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Effect of Combination between Phytase , Xylanase and Protease Enzymes in Different Growing Phases on Growth Performance and Carcass Characteristics of Broiler Chicks.

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ABSTRACT

Four hundred and forty, one day old unsexed Arbor Acres broiler chicks were used to investigate the optimum impact of the combination between phytase , xylanase and protease enzymes to low energy and protein broiler diets at different growing phases on growth performance, carcass characteristics and feeding cost. Chicks were randomly allocated into eleven treatments (5*2+1) included control group (C) and ten treatments divided into two groups without phytase (Ph) enzyme and with Ph (1000 FTU/kg during whole production period) every group had five nutritional plans (NP). The five NP based on using diet contained lower 150 kcal metabolizable energy (ME) and 10% of crude protein (CP) in each feeding phase (D diet). NP 1, chicks fed on D diet; NP2, chicks fed on D diet with supplemental protease enzyme (300000 units/kg diet) during starting phase only (DP_s); 3, chicks fed on D diet with supplemental xylanase enzyme (16000 units/kg diet) during finishing phase only (DX_F); 4, chicks fed on D diet with supplemental protease enzyme during starting phase and supplemental xylanase enzyme during finishing phase at the same previous doses (DP_sX_F); 5, chicks fed on D diet with both supplemental protease enzyme and supplemental xylanase enzyme during all feeding phases at the same previous doses (DPX). Diets of C group was formulated to contain the nutritional requirements of Arbor Acers broiler chicks from all nutrients during the feeding phases. 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 phase (1-40 d of age). Parameters of growth performance, carcass characteristics and feeding cost were calculated. The recorded results showed that, Among NP chicks fed on D presented the worst growth performance during all feeding phases. During starting phase, FCR improved due to using $DP_{S,}$ DP_S X_F or DPX and the best value recorded by using DPX (1.56). While the recorded performance parameters during the finishing phase showed significant improvement of both BWG and FCR by applying DXP (1082) g and 1.78) or DP_S X_F (1055 g and 1.77). Also, phytase enzyme improved BWG and FCR significantly during all growing phases compared to performance of unsupplemented groups. The interactions between NP and phytase supplementation had significant effects on all growth performance parameters during all feeding phases. Both phytase supplementation and applying different NP caused significant effect on both cumulative FI and average daily gain (ADG) during the experimental phases. The overall results of carcass characteristics showed synergism effect of P, X and phytase (DPXPh) on dressing %, breast meat yield and thigh meat yield of broiler chicks beside the superior effect on growth performance parameters. The overall results confirmed the synergism effect between P, X and Phytase enzymes in broiler diets based on corn/soybean. The results recommended using combined supplementation of Phytase, P, and X to low 150 kcal of ME/kg and 10% of CP broiler diets during all growing phases to reach the same growth performance and better carcass, breast meat yield, thigh meat and economic benefits compared to control broiler chicks.

INTRODUCTION

Concerning the studies of optimum balancing of diets for broilers contributes for the success of improvement programs, allowing animals to express their maximal genetic capacity. At the same time, optimal diets may reduce costs of nutrition, improve the income and processing of carcass and still offer a better quality product to the final consumer. Exogenous enzymes have become an important tool to increase the nutritional value of feed ingredients, reduce feed costs, improve the environment and improving poultry performance. Exogenous enzymes such as xylanase (X), amylase (A), and protease (P) are increasingly being used in corn-based diets for broilers (Cowieson, 2010 and Barnard and Belalcazar 2017).

One of the most famous enzymes used in the diets is enzyme Phytase, has a well known effect enhancing the use of the phytic phosphorus from feeds (Laurentiz *et al*., 2009). Thus, it allows the reduction of this element during the elaboration of the diets. However, it was reported that the inclusion of this enzyme can also increase availability of amino acids (Ravindran *et al*., 2000), some ions (Maenz, 2001) and starch (Angel *et al*., 2002). Also, addition of phytas to poultry diets improves performance parameters (Kemme *et al*., 1999; Ravindran *et al*., 2000, 2001; Selle *et al*., 2000, and Coelho *et al*., 2017). The improvements in amino acid utilization associated with the addition of exogenous phytases to poultry diets are likely to be mediated through both a reduced endogenous amino acid loss as well as an improvement in the retention of dietary amino acids (Cowieson *et al*., 2004 and 2006).

Also, xylanase is a carbohydrase enzyme and its positive effective recorded on growth performance of broilers (Olukosi and Adeola, 2008; Williams *et al*., 2014; and Davin *et al*., 2016) through successful hydrolysis of cell wall arabinoxylans (non starch polysaccharides, NSP and increase the access of endogenous digestive enzymes to cell contents. Regarding this xylanase showed positive effect when reduced energy between 50 to 150 kcal ME/kg in broiler diets (Abou El-Wafa *et al*., 2013; Selim *et al*., 2015; and Amerah *et al*., 2016).

In addition, many studies confirmed the positive effect of protease on growth performance of broilers (Angel *et al*., 2011; Freitas *et al*., 2011; and Romero *et al*., 2013 and 2014) and supplementation on protein and amino acids utilization of broilers and reported increased values of ileal digestibility and availability (Angel *et al*., 2011; Freitas *et al*., 2011; and Romero *et al*., 2013 and 2014). Selim *et al*., (2016) reported growth improvement of broilers fed on diets low in protein and supplemented with 300000U protease /kg. Some authors recorded economic and environmental benefits when using proteases in broiler diets by using low protein diets (Odetallah *et al*., 2003; and Selim *et al*., 2016).

Multi-enzyme activity products have been used commercially in broiler diets for over 2 decades. Several studies have reported that a combination of xylanase, amylase, and protease improve broiler performance and nutrient digestibility in corn-based diets (Cowieson and Ravindran, 2008; Tang *et al*., 2014). Also, Selim *et al*., (2017) under publishing data, recorded that adding xylenase and protease combination to lower 10% of CP and 100 kcal ME/kg broiler diet reduce feeding cost and improve growth performance, carcass traits and meat quality. In this respect, Stefanello *et al* (2015) showed that corn-soy diets having phytase and supplemented with xylanase led to increased growth performance, AMEn, and starch digestibility in broilers. Also, Herchler *et al*., (2017) showed the positive effect of the combination between xylanase and phytase on growth performance and breast meat yield in turkey.

In general, supplementation of xylanase and phytase are commonly used to minimize formula costs, formulation risks and animal performance variation, and improve nutrient utilization. This study aimed to investigate the optimum impact of the combination between phytase, xylanase and protease enzymes to low energy and protein broiler diets at different growing phases. The topics of study included growth performance, carcass cuts and feeding cost.

MATERIALS AND METHODS

Birds and Diets: A total number of 440 d. old Arbor Acers broiler chicks distributed into 11 treatments, each presented with 4 replicates of 10 chicks. The experimental design (5*2+1) included control group (C) + five nutritional plan (NP) and two levels of supplemental phytase (Ph) enzyme (0 and 1000 FTU/kg diet during whole production period). The five NP based on using diet contained lower 150 kcal from metabolizable energy and 10% of crude protein of each feeding phase (D). Chicks subjected to one of the following NP: 1, chicks fed on D diet; 2, chicks fed on D diet with supplemental protease enzyme (300000 units/kg diet*) during starting phase only (DPs); 3, chicks fed on D diet with supplemental xylanase enzyme (16000 units/kg diet**) during finishing phase only (DXF); 4, chicks fed on D diet with supplemental protease enzyme during starting phase and supplemental xylanase enzyme during finishing phase at the same previous doses (DPsXF); 5, chicks fed on D diet with both supplemental protease enzyme and supplemental xylanase enzyme during all feeding phases at the same previous doses (DPX). Diets of C group was formulated to contain the nutritional requirements of Arbor Acers broiler chicks from all nutrients during the feeding phases (starting, 0-10d; growing, 11-24d; and finishing 25-40d). All experimental diets based on corn and soybean meal as main sources of energy and protein, respectively. Composition, calculated analysis and prices of experimental diets are presented in Table (1), and the experiment design including NP and supplemental Ph are shown in Table (2).

Management procedures: The experiment was carried out in Fayom Research station Animal Production Research Institute (APRI), Agriculture Research Center, Ministry of Agriculture. Using open system house (based on natural ventilation without cooling) using wire battery cages during April and May months. That model of housing is represents a large proportion of the housing system of small broiler producers in Egypt. Both surrounding temperature and relative humidity % were recorded daily during the 40 days. All chicks subjected to the same management procedures during the period of study.

Table 1. Composition and calculated values of experimental diets.

Diet Ingredients	Starter Diets (1-10 d)		Grower diets (11-22 d)		Finisher diets (23-40 d)	
	control	(10-150)	control	(10-150)	control	(10-150)
Yellow corn	54.69	60.14	60.21	64.54	64.36	69.00
Soybean meal (44%)	31.12	33.90	24.08	28.08	19.09	22.14
Corn gluten meal (62%)	7.50	1.45	8.55	2.13	8.47	2.92
Soybean oil	2.11	0.15	2.51	0.84	3.45	1.50
Di-Ca-P	1.87	1.86	1.93	1.92	1.99	1.97
Limestone	1.31	1.30	1.32	1.30	1.33	1.32
Min. &Vit. mix*	0.40	0.40	0.40	0.40	0.40	0.40
Nacl	0.35	0.35	0.35	0.35	0.35	0.35
Sodium bicarbonate	0.08	0.08	0.08	0.08	0.08	0.08
DL-Methionine	0.24	0.25	0.18	0.21	0.15	0.17
L-lysine (HCl)	0.33	0.12	0.39	0.15	0.33	0.15
Total	100.0	100.0	100	100.0	100	100.0
Chemical analysis						
Crude protein %	23	20.70	21	18.9	19	17.1
ME kcal/kg	3000	2850	3100	2950	3200	3050
Calcium %	1.00	1.00	1.00	1.00	1.00	1.00
Available P %	0.50	0.50	0.53	0.50	0.50	0.50
Sodium %	0.19	0.19	0.19	0.19	0.19	0.19
L. Lysine %	1.38	1.25	1.24	1.12	1.06	0.96
Methionine %	0.67	0.61	0.60	0.55	0.54	0.49
Met + Cys (SAA) %**	1.05	0.95	0.95	0.86	0.86	0.78
Lys./CP	6.00	6.00	5.90	5.90	5.58	5.61
Met./CP	4.56	4.58	4.52	4.55	4.52	4.56
C:P ratio	130.4	140.9	147.2	156.0	168.4	178.3
Cost/ ton at Egyptian Local Price (LE)***	6260	5449	6162	5378	6031	5301

*** Vitamins and minerals premix will provide each kg of diet with: Vit. A, 11000 IU; Vit. D_3, 5000 IU; Vit. E, 50 mg; Vit K_3, 3mg; Vit. B_1, 2mg; Vit. B_2 6mg; B_6 3 mg; B_{12}, 14 mcg; Nicotinicacid 60 mg; Folicacid 1.75 mg, Pantothenicacid 13mg; and Biotine 120 mcg ;Choline 600 mg; Copper 16mg; Iron 40mg; Manganese 120 mg; Zinc 100mg; Idoine 1.25mg; and Selenium 0.3 mg; ** SAA = Methionine + Cystine .**

***** Cost of diets . (10-150) = diet contained lower 150 kcal from metabolizable energy and 10% of crude protein of each feeding phase.**

Table 2. Experimental Nutritional Plan.

Treatment	Supplementations*		
	Starter phase	Grower phase	Finisher phase
Control	Nutritional Requirements of Arbor Acers		
D	150 kcal and 10% CP less than control		
D P_s	Proteas	-	-
D X_f	-	-	Xylanase
D P_s X_f	Proteas*	-	Xylanase
D P X	Proteas + Xylanase	Proteas + Xylanase	Proteas + Xylanase
D Ph	Phytase	Phytase	Phytase
D P_s Ph	Proteas+Phytase	Phytase	Phytase
D X_f Ph	Phytase	Phytase	Xylanase + Phytase
D P_s X_f Ph	Proteas+ Phytase	Phytase	Xylanase + Phytase
D P X Ph	Proteas+ Xylanase+ Phytase	Proteas+ Xylanase+ Phytase	Proteas+ Xylanase+ Phytase

*** Proteas(300 000 U/kg diet); Xylanase (16000U/kg diet); Phytase(1000 FTU/kg diet).**
Starter phase : (1-10 day) Grower phase: (11-22 day) Finisher phase: (23-40 day)

Measurements of Growth Performance: Parameters of growth performance including live body weight (BW), and feed intake (FI) during the feeding phases were recorded. In addition body weight gain (BWG), and feed conversion ratio (FCR) of each feeding phase were calculated. Then cumulative feed intake (CFI) and Average Daily Gain (ADG) during phases of 0-10, 0-24, and 0-40 d were calculated. By the termination of the experiment, cost of nutrition to produce kg of broiler meat of every treatment was calculated according to prices in Egyptian market for ingredients and product in Egyptian pound (LE).

Carcass measurements: At 40 days of age, 4 birds of each treatment were randomly chosen to carry out slaughtering and simple processing procedures. Carcass weight, abdominal fat, and edible parts (liver, gizzard and heart) as percentages of BW were recorded. Each carcass was split in two half length wise through the backbone and keel bone and the right half was used to complete bird segmentation. The right wing quarter used to record weights of breast meat yield, wing drumette and winglette. Also, skin of the right leg quarter was removed before splitting the quarter at the knee joint to thigh and drumstick cuts. Both thigh and drumstick cuts were deboned and weights of meat yield of each cut was recorded (boneless/skinless). All weights of carcass cuts were calculated as percentage from carcass weight.

Statistical analysis: Data of NP (D, DP_S, DX_F, DP_SX_F and DPX) without or with Ph were subjected to two way analysis of variance to detect the effects of NP and Ph enzyme supplementation. Variables showing a significant F-test ($p < 0.05$) were compared to each other's using Duncan's Multiple Range Test (Duncan, 1955). The statistical procedures were computed using SAS (2001). Also data of the 11 treatments including C were subjected to one way analysis of variance to detect the differences between them and Duncan's Multiple Range Test (Duncan, 1955). The models of statistical analysis were:

two way analysis :

$$Y_{ijk} = \mu + P_i + N_j + (PN)_{ij} + e_{ijk}.$$

Where:

Y_{ijk} = Trait measured
μ = Overall mean
P_i = phytes supplementation
N_j = nutritional plan (NP)
$(PN)_{ij}$ = Interaction between phytes and nutritional plan
e_{ijk} = Experimental error

one way analysis

$$Y_{ij} = \mu + T_i + e_{ij} :$$

Where:

Y_{ij} = Trait measured
μ = overall mean of Y_{ij},
T_i = effect of treatment, i = (1,…,11)
e_{ij} = Experimental error

RESULTS AND DISCUSSION

Growth performance: The recorded ambient temperature and relative humidity in broiler house during the experimental phase (Table 3) showed that, the surrounded temperature during the experiment was comfortable during starting phase (28 - 33 °C), and was acceptable (regarding to open house conditions) during growing phase (28 -33 °C). However, the recorded surrounded temperature showed increased degrees during finisher phase (32 - 42 °C). That increase in temperature is normal climatic conditions of middle Egypt during May. That increase of temperature made uncomfortable managerial conditions and had adverse effect on growth performance during that phase (Tables 4 and 5). The relative humidity % ranged between 20 and 55% during all phases of the experiment.

Table 3. Ambient temperature and relative humidity recorded during the trial period

Period	Temperature°C Minimum	Temperature°C Maximum	Relative humidity(%) Minimum	Relative humidity(%) Maximum
Starting (1-10 day)	28	33	20	55
Growing (11-22 day)	28	33	30	45
Finishing (23-40 day)	32	42	30	50
Overall period (1-40 day)	24	42	20	55

Results in Tables (4 and 5) showed that nutritional plan (NP), phytase supplementation and their interactions affected on all growth performance parameters significantly (P value ranged from 0.0001 to 0.04). Among NP, Table (4) clearly showed that chicks fed on D presented the worst growth performance during all feeding phases. During starting phase, FCR significantly improved due to using DP_S, DP_S X_F or DPX and the best value recorded by using DPX (1.56). The recorded improvement in FCR during starting phase by using DP_S decreased during growing and finishing phase. Chicks of DXP treatment recorded the best BWG and FCR during starting and growing phase, While the recorded performance parameters during the finishing phase showed significant improvement of both BWG and FCR by applying DXP (1082 g and 1.78) or DP_S X_F (1055 g and 1.77). However applying DX_F program improved the FCR (1.81) value while the BWG mean value decreased (1040 g). The presented results clearly showed that applying X enzyme during the late growth phase (finisher phase) helped chicks to compensate their weights and convert the growth performance from poor performance to better records at the 40 d of age.

Table 4. Effect of nutritional Plan and phytase supplementation and their interaction during growing phases on growth performance.

Item	0-10 day			11-22 day			23-40 day		
	BWG	FI	FCR	BWG	FI	FCR	BWG	FI	FCR
Means of main effects									
NP (Nutritional Plan)									
D	113.29^{c}	217.12^{a}	1.92^{a}	549.37^{b}	1062.14^{a}	1.93^{a}	1002.77^{d}	1950.71^{a}	1.95^{a}
DP_S	116.98^{bc}	207.26^{ab}	1.78^{bc}	549.09^{b}	1039.88^{ab}	1.89^{a}	1015.02^{cd}	1940.38^{a}	1.91^{a}
DX_F	115.88^{bc}	214.50^{a}	1.85^{ab}	549.33^{b}	1026.33^{ab}	1.87^{ab}	1040.75^{bc}	1884.33^{b}	1.81^{b}
DP_S X_F	118.56^{b}	200.26^{bc}	1.69^{c}	554.18^{b}	1005.14^{ab}	1.81^{b}	1055.54^{ab}	1863.08^{b}	1.77^{b}
DPX	123.60^{a}	193.25^{c}	1.56^{d}	573.94^{a}	950.00^{c}	1.66^{c}	1082.16^{a}	1928.25^{a}	1.78^{b}
Pooled SEM	±1.27	±3.45	±0.03	±6.14	±14.26	±0.02	±10.80	±12.04	±0.02
Phytase (1000 FTU/kg diet)									
Without	115.28^{a}	209.94^{b}	1.82^{a}	544.78^{b}	1029.53^{a}	1.89^{a}	1029.29^{b}	1936.88^{a}	1.88^{a}
Phytase	120.06^{b}	202.68^{a}	1.69^{b}	565.47^{a}	1002.63^{b}	1.77^{b}	1049.06^{a}	1896.03^{b}	1.81^{b}
Pooled SEM	±0.81	±2.13	±0.02	±3.89	±9.03	±6.27	±7.63	±7.63	±0.01
NP × Phytase									
Control	123.62^{ab}	185.00^{d}	1.49^{e}	598.83^{a}	911.88^{e}	1.52^{e}	1084.80^{ab}	1805.00^{f}	1.66^{f}
D	108.62^{d}	221.50^{a}	2.04^{a}	528.71^{d}	1090.00^{a}	2.06^{a}	988.13^{f}	1980.00^{a}	2.00^{a}
DP_s	117.76^{bc}	207.36^{bc}	1.76^{b}	548.60^{cd}	1039.67^{ab}	1.89^{b}	1001.00^{ef}	1970.00^{ab}	1.96^{ab}
DX_f	109.60^{d}	222.00^{a}	2.02^{a}	528.83^{d}	1086.33^{a}	2.05^{a}	1030.33^{cde}	1939.00^{abc}	1.88^{cd}
DP_sX_f	117.77^{bc}	206.70^{abc}	1.75^{b}	546.75^{cd}	1016.75^{b}	1.86^{bc}	1043.38^{bcd}	1890.00^{cde}	1.81^{de}
DPX	121.85^{ab}	194.50^{cd}	1.59^{cde}	563.95^{bc}	946.75^{de}	1.68^{d}	1066.50^{abc}	1925.00^{bc}	1.80^{e}
D Ph	117.95^{bc}	212.75^{ab}	1.80^{b}	564.88^{bc}	1041.25^{ab}	1.84^{bc}	1013.75^{def}	1928.75^{abc}	1.90^{bc}
D P_s Ph	121.68^{abc}	198.33^{def}	1.63^{cd}	560.15^{bc}	1003.33^{bc}	1.79^{c}	1013.72^{def}	1910.00^{cd}	1.88^{cd}
DX_fPh	115.97^{c}	211.75^{ab}	1.82^{b}	556.50^{c}	1015.50^{b}	1.83^{bc}	1050.25^{bcd}	1863.00^{de}	1.77^{e}
DP_sX_fPh	119.72^{abc}	197.50^{bcd}	1.64^{c}	560.56^{bc}	999.00^{bcd}	1.78^{c}	1060.94^{abc}	1850.39^{ef}	1.74^{e}
DPXPh	125.35^{a}	192.00^{cd}	1.53^{de}	583.94^{ab}	954.25^{cde}	1.63^{d}	1097.81^{a}	1931.50^{abc}	1.75^{e}
Pooled SEM	±1.70	±4.61	±0.03	±7.64	±16.93	±0.02	±12.25	±15.75	±0.02
P Value	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
P Value of main effects									
Effect of NP	0.0001	0.0001	0.0001	0.01	0.0001	0.0001	0.0001	0.0001	0.0001
Effect of phytase	0.0004	0.02	0.0001	0.0007	0.04	0.0001	0.04	0.0006	0.0002
NP × Phytase	0.0001	0.0006	0.0001	0.006	0.0003	0.0001	0.0002	0.0001	0.0001

a,b,...= Means in the same column with different superscripts, differ significantly ($P \leq 0.05$)

(D) = diet contained lower 150 kcal from metabolizable energy and 10% of crude protein of each feeding phase.

(DP_s) D with protease enzyme during starting phase only; (DX_f) D with xylanase enzyme during finishing phase only;(DP_sX_f) D with protease enzyme during starting phase and xylanase enzyme during finishing phase;(DPX) D with both protease and xylanase enzyme during all feeding phases;(D Ph) D+phytase; (D P_s Ph) DP_s+phytase ; (DX_fPh)DX_f +phytase; (DP_sX_fPh) DP_sX_f +phytase; (DPXPh) DPX+phytase.

Regarding to the overall effect of phytase supplementation, the addition of phytase enzyme improved BWG and FCR significantly during all phases compared to performance of unsupplemented groups. Phytase supplementation improved values of FCR through increasing BWG and decreasing FI during both grower and finisher phases, but during starter phase the improvement was due to increasing BWG and decreasing feed intake.

The interactions between NP and phytase supplementation had significant effects on all growth performance parameters during all feeding phases.

Among all experimental treatments (including control group), chicks of control group recorded the best growth performance during all feeding phases. The recorded FCR values of control group were 1.49, 1.52 and 1.66 during the three feeding phases. Applying DPXPh (1.53 and 1.63) or DPX (1.59 and 1.68) recorded the second place after control group during starter and grower phases. While at the end of finisher phase there were four treatments in the second place [DP_sX_fPh (1.74), DPXPh (1.75), DX_fPh (1.77) and DPX (1.80), respectively].These results indicated that adding phytase to other enzyme treatments increase the ability of chicks to growth well as a result of the synergism effect between phytase and both of P and X enzymes. On the other side, although phytase supplementation to D formula (applying DPh) enhanced growth performance significantly compared with D group, the recorded values were significantly less than those recorded when phytase supplemented in combination with X or P. Generally, results of Table (4) proved that: 1) the effect of protease enzyme on growth performance during starting phase did not continue to finishing phase.; 2) Applying single supplementation of xylanase enzyme during finisher phase resulted in the same effect of applying xylanase in combination of protease supplementation during starter phase.; 3) There is synergism effect between supplemental phytase and both X and P enzymes.

According to results in Table (5) both phytase supplementation and applying different NP caused significant effect on both cumulative FI and average daily gain (ADG) during the experimental phases. These effects led to significant effect on FCR of the overall experimental phases (0-40 d). The continuous lower cumulative FI recorded by following DPX or DP_S X_F plan. Applying DPX plan resulted in decreasing cumulative FI than D group by 11.0, 10.6 and 4.9 % at 10, 22 and 40 days of age, respectively. While applying DP_S X_F plan decreased the cumulative FI by 7.76, 5.78 and 5.0 % at 10, 22 and 40 days of age, respectively. On the same trend phytase supplementation decreased the cumulative FI by 3.4, 2.7 and 2.29 % at the same ages. These results showed whoever the effect of both NP and phytase supplementation on cumulative FI was gradually subsiding by increasing the period of treatment; the effect was continuous until 40 d of age. Among all experimental treatments, chicks of control group recorded the lowest numerical values of cumulative FI while DP_sX_fPh in starter phase , DPX and DPXPh in starter and grower phases recorded the same significant values at 10 and 22 days of age. In addition applying DPX plan showed continuous positive effect on ADG compared to other NPs followed by DP_SX_F. Using DPX increased ADG by 6.8% at 40 d of age, and DP_SX_F increased the cumulative ADG by 3.72% at the same age, compared with D plan. Phytase supplementation increased the cumulative ADG at 40 days of age by 2.56% (43.33 vs. 42.25 g). The results of one way analysis of variance of all treatments (including control group) showed that chicks of DPXPh group recorded the same value of cumulative ADG recorded by control group (45.17 vs. 45.18 g) at 40 d of age, and followed by applying DPX orDP_SX_FPh. The recorded improvements of both cumulative FI and ADG by applying DPX, DP_SX_F or phytase supplementation reflected on the final body weight and overall FCR. Applying DPX, DP_SX_F improved FCR by 10.8% and 8.7% compared with D during the period of 0 to 40 d of age. Also phytase supplementation caused 4.8% improvement in the same parameter. On the other side, the results of one way analysis of variance showed that the best FCR recorded by control group (1.60) followed by DPXPh (1.70) and both DPX and DP_SX_FPh (1.75). The worst value of growth performance parameters recorded by D group. Generally the current results clearly showed the ability of examined protease, xylanase and phytase to improve growth performance when supplemented to poor feed formula at different growth phases. Furthermore, the results showed synergism effect of combined supplementation PXPh when supplemented to low protein/low energy diet during all growth phases. Applying DP_SX_FPh recorded the equal effect of applying DPX on overall FCR (1.75) which indicated the effect of time and duration of enzyme supplementation on growth performance. These results introduce two choices to the broiler producers to follow depending on the cost of production of each protocol.

Table 5. Effect of nutritional Plan and phytase supplementation and their interaction during growing phases on growth performance.

Item	Cumulative FI (g)			Cumulative ADG(g)			BW (g)		FCR
	0-10 d	0-22	0-40	0-10	0-22	0-40	Initial	40	0-40 d
Means of main effects									
NP (Nutritional Plan)									
D	217.12^{a}	1279.43^{a}	3230.14^{a}	11.42^{c}	30.16^{b}	41.66^{d}	53.59	1720.00^{d}	1.94^{a}
DP_S	207.26^{ab}	1247.14^{ab}	3187.51^{a}	11.70^{bc}	30.28^{b}	42.03^{cd}	52.66	1733.75^{cd}	1.89^{b}
DX_F	214.50^{a}	1240.83^{ab}	3125.17^{b}	11.59^{bc}	30.06^{b}	42.55^{c}	53.17	1755.17^{bc}	1.83^{c}
DP_S X_F	200.26^{bc}	1205.40^{b}	3068.48^{c}	11.85^{b}	30.58^{b}	43.21^{b}	52.44	1780.71^{b}	1.77^{d}
DPX	193.25^{c}	1143.75^{c}	3072.00^{c}	12.36^{a}	31.71^{a}	44.49^{a}	53.17	1832.88^{a}	1.73^{e}
Pooled SEM	±3.45	±15.02	±18.51	±1.13	±0.28	±0.22	±0.47	±9.24	±0.01
Phytase (1000 FTU/kg diet)									
Without	209.94^{a}	1239.11^{a}	3175.99^{a}	11.58^{b}	20.03^{b}	42.25^{b}	53.04	1742.88^{b}	1.88^{a}
Phytase	202.68^{b}	1205.32^{b}	3101.34^{b}	12.01^{a}	31.01^{a}	43.33^{a}	52.98	1786.32^{a}	1.79^{b}
Pooled SEM	±2.13	±9.51	±12.55	±0.08	±0.18	±0.14	±0.29	±5.85	±0.01
NP × Phytase									
Control	185.00^{d}	1096.88^{f}	2901.88^{e}	12.36^{ab}	32.83^{a}	45.18^{a}	52.75	1860.00^{a}	1.60^{g}
D	221.50^{a}	1313.33^{a}	3293.33^{a}	10.93^{d}	29.00^{c}	40.65^{f}	53.75	1680.00^{g}	2.02a
DP_s	207.36^{bc}	1247.03^{c}	3217.03^{ab}	11.77^{bc}	30.29^{b}	41.68^{e}	52.64	1720.00^{f}	1.92^{b}
DX_f	222.00^{a}	1308.33^{ab}	3247.33^{ab}	10.96^{d}	29.02^{c}	41.72^{e}	53.23	1722.00^{ef}	1.94^{b}
DP_sX_f	206.70^{abc}	1223.45^{c}	3113.45^{cd}	11.77^{bc}	30.20^{b}	42.70^{cd}	52.10	1760.00^{cde}	1.82^{d}
DPX	194.50^{cd}	1141.25^{ef}	3066.25^{d}	12.18^{abc}	31.17^{b}	43.80^{b}	53.45	1805.75^{b}	1.75^{e}
D Ph	212.75^{ab}	1254.00^{bc}	3182.75^{bc}	11.79^{bc}	31.03^{b}	42.41^{de}	53.42	1750.00^{def}	1.87^{c}
D P_s Ph	198.33^{def}	1201.67^{cd}	3111.67^{cd}	12.17^{abc}	30.99^{b}	42.38^{de}	52.44	1748.00^{def}	1.83^{cd}
DX_fPh	211.75^{ab}	1227.25^{c}	3090.25^{d}	11.59^{c}	30.29^{b}	42.92^{cbd}	53.47	1770.25^{bcd}	1.80^{d}
DP_sX_fPh	197.50^{bcd}	1196.50^{cde}	3046.89^{d}	11.97^{abc}	30.92^{b}	43.53^{bc}	52.52	1793.75^{bc}	1.75^{e}
DPXPh	192.00^{cd}	1146.25^{def}	3077.75^{d}	12.53^{a}	32.24^{a}	45.17^{a}	52.90	1860.00^{a}	1.70^{f}
Pooled SEM	±4.61	±17.74	±24.37	±0.17	±0.33	±0.28	±0.60	±11.57	±0.013
P Value of main effects:									
Effect of NP	0.0001	0.0001	0.0001	0.0001	0.0007	0.0010	N.S	0.0001	0.0001
Effect of phytase	0.02	0.02	0.0001	0.0009	0.0002	0.0001	N.S	0.0001	0.0001
NP × Phytase	0.0006	0.0001	0.0001	0.0001	0.0003	0.0001	N.S	0.0001	0.0001

a,b,...= Means in the same column with different superscripts, differ significantly ($P\leq 0.05$)

(D) = diet contained lower 150 kcal from metabolizable energy and 10% of crude protein of each feeding phase.

(DP_s) D with protease enzyme during starting phase only; (DX_f) D with xylanase enzyme during finishing phase only;(DP_sX_f) D with protease enzyme during starting phase and xylanase enzyme during finishing phase;(DPX) D with both protease and xylanase enzyme during all feeding phases;(D Ph) D+phytase; (D P_s Ph) DP_s+phytase ; (DX_fPh)DX_f +phytase; (DP_sX_fPh) DP_sX_f +phytase; (DPXPh) DPX+phytase.

Table 4 and 5 showed a clear reduction in final body weight during finishing phase compared to the performance of the ideal growth of Arbor Acers chicks of that phase and this is the result of exposure chicks to high temperature and moisture which is not suitable for the needs of the strain, especially during the finishing phase. These results are in line with the results of some researches who study the effect of high environmental temperature on growth performance and quality of poultry product (Khan *et al*., 2012a,b; Sahin *et al.,* 2013).

The positive response achieved by phytase, protease and xylanase supplementation during starting phase are agreement with Brito *et al.,* (2006) and Leite *et al.,* (2011) who noted that, adding enzyme complex containing protease, and xylanase increased weight gain and improved FCR in broilers between 1 to 21 days of age. Also, Olukosi *et al*., (2007) found increase in weight gain, of broiler (1-21 d) fed corn-soybean diet low in energy (-115 kcal),Ca (- 0.11%) and available P (-0.10 %) when added mixed enzymes (xylanase, amylase and protease) or phytase enzyme individually or in combination.

Some of the researches supported phytase enzyme and agree with the results of our research Barbosa *et al*., (2012) found that the addition of phytase, amylase, xylanase, and protease to diets with reducing in energy, calcium, and phosphorus content, give similar result feed intake and weight gain compared with a diet had adequate nutrient levels. Stefanello *et al*., (2015) showed that the diets supplemented with phytase and with xylanase led to improve growth performance of broiler. Recently, results of Carvalho *et al*.,(2017) and Delezie *et al*., (2017) showed no synergism effect between phytase and protease supplementation to corn soy broiler diets when examined during age 8 to 21 d of age or when examined at different levels of phytase supplementation (from 350 to 200 FTU/kg), respectively. Also, Herchler *et al*., (2017) noted that, during the growth trial of turkey (0-14 wk) fed on diets with reduced (-100 kcal, - 0.145% Ca and - 0.125 % P) increased BW than control when supplemented with enzymes (xylenase and phytase).

In the same side the current results confirmed previous results of other researchers on the positive effect of xylanase and protease enzyme on growth performance of broiler chicks fed on corn soybean meal diets deficient in energy (Olukosi and Adeola, 2008; Abou El-Wafa *et al*., 2013; Selim *et al*, 2015) and deficient in protein, respectively (Ghazi *et al*., 2003; Freitas *et al*., 2011; Williams *et al*., 2014; and Selim *et al*., 2016).

In addition, results of Olukosi *et al*., (2015) supported the synergistic effect between X, P and Amylase enzymes on broiler performance and nutrient digestibility. Also, Amerah *et al*., (2016) Showed that adding X, A and P in combination to lower 10% of CP and 100 kcal ME/kg broiler diet improve FCR by superior to single enzyme supplementation. Recently, Selim *et al*., (2017) Found that, adding combination of both X and P to lower 10% of CP and 100 kcal ME/kg broiler diet improve growth performance and reduce feeding cost at 40 days of age. In the same trend Ruangpanit *et al*.,(2017) study the effect of xylanase supplementation to low energy broiler diets (70,110 and 150 kcal of ME/kg diet) containing phytase supplementation (500 FTU/kg diet) from 1 to 35 d of age. They recorded reduction of growth performance by using 150 kcal lower ME diet, while xylanase supplementation maintain the normal growth performance when added to 70 kcal lower ME diet containing phytase at 500 FTU/kg. Also, Kamran *et al*., (2008) recorded significant decrease of BWG and increased FI and poorer FCR with the reduction of CP and ME for grower and finisher phases.

The current results confirmed our previous results about using single supplementation of P or X to low nutrients broiler diets. Also it confirmed the previous report about positive effect of using supplemental XP to low energy (100 kcal) and low protein (10% form CP requirements). The obtained results in this study give producers extra chance to use lower 150 kcal and 10% form CP requirements by adding phytase at level 1000FTU/kg diet.

Regarding the obtained results of carcass characteristics of broiler chicks, the presented results in Table (6) showed a significant superior effect of applying DPX protocol on dressing % (71.95%), abdominal fat (CAF) % ,1.73% , and thigh meat % (7.83%) relative to carcass weight and compared to other NP. While phytase supplementation increased dressing % only (71.01%). Among experimental treatments including control group the highest values of Dressing %,AF%, breast meat yield % and thigh meat % recorded by DPXPh group (73.63%, 1.78%, 13.57%, and 8.84%, respectively). Chicks of control group gained the lowest percentage of AF(1.29), while the highest value (1.78%) recorded by DPXPh and DP_sX_fPh broilers. Concerning towing quarter (breast meat yield, wing drumette and winglette) the results showed that, no significant differences were found for the wing quarter as a result of the NP or supplementation of Phytase enzyme. On the other hand, DPXPh recorded the highest value of the breast meat yield (13.57%) followed by DP_s (12.63%), while the lowest value of the breast meat yield recorded for Control and DP_sX_f (11.27 and 11.41) respectively. The recorded results showed no significant effect of either NP, phytase supplementation or experimental treatments on % of Drum stick meat yeild. Among experimental treatments the best numerical value of drum stick meat% recorded by DP_SX_F(5.32%).

The overall results of carcass characteristics showed synergism effect of P, X and phytase (DPXPh) on % of dressing, breast meat yield and thigh meat yield of broiler chicks beside the superior effect on growth performance parameters. These results may increase the revenues to broiler producers by giving them higher % of several broiler products.

The results of carcass traits are in agreement with those reported previously Brandão *et al.,* (2007) confirmed no positive effect of the phytase enzyme in carcass, breast and abdominal fat yield. However, considering the reduction of the crude protein in the diets, Faria Filho *et al*.,(2005) found that the reduction crude protein in the diets from 21.5 to 18.5% decreased the breast meat yield and increased the abdominal fat of the birds at 21 days of age. A hypothesis to explain this increase in abdominal fat is based on the caloric increment of the nutrients. One protein gram has higher caloric increment than one carbohydrate or fat gram, that is, it requires a greater amount of energy to be digested, absorbed and metabolized (Musharaf and Latshaw, 1999). So, when the CP content in the feed is reduced the dietary net energy is increased, being a portion this energy used for maintenance and production, and its excess stored as body fat. Whereas, Selim *et al*., (2015) recorded that, single supplementation with X enzyme in broiler diets increased dressing % and breast meat yield %significantly

Gomide *et al.,* (2007) reduction of dietary crude protein did not effect on breast and carcass yields. while , observed a reduction in the thigh + drumstick and increase of the abdominal fat yield. Also, Gomide *et al.,* (2012) found that, the broilers fed diet with 16% of CP showed abdominal fat content 40% higher thanto that recorded for the birds fed diet with 19,18 and 17% CP.

However in report of (Selim *et al.,* 2016) broilers fed on L10 and L15 (diet low in protein by 10 and 15%, respetively) with protease supplementation showed numerical increase of dressing % and abdominal fat %. Also, using XP increased dressing%, and back quarter weight (Selim *et al.,* 2017).

Based on prices of feed ingredients and feed additives in Egyptian market, the cost of each dietary treatment/bird and feeding cost /kg of BW are calculated and presented in Table (7). The presented values showed that although all treatments showed lower feeding cost/bird compared to control treatment. Most of them showed increased values of feeding cost/kg of BW because the final BW was lower than that of control group. Without supplementing phytase, only DPX treatment decreased the feeding cost compared to control feeding cost/kg of BW (9.59 vs. 9.77), while DPsXf recorded the same value of control group (9.77). Adding single supplementation of phytase enzyme to D formula resulted in increasing cost of feeding/kg of BW (10.12) which increased the cost of feeding 3.58% than cost of control. While involving phytase supplementation with P, X or both of them resulted in more improvements. Treatments DXfPh, DPsXfPh and DPXPh improved the relative feeding cost compared to control value by 0.31, 2.97, and 3.48%, respectively. These results confirmed the benefits of combination between supplemental enzymes. The age of chicks and duration of enzyme supplementation are affected on the economic benefits of broiler chicks and these effects depends on the supplemental enzyme. However supplementation of both P and X to D formula during all experimental phases (DPX) gained more economic benefits (1.84) than D Ps Ph, DXfPh, or DPsXf.

Table 6. Effect of nutritional Plan and phytase supplementation and their interaction during growing phases on carcass measurements.

Item	Live weight	Carcass weight	Dressing	Ed Parts %	AF %	Wing quarter: breast meat yield	Wing quarter: wing drumette	Wing quarter: winglette	Leg quarter: Drum Stick meat	Leg quarter: Thigh meat
Means of main effects										
NP (Nutritional Plan)										
D	1625.13^{c}	1117.75^{c}	68.76^{b}	5.16	1.31^{c}	11.84	3.87	1.98	4.67	6.62^{b}
DP_S	1690.50^{b}	1178.75^{b}	69.70^{b}	4.59	1.49^{bc}	12.15	3.75	2.07	4.82	6.80^{b}
DX_F	1699.50^{b}	1185.00^{b}	69.68^{b}	5.41	1.38^{c}	12.00	3.46	1.96	4.65	6.14^{b}
$DP_S X_F$	1739.38^{ab}	1220.38^{b}	70.14^{b}	5.09	1.63^{ab}	11.80	3.88	1.96	5.05	6.23^{b}
DPX	1787.00^{a}	1285.50^{a}	71.95^{a}	6.19	1.73^{a}	12.70	3.74	2.02	4.77	7.83^{a}
Pooled SEM	±19.47	±18.27	±0.509	±0.41	±0.07	±0.24	±0.11	±0.03	±0.15	±0.22
Phytase	Phytase (1000 FTU/kg diet)									
Without	1706.35	1179.55^{b}	69.09^{b}	5.07	1.46	12.03	3.75	1.97	4.87	6.52
Phytase	1710.25	1215.40^{a}	71.01^{a}	5.50	1.55	12.16	3.73	2.037	4.71	6.93
Pooled SEM	±12.31	±11.55	±0.32	±0.26	±0.05	±0.15	±0.07	±0.08	±0.09	±0.14
NP × Phytase										
Control	1798.75^{a}	1233.50^{abc}	68.60^{bc}	6.23	1.29^{c}	11.27^{c}	3.67	2.00	4.25	6.25^{b}
D	1617.75^{d}	1103.00^{e}	68.16^{c}	5.61	1.42^{bc}	11.92^{bc}	3.75	1.94	4.49	6.56^{b}
DP_s	1700.50^{bcd}	1167.00^{cde}	68.62^{bc}	4.66	1.35^{bc}	12.63^{ab}	3.73	2.03	4.97	6.82^{b}
DX_f	1674.00^{cd}	1155.75^{cde}	69.01^{bc}	4.94	1.59^{abc}	12.36^{bc}	3.44	1.92	4.85	6.13^{b}
$DP_s X_f$	1735.75^{abc}	1204.50^{bcd}	69.39^{bc}	4.80	1.68^{ab}	11.41^{c}	3.91	1.96	5.31	6.29^{b}
DPX	1803.75^{a}	1267.50^{ab}	70.27^{bc}	5.36	1.34^{bc}	11.83^{bc}	3.91	1.99	4.73	6.83^{b}
D Ph	1632.50^{d}	1132.50^{de}	69.36^{bc}	4.72	1.56^{abc}	11.75^{bc}	3.99	2.035	4.85	6.69^{b}
$D P_s Ph$	1680.50^{bcd}	1190.50^{bcd}	70.79^{b}	4.52	1.42^{bc}	11.67^{bc}	3.77	2.12	4.66	6.79^{b}
$DX_f Ph$	1725.00^{abc}	1214.25^{bcd}	70.36^{bc}	5.88	1.67^{ab}	11.63^{bc}	3.49	2.01	4.44	6.15^{b}
$DP_s X_f Ph$	1743.00^{abc}	1236.25^{abc}	70.90^{b}	5.38	1.78^{a}	12.19^{bc}	3.84	1.96	4.78	6.18^{b}
DPXPh	1770.25^{ab}	1303.50^{a}	73.63^{a}	7.02	1.78^{a}	13.57^{a}	3.57	2.05	4.82	8.84^{a}
Pooled SEM	±27.70	±25.56	±0.73	±0.56	±0.10	±0.36	±0.16	±0.05	±0.24	±0.31
P Value	0.0002	0.0001	0.0005	0.0932	0.0044	0.0058	0.3300	0.4721	0.2655	0.0001
P Value of main effects:										
Effect of NP	0.0001	0.0001	0.0022	0.1159	0.0045	0.0935	0.1168	0.2377	0.3952	0.0001
Effect of phytase	0.8243	0.0362	0.0002	0.2507	0.2183	0.5487	0.8989	0.0622	0.2535	0.0530
NP × Phytase	0.5904	0.9681	0.5593	0.2502	0.9955	0.0027	0.5186	0.9250	0.2413	0.0095

a,b,...= Means in the same column with different superscripts, differ significantly (P≤ 0.05)

((D) = diet contained lower 150 kcal from metabolizable energy and 10% of crude protein of each feeding phase.

(DP_s) D with protease enzyme during starting phase only; (DX_f) D with xylanase enzyme during finishing phase only;(DP_sX_f) D with protease enzyme during starting phase and xylanase enzyme during finishing phase;(DPX) D with both protease and xylanase enzyme during all feeding phases;(D Ph) D+phytase; (D P_s Ph) DP_s+phytase ; (DX_fPh)DX_f +phytase; (DP_sX_fPh) DP_sX_f +phytase; (DPXPh) DPX+phytase.

Table 7. Effect of experimental treatments on feeding cost of broiler chicks during 40 days of age.

Treatment	Final BW (g)	Total FCR	Feeding cost/bird (L.E)	Feeding cost/kg of BW(L.E)	*Relative improvement
Control	1860.00	1.60	17.66	9.77	-
D	1680.00	2.02	17.57	10.80	-10.54
DP_s	1720.00	1.92	17.19	10.31	-5.53
DX_f	1722.00	1.94	17.39	10.42	-6.65
DP_sX_f	1760.00	1.82	16.69	9.77	0.00
DPX	1805.75	1.75	16.81	9.59	1.84
D Ph	1750.00	1.87	17.16	10.12	-3.58
D P_s Ph	1748.00	1.83	16.80	9.91	-1.43
DX_fPh	1770.25	1.80	16.72	9.74	0.31
DP_sX_fPh	1793.75	1.75	16.50	9.48	2.97
DPXPh	1860.00	1.70	17.05	9.43	3.48

*** Relative improvement= 100 x (Feeding cost/kg of BW of each treatment - Feeding cost/kg of BW of Control group)/ Feeding cost/kg of BW of Control group).**

((D) = diet contained lower 150 kcal from metabolizable energy and 10% of crude protein of each feeding phase.

(DP_s) D with protease enzyme during starting phase only; (DX_f) D with xylanase enzyme during finishing phase only;(DP_sX_f) D with protease enzyme during starting phase and xylanase enzyme during finishing phase;(DPX) D with both protease and xylanase enzyme during all feeding phases;(D Ph) D+phytase; (D P_s Ph) DP_s+phytase ; (DX_fPh)DX_f +phytase; (DP_sX_fPh) DP_sX_f +phytase; (DPXPh) DPX+phytase.

The overall results confirmed the synergism effect between P, X and Phytase enzymes in broiler diets based on corn/soybean. The results recommended using combined supplementation of Phytase, P, and X to low 150kcal of ME/kg and 10% of CP broiler diets during all production phase to reach the same growth performance and better carcass, breast meat yield, thigh meat and economic benefits compared to control broiler chicks.

REFERENCES

Abou El-Wafa, S., S. M. Shalash, N. A. Selim, Abdel-Khalek, A.M. Radwan and A. F. Abdel- Salam. (2013). Response of broiler chicks to xylanase supplementation of corn/rye containing diets varying in metabolizable energy. Int. J. Poult. Sci. 12 (12): 705-713.

Amerah, A, L .Romero, A. Awati, V. Ravindran. (2016). Effect of exogenous xylanase, amylase and protease as single or combined activities on growth performance of broilers fed corn/ soybean meal-based diets. Poultry Science. 0:1–10.

Angel, C. R., W. Saylor, S. L. Vieira, and N. W.ard. (2011). Effects of a monocomponent protease on performance and protein utilization in 7- to 22-day-old broiler chickens. Poult. Sci.,90: 2281–2286.

Angel, R., N. M. Tamim, T. J. Applegate, A. S. Dhandu and L. E. Ellestad. (2002). Phytic acid chemistry: Influence on phytinphosphorus availability and phytase efficacy. J. Appl. Poult. Res. 11:471–480.

Barbosa, R.L., V.L. Dias, K.S. Pereira, F.L. Schmidt, R.M .Franco, A.M. Guaraldo, D.P. Alves , L.A. Passos. (2012). Survival in vitro and virulence of Trypanosoma cruzi in açaí pulp in experimental acute Chagas disease. J Food Prot. 75(3):601-6.

Barnard, L . P and A. Belalcazar. (2017). The interaction between dietary NSP levels and enzyme supplementation on broiler performance. Proceeding of the 21st European Symposium on poultry nutrition 8-11 may spain, 236.

Brandão, P.A., P.G.P. Costa, J.S .Brandão, J.S. Silva, J.H.V.(2007). Efeito da adiçã o de fitase em rações de frangos de corte, durante as fases de crescimento e final. Ciência e Agrotecnologia, Lavras, v.31, n.2, p.492-498.

Brito, C.O., L.F.T. Albino, H.S. Rostagno, P.C. Gomes, M.A, Dionizio, D,C,O.C arvalho. (2006). Adiço de complexomultienzim ticoemdietas à base de sojaextrusada e desempenho de corte. RevistaBrasileira de Zootecnia;35(2):457-461.

Carvalho, D. P., M .F .Pires, P .S .Assuncano, R . A. Nolete, K .A Teixeira, E. S. Fernandes, A .R. Ribeiro and J .H .Stringhini. (2017). Performance of broilers fed starter diets (8-21 days of age) with animal by products and protease. Proceeding of the 21st European Symposium on poultry nutrition 8-11 may spain, 239.

Coelho, M. Francesch and P. Ader (2017). Effect of a new 6-phytase on broiler performance, phosphorus ileal digestibility, bone mineralization and phosphorus excretion Mike International Poultry Scientific Forum Georgia World Congress Center, Atlanta, Georgia January. (Abstract).

Cowieson, A. J. (2010). Strategic selection of exogenous enzymes for corn/soy-based poultry diets. Jpn. Poult. Sci. 47:1–7.

Cowieson, A. J., and V. Ravindran.(2008). Effect of exogenous enzymes in maize-based diets varying in nutrient density for young broilers: Growth performance and digestibility of energy, minerals and amino acids. Br. Poult. Sci. 49:37–44.

Cowieson, A. J., T. Acamovic and M. R. Bedford .(2006). Phytic Acid and Phytase: Implications for Protein Utilization by Poultry. Poult. Sci. 85:878–885.

Cowieson, A. J., T. Acamovic and M. R. Bedford .(2004). The effects of phytase and phytic acid on the loss of endogenous amino acids and minerals from broiler chickens. Br. Poult. Sci. 45:101–108.

Davin, R., F. Yan, J. Lyon, and M. Vázquez-Añón (2016). Effects of a novel xylanase enzyme on broiler performance and intestinal viscosity. International poultry scientific forum January 25-26.

Delezie, E.S.Leleu and D.Feuerstein. (2017) Effects of phytase, alone or combined with protease, on broiler performance and bone mineralization. International Poultry Scientific Forum Georgia World Congress Center, Atlanta, Georgia January. (Abstract).

Duncan, D.B., 1955. Multiple range and multiple F tests. Biometrics, 11: 1-42.

Fariafilho, D.E., P.S. Rosa, B.S. Vieira, , M. Macari, and R.L. Furlan.(2005). Protein levels and environmental temperature effects on carcass characteristics, performance, and nitrogen excretion of broiler chickens from 7 to 21 days of age. Revista Brasileira de Ciência Avícola, São Paulo, v.7, n.4, p.247-253.

Freitas, D. M., S.L. Vieira, C.R. Angel, A. Favero, and A. Maiorka. (2011). Performance and nutrient utilization of broilers fed diets supplemented with a novel mono component protease. J. Appl. Poult. Res. 20: 347–352.

Ghazi, S., J. A. Rooke, and H. Galbraith. (2003). Improvement of the nutritive value of soybean meal by protease and a-galactosidase treatment in broiler cockerels and broiler chicks. Br. Poult. Sci.44: 410–418.

Gomide, E.M., P.B. Rodrigues, R.T.F. Freitas and, E.T. Fialho. (2007) Planos nutricionais com a utilização deaminoácidos e fitase para frangos de corte mantendo oconceito de proteína ideal nas dietas. Revista Brasileira de Zootecnia, Viçosa, v.36, n.6, p.1769-1774,

Gomide, E. M., B. R. Paulo and P. N. Luciana (2012) diets with reduced levels of nutrients supplemented with phytase and amino acids for broilers. Ciênc. agrotec., Lavras, v. 36, n. 1, p. 100-107.

Herchler, M. S. Black and P. Ferket. (2017). The effects of Hostazym® and Optiphos® super dosing in combination with Azomite® on growth performance in market turkeyhens. International Poultry Scientific Forum Georgia World Congress Center, Atlanta, Georgia January. (Abstract).

Kamran, Z., M. Sarwar, M. Nisa, M. A. Nadeem, S. Mahmood, M. E. Babar, and S. Ahmed. (2008). Effect of Low-Protein Diets Having Constant Energy-to-Protein Ratio on Performance and Carcass Characteristics of Broiler Chickens from One to Thirty-Five Days of Age. Poult. Sci. 87:468–474.

Kemme, P. A., A. W. Jongbloed, Z. Mroz, J. Kogut, and A. C. Beynen. (1999). Digestibility of nutrients in growing-finishing pigs is affects by *Aspergillus niger* phytase, phytate and lactic acid levels. 1. Apparent ileal digestibility of amino acids. Livest. Prod. Sci. 58:107–117.

Khan, R.U., S. Naz, Z. Nikousefat, M. Selvaggi, V. Laudadio and V. Tufarelli. (2012a). Effect of ascorbic acid in heat-stressed poultry. World's Poult. Sci. J., 68: 477-489.

Khan, R.U., S. Naz, Z. Nikousefat, V. Tufarelli, M. Javdani, M.S. Qureshi and V. Laudadio. (2012b). Potential applications of ginger (zingiberOfficinale) in poultry diets. World's Poult. Sci. J., 68: 245-252.

Laurentiz, A.C., O.M. Junqueira, R.S. Filardi, K.F. Duarte, V. Assuena and S. Sgavioli. (2009) Desempenho, composição da cama, das tíbias, do fígado e das excretas de frangos de corte alimentados com rações contendo fitase e baixos níveis de fósforo. *Revista Brasileira de Zootecnia*, vol. 38, n. 10, p. 1938-1947.

Leite, P.R.S.C., N.S.M. Leandro, J,H. Stringhini, M.B.Café, N.A. Gomes, R.M. JardimFilho. (2011). Desempenho de frangos de corte e digestibilidade de raçóes com sorgo oumilheto e complexoenzim tico. PesquisaAgropecuÚriaBrasileira;46(3):280-286.

Maenz, D .D. (2001). Enzymatic characteristics of phytases as they relate to their use in animals feeds. In: Bedford MR, Partridge GG, editor. Enzymes in farm animal nutrition. Walling for dab Publishing. p.60-84.

MUSHARAF, N.A. and J.D. LATSHAW. (1999). Heat increment as affected by protein and amino acid nutrition. World’s Poultry Science Journal, Cambridge, v.55, n.3, p.233-240.

Odetallah, N. H., J. J. Wang, J. D. Garlich, and J. C. H. Shih. (2003). Keratinase in Starter Diets Improves Growth of Broiler Chicks. Poult. Sci. 82:664–670.

Olukosi, O. A. and O. Adeola. (2008). Whole body nutrient accretion, growth performance and total tract nutrient retention responses of broilers to supplementation of xylanase and phytase individually or in combination in wheat-soybean meal based diets. J. Poult. Sci. 45:192–198.

Olukosi, O. A., A. J. Cowieson, and O. Adeola. (2007). Age-Related Influence of a Cocktail of Xylanase, Amylase, and Protease or Phytase Individually or in Combination in Broilers. Poult. Sci. 86:77–86.

Olukosi, O. A.,L. A. Beeson,K. Englyst,and L. F. Romero.(2015). Effects of exogenous proteases without or with carbohydrases on nutrient digestibility and disappearance of non-starch polysaccharides in broiler chickens. Poult. Sci. 94:2662–2669.

Ravindran, V., P. H. Selle, G. Ravindran, P. C. H. Morel, A. K. Kies, and W. L. Bryden. (2001). Microbial phytase improves performance, apparent metabolizable energy, and ileal amino acid digestibility of broilers fed a lysine-deficient diet. Poult. Sci. 80:338–344.

Ravindran, V., S. Cabahug, G. Ravindran, P. H. Selle, and W. L. Bryden. (2000). Response of broiler chickens to microbial phytase supplementation as influenced by dietary phytic acid and non-phytate phosphorus levels. II. Effects on apparent metabolisable energy, nutrient digestibility and nutrient retention. Br. Poult. Sci. 41:193–200.

Romero, L. F., C. M. Parsons, P. L. Utterback, P. W. Plumstead, and V. Ravindran. (2013). Comparative effects of dietary carbohydrases without or with protease on the ileal digestibility of energy and amino acids and AMEn in young broilers. Anim. Feed Sci. Technol. 181:35–44.

Romero, L. F., J. S. Sands, S. E. Indrakumar, P. W. Plumstead, S. Dalsgaard, and V. Ravindran. (2014). Contribution of protein, starch, and fat to the apparent ileal digestible energy of corn- and wheat-based broiler diets in response to exogenous xylanase and amylase without or with protease. Poult. Sci. 93:1–13.

Ruangpanit , Y. S. Attamnangkune, C, Traiprom, S.Cervantes-Pahm and S. Charoensin. (2017) .Effect of mannanase and xylanase supplementation on broiler performance and carcass yield . Proceeding of the 21st European Symposium on poultry nutrition 8-11 may spain, 237.

Sahin, K., C. Orhan, M.O. Smith and N. Sahin . (2013).Moleuclar targets of dietary phytochemicals for the allevation of heat stress in poultry. World's Poult. Sci. J., 69: 113-123.

SAS, Statistical Analysis System, (2001). User's Guide Version 8.2, Cary NC. USA.

Selim, A. Nessrin, Amany H. Waly, Hemat A. Abdel Magied, Heba H. Habib, A.A. Fadl and S.M. Shalas. (2015). Furthe benefits of xylanaseenzyme supplementation to low energy corn-soybean meal broiler diets. Egyptian J. Nutrition and Feeds. 18(3): 443-456.

Selim, A. Nessrin,, Heba H. Habib, Hemat A. Abdel Magied, Amany H. Waly, A.A. Fadl, and S.M. Shalash(2016). Evaluation of using protease enzyme at different levels of protein in corn-soybean meal broiler diets. Egypt. Poult. Sci. Vol (36) (I): 231-247.

Selim, A. Nessrin,Hemat A. Abdel Magied, Heba H. Habib, Amany H. Waly, A.A. Fadl, and S.M. Shalash (2017). Using Protease and Xylanase Enzymes as Single or Combined Supplementation to Corn-Soybean Meal Broiler Diets. International Poultry Scientific Forum Georgia World Congress Center, Atlanta, Georgia January 30-31, 2017. (Abstract).

Selle, P. H., V. Ravindran, R. A. Caldwell, and W. L. Bryden. (2000). Phytate and phytase: Consequences for protein utilisation. Nutr. Res. Rev. 13:255–278.

Stefanello, C., S. L. Vieira, G. O. Santiago, L. Kindlein, J. O. B. Sorbara, and A. J. Cowieson.(2015). Starch digestibility, energy utilization, and growth performance of broilers fed corn-soybean basal diets supplemented with enzymes. Poultry science 94:2472–2479.

Tang, D., S. Hao, G. Liu, F. Nian, and Y. Ru.(2014). Effects of maize source and complex enzymes on performance and nutrient utilization of broilers. Asian-Austral. J. Anim. Sci. 27:1755–1762.

Williams, M. P., J. T. Klein, C. L. Wyatt, T. W. York, and J. T. Lee. (2014). Evaluation of xylanase in low-energy broiler diets. J. Appl. Poult. Res. 23:188–195.

تأثير الدمج بين انزيم الفيتيز وانزيمات الزيلنيز والبروتيز فى مراحل عمرية مختلفة على الاداء الانتاجى وبعض قياسات الذبيحة لدجاج التسمين

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تم استخدام اربعمائة وأربعون كتكوت اربرايكر غير مجنس للبحث عن تأثير الدمج بين انزيم الفيتيز وانزيمات الزيلنيز والبروتيز لعلائق كتاكيت التسمين المنخفضه في الطاقه والبروتين عند مراحل عمريه مختلفه علي الأداء الأنتاجي و قطعيات الذبيحه والتكلفه الاقتصاديه. تم توزيع الكتاكيت عشوائيا علي احدي عشر معامله (٢*٥+١) تضمنت مجموعة الكنترول C وعشر معاملات قسمت لمجموعتين، مجموعه بدون اضافة انزيم الفيتيز ومجموعه مضاف اليها انزيم الفيتيز (بمعدل ١٠٠٠ FUT/ كجم عليقه طوال فترة التجربه) وكل مجموعه تحتوي علي خمس تصاميم غذائيه . تعتمد التصاميم الغذائيه علي عليقه منخفه في الطاقه ١٥٠ كيلو كالوري ومنخفضه في البروتين ١٠ % عن عليقة الكنترول في كل مرحله عمريه وهي العليقه D. العليقه الأولي عليقه D والعليقه الثانيه عليقه D مضاف لها انزيم البروتييز بمعدل ٣٠٠٠٠٠ وحده/ كجم عليقه خلال فترة البادي فقط DP_s. والعليقه الثالثه عليقه D مضاف اليها انزيم الزيلينيز بمعدل ١٦٠٠٠ وحدة /كجم عليقة خلال فترة الناهي فقط DX_f . والعليقه الرابعه عليقه D مضاف اليها انزيم البروتييز خلال فترة النامي وانزيم الزيلينيز خلال فترة الناهي DP_sX_f. والعليقه الخامسه D مضاف اليها انزيم البروتييز وانزيم الزيلينيز خلال فترات التغذيه الثلاث DPX. العليقه الكنترول C كونت لتغطي احتياجات سلالة الاربرايكرز خلال المراحل العمريه المختلفه. كل العلائق صممت لتغطي احتياجات السلاله من باقى العناصر الغذائيه. وكل الكتاكيت تم تسكينها في نظام مفتوح تحت نفس ظروف التربيه والرعايه والبيطريه خلال فترة التجربه (من ١-٤٠ يوم). تم حساب قياسات الأداء الإنتاجي وصفات الذبيحه وتكلفة العليقه. اظهرت النتائج المسجله فيما بين التصاميم الغذائيه الخمس ان الكتاكيت المغذاة على العليقه D سجلت اسوأ اداء إنتاجي خلال الثلاث مراحل تغذيه. خلال فترة البادي تحسن معامل التحويل الغذائي نتيجه لإستخدام DP_s وX_F DP_S و DPX وسجل التصميم الغذائي DPX احسن قيمة (١.٥٦) . بينما اظهرت قياسات الاداء خلال فترة الناهى تحسن معنوى لكل من وزن الجسم المكتسب ومعامل التحويل الغذائى عند تطبيق التصميم الغذائى DPX (١٠٨٢ جم و ١.٧٨) والتصميم الغذائى DP_S X_F (١٠٥٥ جم و ١.٧٧) ايضا سجلت المعاملات المضاف لها الفيتيز تحسن معنوى لكل من من وزن الجسم المكتسب ومعامل التحويل الغذائى فى الثلاث مراحل العمرية بالمقارنة بالمعاملات الغير مضاف لها فيتيز. اظهر التداخل بين انزيم الفيتيز والتصاميم الغذائية تاثير معنوى على جميع قياسات الاداء الانتاجى خلال المراحل العمرية . اثر كلا من اضافة الفيتيز وتطبيق التصاميم الغذائية معنويا على كلا من الماكول التراكمى ومتوسط وزن الجسم المكتسب اليومى خلال فترة التجربة .اظهرت نتائج صفات الذبيحة تاثيرا تداخليا بين الثلاث انزيمات للمعاملة DPXPhعلى نسبة التصافى ولحم الصدر والفخذ لكتاكيت التسمين . توصى النتائج باستخدام كل من انزيم الفيتزوالبروتيز والزيلنيز مع العليقة المنخفضة فى الطاقة الممثلة ١٥٠كيلو كالورى والمنخفضة فى البروتين ١٠% لكتاكيت التسمين خلال جميع المراحل العمريه للوصول لنفس الأداء الأنتاجي للكنترول واحسن ذبيحه وافضل محصول للحم الصدر والفخذ و احسن كفاءه اقتصاديه.