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EFFECT OF DIETARY ENERGY LEVEL WITH PROBIOTIC AND ENZYME ADDITION ON PERFORMANCE, NUTRIENT DIGESTIBILITY AND CARCASS TRAITS OF BROILERS

By

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Abstract: *The present study was carried out to investigate the combined effects of feeding starter and grower diets having different metabolizable energy (ME) contents and supplemented with Avian plus, Sicozyme or their combination on growth performance, nutrient digestibility, carcass traits and blood parameters of broiler chicks. Three hundred and twenty four one-day old unsexed broiler chicks (Cobb-500), were randomly divided into nine experimental treatments, each had three equal replications. Three starter and three grower diets were formulated to have 22 and 19% crude protein (CP) for starter and grower periods, respectively, but their ME contents were 3100, 2900 and 2700 kcal/kg. A probiotic (Avian plus: at 150 g/ton diet), an enzyme preparation (Sicozyme: at 500 g/ton diet), or their combination were added; thus, nine experimental diets were formulated and used. Criteria of response were growth performance [in terms of feed intake (FI), live body weight (LBW), body weight gain (BWG), feed conversion ratio (FCR), ME intake (MEI), CP intake (CPI), efficiency of energy utilization (EEU) and efficiency of protein utilization (EPU)], economic efficiency of growth (EEG)), mortality rate, nutrient digestibility, certain carcass traits, and some blood parameters.*

The obtained results could be summarized as follows: Regardless of the effect of feed additives, decreasing dietary ME level in both starter and grower periods from 3100 to 2700 kcal/kg positively affected EEU and percentage of abdominal fat and had no significant effect on final LBW, BWG, FI, CPI, EEG, carcass traits or blood parameters of broiler chicks but FCR, MEI, EPU and digestibility of dry matter, organic matter, crude protein, nitrogen-free extract and ash retention were adversely affected, particularly when ME level reached 2700 kcal/kg diet. However, dietary supplementation with Avian Plus, Sicozyme or their combination had no significant effect on all criteria of response, with the exception of a slight *significant increase in ash retention of birds fed the diets supplemented with the two feed additives as compared to those fed the diets supplemented with either Avian Plus or Sicozyme alone. There were no significant interactions between the energy level and feed additives for all criteria of response measured herein. Based on the obtained results, taking the economic aspect, growth performance and carcass traits into account, it can be concluded that the optimal dietary ME level for broiler chicks is suggested to be between 2900 and 3100 kcal/kg during both starter and grower periods; however, adding probiotics and/or exogenous enzymes can offset the negative effect of feeding low energy diets.*

INTRODUCTION

Dietary energy level appears to be the most important factor affecting feed intake. In recent years, an increasing numbers of broiler chicks are grown to heavy weights to meet consumer demands for deboned poultry meat. But the feed conversion ratio (FCR) in broiler chicks declines with advancing age, making it more important to minimize their feed costs. It is also known that although broilers generally adjust feed intake to achieve a minimum energy intake from diets containing different energy levels, these adjustments are not always precise (**NRC, 1994**). Going insight into the scientific literature, one could easily find inconsistent responses of broiler chicks to varying contents of metabolizable energy (ME) in their diets. The main reasons for this discrepancy are the nutrient composition and/or digestibility of diet, the physical form of diet, type and level of added fat, dietary ME level, strain, gender and age of bird, ambient temperature, and the interactive effects of dietary ME and amino acid density and certain additives (**Dozier III *et al*., 2007 and Zhou *et al*., 2009**).

Currently, probiotics have been used as a feed supplement in diets of different classes of poultry to enhance productive performance and immune responses (**Higgins *et al*., 2008**). In this regard, probiotics supplementation to broiler diets had positive effects on body weight gain, feed conversion ratio, and mortality rate in broiler chickens (**Anjum *et al*., 2005**). Among the proposed mechanisms for the beneficial effects of probiotics are the following: (1) maintaining beneficial microflora in the gastrointestinal tract by inhibiting the growth of pathogenic microorganisms and (2) increase the efficiency of nutrient utilization through improving the intestinal health resulting in higher activities of intestinal enzymes and nutrient availability (**Fuller, 2001**). Probiotics can also benefit the host animal by enhancing the synthesis of certain vitamins, providing digestive enzymes and increasing the production of volatile fatty acids that finally are metabolized in favor of the host **(Fuller, 2001)**. They may also increase the uptake of nutrients from gastrointestinal tract through their indirect effect on its permeability **Higgins *et al.* (2008).**

The use of exogenous enzymes in poultry feeds to improve bird performance is not a new practice but has long been documented. In this regard, **Naqvi and Nadeem (2004)** studied the bioavailability of metabolizable energy through enzyme (Kemzyme) supplementation in broiler rations having three levels of ME (3200, 3000, or 2800 kcal/kg). They found that birds fed the intermediate dietary energy level (3000 kcal/kg) plus Kemzyme exhibited better weight gain and feed conversion ratio as compared to those of birds fed the same dietary ME level without Kemzyme but comparable to those of the control broiler chickens given the control diet (containing ME level of 3200 kcal/kg). Recently, **Perić *et al.* (2008)** investigated the effect of addition of an enzyme complex (containing protease, amylase, β-glucanase, xylanase, pectinase, cellulase and phytase) to diets of different nutritive value on performance of broiler chickens, and found that enzyme addition resulted in positive effects on gain and feed conversion, regardless if it was added to a nutritionally-adequate diet or a diet of diminished nutritive value (contained 0.3 MJ of energy, 0.1% of accessible P and 0.1% Ca less compared to the control diet). More recently, **Zhou *et al.* (2009)** reported that enzyme supplementation in broiler chicken diets could improve the efficiency of energy utilization, particularly in diets with lower levels of ME. However, some investigators did not detect any positive effects of dietary enzyme supplementation for broilers ***(e.g.* Günal *et al.*, 2004** and **Sayyazadeh *et al.*, 2006**).

Therefore, the present study was designed to investigate the response of broiler chicks to feeding plant-protein diets having different ME contents and supplemented with probiotic (Avian Plus) and/or enzyme preparation (Sicozyme) during both starter and grower periods.

MATERIALS AND METHODS

The fieldwork of the present study was performed at the Poultry Research Unit; Agricultural Research and Experiment Center; Faculty of Agriculture, Mansoura University, Egypt. The feeding trial was carried out during January and February, 2008. The aim of study was to investigate the combined effects of feeding starter and grower plant-protein diets having different ME contents and supplemented with Avian plus, Sicozyme or their combination on growth performance, nutrient digestibility, certain carcass traits and some blood parameters of broiler chicks.

Experimental birds and diets:

Three hundred and twenty four, one-day old, unsexed broiler chicks (Cobb-500), having an average body weight of 49±0.6 g, were randomly divided into nine experimental treatments, each had three replications (12 chicks in each). The chicks were raised during the brooding and growing periods inside wire-floored batteries fitted with nipple drinkers and tube feeders and placed in a naturally ventilated rearing room provided with a continuous florescent illumination. During the first three weeks of age, a supplemental heat was offered to chicks. The chicks were vaccinated against avian influenza, Newcastle and Gumboro diseases and reared under similar environmental and managerial conditions. All chicks had free access to fresh drinking water and given the experimental starter diets (0 to 3 weeks of age) and grower diets (3 to 6 weeks age) on an *ad libitum* basis. Three starter and three grower diets were formulated to have 22 and 19% crude protein (CP) for starter and grower periods, respectively, but their ME contents were 3100, 2900 and 2700 kcal/kg in both starter and grower periods (Table 1). The previously mentioned dietary ME levels, tested herein, were termed as normal, intermediate and low, respectively. A probiotic (Avian plus: at 150 g/ton diet), an enzyme preparation (Sicozyme: at 500 g/ton diet), or their combination were applied in this study. Thus, nine experimental diets were formulated (3 levels of ME × 2 feed additives and their combination) and used during the starter and grower periods.

Criteria of response:

The response of broiler chicks was measured in terms of growth performance (including feed intake, live body weight, body weight gain and feed conversion ratio), mortality rate, nutrient digestibility, carcass traits, and some blood parameters. Weekly feed intake (FI) and live body weights (LBW) on a replicate group basis of birds were determined; and thus, body weight gain (BWG), feed conversion ratio (FCR; g feed consumed: g BWG), ME intake (MEI), CP intake (CPI), efficiency of utilization of energy (EEU; kcal consumed: g BWG) and protein (EPU; g CP consumed: g BWG) were calculated throughout the whole experimental period (0 to 6 weeks of age). The economic efficiency of growth (EEG) was also calculated for the whole experimental period as follows: EEG = 100 × [(sale price per kg gain - feed cost per kg gain)/feed cost per kg gain]. Mortality of birds, however, was monitored and recorded daily, and its cumulative rate was calculated.

Digestibility trials:

At 6 weeks of age, 6 chicks were selected from each treatment, around its average body weight, and placed in a separate battery compartment to serve as a metabolic cage, and fed its respective experimental diet for a period of three days. Chemical analyses of the experimental diets and droppings were carried out according to the official methods of analysis of the Association of Official Analytical Chemists **(AOAC, 1990).** The procedure described by **Jakobsen *et al* (1960)** was used for separating the fecal protein fraction in samples of droppings. Based on this procedure, the precipitated protein of droppings represents its undigested part (*i.e.* the fecal protein fraction). The urinary organic matter was calculated by multiplying the percent of urinary nitrogen by the factor 2.62 **(Abou-Raya and Galal, 1971).** Digestibility coefficients of nutrients were calculated for dry matter (DM), organic matter (OM), crude protein (CP), crude fiber (CF), ether extract (EE) and nitrogen-free extract (NFE). The retention rates of ash (AR) and nitrogen (NR) were also determined.

Carcass traits:

At the conclusion of experiment, 3 chicks from each treatment; whose body weight were near the average of its respective treatment, were selected for slaughter test. Prior to slaughter the birds were fasted for 16 hours. Just prior to slaughter and after complete bleeding, the birds were individually weighed, and immediately after scalding their feathers were plucked and evisceration was performed. Procedures of cleaning out and excising the abdominal fat were performed on the hot carcasses. The weight of abdominal fat (AF; the adipose tissues surrounding the gizzard and bursa of Fabricius and those adjacent to the cloaca) was determined. Records on the individual weights of eviscerated carcass (EC), front parts (FP; including breast yield plus neck) hid parts (HP; including thigh plus drumstick yield) and giblets (GIB; *i.e.* heart, liver without gall bladder and skinned empty gizzard) were also maintained. The dissection of carcasses was performed according to the procedure described by **Jensen (1984).** Total edible parts (TEP) were calculated as EC plus GIB. All measurements on carcass traits were expressed as percent of LBW at slaughter.

Blood parameters:

At the termination of experiment (6 weeks of age) blood samples were collected from the jugular veins of birds during slaughtering into heparinized tubes. Blood plasma was separated by centrifugation at 3000 rpm for 15 minutes. Concentrations of total protein (TPR), albumin (ALB), glucose (GLU), cholesterol (CHO), triglycerides (TRI) and the activity of alanine aminotransferase (ALT) and aspartate aminotransferase (AST) in blood plasma were determined using commercial kits according to the methods of **Henry (1964), Doumas *et al.* (1971), Trinder (1969), Allain *et al.* (1974), Tietz (1995)** and **Reitman and Frankel (1957)**, respectively. Blood plasma globulin (GLO) was calculated by subtracting the level of blood plasma albumin from that of total protein.

Statistical analysis:

A completely randomized design with a factorial arrangement of treatments (3×3: three levels of dietary ME by three types of feed additives) was subjected to two-way analysis of variance. Data were statistically processed using Statgraphics Program (**Statistical Graphics Corporation, 1991**). The significant differences among means of treatments, for each criterion, were separated at $P \leq 0.05$ by LSD-multiple range test.

RESULTS AND DISCUSSION

The statistical analysis of the obtained results proved that dietary ME level by type of feed additive interactions had no significant effects on all criteria measured in the present experiment, and hence, only effects of the main factors will be discussed herein below. It is also interesting to point out that mortality of birds was very low and not related to the effect of dietary treatments.

Growth performance of broiler chicks:

Results presented in Tables 2 and 3 summarize the effects of feeding the experimental diets having different ME contents and supplemented with probiotic (Avian Plus) and/or enzyme preparation (Sicozyme) on growth performance and economic efficiency of growth (EEG) of broiler chicks from 0-6 weeks of age. It was observed that decreasing dietary ME level in both starter and grower periods from 3100 to 2700 kcal/kg had no significant effect on final LBW, BWG, FI, CPI or EEG of broiler chicks but FCR was adversely affected ($P<0.01$) when ME level reached 2700 kcal/kg diet, regardless of the effect of feed additives. In agreement with the results of **Jones and Wiseman (1985)** the total amounts of FI for the different groups of broiler chicks during the entire experimental period were approximately similar irrespective of dietary ME level (Table 2), with the result that the total MEI of birds decreased significantly ($P<0.01$) with decreasing dietary ME level from 3100 to 2700 kcal/kg (Table 3).

On the other hand, although MEI of birds fed the intermediate (2900 kcal/kg) and low (2700 kcal/kg) ME diets were significantly lower than those of birds fed the normal (3100 kcal/kg) ME diets, the former achieved significantly better (P<0.01) EEU than the latter. Dietary ME level, however, had no significant on CPI but EPU was negatively affected (P<0.01) for birds fed the low (2700 kcal/kg) ME diets. Indeed, birds fed the low (2700 kcal/kg) ME diets had slightly more total FI and thus total CPI but their total BWG were very close to those of broiler chicks fed the normal (3100 kcal/kg) ME diets, and that could be the main cause for the poorer FCR and EPU exhibited by birds fed the low ME diets compared with their control counterparts. Alternatively, the reduced efficiency of feed and protein utilization of broiler chicks fed the low ME diets might be attributed to their lower ME: CP ratios in both starter and grower-finisher periods (Table 1), a reduction in MEI (Table 3) and/or less nutrient digestibility (*i.e.* DM, OM, CP and NFE, Table 4). It is also interesting to note that although birds fed the low (2700 kcal/kg) ME diets achieved poorer FCR and EPU compared with those fed the normal (3100 kcal/kg) ME diets, the former exhibited comparable or slightly better EEG than the latter (Table 3).

The apparent lack of an effect of dietary ME level on feed intake broiler chicks in the present study is consistent with the revised observations of the **NRC (1994)** that modern strains of broiler chicks could not precisely adjust their feed intake to changes in dietary ME density. Differences in the effects of ME density on broiler feed intake observed in other publications in the scientific literature may have been caused by differences in the range of dietary ME evaluated, the age of the birds, as well as by differences in the dietary formulation techniques used in the respective experiments. In addition, the lack of a significant effect of dietary ME level on LBW and BWG of broiler chicks in the present study is in harmony with the findings of **Summers and Leeson (1984).** Recently, **Dozier III *et al.* (2007)** found that broilers fed low apparent ME (3140 kcal/kg) diets had poorer feed conversion, but final LBW was not influenced compared with birds fed the moderate apparent ME diets (3240 kcal/kg). In partial agreement with the present results, **Leeson *et al.* (1996b)** reported that feeding broiler chicks on diets of 2700 to 3300 kcal ME/kg, by using a dietary range of supplemental fat (from 1.15 to 8.65%), had no effect on growth rate or energy intake but feed intake was linearly increased. Whereas in the present experimental diets in which ME level ranged from 2700 to 3100 kcal/kg, with no added fat, the MEI of birds was significantly depressed with decreasing the dietary ME level but FI and BWG were not affected. The reduction in MEI in response to decreasing dietary ME level coincided with no change in LBW of broiler chicks, observed herein, is in line with the findings of **Leeson *et al.* (1996a).** The findings that birds fed the low (2700 kcal/kg) ME diets were more efficient in converting energy to BWG, but attained an inferior efficiency of protein utilization (EPU) agree with the results obtained by **Leeson *et al.* (1996a)** on broiler chicks.

However, dietary supplementation with Avian Plus, Sicozyme or their combination had no significant effect on criteria of growth performance or EEG of broiler chicks, measured herein, irrespective of dietary ME level (Tables 2 and 3). In line with the present results, **Günal *et al.* (2004)** found that dietary enzyme supplementation had no effect on body weight gain, feed intake, dry matter intake or feed conversion ratio of broilers. Similar results were obtained by **Sayyazadeh *et al.* (2006),** who found that feed intake, live body weight, feed efficiency and survivability of broiler chicks, were not affected by dietary enzyme supplementation. Recently, **Midilli *et al.* (2008)** indicated that dietary probiotic and/or prebiotic supplementation did not significantly affect live body weight, weight gain or feed intake of broiler chicks.

On the other hand, some recent publications indicated positive effects of dietary enzyme or probiotic supplementation on growth performance of broiler chicks. For example, **Timmerman *et al.* (2006)** observed that broilers given drinking water supplemented with chicken-specific probiotic had a productivity index, taking into account daily weight gain, feed efficiency and mortality, superior to that of the non-supplemented birds. In addition, **Gao *et al.* (2008)** demonstrated that dietary supplementation with yeast culture at 2.5 g/kg improved average daily gain and feed conversion of broiler chicks. Moreover, **Perić *et al.* (2008)** observed that enzyme addition to diets of different nutritive values had positive effects on performance of broiler chickens in terms of body weight gain and feed conversion, regardless if it was added to a nutritionally-adequate diet or a diet of diminished nutritive value. More recently, **Zhou *et al.* (2009)** reported that enzyme supplementation in broiler chicken diets could improve the efficiency of energy utilization, particularly in diets with lower levels of ME. In addition, **Sherif (2009a)** observed positive effects for adding different types of enzyme preparations in the grower-finisher diets of broilers on final live body weight, weight gain, but feed intake and feed conversion were not affected; Natuzyme and Sicozyme brought about the best results. In another study, **Sherif (2009b)** found that dietary supplementation with Avian plus and Natuzyme improved feed conversion and economic efficiency of growth for broiler chicks fed plant protein diets, but feed intake and body weight gain were not affected.

Digestibility of nutrients:

The data on digestibility of nutrients at 6-week-old broilers as affected by feeding experimental diets having different ME contents and supplemented with Avian Plus and/or Sicozyme are shown in Table 4. Apart from the effect of feed additives, decreasing dietary ME level from 3100 to 2700 kcal/kg was associated with significant reductions in the digestibility coefficients of DM, OM, CP and NFE, and ash retention. But feeding the intermediate ME (2900 kcal/kg) diets negatively affected the digestibility of DM, OM and ash retention as compared to those of birds fed the normal ME (3100 kcal/kg) diets. It is worthy noting that the lower ME diets, used in the present study, were formulated using higher amounts of wheat bran, a feed ingredient known to have antinutritional factors such as phytic acid and non-starch polysaccharides, which may contribute to lower digestibility of DM, OM, CP and/or NFE, and reduced ash retention. Feed additives applied herein, however, did not affect nutrient digestibility of broiler chicks, with the exception of a slight significant increase in ash retention of birds fed the diets supplemented with the two feed additives as compared to those fed the diets supplemented with either Avian Plus or Sicozyme alone.

In line with the present results, **Zhou *et al.* (2009)** indicated that the apparent digestibility of DM and retention of CP decreased linearly with decreasing ME level in broiler diets from 12.55 to 11.55 MJ/kg. Contrary to the present findings, **Ghazalah and Alsaady (2008)** observed no significant effects of dietary energy level on digestibility of OM, CP or NFE of broiler chicks. However, **El-Husseiny *et al.* (2002)** found that decreasing dietary energy level (from 3200 to 2800 kcal/kg) had a positive effect on the digestibility of CP whereas those of EE, NFE and ME were negatively affected. In general, differences in nutrient digestibility of broiler chicks fed diets of varying energy contents may stem from a number of factors such as dietary nutrient density, feed ingredients, level of added fat, age of bird and/or other factors that may directly or indirectly affect absorption and availability of nutrients.

The insignificant differences in digestibility of nutrients, observed herein, for broiler chicks fed diets supplemented with Avian Plus and/or Sicozyme disagree with results obtained by **Sherif (2009a)**, who found that adding different types of commercial enzyme preparations to broiler diets had positive effects on the digestibility of CP and EE, and nitrogen retention as compared to those fed the non-supplemented diets. Similar results were also reported by **Sherif. (2009b)**, who demonstrated that digestibilities of DM, OM and NFE of boiler chicks were improved in response to adding Avian plus and Natuzyme to their diets. In addition, **Wang *et al.* (2005)**

found that apparent CP digestibility in broiler chicks increased linearly in response to feeding diets supplemented with graded levels of commercial enzymes.

Carcass traits of broiler chicks:

Data in Table 5 summarize the effects of feeding the experimental diets containing different ME contents and supplemented with Avian Plus and/or Sicozyme on carcass traits of 6-week-old broiler chicks. It was observed that with the exception of abdominal fat, other carcass traits of broilers were not significantly affected by either dietary ME level or feed additives. The relative weight of abdominal fat (% of LBW) was significantly decreased (P<0.01) in response to decreasing dietary ME level from 3100 to 2700 kcal/kg but feed additives had no effect.

The observed reduction in abdominal fat of broilers in response to decreasing dietary ME level could be attributed mainly to narrowing the calorie: CP ratio in their diets, since all groups of birds ate approximately similar amounts of feed and no supplemental fat was used (Table 2), and all the experimental diets had similar contents of EE (Table 1). In the present study, the dietary calorie: CP ratio decreased by 18 units (from 140.63 to 122.66) in starter diets and by 21 units (from 163.26 to 142.11) in grower diets with decreasing ME level from 3100 to 2700 kcal/kg diet. The reduction in abdominal fat content of broilers in response to decreasing dietary ME level in the present study agrees with the results reported by **Deaton and Lott (1985)** and **Rabie and Szilagyi (1998)** who found that the relative weight of abdominal fat increased as dietary energy level increased. Similarly, **Leeson *et al.* (1996b)** reported significant reductions in abdominal fat pad as percentage of carcass weight in response to decreasing ME contents in broiler diets from 3300 to 2700 kcal/kg. On the other hand, it has been reported that increasing concentrations of dietary ME will not alter abdominal fat percentage if the ratio of calories to CP remains constant **(Hidalgo *et al.*, 2004).**

In agreement with the present results, **Holsheimer and Ruesink (1993)** observed that carcass yields were unresponsive to dietary ME level, within a range of 2750 to 3250 kcal of ME/kg of diet. In a later study, **Hidalgo *et al.*, (2004)** reported similar carcass yield responses to increasing ME concentration in the diets of straight-run broilers. In addition, **Downs *et al.* (2006)** found that dietary energy density did not influence carcass characteristics of broiler chicks. However, the observation that dietary Avian Plus and/or Sicozyme had no significant effect on carcass traits of broiler chicks in the present study is in partial accordance with the findings of **Sayyazadeh *et al.* (2006)** who found that carcass yield and abdominal fat of broiler chicks were not significantly affected by enzyme supplementation to maize, wheat and barley-based diets. Similar results were also obtained by **Sherif (2009b)** who found that adding graded levels of Avian plus and Natuzyme in plant-protein diets for broiler chicks did not affect carcass traits of birds.

Blood parameters of broiler chicks:

Data of blood parameters for 6-week-old broiler chicks fed the experimental diets containing different ME contents and supplemented with Avian Plus and/or Sicozyme are presented in Table 6. It is evident that neither dietary ME level nor feed additives had a significant effect on all blood plasma parameters, examined herein, including levels of glucose, cholesterol, total protein, albumin globulin and triglycerides, and activities of transaminases: AST and ALT in blood plasma.

The present results are in partial agreement with those reported by **Corduk *et al.* (2007)** who found that dietary ME density had no significant effect on blood serum concentrations of glucose, cholesterol, triglycerides and creatinine of the broiler chickens. They also found that activity of AST in blood serum was elevated in chickens fed a high ME diet (13.39 MJ/kg) compared to those on a low ME diet (12.55 MJ/kg). Similar data were published by **Elagib *et al.* (2008)** who found that dietary energy level appeared to have no significant effect on blood plasma levels of total protein, albumin and globulin in boiler chicks. In addition, **Ragab and Osman (2008)** showed that broilers fed a high energy finisher diet (ME of 3320 kcal/kg) exhibited comparable levels of serum constituents to those fed the control diet (ME of 3135 kcal/kg), with the exception of higher levels of total protein and globulin for birds fed the high energy diet. Inconsistent with the present results, **El-Husseiny and Ghazalah (1989)** demonstrated that lipid constituents of blood serum increased with increasing the energy level in boiler diets. In a later study, **El-Husseiny *et al.* (2002)** found that decreasing dietary energy level (from 3200 to 2800 kcal/kg) in broiler diets decreased blood plasma total lipids, cholesterol and glucose. Recently, **Abou-Zeid *et al.* (2007)** found that increasing energy level in broiler diets resulted in an increase in plasma total lipids, triglycerides and cholesterol.

The lack of a significant effect of feed additives, utilized in the present study, on blood plasma parameters of broiler chicks is in harmony with the findings of **Sherif (2009a, b)**. In his first study, **Sherif (2009a)** found that adding different types of commercial enzymes preparations

(Phytase, Natuzyme, Sicozyme or Avizyme) to broiler diets had no effects on blood parameters. In the second study, **Sherif (2009b)** found that plasma blood parameters of broiler chicks were not affected by adding probiotic (Avian plus) and enzyme preparation (Natuzyme) in their diets. On the other hand, there is evidence that probiotic supplementation led to a significant decrease in blood plasma cholesterol and/or triglycerides (*e.g.* **Gudev *et al.*, 2008**; **Paryad and Mahumoudi (2008)** in pigs and broiler chicks.

Taking the economic aspect, growth performance and carcass traits into account, it can be concluded that the optimal dietary ME level for broiler chicks is suggested to be between 2900 and 3100 kcal/kg during both starter and grower periods; however, adding probiotics and/or exogenous enzymes can offset the negative effect of feeding low energy diets.

Table 1: Composition and chemical analyses of the experimental diets fed to broiler chicks

Ingredients	Starter diets* ME levels			Grower diets* ME levels		
	3100	2900	2700	3100	2900	2700
Yellow corn	65.10	58.72	52.25	70.80	64.30	56.68
Soybean meal (44% CP)	14.20	22.80	31.52	11.00	19.60	22.63
Wheat bran	—	4.00	8.00	1.28	5.28	13.00
Corn gluten meal (60%CP)	15.50	9.50	3.50	12.15	6.29	3.29
Dicalcium phosphate	2.20	2.10	2.00	2.00	1.90	1.80
Limestone	1.80	1.80	1.80	1.80	1.80	1.80
Common salt	0.30	0.30	0.30	0.30	0.30	0.30
Vit. & min. Premix**	0.30	0.30	0.30	0.30	0.30	0.30
DL-Methionine	0.10	0.15	0.18	0.05	0.10	0.13
Lysine-HCl	0.50	0.33	0.15	0.32	0.13	0.07
Total	100	100	100	100	100	100
Calculated analysis (air dry basis)						
ME; kcal/kg	3101	2901	2701	3102	2903	2703
CP; %	22.05	22.02	22.02	19.00	19.03	19.02
ME: CP ratio	140.63	131.74	122.66	163.26	152.55	142.11
EE; %	2.97	2.77	2.57	3.12	2.92	2.80
CF; %	2.63	3.45	4.28	2.63	3.45	4.30
Ca; %	1.22	1.23	1.23	1.17	1.17	1.17
Total P; %	0.76	0.79	0.83	0.72	0.75	0.80
Non-phytate P; %	0.48	0.48	0.48	0.44	0.44	0.44
Lysine; %	1.21	1.21	1.21	0.93	0.92	0.93
Methionine; %	0.54	0.54	0.54	0.43	0.44	0.45
Meth. & cystine; %	0.92	0.92	0.91	0.77	0.77	0.78
Determined analysis (on dry matter basis)						
DM; %	91.32	91.41	91.25	92.54	92.67	92.44
CP; %	23.29	23.32	23.35	20.08	20.14	20.24
Ash; %	6.69	6.80	6.85	6.76	7.01	6.76
EE; %	3.39	3.11	2.99	3.11	2.88	2.86
CF; %	2.79	3.68	4.50	2.71	3.59	4.46
NFE; %	63.84	63.09	62.31	67.34	66.38	65.68
Cost of 1kg diet; L.E.	2.56	2.50	2.43	2.40	2.39	2.25

*: All starter and grower diets were used after supplementation with Avian plus (150g/ton), Sicozyme (500g/ton) or their combination.

Avian plus is a probiotic containing *Lactobacillus acidophilus*, 90,000,000 CFU/kg; *Bifedobacteruim longhum*, 90,000,000 CFU/kg; *Bifedobacterium thermophilum*, 90,000,000 CFU/kg; *Enteroccus faecium*, 90,000,000 CFU/kg and *Lactobacillus planetarium*, 400,000,000 CFU/kg, as declared by the manufacturer.

Sicozyme is an enzyme preparation containing Endo-1, 3 (4) beta glucanase, 40000 U/kg; Protease, 10000 U/kg; Pectinase, 40000 U/kg and Amylase, 8000000 U/kg, as declared by the manufacturer.

** Each 3 kg premix contains: Vit. A, 12,000,000 IU; Vit. D_3, 2,500,000 IU; Vit. E, 10 g; Vit. K, 2.5 g; Vit. B_2, 5 g; Vit. B_6, 1.5 g; Vit. B_{12}, 10 mg; Biotin, 50 mg; Folic acid, 1.0 g; Nicotinic acid, 30 mg; Pantothenic acid, 10 g; Antioxidant, 10 g; Mn, 60 g; Cu, 10 g; Zn, 55 g; Fe, 35 g; I, 1.0 g; Co, 250 mg and Se, 150 mg.

Table 2: Effects of feeding the experimental diets on growth performance of broiler chicks from 0-6 weeks of age

Dietary treatments	Criteria of growth performance				
	LBW[1] (g)		BWG[2] (g)	FI[3] (g)	FCR[4] (g feed: g gain)
Main factors	day-old	42 d-old	0- 6 weeks old	0- 6 weeks old	0- 6 weeks old
ME level (kcal/kg): A					
3100: A1	48.84	1937.6	1889	3656.3	1.938[a]
2900: A2	48.80	1963.6	1915	3680.4	1.921[a]
2700: A3	49.63	1912.6	1863	3798.3	2.040[b]
SEM[5]	0.35	27.68	27.60	51.46	0.017
Significance	NS	NS	NS	NS	**
Feed additive: B					
Avian Plus: B1	49.12	1930.4	1881	3696.8	1.966
Sicozyme :B2	49.21	1960.8	1912	3748.8	1.963
Pro. + Enz.: B3	48.94	1922.5	1874	3689.4	1.970
SEM[5]	0.35	27.68	27.60	51.46	0.017
Significance	NS	NS	NS	NS	NS
AB Interactions:					
A1×B1	48.61	1988.2	1940	3760.0	1.938
A1×B2	49.17	1959.3	1910	3643.8	1.912
A1×B3	48.75	1865.1	1816	3565.0	1.963
A2×B1	49.03	1930.7	1882	3531.9	1.876
A2×B2	48.89	1967.9	1919	3776.0	1.968
A2×B3	48.47	1992.2	1944	3733.3	1.921
A3×B1	49.72	1872.2	1823	3798.5	2.084
A3×B2	49.58	1955.3	1906	3826.8	2.010
A3×B3	49.58	1910.3	1861	3769.7	2.026
SEM[5]	0.598	47.94	47.80	89.13	0.029
Significance	NS	NS	NS	NS	NS

[1-5]: Refer to live body weight, body weight gain, feed intake, feed conversion ratio and standard error of the means, respectively. **: Significant at $P \leq 0.01$, NS: Not significant.

Table 3: Effects of feeding the experimental diets on energy and protein intakes and utilization, and economic efficiency of growth (EEG) of broiler chicks from 0-6 weeks of age

Dietary treatments	MEI[1] (kcal)	EEU[2] (kcal MEI: g gain)	CPI[3] (g)	EPU[4] (g CPI: g gain)	EEG (%)
Main factors	0- 6 weeks old	0- 6 weeks old	0- 6 weeks old	0- 6 weeks old	0- 6 weeks old
ME level (kcal/kg): A					
3100: A1	11340.8[a]	6.010[a]	721.2	0.382[b]	160.8
2900: A2	10682.4[b]	5.577[b]	727.6	0.380[b]	165.1
2700: A3	10265.1[b]	5.513[b]	749.2	0.402[a]	163.6
SEM[5]	150.69	0.049	9.819	0.003	2.25
Significance	**	**	NS	**	NS
Feed additive: B					
Avian Plus: B1	10726.6	5.696	729.4	0.388	163.4
Sicozyme :B2	10868.0	5.691	740.1	0.388	163.5
Pro. + Enz.: B3	10693.9	5.713	728.5	0.389	162.6
SEM[5]	150.69	0.049	9.819	0.003	2.25
Significance	NS	NS	NS	NS	NS
AB Interactions:					
A1×B1	11662.6	6.012	741.5	0.382	160.4
A1×B2	11302.1	5.931	718.5	0.377	164.4
A1×B3	11057.8	6.087	703.5	0.387	157.6
A2×B1	10251.5	5.444	697.6	0.371	171.7
A2×B2	10959.8	5.711	746.9	0.389	158.7
A2×B3	10836.0	5.575	738.2	0.380	165.0
A3×B1	10265.5	5.633	749.1	0.411	158.1
A3×B2	10342.1	5.431	754.8	0.396	167.5
A3×B3	10187.8	5.476	743.8	0.400	165.2
SEM[5]	261.0	0.085	17.01	0.006	3.89
Significance	NS	NS	NS	NS	NS

[1-5]: Refer to ME intake, efficiency of energy utilization, CP intake, efficiency of protein utilization and standard error of the means, respectively. **: Significant at $P \leq 0.01$, NS: Not significant.

Table 4: Effects of feeding the experimental diets on the nutrients digestibility of 6-week-old broiler chicks

Dietary treatments	Digestibility coefficients of nutrients							
	DM[1]	OM[2]	CP[3]	EE[4]	CF[5]	NFE[6]	NR[7]	AR[8]
Main factors	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
ME level (kcal/kg): A								
3100: A1	76.1[a]	78.6[a]	93.4[a]	84.7	15.9	83.7[a]	69.2	42.0[a]
2900: A2	74.6[b]	77.4[b]	93.3[a]	86.0	16.1	82.9[a]	69.0	37.6[b]
2700: A3	71.9[c]	74.6[c]	92.0[c]	85.6	17.5	80.9[b]	65.0	35.3[b]
SEM[9]	0.335	0.326	0.388	0.998	0.880	0.471	1.45	1.27
Significance	**	**	*	NS	NS	**	NS	**
Feed additive: B								
Avian Plus: B1	74.2	76.9	92.9	84.7	16.6	83.1	66.2	36.2[b]
Sicozyme :B2	74.1	76.8	92.6	85.5	16.2	82.5	67.8	37.3[b]
Pro. + Enz.: B3	74.4	76.8	93.1	86.0	16.7	82.0	69.2	41.4[a]
SEM[9]	0.335	0.326	0.388	0.998	0.880	0.471	1.45	1.27
Significance	NS	NS	NS	NS	NS	NS	NS	*
AB Interactions:								
A1×B1	76.0	78.7	93.3	83.5	15.0	84.6	67.0	38.7
A1×B2	75.6	78.1	93.1	85.6	17.3	82.8	69.6	40.9
A1×B3	76.8	79.0	93.8	85.0	15.3	83.6	71.1	46.5
A2×B1	73.8	76.6	93.1	84.3	19.3	81.7	68.8	36.7
A2×B2	75.3	78.1	93.5	86.7	13.4	84.2	68.8	37.9
A2×B3	74.8	77.5	93.2	86.9	15.8	82.9	69.4	38.1
A3×B1	72.6	75.5	92.3	86.2	15.5	83.0	62.9	33.2
A3×B2	71.4	74.2	91.4	84.3	18.0	80.4	65.0	32.9
A3×B3	71.7	74.0	92.2	86.2	19.0	79.4	67.1	39.6
SEM[9]	0.581	0.565	0.672	1.73	1.52	0.816	2.51	2.19
Significance	NS	NS	NS	NS	NS	NS	NS	NS

[1-9]: Refer to dry matter, organic matter, crude protein, ether extract, crude fiber, nitrogen-free extract, nitrogen retention, ash retention and standard error of the means, respectively.
**: Significant at P≤0.01, *: Significant at P≤0.05, NS: Not significant.

Table 5: Effects of feeding the experimental diets on carcass traits of broiler chicks at 42 days of age

Dietary treatments Main factors	LBW[1] (g)	EC[2] (%)	FP[3] (%)	HP[4] (%)	GIB[5] (%)	TEP[6] (%)	AF[7] (%)
ME level (kcal/kg): A							
3100: A1	2084	68.38	38.09	30.30	4.37	72.75	1.97[a]
2900: A2	2062	69.16	38.49	30.67	4.18	73.33	1.60[b]
2700: A3	2062	68.28	38.73	29.54	4.16	72.44	1.03[c]
SEM[8]	38.68	0.447	0.565	0.610	0.129	0.447	0.112
Significance	NS	NS	NS	NS	NS	NS	**
Feed additive: B							
Avian Plus: B1	2075	68.77	37.47	31.31	4.26	73.03	1.55
Sicozyme :B2	2057	68.37	39.24	29.13	4.25	72.62	1.63
Pro. + Enz.: B3	2076	68.68	38.61	30.07	4.19	72.87	1.42
SEM[8]	38.68	0.447	0.565	0.610	0.129	0.447	0.112
Significance	NS	NS	NS	NS	NS	NS	NS
AB Interactions:							
A1×B1	2097	68.28	36.39	31.89	4.40	72.68	2.07
A1×B2	2090	68.17	39.38	28.80	4.50	72.67	2.07
A1×B3	2065	68.69	38.49	30.20	4.20	72.89	1.78
A2×B1	2060	69.33	38.37	30.95	4.26	73.58	1.53
A2×B2	2032	69.40	39.45	29.95	4.12	73.51	1.67
A2×B3	2095	68.74	37.64	31.10	4.15	72.90	1.60
A3×B1	2068	68.70	37.63	31.07	4.13	72.84	1.06
A3×B2	2048	67.53	38.88	28.64	4.15	71.68	1.14
A3×B3	2068	68.60	39.69	28.91	4.21	72.81	0.89
SEM[8]	67.0	0.773	0.979	1.056	0.224	0.774	0.195
Significance	NS	NS	NS	NS	NS	NS	NS

[1-8]: Refer to live body weight at slaughter and relative weights (% of LBW) of eviscerated carcass, front parts, hind parts, giblets, total edible parts, abdominal fat and standard error of the means, respectively.

**: Significant at $P \leq 0.01$, NS: Not significant.

Table 6: Effects of feeding the experimental diets on some blood plasma parameters of broiler chicks at 42 days of age

Dietary treatments	GLU[1]	CHO[2]	TPR[3]	ALB[4]	GLO[5]	TRI[6]	AST[7]	ALT[8]
Main factors	(mg/dL)		(g/dL)			(mg/dL)	(U/l)	(U/l)
ME level (kcal/kg): A								
3100: A1	219	97.9	3.51	1.48	2.03	106.1	123	37.11
2900: A2	230	109.0	2.99	1.71	1.28	96.5	111	37.56
2700: A3	241	105.0	3.27	1.59	1.68	101.8	122	36.89
SEM[9]	7.39	5.43	0.30	0.07	0.32	5.89	4.93	1.21
Significance	NS	NS	NS	NS	NS	NS	NS	NS
Feed additive: B								
Avian Plus: B1	229	109.2	3.50	1.59	1.91	97.9	114	37.89
Sicozyme :B2	227	103.7	3.22	1.68	1.54	99.7	124	37.89
Pro. + Enz.: B3	234	99.1	3.04	1.51	1.53	106.9	118	35.78
SEM[9]	7.39	5.43	0.30	0.07	0.32	5.89	4.93	1.21
Significance	NS	NS	NS	NS	NS	NS	NS	NS
AB Interactions:								
A1×B1	213	103.1	3.53	1.37	2.17	98.1	117	36.33
A1×B2	222	94.4	3.63	1.63	2.00	95.6	126	37.33
A1×B3	221	96.3	3.37	1.43	1.93	124.7	125	37.67
A2×B1	234	116.2	3.20	1.80	1.40	99.7	116	39.0
A2×B2	223	105.0	2.63	1.73	0.90	90.6	109	38.33
A2×B3	234	106.0	3.13	1.60	1.53	99.4	107	35.33
A3×B1	240	108.4	3.77	1.60	2.17	96.0	108	38.33
A3×B2	237	111.6	3.40	1.67	1.73	112.8	138	38.0
A3×B3	246	95.0	2.63	1.50	1.13	96.6	121	34.33
SEM[9]	12.81	9.41	0.52	0.12	0.55	10.20	8.54	2.09
Significance	NS	NS	NS	NS	NS	NS	NS	NS

[1-9]: Refer to levels of glucose, cholesterol, total protein, albumin, globulin and triglycerides, and activity of aspartate aminotransferase and alanine aminotransferase in blood plasma, and standard error of the means, respectively. NS: Not significant.

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الملخص العربي

تأثير مستوي طاقة الغذاء وإضافة المنشطات الحيوية والإنزيمات علي الأداء الانتاجي ومعاملات هضم العناصر الغذائية ومواصفات الذبيحة لكتاكيت اللحم

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أجريت هذه الدراسة لمعرفة التأثير المشترك للعلائق النباتية المحتوية علي مستويات مختلفة من الطاقة والمزودة بالمنشط الحيوي (Avian plus) أو المستحضر الانزيمي (Sicozyme) أو مخلوطهما معاً علي معايير النمو ومعاملات هضم العناصر الغذائية ومواصفات الذبيحة وبعض مقاييس الدم لكتاكيت اللحم. تم توزيع عدد ٣٢٤ كتكوتا غير مجنس عمر يوم من سلالة Cobb-500 عشوائيا في ٩ معاملات تجريبية بكل معاملة ثلاث مكررات متساوية. تم تكوين ثلاثة علائق بادئة وثلاثة علائق نامية تحتوي علي ٢٢%، ١٩% بروتين خام علي التوالي لكن مستويات الطاقة القابلة للتمثيل بالعلائق كانت ٣١٠٠، ٢٩٠٠، ٢٧٠٠ ك كالوري/كجم. تم إضافة المنشط الحيوي إلى العلائق بمعدل ١٥٠ جم/طن أوالمستحضر الانزيمي بمعدل ٥٠٠ جم/طن أو إضافة مخلوطهما معا، بالتالي تم تكوين تسعة علائق تجريبية. تم أخذ قياسات النمو المتمثلة في استهلاك العلف ووزن الجسم والزيادة الوزنية ومعدل التحويل الغذائي واستهلاك الطاقة والبروتين ومعدل الاستفادة من الطاقة والبروتين وكذلك تم حساب الكفاءة الاقتصادية للنمو ومعدل النفوق ومعاملات هضم العناصر الغذائية ومواصفات الذبيحة وبعض قياسات الدم. ويمكن تلخيص أهم النتائج فيما يلي: بغض النظر عن تأثير الاضافات الغذائية، أحدث خفض طاقة الغذاء خلال مرحلتي البادئ والنامي من ٣١٠٠ إلي ٢٧٠٠ ك كالوري/كجم أثرا إيجابيا علي معدل الاستفادة من الطاقة ونسبة الدهن البطني في الذبيحة ولم يؤثر معنويا علي وزن الجسم النهائي وكذلك الزيادة الوزنية والمأكول من الغذاء والبروتين والكفاءة الاقتصادية للنمو وصفات الذبيحة ومقاييس الدم لكتاكيت اللحم، بينما نتج عن خفض طاقة الغذاء أثرا سلبيا علي كل من معامل التحويل الغذائي واستهلاك الطاقة ومعدل الاستفادة من البروتين ومعاملات هضم كل من المادة الجافة والمادة العضوية والبروتين الخام والمستخلص خالي الأزوت والمحتجز من الرماد وخاصة عند خفض مستوي طاقة العليقة إلى ٢٧٠٠ ك كالوري/كجم. لم يكن لإضافة المنشط الحيوي أو المستحضر الانزيمي أو مخلوطهما للعلائق تأثيرا معنويا علي كل القياسات المأخوذة باستثناء زيادة معنوية في نسبة المحتجز من الرماد للطيور المغذاة علي العلائق المضاف لها مخلوط المنشط الحيوي والمستحضر الانزيمي معاً. لم يلاحظ تأثير معنوي للتفاعل بين مستوى طاقة الغذاء والاضافات الغذائية علي كل القياسات المأخوذة في هذه الدراسة. وبناء علي نتائج هذه الدراسة، وبالنظر للناحية الاقتصادية والأداء الانتاجي ومواصفات الذبيحة يمكن استنتاج أن مستوي طاقة الغذاء المناسب لكتاكيت اللحم في حدود ٢٩٠٠ – ٣١٠٠ ك كالوري/كجم خلال فترتي البادئ والنامي، ومن ناحية أخرى فإن إضافة المنشط الحيوي و/أو المستحضر الانزيمي للعلائق يمكن أن يعادل التأثير السلبي للتغذية على العلائق منخفضة الطاقة.