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Performance, Abdominal Fat and Economic Efficiency of Broilers Fed Different Energy Levels Supplemented with Xylanase and Amylase from 14 to 40 Days of Age

Amani W. Youssef, H.M.A. Hassan, H.M. Ali and M.A. Mohamed

Department of Animal Production,
National Research Centre, Dokki, Giza, Egypt, P.O. Box 12622

Abstract: An experiment was conducted to study the effect of a commercial enzyme preparation (Xylam®) containing xylanase and amylase on performance, abdominal fat and economic efficiency of broiler chicks fed corn-soybean meal diets containing different levels of energy from 14 to 40 days of age. Three diets were formulated with metabolizable energy contents being 3000, 2900 and 2850 Kcal/kg for growing (14-23 days); 3100, 3000 and 2950 Kcal/kg for finishing (24-32 days) and 3200, 3100 and 3050 Kcal/kg for withdrawal (33-40 days) period. Diet 1 was fed without enzymes and served as a control diet. Diets 2 and 3 were fed without or with 0.5 g/Kg of xylam. Though, five dietary treatments were examined on 300 14-day-old (Hubbard) broiler chicks. Every dietary treatment was fed to 5 replicates (12 chicks each).The results showed no significant differences among dietary treatments on BWG for the growing period. Meanwhile, birds fed diet 3 of the lowest energy level with enzyme supplementation gained more BW compared to birds fed the other diets at finishing, withdrawal and overall periods. However, birds fed diet 3 with enzyme supplementation significantly ($P<0.05$) consumed less feed than those fed the control or low energy diets (diet 2 and 3) without enzyme at growing period. The best FCR values were obtained for birds fed low energy diets (diet 2 and 3) with enzyme supplementation. Worse FCR values were obtained for birds fed the low energy diets without enzyme supplementation. Carcass characteristics were not affected by treatments. Reducing energy level increased ($P<0.05$) abdominal fat percent. However, enzyme supplementation decreased ($P<0.05$) abdominal fat percent and reduced the relative cost per unit of weight gain compared to the control. It could be concluded that adding enzymes to corn soybean meal diets allowed the reduction in the energy level of broiler diets by about 150 kcal. Enzyme supplementation tended to improve performance, decreased abdominal fat and enhanced economic efficiency.

Key words: Broiler · Low energy · Enzymes · Performance · Abdominal fat

INTRODUCTION

Exogenous enzymes supplementation to poultry diets improves production efficiency by increasing the digestion of low quality products and reducing nutrient loss through excreta, allowing the reduction of diets nutritional levels with likely economic advantages [1, 2]. Torres *et al.* [3] evaluating the enzymes influence on broiler chickens performance, verified that lower energy and protein levels, supplemented with enzymes, provided the broilers a similar performance as those fed diets with normal nutrient levels without affect performance and reducing costs. Angelovieova *et al.* [4] reported that an important indicator of the effective feed utilization is the ratio between feed intake and each kilogram of body weight gain (feed: gain ratio). Consequently, an economic evaluation of feedstuffs used in diets can be simply attained through cost feeding by gain kilogram calculation. The addition of a commercial multi-enzyme containing xylanase, amylase and protease activities to a corn-SBM broiler diet results in a significant improvement in BW gain (1.9%) and feed-to-gain ratio (2.2%) [5]. Abudabos [6] reported that addition of enzymes to corn soybean meal diets improved ($P<0.001$) body weight and feed conversion efficiency at 42 and 49 d of broiler chicks. On the other hand, the increase in growth rate of modern broiler chickens has been associated with increased fat deposition. The greatest percentage of abdominal fat in carcass the lowest carcass consumption value, also, excessive abdominal fat deposition delays processing

Corresponding Author: H.M.A. Hassan, Department of Animal Production, National Research Centre, Dokki, Giza, Egypt, P.O.Box 12622, E-mail: hussein8768@yahoo.com.

procedures and may cause problem during carcass evisceration [7]. Using enzyme preparation (carbohyrase) in broiler diets significantly ($P<0.05$) reduced abdominal fat measured either as absolute weight or percent of live body weight [8, 9].

There are different economic approaches considering enzymes incorporation on diets formulation. A simpler and probably, more practical application, called "over the top", aim to improve performance more economically and consist in supplement a standard diet with enzymes, without alter its nutritional levels. Another alternative is to manipulate diet formulation by reducing nutrients and adding exogenous enzymes in order to restore the nutritional value of the standard diet, seeking the same performance that a diet with normal nutritional levels would provide [10, 11].

Therefore, the aim of this study was to investigate the effect of xylanase and amylase enzymes on growth performance, abdominal fat and economic efficiency of broiler chicks fed corn-soybean meal diets containing different levels of energy.

MATERIALS AND METHODS

An experiment was designed to study the effect of adding preparation enzyme to diets containing different levels of energy on performance, abdominal fat and economic efficiency of broiler chicks. Commercial enzyme preparation (Xylam®) produced by Nutrex Company were used in the present study. Xylam® is a bacterial enzyme preparation prepared from *Bacillus subtilis* and *Bacillus amyloliquefaciens*. It contains 1.260 u/g endo-1, 4 β-xylanase and 8.00 u/g α-amylase.

Birds, Diets and Housing: A total number of 500 unsexed one day old (Hubbard) broiler chicks were used in this study. Chicks were brooded in a warmed fumigated brooder house and fed on a starter diet (23% CP, 2950 kcal ME/Kg) to 13 days of age. Birds were then individually weighed and 300 chicks with almost the same body weight were divided into five groups (5 replicates of 12 chicks, each). The average initial live body weight of all replicates was similar. Replicates were randomly allocated in batteries of three-tier system that has 25 compartments (5 replicates × 5 dietary treatments). Diets were formulated based on corn and soybean meal. Formulation and nutrient composition of the experimental diets are shown in Table 1. The diets were formulated to cover the nutrient requirements of Hubbard broilers. Three experimental diets were formulated to contain 3000, 2900 and 2850 for the grower (14 to 23d) period, 3100, 3000 and 2950 kcal ME/Kg for the finisher (24to 32d) period and 3200, 3100 and 3050 kcal ME/Kg for withdrawal (33 to 40d) period, respectively. Diet 1 was fed without enzyme and served as a control diet. Diets 2 and 3 were fed without or with 0.5 g/Kg of xylam and served low energy diets. Therefore, a total of five dietary treatments were offered.

Table 1: Formulation and nutrient composition of experimental diets

	Grower			Finisher			Withdrawal		
Ingredients %	Diet 1	Diet 2	Diet 3	Diet 1	Diet 2	Diet 3	Diet 1	Diet 2	Diet 3
Yellow corn	55.95	58.1	59.55	57.05	58.87	59.77	62.39	64.69	65.84
Soybean meal (44%)	36.3	36.0	35.6	34.0	34.0	34.0	28.2	27.8	27.6
Vegetable oil	3.4	1.55	0.5	4.72	2.9	2	5.3	3.4	2.45
Limestone	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Dicalcium phosphate	1.9	1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.7
Vit. and Min. mix(1)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Salt	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
L-Lysine HCl	0.2	0.2	0.2	0.18	0.18	0.18	0.18	0.18	0.18
DL-Methionine	0.3	0.3	0.3	0.3	0.3	0.3	0.28	0.28	0.28
Total	100	100	100	100	100	100	100	100	100
Nutrient Composition (2)									
Crude protein	21	21	21	20	20	20	18	18	18
ME (Kcal/Kg)	3000	2900	2850	3100	3000	2950	3200	3100	3050
Lysine	1.27	1.27	1.27	1.18	1.18	1.18	1.07	1.07	1.07
Methionine+Cystne	0.99	0.99	0.99	0.9	0.9	0.9	0.86	0.86	0.86
Calcium	1.01	1.01	1.01	0.97	0.97	0.97	0.94	0.94	0.94
Nonphytate P	0.5	0.5	0.5	0.47	0.47	0.47	0.44	0.44	0.44

(1) Vitamin - mineral mixture supplied per Kg of diet: Vit A, 12000 I.U; Vit D_3, 2200 I.U; Vit E, 10 mg; Vit K_3, 2 mg; Vit B_1, 1mg; Vit B_2, 4mg; Vit B_6, 1.5mg; Vit B_{12}, 10µg; Niacin, 20 mg; Pantothenic acid, 10 mg; Folic acid, 1 mg; Biotin, 50 µg; Choline chloride 500 mg; Copper, 10 mg; Iodine, 1mg; Iron, 30 mg; Manganese, 55 mg; Zinc, 50 mg and Selenium, 0.1 mg.

(2) Calculated values based on feed composition Tables of NRC [27]

Feed and water were allowed for *ad libitum* consumption. After fasting overnight, birds were weighed and feed consumption was recorded per replicate at 23, 32 and 40 days of age. Body weight gain and feed conversion ratio were then calculated. Gas heaters were used to keep the required temperature for the brooding period and light was provided 23 hr daily during the experiment. Birds were vaccinated against AI, ND, IB and IBD throughout the experimental period. After such medical treatments, a dose of vitamins (AD_3E) was offered in the drinking water for the successive 3 days.

Carcass Measurements: At day 40, six representative chicks with body weight close to the group average were selected from every treatment for carcass characteristics. Chicks were fasted for approximately 12 hr to empty their alimentary tract and then individually weighed, slaughtered, feathered and eviscerated. Weights of carcass, liver, heart and gizzard were recorded. The fat surrounding the gizzard and the abdominal fat were removed and weighed. The percentage of carcass, organs and abdominal fat to live body weight was calculated.

Economic Efficiency: Economic efficiency of using enzyme was calculated from money output- input analysis and represented as the cost of feed needed to obtain one kilogram body weight and the net revenue per unit of total cost under local conditions.

Statistical Analysis: Data were statistically analyzed for analysis of variance using the General Linear Model of SAS [12]. One way analysis of variance was used. Significant differences among treatment means were separated by Duncan's multiple rang test [13] with a 5% level of probability.

RESULTS AND DISCUSSION

Growth Performance: The results of broiler performance as affected by dietary treatments are shown in Tables 2 and 3. A trend was recorded on such parameters (BWG, FI and FCR) for the different growth intervals (growing, finishing and withdrawal) and the entire period (14-40 days of age).During the growing period (14-23d), no significant differences were observed among dietary treatments on BWG. Feed intake linearly increased with reducing energy level. Enzyme supplementation to diet 2 and 3 decreased ($P<0.05$) FI compared with the control diet. Birds fed diet 3 with enzyme supplementation significantly ($P<0.05$) consumed less feed than those fed other diets. Feed conversion ratio was significantly ($P<0.05$) affected by dietary treatments. The best FCR values were obtained for birds fed low energy diets with enzyme supplementation (1.60 and 1.61). Meanwhile, worse FCR value was obtained for birds fed the diet 3 without enzyme supplementation (1.68). During the finishing period (24-32d), birds fed diet 3 with enzyme

Table 2: Effect of enzyme supplementation on broiler performance during growing and finishing periods

	Growering (14-23 days)			Finishering (24-32 days)		
Item	BWG (g)	FI (g)	FCR (g/g)	BWG (g)	FI (g)	FCR (g/g)
Diet 1 (control)	462	756^{ab}	1.63^{abc}	599^{ab}	1022	1.71^{ab}
Diet 2 (low energy1)	462	773^{a}	1.67^{ab}	600^{ab}	1022	1.75^{a}
Diet 3 (low energy2)	455	763^{a}	1.68^{a}	588^{ab}	1032	1.75^{a}
Diet 2 + enzymes	439	708^{bc}	1.60^{c}	571^{b}	984	1.72^{ab}
Diet 3 + enzymes	437	705^{c}	1.61^{c}	641^{a}	1077	1.68^{b}
SE of means	±3.83	±7.30	±0.01	±7.72	±11.15	±0.01
Significances	NS	*	*	*	NS	**

a-d Mean within each column with no common superscript differ significantly ($p < 0.05$). * $P<0.05$ NS: not significant

Table 3: Effect of enzyme supplementation on broiler performance during withdrawal and overall periods

	Withdrawal (33-40days)			Overall (14-40days)		
Item	BWG (g)	FI (g)	FCR (g/g)	BWG (g)	FI (g)	FCR (g/g)
Diet 1 (control)	622^{ab}	1204	1.94^{b}	1683^{ab}	2982	1.77^{ab}
Diet 2 (low energy1)	613^{ab}	1212	1.98^{ab}	1676^{ab}	3036	1.81^{ab}
Diet 3 (low energy2)	599^{ab}	1206	2.01^{a}	1642^{ab}	3002	1.83^{a}
Diet 2 + enzymes	590^{b}	1162	1.97^{ab}	1600^{b}	2853	1.78^{ab}
Diet 3 + enzymes	645^{a}	1257	1.95^{b}	1723^{a}	3040	1.76^{b}
SE of means	±6.79	±11.19	±0.01	±15.24	±24.91	±0.01
Significances	*	NS	*	*	NS	*

a-d Mean within each column with no common superscript differ significantly ($p< 0.05$). * $P<0.05$ NS: not significant

supplementation gained more weight than those fed the control diet. No significant differences were observed among other dietary treatments on BWG. Feed intake did not differ among dietary treatments. Feed conversion ratio slightly affected by dietary treatments. Enzyme supplementation improved FCR compared with the control diet. Enzyme supplementation to diet 3 improved ($P<0.01$) FCR compared with the control birds and those fed low energy diets without enzyme supplementation.

During the withdrawal period (33-40d), reducing energy level or adding enzyme preparations to low energy diets slightly affected BWG. Adding enzyme preparations to diet 2 did not improve BWG, while adding enzyme preparations to diet 3 improved BWG compared to the control or diet 2 without enzyme supplementation. Enzyme supplementation to diet 3 improved ($P<0.05$) BWG compared with diet 3 without enzyme supplementation but with no significant effect compared with the control diet. No significant differences were observed among dietary treatments on FI. Values of FCR impaired ($P<0.05$) for birds fed the low energy diets without enzyme supplementation compared to birds fed the control diet. No significant differences were observed on FCR between birds fed the control or low energy diets supplemented with enzyme.

The results of the overall experiment period (14-40d) showed that adding enzyme preparations to diet 2 did not improve BWG. Meanwhile, adding enzyme to diet 3 of the lowest energy level improved BWG compared with diet 3 without enzymes supplementation ($P<0.05$) and the control diet ($P>0.05$). No significant differences were observed among dietary treatments on FI. FCR were slightly affected for birds fed low energy diets with or without enzyme supplementation compared to birds fed the control diet. FCR values improved ($P<0.05$) for birds fed diet 3 with enzyme supplementation being (1.76) compared to birds fed diet 3 without enzyme supplementation being (1.83). The results indicated that adding enzyme preparations contained xylanase and amylase to corn soybean meal diets of low energy levels increase efficiency of feed utilization, improved broiler performance and allowed the reduction in the dietary energy level by about 150 kcal. The results revealed a significant improvement in feed efficiency at 23 and 32 days of age for birds received the enzyme supplemented diets. This could be explained by the improvement in body weight. The results indicated that the efficiency of dietary utilization increased in chicks fed enzyme compared to those fed the control diet, since broilers fed diets supplemented with enzyme consumed less feed compared to those fed the control diet. This result is in agreement with the findings of Ranade and Rajmane [14], who reported a lower feed intake and significant improvement in feed conversion efficiency of broilers, fed supplemented diets with enzyme preparation containing cellulase, protease, xylanase, beta-glucanase and alpha-amylase activities. The improvements in body weight gain of broilers fed the enzyme supplemented diets could be ascribed to the increased nutrient digestibility. Some studies reported a significantly positive growth performance response in maize-based diets supplemented with enzymes, either multiple enzymes which contains xylanase, protease and amylase or a single protease enzyme [15, 16]. Zanella *et al.* [15] reported a significant increase in body weight gain and improvement in feed efficiency of broilers fed corn-soybean meal diets supplemented with enzyme compared to those fed the control diet. Feed conversion ratio was improved by enzyme addition, which is in agreement with recent reports [17-19]. Lee *et al.* [17] reported that body weight gain and feed conversion ratio improved ($p<0.05$) in chicks that were fed low energy diets containing multiple enzymes than those received the control diets without multiple enzymes supplementation during the finisher period (22-32 d) and the entire experimental period (1-32d). Nian *et al.* [18] showed that supplementation of xylanase had no effect on weight gain and feed intake of broilers. But, FCR was improved ($P<0.05$) by 4.3% with supplemental Xylanase. These results confirmed those obtained by Hassan *et al.* [19] who reported that using enzyme preparation increased efficiency of feed utilization. A pronounced effect on FCR was detected particularly on low energy diets.

Carcass Characteristics: The effects of dietary treatments on carcass characteristics of 40 days old broilers are shown in Table 4. No significant differences were detected on whole carcass weight, dressing percentage, heart, gizzard and liver (% body weight) among treatments. Reducing energy level increased ($P<0.05$) abdominal fat percent compared with the control diet. However, enzyme supplemented diets decreased ($P<0.05$) abdominal fat percent. It could be concluded that enzyme supplementation did not affect carcass characteristics of broilers. However, enzymes supplementation decreased abdominal fat percent. These results are consistent with Biswas *et al.* [20], Kidd *et al.* [21] and Hassan *et al.* [19] who found that carcass yields and internal organs were not affected due to enzyme addition. P ishnamazi and Pourreza [9] showed that

Table 4: Effect of enzymes supplementation on carcass characteristics

Item	Carcass (g)	Dressing %	Liver %	Heart %	Gizzard %	Fat %
Diet 1 (control)	1440	71	2.19	0.51	1.44	1.54bc
Diet 2 (low energy1)	1428	70	2.27	0.49	1.44	1.82ab
Diet 3 (low energy2)	1343	69	2.45	0.51	1.54	1.94a
Diet 2 + enzymes	1415	70	2.25	0.55	1.47	1.36c
Diet 3 + enzymes	1395	71	2.19	0.54	1.4	0.88d
SE of means	±11.17	±0.20	±0.06	±0.01	±0.02	±0.08
Significances	NS	NS	NS	NS	NS	*

a-d Mean within each column with no common superscript differ significantly ($p< 0.05$).* $P<0.05$ NS: not significant

Table 5: Effect of enzyme supplementation on economic efficiency at the end of the experimental period.

Item	FI (g)	Feed Cost[1] (LE)	BWG (g)	Total[2] Revenue	Net Revenue	EE[3]	REE%[4]
Diet 1 (control)	2982	8.94	1683	16.83	7.89	0.88	100
Diet 2 (low energy1)	3036	8.67	1676	16.76	8.09	0.93	105.7
Diet 3 (low energy2)	3002	8.47	1642	16.42	7.95	0.94	106.8
Diet 2 + enzymes	2853	8.3	1600	16	7.7	0.93	105.7
Diet 3 + enzymes	3040	8.66	1723	17.23	8.54	0.99	112.5

[1]Sum of feed cost in growing, finishing and withdrawal periods.

[2] Assuming that selling price of one Kg live body weight is (10 L.E)

[3] Net revenue per unit feed cost

[4] Assuming that economical efficiency of the control group equal 100.

the enzyme used in broiler diets caused a significant decrease ($P < 0.01$) in abdominal fat. Saleh *et al.* [22] found that chicks fed on enzyme supplemented diets gained more weight than the control as a result of improvement in feed conversion ratio. The enzyme treatment resulted in decreased abdominal fat weight. Hassan *et al.* [19] reported that fat deposition slightly decreased with the addition of enzyme preparation on either male or female birds. Excessive fat is one of the main problems faced the broiler industry these days, since it not only reduces carcass yield and feed efficiency but also causes rejection of the meat by consumers [23] and causes difficulties in processing [24]. Consumers prefer poultry meat, as it is not only low in fat but also in saturated fatty acids, it is rightly believed that restricted consumption of animals fats can be a major factor in preventing diseases of cardiovascular system . In broiler chickens, abdominal fat is a waste product during carcass processing. It delays processing procedures and may cause problem during carcass evisceration [7]. Using enzyme preparation in broiler diets significantly ($P<0.05$) reduced abdominal fat measured either as absolute weight or percent of live body weight. This could introduce a new way in ameliorating the problem of increasing carcass fat which adversely affects consumer acceptance and health. Meanwhile, it also affects the end product, waste management and by-product composition. It is well known that nutritional factors can be manipulated to some extent to reduce body fat [8].

Economic Efficiency: Results of economic efficiency (E.E) and relative economical efficiency (R.E.E) estimated for the different treatments at the end of the experiment are shown in Table 5. According to the input/output, economical efficiency and relative economical efficiency were ranged between 0.88-0.99 and 100- 112.50% for the control and the experimental treatments. The best value for (E.E, 0.99) and (R.E.E. 112.50%) had been recorded with birds fed low energy diet (diet 3) with enzyme supplementation compared to the control diet. Economic data clearly indicated that enzyme supplementation is more feasible and economical to obtain maximum profitability from broiler production. The results indicated that enzyme supplementation reduced the relative cost per unit of weight gain. Relative economics revealed higher returns in diet 3 supplemented with enzyme followed by diet 3 without enzyme supplementation and diet 2 with or without enzyme and least in control diet. It is obviously that feeding dietary treatments decreased production cost compared to the control. It is worthy to note that supplementing low energy diet (diet 3) with enzymes resulted to reduction in feed cost. Across all dietary treatments adding enzymes to low energy diets had better values in this respect. These results agreed with those of Mikulski *et al.* [25] who reported that enzyme supplementation decreased the relative cost of broiler feeds by 4 to 18% compared to feed of no enzyme supplement. Also, Sherif [26] found that enzyme supplementation to broiler diets improved economic efficiency.

In conclusion, enzymes can be effectively added to broiler diets of low energy levels without adverse effect on growth performance, carcass characteristics and it did reduce abdominal fat and increase efficiency of feed utilization. It plays a role in the poultry industry by supplying energy at a more cost effective price.

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