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FURTHER BENEFITS OF XYLANASE ENZYME SUPPLEMENTATION TO LOW ENERGY CORN-SOYBEAN MEAL BROILER DIETS

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SUMMARY

This experiment was conducted to study the ability of supplemental xylanase enzyme (Xyl) to improve growth performance, carcass traits, meat quality and feeding cost of broilers fed on low metabolizable energy (ME) corn-soybean meal diets. Two hundred and forty, one day old unsexed Arbor Acres broiler chicks were randomly distributed into six treatments (2x3 factorial design) each had four replicates. Chicks were fed on corn-soybean diet supplemented with two levels of Xyl (0 and16000 U/kg of diet), and three ME levels which were standard strain recommendation (STD), 100 kcal lower than STD (E100) and 150 kcal lower than STD (E150) of each feeding phase for STD, E100, and E150 levels, respectively. The dietary ME values were 3000, 2900 and 2850 kcal/kg diet at starter phase; 3100, 3000 and 2950 kcal /kg at grower phase; and 3200, 3100 and 3050 kcal/kg at the finisher phase. All diets were formulated to save the strain requirements from the rest of nutrients. All chicks were housed in open system broiler house and received the same managerial conditions and veterinary program during experimental period (1-40 d of age). Parameters of growth performance, carcass characteristics, physical and chemical evaluation of broiler meat were carried out and feeding cost was calculated. The recorded results showed that xylanase supplementation to broiler diets resulted in significant improvement of body weight, body weight gain, feed conversion ratio, dressing %, and breast meat yield %, while feed intake and ultimate pH (pHu) of both breast and thigh cuts were decreased. Regarding to ME of diets, reducing ME values from STD level to E150 level caused significant reduction in final body weight, abdominal fat %, pHu of breast meat samples and concentrations of malondialdehyde (MDA) and low density lipoprotein (LDL). Furthermore this reduction of ME levels caused significant increase of feed intake, % of drum stick and concentration of total protein of broiler meat at 40 d of age. Among experimental treatments chicks of both STD+Xyl and E100+Xyl treatments showed better growth performance, carcass traits, and meat quality compared with other treatments. In addition applying these treatments resulted in saving 9.25 % and 3.51% from feeding cost/kg of body weight relative to feeding cost of STD group. According to these results it could be concluded that adding xylanase enzyme to either STD or E100 corn-soybean meal broiler diets could enhance the quality of produced broiler accompanied with saving in feeding cost.

Keywords: broiler, xylanase, metabolizable energy, performance, meat quality.

INTRODUCTION

Both reducing feeding cost at commercial poultry farms and producing better quality of broiler meat are the most important targets of producers in the field of poultry industry and this led to an increasing interest in using exogenous enzyme products in corn-soy diets (Cowieson and Ravindran, 2008 and Cowieson, 2010). Poultry rations contains different kinds and levels of antinutritional factors which reducing nutrients digestibility like non starch polysaccharides (NSP) compounds (Knudsen, 1997; Bedford, 2000; and Yu and Chung, 2004). These compounds have the ability to prevent access to nutrients by encapsulating them (Gracia *et al*., 2003; Cowieson, 2005; Choct, 2006; and Slominski 2011). Also, corn-soy-based diets contains numerous antinutritional factors, such as β-glucans, β-mannose, protease inhibitors and lectins, and it has been proved that the addition of exogenous enzymes in corn-soy-based diets is reasonable and practicable (Yang *et al*., 2010). Previous studies indicated that NSP concentration in whole corn grain about 27–32 g of xylose/kg (Knudsen, 1997) while soybean meal contained 18–19 g of xylose/kg (Knudsen, 1997; and Irish and Balnave, 1993). NSP can increase digesta viscosity, which has been related to a reduction in starch, protein, and fat digestibility (Bedford *et al*., 1991; and Meng *et al*., 2005); however, corn-soy diets may not contain sufficient concentrations of high-molecular weight soluble polysaccharides to increase intestinal viscosity to a point that is detrimental to nutrient utilization by poultry (Gracia *et al*., 2003; and Knudsen, 2014).

Cowieson (2010) estimated the indigestible energy by feeding typical corn-soy ration by 400 to 450 kcal of energy per kg of diet. The author reported that use of exogenous enzymes can be a good strategy to release this energy and make it available to birds. In this trend numerous studies investigated using exogenous carbohydrases such as xylanases has been reported to improve energy utilization and the performance of broilers (Bedford,1995; Olukosi and Adeola, 2008; and Williams *et al*., 2014) by hydrolysis of cell wall arabinoxylans and improve the access of endogenous digestive enzymes to cell contents (Kocher *et al*., 2003; Meng *et al*., 2005; Omar *et al.*, 2008; and Francesch and Geraert, 2009). Choct *et al.,* (1995) mentioned that xylanase was successfully hydrolyze NSP in poultry diet. Bedford (1995) reported that the overall effects of enzymes additives improve live weight and feed conversion ratio and increase the levels of metabolizable energy of the cereal or the ration as a whole. Panda *et al*., (2012) reported that AME can be reduced by 100kcal/kg in maize-soybean meal based broilers diet by supplementing carbohydrase enzyme (xylanase, glucanase, cellulase and mannanase). Abou El-Wafa *et al*., (2013) reported the same results by adding xylanase to broiler corn-soybean meal based diets. While Youssef *et al*., (2011) concluded that a mixture of enzyme preparation containing xylanase and amylase added to corn-based diet could reduce the dietary energy level about 150 kcal/kg without a negative effect on growth performance or carcass traits. Gehring *et al*., (2013) concluded that responses to exogenous enzyme supplementation are not constant and are influenced by type of feed ingredients and other factors.

The objective of the current study was to evaluate the ability of supplemental xylanase to enhance growth performance, carcass traits, meat quality and feeding cost of broilers fed low energy corn-soybean meal diets.

MATERIALS AND METHODS

Experimental diets and birds:

Two hundred and forty unsexed one day old Arbor Acres broiler chicks were wing banded, weighed and randomly allocated in a 2x3 factorial design in six experimental groups; each group contains four replicates of ten chicks each. Chicks were fed on diets contained the requirements of all nutrients except metabolizable energy (ME). The examined three ME levels were standard requirements of chicks' strain (STD), lower 100 kcal/kg diet in each feeding phase than STD (E100), and lower 150 kcal/kg diet in each feeding phase than STD (E150). Two level of xylanase enzyme supplementation (0 and 16000 U xylanase/kg diets) were examined. The experimental diets STD, E100 and E150 contained 3000, 2900 and 2850 kcal/kg during starter period (1-10 d), 3100, 3000 and 2950 kcal/kg during grower period (11-24 d), and 3200, 3100 and 3050 kcal/kg during finisher period (25-40 d), respectively as described in Table (1). The examined xylanase source was commercial enzyme (Econase XT25) which supplemented at level 100 mg/kg diet to provide 16000 U xylanase/kg diets. All chicks were fed on examined diets *ad libitum* in wire battery cages and received the same management and veterinary procedures during the experimental period (1 - 40 d). Growth performance parameters including live bodyweight (BW), body weight gain (BWG), feed intake (FI), and feed conversion ratio (FCR) were recorded during feeding phases and the overall experimental period.

Table (1): Composition and calculated analysis of experimental diets

Ingredient	Starter (1-10 days)			Grower (11-22 days)			Finisher (23-40 days)		
	STD	E100	E150	STD	E100	E150	STD	E100	E150
Yellow corn	55.10	55.00	54.90	60.65	62.31	62.55	64.74	66.51	65.7
Soybean meal (44%)	31.00	33.57	36.17	23.84	24.44	25.86	19.25	19.48	23.09
Corn gluten meal (60%)	7.50	5.88	4.00	8.57	8.00	7.00	8.16	8.0	5.30
Soybean oil (SO)	1.80	0.95	0.45	2.27	0.60	0.00	3.28	1.44	1.44
Di-Ca-P	2.00	2.00	2.00	1.75	1.75	1.75	1.55	1.55	1.55
Limestone	1.15	1.20	1.15	1.46	1.46	1.46	1.58	1.58	1.58
NaCl	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
Vit.&Min. pre-mix*	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Sodium bicarbonate	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
DL Methionine	0.24	0.26	0.27	0.19	0.19	0.19	0.17	0.17	0.19
L-Lysine HCl	0.34	0.27	0.19	0.40	0.38	0.32	0.40	0.40	0.28
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Calculated analysis									
Crude protein%	23.00	23.00	23.00	21.00	21.00	21.00	19.00	19.00	19.00
ME (kcal/kg diet)	3000	2904	2850	3093	3000	2950	3200	3100	3050
Crude fiber%	3.68	3.81	3.99	3.32	3.38	3.49	3.06	3.06	3.30
Ether extract%	4.52	3.97	2.97	5.05	3.52	2.92	6.21	4.37	4.21
Calcium %	0.98	0.97	0.98	1.00	1.00	1.00	1.00	1.00	1.00
Available P %	0.52	0.52	0.53	0.47	0.46	0.47	0.42	0.42	0.42
Sodium %	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Lysine %	1.38	1.38	1.38	1.24	1.26	1.24	1.11	1.11	1.11
Methionine %	0.67	0.68	0.67	0.60	0.60	0.60	0.55	0.55	0.55
Methionine+Cystine%	1.05	1.05	1.05	0.95	0.96	0.95	0.87	0.87	0.87
Cost / ton at Egyptian Local Price (LE) [#]	3550	3471	3400	3443	3327	3263	3372	3260	3200

** Vitamins and minerals premix will provide each kg of diet with: Vit. A, 11000 IU; Vit. D3, 5000 IU; Vit. E, 50 mg; Vit K3, 3mg; Vit. B1, 2mg; Vit. B2 6mg; B6 3 mg; B12, 14 mcg; Nicotinic acid 60 mg; Folic acid 1.75 mg, Pantothenic acid 13mg; Biotine 120 mcg ; Choline 600 mg; Copper 16mg; Iron 40mg; Manganese 120 mg; Zinc 100mg; Idoine 1.25mg; and Selenium 0.3 mg; # Cost of Xylanase supplemented diets increased 22 LE/Ton feed. STD = Standard requirements*

Slaughtering and carcass characteristics:

At the end of the experiment (40 days of age), four birds of each treatment were slaughtered to record carcass characteristics. Carcass, abdominal fat, edible parts (liver, gizzard and heart) were weighted and calculated as % from live body weight. Also, Weights of front quarter (FQ) which include breast quarter muscles and skin (without wing) and back quarter (BQ) which include drumstick and thigh were recorded as percentage from carcass weight. While weights including of drumstick (DS) and thigh samples were recorded as percentage of back quarter. Skin weight of every part was recorded as percentage of its part. Then, FQ and BQ samples (72 samples) were kept for 24 h at 4°C to complete the physical and chemical evaluation of broiler meat.

Meat quality measurements:

Physical measurements:

After slaughtered 72 samples (24 breast, 24 thigh and 24 drumsticks) samples were subjected to drip loss % and ultimate pH (pHu) during the 24 h after slaughtering. Drip loss% was calculated as the percentage of the difference between weights of samples before and after storage 24 h. and divided by the first weight as described by Saenmahayak *et al*., (2012). Samples were lightly blotted using filter paper before reweighting. Concerning pHu, during 24 h of chilling the samples on 4°C were used to measure pHu as described by Selim *et al*., (2013) using pH meter, provided by a temperature control system, by probe method. The minimum depth to adopt was 1 cm after incision of the muscles.

Chemical measurements:

Samples of breast, thigh and drum stick (DS) of each slaughtered bird were homogenized at equal weight basis then stored on -20°C for 60 days before used to determine concentrations of malondialdehyde (MDA), total protein (TP), low density lipoprotein (LDL) and high density lipoprotein (HDL) in meat extract. Meat extract of each sample was prepared by using 10 ml of phosphate buffer pH 7.4 Colorimetric methods using analytical commercial kits produced by Biodiagnostic Company, Egypt (Selim *et al*., 2014).

Statistical analysis:

The collected data were subjected to two way analysis of variance to detect the effects of xylanase supplementation and ME level using the general liner model (GLM) procedure of SAS User's guide (SAS, 2001) as the following model:

$Y_{ijk} = \mu + X_i + M_j + (XM)_{ij} + e_{ijk}$.

Where:

Y_{ijk} = Trait measured

μ = Overall mean

X_i = Xylanase supplementation i= (1, 2)

M_j = Metabolizable energy level j= (1,., 3)

$(XM)_{ij}$ = Interaction between xylanase supplementation and metabolizable energy level.

e_{ijk} = Experimental error

In addition data of all experimental treatments were subjected to one way analysis of variance to detect the differences between all treatments as following model:

$$Y_{ij} = \mu + Ti + e_{ij}$$

Where:

μ = overall mean of Yij,

T_i = effect of treatment, i = (1,…, 6)

e_{ij} = Experimental error

In addition data of all experimental treatments were subjected to one way analysis of variance to detect the differences between them. Duncan's Multiple Range test (Duncan's, 1955) was used to separate means when separation was relevant. Statistical significance was accepted at probability level of ($p<0.05$).

RESULTS AND DISSCUSION

Growth performance:

The recorded results of growth performance parameters of broilers during the experimental period are shown in Table (2). These results showed that xylanase supplementation to corn-soybean meal broiler diets could enhance final BW, BWG and FCR significantly, and could reduce values of FI. The improvement of FCR was 8% compared with the value of unsupplemented group. Regarding experimental ME levels, reducing 150 kcal/kg diet led to significant reduction of broiler BW and BWG and increased the consumed feed during the experiment compared to E100 recorded values. This situation led to significant deterioration of FCR by 4.1 % and 14.3% by using E100 and E150 diets compared with STD diets, respectively. Among experimental treatments, all treatments recorded better BW and BWG except treatment E150 when compared with STD values. Chicks of STD + Xyl and E100 + Xyl treatments recorded the best FCR compared with other treatments (10% and 4% improvements compared with STD group). The obtained mean values of growth performance parameters of experimental treatments showed that xylanase supplementation to E150 diets could compensate some of ME reduction and help chicks to increase BWG and improve FCR compared with unsupplemented treatment (1949 vs. 1790 and 1.83 vs. 2.01, respectively).

Table (2). Effect of xylanase enzyme supplementation and metabolizable energy level on growth performance of broiler chicks at 40 days of age.

a,b,...= Means in the same column with different superscripts, differ significantly (P<0.05); N.S= Non significant.
STD = Standard requirements; Xyl = Xylanase; E100 = 100 kcal/kg diet lower than STD
E150 =150 kcal/kg diet lower than STD.

Treatment	Body weight (g)	Feed intake (g)	Body weight gain (g)	Feed conversion ratio
Main effect				
- Xylanase Supplementation (16000U/kg)				
Without	1856.16 ^{b}	3371.69 ^{a}	1816.16 ^{b}	1.86 ^{a}
With (Xyl.)	1968.60 ^{a}	3291.42 ^{b}	1928.60^{a}	1.71^{b}
Mean of SE	±14.31	±26.99	±14.31	±0.01
Probability	0.0001	0.05	0.0001	0.0001
-Metabolizable Energy (kcal/kg)				
STD	1914.38^{ab}	3146.81 ^{c}	1874.38 ^{ab}	1.68 ^{c}
E100	1953.13 ^{a}	3342.52 ^{b}	1913.13 ^{a}	1.75 ^{b}
E150	1869.63 ^{b}	3505.32 ^{a}	1829.63 ^{b}	1.92 ^{a}
Mean of SE	±17.53	±33.06	±17.53	±0.02
Probability	0.01	0.0001	0.01	0.0001
Treatments				
STD	1846.25 ^{b}	3194.63^{cd}	1806.25 ^{b}	1.77 ^{b}
STD+Xyl	1982.50 ^{a}	3099.00^{d}	1942.50 ^{a}	1.59 ^{d}
E100	1932.22 ^{a}	3401.04^{ab}	1892.22 ^{a}	1.80 ^{b}
E100+Xyl	1974.03 ^{a}	3284.00^{bc}	1934.03 ^{a}	1.70 ^{c}
E150	1790.00 ^{b}	3519.39 ^{a}	1750.00 ^{b}	2.01 ^{a}
E150+Xyl	1949.26 ^{a}	3491.25 ^{a}	1909.26 ^{a}	1.83 ^{b}
Mean of SE	±24.79	±46.75	±24.79	±0.02
Probability	0.0001	0.0001	0.0001	0.0001

The overall results of growth performance showed that applying STD + xyl and E100 + Xyl diets in feeding broiler may be help producers to gain acceptable broiler weights with improved FCR values.

Concerning xylanase supplementation, the results of the current study were in agree with those reported previously by (Cowieson, 2005; Nian *et al*., 2011; and Williams *et al*., 2014; and Pirgozliev *et al.,* (2015). The authors reported improved growth performance of broilers when fed on corn-soybean meal based diets supplemented with xylanase enzyme.

Cowieson *et al.,* (2010) reported significant improvement of FCR of broilers with xylanase supplementation due to increased BWG accompanied with no effect on FI, which suggested that xylanase increased the feed use efficiency (O'Neill and Lui , 2011).

O'Neill *et al*., (2012) examined the effect of xylanase supplementation to low energy broiler diets (lower 100 kcal/kg diet than recommendation) based on corn-soybean meal and reported significant improvement of growth performance after the first 21 days of age. They concluded that decreasing ME of broiler diets resulted in worsened performance and xylanase supplementation might improve FCR. On the same trend Abou El-Wafa *et al*., (2013) found that the effect of dietary ME level reveal a significant decrease in total BWG associated with a corresponding increase in total FI and a worsening in FCR as the dietary ME decreased 50 and 100 kcal/kg diet. The same authors reported that inclusion xylanase significantly improved FCR without affecting total BWG. Also, Pirgozliev *et al.,* (2015) showed that xylanase supplementation to broiler diets improved dietary AME.

Reducing ME of broiler diets 100 and 150 kcal/kg diet than STD resulted in significant depression of BWG and FCR as found in reports of Downs *et al*.,(2006); Golian *et al*., (2010); O'Neill *et al*., (2012); and Abou El-Wafa *et al*., (2013), and some of them reported associated increase of FI (O'Neill *et al*., (2012).

Xylanase hydrolyses NSP through breakdown β 1-4, D-xylosidic linkage of highly polymerized and substituted β 1-4 linked D-xylobiose, xylotriose and glucuronosyl residues. Furthermore, xylanase may create pre-biotic xylo-oligomers that benefit digestion indirectly via increased fermentation in the hindgut and stimulation of the ileal brake mechanism (Cowieson, 2005*).*

However some experiments showed positive effect of xylanase supplementation to broiler diets on growth performance (Choct *et al*., 1995; Abou El-Wafa *et al*., 2013; Williams *et al*., 2014; and Pirgozliev *et al.,* 2015). On the other side no effect on growth performance with supplementing various carbohydrases (Kocher *et al*., 2003 and Singh *et al*., 2012).

Carcass characteristics:

The recorded results of carcass characteristics of broiler chicks of experimental treatments at 40 d of age are presented in Table (3). The results showed significant increase of dressing % and breast meat yield % (5.3% and 7.1%) by xylanase supplementation, while % of edible parts and skin of FQ were decreased by 9.4% and 17 % as compared with unsupplemented group, respectively. Regarding ME of broiler diets, decreasing ME from E100 to E150 caused a significantly reduction (3.9 %) in dressing %, however values of abdominal fat % showed significant reduction by decreasing ME level from STD to E100 and extra numerical reduction by using E150. Although, using E100 diets produced the highest value of breast meat yield (20.33% from carcass), values of BQ did not changed significantly by using varying ME levels. Reducing ME from STD to E100 or to E150 led to significant increase of drum stick (DS) % accompanied with significant depression of thigh %. Between experimental treatments, broilers fed on low ME diets showed significant reduction of abdominal fat %. Generally chicks fed on diets supplemented with Xy1 either with STD or E100 showed significantly the highest dressing and breast meat yield %.

The obtained results showed significant enhancement of xylanase supplementation on dressing % and breast meat yield % while abdominal fat % did not affected. These results are in match with those reported by some workers who interested with the effects of xylanase supplementation on carcass traits of broilers and detected significant increase of dressing (Medhi *et al*., 2003; and Khan *et al*., 2006). Williams *et al*., (2014) explained this improvement by increasing the energy utilization of broiler diets fed on xylanase diets. Another suggestion reported by Medhi *et al*., (2003); and Khan *et al*., (2006) who suggested the improvement might be due to improve the growth rate of broiler and thereby increased the dressing percentage. Controversy, Abou El-Wafa *et al.,* (2013) examined the effect of xylanase supplementation to broiler diets based on corn or corn/rye at recommended and reduced ME levels (50 and 100 kcal/kg) and recorded no significant effect of xylanase on dressing % but the % of abdominal fat was decreased by 25.41% compared with unspplemented group. Furthermore many researchers reported no effect of carbohydrases on dressing % and general carcass traits of broilers (NarsimhaRao, 1998; and Hanumantharao *et al.,* 2003).

The recorded reduction of abdominal fat % in current results due to decreased ME in broiler diets were different than those reported previously by some researchers (Abudabos , 2012; Abou El-Wafa *et al*., 2013; Williams *et al*., 2014; and Miah *et al.,* 2014). These reports showed no significant effect of using low ME broiler diets (reduction levels varied from 40 to 170kcal/kg) on dressing %, abdominal fat % or the overall carcass characteristics.

Table 3

Meat quality:

Effect of xylanase supplementation and ME levels of broiler diets on some quality measurements of broiler meat are shown in Table (4). The presented results showed that xylanase supplementation to corn-soybean meal broiler diets caused significant reduction of pHu of both breast meat and thigh accompanied with significant reduction of drip loss % of thigh. Both drip loss % and pHu of DS did not affected significantly by xylanase supplementation. On the other side the determined values of broiler meat chemical quality measurements (MDA, LDL, HDL and TP) did not changed as a response to xylanase supplementation. Regarding of ME of broiler diets, reducing ME either 100 or 150 kcal/kg than broiler requirements led to significant reduction of pHu of breast samples while only E100 reduce significantly breast meat drip loss %. No significant effect on drip loss % and pHu was detected in other cuts. Furthermore, determined concentrations of MDA and LDL of meat samples were reduced by decreasing ME of diets associated with increased concentrations of meat TP significantly.

Table (4): Effect of xylanase enzyme supplementation and metabolizable energy level on some physical and chemical meat quality of broiler chicks at 40 days of age.

Treatment	Physical measurements						Chemical measurements			
	Breast		Thigh		Drum Stick					
	Drip Loss	pHu	Drip Loss	pHu	Drip Loss	pHu	MDA (nmol/100 g meat)	T.P (mg/100g meat)	LDL (mg/100g meat)	HDL (mg/100g meat)
Main effect										
	- Xylanase Supplementation (16000U/kg)									
Without	3.19	6.15^{a}	4.48^{a}	6.59^{a}	1.26	6.42	392.64	65.41	1100.00	686.78
With (Xyl.)	2.87	5.87^{b}	3.84^{b}	6.31^{b}	1.04	6.52	363.22	69.76	1073.81	698.24
Mean of SE	±0.11	±0.07	±0.15	±0.07	±0.09	±0.4	±18.52	±1.64	±32.78	±17.14
Probability	N.S	0.01	0.01	0.01	N.S	N.S	N.S	N.S	N.S	N.S
	Metabolizable Energy (kcal/kg)									
STD	3.46^{a}	6.88^{a}	4.37	6.50	1.32	6.40	461.03^{a}	48.21^{b}	1338.33^{a}	671.06
E100	2.50^{b}	5.54^{b}	3.79	6.37	1.01	6.50	361.27^{b}	75.05^{a}	945.48^{b}	684.14
E150	3.13^{a}	5.62^{b}	4.31	6.47	1.14	6.50	311.50^{b}	79.49^{a}	976.91^{b}	722.33
Mean of SE	±0.14	±0.08	±0.18	±0.08	±0.11	±0.05	±22.68	±2.00	±40.15	±20.99
Probability	0.001	0.0001	N.S	N.S	N.S	N.S	0.002	0.0001	0.0001	N.S
	Treatments									
STD	3.62^{a}	7.20^{a}	4.73^{a}	6.57^{ab}	1.42	6.40	506.10^{a}	43.78^{c}	1367.14^{a}	727.51^{ab}
STD+Xyl	3.30^{ab}	6.55^{b}	4.01^{ab}	6.44^{ab}	1.21	6.42	415.96^{ab}	52.65^{b}	1309.52^{a}	614.60^{c}
E100	2.90^{b}	5.67^{c}	4.22^{a}	6.52^{ab}	1.03	6.47	364.32^{bc}	74.90^{a}	1005.71^{b}	640.44^{bc}
E100+Xyl	2.10^{c}	5.41^{c}	3.35^{b}	6.22^{b}	0.99	6.54	358.22^{bc}	75.20^{a}	885.24^{b}	727.83^{ab}
E150	3.06^{ab}	5.58^{c}	4.48^{a}	6.68^{a}	1.34	6.39	307.51^{c}	77.55^{a}	927.14^{b}	692.39^{abc}
E150+Xyl	3.20^{ab}	5.67^{c}	4.14^{ab}	6.26^{b}	0.93	6.62	315.49^{bc}	81.42^{a}	1026.67^{b}	752.28^{a}
Mean of SE	±0.48	±0.25	±0.54	±0.10	±0.24	±0.07	±32.07	±2.84	±56.78	±29.69
Probability	0.003	0.0001	0.04	0.09	N.S	N.S	0.008	0.0001	0.0002	0.04

a,b,...= Means in the same column with different superscripts, differ significantly (P<0.05); N.S= Non significant.
STD = Standard requirements; Xyl = Xylanase; E100 = 100 kcal/kg diet lower than STD; E150 =150 kcal/kg diet lower than STD.

Among experimental treatments the most influenced cut was breast meat whereas its determined pHu and drip loss % were significantly affected by treatments. There was general reduction in pHu values of breast meat in samples of all treatments compared with STD value, while only E100 and E100+Xyl samples showed significantly decrease of drip loss % compared with that value of STD treatment. The lowest pHu and drip loss % values of thigh recorded by E100+Xyl. The worst values of TP, MDA and LDL concentrations recorded for STD samples at high significant levels.

The overall results of broiler physical and chemical meat quality examination showed clear improvement of breast meat pHu by both xylanase supplementation and low ME level and general enhancement of chemical quality and self life of produced meat. Samples of E100+Xyl treatments showed general better meat characteristics compared with other treatments. These results were in agreement with those reported by (Allen *et al*., 1997; Tang *et al.,* 2007; and Zakaria *et al.,* 2010) about effect of xylanase or ME on broiler meat. Tang *et al.* (2007) found that pH value of broiler meat increased by the increasing energy level of diets. In addition decreasing pH value of broiler meat with xylanase supplementation to low energy broiler diets resulted in increase shelf-life of muscles (Allen *et al*., 1997). Controversially, some other researchers could not report that improvement either in physical or chemical quality of meat by using carbohydrate enzymes preparations in broiler diets (Jeroch *et al*., 1991). Zakaria *et al.* (2010) used commercial enzyme preparation containing carbohydratases and failed to detect significant change of pH, cooking loss and water holding capacity of broiler meat.

According to the reported relationship between pH and ability to glycogen storage in breast meat by Le-Bihan-Duval *etal.* (2008), the reported reduction of breast pHu in this study due to xylanse supplementation or reducing ME of diets proved that glycogen storage in breast meat was increased. Based on results of pHu and drip loss %, the ability of breast and thigh meat to processing might be increased whereas water holding capacity and glycogen were increased (Barbut, 1993 and Zhang and Savage, 2010) by xylanase supplementation or reducing ME of diet whereas pHu and drip loss % decreased.

Feeding cost:

Results in Table (5) showed the effect of experimental treatments on feeding cost/bird, feeding cost/kg of live BW in Egyptian pounds. In addition feeding cost of STD group was considered to be the basic feeding cost and the differences of feeding cost of other treatments were calculated relative to it in %. The calculated values showed that xylanase supplementation to STD and E100 diets resulted in 9.25 % and 3.51% saving in feeding cost/kg BW of broiler chicks relative to cost STD group. On the other side reducing ME of broiler diets by 100 and 150 kcal/kg diets without extra xylanase supplementation led to increased feeding cost by 1.57 and 13.59 % relative to STD, respectively. Although Xylanase supplementation to E150 diets helped chicks to compensate the reduced ME and reducing feeding cost/kg BW (4.06 vs 13.59 % increasing cost), the obtained improvement in growth performance was not sufficient to record saving in feeding cost compared with STD value. The greatest saving % in feeding cost recorded by STD+Xyl group followed by E100+Xyl group (9.25 and 3.51%, respectively).

Table (5): Effect of experimental treatments on feeding cost of broiler chicks during 40 days of age.

Treatment	Final BW (g)	Total BWG (g)	FCR	Feeding cost/bird (LE)	Feeding cost/kg of BW(LE)	Relative difference of feeding cost from STD*(%)
STD	1846	1806	1.77	10.89	6.03	--
STD+Xyl	1982	1942	1.59	10.63	5.47	9.25 (Saving cost)
E100	1932	1892	1.80	11.59	6.12	1.57 (Increasing cost)
E100+Xyl	1974	1934	1.70	11.25	5.82	3.51 (Saving cost)
E150	1790	1750	2.01	11.99	6.85	13.59 (Increasing cost)
E150+Xyl	1949	1909	1.83	11.98	6.27	4.06 (Increasing cost)

** Relative difference of feeding cost from STD = 100 x (Feeding cost/kg of BW of each treatment - Feeding cost/kg of BW of STD group)/ Feeding cost/kg of BW of STD group). STD = Standard requirements; Xyl = Xylanase; E100 = 100 kcal/kg diet lower than STD; E150 =150 kcal/kg diet lower than STD.*

CONCLUSION

According to the obtained results of xylanasae enzyme supplementation to low metabolizable energy corn-soybean meal broiler diets on growth performance, carcass traits, meat quality and feeding cost/kg of body weight, it could be concluded that adding xylanase at 16000 U/kg diet to either STD or E100 broiler corn-soybean meal diets could enhance the quality of produced broilers accompanied with saving in feeding cost.

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الفوائد الإضافية لإنزيم الزيلينيز فى علائق الأذره وكسب فول الصويا المنخفضه فى الطاقه لكتاكيت التسمين

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تهدف هذه التجربه الى دراسة قدرة إنزيم الزيلينيز المضاف على تحسين أداء النمو و صفات الذبيحه و جودة اللحم وتكاليف التغذيه لكتاكيت التسمين المغذاه على علائق الأذره وكسب فول الصويا المنخفضه فى الطاقه. تم توزيع مائتين واربعون كتكوت تسمين غير مجنس عمر يوم سلالة أربر إيكرز عشوائيا الى ستة معاملات (تصميم عاملى 2*3) كل معامله تحتوى على اربع مكررات. غذيت الكتاكيت على علائق الأذره وكسب فول الصويا المضاف اليها مستويين من إنزيم الزيلينيز (بدون و 16000وحدة إنزيم /كيلو جرام علف) وثلاث مستويات من الطاقة الممثله وهى القياسيه (الموصى بها للسلاله) وأقل 100 كيلوكالورى من القياسيه واقل 150 كيلو كالورى من القياسيه (E100 و E150 على التوالى) وذلك لكل مرحله تغذيه. و كانت مستويات الطاقه بالعلائق 3000 و 2900 و2850 كيلو كالورى/كيلو جرام علف فى مرحلة البادى و 3100 و 3000 و 2950 كيلو كالورى/كيلو جرام علف فى مرحلة النامى و 3200 و 3100 و 3050 كيلو كالورى/كيلو جرام علف فى مرحلة الناهى لكلا من العليقه القياسيه و E100 وE150 على التوالى. تم تكوين العلائق لتوفيرإحتياجات السلاله من بقية العناصر الغذائيه. تم تسكين الكتاكيت فى نظام العنابر المفتوحة و خضعت لنفس برنامج الرعاية و البيطرة خلال فترة التجربة (من 1-40 يوم). تم تسجيل مقاييس الأداء الإنتاجى وصفات الذبيحه وتقيم الصفات الطبيعيه والكيماويه للحم و كذلك حساب تكاليف التغذيه . وأظهرت النتائج أن إضافة إنزيم الزيلينيز الى علائق كتاكيت التسمين أدى إلى تحسن الزياده فى وزن الجسم و معدل التحويل الغذائى ونسبة التصافى ونسبة لحم الصدر بينما أدى إلى إنخفاض الغذاء المأكول ودرجة الحموضه (pHu) للحم الصدر والفخذ. أدى إنخفاض مستوى الطاقه 150 كيلو كالورى فى العليقه عن المستويات القياسيه الى إنخفاض معنوى لوزن الجسم النهائى ونسبة دهن البطن و pHu عينات لحم الصدر وتركيز المالون داى الدهيد (MDA) و الليبوبروتينات منخفضة الكثافة (LDL). ايضا ادى انخفاض مستوى الطاقه فى العليقه الى زيادة معنويه لكمية المأكول ونسبة الدبوس وتركيز البروتين الكلى فى اللحم لكتاكيت التسمين عمر 40 يوم. وأظهرت نتائج المعاملات أن كلا من المعامله القياسيه المضاف لها إنزيم الزيلينيز (STD+Xyl) والمعامله المنخفضه فى الطاقه 100 كيلو كالورى والمضاف لها الزيلينيز (E100+Xyl) أظهرت تحسن فى اداء النمو و صفات الذبيحه و جودة اللحم بالمقارنه بالمعاملات الاخرى. كذلك أدى تطبيق هاتان المعاملتان الى خفض تكلفة التغذيه لكل كيلو جرام وزن جسم بنسبة 9.25 %و3.51 % وذلك منسوبا الى تكلفة التغذيه للعليقه القياسيه. ونستخلص من هذه النتائج يمكننا استخلاص أن إضافة إنزيم الزيلينيز إلى كلا من العليقه القياسيه والعليقه المنخفضه فى الطاقه بمقدار 100 كيلو كالورى يؤدى إلى تحسن جودة الكتاكيت المنتجه مع توفير فى تكاليف التغذيه.