J. Agric. Sci. Mansoura Univ., 28 (10): 7139 - 7155, 2003

EFFECTS OF DIETARY ENZYME SUPPLEMENTATION WITH SOME PLANT PROTEIN LEVELS ON THE PERFORMANCE OF BROILER CHICKS

Sherif, Kh. El.; M. H. Rabie; F. S. A. Ismail and A. H. Raya
Poultry Production Department, Faculty of Agriculture, Mansoura University, Egypt

ABSTRACT

The present study was carried out to evaluate the response of broiler chickens fed diets with different crude protein levels to dietary enzyme (Allzyme Vegpro) supplementation. Day-old unsexed broiler chicks were fed on a commercial starter diet (contained 22% crude protein and metabolizable energy, ME, of about 3100 kcal/kg) up to 17 days of age. Then, two hundred and fifty-two birds were randomly distributed into six equal experimental groups, each with six equal replicate groups, kept at the rearing batteries and fed *ad libitum* their respective mash experimental diets. Six iso-energetic diets (ME of about 3000 kcal/kg) contained three levels of crude protein (20, 18 or 16%) and two levels of enzyme supplementation (0.0 or 1.5 g/kg diet) were formulated and used from 17 to 45 days of age. The criteria of response were live body weight, daily weight gain, feed intake, protein intake and feed conversion. Total mortality and economic efficiency of feeding were also determined. Nutrient digestibilities of the experimental diets were measured when the birds were 5 weeks of age. At the termination of the study, certain parameters of carcass traits and some blood constituents (plasma levels of glucose, total protein, total lipids and cholesterol as well as activities of plasma transaminases: AST and ALT) were quantified. The results obtained, for the whole experimental period, can be summarized as follows:

Regardless of enzyme supplementation, decreasing dietary crude protein (CP) level from 20 to 16% adversely affected ($P\leq0.01$) live body weight, body weight gain, daily protein intake, feed conversion ratio and economic efficiency of feeding. Also, decreasing dietary CP level significantly ($P\leq0.01$) increased abdominal fat percentage. However, dietary CP level had no significant effects on mortality of chicks, daily feed intake, nutrient digestibility, tested blood parameters or carcass traits. Enzyme supplementation, regardless of dietary CP level, significantly improved ($P\leq0.01$) the feed conversion ratio of broiler chicks during the whole period of study. All other criteria measured were not significantly ($P>0.05$) influenced by the enzyme supplementation. Also, the interactions between dietary CP level and enzyme supplementation were not significant ($P>0.05$) for all studied criteria. Under the conditions of this study, economically, it was concluded that a level of 20% CP with or without enzyme supplementation is the optimal dietary protein level in grower broiler diets for maximizing broiler growth performance and optimizing the efficiency of feed utilization. The diet should also be well balanced in all nutrients and its CP content should provide a balanced pattern of amino acids.

Keywords: Allzyme Vegpro, dietary protein level, broiler performance

INTRODUCTION

Nowadays, there is an ongoing progress in the biotechnological techniques addressed to the production of commercial feed enzymes. This progress may be involved in the current enhanced use of certain exogenous enzymes in diets of broiler chicks, for improving their efficiency of feed utilization and/or optimizing the growth performance of chicks. Thus, certain feed enzymes (e.g. carbohydrase, protease, lipase and phytase) are intentionally added to animal and poultry diets. The main targets for the use of these enzymes are to increase the digestibility and availability of nutrients, to remove the anti-nutritional factors, to reduce feed formulation costs by using alternative feedstuffs and for environmental reasons (Campbell and Bedford, 1992; Ferket, 1993; Bedford and Morgan, 1996; Sebastian *et al.*, 1997; Pluske and Lindemann, 1998).

In the meantime, some nutritionists have a tendency to formulate the diets of broiler chicks based primarily or sometimes exclusively on plant feed ingredients. The crude protein (CP) of a feed is usually considered the most expensive component, particularly in poultry diets. Recently, Kidd and Kerr (1996) and Kidd *et al.* (1996) have pointed out that reducing CP in poultry diets may reduce feed cost, improve the efficiency of nitrogen (N) utilization, reduce N excretion in the excreta and improve the poultry tolerance to heat stress. However, the extent to which dietary CP can be reduced without compromising bird performance remains inconclusive.

Reduced dietary CP has been reported to have adverse effects on broiler chicks even when the essential amino acids requirements were met. Fancher and Jensen (1989a,b) had attained inferior performance for broiler chicks fed low-protein, amino acid-supplemented diets compared with performance of birds fed a more conventional protein concentration, during the grower period (21-42 days of age). Similarly, broiler performance, as measured by body weight gain, feed conversion and abdominal fat percentage, was adversely affected when the birds were fed diets having CP levels below 20%, during the period from 3 to 6 weeks of age (Cable and Waldroup, 1991; Moran *et al.*, 1992; Kassim and Suwanpradit, 1996). Other investigators, however, had achieved performance of broiler chicks fed low-protein, amino acid-supplemented diets equivalent to that of birds receiving higher protein diets. Uzu (1982) indicated that when the broiler chicks were fed on a 16% CP diet supplemented with methionine and lysine from 28 to 49 days of age they attained growth equal to that obtained with a 20% CP diet. But feed efficiency was not consistently improved to a level equal to that of controls. Nakajima *et al.* (1985) demonstrated that body weights of chicks fed low CP diets (approximately 16%) supplemented with methionine and lysine were not significantly different from those fed higher CP diets (approximately 19%), from 21 to 65 days of age. Summers and Leeson (1985) observed that CP level had little influence on male broiler chick body weight gain and feed conversion, when the birds were fed a range of dietary CP levels (16 to 22%) from 28 to 49 days of age. Also, Stilborn and Waldroup (1988, 1989) reported equivalent performance of 3- to 6-week broilers fed either a 14% CP diet supplemented with synthetic amino acids or a 20% CP diet containing only added methionine. More recently, Jeroch and Pack (1995) concluded that a dietary CP level of 18% to 18.7% could support performance and carcass fat deposition of finishing broilers equal to diets containing 20.4% or 21.5% CP, respectively, when sulfur amino acid content was adequate.

Depending on the scientific literature, some factors might have been involved in the different responses of broiler chicks to dietary CP levels during the fattening period. These may include dietary protein quality (i.e. amino acid availability), the gender and genetic make-up of the bird, the form of which the diets were offered, the course of experimental period, the age of birds at start or the end of experiments, and others. Anyway, as the dietary CP level decreases, the amino acid composition of the diet should match the bird's amino acid requirements for maintenance and tissue accretion in order to obtain optimum performance.

Therefore, the current study was designed to investigate the responses of broiler chicks fed low-protein diets to enzyme supplementation.

MATERIALS AND METHODS

The present study was undertaken (during the period from September to November, 1998) at the Agricultural Experiments and Researches Station, Poultry Production Farm, Faculty of Agriculture, Mansoura University, Egypt.

Birds and housing

Two hundred and fifty-two unsexed Hubbard broiler chicks were used in this study. The chicks were fed on a commercial starter diet (contained 22% CP and metabolizable energy of about 3100 kcal/kg and composed of 65% yellow corn, 25% soybean meal and 10% broiler concentrates) and grown in conventional wire-floored battery brooders until the birds were 17 days of age. Then, they were wing-banded, weighed individually and randomly distributed into six equal experimental groups (6×42), each with 6 replications (7 chicks per replication) and immediately transferred to the rearing batteries. During both the starter and grower periods the chicks were raised in an open-sided house, fitted with gas-heaters, and supplied with continuous lighting. Birds had free access to feed and water throughout the experimental period (17 to 45 days of age).

Diets and treatments

Three iso-energetic mash diets [metabolizable energy (ME), of about 3000 kcal/kg] containing CP levels of 20, 18 or 16% were formulated with or without enzyme supplementation (150 g/100 kg diet); thus, 6 experimental diets were prepared and used. The enzyme preparation used herein was supplied by Alltech Inc., and termed Allzyme Vegpro, since it was produced in an attempt to improve the feeding value of vegetable proteins. As declared by the supplier, it contains protease, cellulase, pentosanase, alpha-glactosidase and amylase. Regardless of CP level, these diets were formulated to meet or slightly exceed the nutrient requirements of broilers, as suggested by the National Research Council (NRC, 1994), with slightly lower ME contents. The metabolizable energy and crude protein contents of the supplemental lysine (4600 kcal/kg, 119.75 g/100 g) and methionine (3680 kcal/kg, 58.69 g/100 g) were involved in the calculated compositions of the experimental diets (NRC, 1994). Ingredient compositions and proximate analyses are shown in Table 1. It is important to point out that a 20% CP diet was considered to be the control diet.

Performance criteria

Criteria of growth performance included live body weight (LBW), daily weight gain (DWG), daily feed intake (DFI), daily protein intake (DPI), feed conversion ratio (FCR; units of feed : unit of gain), total mortality and economic efficiency of feeding (EEF), during the entire experimental period.

Live body weights of the chicks were recorded individually. Feed intake, protein intake, body weight gain and feed conversion were weekly determined on a replicate group basis. Calculated CP contents of the experimental diets (Table 1) and values of feed intake for the six replications of each dietary treatment were used to compute the CP intakes. Mortality was monitored and recorded daily. EEF was calculated as price of kg gain (i.e. sale price per kg of live birds) minus feed cost of kg gain. Cost per kg diet (Table 1) and values of FCR for the six replicate groups of each treatment were used to calculate the feed cost per kg gain.

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

Ingredients %	Experimental diets*		
	1 + 2	3 + 4	5 + 6
	20% CP	18% CP	16% CP
Yellow corn	59.42	66.92	74.11
Soybean meal (SBM, 44%)	34.10	27.60	21.20
Sunflower oil	2.80	1.60	0.50
Dicalcium phosphate	1.60	1.60	1.70
Limestone	1.40	1.40	1.40
Common salt	0.30	0.30	0.30
Vit. & Min. premix**	0.30	0.30	0.30
L-Lysine.HCl	---	0.14	0.30
DL-Methionine	0.08	0.14	0.19
Total	100	100	100
Determined analysis (dry matter basis):			
Dry matter; %	89.66	89.88	89.65
Crude protein; %	22.12	19.92	17.79
Ether extract; %	5.81	4.73	4.10
Crude fiber; %	4.15	3.91	3.63
Ash; %	6.19	6.26	6.24
NFE; %	61.73	65.18	68.24
Calculated analysis (as fed basis):			
ME; kcal/kg	3024	3023	3025
Crude protein; %	20.10	18.08	16.10
Calorie: protein ratio	150.4	167.2	187.9
Ether extract; %	5.33	4.36	3.49
Crude fiber; %	3.69	3.40	3.11
Calcium; %	0.99	0.98	0.98
Total phosphorus; %	0.68	0.67	0.66
Avail. phosphorus; %	0.41	0.40	0.40
Lysine; %	1.07	1.06	1.06
Methionine; %	0.40	0.43	0.45
Meth. & Cys.; %	0.73	0.73	0.73
Cost P.T./kg diet***	80.9 (83.9)*	78.6 (81.6)*	76.7 (79.7)*

*: Each 100 kg of diets 2, 4 and 6 was supplemented with 150 g enzyme preparation (Allzyme Vegpro).

**: Each 3-kg package contains: Vit. A, 12,000,000 IU; Vit. D_3, 2,500,000 IU; Vit. E, 10,000 mg; Vit. K_3, 2.500 mg; Vit. B_2, 5,000 mg; Vit. B_6, 1.500 mg; Vit. B_{12}, 10 mg; Biotin, 50 mg; Folic acid, 1000 mg; 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 g; Co, 0.25 g and Se, .015 g.

***: Prices of the experimental diets according to the prevailing market prices of feed ingredients during the experimental period.

Digestibility of nutrients

In order to evaluate the digestion coefficients of nutrients in the experimental diets, digestibility trials were initiated when the birds were 35 days of age. Six birds per treatment, with an average body weight, were selected and kept in a separate division of a growing battery fitted with galvanized metal trays. They were fed their respective experimental diet for a two-day pretest adaptation period, followed by a three-day test period during which daily feed intake and total excreta voided were quantitatively determined. The proximate analyses for the experimental diets and dried representative samples of excreta were carried out according to the Association of Official analytical Chemists (AOAC, 1984). Fractions of fecal and urinary nitrogen (N) in the excreta were chemically separated according to the method of Jakobsen *et al.* (1960) in order to determine the protein digestibility. The percent of urinary organic matter was calculated by multiplying the percentage of urinary N by the factor 2 .62 (Abou-Raya and Galal, 1971). Digestion coefficients were calculated for dry matter (DM), organic matter (OM), crude protein (CP), crude fiber (CF), ether extract (EE) and nitrogen free extract (NFE). Percentage nitrogen retained was also calculated.

Carcass traits

At 45 days of age (marketing age), 6 birds from each treatment, with an average body weight, were individually weighed and sacrificed by cutting the cervical jugular veins. Then, their carcasses were traditionally processed. Procedures of cleaning out and excising the abdominal fat were performed on hot carcasses. The abdominal fat was defined as the adipose tissues surrounding the gizzard and bursa of Fabricius and cloaca. Records on individual weights of eviscerated carcass, giblets (i.e. heart, liver without gall bladder and skinned empty gizzard) and abdominal fat contents were maintained. Thereafter, each eviscerated carcass was dissected at the end of ribs into two portions, termed breast and thigh yields. Carcass yield was calculated as eviscerated carcass plus giblets. All carcass traits measurements were expressed as percent of live body weight at slaughter.

Blood parameters

At the end of the experiment (45 days of age), blood samples were individually collected in heparinized tubes, by puncturing the wing veins of six birds per treatment. As soon as possible, blood plasma samples were separated by centrifugation and stored at –20 °C for later analysis. Individual plasma samples were analyzed, using commercial kits, for the determination of glucose, total protein, total lipids and cholesterol according to the methods of Trinder (1969), Henry (1964), Frings and Dunn (1970) and Allain *et al.* (1974). Also, the activities of plasma transaminases: aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were determined using commercial kits according to the methods of Reitman and Frankel (1957).

Statistical analysis

A completely randomized design in a factorial arrangement of treatments (3×2), three levels of dietary CP with or without enzyme supplementation, was employed to separate the effect of CP level from that of enzyme supplementation. The statistical processing of data was performed by using a computerized multi-factor analysis of variance with P values of 0.05 or less considered significant. The significantly different means for each criterion were separated by LSD-multiple range test (Quattro program, Borland, 1990 and Statgraphics Program, Version 5.0, Rockville, 1991).

RESULTS AND DISCUSSION

Performance of chicks

The performance as well as economic efficiency of feeding (EEF) of broiler chicks fed diets containing different CP levels with or without enzyme supplementation from 17 to 45 days of age are presented in Tables 2, 3 and 4, respectively. Total mortality of chicks has occurred during the last week of the experimental period and was not related to the dietary treatments. The analysis of variance revealed that dietary CP level by enzyme supplementation interaction was not significant in all performance criteria studied. Thus, only the main treatment effects will be discussed.

Apart from enzyme supplementation, decreasing dietary CP level from 20% to 16% in the grower diets of broiler chicks adversely affected ($P \leq 0.01$) their live body weight, daily weight gain, daily protein intake and feed conversion ratio during the whole experimental period from 17 to 45 days of age (Tables 2 and 4). Daily feed intake, however, was not significantly affected ($P > 0.05$) by the dietary CP level (Table 3). Although the experimental diets, used in the present study, contained different CP levels, these diets were consumed at approximately similar rates by all the experimental groups of chicks. It was evident that the chicks were unable to distinguish the different dietary CP contents and did not compensate for reduced protein by increased feed intake. In addition, since all the experimental diets, used herein, were iso-energetic (Table 1) and similar trends of feed intake were observed for all the experimental groups of chicks, the growth depression occurred in chicks fed the lower CP diets (18 or 16%) could not be attributed to reductions in ME intake.

However, the deteriorated feed conversion ratio and lower live body weights and weight gains attained by birds fed the lower CP diets may be attributed to reduced protein intakes of these diets as compared with the control diet (Table 3), irrespective of enzyme supplementation. Since the total sulfur amino acids and lysine contents of the current experimental diets have been met or slightly exceeded the recommendations of NRC (1994) (Table 1), another possible causative factor for the aforementioned growth depression is that threonine contents in the lower CP diets became more limiting, because no supplemental threonine was added. This limitation might have been resulted in amino acid imbalances and thereby, reduced the efficiency of protein utilization. The latter explanation harmonizes with the general viewpoint of poultry nutritionists that the total sulfur amino acids, lysine and threonine are considered to be the first, second and third limiting amino acids, respectively, in corn-soybean meal broiler diets. In this regard, however, Schutte *et al.* (1992) have concluded that corn-soybean meal rations adequate in total sulfur amino acids and lysine fed to broilers from 7 to 28 days of age are first, second and third limiting in threonine, arginine and valine.

Table 2: Effects of feeding diets containing different crude protein levels with or without enzyme (E) supplementation on live body weight and daily weight gain of broiler chicks from 17 to 45 days of age

Treatments	Live body weight (g)				
	17-day old	24-day old	31-day old	38-day old	45-day old
CP level (A)					
20%	491	793	1168^a	1581^a	1945^a
18%	485	779	1131^b	1541^a	1883^b
16%	493	781	1104^b	1488^b	1823^c
SEM[1]	3.8	7.5	12.3	16.0	21.22
Sign. level	NS	NS	**	**	**
Enzyme (B)					
Without	491	783	1128	1526	1866
With	488	785	1141	1547	1901
SEM	3.1	6.1	10.0	13.1	17.33
Sign. level	NS	NS	NS	NS	NS
Interaction AB					
20% CP	496	798	1159	1572	1943
20% CP +E	486	788	1178	1589	1947
18% CP	481	773	1118	1525	1838
18% CP +E	489	785	1144	1556	1929
16% CP	495	780	1109	1480	1819
16% CP +E	490	782	1101	1495	1826
SEM	5.4	10.6	17.4	22.7	30.0
Sig. Level	NS	NS	NS	NS	NS

Treatments	Daily weight gain (g)				
	17-24 days old	24-31days old	31-38 days old	38-45 days old	17-45 days old
CP level (A)					
20%	43.1	53.7^a	58.9	51.7	51.8^a
18%	42.0	50.2^a	58.6	49.2	50.0^a
16%	41.2	46.3^b	54.7	47.9	47.5^b
SEM	1.0	1.3	1.9	2.8	0.8
Sign. level	NS	**	NS	NS	**
Enzyme (B)					
Without	41.8	49.3	56.7	48.8	49.1
With	42.4	50.8	58.0	50.4	50.4
SEM	0.8	1.0	1.6	2.3	0.7
Sign. level	NS	NS	NS	NS	NS
Interaction AB					
20% CP	43.1	51.6	59.0	52.6	51.6
20% CP +E	43.1	55.7	58.7	50.8	52.1
18% CP	41.7	49.3	58.2	45.3	48.6
18% CP +E	42.4	51.2	58.9	53.2	51.4
16% CP	40.6	47.0	53.0	48.5	47.3
16% CP +E	41.7	45.5	56.4	47.2	47.7
SEM	1.4	1.8	2.7	4.0	1.1
Sig. Level	NS	NS	NS	NS	NS

a-c: Means in the same column for each criterion having different superscripts differ significantly.

[1]: SEM refers to the standard error of the means.

Significance level: NS = not significant; ** = significant at $P \leq 0.01$.

Table 3: Effects of feeding diets containing different crude protein levels with or without enzyme (E) supplementation on daily feed intake and daily protein intake of broiler chicks from 17 to 45 days of age

Treatments	Daily feed intake (g)				
	17-24 days old	24-31days old	31-38 days old	38-45 days old	17-45 days old
CP level (A)					
20%	59.7	99.9	118.2	144.9	105.7
18%	59.9	98.6	126.3	135.3	105.0
16%	60.5	100.6	126.9	139.8	106.9
SEM[1]	1.6	2.0	4.4	7.2	1.8
Sign. Level	NS	NS	NS	NS	NS
Enzyme (B)					
Without	60.0	99.5	122.0	143.2	106.2
With	60.1	99.9	125.5	136.7	105.6
SEM	1.3	1.7	3.6	5.9	1.4
Sign. Level	NS	NS	NS	NS	NS
Interaction AB					
20% CP	60.6	98.3	116.6	156.0	107.9
20% CP +E	58.8	101.4	119.7	133.7	103.4
18% CP	60.7	98.5	125.3	130.9	103.9
18% CP +E	59.1	98.7	127.3	140.0	106.2
16% CP	58.5	101.7	124.2	142.6	106.8
16% CP +E	62.5	99.4	129.6	136.9	107.1
SEM	2.3	2.9	6.3	10.2	2.5
Sig. Level	NS	NS	NS	NS	NS
Treatments	Daily protein intake (g)				
	17-24 days old	24-31days old	31-38 days old	38-45 days old	17-45 days old
CP level (A)					
20%	12.01[a]	20.07[a]	23.75[a]	29.12[a]	21.24[a]
18%	10.84[b]	17.83[b]	22.84[a]	24.46[b]	18.99[b]
16%	9.74[c]	16.19[c]	20.43[b]	22.5[b]	17.22[c]
SEM[1]	0.29	0.38	0.80	1.32	0.32
Sign. level	**	**	*	**	**
Enzyme (B)					
Without	10.86	17.98	22.03	26.00	19.22
With	10.86	18.08	22.65	24.72	19.08
SEM	0.23	0.31	0.65	1.08	0.26
Sign. level	NS	NS	NS	NS	NS
Interaction AB					
20% CP	12.19	19.76	23.44	31.36	21.69
20% CP +E	11.82	20.39	24.06	26.88	20.79
18% CP	10.98	17.81	22.66	23.67	18.78
18% CP +E	10.69	17.85	23.02	25.24	19.20
16% CP	9.42	16.38	20.00	22.96	17.19
16% CP +E	10.07	16.01	20.86	22.04	17.24
SEM	0.40	0.54	1.12	1.87	0.45
Sig. Level	NS	NS	NS	NS	NS

a-c:Means in the same column for each criterion having different superscripts differ significantly.

[1]: SEM refers to the standard error of the means.

Significance level: NS = not significant;

* = significant at $P \leq 0.05$;

** = significant at $P \leq 0.01$.

Table 4: Effects of feeding diets containing *different crude protein* levels w ith o r w ithout enzyme (E) supplementation on feed conversion ratio and economic efficiency of feeding of broiler chicks from 17 to 45 days of age

Treatments	Feed conversion ratio (g:g)					Economic efficiency of feeding, L.E.
	17-24 days old	24-31 days old	31-38 days old	38-45 days old	17-45 days old	
CP level (A)						
20%	1.398	1.864^{a}	2.133^{a}	2.642^{a}	2.040^{a}	3.07^{a}
18%	1.426	1.968^{b}	2.187^{b}	2.669^{a}	2.101^{b}	3.07^{a}
16%	1.469	2.182^{c}	2.323^{c}	2.956^{b}	2.252^{c}	2.99^{b}
SEM	0.04	0.03	0.02	0.05	0.02	0.014
Sign. level	NS	**	**	**	**	**
Enzyme (B)						
Without	1.436	2.027	2.245^{b}	2.776	2.164^{b}	3.05
With	1.426	1.982	2.184^{a}	2.735	2.098^{a}	3.04
SEM	0.03	0.02	0.01	0.04	0.01	0.011
Sign. level	NS	NS	**	NS	**	NS
Interaction AB						
20% CP	1.408	1.905	2.179	2.650	2.093	3.06
20% CP +E	1.389	1.824	2.087	2.633	1.987	3.09
18% CP	1.459	2.003	2.212	2.710	2.137	3.07
18% CP +E	1.393	1.933	2.162	2.628	2.066	3.06
16% CP	1.442	2.173	2.345	2.970	2.261	3.02
16% CP +E	1.497	2.191	2.302	2.943	2.243	2.96
SEM	0.06	0.04	0.02	0.07	0.02	0.019
Sig. Level	NS	NS	NS	NS	NS	NS

a-c: Means in the same column for each criterion having different superscripts differ significantly.
[1]: SEM refers to the standard error of the means.
Significance level: NS = not significant; ** = significant at P≤0.01.

Generally speaking, the adverse effects of reducing dietary CP level on the growth performance and feed conversion ratio of broiler chicks in this study are in line with the findings of Cabel and Waldroup (1991); Moran *et al.* (1992) and Kassim and Suwanpardit (1996). These investigators, independently, found that performance of broilers as measured by body weight gain and feed conversion was significantly depressed when the birds were fed on dietary CP level blew 20%.

Enzyme supplementation, independent of dietary CP level, significantly improved (P≤0.01) the feed conversion ratio of broiler chicks during the whole experimental period (Table 4) but had no significant effects (P>0.05) on 45-day live body weight, daily weight gain, daily feed intake, daily protein intake or economic efficiency of feeding (Tables 2, 3 and 4). These results clearly show that enzyme supplementation could offset the poor growth achieved by broilers fed the lower CP diets. The perusal of the data may lead one to conclude that dietary enzyme supplementation improved LBW, DWG and FCR by 1.87, 2.65 and 3.05%, respectively, regardless of dietary CP level. In agreement with the present results, Zanella *et al.* (1999) reported that supplementation of broilers diets with an enzyme mixture containing amylase, protease and xylanase improved their body weight and feed conversion ratio by 1.9 and 2.2%, respectively.

Although enzyme supplementation significantly improved FCR of broiler chicks during the entire experimental period, it failed to exhibit significant differences in either feed intake or body weight gain. Similar results were obtained by Swift *et al.* (1996) who evaluated the effects of Vegpro on expanded and pelleted corn-soybean meal diets for broilers. They found that FCR was significantly improved by the enzyme addition to the expanded diet over a 35-day feeding period. Similarly, Stanley *et al.* (1996) investigated the effect of Vegpro addition on various levels of cottonseed meal (CSM) in diets for broiler chicks. They demonstrated that the inclusion of Vegpro to broiler diets resulted in significant improvements in FCR, regardless of the level of CSM in the diet.

Nutrient digestibility

The digestibility trial was conducted in order to provide information on any possible differences in nutrient digestibilities among the different experimental diets. Data on nutrient digestibilities and percentage of nitrogen retained in 5-week-old broiler chicks fed diets containing different CP levels with or without enzyme supplementation are given in Table 5. The dietary treatments had no significant effects ($P>0.05$) on the digestibility of DM, OM, CP, EE, CF or percentage of N retention. The exception was the significant increase ($P\leq0.01$) in NFE digestibility in favor of the high CP diets. It is noteworthy that this significant difference in NFE digestibility may be a consequence to some carry-over laboratory errors or approximations rather than due to the effect of dietary treatments. The insignificant differences in digestion coefficients of nutrients of the present experimental diets might be a reflection to an interaction among multi-factors such as the optimal processing of the diets, the good health status of the bird, the ineffectiveness of enzyme preparation used or others. These results, however, may exclude the digestibility coefficients of nutrients as limiting factors responsible for the impaired growth performance attained by broilers fed the lower CP levels. In other words, other factors may have interacted and exerted their adverse effect at the metabolic level.

In disagreement with the present results, Swift *et al.* (1996) found that Allzyme Vegpro supplementation to broiler corn-soybean meal grower diets significantly improved nitrogen and energy digestibility. Zanella *et al.* (1999) reported that enzyme supplementation to corn-soybean broiler diets improved CP digestibility by 2.9% but this improvement was not equal for all amino acids. They also stated that, of the amino acids most important for broilers fed corn-soybean diets, the digestibilities of methionine, lysine and arginine were not significantly improved by the enzyme supplementation, however, those of valine and threonine were improved by 2.3 and 3.0%, respectively. The enzyme preparation used in their study was consisted of xylanase, protease and amaylase. However, Pettersson and Aman (1989) observed significant improvements in OM, CP and starch digestibilities when broiler chicks were fed wheat-rye-soybean meal diets supplemented with pentosanase, despite the fact that the enzyme mixture contained little amylase and proteinase. They proposed that this response was attributable to a decreased viscosity of the digesta and an enhanced release of nutrients from the gain cells by the action of enzymes on the cell walls.

Table 5: Digestibility coefficients of nutrients in 35-day-old broiler chicks fed diets containing different crude protein levels with or without enzyme (E) supplementation

Treatments	Digestion coefficients %						N retention %
	DM	OM	CP	EE	CF	NFE	
CP level (A)							
20%	76.18	79.57	87.28	86.23	16.93	89.80[a]	58.29
18%	77.02	80.08	88.09	86.77	19.40	88.99[a]	59.32
16%	76.54	79.67	87.71	86.91	16.71	88.26[b]	56.78
SEM[1]	0.36	0.32	0.29	0.44	1.67	0.25	0.68
Sign. level	NS	NS	NS	NS	NS	**	NS
Enzyme (B)							
Without	76.42	79.67	87.60	86.50	17.62	88.90	58.08
With	76.73	79.88	87.79	86.78	17.74	89.14	58.19
SEM	0.29	0.26	0.23	0.36	1.37	0.20	0.56
Sign. level	NS	NS	NS	NS	NS	NS	NS
Interaction AB							
20% CP	76.05	79.31	86.83	85.60	18.42	89.34	58.76
20% CP +E	76.30	79.83	87.74	86.86	15.43	90.27	57.83
18% CP	77.05	80.31	88.38	87.04	17.37	89.27	59.73
18% CP +E	76.98	79.86	87.80	86.51	21.44	88.71	58.91
16% CP	76.17	79.40	87.59	86.86	17.08	88.08	55.74
16% CP +E	76.90	79.94	87.84	86.97	16.33	88.43	57.82
SEM	0.51	0.46	0.40	0.62	2.36	0.35	0.97
Sig. Level	NS	NS	NS	NS	NS	NS	NS

a-b: Means in the same column for each criterion having different superscripts differ significantly.

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

Carcass traits:

Data in Table 6 summarize the effects of feeding three dietary CP levels with or without enzyme supplementation and their interactions on percentages of some carcass traits of 45-day-old broiler chicks. With the exception of abdominal fat percentage, no significant ($P>0.05$) differences were observed in all carcass traits studied. Decreasing the dietary CP level from 20 to 16%, regardless of enzyme supplementation significantly ($P \leq 0.01$) increased the abdominal fat percentage. The significant increases in abdominal fat content in carcasses of broilers due to decreasing dietary CP level may be a consequence of the widening of the calorie to protein ratio. In this regard, Bartov (1979) indicated that one of the primary mechanisms involved in reducing carcass fat by feeding high CP diets is the associated increased energy expenditure and increased heat increment required for uric acid synthesis, this requirement for energy would come at the expense of that used for fat synthesis. This result is in line with that reported by Fancher and Jensen (1989b), Cabel and Waldroup (1991) and Rabie *et al.* (1997) who found that abdominal fat deposition was significantly increased in response to decreasing dietary CP level in broiler grower diets. In general, irrespective of dietary treatments and strain of broiler chicks, the means for the percentages of carcass traits and components obtained herein are in good agreement with those reported by Sherif *et al.* (1995), Rabie *et al.* (2002) and Raya *et al.* (2003a).

Table 6: Effects of feeding diets containing different crude protein levels with or without enzyme (E) supplementation on percentages of carcass traits of 45-day-old broiler chicks

Treatments	Body weight, g	Giblets %	Breast yield %	Thigh yield %	Eviscerated carcass %	Carcass yield %	Abdominal fat %
CP level (A)							
20%	1923[a]	3.63	37.55	29.82	69.60	73.23	1.28[b]
18%	1862[b]	3.72	37.15	29.21	68.66	72.39	1.17[b]
16%	1813[c]	3.71	37.32	29.57	69.23	72.94	1.18[a]
SEM[1]	13.3	0.08	0.51	0.44	0.62	0.60	0.13
Sign. level	**	NS	NS	NS	NS	NS	**
Enzyme (B)							
Without	1863	3.62	37.56	29.07	68.92	72.53	1.55
With	1868	3.76	37.12	30.00	69.41	73.17	1.54
SEM	10.8	0.06	0.42	0.36	0.50	0.49	0.11
Sign. level	NS	NS	NS	NS	NS	NS	NS
Interaction AB							
20% CP	1928	3.58	37.47	29.74	69.41	72.99	1.24
20% CP +E	1918	3.68	37.63	29.89	69.78	73.46	1.33
18% CP	1843	3.53	37.47	28.66	68.41	71.93	1.30
18% CP +E	1880	3.92	36.84	29.77	68.92	72.84	1.03
16% CP	1818	3.74	37.75	28.80	68.94	72.68	2.10
16% CP +E	1806	3.68	36.90	30.33	69.52	73.20	2.26
SEM	18.8	0.11	0.72	0.62	0.87	0.84	0.19
Sig. Level	NS	NS	NS	NS	NS	NS	NS

a-c: Means in the same column having different superscripts differ significantly.
[1]: SEM refers to the standard error of the means.
Significance level: NS = not significant; ** = significant at P≤0.01.

Blood parameters:

Blood parameters of broiler chicks, tested herein, were selected to serve as a mirror for the health, nutritional and metabolic states of the birds. Table 7 illustrates data on these blood parameters (plasma levels of glucose, total protein, total lipids and cholesterol as well as the activities of plasma transaminases: AST and ALT) of 45-day-old broiler chicks fed the experimental diets. The analysis of variance of the data revealed that neither dietary CP level, enzyme supplementation nor their interaction could significantly affect any of the tested parameters. The absence of significant differences among the dietary treatments for all blood parameters, tested herein, may reflect normal metabolic processes and functions of organs and tissues. Generally, regardless of dietary treatments and age of growing birds, means of blood parameters measured in this study are in good agreement with those reported by Ross *et al.* (1978), Freeman (1984), Bailey and Gibson (1989), Rabie *et al.* (2002) and Raya *et al.* (2003b).

CONCLUSION

Under the conditions of this study, economically, it was concluded that a level of 20% CP with or without enzyme supplementation is the optimal dietary protein level in grower broiler diets for maximizing broiler growth performance and optimizing the efficiency of feed utilization. The diet should also be well balanced in all nutrients and its CP content should provide a balanced pattern of amino acids.

Table 7: Blood parameters of 45-day old broiler chicks fed diets containing different crude protein levels with or without enzyme (E) supplementation

Treatments	Glucose (mg/dL)	Total protein (g/dL)	Total lipids (g/L)	Cholesterol (mg/dL)	AST (U/L)	ALT (U/L)
CP level (A)						
20%	231	3.89	4.71	109	125	36
18%	230	3.97	4.60	114	128	35
16%	233	3.83	4.64	113	125	33
SEM[1]	2.0	0.11	0.08	1.7	2.4	2.4
Sign. level	NS	NS	NS	NS	NS	NS
Enzyme (B)						
Without	232	3.88	4.63	112	126	33
With	231	3.92	4.67	112	126	37
SEM	1.7	0.09	0.07	1.4	2.0	1.9
Sign. level	NS	NS	NS	NS	NS	NS
Interaction AB						
20% CP	232	3.90	4.73	111	127	37
20% CP +E	230	3.88	4.70	108	124	35
18% CP	230	4.07	4.57	113	128	34
18% CP +E	230	3.87	4.63	115	128	37
16% CP	233	3.66	4.60	113	123	29
16% CP +E	234	4.00	4.69	114	128	37
SEM	2.9	0.16	0.12	2.4	3.4	3.4
Sig. Level	NS	NS	NS	NS	NS	NS

[1]: SEM refers to the standard error of the means.
NS = not significant.

REFERENCES

Abou-Raya, A. K. and A. Gh. Galal (1971). Evaluation of poultry feeds in digestion trials with reference to some factors involved U. A. R. (Egypt), Animal Production, 11: 207-221.

Allain, C. A.; L. S. Poon; C. S. G. Chang; W. Richmond and P. C. Fu (1974). Enzymatic determination of total serum cholesterol. Clinical Chemistry, 20: 470-475.

Association of Official Analytical Chemists (A.O.A.C., 1984). Official Methods of Analysis. 14th Ed, A.O.A.C., Arlington, Virginia, USA.

Bailey, C. A. and R. M. Gibson (1989). Ochratoxin A and dietary protein. 2. Effects on hematology and various clinical chemistry measurements. Poultry Sci., 68: 1664-1671.

Bartov, I. (1979). Nutritional factors affecting the quantity and quality of carcass fat in chickens. Feederation Proceedings, 38: 2627-2630.

Bedford, M. R. and A. J. Morgan (1996). The use of enzymes in poultry diets. World's Poultry Sci. J., 52: 61-68.

Borland International, Inc., (1990). Quattro Program, Version 1.0

Cabel, M. C. and P. W. Waldroup (1991). Effect of dietary protein level and length of feeding on performance and abdominal fat content of broiler chickens. Poultry Sci., 70: 1550-1558.

Campbell, G. L. and M. R. Bedford (1992). Enzyme applications for monogastric feeds: a review. Canadian J. Anim. Sci., 72: 449-466.

Fancher, B. I. and L. S. Jensen (1989a). Influence on performance of three to six-week-old broilers of varying dietary protein contents with supplementation of essential amino acid requirements. Poultry Sci., 68: 113-123.

Fancher, B. I. and L. S. Jensen (1989b). Dietary protein level and essential amino acid content: Influence upon female broiler performance during the grower period. Poultry Sci., 68: 897-908.

Ferket, P. R. (1993). Practical use of feed enzymes for turkeys and broilers. J. Appl. Poultry Res., 2: 75-81.

Freeman, B. M. (1984). Appendix: Biochemical and Physiological Data. In: Physiology and Biochemistry of the Domestic Fowl. Vol. 5, pp. 407-424. B.M. Freeman (Ed.), Academic Press, London, UK.

Frings, C. S. and R. T. Dunn (1970). A colorimetric method for determination of total serum lipids based on the sulfo-phosphovanillin reaction. Amer. J. Clin. Pathol., 53: 89-91.

Henry, R. J. (1964). Clinical Chemistry: Principles and Technics, Harper and Row Publishers, New York.

Jakobsen, P. E.; K. Gertov and S. H. Nielsen (1960). Fordøjelighedsforsøg med fjerkrae. "Digestibility trials with poultry) 1. Fordø jelseskanalen hos høns samt metodiske problemer ved gennemførelsen af fordøjelighedsforsøg. 322 beretning fra forsøgslaboratoriet, København.

Jeroch, H. and M. Pack (1995). Effects of dietary sulphur amino acids and crude protein on the performance of finishing broilers. Archives of Animal Nutrition, 48: 109-118.

Kassim, H. and S. Suwanpradit (1996). The effects of dietary protein levels on the carcass composition of starter and grower broilers. Asian-Australasian Journal of Animal Sciences, 9: 261-266.

Kidd, M. T. and B. J. Kerr (1996). L-Threonine for poultry: A review. J. Appl. Poultry Res., 5: 358-367.

Kidd, M. T.; B. J. Kerr; J. D. Firman and S. D. Boling (1996). Growth and carcass characteristics of broilers fed low-protein, threonine-supplemented diets. J. Appl. Poultry Res., 5: 180-190.

Moran, E. T., Jr.; R. D. Bushong and S. F. Bilgili (1992). Reducing dietary crude protein for broilers while satisfying amino acid requirements by least-cost formulation: Live performance, litter composition, and yield of fast-food carcass cuts at six weeks. Poultry Sci., 71: 1687-1694.

Nakajima, T.; H. Kishi; T. Kusubae; H. Wakamatsu and Y. Kusutani (1985). Effect of L-threonine and DL-tryptophan supplementation to the low protein practical broiler finisher diet. Japanese Poultry Science, 22: 10-16.

National Research Council (NRC, 1994). Nutrient Requirements of Poultry. 9th revised edition, National Academy Press, Washington, DC.

Pettersson. D. and P. Aman (1989). Enzyme supplementation of a poultry diet containing rye and wheat. Brit. J. Nutr., 62: 139-149.

Pluske, J. R. and M. D. Lindemann (1998). Maximising the response in pig and poultry diets containing vegetable proteins by enzyme supplementation. In: Lyons, T. P. and K. A. Jacques (eds) Passport to the Year 2000, Biotechnology in the Feed Industry. Proceedings of Alltech's 14th Annual Symposium. Nottingham University Press, Nottingham, UK, pp: 375-392.

Rabie, M. H.; Kh. El. Sherif; F. S. A. Ismail and A. H. Raya (2002). Efficiency of utilization of plant protein diets by the broiler chicks. J. Agric. Sci. Mansoura Univ., 27(10): 6613-6627.

Rabie, M. H.; M. Szilágyi and T. Gippert (1997). Effects of dietary L-carnitine supplementation and protein level on performance and degree of meatness and fatness of broilers. Acta Biologica Hungarica, 48(2): 221-239.

Raya, A. H.; Kh. El. Sherif; Tork. M. Dorra and Z. M. Kalaba (2003a). The use of early-age feed restriction and/or potassium chloride for alleviating the adverse effects of heat stress on broiler chicks: 1. Effects on broiler performance, carcass traits and economic efficiency. J. Agric. Sci., Mansoura Univ., 28(1): 273-291.

Raya, A. H.; Kh. El. Sherif; Tork M. Dorra and Z. M. Kalaba (2003b). The use of early-age feed restriction and/or potassium chloride for alleviating the adverse effects of heat stress on broiler chicks. 2. Effects on some physiological parameters, blood constituents and digestibility of nutrients. J. Agric. Sci. Mansoura Univ., 28(1):293-314.

Reitman, S. and S. Frankel (1957). A colorimetric method for the determination of serum glutamic oxaloacetic and glutamic pyruvic transaminases. Amer. J. Clin. Path., 28: 56-63.

Rockville (1991). Statgraphics program, version 5.0 STSC.

Ross, J. G.; G. Christie; W. G. Halliday and R. Morley-Jones (1978). Haematological and blood chemistry "comparison values" for clinical pathology in poultry. Veterinary Record, 102: 29-31.

Schutte, J. B.; J. de Jong and J. P. Holsheimer (1992). Dietary protein *in* relation to requirement in poultry and pollution. *In: Proc.* 19th World's Poultry Congress, pp. 231-235, *Amsterdam* 19-24 Sept., Wageningen, Ponsen&Looijen.

Sebastian, S.; S. P. Touchburn; E. R. Chavez and P. C. Lague (1997). Apparent digestibility of protein and amino acids in broiler chickens fed a corn-soybean diet supplemented with microbial phytase. Poultry Sci., 76: 1760-1769.

Sherif, Kh. El.; T. Gippert and D. Gerendai (1995). Replacing soybean meal with sunflower meal in broiler rations and its effects on the performance of chicks and carcass traits. Állattenystés és Takarmanyozás, 44(6): 525-532.

Stanley, V. G.; C. Gray; H. Chukwu and D. Thompson (1996). Effects of enzyme (treatment) in enhancing the feeding value of cottonseed meal and soybean meal in broiler chick diets. 12th Annual Symposium on Biotechnology in the Feed Industry. Lexington, Kentucky. Supplement 1, enclosure code UL 2.2.

Stilborn, H. L. and Waldroup (1988). Minimum levels of dietary protein for growing broilers. Poultry Sci., 67(suppl.1): 36. (Abstr.).

Stilborn, H. L. and Waldroup (1989). Utilization of low-protein grower diets for broiler chickens. Poultry Sci., 68(Suppl.1) 142.(Abstr.).

Summers, J. D. and S. Leeson (1985). Broiler carcass composition as affected by amino acid supplementation. Canadian J. Anim. Sci., 65: 717-723.

Swift, M. L.; M. A. G. von Keyserlingk; A. Leslie and D. Teltge (1996). The effect of Allzyme Vegpro supplementation and expander processing on the nutrient digestibility and growth of broilers. 12th Annual Symposium on Biotechnology in the Feed Industry. Lexington, Kentucky. Supplement 1, enclosure code UL 2.1.

Trinder, P. (1969). Determination of glucose in blood using glucose oxidase with an alternative oxygen acceptor. Ann. Clin. Biochem, 6: 24-27.

Uzu, G. (1982). Limit of reduction of the protein level in broiler feeds. Poultry Sci., 61: 1557-1558. (Abstr.)

Zanella, I.; N. K. Sakomura; F. G. Silversides; A. Fiqueirdo and M. Pack (1999). Effect of enzyme supplementation of broiler diets based on corn and soybeans. Poultry Sci., 78: 561-568.

J. Agric. Sci. Mansoura Univ., 28 (10),october, 2003

تأثير الإضافة الإنزيمية للعلائق المحتوية علي مستويات مختلفة من البروتين النباتي علي أداء كتاكيت اللحم

خليل الشحات شريف، محمود حسن ربيع، فوزي صديق عبد الفتاح إسماعيل، عبد البصير حمزة أبو ريا
قسم إنتاج الدواجن – كلية الزراعة – جامعة المنصورة

أجريت هذه الدراسة لتقييم استجابة كتاكيت اللحم المغذاة علي مستويات مختلفة من البروتين النباتي لإضافة المستحضر الإنزيمي(ألزيم فجبرو). غذيت كتاكيت هبرد عمر يوم علي عليقة تجارية بها بروتين خام حوالي ٢٠% وطاقة ممثلة حوالي ٣١٠٠ كيلوكالوري/كجم حتى عمر ١٧ يوما. عند ذلك العمر تم توزيع ٢٥٢ كتكوت علي ٦ معاملات تجريبية متساوية بكل معاملة ٦ مكررات متساوية العدد. تم تربية الكتاكيت في بطاريات رعاية وغذيت علي العلائق التجريبية من عمر ١٧ يوم حتى نهاية التجربة (٤٥ يوماً من العمر). تم تكوين ٦ علائق تجريبية متساوية في الطاقة الممثلة (٣٠٠٠ كيلوكالورى/كجم) بها ٣ مستويات من البروتين الخام هي ٢٠، ١٨ أو ١٦% ومستويان من المستحضر الإنزيمي هما صفر أو ١,٥ جم/كجم عليقة وتم تغذية الطيور عليها من ١٧ حتى ٤٥ يوما من العمر. تم تسجيل البيانات عن وزن الجسم والزيادة الوزنية اليومية واستهلاك العلف والتحويل الغذائي والنفوق والكفاءة الاقتصادية للتغذية. أيضا تم تقدير معاملات هضم العناصر الغذائية للعلائق التجريبية علي الطيور عند عمر ٥ أسابيع. عند نهاية التجربة تم إجراء اختبار ذبح و تم أخذ عينات دم لتقدير بعض مكونات بلازما الدم وهي الجلوكوز، البروتينات الكلية، الدهون الكلية، الكولسترول، نشاط إنزيمات الترانسأمينيزات (AST-ALT). ويمكن تلخيص أهم النتائج المتحصل عليها كالآتي:-

بغض النظر عن تأثير إضافة الإنزيم، نقص مستوى بروتين الغذاء من ٢٠ إلى ١٦% أثر سلبيا ومعنويا علي كل من وزن الجسم الحي، الزيادة الوزنية، البروتين المأكول، التحويل الغذائي والكفاءة الاقتصادية للتغذية. نقص بروتين الغذاء أيضا أدى إلي زيادة دهن البطن لذبائح الطيور معنويا. لم يؤثر بروتين الغذاء علي كل من نفوق الكتاكيت، العلف اليومي المأكول، هضم العناصر الغذائية، مركبات الدم المدروسة أو مواصفات الذبائح. بغض النظر عن تأثير مستوى بروتين الغذاء، إضافة الإنزيم أدت إلي تحسن التحويل الغذائي خلال فترة التجربة (من ١٧-٤٥ يوما من العمر). بينما باقي الصفات المدروسة لم تتأثر بإضافة الإنزيم. أما تأثير التفاعل بين مستوى بروتين الغذاء وإضافة الإنزيم لم يكن معنويا علي كل الصفات المدروسة. من الملاحظ تحت ظروف هذه التجربة ومن الناحية الاقتصادية يمكن استنتاج أن مستوى ٢٠% بروتين خام في علائق كتاكيت التسمين النامية بدون إضافة أو بإضافة الإنزيم هو المستوى الأمثل لتعظيم أداء الكتاكيت النامية والحصول علي أفضل تحويل غذائي. كما يجب أن تكون العليقة متزنة في كل العناصر الغذائية ومحتواها من البروتين الخام يوفر الأحماض الأمينية بالكميات المطلوبة.