Assiut Veterinary Medical Journal Assiut Vet. Med. J. Vol. 71 No. 184 January 2025, 350-363

10.21608/avmj.2025.310306.1337 Assiut University website: www.aun.edu.eg

EFFECT OF DIETARY PROBIOTICS AND ENZYMES ADDITION ON BROILER PERFORMANCE, CARCASS CHARACTERISTICS AND INTESTINAL MORPHOLOGY

MAMDOUH OMAR ABD-ELSAMEE [1]; AHMED MOHAMED ABDEL-KHALEK[2]; RAGAB REZK ELSHARKAWY [2] AND HANY MOHAMED RAMADAN ELSHERIF[1]

[1] Department of Animal Production, Faculty of Agriculture, Cairo University, Giza, Egypt
[2] Animal Production Research Institute, Agricultural Research Center, Giza, Egypt

Received: 4 September 2024; **Accepted:** 30 October 2024

ABSTRACT

This study investigated the impact of using probiotic *Pediococcus acidilactici* (PRO), phytase (PHY) and xylanase (XYL) on growth performance, including carcass characteristics and intestinal morphology of 210-day-old Arbor Acres broiler chicks. The chicks were divided into seven dietary treatments of 3 replicates with 10 birds each for 35 days. Experimental groups were T1 which was fed a basal diet; T2 fed a control diet with 100 g of probiotic /ton feed; T3 fed a control diet with 100 g of phytase /ton feed; T4 fed a control diet with 100 g of xylanase /ton feed; T5 fed control diet with 100 g of phytase + 100 g xylanase /ton feed; T6 fed control diet with 100 g xylanase + 100 g Probiotic/ton feed and T7 fed control diet with 100 g phytase + 100 g of probiotic /ton feed, respectively. Results showed no significant differences between treatments in total growth performance except for giblets; however, the treatment with supplemental PHY+XYL (T5) had a 5.15% increase in BWG compared with the control group. Spleen and bursa weight were significantly affected by dietary treatments, where chicks fed either PRO+XYL or PRO were recorded as having the highest intestinal villi height and villi/ crypt ratio compared to the control. It could be concluded that the dietary supplementation of 100 g xylanase + 100 g probiotic/ ton feed or phytase at 500 FTU/kg diet + β-xylanase at 1600 BXU/kg resulted in enhanced growth performance, gut morphology and carcass characteristics in broiler chickens.

Keywords: Xylanase, phytase, probiotic, broiler performance

INTRODUCTION

Broiler chicks for commercial production have been developed over the recent years (Gado *et al*., 2019). It's a dietetic white meat that provides animal protein at rational prices compared to other protein sources (Nasr *et al*., 2021). It can be a result of increased feed conversion efficiency and reduced poultry feed costs (Karar *et al*., 2023). So, good feeding practices are a must to improve broiler chicken growth performance.

Many countries have used antibiotics as growth promoters because birds are exposed to many stressors during their breeding that could affect growth, mortality and health. Antibiotics have been used in poultry nutrition not only as growth promoters but also as immunostimulators, which improve

Corresponding author: Ragab Rezk Elsharkawy
E-mail address: drragab.info@gmail.com.
Present address: Animal Production Research Institute, Agricultural Research Center, Giza, Egypt *

the immune system function of animals, thus improving their performance and health status (Fadl *et al*., 2020). However, there are increasing consumer concerns about drug residues in meat and meat products and the rise of antibiotic resistance of pathogenic bacteria that could be transmitted to humans (Vieco-Saiz *et al*., 2019). For this reason, the EU and some other countries banned the addition of antibiotics in animal diets as therapeutics and growth promoters since 2006 (Zia Ur Rehman *et al.*, 2017), which in turn has resulted in a depression in poultry performance (Waqas *et al*., 2019). So, this concept motivates researchers to find low-cost natural alternatives and the same efficacy to improve animal health (Abudabos *et al*., 2018). However, poultry diets mainly contain plant-based materials containing phytate and many anti-nutritional factors. The most common anti-nutritional factors present in a plant-based ingredients diet are non-starch polysaccharides (NSPs) (Anwar *et al*., 2023). So, supplemental enzymes such as phytase and xylanase are improving feed digestibility allowing the use of a wide range of feed materials with high fiber content and improving poultry performance with the least cost diets (Alabi *et al*., 2019). Probiotics are involved in enhancing poultry immunity and maintaining the intestinal barrier (Huang *et al*., 2019), improving nutrient digestibility coefficients and intestinal health of broilers (He *et al*., 2019), and favouring microbiota of beneficial microorganisms (Rodrigues *et al*., 2020). Xylanase participated in increasing the nutrient availability of plant-based ingredients by improving fiber breakdown (Adeola and Cowieson, 2011). Xylanase could modulate the intestinal microbiota through the breakdown of NSPs (Craig *et al*., 2020). Also, exogenous phytase is widely used in poultry diets to reduce inorganic phosphorus supplementation, which improves other nutrient utilization and minimizes nutrient excretion into the environment. Phytase degrades the phytates and releases the phytate-bound nutrients, particularly minerals (P, iron and zinc), in addition to amino acids and carbohydrates (Romano and Kumar, 2018). Also, Elsagheer *et al*. (2022) found that broilers fed a probiotic or enzyme diet had better carcass characteristics and intestine morphology. Machado *et al*. (2020) concluded that the supplementation of 100 ppm probiotics and 100 ppm xylanase to broiler diets led to increased growth performance. Gulizia *et al*. (2023) concluded that phytase supplementation increased fat digestibility, reduced FCR and increased phosphorus digestibility. Also, Schramm *et al*. (2017) found that the combination of xylanase at 50, 100 and 150 FXU/kg diet in the presence of phytase at 1000 FTU/kg diet improved the nutrient digestibility of broiler chickens.

Therefore, the current study was conducted to investigate the effect of dietary probiotics, xylanase and phytase on some performance indices in broiler chickens.

MATERIALS AND METHODS

The present experiment was approved by the Institutional Animal Care and Use Committee (CU-IACUC), Cairo University, Egypt (CU-II-F-21-24).

Management

This experiment was carried out at the QRD research farm in Giza, Egypt, during October and November 2022. Diets and water were offered *ad-libitum* all over the experiment periods. Chicks were kept under similar managerial conditions. Artificial lighting was available continuously during the growth period. Gas heaters provide chicks with the heat needed during the brooding period. Chicks were vaccinated with Hitchner B-1 against Newcastle disease + IB (eye drop). Chicks were vaccinated against IBD, ND+AI and ND+IB.

Probiotic and enzyme sources:

Probiotic (BACTOCELL PA 10)

BACTOCELL PA 10 is a feed additive based on a live lactic acid bacteria (*Pediococcus acidilactici* CNCM I-4622 –

MA 18/5M) ($1x10^{10}$ CFU/g) produced by Lallemand - USA company.

Phytase (Quantum ™ blue 5G)

Quantum ™ blue 5G is a commercial phytase produced by *Trichoderma reesei* that contains (5000 FTU/g) and it is produced by Roal Oy, Finland.

Xylanase (Econase® XL 25)

Econase® XL 25 is a commercial xylanase produced by *Trichoderma reesei* that contains (16000 BXU/g) and it is produced by Roal Oy, Finland.

Experimental birds and diets

A total of 210 day-old Arbor Acres broiler chicks were housed in 3 deck battery cages with dimensions 60*100*25 cm^3, randomly divided into seven dietary treatments with 3 replicates of 10 birds each and kept in a semi-closed house at the same environmental conditions. The different treatment groups; Group 1 (T1) were fed the control diets at starter, grower and finisher periods (Table 1), which were formulated to meet the requirements recommended by the Arbor Acres broilers nutrition guide (2022). Group 2 (T2) fed a control diet with 100 g probiotic; T3 fed a control diet with 100 g phytase; T4 group fed a control diet with 100 g xylanase; T5 fed a control diet with 100 g phytase + 100 g xylanase; T6 fed a control diet with 100 g xylanase+100 g probiotic and T7 group fed a control diet with 100 g phtyase +100 g probiotic, respectively.

Measurements

Performance parameters

The chicks were individually weighed at the start and at the end of each growth interval to calculate the live body weight gain (LBWG). Feed consumption (FC) was recorded and used to estimate the feed conversion ratio (FCR).

Carcass characteristics

Five birds with the same average weight from each group were slaughtered to complete bleeding and plucked off feathers. Lymphoid organs (bursa and spleen) and giblets (heart, gizzard and liver) were weighed and expressed as a percentage of live body weight upon slaughtering.

Intestinal histo-morphological measurements

The total number of the intact, well-oriented crypt-villus units was detected in three replicates for each intestinal cross-section for each sample. The traits for villus selection were based on the existence of intact *lamina propria*. Villus height was measured from the tip of the villus to the villus-crypt junction, while crypt depth was detected as the depth of the invagination between adjacent villi.

Statistical analysis

The statistical analysis was computed using analysis of variance as described in the SAS program (SAS® Institute, 2004). The significant difference means between treatments were separated by Duncan's Multiple Range (Duncan, 1955).

The experimental models were as follows:

One way analysis

$Y_{ij} = \mu + T_i + e_{ij}$, where Y_{ij} = observations, μ = the overall mean, T_i = effect of treatment (i= 1, ...7) and e_{ij} = experimental error.

RESULTS

Productive performance

The effect of probiotics and enzymes on broiler performance (LBW, BWG, FC and FCR) at starter, grower and finisher periods is presented in Tables (2 and 3). Chicks fed diets with phytase + xylanase (T5) significantly ($P < 0.05$) improved LBW compared to control and other treatments except for T2, while the groups fed PRO + PHY (T7) and control (T1) diets recorded within the lowest LBW (399, 406.75 g) respectively, during starter period. Chicks which fed diets with probiotics (T2) significantly achieved the highest LBW by 6.79% compared to the control during the grower period and numerically during the finisher period, comparing with all experimental groups except for the T7 (PRO

+ PHY) group. Chicks fed diets with PHY + XYL (T5) were significantly increased in LBWG (394.25 g) compared to all other groups and numerically to that fed diets with probiotic (T2) which significantly gained the highest weight by 66.26%, compared to control. Group T5 was numerically recorded as the best LBWG by 5.15%, compared to control, and significantly by 8.59%, compared to T7 chicks. Non-significant observations were recorded in neither feed consumption (FC) nor feed conversion ratio (FCR) between all experimental groups during both starter and grower periods. Chicks which fed diets with the PHY + XYL combination significantly consumed feed in an increase of 3.32% more than those fed the control diet during the finisher period. Also, the chicks of T5 (PHY + XYL) were numerically recorded as having the highest feed consumption, compared to all tested groups, except for the T7 group. Chicks of T5 and T6 groups were numerically the lowest feed conversion ratio during the overall period (1.46), followed by chicks of T2 (1.47).

Generally, the group T2 significantly ($P<0.05$) recorded the highest LBW and LBWG during the grower period by 7.56 and 7.71% respectively, compared to the control. Group 2 fed PRO significantly achieved the highest LBWG during the grower period by 7.71%, compared to control. Chicks of T5 fed PHY+XYL numerically achieved the highest LBW and LBWG during the overall period by 5.03 and 5.15% respectively, and the lowest FCR by 2.73% compared to the control.

Lymphoid organs

The effects of probiotics and enzymes on relative lymphoid organ percentages are tabulated in Table (4). Chicks fed diets containing probiotics (T2) were significantly ($P< 0.05$) recorded bursa percentage higher than all other groups. Chicks fed a control diet were numerically recorded with the highest spleen percentage compared to T2 (PRO) and T3 (PHY) and significantly compared to other groups.

Carcass characteristics

The effects of probiotics and enzymes on carcass characteristics are presented in Table (5). There were no significant differences in carcass, liver, and heart percentages. Chicks fed diets supplemented with PHY + XYL were not significantly recorded as having the lowest fat percentage, while chicks of the control group numerically recorded the highest gizzard percentage compared to T2 and T3 and significantly compared to all other groups. Giblet percentages were significantly affected by dietary treatment, with the highest recorded value for the control group.

Small intestines histo-morphology

The results marked significant differences in the histomorphometric parameters of all experimental groups, compared to the control group (T1) (Table 6, Figures (1-4)). Concerning the intestinal histomorphometry, the chicks of group 2 fed a diet containing probiotics showed significant increases in intestinal villi height and V/C ratio. On the other hand, the chicks fed a diet containing probiotic + xylanase (T6) enhanced the gut histo-morphometry parameters with an increase of intestinal villi height and V/C ratio. The present data revealed that dietary supplementation of probiotics, individually or in the presence of xylanase PRO+XYL, greatly affects intestinal parameters, and their positive impact was exerted in the intestine. The best results were recorded in groups (2 and 6). Meanwhile, there are no significant differences between groups (3, 5 and 7) as they nearly had the same effect on the intestinal parameters. The analysis of histomorphometric parameters of T4 revealed a significant reduction of villi height and increased crypt depth.

Table (1). Ingredient composition proximate chemical analysis of the basal diet.

Feed ingredients %	**starter**	**grower**	**finisher**
	1-10 d	11-24 d	25-35 d
Yellow corn	51.02	55.58	61.08
Soybean meal (46%)	40.93	37.18	31.89
Crude soy oil	3.40	3.50	3.50
Monocalcium phosphate	1.65	1.25	1.15
Lime stone	1.50	1.20	1.10
Vitamins and Minerals Premix	0.3	0.3	0.3
NaCl	0.35	0.35	0.35
Sodium bicarbonate	0.1	0.10	0.10
DL-Methionine	0.27	0.22	0.22
L-Lysine HCL	0.15	0.01	0.01
Choline chloride (60%)	0.33	0.31	0.30
Total	100	100	100
Calculated analysis			
Crude protein (%)	23.00	21.50	19.50
Metabolizable Energy (Kcal/Kg)	2975	3050	3100
Crude Fiber (%)	3.47	3.36	3.19
Ethter Extract (%)	5.92	6.33	6.27
Calcium (%)	0.95	0.76	0.69
Available Phosphorus (%)	0.51	0.42	0.39
Methionine	0.65	0.58	0.56
Methionine+Cystine	1.01	0.92	0.87
Lysine	1.46	1.25	1.11
Sodium	0.20	0.20	0.19

Each 1 Kg diet contains:
Vit.A 13000 IU, Vit.D3 5000 IU, Vit.E 80 IU, Vit.K3 4 mg, Vit.B1 5 mg, Vit.B2 9 mg, Vit.B12 0.02 mg, Vit. B6 5 mg, Niacin 70 mg, Pantothenic acid 20 mg, Folic acid 2.50 mg, Biotin 0.35 mg, Copper 16 mg, Iodine 1.25 mg, Iron 20 mg, Zinc 120 mg, Manganese 120 mg, Selenium 0.30 mg and Cobalt 0.10 mg.

Table (2). Effect of probiotic, phytase and xylanase on average live body weight and average body weight gain

Tr. No.	**Treatment**	**Body weight (g)**				**Body weight gain (g)**			
						starter	**grower**	**finisher**	**overall period**
		1d	**14d**	**28d**	**35d**	**1-14d**	**15-28d**	**29-35d**	**1-35d**
T1	**Control**	44.7	406.75[cd]	1265.8[cd]	1901.13	362.00[cd]	859.06	635.32	1856.38
T2	**(PRO)**	44.7	426.50[ab]	1351.82[a]	1961.36	381.75[ab]	925.32	609.55	1916.61
T3	**(PHY)**	44.7	419.00[bc]	1316.36[abc]	1923.18	374.25[bc]	897.36	606.82	1878.43
T4	**(XYL)**	44.7	416.00[bc]	1288.64[bcd]	1887.28	371.25[bc]	872.64	598.64	1842.53
T5	**(PHY + XYL)**	44.7	439.00[a]	1342.28[ab]	1996.82	394.25[a]	903.28	654.55	1952.07
T6	**(PRO + XYL)**	44.7	419.50[bc]	1324.09[abc]	1945.45	374.75[bc]	904.59	621.36	1900.70
T7	**(PRO + PHY)**	44.7	399.00[d]	1252.73[cd]	1842.27	354.25[d]	853.73	589.64	1797.52
	SEM	0.144	4.96	18.97	36.92	4.97	18.91	47.55	36.87
	***P* value**	1.00	0.0004	0.008	0.124	0.0004	0.11	0.96	0.12

[a, b…etc.] Means in the same column, within effect, with different superscripts are significantly different ($P < 0.05$).

Table (3). Effect of probiotic, phytase and xylanase on feed consumption and feed conversion ratio.

Tr. No.	Treatments	Feed consumption (g)				Feed conversion ratio (g feed/g gain)			
		starter	grower	finisher	overall period	starter	grower	finisher	overall period
		1-14d	15-28d	29-35d	1-35d	1-14d	15-28d	29-35d	1-35d
T1	**Control**	455	1257	1069^{b}	2781.15^{ab}	1.25	1.46	1.71	1.50
T2	**(PRO)**	459.50	1276.75	1089^{ab}	2825.38^{ab}	1.20	1.38	1.84	1.47
T3	**(PHY)**	464.50	1289.75	1078.25^{b}	2832.23^{ab}	1.24	1.44	1.79	1.50
T4	**(XYL)**	456.50	1263.50	1067.25^{b}	2786.98^{ab}	1.23	1.45	1.82	1.51
T5	**(PHY + XYL)**	463	1276.25	1104.50^{a}	2843.90^{a}	1.17	1.41	1.71	1.46
T6	**(PRO + XYL)**	447	1259.50	1073.25^{b}	2779.73^{ab}	1.19	1.39	1.73	1.46
T7	**(PRO + PHY)**	450	1256	1065.50^{b}	2771.58^{b}	1.27	1.47	1.83	1.54
	SEM	10.70	11.19	8.38	19.54	0.030	0.036	0.129	0.025
	***P* value**	0.89	0.30	0.03	0.07	0.25	0.50	0.97	0.27

[a, b] Means in the same column, within effect, with different superscripts are significantly different.

Table (4). Effect of probiotic, phytase and xylanase on relative lymphoid organs weight.

Tr. No.	Treatments	Relative lymphoid organs weights	
		Bursa %	Spleen %
T1	**Control**	0.20^{d}	3.18^{a}
T2	**(PRO)**	0.38^{a}	2.81^{ab}
T3	**(PHY)**	0.26^{bcd}	2.77^{ab}
T4	**(XYL)**	0.29^{bc}	2.52^{b}
T5	**(PHY + XYL)**	0.22^{cd}	2.56^{b}
T6	**(PRO + XYL)**	0.29^{bc}	2.34^{b}
T7	**(PRO + PHY)**	0.30^{b}	2.38^{b}
	SEM	0.024	0.011
	***P* value**	0.001	0.0001

[a, b…etc.] Means in the same column, within effect, with different superscripts are significantly different ($P<0.05$).

Table (5). Effect of probiotic, phytase and xylanase on carcass characteristics.

Tr. No.	Treatments	LBW	Carcass weight	Carcass %	Liver %	Heart %	Gizzard %	Fat %
T1	**Control**	2108.8	1531.25	72.75	3.51	0.70	3.18^{a}	1.33
T2	**(PRO)**	2330	1647.50	70.71	3.04	0.67	2.81^{ab}	1.08
T3	**(PHY)**	2083.8	1467.50	70.39	3.39	0.72	2.77^{ab}	0.97
T4	**(XYL)**	2115	1516.25	71.65	3.42	0.70	2.52^{b}	1.22
T5	**(PHY + XYL)**	2252.5	1603.75	71.24	3.17	0.66	2.56^{b}	0.74
T6	**(PRO + XYL)**	2312.5	1668.75	72.13	3.12	0.63	2.34^{b}	1.04
T7	**(PRO + PHY)**	2082.5	1490	71.56	3.44	0.67	2.38^{b}	1.18
	SEM	85.39	63.61	0.88	0.151	0.031	0.145	0.171
	***P* value**	0.17	0.21	0.56	0.24	0.53	0.007	0.32

[a, b] Means in the same column, within effect, with different superscripts are significantly different ($P < 0.05$).

Table (6). Effect of probiotic, phytase and xylanase on intestinal histomorphology.

Tr. No.	Treatments	Intestinal histomorphometric parameters (µm)		
		Villous Height (V)	Crypt depth (C)	V:C ratio
T1	Control	1307.38[b]	246.65[b]	5.484[b]
T2	(PRO)	1347.49[b]	225.01[b]	6.463[a]
T3	(PHY)	1159.38[c]	246.95[b]	4.928[b]
T4	(XYL)	990.63[d]	241.71[b]	4.246[c]
T5	(PHY + XYL)	1171.03[c]	225.57[b]	5.495[b]
T6	(PRO + XYL)	1533.74[a]	248.49[b]	6.691[a]
T7	(PRO + PHY)	1177.02[c]	342.17[a]	3.629[c]
	SEM	31.86	8.44	0.238
	P value	0.0001	0.0001	0.0001

[a, b…etc.] Means in the same column, within effect, with different superscripts are significantly different ($P < 0.05$).

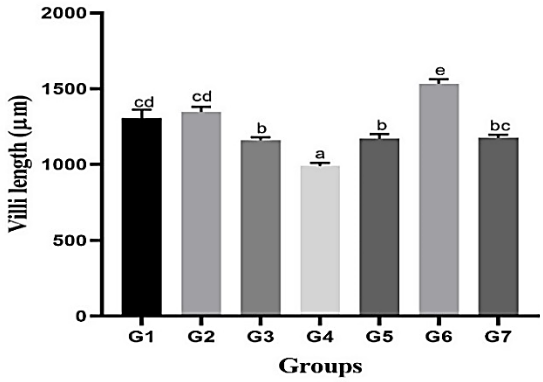

Figure (1). Villus length

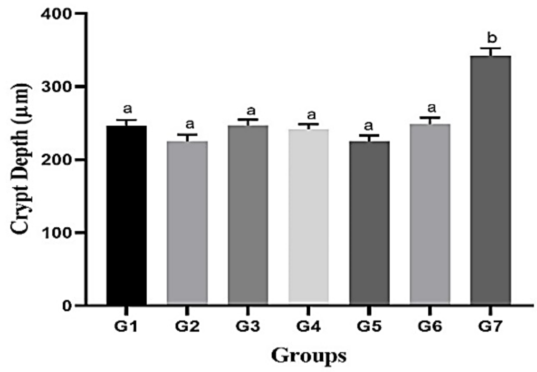

Figure (2). Crypt depth

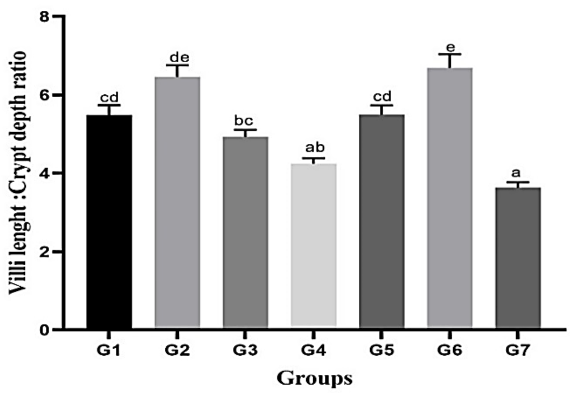

Figure (3). Villus length to crypt depth ratio

Figures 1-3. The villus length, crypt depth and villus length to crypt depth ratio.

G1 control group, G2 group supplemented with 100 g probiotic, G3 group supplemented with 100 g phytase, G4 group supplemented with 100 g xylanase, G5 group supplemented with 100 g phytase + 100 g xylanase, G6 group supplemented with 100 g probiotic + 100 g xylanase and G7 group supplemented with 100 g phytase + 100 g probiotic.

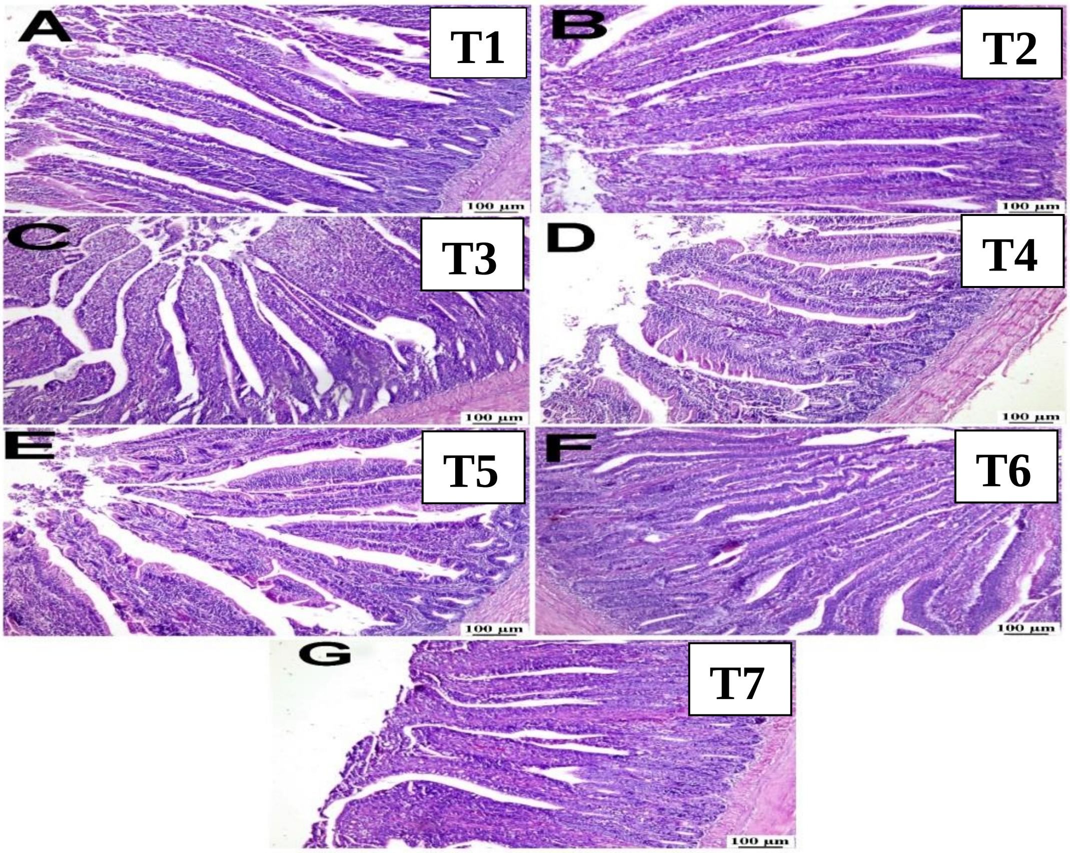

Figure (4). Photomicrograph showing the intestine of broiler chicken (H&E).
T1 control group, T2 group supplemented with 100 g probiotic, T3 group supplemented with 100 g phytase, T4 group supplemented with 100 g xylanase, T5 group supplemented with 100 g phytase + 100 g xylanase, T6 group supplemented with 100 g probiotic + 100 g xylanase and T7 group supplemented with 100 g phytase + 100 g probiotic.

DISCUSSION

The performance results showed that the dietary addition of probiotic + xylanase or phytase + xylanase to broiler diets improved the performance compared to the control one. The overall growth performance parameters were improved by supplementing the diet with phytase 500 FTU/kg in addition to β-xylanase 1600 BXU/kg compared to the control group. The dietary supplementation of phytase and xylanase positively affects growth performance by improving gut morphology and carcass percentage in broiler chickens (Basant *et al*., 2023). The enhanced growth performance induced by the addition of xylanase and phytase highlights the role of phytase in improving nutrient utilization as a result of phytate hydrolysis and decreasing its anti-nutritional effects (Dersjant-Li *et al*., 2015; Song *et al*., 2019). Also, improved growth after the addition of xylanase and phytase could be explained by the improvement in Ca and P digestibility caused by phytase that increases the bioavailability of P and Ca, which may express different effects on the intestinal and bone health and enhance the healthy balance of intestinal microbiota of broiler chickens (Moita *et al*., 2021).

Our results agreed with Basant *et al*. (2023), who concluded that broilers fed phytase at 500 FTU/kg + xylanase at 250 ppm enhanced villi height and intestinal morphology, thus improving feed efficiency and growth performance. Lee *et al*. (2010) demonstrated that both phytase (500 FTU/kg) and xylanase (1100 U/kg) enzymes could improve gut health in terms of decreasing the intestinal viscosity by 12.40% compared to control, which enhances the nutrient absorption and growth performance of chicken broilers. Moreover, the chicks fed a diet containing either XYL + PHY or PRO + XYL achieved the best FCR agreed with Machado *et al*. (2020), who reported that supplementation of broiler diets with 100 ppm probiotic and 100 ppm xylanase improved FCR by 3.75% and increased LBWG and feed intake by 5.60% and 1.99% respectively, compared to control, as a result of improvement of gut microbiota and decreased intestinal viscosity. Similarly, Nusairat *et al*. (2018) reported that supplementation of broiler diets with a combination of *bacillus subtilis* probiotic at $1x10^6$ CFU/g and β1,4 xylanase at 15000 XU/kg increased LBW by 5.38% and improved FCR by 5.78% compared to control during the overall period. Similarly, Momtazan *et al*. (2011) concluded that a combination of enzyme complex and probiotics could enhance feed efficiency and improve broiler performance more than supplemented individually. One reason for this interaction may be the synergistic effect between enzymes by degrading the anti-nutritive factors and so alleviating the viscosity of the digesta, and probiotic by increasing the beneficial microflora, short-chain fatty acids (SCFAs) production and lowering the pH of the digestive tract and the increasing of gut digestive enzymes (Wang *et al*., 2021; Sun *et al*., 2022). Also, Kirkpiner *et al*. (2018) concluded that dietary combinations of 0.5 g + 0.5 g/kg of probiotic and multienzymes complex (including phytase and xylanase) in feed increased final BW and BWG by 2.40 and 2.44%, respectively. Also, intestinal viscosity and pH are lowered by 8.13% and 2.66%, while non-significant differences were observed in neither feed consumption nor feed conversion ratio, compared to the control group.

The results also indicated significant differences between treatments for relative lymphoid organs bursa and spleen. The significant increase in the weight of lymphoid organs may be attributed to the effect of probiotic microflora that enhanced the immune system response leading to an increase in the lymphocyte numbers of the primary lymphoid organs (Kabir *et al*., 2004; Yaqoob *et al*., 2022). On the same line, Abdel Moati *et al*. (2022) concluded that significant differences were observed in bursa weight by 30% through the addition of broiler chicken diets with 15000 ppm probiotic (Enviva® PRO 201 BA) individually and by 35% when adding 15000 ppm probiotic (Enviva® PRO 201 BA) + 400 ppm enzyme mixture (EXTRA® XAP 101TPT), compared to control group. The results agreed with Ali *et al*. (2018) found that bursa weight significantly ($P<0.05$) increased by 38.8%, compared to control through the addition of 200 ppm multienzymes (Avizyme®) and 500 ppm probiotics (Biacton) in broiler chicken diets. On the other hand, Elsagheer *et al*. (2022) concluded that there were no significant ($P>0.05$) differences in relative weights of bursa and spleen when adding broiler diets with 1000 ppm probiotic (Guardizen-M) or 500 ppm enzymes (Fra®Multizyme) at 35 days of age among all experimental groups.

Furthermore, our results indicated significant improvements in fat formation when chicks were fed diets with PHY+XYL, where they had a lower fat percentage 44.3%, compared to the control. Whereas, no significant differences were observed between treatments, neither for carcass nor giblets (liver, heart, gizzard). Our results agreed with many researchers who reported that the addition of 1000 ppm probiotic (Guardizen-M) or 500 ppm enzymes (Fra®Multizyme) (Elsagheer *et al*. 2022), xylanase + probiotic (Machado *et al*. 2020) or 200 ppm multienzymes (Avizyme®) and 500 ppm probiotics (Biacton) (Ali *et al*. 2018) to broiler diets improved carcass characteristics significantly (P<0.05) through lowering abdominal fat up to 10%, 28% or 49.3%, respectively less than the control, while the carcass and giblets percentage was not affected significantly. Moreover, Rehman *et al*. (2020) stated that probiotics did not show any significant effect on liver, heart and gizzard weights for broilers at 1-35 d of age.

On the other hand, Abdel Moati *et al*. (2022) found that no significant differences were observed in abdominal fat content or giblets percentage among all experimental treatments by the addition of broiler chicken diets with 15000 ppm probiotic (Enviva® PRO 201 BA) + 400 ppm enzyme mixture (EXTRA® XAP 101TPT).

The present data showed that dietary supplementation of probiotics individually, or in the presence of xylanase PRO+XYL, greatly affect intestinal parameters. These results agreed with that reported by Elsagheer *et al*. (2022), who found that the addition of 1000 ppm probiotics or 500 ppm enzymes improved intestine morphology.

CONCLUSION

It can be concluded that the addition of broiler chicken diets with 100 ppm probiotic + XYL (1600 BXU/kg) or PHY (500 FTU/kg) + XYL (1600 BXU/kg) had positive effects on broiler growth performance and gut morphology compared to the control group.

REFERENCES

Abdel Moati, YAa.; Eissa, NMa; Abouelezz, KFM. and Younis, M. (2022). Effect of dietary supplementation of probiotics, enzymes and their combination on growth performance, meat yield, intestinal microbiota and plasma analysis of broiler chicks Archives of Agriculture Sciences Journal 5(2) 136–152.

Abudabos, AM.; Alyemni, AH.; Dafalla, YM. and Khan, RU. (2018): The effect of phytogenics on growth traits, blood biochemical and intestinal histology in broiler chickens exposed to Clostridium perfringens challenge. J. Appl. Anim. Res., 46: 691-695. https://doi.org/10.1080/09712119.2017.1383258.

Adeola, O. and Cowieson, A.J. (2011): Board-invited review: Opportunities and challenges in using exogenous enzymes to improve nonruminant animal production. Journal of Animal Science 89:3189-3218. https://doi.org/10.2527/jas.2010-3715.

Alabi, OO.; Shoyombo A J.; Akpor, OB.; Oluba, OM. and Adeyonu, AG. (2019): Exogenous enzymes and the digestibility of nutrients by broilers: A Mini Review. Int. J. Poult. Sci. 18:404-409. doi: 10.3923/ijps.2019.404.409.

Ali, RAM.; El-Shafey, AS. and El-Kelawy, MI. (2018): Immuno physiological and productive respose of broiler chicks to dietary supplementation with multi-enzyme and/or probiotics. Egyptian Poultry Science Journal, 38(4): 1047-1067.

Anwar, U.; Riaz, M.; Farooq, MK.; Mustafa, R.; Farooq, U.; Ashraf, M.; Munir, H.; Auon, M.; Hussain, M.; Hussain, M.; Chisti, MFA.; Bilal, MQ.; Abd ur Rehman and Aziz ur Rahman, M. (2023): Impact of exogenous xylanase and phytase, individually or in combination, on performance, digesta viscosity and carcass characteristics in broiler birds fed wheat-based diets. Animals, 13, 278. https://doi.org/10.3390/ani13020278.

Basant, MS.; Asmaa, SM.; Zainab, SOA.; Abdelrhman, MG.; Khaled, NEF (2023): The potential Enhancing Effect of both Phytase and β-xylanase Enzymes on Performance, Bone Mineralization and Nutrient Absorption in broiler Chicken, J. Adv. Vet. Res. 13: (5), 806-814.

Craig, AD.; Khattak, F.; Hastie, P.; Bedford, MR. and Olukosi, OA. (2020): Xylanase and xylo-oligosaccharide prebiotic improve the growth performance and concentration of potentially prebiotic oligosaccharides in the ileum of broiler chickens. British Poultry Science 61:70-78. https://doi.org/10.1080/00071668.2019.1673318.

Dersjant-Li, Y.; Awati, A.; Schulze, H. and Partridge, G. (2015): Phytase in non-ruminant animal nutrition: a critical review on phytase activities in the gastrointestinal tract and influencing factors. Journal of the Science of Food and Agriculture 95, 878–896.

Duncan, DB. (1955): Multiple range and multiple F-test. Biometrics, 11: 1-42. https://doi.org/10.2307/3001478.

Elsagheer, MA.; Yasein, MM.; Nadi, ME. and Mohamed, ESM. (2022): Impact of Dietary Supplementation of Probiotic or Enzymes on Carcass Traits and Intestinal Microflora of Broiler. Assiut Journal of Agriculture Science 53: (4) 108-124. DOI: 10.21608/ajas.2022.155347.1166

Fadl, SE.; El-Gammal, G.; Sakr, OA.; Salah, AA.; Atia, AA.; Prince, AM.; Hegazy, AM. (2020): Impact of dietary Mannan oligosaccharide and β-Glucan supplementation on growth, histopathology, E-coli colonization and hepatic transcripts of TNF-α and NF-κB of broiler challenged with E. coli. BMC Vet. Res., 16: 204. https://doi.org/10.1186/s12917-020-02423-2.

Gado, AR.; Ellakany, HF.; Elbestawy, AR.; Abd El-Hack, ME.; Khafaga, AF.; Taha, AE.; Arif, M. and Mahgoub, SA. (2019): Herbal medicine additives as powerful agents to control and prevent avian influenza virus in poultry – A review. Annals of Animal Science, 19(4), 905–935. DOI: https://doi.org/10.2478/aoas-2019-0043.

Guliziaa, JP.; Susan, MB.; Jose, IV.; Santiago, JS.; Sara, LM.; Tri, D. and Wilmer, JPa (2023): The effects of phytase and a multicarbohydrase complex containing α-galactosidase on performance, processing yield, and nutrient digestibility in the broiler chicken, Journal of Applied Animal Research 2023, VOL. 51, NO. 1, 308–322. https://doi.org/10.1080/09712119.2023.2197975

Hadeel, H. (2021): Feed additives in poultry. Assiut Vet. Med. J. (67):168, 87-100. DOI.10.21608/AVMJ.2021.177853.

He, T.; Long, S.; Mahfuz, S.; Wu, D.; Wang, X.; Wei, X. and Piao, X. (2019): Effects of probiotics as antibiotics substitutes on growth performance, serum biochemical parameters, intestinal morphology, and barrier function of broilers. Animals 9:985. https://doi.org/10.3390/ani9110985.

Huang, L.; Luo, L.; Zhang, Y.; Wang, Z. and Xia, Z. (2019): Effects of the dietary probiotic, Enterococcus faecium NCIMB11181, on the intestinal barrier and system immune status in Escherichia coli O78-challenged broiler chickens. Probiotics and Antimicrobial Proteins 11:946-956. https://doi.org/10.1007/s12602-018-9434-7.

Kabir, SML.; Rahman, MM.; Rahman, MB.; Rahman, MM. and Ahmed, SU. (2004): The dynamics of probiotics on growth performance and immune response in broilers. Int. J. Poult. Sci. 3:361-4. ttps://doi.org/10.3923/ijps.2004.361.364.

Karar, EMH.; Atta, AMM.; Gharib, HBA. and El-Menawey, MAA. (2023): Impact of Prebiotic Supplementation on Productive Performance, Carcass Traits, and Physiological Parameters of Broiler Chickens under High Stocking Density Condition. J. World Poult. Res., 13(1): 48-60.

Kırkpınar, F.; Açıkgoz, Z.; Mert, S.; Işık, O. (2018): Effects of Dietary Probiotic, Prebiotic and Enzyme Mixture Supplementation on Performance, Carcase, Organ, Ileal pH and Viscosity of Broilers, J. Anim. Prod., 59 (2):1-9, DOI: 10.29185/ hayuretim.469862.

Lee, S.; Kim, J.; An, B.; Kang, C. (2010): Effects of Multiple Enzyme (ROVABIO® Max) Containing Carbohydrolases and Phytase on Growth Performance and Intestinal Viscosity in Broiler Chicks Fed Corn Wheat-Soybean Meal Based Diets. Asian-Australasian Journal of Animal Sciences 23, 1198-1204.

Machado, NJB.; Cruz, FGG.; Brasil, RJM.; Rufino, JPF.; Freitas, LW.; Dilelis, F.; Quaresma, DV. and Lima, CAR. (2020): Effects of xylanase and probiotic supplementation on broiler chicken diets. Revista Brasileira de Zootecnia 49:e20190216. https:// doi.org/10.37496/rbz4920190216

Moita, VHC.; Duarte, ME. and Kim, SW. (2021). Supplemental effects of phytase on modulation of mucosa-associated microbiota in the jejunum and the impacts on nutrient digestibility, intestinal morphology, and bone parameters in broiler chickens. Animals 2021, 11, 3351.

Momtazan, R.; Moravej, H.; Zaghari, M. and Taheri, HR. (2011): A note on the effects of a combination of an enzyme complex and probiotic in the diet on performance of broiler chickens. Irish Journal of Agricultural and Food Research 50: 249–254.

Nasr, MAF.; Alkhedaide, AQ.; Ramadan, AAI.; Hafez, AES. and Hussein, MA. (2021). Potential impact of stocking density on growth, carcass traits, indicators of biochemical and oxidative stress and meat quality of different broiler breeds. Poultry Science, 100(11): 101442. DOI: https://www.doi.org/10.1016/j.psj.2021.101442.

Nusairat, B.; James, M.; James, T. and Jeng-Jie, W. (2018): Effect of xylanase and Bacillus direct fed microbial as an alternative to antibiotic growth promoters, improves live performance and gut health in sub-clinical challenged broilers. Int. J. Poult. Sci. 17: 362-366.

Rehman, A.; Arif, M.; Sajjad, N.; Al-Ghadi, M.; Alagawany, M.; Abd, El-Hack M, and Swelum, A. (2020): Dietary effect of probiotics and prebiotics on broiler performance, carcass, and immunity. Poultry Science, 99(12): 6946-6953.

Rodrigues, DR.; Briggs, W.; Duff, A.; Chasser, K.; Murugesan, R.; Pender, C.; Ramirez, S.; Valenzuela, L. and Bielke, LR. (2020): Comparative effectiveness of probiotic-based formulations on cecal microbiota modulation in broilers. PLoS ne15:e0225871. https://doi.org/10.1371/journal.pone.0225871

Romano, N., Kumar, V. (2018). Chapter 4 - Phytase in animal feed. In: Nunes CS, Kumar V, editors. Enzymes in Human and Animal Nutrition, Academic Press 73–88.

Santoso, U.; Tanaka, K. and Ohtani, S. (1995). Effect of dried Bacillus subtilis culture on growth, body composition and hepatic lipogenic enzyme activity in female broiler chicken. Br. J Nutr. 74(4):523-529. doi: 10.1079/bjn19950155.

SAS Institute (2004): SAS, DSTAT users Guide. SAS Institute, Inc. Cary, NC. https://support.sas.com/en/software/sasstat-support.html.

Schramm, VG.; Durau, JF.; Barrilli, LNE.; Sorbara, JOB.; Cowieson, AJ.; Félix, AP. and Maiorka, A. (2017): Interaction between xylanase and phytase on the digestibility of corn and a corn/soy diet for broiler chickens. Poultry Science 96:1204–1211 http://dx.doi.org/10.3382/ps/pew356.

Song, HY.; El Sheikha, AF.; Hu, DM. (2019): The positive impacts of microbial phytase on its nutritional applications. Trends in Food Science and Technology 86, 553–62.

Sun, Y.; Zhang, Y.; Liu, M.; Lai, W.; Geng, S.; Yuan, T.; Liu, Y.; Di, Y.; Zhang, W. and Zhang, L. (2022): Effect of Bacillus amyloliquefaciens CECT 5940 supplementation on growth performance, antioxidant status, immunity and digestive enzymes activity on broiler fed corn-wheat-soybean meal diets. Poultry Science 101:(2) https://doi.org/10.1016/j.psj.2021.101585.

Vieco-Saiz, N.; Belguesmia, Y.; Raspoet, R., Auclair, E.; Gancel, F.; Kempf, I. and Drider, D. (2019): Benefits and inputs from lactic acid bacteria and their bacteriocins as alternatives to antibiotic growth promoters during food-animal production. Frontiers in Microbiology, 10, 57.

Wang, B.; Zhou, Y.; Tang, L.; Zeng, Z.; Gong, L.; Wu, Y. and Li, WF. (2021). Effects of *Bacillus amyloliquefaciens* Instead of Antibiotics on Growth Performance, Intestinal Health, and Intestinal Microbiota of Broilers. Front. Vet. Sci. Vol.8. doi: 10.3389/fvets.2021.679368.

Waqas, M.; Mehmood, S.; Mahmud, A.; Saima, HJ.; Ahmad, S.; Tahir, KA.; Abdel-Rehman, MW. and Shaheen, MS. (2019). Effect of yeast based mannan oligosaccharide (Actigen™) supplementation on growth, carcass characteristics and physiological response in broiler chickens. Indian J. Anim. Res., 53(11): 1475-1479. https://doi.org/10.18805/ijar.B-923.

Yaqoob, MY.; Geng, W. and Minqi, W. (2022). An updated review on probiotics as an alternative of antibiotics in poultry — A review. Anim. Biosci. 35:1109-1120. https://doi.org/10.5713/ab.21.0485.

Zia, UR.; Chand, N. and Khan, RU. (2017). The effect of vitamin E, L-carnitine and ginger on production traits, immune response and antioxidant status in two broiler strains exposed to chronic heat stress. Environ. Sci. Poll. Res., 24: 26851-26857. https://doi.org/10.1007/s11356-017-0304-8.

تأثير إضافة البروبيوتك والإنزيمات فى العليقة على أداء كتاكيت التسمين

ممدوح عمر عبد السميع ، أحمد محمد عبد الخالق ، رجب رزق الشرقاوى ، هانى محمد رمضان الشريف

Email: drragab.info@gmail.com Assiut University web-site: www.aun.edu.eg

أجريت هذه التجربة لدراسة تأثير إضافة البروبيوتك و إنزيم الفيتيز والزيلانيز فى العليقة على معدل أداء كتاكيت التسمين. تم إجراء التجربة على ٢١٠ كتكوت أربور إيكرز أبيض عمر يوم مسكنة فى بطاريات فى عنبر شبه مغلق تحت نفس ظروف الرعاية. تم تقسيم الكتاكيت إلى ٧ معاملات لكل منها ٣٠ كتكوت مقسمة على ٣ مكررات (١٠ كتاكيت / مكرر) واستمرت التجربة حتى عمر ٣٥ يوم. وكان توزيع المجموعات التجريبية كالتالى: المعاملة الأولى هى الكنترول مغذاة على عليقة بدون بروبيوتك أو إنزيمات، المعاملة الثانية تغذت على عليقة الكنترول + ١٠٠ جرام بروبيوتك / طن علف، المعاملة الثالثة تغذت على عليقة الكنترول + ١٠٠ جرام فيتيز/ طن علف ، المعاملة الرابعة تغذت على عليقة الكنترول + ١٠٠ جرام زيلانيز/ طن علف ، المعاملة الخامسة تغذت على عليقة الكنترول + ١٠٠ جرام فيتيز + ١٠٠ جرام زيلانيز/ طن علف ، المعاملة السادسة تغذت على عليقة الكنترول + ١٠٠ جرام بروبيوتك + ١٠٠ جرام زيلانيز/ طن علف ، المعاملة السابعة تغذت على عليقة الكنترول + ١٠٠ جرام بروبيوتك + ١٠٠ جرام فيتيز/ طن علف على التوالى. أوضحت النتائج أنه لا يوجد فروق معنوية بين المعاملات التجريبية على معدلات أداء الطيور فيما عدا مجموع الأحشاء المأكولة (الكبد، القلب، القونصة والطحال)، حققت الطيور بالمعاملة الخامسة المغذاة على عليقة الكنترول + ١٠٠ جرام فيتيز + ١٠٠ جرام زيلانيز/ طن علف زيادة معنوية فى وزن الجسم بمعدل ٥,١٥٪ مقارنة بالكنترول. كما تأثرت نسبة الأعضاء الليمفاوية (البرسا والطحال) معنوياً بين المعاملات. كما حققت كل من الطيور المغذاة على ١٠٠ جرام بروبيوتك / طن علف و المغذاة على عليقة الكنترول + ١٠٠ جرام بروبيوتك + ١٠٠ جرام زيلانيز/ طن علف أفضل طول للخملات بالمقارنة بالكنترول. مما سبق يمكن استنتاج أن إضافة ١٠٠ جرام فيتيز (٥٠٠ وحدة إنزيم / كجم علف) + ١٠٠ جرام زيلانيز (١٦٠٠ وحدة إنزيم / كجم علف) / طن علف، أو ١٠٠ جرام بروبيوتك + ١٠٠ جرام زيلانيز/ طن علف لها تأثير إيجابى على معدل الأداء الإنتاجى والتركيب التشريحى للأمعاء وخصائص الذبيحة لكتاكيت التسمين.

الكلمات المفتاحية: زيلانيز , فيتيز , بروبيوتك , أداء كتاكيت التسمين.