



EFFECT OF LOW-PROTEIN IN ISO-ENERGETIC DIETS ON PERFORMANCE, CARCASS CHARACTERISTICS, DIGESTIBILITIES AND PLASMA LIPIDS OF BROILER CHICKENS

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ABSTRACT: This study was conducted to determine the effect of low or high protein diets with constant ME on growth performance, carcass characteristics, digestibilities and blood parameters of Cobb Avian 48 broilers from 1 to 34 d of age. A total number of 2080 one-day-old chicks were housed randomly in 16 pens and divided into two experimental groups, each group divided into 8 replicates and each replicate has 130 birds/ pen. All birds were fed pre-starter diet (CP, 23% and ME, 2950 kcal/kg) for 4 days then the birds were divided into two experimental diets which were formulated to have 2 levels of CP respectively, in each phase: 22 and 21% CP with 3050 kcal/kg in the starter phase (5 to 10 d); 20 and 19% CP with 3100 kcal/kg in the grower phase (11 to 25 d); and 19 and 18% CP with 3180kcal/kg in the finisher phase (26 to 34 d). Digestible Lysine was maintained at 1.22, 1.12, and 0.96% of the diet in the starter, grower, and finisher periods, respectively. Body weight gain, feed intake and feed conversion as well as thigh and liver weights were not influenced by changing protein level in the diets. However, carcass weight and breast muscle weight were increased significantly ($P \leq 0.05$). On the other hand, abdominal fat weight was decreased ($P \leq 0.05$) by feeding low protein diet. Although, dry matter and crude fat utilization were not affected, while, crude protein and crude fiber utilization were improved by feeding low protein diets. Plasma GOT, GPT and total cholesterol were not changed, while; plasma HDL was increased by feeding low protein diets. Furthermore, it was observed a decrease in muscle and liver MDA by feeding low protein diets, indicating the improving of the anti-oxidative activities by decreasing the protein content in broiler diets. Economic efficiency was improved by feeding low protein diets compared to high protein diets. In conclusion, feeding Cobb Avian 48 broilers on 1% lower protein diets than the strain recommendation, at constant ME, with the same amino acids levels had not adversely affected the growth performance, carcass parameters and liver functions, while; dietary crude protein and crude fiber utilization were improved.

Key words: Broilers, Low Protein, Digestibility, Growth Performance.

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INTRODUCTION

Feeding broiler on low protein diets may reduce feed cost and allow for use of alternate feedstuffs and considered as one of the most important decisions for broiler nutritionists, because of the expense of providing sufficient protein to growing broilers. Numerous studies have been carried out to investigate the possibility of reducing dietary crude protein (CP) levels. However, meeting the nutritional requirements for growing birds constitutes the majority of costs associated with poultry production (May et al., 1998), accounting for around 75 percent of the expense (Nakaue and Arscott, 1991), and certainly is becoming an issue of even greater significance as the prices of feed ingredients continue to rise. A large portion of that cost involves meeting the protein and amino acid requirements of birds (Corzo et al., 2004; Firman and Boling, 1998; Firman, 1994). By reducing the level of crude protein in the diet it is possible to achieve significant cost savings (Eits et al., 2005). Firman (1994) reported that it is possible to save five dollars per ton of feed by reducing the protein level in the diet of turkeys by one percent. In addition to reduce feed costs, the ability to lower crude protein in the diet can result in decreased nitrogen excretion (Kidd et al., 1996; Ferguson et al., 1994; Nahm, 2002; Namroud et al., 2008), improved ability to cope with heat stress, and allow for the use of a greater variety of feedstuffs (Kidd et al., 1996), which can be valuable in itself as a method to increase flexibility in the choice of locally available feedstuffs, potentially decreasing transportation costs. Findings on different levels of (CP) effect in iso-energetic diets on broiler metabolism and body composition is necessary in order to understand broilers' response to different levels of protein (Horniakova and Abas, 2009). However, some researcher's studies

had found that reducing dietary crude protein does not affect growth performance (Parr and Summers, 1991; Moran and Stilborn, 1996). On the other hand, rate and efficiency of growth is lower, and carcass composition becomes inferior in broilers fed diets in which crude protein has been lowered by more than 2.5% of the chicken requirements, even when all known nutrient requirements are supplemented such as amino acids (Aletor et al., 2000; Bregendahl et al., 2002; Sterling et al., 2005; Waldroup et al., 2005a). Therefore, in the present study, an experiment was conducted to investigate the effect of feeding low or high CP diets at constant ME on growth performance, carcass characteristics, nutrients digestibilities and blood parameters of Cobb Avian 48 broilers.

MATERIALS AND METHODS

Birds and Housing: The animal experiment was conducted in accordance with the guideline of Kafrelsheikh University, Egypt. The experiment was conducted in an environmentally controlled house. A total number of 2080 one-day-old (Cobb Avian 48) broiler chickens were housed randomly in 16 pens and divided into two experimental groups, each group divided to 8 replicates and each replicate had 130 birds/ pen. The chickens and diets were supplied from Fat- Hens Company, Tanta, Egypt. Birds were vaccinated against Newcastle disease virus on 6 d and 21d, and the birds were kept under standard management conditions; as feed and water were provided ad libitum throughout the experimental period. The whole experimental period was divided into 4 phases: pre-starter commercial diet (1 to 4 d), starter (5 to 10 d), grower (11 to 25 d), and finisher (26 to 34 d).

Experimental Diets:

The feed ingredients used for the formulation of experimental diets were analyzed in triplicate for their dry matter, crude protein, ether extract crude fiber content according to (AOAC, 1990). According to the nutrient recommendations of the Cobb Avian 48 management guide (2014), two experimental diets were formulated to have 2 levels of CP in the last phases of growth: 22 and 21% CP with 3050 kcal/kg in the starter phase; 20 and 19% CP with 3100 kcal/kg in the grower phase; and 19 and 18% CP with 3180 kcal/kg in the finisher phase (Table 1). Digestible Lysine was maintained at 1.22, 1.12, and 0.96% of the diet in the starter, grower, and finisher periods, respectively, and the limiting amino acids like Methionine, Threonine, and Tryptophan were included according to Cobb Avian 48 recommendations. Each experimental diet was offered randomly to 8 replicates, and the experimental diets were fed from 4 to 34 d of age.

Data Collection:

Feed intake and body weight gain were recorded at the end of each diet phase, accordingly weight gain and feed conversion ratio (FCR) were easily calculated. At the end of experiment, 3 birds from each replicate were randomly selected and slaughtered (24 bird/treatment), and data on carcass yield calculated as % of live body weight including deboned breast meat yield, thigh yield, abdominal fat, and relative weights of liver and heart were recorded. Mortality was also recorded during the entire experiment. At slaughtering, blood samples were collected into heparinised test tubes, quickly centrifuged at 5,900 ×g for 10 minutes at 4°C to separate plasma, and stored at -30°C until analysis. In the last three days of the experiment, excreta were collected from 24 bird/ treatment and weighed. Then the samples were dried in a drying oven at 60 °C for 24 h. The

complete dried samples were homogenized, sampled, and then finely ground to analyze for DM according to AOAC (1994). Crude protein content in diet and excreta was determined using the Kjeldahl method (AOAC, 1994) and crude fat was measured with Soxhlet according to Bligh and Dyer (1959). Digestion coefficients of nutrients were calculated for dry matter, crude protein, crude fiber and crude fat by analyses of the diets and collected excreta.

Plasma GOT, GPT, total cholesterol level (TC), high-density lipoprotein (HDL) were measured colorimetrically by using commercial kits (Diamond Diagnostics, Egypt) according to the procedures outlined by the manufacturer. Concentration of muscle Malondialdehyde (MDA) was measured by the method of Ohkawa et al., (1979).

Economical efficiency is defined as the net revenue per unit feed cost calculated from input output analysis as described by Hassan et al., (1996).

Statistical Analysis

The differences among treatments were statistically analyzed by T test using SPSS Statistics 17.0 (SPSS 2008). $P \leq 0.05$ was set as limit of significance.

RESULTS AND DISCUSSION

Five birds were died from each treatment during the experimental period. Data presented in Table 2 shows the effects of dietary high or low protein content on growth performance of broiler chickens. Feeding high or low dietary protein content did not influence body weight gain, feed intake and feed conversion. Considerable amounts of researches have been done to evaluate the effects of low-protein diets on the growth performance and carcass characteristics of broiler chickens. However, conflicting results from these studies do not allow a clear conclusion on the effects of these diets on practical broiler production. Trials evaluating the effect of low CP diets have reported inferior

performance on broiler productivity however; others suggested no difference in growth by low protein diets. In this study, feeding high (22, 20, 19 %) or low (21, 19, 18%) dietary protein did not affect growth performance. This is in agreement with different studies (Parr and Summers, 1991; Deschepper and De Groot, 1995; Moran and Stilborn, 1996; Yamazaki et al., 1996; Aletor et al., 2000; Kamran et al., 2010). On the other hand, Kamran et al., (2008) reported that feed intake was linearly increased with reduced CP diets during grower, finisher, and overall periods. Nevertheless, the preponderance of information suggests that feed efficiency and growth performance were reduced when the dietary CP level is reduced by more than 3% from NRC (1994), even when all known nutrient requirements are met (Fancher and Jensen, 1989; Aletor et al., 2000; Bregendahl et al., 2002; Sterling et al., 2005; Waldroup et al., 2005b).

In this study, thigh and liver weights were not affected. However, carcass weight and breast muscle weight were increased significantly ($p < 0.05$). On the other hand, abdominal fat weight was decreased by feeding low protein diet. Results of increased abdominal fat and decreased muscle weight by high protein diet are in complete agreement with Yamazaki et al., (1998); (2006); Moran and Stilborn (1996). One of the mechanisms involved in decreasing carcass fatness by feeding greater protein level diets is the associated increased heat increment involved in deamination and transamination of surplus amino acids to other metabolites and finally uric acid. Rosebrough et al., (2002) showed that increase of CP can dramatically decrease *in vitro* lipogenesis. They suggested that a combination of mRNA stability and posttranscriptional events interact to regulate lipogenesis in the chicken.

Data in Table 3 shows the effect of dietary high and low protein content on

nutrients digestibility. Dry matter and crude fat digestibility were not affected by low or high diet protein content, on the other hand, crude protein and crude fiber digestibility were improved significantly ($p < 0.05$) by lowering dietary protein content. These results agree with Dean et al., (2006) and Namroud et al., (2008), who reported that with the reduction in crude protein ranging from just a few percentage points up to a 25% did not affect the growth performance and nutrients digestibility. Also, Bregendahl et al., (2002) reported that dry matter, crude protein and crude fat digestibility were not affected by changed protein when accept the chicken requirements. In this connection, studies of Blair et al., (1999); Aletor et al., (2000); Swennen et al., (2004) reported that the low protein utilization for broilers fed high-protein diets has been observed. However, Gong et al., (2005) found that no treatment differences were detected for dry matter, energy and crude protein digestibility by feeding low protein diet.

Plasma concentrations of GOT, GPT and total cholesterol (Fig.1. A, B,C) were not affected, however, Plasma HDL increased significantly ($P \leq 0.05$) (fig.1. D) by low protein diet. These result disagree with Gong et al., (2005) who found that serum cholesterol levels of broilers fed high dietary was higher ($p < 0.05$) than low protein diet. The liver function enzymes as GOT and GPT were not affected by decreasing 1% of dietary protein indicating that decreasing 1% of dietary protein is still safe to the broilers. This result is in agreement with Dairo et al., (2010) who found that plasma GOT and GPT were not affected by decreasing dietary protein by 1%.

Figure 2 shows the effect of feeding low or high protein diet on muscle and liver MDA concentration. Muscle and liver MDA concentration were decreased by feeding low protein diets, indicating an improving of the anti-oxidative activities

by decreasing the protein content in broiler diets by 1% CP. In this respect, Jimoh et al., (2005) found a significant increase ($P < 0.05$) in the concentration of malondialdehyde in the tissues of animals fed very low protein diet (more than 5%) is an indication of increased lipid peroxidation in those tissues.

Results of economic efficiency (E.E) for chicks fed experimental diets during the experiment period are summarized in Table 4. There is considerable cost saving with using low protein diets compared to high protein diet.

CONCLUSION

Feeding Cobb Avian 48 broilers on low protein diets at constant ME with same amino acids levels has not adversely affected the growth performance, carcass parameters and liver functions. While; protein utilization was improved with good impact on economical efficiency.

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Table (1): Composition and nutrient analysis of the experimental diets.

	High Protein			Low Protein		
	Starter %	Grower %	Finisher %	Starter %	Grower %	Finisher %
Yellow Corn	53.50	56.60	60.60	57.40	61.77	63.60
Soy bean meal 44%	35.20	33.30	27.00	30.97	27.60	24.60
Corn gluten meal 62%	3.40	1.30	3.70	4.40	3.00	3.40
Soybean oil	3.80	4.80	4.70	3.00	3.50	4.30
Limestone	1.10	1.00	1.00	1.10	1.00	1.10
L-Lysine HCl	0.17	0.17	0.17	0.30	0.30	0.17
DL-Methionine	0.25	0.25	0.25	0.25	0.25	0.25
NaCl	0.35	0.35	0.35	0.35	0.35	0.35
Premix*	0.30	0.30	0.30	0.30	0.30	0.30
Sodium bicarbonate	0.20	0.20	0.20	0.20	0.20	0.20
Threonine	0.03	0.03	0.03	0.03	0.03	0.03
Dicalcium phosphate	1.70	1.70	1.70	1.70	1.70	1.70
	100	100	100	100	100	100
Nutrient composition (analyzed values)						
Metabolizable energy, Kcal/kg	3050	3100	3180	3050	3100	3180
Crude protein, %	22	20	19	21	19	18
Calcium, %	0.93	0.87	0.85	0.93	0.87	0.85
Phosphorus, %	0.44	0.43	0.42	0.44	0.43	0.42
Sodium, %	0.21	0.21	0.21	0.21	0.21	0.21
Chloride, %	0.25	0.25	0.25	0.25	0.25	0.25
Digestible Lys, %	1.22	1.12	0.96	1.22	1.12	0.96

*The mixture supplied: retinol, 1.4 mg/kg; DL-γ-tocopherol acetate, 6.5 mg/kg; thiamine hydrochloride, 2.6 mg/kg; riboflavin, 6.5 mg/kg; pyridoxine hydrochloride, 1.30 mg/kg; calcium D-pantothenate, 10.4 mg/kg; nicotinic acid, 26 mg/kg; menadione sodium bisulfite, 650 μg/kg; D-biotin, 70 μg/kg; choline chloride, 780 μg/kg; pteroylglutamic acid, 520 μg/kg; cyanocobalamin, 26 μg/kg; cholecalciferol, 13 μg/kg.

Table (2): Effect of feeding low or high CP on body weight gain (BWG), feed intake (FI) feed conversion ratio (FCR) and organs weight % (Carcass weight, breast muscle weight, BMW; thigh muscle weight, TMW; liver weight, LW).

	Low Protein	High Protein	Significance
Initial BW after 4-d-old (g)	182 ± 2	183 ± 3	NS
BWG (g/30day)	1914 ± 12	1900 ± 14	NS
FI (g/30 day)	3235 ± 34	3255 ± 26	NS
FCR	1.69 ± 0.2	1.71 ± 0.3	NS
Carcass weight (g/100g BW)	73.4 ^a ± 1.1	71.9 ^b ± 0.9	*
BMW (g/100g BW)	22.8 ^a ± 1.1	21.1 ^b ± 0.9	*
TMW(g/100g BW)	15.4 ± 0.8	14.9 ± 0.7	NS
LW(g/100g BW)	1.88 ± 0.04	1.82 ± 0.06	NS
Abdominal fat W(g/100g BW)	1.52 ^b ± 0.04	1.79 ^a ± 0.05	*

Values are expressed as means ± standard error; means with different superscripts differ from each other ($P \leq 0.05$). BW, body weight; BWG, body weight gain; FI, feed intake; FCR, feed conversion ratio; BMW, breast muscle weight; TMW, thigh muscle weight; LW, liver weight.

Table (3): Effect of feeding low or high CP on nutrients digestibility.

	Low Protein	High Protein	Significance
Dry matter digest, %	75.2 ± 4.1	74.9 ± 5.2	NS
Crude protein digest, %	79.5 ^a ± 6.1	73.4 ^b ± 4.6	*
Crude fat digest, %	56.4 ± 4.2	57.1 ± 2.6	NS
Crude fiber digest, %	28.9 ^a ± 3.2	25.4 ^b ± 3.3	*

Values are expressed as means ± standard error; means with different superscripts differ from each other ($P \leq 0.05$).

Broilers, Low Protein, Digestibility, Growth Performance.

Table (4): Input/output analysis and economical efficiency of growing chicks fed the low and high protein diets

	Low Protein	High Protein
Feed cost (L.E) ¹	11.323	12.044
Selling revenue (L.E) ²	29.344	29.162
Net revenue (L.E) ³	18.021	17.118
E.E ⁴	1.59	1.42
R.E.E ⁵ %	111.97	100

¹ Feed cost = number of kg feed per bird X price of kg feed (3.5 L.E for low protein diet and 3.7 L.E for high protein diet).

² Selling revenue = body weight gain per bird X price of kg for live body weight chick (14 L.E).

³ Net revenue = difference between selling revenue and feed cost.

⁴ E.E (Economic efficiency) = net revenue/feed cost.

⁵ R.E.E (Relative economic efficiency for low protein diets), assuming high protein diets = 100%

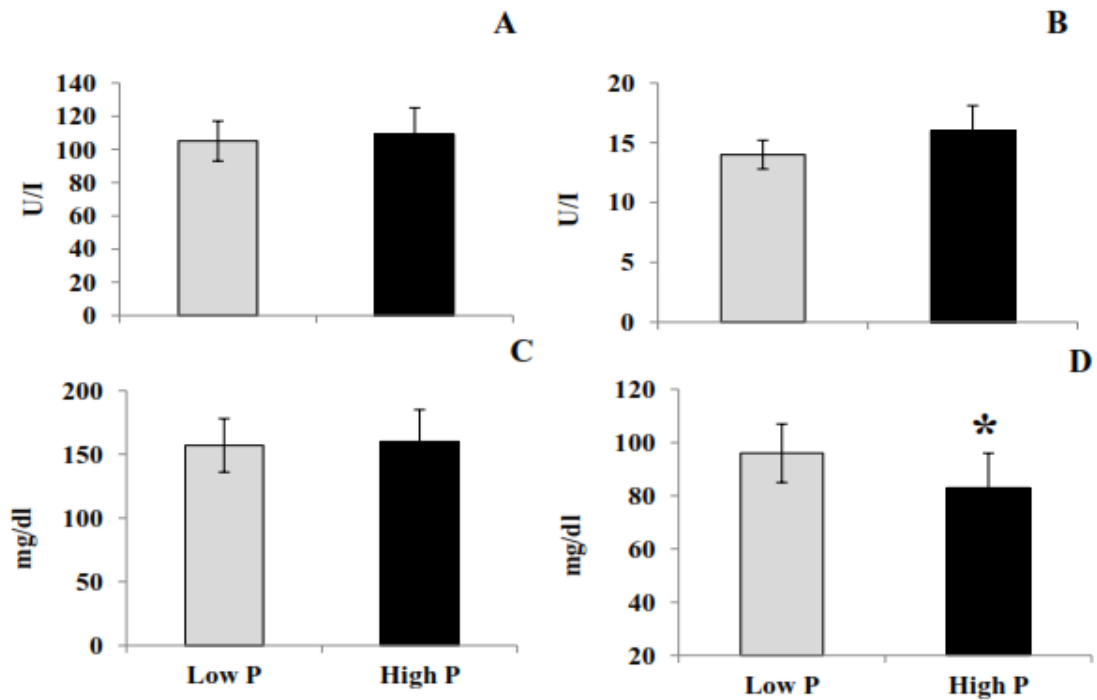


Figure 1. The effects of feeding low or high CP on plasma GOT (A), GPT (B), total cholesterol (C), HDL (D). Values are expressed as means \pm standard error; means with different superscripts differ from each other ($P \leq 0.05$).

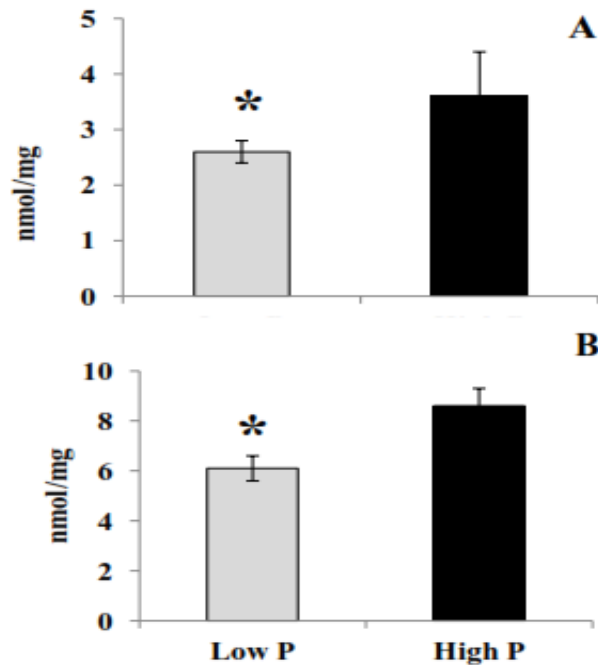


Figure 2. The effects of feeding low or high CP on muscle MDA (A) and liver MDA (B). Values are expressed as means \pm standard error; means with different superscripts differ from each other ($P \leq 0.05$).

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الملخص العربي

تأثير التغذية علي علائق منخفضة في نسبة البروتين وثابتة في الطاقة علي الأداء الإنتاجي وخصائص الذبيحة ومعاملات الهضم وبلازما الدم والكفاءة الإقتصادية في كتاكيت اللحم كب- أيفيان ٤٨

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قسم إنتاج الدواجن - كلية الزراعة جامعة كفر الشيخ - كفر الشيخ - مصر

في هذا البحث تم دراسة تأثير التغذية علي علائق منخفضة ومرتفعة في نسبة البروتين مع ثبات محتواها من الطاقة والاحتياجات من الاحماض الامينية علي الاداء الانتاجي وخصائص الذبيحة ومعاملات الهضم ودهون الدم لكتاكيت اللحم لسلالة كب ايفيان ٤٨ من عمر يوم حتي ٣٤ يوم. تم استخدام عدد ٢٠٨٠ طائر عمر يوم، تم تسكينها في ١٦ حاجز وتم تحصين الطيور وتغذيتهم جميعا علي عليقة سوبر بادئ تحتوي علي ٢٣% بروتين و ٢٩٥٠ كيلو كالوري طاقة لمدة ٤ أيام . بعد الأربعة أيام الأولى تم وزن الطيور و قسمت الي معاملتان بحيث تحتوي كل معاملة علي ٨ مكررات وبكل مكررة ١٣٠ طائر. تم تغذية المعاملة الاولى علي عليقة بادئ ونامي وناهي ٢٢، ٢٠، ١٩% بروتين علي التوالي والمعاملة الثانية علي عليقة بادئ ونامي وناهي ٢١، ١٩، ١٨% بروتين علي التوالي مع تثبيت الطاقة بحيث كانت في المعاملتان ٣٠٥٠، ٣١٠٠، ٣١٨٠ كيلو كالوري في البادئ والنامي والناهي علي التوالي . لم يتأثر وزن الجسم وإستهلاك العلف والكفاءة التحويلية معنويا وأيضا وزن الذبيحة والكبد ، بينما زاد وزن عضلات الصدر وإنخفض وزن الدهن البطني معنويا عند تقليل البروتين بنسبة ١% عن الإحتياجات المصرح بها للسلالة المستخدمة في الدراسة . لم تتأثر معاملات هضم المادة الجافة والدهون الخام لم تتأثر بينما تحسنت معاملات هضم البروتين والالياف بانخفاض البروتين. لم تتغير إنزيمات الكبد ومحتوي الدم من الكوليسترول فيما زادت نسبة الكوليسترول المفيد في الدم ، كما زادت موانع اكسدة الدهون في اللحم والكبد بانخفاض البروتين . يستنتج من الدراسة أنه بخفض نسبة البروتين في علائق التسمين لسلالة كب ايفيان ٤٨ بمقدار ١% في مراحل البادئ والنامي والناهي مع تثبيت الطاقة والاحماض الامينية لم يتأثر الأداء الانتاجي فيما زاد وزن عضلات الصدر وتحسن هضم البروتين والالياف مما له اثر جيد في خفض تكاليف التغذية لهذه السلالة في المستقبل