

GROWTH PERFORMANCE, BLOOD PARAMETERS AND INTESTINAL MORPHOLOGY OF MOLAR DUCKLINGS FED DIETS SUPPLEMENTED WITH PROBIOTICS

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SUMMARY

The present study was conducted to investigate the effect of feeding commercial probiotic preparation (Proact) supplementation on growth performance, carcass traits, blood parameters, intestinal morphological parameters and economical efficiency. A total of 240, one-day old Molar ducklings were individually weighed, wing-banded and randomly assigned to eight equal groups each of 3 replicates (30 birds each). All birds were fed a starter diet until 21- day of age and finisher diet from 22 day until marketing (70 d). Ducklings of group 1 (control) were fed the starter and finisher diets without Proact supplementation. Ducklings of groups 2, 3, 4, 5, 6, 7 and 8 were fed the control diets plus graded levels of Proact (0.25, 0.50, 0.75, 1.00, 1.25, 1.50 and 1.75g/ kg diet, respectively). Results revealed that ducklings of group 4 (0.75) showed significantly ($P \leq 0.05$) higher body weight, body weight gain, feed intake and performance index. Moreover, feed conversion ratio, European efficiency index and economic efficiency were significantly improved. Carcass and giblets weights and percentage were significantly ($P \leq 0.05$) increased with the supplementation. Probiotics supplementation (0.75g/ kg diet) significantly increased serum glucose and liver enzymes (AST and ALT), and significantly ($P \leq 0.05$) decreased creatinine, cholesterol, triglyceride and total lipids. However, total protein and albumen were not affected. Moreover, villi height, villi width and villi height: villi width ratio were significantly improved by the addition of probiotics up to 0.75g/ kg diet. Therefore, it may be concluded that supplementation of 0.75g probiotics/ kg diet could be used in diets of Molar ducklings from 0-10 weeks of age to improve growth performance, feed efficiency, and carcass traits.

Keywords: probiotics, ducklings, performance, carcass, blood parameters, intestinal morphology.

INTRODUCTION

The primary role of a diet is not only to provide enough nutrients to fulfill metabolic requirements of the body, but also to modulate various functions of the body. Probiotics, prebiotics, and synbiotic are either beneficial microorganisms or substrates that facilitate the growth of these microorganisms, which can be suitably harnessed (Awad *et al.*, 2009).

Probiotics are defined as live microbial food supplements which beneficially affect the host by improving its intestinal microbial balance. Furthermore, lactic acid bacteria are important aflatoxin reducer microorganisms, as has been emphasized by Hernandez- Mendoza *et al.*, (2009).

Functional supplements, such as probiotics, regulate gut microbiota (Hemarajata and Versalovic, 2012) and improve performance (Peng *et al.*, 2016). Improvement in growth performance and feed efficiency of broiler chickens fed probiotics is thought to be induced by the total effects of probiotic action including the maintenance of beneficial microbial population, improving feed intake and digestion and altering bacterial metabolism (Mountzouris *et al.*, 2007).

In broiler nutrition, probiotic species belonging to *Lactobacillus*, *Streptococcus*, *Bacillus*, *Bifidobacterium*, *Enterococcus*, *Aspergillus*, *Candida*, and *Saccharomyces* have a beneficial effect on broiler

performance (Kabir *et al.*, 2004), modulation of intestinal microflora and pathogen inhibition (Pascual *et al.*, 1999), and immunomodulation (Koenen *et al.*, 2004).

Therefore, the aim of this study was to evaluate the efficiency of feeding graded levels of probiotic product (Proact) on duckling's performance, blood parameters and intestinal morphological parameters.

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.

A total of 240, one-day old Molar ducklings (obtained from Mesangere Company for ducks), were individually weighed, wing- banded and randomly assigned to eight equal groups nearly similar in average body weight (each of 3 replicates of 30 birds each), period (70 days). Artificial light was used to provide 24 hour photo period. All birds were fed starter diet until 21- day of age and finisher diet from 22 day until marketing (Table 1). Proact was purchased from Zeus Biotech Limited, India, and sale from Delta Vet Center for animal feeding, Egypt.

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

Ingredient	Starter diet	Finisher diet
Yellow corn, 8.5%.	64.45	70.20
Soybean meal, 48%.	30.90	25.60
Vegetable oil.	0.60	0.50
Mono-calcium phosphate.	1.60	1.50
Limestone, ground.	1.70	1.50
Vitamins and minerals mixture ¹ .	0.30	0.30
Salt (Sodium chloride).	0.30	0.30
DL- Methionine ² .	0.15	0.10
Total	100	100
Calculated analysis (air dry basis) ³ :		
Crude protein, %.	20	18
ME, k cal/ kg diet.	2904	2970
C/ P ratio.	145	165
Calcium, %.	1.00	0.90
Available phosphorous, %.	0.48	0.45

¹Vitamins and minerals mixture at 0.30 % of the diet supplies the following/ kg of the diet: Vit. A, 12000 IU; Vit. D₃, 2500 IU; Vit. E, 10 mg; Vit. K₃, 3 mg; Vit B₁, 1 mg; Vit. B₂, 4 mg; Pantothenic acid, 10 mg ;Nicotinic acid, 20 mg; Folic acid, 1 mg; Biotin, 0.05 mg; Niacin, 40 mg; Vit.B₆, 3 mg; Vit B₁₂, 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.

²DL – Methionine: 98%feed grade (98 %Methionine). ³Calculated according to NRC (1994).

Proact is a unique probiotic combination of spore forming lactic acid, which contains *Bacillus subtilis*: 1.75×10^{12} CFU, *Bacillus licheniformis*: 1.75×10^{12} CFU and total viable count: 3.5×10^{12} CFU/ g, and dextrose monohydrate as a carrier up to 1kg. Ducklings of group 1 (control) was fed the starter and finisher diets that did not supplemented with Proact. Ducklings of groups 2, 3, 4, 5, 6, 7 and 8 were fed the control diets plus graded levels of Proact as follows: 0.25, 0.50, 0.75, 1.00, 1.25, 1.50 and 1.75g/ kg diet, respectively. Diets were formulated to provide the recommended requirements according to the NRC (1994).

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

Where: $EEI = (\text{Mean BW, kg} \times \text{Livability, \%}) / (\text{Marketing age, days} \times \text{FCR}) \times 100$.

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 and with giblets (liver, heart and gizzard) weights were recorded and calculated relative to live body weight as follows:

$$\text{Dressed \%} = (\text{carcass wt.} + \text{giblets wt.}) / \text{LBW} \times 100.$$

The small intestines of ducklings were removed immediately after slaughtering at 70 days age and segments of approximately 2 cm were taken from duodenum, jejunum and ileum 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). Particular segments were gently flushed and rinsed with 0.9% physiological saline and then fixed in a 4% neutral-buffered formalin solution for histological study.

At slaughtering, individual blood samples 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, triglyceride, lipids, cholesterol, creatinine, glucose and albumin were determined using commercial kits. Also, liver enzymes including aspartate transaminase (AST) and alanine transaminase (ALT) were calorimetrically estimated. 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 subjected to one way ANOVA 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:

$$Y_{ij} = \mu + \alpha_i + E_{ij},$$

Where:- Y_{ij} = an observation. μ = Overall mean. α_i = effect of treatment ($i = 1, 2, 3, 4, \dots, 8$), and E_{ij} = Random error.

RESULTS AND DISCUSSION

Body weight and body weight gain:

The effect of dietary graded levels of probiotics supplementation on growth performance and performance index (PI) of white Molar ducklings at 3 and 10 weeks of age is presented in Table (2). Results indicate that at 3 weeks of age, there are significant differences among probiotic levels. Ducklings fed 1g Proact/ kg diet showed significantly ($P \leq 0.05$) higher body weight (1043g) followed by those fed 0.75, 0.50 and 1.25g/ kg diet (1034, 1011 and 1016g, respectively) as compared to 880g for the control group. The same trend was noticed at the marketing age (70 days). Groups fed the diets supplemented with 0.75, 1.00 and 0.50g probiotic / kg diet have significantly the heaviest BW (4312, 4191 and 4178g, respectively) which is more than the control group (3546g) by about 21.60, 18.19 and 17.82%.

The average daily weight gain from 0 – 3 and 0 – 10 wks of groups fed Proact showed higher daily weight gain specially for chicks fed levels of 0.75 and 1.00g Proact / kg diet compared to the control group and the other supplemented groups (Table 2).

Furthermore, the same trend was noted in performance index (for the 0 - 3 and 0 -10 wks periods) where ducklings fed Proact at levels of 0.75 and 1.00g/ kg diet exhibited the best performance index compared to the control group being (53.02 and 57.16%) and (141.46 and 130.24 %), respectively in comparison with 40.90 and 106.48% for the control group at the same periods.

These results are in agreement with the results of Alkhalf *et al.* (2010) and Thomas *et al.* (2015) who reported that probiotic supplementation improved body weight and daily weight gain.

In contrast, Mohan *et al.* (1996) found that the beneficial effect of probiotic on chicken occurred only after the 4th week of age. Also, Hassan *et al.* (2015) noted that inclusion of 0.1% *Saccharomyces cerevisiae*

to 12, 14 or 16% protein diet had no effect on BW until the 4th week of feeding; however, it began to increase significantly ($P \leq 0.05$) from the 5th week until the end of the experiment compared to the control group.

Table (2): Effect of dietary graded levels of Proact supplementation on growth performance and performance index of Molar ducks at 3 and 10 weeks of age (Means \pm S.E).

Treatment ¹	Body weight (g)		Body weight gain/ d (g)		Performance Index (PI, %) ²	
	3 weeks	10 weeks	3 weeks	10 weeks	3 weeks	10 weeks
T ₁	880 ^d ± 9.58	3546 ^e ± 37.46	40 ^d ± 0.46	51 ^c ± 0.53	40.90 ^d ± 0.94	106.48 ^d ± 3.64
T ₂	973 ^c ± 11.84	4079 ^c ± 34.35	44 ^c ± 0.56	58 ^b ± 0.49	46.52 ^c ± 1.16	127.53 ^b ± 3.01
T ₃	1011 ^{ab} ± 10.88	4178 ^b ± 28.09	46 ^{ab} ± 0.52	59 ^{ab} ± 0.40	50.44 ^{ab} ± 1.15	123.76 ^b ± 2.11
T ₄	1034 ^a ± 13.58	4312 ^a ± 37.22	47 ^a ± 0.65	61 ^a ± 0.53	53.02 ^a ± 1.50	141.46 ^a ± 4.28
T ₅	1043 ^a ± 9.57	4191 ^b ± 66.90	47 ^a ± 0.45	59 ^{ab} ± 0.96	57.16 ^a ± 1.08	130.24 ^{ab} ± 4.81
T ₆	1016 ^{ab} ± 13.16	4117 ^c ± 69.66	46 ^{ab} ± 0.63	58 ^b ± 0.99	50.47 ^{ab} ± 1.39	138.01 ^{ab} ± 5.39
T ₇	999 ^b ± 11.91	4048 ^c ± 46.46	45 ^{bc} ± 0.57	57 ^b ± 0.66	48.54 ^b ± 1.21	116.39 ^c ± 3.13
T ₈	990 ^{bc} ± 12.64	3615 ^d ± 35.80	41 ^d ± 0.63	51 ^c ± 0.51	48.82 ^{2,3b} ± 1.49	126.50 ^b ± 4.64
Sig.	*	*	*	*	*	*

¹T₁: Basal diet (control), T₂: control + 0.25g Proact/ kg diet, T₃: control + 0.50 g Proact/ kg diet, T₄: control + 0.75 g Proact/ kg diet, T₅: control + 1.00 g Proact/ kg diet, T₆: control + 1.25 g Proact/ kg diet, T₇: control + 1.50 g Proact/ kg diet, T₈: control + 1.75 g Proact/ kg diet.

² means \pm S.E. of 3 replicates/ treatment.

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

Feed intake and feed conversion ratio:

Data of daily feed intake (FI) and feed conversion ratio (FCR) of Molar ducklings fed graded levels of Proact biweekly and during 0 – 3 and 0 – 10 weeks are presented in Table (3). Birds fed different levels of probiotics significantly consumed more feed than the control group. Whereas, birds fed Proact level at 1.75g/ kg diet consumed significantly less feed than the other Proact groups and nearly equal to the control group at the same periods (79 and 144 vs. 81 and 149g/ day, respectively).

Feed conversion ratio (FCR) was significantly improved by probiotics supplementation during the experimental period (0 – 10 weeks of age). From Table 3, it is obvious that inclusion of 0.75 and 1.00g Proact/ kg diet improved FCR compared to the control group, being (1.88, 1.75 vs. 2.05) and (3.07, 3.27 vs. 3.33) at periods of 0 – 3 and 0 – 10 weeks, respectively.

Ducklings fed Proact level of 1.75g/ kg diet proved better FCR compared to the other groups, meanwhile, the control group showed the worst FCR at all periods. The improvement in BW, BWG, FI and FCR of group 4 may be due to the increased efficiency of digestion and nutrient absorption processes in the presence of Proact bacteria.

.Edens (2003) reported that diets supplementation with probiotic allows the development of beneficial bacteria in the digestive tract of the host and improving its performance.

The present findings are in agreement with those of Willis and Reid (2008) and Alkhalf *et al.* (2010) who observed significant differences in feed consumption and efficiency of broiler chickens receiving probiotic.

Also, Hassan *et al.* (2015) noted that total feed intake of ducklings fed 16% protein diet supplemented with 0.1% *S. cerevisiae* is slightly higher than the control birds during the whole experiment.

Table (3): Effect of dietary graded levels of Proact supplementation on feed intake and feed conversion ratio of Molar ducks at 3 and 10 weeks of age (Means \pm S.E).

Treatment ¹	Feed intake (g)		Feed conversion ratio g feed/ g gain	
	3 weeks	10 weeks	3 weeks	10 weeks
T ₁	81 ^c \pm 0.08	149 ^c \pm 0.58	2.05 ^a \pm 0.23	3.33 ^{ab} \pm 0.10
T ₂	88 ^{ab} \pm 0.2	166 ^a \pm 0.17	2.01 ^b \pm 0.27	3.18 ^b \pm 0.36
T ₃	88 ^{ab} \pm 0.21	162 ^b \pm 0.40	1.92 ^{bc} \pm 0.21	3.37 ^{ab} \pm 0.52
T ₄	88 ^{ab} \pm 0.15	163 ^{ab} \pm 0.65	1.88 ^c \pm 0.25	3.07 ^c \pm 0.11
T ₅	83 ^b \pm 0.51	164 ^{ab} \pm 0.28	1.75 ^d \pm 0.17	3.27 ^b \pm 0.41
T ₆	89 ^a \pm 0.10	162 ^b \pm 0.49	1.94 ^{bc} \pm 0.26	3.05 ^c \pm 0.17
T ₇	89 ^a \pm 0.22	162 ^b \pm 0.58	1.98 ^{bc} \pm 0.24	3.50 ^a \pm 0.28
T ₈	79 ^c \pm 0.54	144 ^c \pm 0.39	1.93 ^{bc} \pm 0.22	2.82 ^d \pm 0.23
Sig.	*	*	*	*

¹T₁: Basal diet (control), T₂: control + 0.25g Proact/ kg diet, T₃: control + 0.50 g Proact/ kg diet, T₄: control + 0.75 g Proact/ kg diet, T₅: control + 1.00 g Proact/ kg diet, T₆: control + 1.25 g Proact/ kg diet, T₇: control + 1.50 g Proact/ kg diet, T₈: control + 1.75 g Proact/ kg diet.

² means \pm S.E. of 3 replicates/ treatment.

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

Selvamohan *et al.* (2012) found that probiotic supplementation led to beneficial production of multiple enzymes including α amylase, α acetolactate decarboxylase, β glucanase, malt genic amylase, urease, protease, xylanase, chitinase, phytase, cellulose, hemicellulose and lipase. *Bacillus amyloliquefaciens* has been found to produce the enzyme β mannase (Mabrouk and El-Ahwany, 2008). Production of these enzymes in ducks small intestine would increase their ability to digest and absorb a larger percentage and variety of nutrient in their feed.

In contrast, Zurmiat *et al.* (2017) indicated that all three doses of *B. amyloliquefaciens* (1000, 2000 and 3000ppm/ kg diet) significantly decreased feed consumption compared to the control, besides, feed consumption at 6 weeks old was significantly reduced as the dose of probiotic increased.

Carcass traits:

Results in Table (4) reveal that the addition of graded levels of probiotics to Molar duckling's diets were significantly affected on some carcass traits (weights and percentages). Ducklings received 0.75g Proact/ kg diet acquired the highest carcass weight (3041g) and giblets weight (341g) compared to the control group (2627 and 248 g, respectively). This indicates that this feed additive has a positive impact on carcass traits.

These results are in agreement with the results of Hascik *et al.* (2009) who conducted that there is statistically significant influence of the supplementation of probiotic on carcass traits of broiler chickens. In contrast, our results are opposite to the results of Weis and Hrnar (2013) and Hassan *et al.* (2015) who reported that there was no significant difference in all carcass traits due to probiotics supplementation.

Serum blood parameters:

Supplementation of graded levels of probiotics showed no significant differences in the concentration of serum total protein, albumen and activity of ALT enzyme (Table 5). However, adding different levels of probiotics significantly increased both serum glucose and activity of AST enzyme, whereas, significantly reduced serum creatinine, cholesterol, triglycerides and total lipids compared to the control group.

Our results are in agreement with those of Hassan *et al.* (2015) who reported that probiotics did not significantly affect serum total protein level. However, Joy and Samual (1997) stated that adding probiotic to broiler diets significantly decreased serum cholesterol. Also, Mohan *et al.* (1996) proved that probiotic exhibited lipid lowering properties which might be related to the interference of probiotic bacteria with cholesterol absorption in the gut by conjugating bile salts or directly assimilating cholesterol.

However, Panda *et al.* (2006) stated that concentration of serum protein significantly increased due to probiotic supplementation. While, Djouvinov *et al.* (2005) reported that serum cholesterol was not significantly affected by feeding probiotic preparation to mule ducklings.

Table (4): Effect of dietary graded levels of Proact supplementation on some carcass traits of Molar ducks at 10 weeks of age (Means \pm S. E).

Treatments ¹	LBW (g) ⁴	Carcass weight (g) ⁵	Dressing (%) ⁶	Giblets weight (g)	Liver (%)	Heart (%)	Gizzard (%)
T ₁	3641 ^b \pm 45.50	2627 ^b \pm 42.00	72.15 \pm 0.42	248 ^d \pm 3.50	3.52 ^c \pm 0.11	1.07 ^b \pm 0.03	2.23 ^{2,3a} \pm 0.18
T ₂	4009 ^a \pm 42.20	2862 ^a \pm 18.00	71.39 \pm 1.13	298 ^{bc} \pm 3.50	4.47 ^b \pm 0.19	1.00 ^{bc} \pm 0.10	1.97 ^{bc} \pm 0.29
T ₃	4105 ^a \pm 24.00	2930 ^a \pm 13.00	71.38 \pm 1.53	298 ^{bc} \pm 3.00	4.41 ^b \pm 0.01	0.99 ^{bc} \pm 0.21	1.86 ^c \pm 0.22
T ₄	4154 ^a \pm 30.00	3041 ^a \pm 28.50	73.21 \pm 1.21	341 ^a \pm 1.00	4.77 ^a \pm 0.01	1.34 ^a \pm 0.70	2.11 ^{ab} \pm 0.21
T ₅	4059 ^a \pm 24.00	2938 ^a \pm 20.00	72.38 \pm 1.96	304 ^b \pm 0.50	4.24 ^b \pm 0.11	1.20 ^{ab} \pm 0.18	2.06 ^{abc} \pm 0.54
T ₆	4039 ^a \pm 20.50	2856 ^a \pm 14.00	70.71 \pm 0.70	306 ^b \pm 3.50	4.26 ^b \pm 0.05	1.18 ^{ab} \pm 0.90	2.15 ^{ab} \pm 0.27
T ₇	3993 ^a \pm 22.00	2874 ^a \pm 16.00	71.98 \pm 1.33	301 ^{bc} \pm 6.00	4.28 ^b \pm 0.20	1.05 ^{bc} \pm 0.10	2.20 ^a \pm 0.30
T ₈	3967 ^{2,3a} \pm 16.00	2870 ^a \pm 12.00	72.35 \pm 0.23	290 ^c \pm 2.00	4.33 ^b \pm 0.04	0.94 ^c \pm 0.17	2.02 ^{abc} \pm 0.51
Sig.	*	*	N.S.	*	*	*	*

¹T₁: Basal diet (control), T₂: control + 0.25g Proact/kg diet, T₃: control + 0.50 g Proact/kg diet, T₄: control + 0.75 g Proact/kg diet, T₅: control + 1.00 g Proact/kg diet, T₆: control + 1.25 g Proact/kg diet, T₇: control + 1.50 g Proact/kg diet, T₈: control + 1.75 g Proact/kg diet.

² means \pm S.E. of 3 replicates/ treatment.

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

⁴LBW= Live Body weight. ⁵Carcass weight (g) without giblets. ⁶ dressing (%) was calculated relative to live body weight.

Intestinal morphological parameters:

Data concerning morphological parameters are presented in Table (6) and Figures (1, 2 and 3). The results reveal that villi height, villi width and villi height : villi width ratio were significantly increased progressively with probiotics supplementation levels up to 1.25g/ kg diet and thereafter, tended to decrease, but still better than the control.

Except for jejunum villi width, duodenum villi height and width of chicks fed diets supplemented with 1.25g probiotics/ kg diet were 34.05 and 82.65% higher than the control in comparison with the other levels and was 76.61% in the jejunum villi height for the same group. On the other side, ducklings fed 1g probiotics/ kg diet had the highest jejunum villi width percent (59.31%) and the best ileum villi height and width percent (61.95 and 52.38%) compared to the control and the other treatments.

Table (5): Effect of dietary graded levels of Proact supplementation on some serum blood parameters of Molar ducks at 10 weeks of age (Means \pm S. E).

Trt ¹	TP	Alb.	Cr.	Chol.	Glu.	TG	TP	AST	ALT
	-----g/dl-----				mg/dl			----- U/L -----	
T ₁	2.75 \pm 0.64	1.40 \pm 0.10	0.36 ^a \pm 0.06	180.30 ^a \pm 10.70	5.38 ^b \pm 0.88	146.50 ^a \pm 14.50	553.89 ^a \pm 37.41	30.10 ^{2,3} ^c \pm 1.32	22.15 \pm 2.82
T ₂	2.87 \pm 0.01	1.69 \pm 0.32	0.23 ^b \pm 0.08	122.45 ^d \pm 15.45	6.32 ^{ab} \pm 1.33	126.60 ^{ab} \pm 10.60	386.66 ^b \pm 45.15	42.40 ^a \pm 7.10	29.39 \pm 11.79
T ₃	2.98 \pm 0.40	1.65 \pm 0.13	0.24 ^b \pm 0.01	135.55 ^c \pm 1.45	7.90 ^{ab} \pm 0.10	121.50 ^b \pm 1.50	444.20 ^b \pm 4.84	40.55 ^a \pm 0.10	20.25 \pm 2.650
T ₄	3.15 \pm 0.52	1.54 \pm 0.07	0.28 ^b \pm 0.03	147 ^c \pm 10.00	11.79 ^a \pm 4.35	119.50 ^{ab} \pm 8.50	453.81 ^{ab} \pm 31.21	40.42 ^a \pm 3.29	17.53 \pm 1.93
T ₅	3.13 \pm 0.23	1.50 \pm 0.09	0.31 ^b \pm 0.05	146.85 ^c \pm 0.85	7.29 ^{ab} \pm 0.52	121.50 ^b \pm 4.50	445.93 ^b \pm 2.57	42.50 ^a \pm 5.40	73.90 \pm 7.70
T ₆	2.96 \pm 0.58	1.66 \pm 0.14	0.27 ^b \pm 0.02	154.55 ^{bc} \pm 9.55	7.07 ^{ab} \pm 1.23	120.55 ^{ab} \pm 4.45	470.69 ^{ab} \pm 24.92	39.72 ^{ab} \pm 4.42	24.75 \pm 3.55
T ₇	2.91 \pm 0.44	1.59 \pm 0.04	0.29 ^b \pm 0.08	154.90 ^{bc} \pm 16.20	6.39 ^{ab} \pm 1.04	117.80 ^{ab} \pm 10.80	469.95 ^{ab} \pm 47.68	37.80 ^{ab} \pm 7.70	25.33 \pm 8.27
T ₈	2.89 \pm 0.29	1.82 \pm 0.05	0.29 ^b \pm 0.08	168.85 ^b \pm 1.85	6.05 ^{ab} \pm 0.27	98.50 ^b \pm 3.50	391.39 ^b \pm 7.47	41.20 ^a \pm 0.60	23 \pm 1.30
Sig.	N.S	N.S	*	*	*	*	*	*	N.S

¹T₁: Basal diet (control), T₂: control + 0.25g Proact/ kg diet, T₃: control + 0.50 g Proact/ kg diet, T₄: control + 0.75 g Proact/ kg diet, T₅: control + 1.00 g Proact/ kg diet, T₆: control + 1.25 g Proact/ kg diet, T₇: control + 1.50 g Proact/ kg diet, T₈: control + 1.75 g Proact/ kg diet.

² Means \pm S.E. of 3 replicates/ treatment. Trt. = Treatment, TP = Total protein, Alb. = Albumin, r. = Creatinine, Chol. = Cholesterol, Glu. = Glucose, TG = Triglyceride, TP = Total lipids

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

Table (6): Effect of dietary graded levels of Proact supplementation on intestinal sections morphology of Molar ducks at 10 weeks of age (Means \pm S. E).

Treatment ¹	Duodenum villi (μ m)			Jejunum villi (μ m)			Ileum villi (μ m)		
	Height, H	Width, W	H/ W	Height, H	Width, W	H/ W	Height, H	Width, W	H/ W
T ₁	1304 ^e \pm 6.73	98 ^c \pm 4.86	13.34 ^c \pm 0.61	915 ^e \pm 7.02	145 ^c \pm 2.65	6.31 ^b \pm 0.18	728 ^d \pm 7.21	126 ^d \pm 3.65	5.76 ^{2,3bcd} \pm 0.21
T ₂	1420 ^d \pm 5.59	100 ^c \pm 5.99	14.23 ^b \pm 0.66	1140 ^d \pm 9.57	167 ^b \pm 3.70	6.85 ^b \pm 0.19	852 ^c \pm 9.97	137 ^{cd} \pm 4.20	6.23 ^{ab} \pm 0.19
T ₃	1504 ^{cd} \pm 6.63	137 ^b \pm 3.57	10.99 ^d \pm 0.35	1229 ^c \pm 11.63	180 ^b \pm 7.36	6.83 ^b \pm 0.17	860 ^c \pm 8.88	151 ^c \pm 5.31	5.70 ^{bc} \pm 0.15
T ₄	1590 ^c \pm 5.02	163 ^a \pm 8.29	9.76 ^d \pm 0.27	1396 ^b \pm 5.55	220 ^a \pm 6.75	6.35 ^b \pm 0.12	1159 ^a \pm 6.65	171 ^b \pm 6.60	6.78 ^a \pm 0.16
T ₅	1649 ^b \pm 3.73	171 ^a \pm 7.84	9.65 ^d \pm 0.25	1545 ^a \pm 4.06	231 ^a \pm 2.70	6.65 ^b \pm 0.12	1179 ^a \pm 4.45	192 ^a \pm 3.80	5.15 ^{bcd} \pm 0.19
T ₆	1748 ^a \pm 2.44	179 ^a \pm 3.39	9.77 ^d \pm 0.30	1616 ^a \pm 5.87	150 ^c \pm 3.95	10.82 ^a \pm 0.38	1112 ^{ab} \pm 6.10	180 ^{ab} \pm 5.65	5.63 ^{cd} \pm 0.13
T ₇	1664 ^b \pm 4.36	110 ^c \pm 8.61	15.13 ^a \pm 0.89	1485 ^b \pm 6.49	136 ^c \pm 9.96	10.93 ^a \pm 0.37	950 ^b \pm 7.97	175 ^{ab} \pm 6.15	5.43 ^d \pm 0.16
T ₈	1580 ^c \pm 8.81	99 ^c \pm 7.45	15.99 ^a \pm 0.75	1287 ^c \pm 7.45	115 ^d \pm 7.25	11.26 ^a \pm 0.50	875 ^c \pm 4.50	141 ^{cd} \pm 3.70	6.23 ^{ab} \pm 0.11
Sig.	*	*	*	*	*	*	*	*	*

¹T₁: Basal diet (control), T₂: control + 0.25g Proact/ kg diet, T₃: control + 0.50 g Proact/ kg diet, T₄: control + 0.75 g Proact/ kg diet, T₅: control + 1.00 g Proact/ kg diet, T₆: control + 1.25 g Proact/ kg diet, T₇: control + 1.50 g Proact/ kg diet, T₈: control + 1.75 g Proact/ kg diet.

² means \pm S.E. of 3 replicates/ treatment.

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

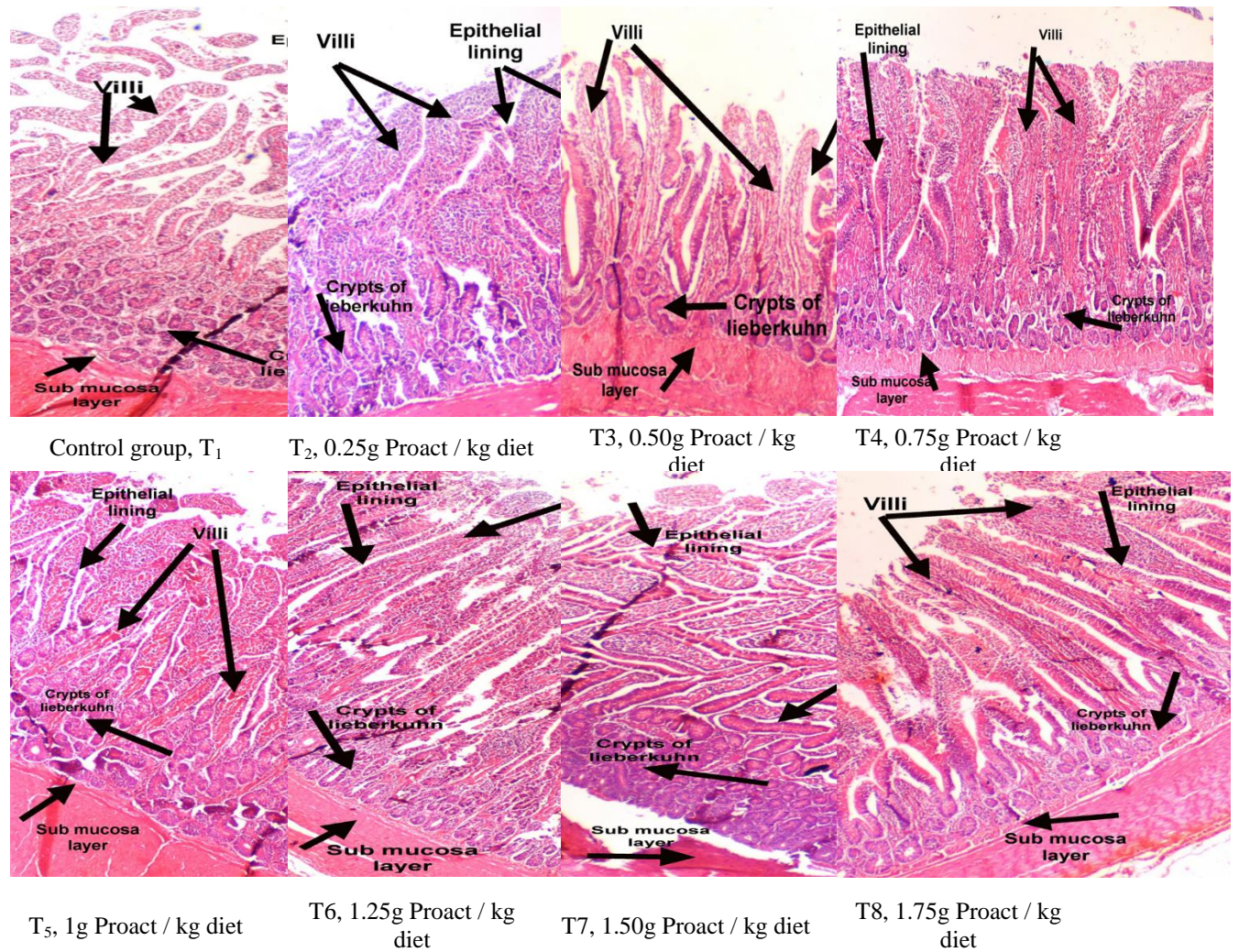


Figure (1): Effect of dietary graded levels of Proact supplementation on intestinal Duodenum section of Molar ducks at 10 weeks of age.

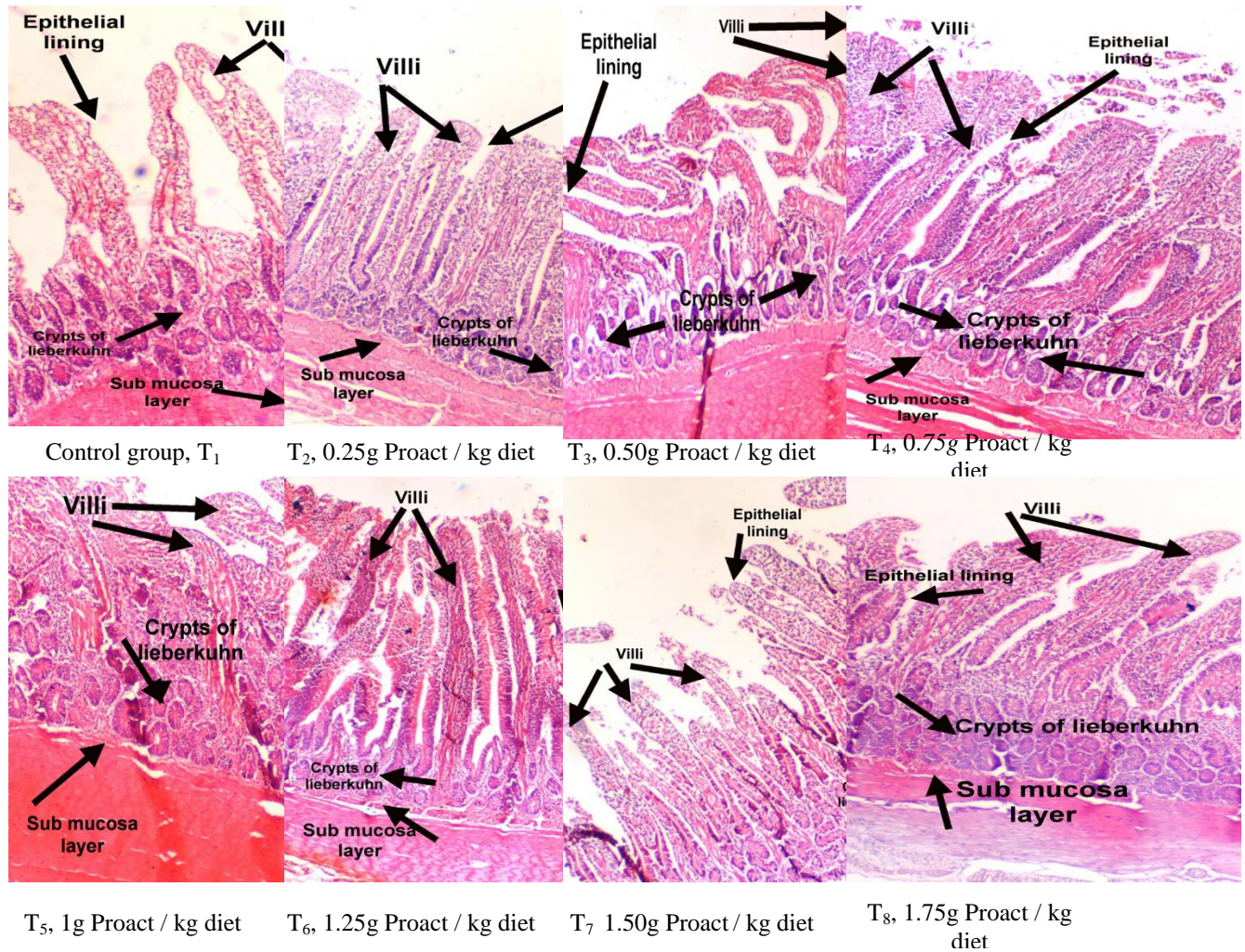


Figure (2): Effect of dietary graded levels of Proact supplementation on intestinal Jejunum section of Molar ducks at 10 weeks of age.

It is understood that greater villus height is an indicator that the function of intestinal villi is activated (Shamoto and Yamauchi, 2000). This fact suggests that the villus function is activated after feeding of dietary probiotic. Moreover, increased passive absorption of glucose and proline was reported in broiler chickens fed a probiotic containing lactobacilli, *B. thermophilum*, and *E. faecium* (Chichlowski *et al.*, 2007).

The histomorphological changes in the intestine of ducklings in the present study provide new information regarding the potential for using probiotics in their diets. Increasing the villus height suggests an increased surface area capable of greater absorption of available nutrients (Caspary, 1992). A shortening of the villi and deeper crypts may lead to poor nutrient absorption, increased secretion in the gastrointestinal tract, and lower performance (Xu *et al.*, 2003).

The villus crypt is considered as the villus factory and deeper crypts indicate fast tissue turnover to permit renewal of the villus as needed in response to normal sloughing or inflammation from pathogens or their toxins and high demands for tissue (Anonymous, 1999).

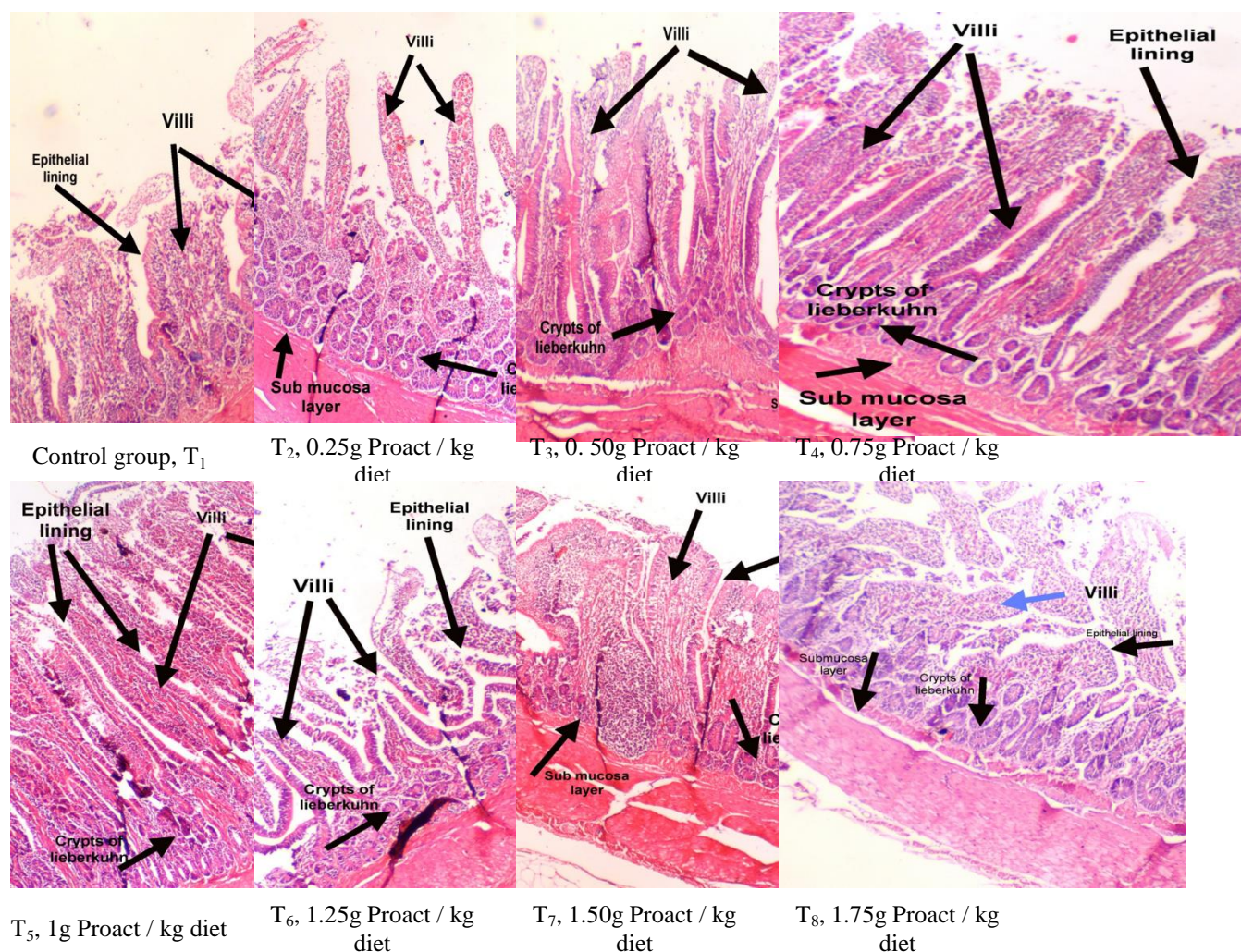


Figure (3): Effect of dietary graded levels of Proact supplementation on intestinal Ileum section of Molar ducks at 10 weeks of age.

Our results are in synergism with the findings of Chichlowski *et al.* (2007) who found that addition of probiotic containing lactobacilli, *B. thermophilum*, and *E. faecium* to the broiler diet increased the jejunal villus height. Longer villi were found in the ileum of chicks and turkeys treated with *Lactobacillus reuteri* (Dunham *et al.*, 1993) and in the ileum of adult male layers with slight improvement in feed efficiency after dietary addition of *Bacillus subtilis* (Samanya and Yamauchi, 2002).

In addition, longer villi were induced by dietary amylase (Ritz *et al.*, 1995). The concentrations of amylase in broiler intestine were increased after supplementation of diet with either a single strain of *Lactobacillus acidophilus* or a mixture of *Lactobacillus* strains (Jin *et al.*, 2000). It is assumed that an increased villus height is paralleled by an increased digestive and absorptive function of the intestine due to increased absorptive surface area, expression of brush border enzymes, and nutrient transport systems (Pluske *et al.*, 1996).

Economic efficiency:

Results of feeding cost for ducks fed the experimental diets are presented in Table (7). The relative economic efficiency measures the difference between the income of the business and the cost of the feed and is a product of meat production and marketing price. Production volume is influenced by feed price, feed intake, final body weight, mortality and marketing price. Through our inputs and outcomes for 10 weeks old Molar ducklings, relative economic efficiency was increased with the addition of probiotics up to 0.75g/kg diet (REF=112%), and net revenue = 95.82 L.E. compared to 75.22 L.E. for the un-supplemented group.

Also, European efficiency index confirms these results and ducklings of group 4 had 201 compared to 150 for the control group.

Table (7): Effect of dietary graded levels of Proact supplementation on the economic efficiency of the experimental diets at 70 days of age.

Item	Dietary treatment 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	4.08	4.18	4.31	4.19	4.12	4.05	3.62
Body weight gain, kg.	3.50	4.03	4.13	4.26	4.14	4.07	4.00	3.57
Total revenue ² , L. E.	133	153	157	162	157	155	152	136
Feed intake, kg.	10.43	11.62	11.34	11.41	11.48	11.34	11.34	10.08
Price of one kg feed, L. E.	5.54	5.62	5.71	5.79	5.88	5.96	6.04	6.13
Feed cost, L. E.	57.78	65.30	64.75	66.06	67.50	67.59	68.49	61.97
Net revenue ³ , L. E.	75.22	87.84	92.19	95.82	89.82	87.07	83.51	73.76
Economical efficiency ⁴ .	1.30	1.35	1.42	1.45	1.33	1.29	1.22	1.19
Relative economic efficiency, %.	100	104	109	112	102	99	94	92
European efficiency index ⁵ .	152	183	177	201	183	193	165	183

¹T₁: Basal diet (control), T₂: control + 0.25g Proact/kg diet, T₃: control + 0.50 g Proact/kg diet, T₄: control + 0.75 g Proact/kg diet, T₅: control + 1.00 g Proact/kg diet, T₆: control + 1.25 g Proact/kg diet, T₇: control + 1.50 g Proact/kg diet, T₈: control + 1.75 g Proact/kg diet.

Price of one kg live body weight was 38 L.E.

Price of one kg Proact was 337.50 L.E.

²Total revenue = live body weight gain × marketing price.

³Net revenue = Total revenue – Feed cost.

⁴Economical efficiency = Net revenue / Feed cost.

⁵European efficiency index, EEI = (Mean body weight, kg × livability, %) / (marketing age, days × feed conversion ratio) × 100.

CONCLUSION

The obtained results indicate that supplementation of 0.75g probiotic (Proact)/ kg diet can be used in diets of Molar ducklings from 0-10 weeks of age to improve performance, feed efficiency, and economic efficiency.

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تأثير إضافة مستويات متدرجة من البروبيوتيك على كفاءة النمو ومكونات الدم والتغير الهستولوجي للأمعاء في صغار البط المولر

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أجريت هذه الدراسة بهدف معرفة تأثير إضافة البروبيوتيك في صورة المخلوط التجاري (Proact) على أداء صغار البط المولر وبعض صفات الذبيحة وبعض مكونات الدم والتغيرات الهستولوجية في الأمعاء وكذلك الكفاءة الاقتصادية. استخدم عدد 240 صغار البط المولر عمر يوم، قسمت عشوائيا إلى 8 مجاميع تجريبية بكل منها 3 مكررات (30 ككتوت/ مكررة). تم التغذية على عليقة بادية خلال الفترة من عمر يوم - 21 يوم وعليقة ناهى حتى عمر التسويق (70 يوم). تم تغذية ككتايت المعاملة الأولى (الكنترول) على العليقة البادية والناهى بدون إضافة البروبيوتيك، بينما المعاملات من 2 - 8 تم تغذيتها على عليقة الكنترول مضاف إليها البروبيوتيك بالمستويات (0.25، 0.50، 0.75، 1، 1.25، 1.50 و 1.75 جم/كجم عليقة) على التوالي.

وقد أوضحت النتائج أن صغار البط التي تم تغذيتها على عليقة مضاف إليها بروبيوتيك بمستوى 0.75g جم/كجم عليقة كانت الأعلى معنويا في وزن الجسم والزيادة في وزن الجسم وكمية العلف المأكول ودليل الأداء. كما تحسن كل من معدل تحويل الغذاء، دليل الكفاءة الأوروبية والكفاءة الاقتصادية وزاد وزن ونسبة كل من الذبيحة والأحشاء الداخلية المأكولة بإضافة البروبيوتيك. كذلك زاد معنويا كمية الجلوكوز ونشاط انزيمات الكبد (AST and ALT) بإضافة البروبيوتيك وخفضت معنويا كل من الكرياتينين، الكوليستيرول والدهون الثلاثية والدهون الكلية بينما لم تؤثر الإضافة على كل من البروتين الكلى والألبومين. كما تحسن كل من ارتفاع وعرض الخملات والنسبة بينهما بإضافة البروبيوتيك بمستوى 0.75g جم/كجم عليقة.

وبصفة عامة أوضحت النتائج أنه يمكن تغذية صغار البط على عليقة مضاف إليها بروبيوتيك في هيئة المستحضر التجاري (Proact) بمستوى 0.75g جم/كجم عليقة من عمر يوم وحتى عمر 10 أسابيع حيث حسنت من النمو والكفاءة الغذائية والاقتصادية