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INFLUENCE OF DIETARY POLYZYME IN LOW CRUDE PROTEIN DIET ON THE PERFORMANCE OF WHITE MOLAR DUCKS

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ABSTRACT: The present experiment was conducted to investigate the effect of Polyzyme supplementation in low crude protein diets on Molar ducks on growth performance, carcass traits, some blood serum parameters, some histomorphological measurements, economic efficiency and European efficiency index. Two hundred and forty, un-sexed one day old White Molar duck chicks were used and assigned to eight groups nearly similar in average body weight, (3 replicates of 10 birds each). Polyzyme was added at the levels (0, 1, 2 and 3g/ Kg diet) to the low crude protein content that was used as a negative control (18 and 16 % CP) and the diet with normal content of crude protein, which was used as the positive control (20 and 18% CP) treatment during the periods of starter (1-21 days) and finishing (22-70 days), respectively. Results indicated that, ducks fed negative control + 3g Polyzyme/ Kg diet having the significantly higher body weight compared to the control groups. Birds fed the negative control diet with different levels of polyzyme had significantly ($P \leq 0.05$) consumed more feed than the negative control diet without supplementation at 10 weeks of age. Feed conversion ratio (FCR) and performance index (PI) were improved in birds fed negative control diet with 3g Polyzyme/ Kg diet, (T_4). Addition of graded levels of Polyzyme to Molar diets was significantly affecting some carcass traits and increased both serum glucose and AST activity, cholesterol, triglycerides and total lipids compared to the negative control group but significantly reduced serum createnine. Morphological sections of Molar small intestine revealed that villi height, width and villi height : villi width are significantly increased with the Polyzyme supplementation levels up to the level of 3 g/ kg diet and tend to decrease after that, but still better than the negative control group. In general, and through the results obtained from feeding White Molar duck chicks from one day to 10 weeks of age on low crude protien diets (18 and 16%) with addition of different levels of commercial Polyzyme mixture (1, 2 and 3g/ Kg diet) improved growth performance due to increased activity of the small intestine and rate of nutrient absorption. The european efficiency ratio and performance index were improved when adding 3g Polyzyme/ Kg diet (4^{th} treatment), while the economic efficiency and relative economic efficiency were better (1.56 and 110.64, respectively) in the 2^{nd} treatment which chicks fed low crude protein diet +1g Polyzyme compared to the other trearments.

Keywords: *Multi – enzyme, performance, carcass trairs, some blood parameters, intestinal morphology and ducks*

INTRODUCTION

Protein in modern poultry production practice is predominantly sourced from soybean meal (SBM), which is high in protein with well-balanced amino acids (AA) coupled with high digestibility (Ndazigaruye *et al*., 2019). This meal represented about approximately 80% of the protein and amino acid requirements of all types of poultry in all life stages. Poultry needs a specific quantity and balance of essential amino acids (EAA) and nitrogen (for synthesis of non-essential amino acids, NEAA) rather than crude protein (NRC, 1994). Chickens fed the standard levels of dietary protein can synthesize NEAA from excess EAA. However, when low-protien (LP) diets are used, less EAA is available for NEAA synthesis. Therefore, reducing dietary crude protein without deleterious effects on broiler performance is a great challenge for broier nutrientitionist. Not only reduced protein regimes diet in poultry nutrition is considered an alternative application to reduce feeding cost, but also to reduce the environmental pollution (Kobayashi *et al*., 2013). Generally, feeding low crude protein (Low-CP) diet increases the fat content, while, reducing the energy density

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decreased the fat content and protein increases deposition in the carcass (Zhan *et al*., 2007). Feed utilization can be met with inclusion of enzymes, antimicrobial, probiotics, prebiotic or natural products (Al-khalifah, 2018).

Exogenous enzyme blends containing various combinations of amylase, protease, xylanase, glucanase, cellulase, mannanase, pectinase and phytase have been assessed in chickens diets which contain high levels of soluble non-starch polysaccharides (NSP), low protein level and found to improve nutrients digestibility and bird growth (Law *et al*., 2019 and Giacobbo *et al*., 2021). Therefore, exogenous proteases enzyme have been introduced into livestock feed to improve its nutritive value (Cowieson and Roos, 2016), use of single protease is still under investigation for wide spread application. Several enzymes are commercially available and their use has significantly increased in corn-SBM based diets to improve growth performance of broiler chickens through improved protein and amino acid digestibility (Selim *et al*., 2016 and Ndazigaruye *et al*., 2019). Dietary enzyme can facilitate the utilization of protein that are other wise unavailable to the animal, especially when feed ingredients are of low quality and /or have low bioavailability (Kocher *et al*., 2002).

It has been reported that dietary enzyme enhances weight gain and feed efficiency by improving amino acid content and energy utilization and reducing proteolytic fermentation, bacterial toxins and the amount of nutrients executed in feces, thereby reducing potential environmental pollutants (Mahmood *et al*., 2017). Therefore, this study was aimed to evaluate the effect of adding Polyzyme (multi-enzyme) to low crude protein diets to reduce feeding cost and to improve duck performance, carcass traits, some blood components and histological intestine parameters and economical efficiency.

MATERIALS AND METHODS

The present study was conducted at a private farm in Sadat City, Menoufia Governorate, Egypt, throughout the experimental period from July to September 2018. Two hundred and forty, unsexed one day old White Molar duck chicks (obtained from Mesangere Company for ducks), were used in this study, grown over 70 days. Ducks were individually wing-banded, weighed and randomly assigned to eight groups nearly similar in average body weight, (3 replicates of 10 birds each), kept in a separate pen, reared under similar management and hygienic conditions. Feed and water were provided *ad-libitum* during the experimental period (70 days). Artificial light and day lights were used to provide 24 hour photo period. Polyzyme* was added at the levels (0, 1, 2 and 3g/ Kg diets) to the low crude protein content that was used as negative control (18 and 16 % CP) and with the normal content of crude protein, which was used as the positive control (20 and 18% CP) during the periods of starter (1-21 days) and finisher (22-70 days), respectively (Table l). Birds received their diets to save the nutrient requirements according to the NRC (1994) recommendations.

Body weight (BW), body weight gain (BWG), feed intake (FI) and mortality were weekly recorded. Feed conversion ratio (FCR, g feed /g gain) was calculated every week during the experimental period. Performance index (PI) was calculated according to North (1981), where: PI = live body weight, kg × 100/ feed conversion ratio. European efficiency index (EEI) was calculated also as cited by Soltan and Kusainova (2012), where: EEI = (Mean BW, kg × Livability, %) / (Marketing age, days × FCR) × 100.

*Xylanase 2000000U; Protease 375000U; Lipase 25000U; Pectanase 120000U; Mannase 100000U; Amylase 750000U; Cellulase 200000U; Phytase 25000U; ß Glucanase 200000U and Galctocidasse 200000U/ 0.5 Kg polyzyme.

Table 1: Composition and calculated analysis of the experimental diets fed during starting (1 - 21) and finishing periods (22 - 70) days of age.

Ingredients	Negative control diets		Positive control diets	
	Starter	Finisher	Starter	Finisher
Yellow corn, 8.5%.	68.19	71.07	61.50	68.19
Soybean meal, 44%.	27.75	21.85	33.49	27.75
Vegetable oil.	-	-	1.05	-
Wheat bran, 12%.	-	3.00	-	-
Mono - Calcium phosphate.	1.60	1.60	1.55	1.60
Limestone, ground.	1.70	1.70	1.68	1.70
Vitamins and minerals mixture[1].	0.30	0.30	0.30	0.30
Salt (Sodium chloride).	0.30	0.30	0.30	0.30
DL- Methionine[2].	0.16	0.18	0.13	0.16
Total	100	100	100	100
Calculated analysis (air dry basis)[3]:				
Crude protein, %.	18.01	16.01	19.96	18.01
ME, k cal/ kg diet.	2906	2908	2902	2906
C/ P ratio.	161	182	145	161
Calcium, %.	0.99	0.99	0.99	0.99
Available phosphorous, %.	0.47	0.47	0.47	0.47

[1]Vitamins and minerals mixture at 0.30 % of the diet supplies the following/ kg of the diet: Vit. A, 12000 IU; Vit. D_3, 2500 IU; Vit. E, 10 mg; Vit. K_3, 3 mg; Vit B_1, 1 mg; Vit. B_2, 4 mg; Pantothenic acid, 10 mg ;Nicotinic acid, 20 mg; Folic acid, 1 mg; Biotin, 0.05 mg; Niacin, 40 mg; Vit.B_6, 3 mg; Vit B_{12}, 0.02 mg; Choline chloride, 400 mg; Mn, 62 mg; Fe, 44 mg; Zn, 56 mg; I, 1 mg; Cu, 5 mg and Se, 0.01 mg.

[2]DL – Methionine: 98% feed grade (98 % Methionine).

[3]Calculated according to NRC (1994).

At the end of the experiment (10 weeks of age), 6 birds from each treatment around the average live body weight were randomly chosen, fasted for about 12 hours, weighed and slaughtered to complete bleeding, followed by plucking the feathers. Carcass without giblets and some giblets (liver, heart and gizzard) weights were calculated relative to pre-slaughter weight. Dressing percentage was calculated as following: Dressing % = Empty carcass weight / pre–slaughter weight × 100.

Individual blood samples from the same slaughtered birds for each dietary treatment were collected into tubes without heparin and serum was separated by centrifugation at 3000 rpm for 15 minutes and frozen at -20 ◦C until analysis. Serum total protein, tri-glyceride, lipids, cholesterol, createnine, glucose and albumin were determined using commercial kits. Also, liver enzymes including aspartate transaminase (AST) and alanine transaminase (ALT) were colorimetrically estimated.

The small intestines of chicks were removed immediately, after slaughtering and segments of approximately 2 cm were taken from duodenum, jejunum and ileum at 70 days of age for histological analysis. Segments referred to the midpoint of the duodenum (from gizzard to pancreo-biliary duct, duodenum), jejunum (the midpoint between the entry of the common bile duct and the Meckel's diverticulum), and ileum (from Meckel's diverticulum to ileocecal junction) were gently flushed and rinsed with 0.9% physiological saline and then fixed in a 4% neutral-buffered formalin solution for histological study. Intestinal samples were transferred from formaldehyde after dehydration by passing tissue through a series of alcohol solutions, cleared by xylene and were embedded in paraffin. All samples were sectioned at 5-µm thickness using a rotary microtome. Sections were sequentially transferred to glass slides and stained with Hematoxylin and Eosin (H and E). After being dried, sections were analyzed under a light 37 microscope. Morphometric measurements were performed on 9 villi chosen from each sample. The height of intestinal villi was measured from the tip to the base of villi at the opening crypt, and the villus width was measured at its midpoint (Geyra et al., 2001).

The economic efficiency of the experimental diets used in the present study was calculated from the input – output analysis (Heady and Jensen, 1954), assuming that the other head costs were constant.

Data were statistically analyzed by the completely randomized design using SPSS, (2011) program and the differences among means were determined using Duncan's multiple range test (Duncan, 1955). Percentages were transformed to the corresponding arcsine values before performing statistical analysis (Snedecor and Cochran, 1982). The model applied was: $Yij = \mu + \alpha i + Eij$, where: Yij= an observation,
μ = Overall mean, αi= effect of treatment (I = 1, 2, 3, 4…8), and Eij = Experimental random error.

RESULTS AND DISCUSSION

Body weight and daily body weight gain:

Effect of dietary different levels of multi-enzyme supplementation in negative and positive diets on body weight and average daily gain of White Molar ducks at 3 and 10 weeks of age are shown in Table (2). The results showed that chicks fed low crude protein, without multi enzyme (T1) had significantly lower ($P \leq 0.05$) BW (879.8 g), and ADG (39.62g) compared to the positive control group without multi-enzyme, (T5); (1042.57 and 47.37g), respectively at 3 weeks of age.

In general, dietary multi-enzyme significantly increased ($P \leq 0.05$) body weight and daily gain in White Molar ducks at 3 week of age. Ducks fed negative control supplemented with 3g multi-enzyme/ Kg diet (T4) having the significantly higher body weight (1034.17g), followed by those fed 2g and 1g multi-enzyme/ Kg diet (1010.53 and 972.53g, respectively) compared to 1015.60, 999.17 and 1001.23g in chicks fed the positive control diet with 1g, 2g and 3g multi-enzymes/ Kg diet (T6, T7 and T8), respectively. Also, data of daily gain was significantly ($P \leq 0.05$) increased in negative control group + 3g multi-enzyme/ Kg diet (T4, 46.98 g) compared to 45.40 g in the 8th group at 3 weeks of age.

Table 2: Body weight and body weight gain (g) of White Molar ducks fed low and normal crude protein diets supplemented with different levels of Polyzyme at 3 and 10 weeks of age (Means ± S. E).

Dietary treatments[1]	Body weight, g.		Body weight gain, d/g.	
	3 weeks	10 weeks	0-3 weeks	0-10 weeks
T_1 (Negative control)	$879.8^d \pm 9.58$	$3546.47^d \pm 37.46$	$39.62^c \pm 0.46$	$49.98^{2,3d} \pm 0.53$
T_2	$972.53^c \pm 11.84$	$4079.13^c \pm 34.35$	$44.04^c \pm 0.56$	$57.59^{bc} \pm 0.49$
T_3	$1010.53^b \pm 10.88$	$4181.17^{ab} \pm 28.17$	$45.85^{ab} \pm 0.52$	$59.05^b \pm 0.40$
T_4	$1034.17^a \pm 13.58$	$4312.37^a \pm 37.22$	$46.98^a \pm 0.65$	$60.92^a \pm 0.53$
T_5 (Positive control)	$1042.57^a \pm 9.57$	$4191.37^{ab} \pm 30.01$	$47.37^a \pm 0.45$	$59.19^b \pm 0.96$
T_6	$1015.60^b \pm 13.16$	$4163.90^b \pm 35.69$	$46.07^{ab} \pm 0.63$	$58.80^b \pm 50.77$
T_7	$999.17^b \pm 11.91$	$4047.87^c \pm 46.46$	$45.31^b \pm 0.57$	$57.15^{bc} \pm 0.66$
T_8	$1001.23^b \pm 12.64$	$4015.10^c \pm 35.80$	$45.40^b \pm 0.60$	$56.68^c \pm 0.51$
Sig.	*	*	*	*

[1] T_1: Negative control diet, T_2: Negative control + 1g Polyzyme / kg diet, T_3: Negative control + 2g Polyzyme / kg diet, T_4: Negative control + 3g Polyzyme / kg diet, T_5: Positive control diet, T_6: Positive control + 1g Polyzyme / kg diet, T_7: Positive control + 2g Polyzyme / kg diet, T_8: Positive control + 3g Polyzyme / kg diet.
[2] means ± S.E. of 3 replicates/ treatment.
[3] a,b,c………etc: Means within the same column with different superscripts are significantly different ($P \leq 0.05$).

On the marketing age (10th weeks), ducks fed the negative control diets supplemented with 3g multi-enzyme, (T4) had significantly the highest BW and ADG (4312.37 and 60.92 g) followed by chicks fed T3 diet and those fed positive control diet, (T5 and T6 groups), BW values of T3, T5 and T6 were 4181.17, 4191.37 and 4163.90 g and ADG values being 59.05, 59.19 and 58.80 g, respectively compared to those fed the negative control group, T1 (3546.47 and 49.98 g) which recorded the worest performance. These results are in agreement with the finding of Bedford and Morgan (1996) who showed that enzyme addition improves the performance of poultry through reducing the viscosity of intestinal content so, improving the nutritive value of the diet. This is congruent with previous findings (Ndazigarye et al., 2019 and Teymouri and Hasssanabdi, 2021).

Also, Metwally *et al.* (2020) mentioned that addition of multi-enzyme in wheat and barley based diets had significantly ($P \leq 0.05$) increased BWG compared to the control group. Al-harthi *et al.* (2020) found that phytase supplementation improved BWG in broiler chickens which enhanced broiler body weight gain performance. Supplementation with multi-enzyme tended to improve the nutritive value of corn-soybean diet in broiler chicks (Shirmohammad and Mehri, 2011). On the other hand Castro *et al.* (2019) and law *et al*. (2019) observed that the effect of xylanase in diets based on corn and soybean meals (1ow viscosity) did not improved BWG for turkeys (Jamroz *et al.*, 1998).

Feed intake and feed conversion ratio:

Results of daily feed intake (FI) and FCR of White Molar ducks fed low crude protein diets with different levels of multi-enzyme (1, 2 and 3 g / Kg diets) during 0 – 3 and 0 - 10 weeks are summarized in Table (3). Ducks fed the negative control without multi-enzyme supplement (T_1) had significantly decreased feed intake 78.12 and 148.80 g compared to the positive control groups (T_5), being; 86.39 and 158.85 g during 0 -3 and 0 -10 week of age, respectively. There were significant effects on feed intake due to feeding low crude protein diet supplemented with multi-enzyme (groups T_2, T_3 and T_4). During the first 3 weeks (starting period), there were no significant differences between groups fed low crude protein diet supplemented with different levels of Polyzyme (1, 2 and 3g/ Kg diet) and the positive control without supplementation, being 85.57, 87.12, 88.29 and 86.39 g feed / chick/ day. The same trend was noticed between chicks fed the positive control diet supplemented with 1, 2 or 3g Polyzyme (90.34, 91.80 and 91.92g feed/ chick/ day) which recorded the highest values, while, the lowest value was recorded in chicks fed the negative control diet (78.12g feed/ chick/ day). During the period (0 - 10 weeks), there were no significant differences between chicks fed low crude protein diet supplemented with 2 and 3g multi-enzyme. Negative control group supplemented with 2 and 3 g Polyzyme / Kg diet recorded FI the highest values (162.11 and 160.42g/ chick/ d.), respectively during 0 - 10 weeks of age. In overall period (0 - 10 weeks), multi-enzyme supplementation significantly increased feed intake especially in low crude protein diet.

Feed conversion ratio (FCR) was significantly improved by the supplementation. Data revealed that FCR was significantly improved by the supplementation during the experimental period (0-10 weeks of age). At the first period (0 - 3 weeks), there were no significant differences between chicks fed the negative control diet without or with multi-enzyme supplemented diet and chicks fed the positive control diet + 1g Polyzyme/ Kg diet (1.98, 1.95, 1.91. 1.89 and 1.97, respectively). Ducks fed low protein with 3 g multi-enzyme/ Kg diet (T_4) showed better FCR (2.64) compared to the other levels of multi-enzyme groups, whereas the negative control group showed the worst FCR (2.99, T_1) compared to the other treatments in all period (0 - 10 weeks of age).

The comparatively more feed intake on enzyme supplementation are supported by Alam *et al*. (2003) who reported increased feed intake on diet with exogenous enzymes for broilers. Since use of enzyme, decreases mean retention time of digesta in the gizzard and large intestine and increases gut motility. Digesta viscosity and microbial fermentation decrease nutrient digestibility and the rate of absorption are increased so that more feed can be consumed. The feed conversion ratio was unallered due to low energy, protein diet and also enzyme supplementation (Dongare *et al.,* 2017). The results of the present study substantiated the findings of Lazaro *et al.* (2003) and Goli and Shahryar (2015) who reported that fungal enzyme preparation significantly improved the weight gain and feed conversion ratio of birds fed corn, rye, wheat and barley based diets. Responses to enzyme supplementation depend on the bird's age, which is apparently related to both the type of gut microflora present and the physiology of the bird. In old birds, due to enhanced fermentation capacity of the microflora, their intestine have a greater capacity to deal with the effects of high viscosity (Vukic-vranjes and Wenk, 1995).

Performance index, (PI %) and European efficiency index (EEI):

Experimental results in Table (4) showed the effect of dietary multi-enzyme supplementation to low crude protein diets of White Molar ducks on performance index (PI, %) and European efficiency index (EEI %) at 3 and 10 weeks of age. In all levels, results revealed that multi-enzyme supplementation by the level of 3g/ Kg low crude protein diet significantly increased performance index in all periods; (0 - 3, 52.79 %) and 162.33 % as an overall period 0 - 10 weeks of age in comparison with the negative control group which recorded the worst PI. Overall European efficiency index was improved by polyzyme supplementation, chicks fed low crude protein diet supplemented with 3g/ Kg diet was the highest (233.22 %) followed by those fed the positive control diet without supplementation (221.69%), while the worest value was noticed in chicks fed low crude protein diet without polyzyme (169.62%). In general, different levels of multi-enzyme supplementation to the positive control diet recorded the same PI and the significantly was noticed with the supplementation to the negative control diet which revealed that the polyzyme may improve the digestibility of nutrient. These finding are supported with that of Noy and Sklan, (1995) and Uni *et al.* (1995) who suggested that the inclusion of enzymes during the initial phase of the chickens may improve the digestibility of the nutrients and the performance of the bird.

Table 3: Feed intake and Feed conversion ratio of White Molar ducks fed low and normal crude protein diets supplemented with different levels of Polyzyme at 3 and 10 weeks of age (Means ± S. E).

Dietary treatments[1]	Feed intake (g / chick / day)		Feed conversion ratio (g gain/g feed)	
	0-3 weeks	0-10 weeks	0-3 weeks	0-10 weeks
T_1 (Negative control)	$78.12^{c} \pm 0.25$	$148.80^{c} \pm 0.19$	$1.98^{b} \pm 0.02$	$2.99^{2,3a} \pm 0.03$
T_2	$85.57^{b} \pm 0.05$	$154.76^{b} \pm 0.26$	$1.95^{b} \pm 0.03$	$2.69^{bc} \pm 0.02$
T_3	$87.12^{b} \pm 0.04$	$162.11^{a} \pm 0.18$	$1.91^{bc} \pm 0.02$	$2.75^{b} \pm 0.02$
T_4	$88.29^{b} \pm 0.07$	$160.42^{a} \pm 0.25$	$1.89^{c} \pm 0.03$	$2.64^{c} \pm 0.02$
T_5 (Positive control)	$86.39^{b} \pm 0.14$	$158.85^{ab} \pm 0.12$	$1.83^{c} \pm 0.02$	$2.70^{bc} \pm 0.04$
T_6	$90.34^{a} \pm 0.05$	$158.05^{ab} \pm 0.23$	$1.97^{b} \pm 0.03$	$2.70^{bc} \pm 0.03$
T_7	$91.80^{a} \pm 0.05$	$151.32^{cb} \pm 0.45$	$2.04^{a} \pm 0.03$	$2.66^{c} \pm 0.03$
T_8	$91.92^{a} \pm 0.01$	$152.47^{b} \pm 0.44$	$2.03^{a} \pm 0.03$	$2.70^{bc} \pm 0.02$
Sig.	*	*	*	*

[1]T_1: Negative control diet, T_2: Negative control + 1g Polyzyme / kg diet, T_3: Negative control + 2g Polyzyme / kg diet, T_4: Negative control + 3g Polyzyme / kg diet, T_5: Positive control diet, T_6: Positive control + 1g Polyzyme / kg diet, T_7: Positive control + 2g Polyzyme / kg diet, T_8: Positive control + 3g Polyzyme / kg diet.

[2] means ± S.E. of 3 replicates/ treatment.

[3]a,b,c………etc: Means within the same column with different superscripts are significantly different ($P \leq 0.05$).

Table 4: Effect of feeding White Morlar ducks on diets with low and normal crude protein content with different levels of Polyzyme on the performance index (%) at 3 and 10 weeks of age and the European efficiency index (%) at 10 weeks of age (Means ± S. E).

Dietary treatments[1]	Performance index		European efficiency index[4]
	3 weeks	10 weeks	10 weeks
$T_{1\ (Negative\ control)}$	$42.38^{d} \pm 0.99$	$117.89^{2,3c} \pm 2.46$	169.62
T_2	$47.85^{c} \pm 1.20$	$150.35^{b} \pm 2.54$	217.74
T_3	$50.87^{bc} \pm 1.17$	$150.78^{b} \pm 2.05$	217.14
T_4	$52.79^{ab} \pm 1.49$	$162.33^{a} \pm 2.87$	233.22
$T_{5\ (Positive\ control)}$	$54.71^{a} \pm 1.04$	$155.59^{ab} \pm 5.24$	221.69
T_6	$49.64^{bc} \pm 1.36$	$153.87^{ab} \pm 4.02$	220.11
T_7	$47.17^{c} \pm 1.18$	$151.64^{b} \pm 3.64$	217.51
T_8	$47.34^{c} \pm 1.28$	$147.72^{b} \pm 2.75$	212.70
Sig.	*	*	*

[1]T_1: Negative control diet, T_2: Negative control + 1g Polyzyme / kg diet, T_3: Negative control + 2g Polyzyme / kg diet, T_4: Negative control + 3g Polyzyme / kg diet,T_5: Positive control diet, T_6: Positive control + 1g Polyzyme / kg diet, T_7: Positive control + 2g Polyzyme / kg diet, T_8: Positive control + 3g Polyzyme / kg diet.
[2] means ± S.E. of 3 replicates/ treatment.
[3]a,b,c………etc: Means within the same column with different superscripts are significantly different ($P \leq 0.05$).
[4]European efficiency index, EEI = (Mean body weight, kg × livability, %)/ (marketing age, days × feed conversion ratio) × 100.

Carcass traits:

Results obtained in Table (5) showed the effect of Polyzyme supplementation on some carcass traits of White Molar ducks at 10 weeks of age. There were significant differences between all treatments on most observed carcass characteristics. Supplementation of 1, 2 and 3 g multi-enzyme/ Kg low crude protein diets (T_2, T_3 and T_4) significantly ($P \leq 0.05$) increased empty carcass weight (2910, 2990 and 3084 g) compared to the negative control (T_1, 2485 g). Chicks fed un-supplemented positive control had increased carcass weight being 3006g which recorded the highest dressing percentage (73.23%). Almost, dressing percentage was the same in all treatments fed low or normal crude protein diet supplemented with different levels of polyzyme except in chicks fed low crude protein diet without supplementation which recorded the lowest dressing percentages (71.86%). Supplementation of 3 g multi-enzyme to low protein diets (T_4) significantly ($P \leq 0.05$) increased all carcass traits and gibiets weight (g), which suggests that there was a positive response to increase calorie-protein ratio when multi-enzymes were supplemented and the improvement on most observed carcass traits were related with increased body size. Gizzard percentage was affected by the addition of polyzyme supplementation to the low crude protein diets but without significance. It’s clear that inadequate CP consequently amino acid negatively influence the broiler carcass composition (dressing and giblets percentage) in comparison with the control and the negative control diet supplemented with exogenous enzymes (T_2, T_3 and T_4). In general, it was noted that enzyme supplementation increased carcass yield Wang *et al.* (2005) and Goli and Shahryar (2015) in broiler chicks. Gitoee *et al.* (2015) showed that birds fed diets supplemented with 500 mg Avizyme 1502, (combination of xylanase, α-amylase and protease)/ Kg had a significantly ($P \leq 0.05$) higher giblets weight and some carcass traits at 42 and 49 days. In contrast, our results are opposite to the results of Saleh *et al.* (2004), Zakaria *et al.* (2010) and Castro *et al.* (2019) who noted that alpha-amylase supplementation did not influence carcass parameters. The same trend was noticed by Café *et al.* (2002) who reported that addition of commercial multi-enzymes to corn-soybean meal-based diets did not improve dressing percentage.

Table 5: Carcass traits of White Molar ducks fed low and normal crude protein diets supplemented with different levels of Polyzyme at 10 weeks of age (Means ± S. E).

Treatments[1]	Carcass traits						
	Pre-slaughter weight, g	Empty Carcass weight, g[4]	Dressing %[5]	Giblets weight, g	Heart[6] %	Gizzard[6] %	Liver[6] %
$T_{1\ (Negative\ control)}$	$3458^{c} \pm 6.67$	$2485^{c} \pm 8.33$	$71.86^{c} \pm 0.08$	$204.18^{d} \pm 9.61$	$0.95^{a} \pm 0.04$	2.03 ± 0.18	$2.92^{2,3a} \pm 0.08$
T_2	$3997^{a} \pm 31.43$	$2910^{ab} \pm 24.47$	$72.80^{ab} \pm 0.24$	$256.66^{ab} \pm 4.10$	$1.18^{a} \pm 0.04$	1.98 ± 0.02	$3.25^{a} \pm 0.09$
T_3	$4089^{a} \pm 30.66$	$2990^{a} \pm 49.41$	$73.12^{ab} \pm 0.45$	$247.67^{b} \pm 3.18$	$1.06^{a} \pm 0.05$	1.98 ± 0.05	$3.02^{b} \pm 0.05$
T_4	$4228^{a} \pm 14.35$	$3084^{ab} \pm 50.60$	$72.94^{b} \pm 1.48$	$269.33^{a} \pm 6.36$	$1.25^{a} \pm 0.02$	1.89 ± 0.03	$3.23^{a} \pm 0.05$
$T_{5\ (Positive\ control)}$	$4105^{ab} \pm 28.90$	$3006^{ab} \pm 44.09$	$73.23^{a} \pm 0.46$	$225.33^{c} \pm 7.42$	$0.91^{b} \pm 0.05$	1.82 ± 0.09	$2.76^{c} \pm 0.11$
T_6	$4079^{b} \pm 20.67$	$2963^{b} \pm 50.11$	$72.64^{b} \pm 0.28$	$242.00^{b} \pm 5.29$	$1.01^{a} \pm 0.02$	1.96 ± 0.05	$2.94^{a} \pm 0.07$
T_7	$3961^{a} \pm 48.88$	$2873^{ab} \pm 57.74$	$72.53^{ab} \pm 0.79$	$233.58^{bc} \pm 4.33$	$1.01^{b} \pm 0.03$	1.90 ± 0.05	$2.98^{c} \pm 0.005$
T_8	$3932^{a} \pm 52.68$	$2829^{ab} \pm 28.30$	$71.95^{b} \pm 1.00$	$245.25^{b} \pm 10.10$	$1.12^{a} \pm 0.06$	1.98 ± 0.09	$3.13^{b} \pm 0.09$
Sig	*	*	*	*	*	NS	*

[1] T_1: Negative control diet, T_2: Negative control + 1g Polyzyme/ kg diet, T_3: Negative control + 2g Polyzyme / kg diet, T_4: Negative control + 3g Polyzyme / kg diet, T_5: Positive control diet, T_6: Positive control + 1g Polyzyme / kg diet, T_7: Positive control + 2g Polyzyme / kg diet, T_8: Positive control + 3g Polyzyme / kg diet.
[2] means ± S.E. of 3 replicates/ treatment.
[3] a,b,c……..etc: Means within the same column with different superscripts are significantly different ($P \leq 0.05$).
[4] empty carcass weight (g) without giblets. 5dressing (%) was calculated relative to pre-slaughter weight. 6Giblets were calculated relative to pre- slaughter weight.

Serum blood parameters:

Data on some serum biochemical parameters of White Molar ducks are shown in Table (6). It's clearly that all groups fed diets supplemented with polyzyme had significantly varied effects on some blood biochemical parameters. Chicks fed low crude protein diet supplemented with 2 and 3 g Polyzyme/ Kg diet had significantly increased total protein and it may be equal to its value in the positive control group (T_5); being 3, 2.85 and 3.06g / dl, respectively. Albumen and createnine had significantly varied effects by the supplementation but almost were reduced with the addition of polyzyme, while an opposite trend was observed in blood glucose and total lipids. Enzymes supplementation to the positive control group (T_7) had significantly ($P \leq 0.05$) reduced blood total lipids, cholesterol and tri-glyceides being (391.00, 125.67 and 105.33 mg / dl) in comparison with the negative control (T_1, 442.06, 142.17 and 118.30 mg/ dl, respectively and positive control, T_5 (450.90, 155.00 and 129.67 mg/ dI) at 10 weeks of age. While, ALT concentrations was not significantly affected compared to chicks fed diets without multi-enzymes supplementation. These results are in agreement with Abdel-Hafeez *et al.* (2017) who reported that dietary enzyme supplementation significantly decreased total cholesterol concentration of blood broiler chicks. Hajati *et al*. (2009) reported that enzyme inclusion increased the concentration of blood total cholesterol at 10, 28 and 42 d of age, ($P \leq 0.05$) of broiler chicks.

Intestinal morphological parameters:

Means of different morphological sections of Molar ducks small intestine are presented in Table (7) and illustrated in Figures (1-8). The highest villi height in duodenum were observed in groups fed the positive control diet without polyzyme (T_5, 1779µm) and in chicks fed the negative control diet supplemented with 3g polyzyme, (T_4) being 1726 µm. The same trend was noticed in jejunum and ileum height (Caspary, 1992). The best ileum villi height: width ratio was noticed in chicks fed the positive control diet without polyzyme (T_5, 17.95 µm) in comparison with the other supplemented and un-supplemented group. It's understood that greater villus height is an indicator that the function of intestinal villi is activated (Yasar and Forbes, 2000 and Shamoto and Yamanchi, 2000).

Increasing the villus height suggests an increased surface area capable of greater absorption of available nutrients by the enzyme supplementation. These results are in a harmony with the results of Puangkhum *et al.* (2019) who showed that multi-enzyme supplementation had higher small intestinal morphology (villus height, crypt depth and villus height/ crypt depth ratio) of ducks at 45 days of age. Sharifi *et al.* (2013) showed that Natuzyme-supplemented diets consuming wheat or wheat and canola meal led to significant increase of villi height and the ratio between villus heights: crypt depth in the small intestine.

Economic efficiency:

Data pertaining to dietary low crude protein with or without Polyzyme of different levels supplementation on economical and relative economic efficiency are presented in Table (8). In comparison with the positive control, T_5 (100%), the supplementation of Polyzyme improved economical and relative economic efficiency (T_2); 110.64 negative control with 1g multi-enzyme/ Kg diets. While the lowest of economical and relative economic efficiency being (1.25 and 88.65) in the negative control (T_1) though our inputs and outcomes for 10 weeks White Molar ducks.This results harmony with Selim *et al*. (2016) and Behera *et al*. (2016) noted that addition of enzyme to low protein reduced the feeding GST/ Kg of live body weight.

Table 6: Serum blood parameters of White Molar ducks fed low and normal crude protein diets supplemented with different levels of Polyzyme at 10 weeks of age (Means ± S. E).

Treatments[1]	Total Protein	Albumen	Createnine	Cholesterol	Glucose	Tri glycerides	Total lipids	AST	ALT
	---------------- g/dl----------		---------------- mg/dl ---------		---------------- mg/dl ---------			---------------- U/L ---------------	
T_1 (Negative control)	$2.62^{b} \pm 0.22$	$1.87^{a} \pm 0.01$	$0.36^{a} \pm 0.11$	$142.17^{bc} \pm 3.77$	$6.10^{d} \pm 0.61$	$118.30^{ab} \pm 4.94$	$442.06^{bc} \pm 3.32$	$40.21^{2,3,b} \pm 2.20$	26.58 ± 0.91
T_2	$2.50^{bc} \pm 0.06$	$1.50^{c} \pm 0.05$	$0.26^{b} \pm 0.0802$	$153.80^{abc} \pm 1.58$	$7.15^{b} \pm 0.91$	$120.83^{ab} \pm 1.01$	$460.99^{bc} \pm 7.81$	$39.95^{b} \pm 7.10$	27.95 ± 3.22
T_3	$3.00^{a} \pm 0.11$	$1.66^{bc} \pm 0.02$	$0.26^{b} \pm 0.02$	$180.53^{a} \pm 3.29$	$8.54^{a} \pm 0.22$	$146.00^{a} \pm 8.66$	$555.36^{a} \pm 16.09$	$55.07^{a} \pm 1.10$	26.87 ± 1.88
T_4	$2.85^{ab} \pm 0.03$	$1.82^{ab} \pm 0.03$	$0.35^{ab} \pm 0.06$	$168.07^{ab} \pm 16.45$	$7.28^{b} \pm 0.46$	$125.03^{ab} \pm 13.83$	$507.02^{ab} \pm 51.31$	$34.73^{c} \pm 0.59$	24.09 ± 1.02
T_5 (Positive control)	$3.06^{a} \pm 0.17$	$1.53^{bc} \pm 0.21$	$0.29^{b} \pm 0.07$	$155.00^{abc} \pm 20.78$	$6.70^{c} \pm 0.10$	$129.67^{ab} \pm 17.61$	$450.90^{bc} \pm 0.93$	$39.18^{c} \pm 4.54$	27.42 ± 2.55
T_6	$2.69^{b} \pm 0.28$	$1.80^{ab} \pm 0.07$	$0.39^{a} \pm 0.06$	$144.33^{bc} \pm 3.76$	$6.77^{c} \pm 0.12$	$117.07^{ab} \pm 0.64$	$445.82^{bc} \pm 7.88$	$43.20^{b} \pm 0.92$	24.43 ± 2.19
T_7	$2.43^{c} \pm 0.10$	$1.50^{c} \pm 0.02$	$0.23^{b} \pm 0.03$	$125.67^{c} \pm 4.91$	$8.00^{a} \pm 0.51$	$105.33^{b} \pm 2.03$	$391.00^{c} \pm 9.12$	$33.29^{c} \pm 0.15$	25.44 ± 1.89
T_8	$2.97^{a} \pm 0.20$	$1.59^{bc} \pm 0.12$	$0.27^{b} \pm 0.02$	$140.00^{bc} \pm 2.31$	$9.78^{a} \pm 0.24$	$116.00^{ab} \pm 0.58$	$434.95^{bc} \pm 6.11$	$36.83^{c} \pm 5.92$	26.47 ± 0.32
Sig	*	*	*	*	*	*	*	*	N.S

[1] T_1: Negative control diet, T_2: Negative control + 1g polyzyme/ kg diet, T_3: Negative control + 2g polyzyme/ kg diet, T_4: Negative control + 3g polyzyme/ kg diet, T_5: Positive control diet, T_6: Positive control + 1g polyzyme/ kg diet, T_7: Positive control + 2g polyzyme/ kg diet, T_8: Positive control + 3g polyzyme/ kg diet.
[2] means ± S.E. of 3 replicates/ treatment.
[3] a,b,c.........etc: Means within the same column with different superscripts are significantly different ($P \leq 0.05$).

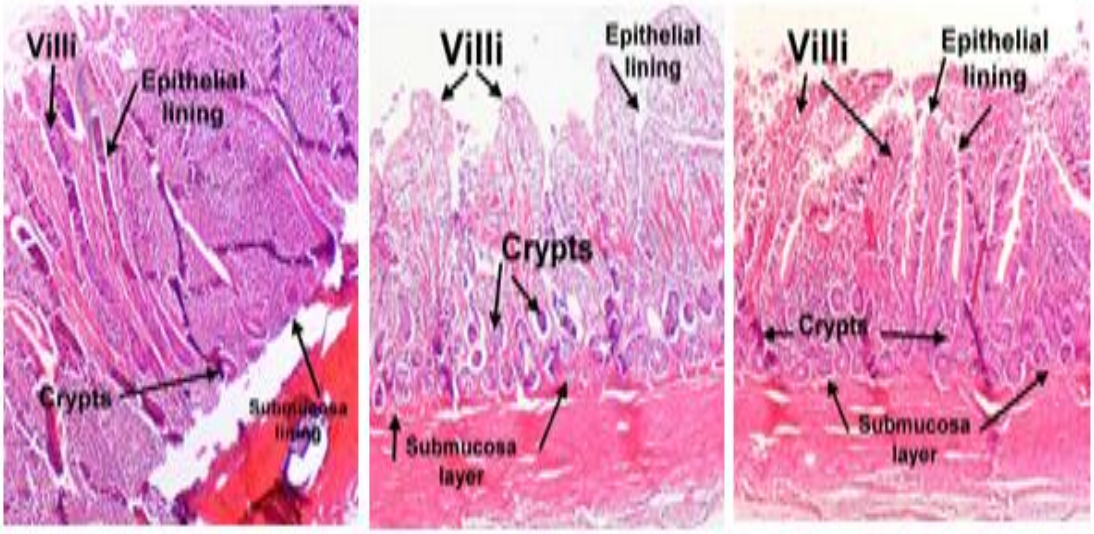
Table 7: Intestinal sections morphology of White Molar ducks fed low and normal crude protein diets supplemented with different levels of Polyzyme Means ± S. E).

Treatments[1]	Duodenum villi (µm)			Jejunum villi (µm)			Ileum villi (µm)		
	Height, H	Width, W	H/ W	Height	Width	H/ W	Height	Width	H/ W
$T_{1\ (Negative\ control)}$	$1383.00^{ab} \pm 11.97$	$45.00^{d} \pm 8.67$	$32.04^{a} \pm 3.69$	$1142.00^{bc} \pm 10.46$	$72.00^{c} \pm 11.51$	$17.20^{ab} \pm 4.37$	$1082.00^{ab} \pm 12.30$	$84.00^{b} \pm 2.03$	$12.95^{2,3b} \pm 1.78$
T_2	$1442.00^{ab} \pm 19.55$	$86.00^{b} \pm 11.49$	$17.36^{bc} \pm 2.16$	$1105.00^{bc} \pm 12.15$	$79.00^{c} \pm 7.08$	$14.14^{abc} \pm 1.12$	$926.00^{b} \pm 78.98$	$100.00^{b} \pm 6.40$	$9.19^{c} \pm 0.21$
T_3	$1324.00^{b} \pm 44.17$	$71.00^{c} \pm 7.79$	$18.64^{c} \pm 2.97$	$1222.00^{b} \pm 15.73$	$93.00^{b} \pm 8.75$	$13.13^{a} \pm 1.13$	$989.00^{b} \pm 38.55$	$95.00^{b} \pm 11.74$	$10.41^{c} \pm 1.37$
T_4	$1726.00^{a} \pm 25.63$	$137.00^{a} \pm 30.39$	$12.59^{ab} \pm 6.50$	$1386.00^{ab} \pm 60.52$	$78.00^{c} \pm 8.12$	$17.76^{abc} \pm 3.04$	$1114.00^{ab} \pm 48.84$	$132.00^{ab} \pm 24.68$	$8.43^{bc} \pm 0.88$
$T_{5\ (Positive\ control)}$	$1779.00^{a} \pm 18.03$	$94.00^{b} \pm 8.16$	$19.53^{b} \pm 3.65$	$1496^{a} \pm 63.69$	$81.00^{bc} \pm 1.79$	$18.42^{a} \pm 1.38$	$1437.00^{a} \pm 47.45$	$80.00^{b} \pm 1.70$	$17.95^{a} \pm 0.22$
T_6	$1396.00^{ab} \pm 25.86$	$76.00^{c} \pm 9.24$	$18.94^{bc} \pm 2.39$	$933.00^{c} \pm 69.14$	$149.00^{a} \pm 24.63$	$6.83^{c} \pm 1.67$	$799.00^{c} \pm 43.44$	$187.00^{a} \pm 70.40$	$4.64^{d} \pm 0.84$
T_7	$1322.00^{b} \pm 50.01$	$126.00^{a} \pm 3.22$	$10.56^{c} \pm 1.66$	$1191.00^{b} \pm 12.01$	$104.00^{ab} \pm 1.99$	$11.42^{abc} \pm 0.94$	$875.00^{bc} \pm 53.90$	$172.00^{a} \pm 30.32$	$5.09^{d} \pm 0.33$
T_8	$1575^{ab} \pm 87.92$	$83.00^{b} \pm 4.41$	$19.22^{bc} \pm 2.10$	$1137.00^{bc} \pm 7.45$	$119.00^{ab} \pm 21.23$	$10.31^{bc} \pm 2.17$	$778.00^{c} \pm 23.34$	$91.00^{b} \pm 11.31$	$8.77^{c} \pm 0.88$
Sig	*	*	*	*	*	*	*	*	*

[1] T_1: Negative control diet, T_2: Negative control + 1g Polyzyme / kg diet, T3: Negative control + 2g Polyzyme / kg diet, T_4: Negative control + 3g Polyzyme / kg diet, T_5: Positive control diet, T_6: Positive control + 1g Polyzyme / kg diet, T_7: Positive control + 2g Polyzyme/ kg diet, T8: Positive control + 3g Polyzyme / kg diet.

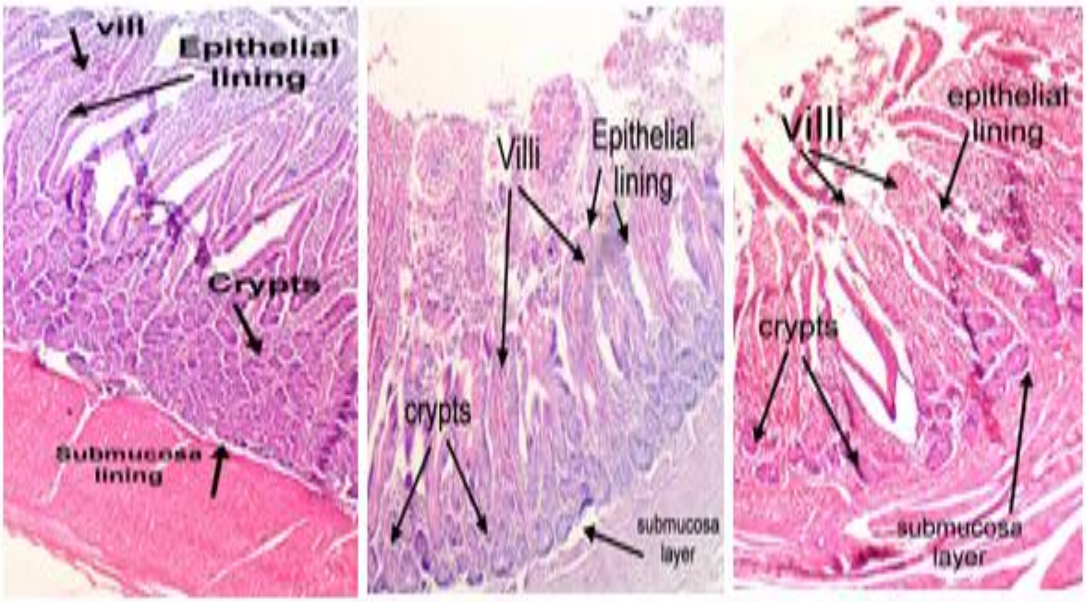
[2] means ± S.E. of 3 replicates/ treatment.

[3] a,b,c.........etc: Means within the same column with different superscripts are significantly different ($P \leq 0.05$).



duodenum Jejunum ileum

Figure 1: Duodenum, Jejenum and section in negative control group.



duodenum Jejunum ileum

Figure 2: Duodenum, Jejenum and section in negative control group +1g

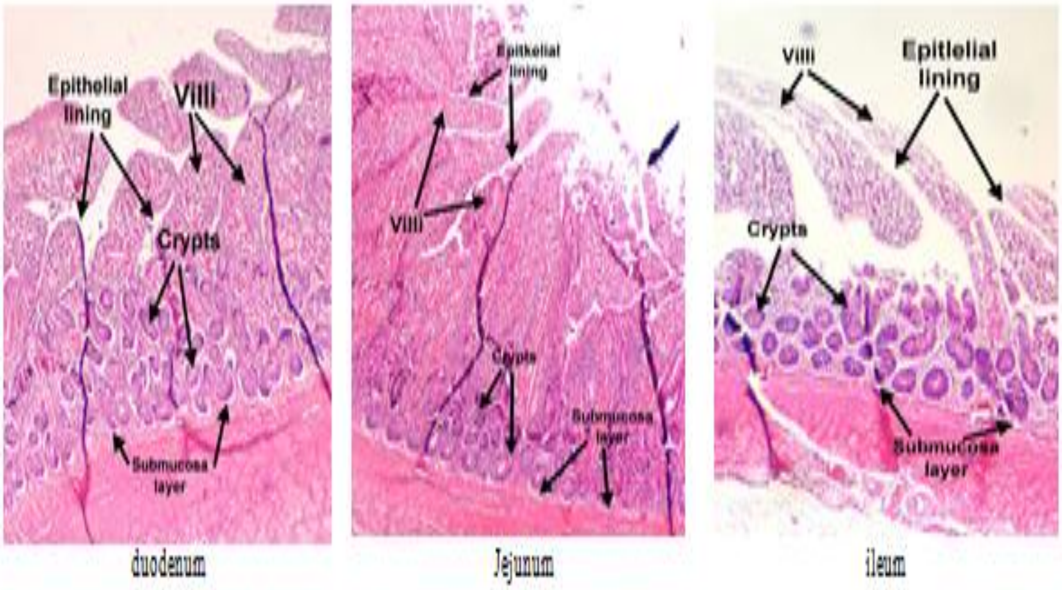


Figure 3: Duodenum, Jejenum and section in negative control group +2g

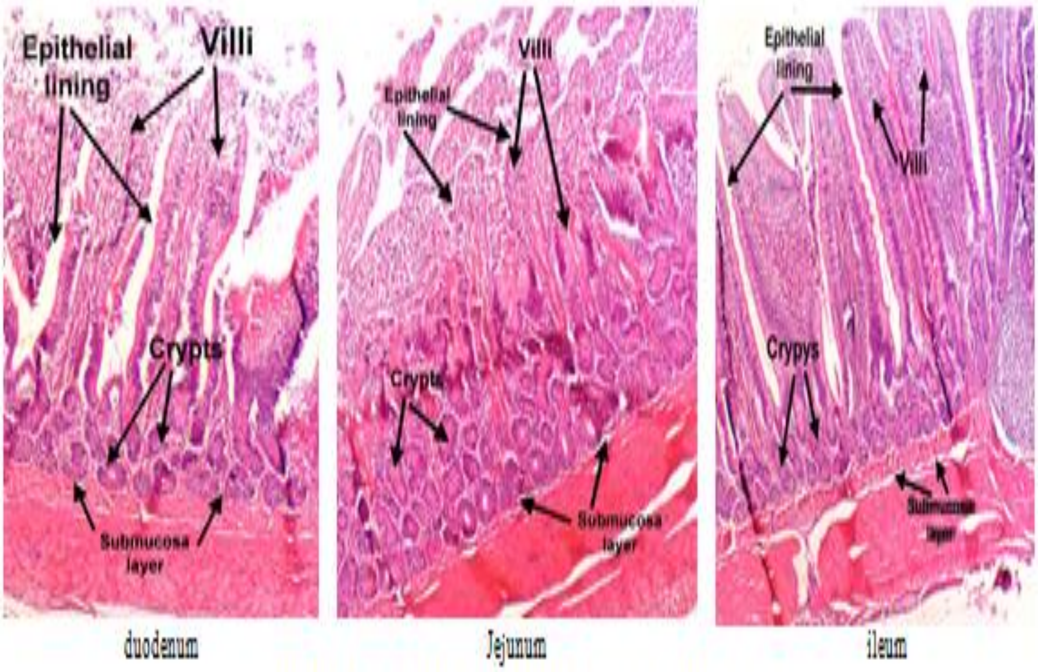


Figure 4: Duodenum, Jejenum and section in negative control group +3g

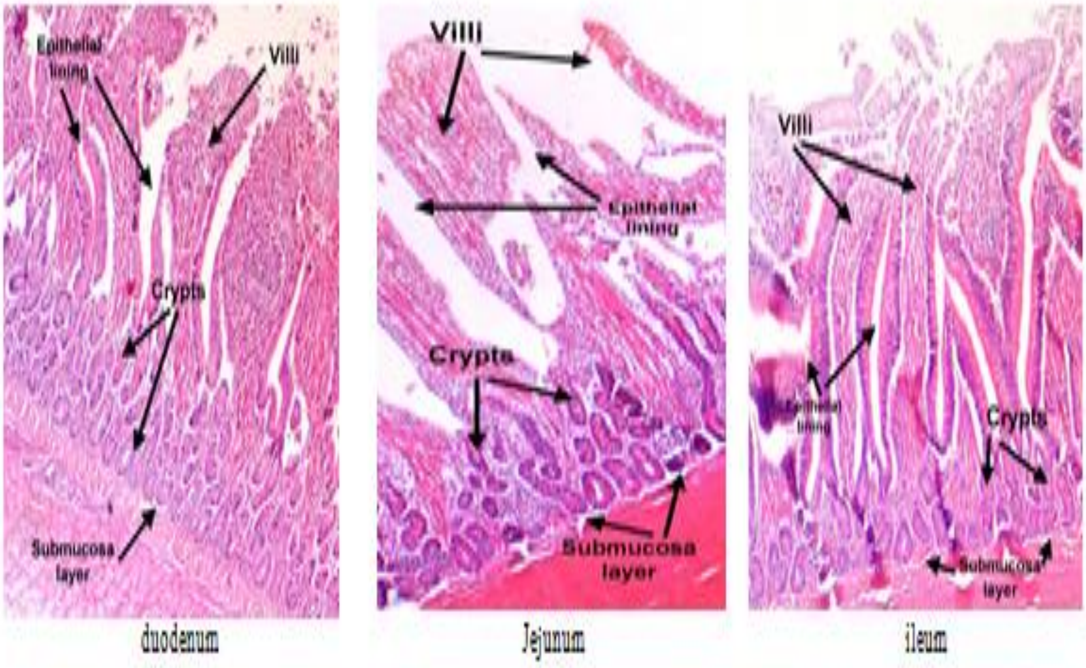


Figure 5: Duodenum, Jejenum and section in positive control group.

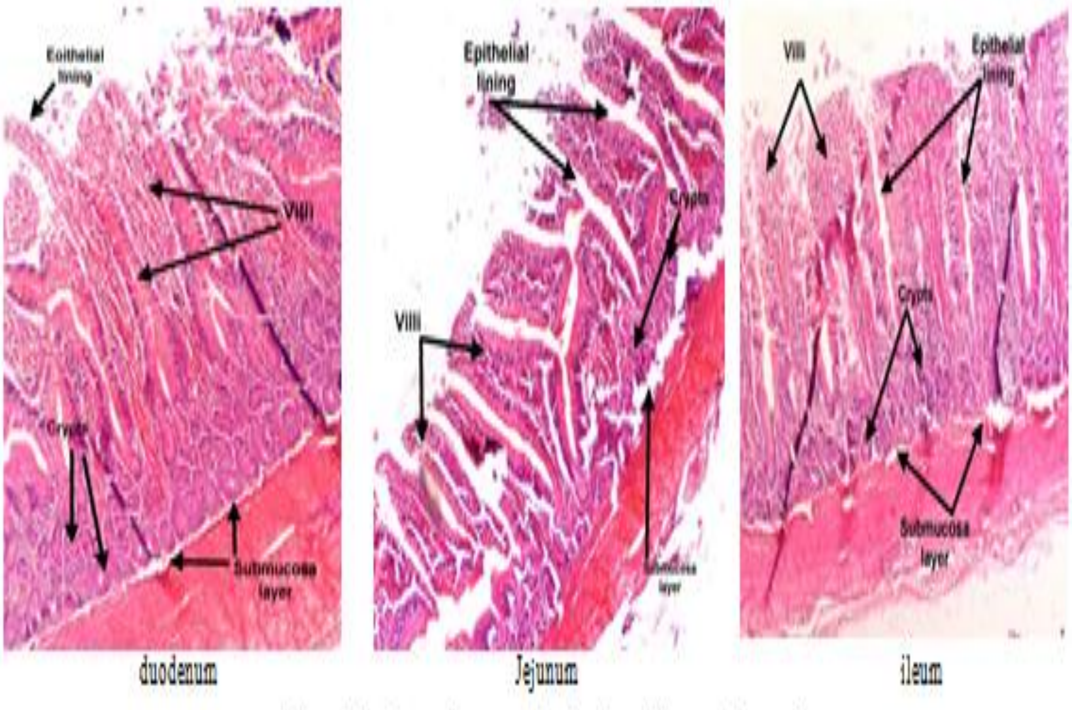
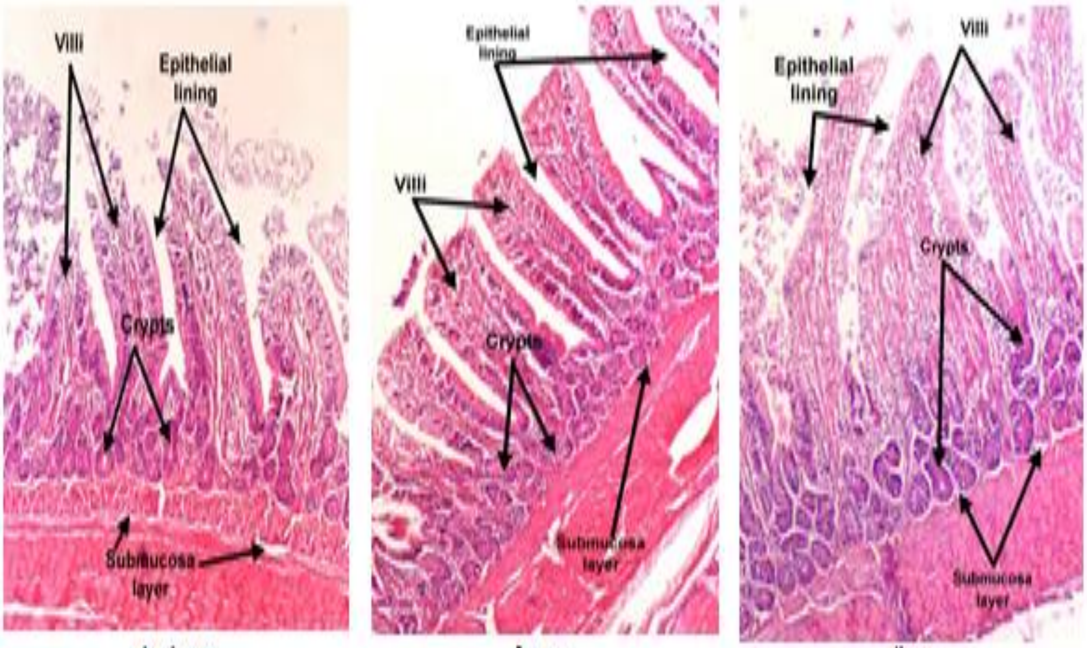
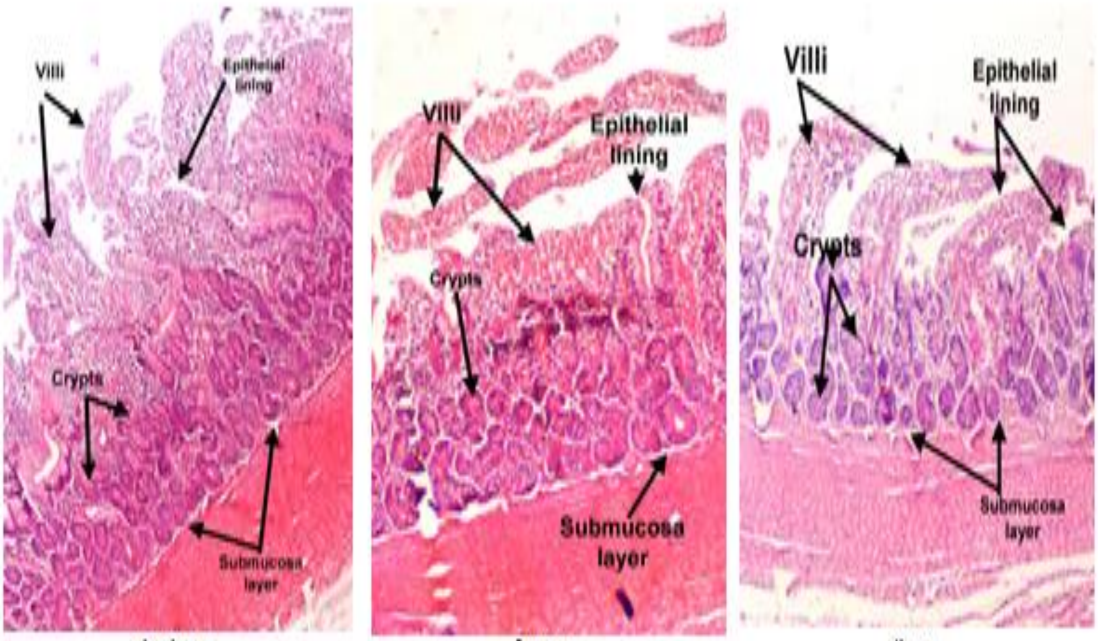


Figure 6: Duodenum, Jejenum and section in positive control group +1g.



duodenum Jejunum ileum

Figure 7: Duodenum, Jejenum and section in positive control group +2g



duodenum Jejunum ileum

Figure 8: Duodenum, Jejenum and section in positive control group +3g

Table 8. Economic efficiency of White Molar ducks fed low crude and normal protein diets supplemented with different levels of Polyzyme at 70 days of age.

Items	Dietary treatments[1]							
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Initial body weight, g.	47.70	47.60	47.63	47.63	47.73	47.80	47.70	47.77
Final body weight, kg.	3.55	4.10	4.18	4.31	4.19	4.16	4.05	4.02
Body weight gain, kg.	3.50	4.05	4.13	4.26	4.14	4.11	4.00	3.97
Total revenue[2], L. E.	133	154	157	162	157	156	152	151
Feed intake, kg.	10.41	10.38	11.35	11.23	11.12	11.07	10.59	10.68
Price of one kg feed, L. E.	5.67	5.80	5.92	6.05	5.85	5.98	6.10	6.23
Feed cost, L. E.	59.00	60.20	67.19	67.94	65.10	66.20	64.60	66.54
Net revenue[3], L. E.	74.00	93.80	89.81	94.06	91.90	89.80	87.40	84.46
Economical efficiency[4].	1.25	1.56	1.34	1.38	1.41	1.36	1.35	1.27
Relative economic efficiency, %.	88.65	110.64	95.04	97.87	100	96.50	95.70	90.10

[1]T_1: Negative control diet, T_2: Negative control + 1g Polyzyme / kg diet, T_3: Negative control + 2g Polyzyme / kg diet, T_4: Negative control + 3g Polyzyme / kg diet,T_5: Positive control diet, T_6: Positive control + 1g Polyzyme / kg diet, T_7: Positive control + 2g Polyzyme / kg diet, T_8: Positive control + 3g Polyzyme / kg diet.
Price of one kg live body weight was 38 L.E. Price of one kg multi enzymes was 125 L.E.
[2]Total revenue = live body weight gain × marketing price.
[3]Net revenue = Total revenue – Feed cost. [4]Economical efficiency = Net revenue / Feed cost.

Conclusion:

In general, and through the results obtained from feeding White Molar duck chicks from one day to 10 weeks of age on low crude protien diets (18 and 16%) during the starter period (1 – 21 d) and the finisher (22 – 70 d) with addition of different levels of commercial Polyzyme mixture (1, 2 and 3g/ Kg diet) improved growth performance due to increased activity of the small intestine and rate of nutrient absorption. The european efficiency ratio and performance index were improved when adding 3g Polyzyme Kg diet (4th treatment), while the economic and relative efficiency were better (1.56 and 110.64, respectively) in the 2nd treatment in which chicks fed low crude protein diet +1g Polyzyme compared to the other trearments.

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تأثير إضافة البوليزايم إلى العلائق المنخفضة البروتين على أداء البط المولار

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الملخص العربى

أجريت هذة التجربة لدراسة تأثير لإضافة البوليزايم فى علائق البط المولار المنخفضة فى محتواها من البروتين الخام على أداء النمو، صفات الذبيحة، وبعض قياسات سيرم الدم، بعض القياسات الهستولوجية، الكفاءة الاقتصادية ودليل الكفاءة الأوربى. استخدم 240 كتكوت بط مولار أبيض غير مجنس عمر يوم – قسمت عشوائياً إلى 8 مجموعات تجريبية بكل منها 3 مكررات (10 كتاكيت / مكررة). أضيف مخلوط الإنزيمات التجارى (Polyzyme) بمستوى صفر، 1، 2 و3 جم /كجم إلى العليقة المنخفضة فى محتواها من البروتين الخام التى استخدمت كمعاملة للكنترول السالب (18 ، 16% بروتين خام) والعليقة ذات المحتوى الطبيعى من البروتين الخام التى استخدمت كمعاملة لكنترول الموجب (20 ، 18 % بروتين خام) خلال فترتى البادئ (1-21 يوم) والناهى (22-70 يوم) على التوالى.

أشارت نتائج التجربة إلى أن طيور المجموعة الرابعة التى غذيت على عليقة الكنترول السالب المضاف إليها 3 جم بوليزايم /كجم عليقة كانت أعلى معنوياً فى وزن الجسم مقارنة بمجموعة الكنترول. الطيور التى غذيت على عليقة الكنترول السالب المضاف إليها مستويات مختلفة من البوليزايم استهلكت علائق أكثر معنوياً ($P \leq 0.05$) مقارنة بمجموعة الكنترول السالب عند عمر 10 أسابيع. معدل تحويل الغذاء ودليل الأداء تحسنت فى الطيور التى غذيت على عليقة الكنترول السالب المضاف إليها 3 جم بوليزايم / كجم (المعاملة الرابعة). تحسنت بعض صفات الذبيحة بإضافة مستويات متدرجة من الانزيم إلى العلائق. ارتفع معنوياً مستوى كل من الجلوكوز وإنزيمات AST فى السيرم نتيجة إضافة مستويات متدرجة من Polyzyme – بينما انخفض معنوياً كل من مستوى الكوليسترول والدهون الثلاثية والدهون الكلية مقارنة بمجموعتى الكنترول. وأوضح الفحص المورفولوجى لأجزاء من الأمعاء الدقيقة لكتاكيت البط زيادة معنوية فى ارتفاع وعرض الخملات والنسبة بينهما بإضافة مستويات متدرجة من الانزيم حتى مستوى 3 جم / كجم عليقة الكنترول السالب، ولكن لاتزال أفضل من مجموعة الكنترول السالب. وبصفة عامة ومن النتائج المتحصل عليها من تغذية كتاكيت البط المولار الأبيض من عمر يوم حتى 10 أسابيع على علائق منخفضة فى محتواها من البروتين الخام (18 ، 16%) خلال فترتى البادئ (من 1 – 21 يوم) والناهى (من 22 – 70 يوم) على التوالى مع إضافة مستويات متدرجة (1، 2 و3 جم / كجم عليقة) من مخلوط الانزيم التجارى Polyzyme – لوحظ تحسن أداء النمو نتيجة زيادة نشاط الأمعاء الدقيقة ومعدل الكفاءة الأوربى ودليل الأداء عند إضافة 3 جم Polyzyme / كجم عليقة (المعاملة الرابعة) – بينما كانت الكفاءة الاقتصادية والكفاءة الاقتصادية النسبية أفضل (1.56 ، 110.64 على التوالى) فى عليقة المعاملة الثانية المضاف إليها مخلوط الإنزيم التجارى Polyzyme بمعدل 1جم / كجم عليقة مقارنة بباقى المعاملات.

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