantly different ($P < 0.01$)
[d] Standard error of treatment means

Table 5. Growth performance of broiler chickens fed the experimental diets (4-6 weeks)

	Experimental diets				
		% Soybean meal protein replacement			± SE[d]
	Control	25 %	50 %	75 %	
Initial weight, g	994	1050	1000	946	16.68
Final weight at 6-wk, g	1525[bc]	1650[a]	1590[ab]	1492[c]	22.61
Weight gain, g	531[b]	600[a]	590[a]	546[b]	3.10
Feed intake, g	1475[b]	1520[ab]	1535[a]	1550[a]	20.48
Feed conversion ratio	2.77[ab]	2.53[c]	2.60[bc]	2.84[a]	0.18
Feed cost, LE	1.23	1.25	1.24	1.25	

[abc] Means in the same row with different superscripts are significantly different ($P < 0.01$).
[d] Standard error of treatment means

Table 6. Allover Performance of broiler chickens fed the experimental diets (0-6 weeks)

	Experimental diets				
		% Soybean meal protein replacement			± SE[d]
	Control	25 %	50 %	75 %	
Initial weight, g	44.20	44.20	43.20	43.00	0.39
Final weight, g	1525[bc]	1650[a]	1590[ab]	1492[c]	20.48
Weight gain, g	1480.8[bc]	1605[a]	1546[ab]	1449[c]	21.79
Total feed intake, g	3179	3193	3206	3233	33.42
Feed conversion ratio	2.15[ab]	1.98[c]	2.07[bc]	2.23[a]	2.23
Feed efficiency	46.58[bc]	50.29[a]	48.15[ab]	46.36[c]	0.042
Feed cost, LE	2.71	2.65	2.61	2.61	

[abc] Means in the same row with different superscripts are significantly different ($P < 0.01$).
[d] Standard error of treatment means.

Table 7. Biochemical parameters of broiler chickens fed the experimental diets for 6 weeks

Biochemical parameter	Experimental diets				
		% Soybean meal protein replacement			± SE[e]
	Control	**25 %**	**50 %**	**75 %**	
T3 (ng/ml)	2.14[c]	3.17[b]	3.18[b]	3.91[a]	0.05
T4 (ng/ml)	62.50[d]	113.30[c]	138.50[a]	125[b]	1.24
Glucose (mg/dl)	126.89[a]	107.28[b]	94.19[c]	76.93[d]	1.11
Total proteins (gm/dl)	7.18[b]	8.41[a]	7.24[b]	7.61[b]	0.31
Albumin (gm/dl)	4.77[a]	3.44[bc]	3.22[c]	3.85[b]	0.07
Globulin (gm/dl)	2.41[c]	4.97[a]	4.02[b]	3.76[b]	0.08
Triacylglycerol (mg/dl)	240.83[a]	137.17[c]	179.57[b]	66.65[d]	1.38
Total cholesterol (mg/dl)	220.83[a]	208.10[b]	211.05[b]	212.62[b]	3.15
HDL (mg/dl)	19.53[b]	38.21[a]	29.0[a]	27.67[a]	1.76
LDL (mg/dl)	152.76[b]	142.92[c]	144.98[c]	161.58[a]	2.12

[abcd] Means in the same row with different superscripts are significantly different ($P < 0.01$).
[e] Standard error of treatment means.

Table 8. Vitamin C and glycogen concentrations in hepatic tissues and the activity of serum transaminases of broiler chickens fed the experimental diets for 6 weeks

Parameter	Experimental diets				
		% Soybean meal protein replacement			± SE[e]
	Control	**25 %**	**50 %**	**75 %**	
Liver vitamin C (mg/100g tissue)	46.07[b]	65.49[a]	73.37[a]	71.81[a]	2.75
Liver glycogen (gm/100 gm tissue)	1.65[c]	2.36[b]	2.82[a]	3.06[a]	0.12
AST (U/L)	25.02[b]	26.40[b]	23.87[b]	40.32[a]	1.36
ALT (U/L)	29.40[b]	26.16[b]	29.35[b]	46.75[a]	1.48
GGT (U/L)	21.35[b]	19.40[b]	18.41[b]	38.06[a]	1.31

[abcd] Means in the same row with different superscripts are significantly different ($P < 0.01$).
[e] Standard error of treatment means.

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الملخص العربى

معدلات النمو وبعض القياسات البيوكيميائية فى بدارى التسمين المغذاة على علائق تحتوى على كسب حبة البركة

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أجريت هذه الدراسة لاستبيان تأثير إحلال بروتين كسب حبة البركة بدلاً من بروتين كسب فول الصويا (جزء / جزء) فى علائق بدارى التسمين على معدلات النمو وبعض القياسات البيوكيميائية فى مصل الدم ونسيج الكبد، إستخدام عدد ٢٤٠ كتكوت تسمين عمر يوم من سلالة هبرد تم تقسيمها عشوائياً إلى ٤ مجموعات متساوية كل مجموعة تحتوى على ٣ مكرارات فى كل منها ٢٠ كتكوت، ثم تكوين علايق (بادي، نامي، ناهي) متساوية تقريباً فى محتوى البروتين والطاقة فى كل مرحلة، إستخدم ٣ مستويات إحلال (٢٥ ، ٥٠ ، ٧٥ ٪) مقارنة بالعليقة الضابطة، تم تغذية الكتاكيت على هذه العلائق لمدة ستة أسابيع وفى نهاية التجربة تم أخذ عينات من الدم والكبد لقياس بعض التغيرات البيوكيميائية فى مصل الدم ونسيج الكبد وكذلك نشاط بعض إنزيمات الكبد.

أوضحت النتائج أن إحلال بروتين كسب حبة البركة بدلاً من بروتين كسب فول الصويا عند معدل ٢٥ ٪ أدى إلى زيادة معنوية فى كل من وزن الجسم، معدل الزيادة اليومية، معامل التحويل الغذائى وكفاءة التحويل الغذائى مقارنة بالمعاملات الأخرى وذلك طوال فترة التجربة، بينما لم تكن هناك فروق معنوية فى هذه القياسات عند معدل إحلال ٥٠ أو ٧٥ ٪ مقارنة بالعليقة الضابطة.

أدى إحلال بروتين كسب حبة البركة جزئياً بدلاً من بروتين كسب فول الصويا إلى زيادة معنوية فى مستوى هرمونات الغدة الدرقية (T_4، T_3) وانخفاض معنوى فى مستوى الجلوكوز فى مصل الدم وذلك عند معدل إبدال ٢٥ ، ٥٠ ، ٧٥ ٪ مقارنة بالمجموعة الضابطة، ارتفع معنوياً مستوى كل من البروتينات الكلية والجلوبيولينات وذلك عند إستخدام معدل إحلال ٢٥ ٪ مقارنة بالعلائق الأخرى. أدى إستخدام بروتين كسب حبة البركة عند معدل إحلال ٢٥ ٪ من بروتين كسب فول

الصويا إلى إنخفاض معنوى فى تركيز كل من الكوليستيرول والليبوبروتينات ذات الكثافة المنخفضة (LDL) بينما كانت هناك زيادة معنوية فى تركيز الليبوبروتينات ذات الكثافة العالية (HDL) وذلك عند معدل إحلال ٢٥، ٥٠، ٧٥٪ من بروتين كسب فول الصويا.

سجلت أيضاً زيادة معنوية فى محتوى كل من ڤيتامين ج ، والجليكوچين فى أنسجة الكبد عند إستخدام بروتين كسب حبة البركة بدلاً من بروتين كسب فول الصويا فى كل مستويات الإحلال، لم يتأثر مستوى نشاط كل من إنزيمات GGT، AST، ALT فى أنسجة الكبد عند مستوى إحلال ٢٥، ٥٠٪ بينما زاد مستوى نشاط هذه الإنزيمات معنوياً عند مستوى إحلال ٧٥٪ مقارنة بالمجموعة الضابطة.

يتضح من نتائج هذه الدراسة أنه يمكن إستخدام بروتين كسب حبة البركة جزئياً بدلاً من بروتين كسب فول الصويا حتى مستوى ٢٥٪ فى علائق بدارى التسمين دون تأثير سلبى على معدلات النمو أو القياسات البيوكيميائية.