Egyptian J. Nutrition and Feeds (2025), 28(3):335-344

EFFECT OF WHEAT BRAN WITH OR WITHOUT ENZYMES SUPPLEMENTATION ON INTESTINAL MORPHOLOGY, ENZYMES ACTIVITY AND CECUM MICROBIOLOGY OF BROILER CHICKS

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(Received 30/8/2025, accepted 10/10/2025)

SUMMARY

The present study was conducted to evaluate the possible effect (s) of enriching the broiler chick's diet with wheat bran (WB) on intestinal morphology, enzymes activity and cecum microbiology of broiler chicks. A total number of 210 unsexed one-day-old broiler chicks Indian River were used. These chicks were randomly distributed into Seven groups of 30 chicks each, in three replicates (10chicks each). The first group was fed the basal diet (control group), while groups (T_{1-6}) were fed diet with 5%, 7.5%, and 10% respectively without and with enzymes. The results showed that at five weeks significant effect between treatments in total length of digestive tract, total small intestinal and cecum length compared with control, there were significantly improved in birds fed WB (T_{1-6}) on Amylase, Cellulase and Xylanase activity in addition to significant increase in Villi length, Villi width and Crypt depth. Used WB in broiler (T_{1-6}) led to increase in total counts of bacteria compared to control group, increase in the count of lactic acid bacterium, and decrease the count of Coliforms.

Keywords: *Wheat Bran, Crude Fiber, Intestinal Morphology, Enzymes Activity, Cecum Microbiology, and Broiler.*

INTRODUCTION

Fiber is a naturally occurring element of feedstuff obtained from plants and is crucial to chicken feed. Studies and experiments carried out in previous years have indicated unfavorable influences regarding the daily intake, growth performance, and digestibility of nutrients (Sklan *et al.,* 2003). Water-soluble and insoluble dietary fibers (IDF) are the two categories into which they fall (Owusu-Asiedu *et al.,* 2006; and Tellez *et al.,* 2014).

The structure of soluble dietary fibers (SDF) is typically viscous, which increases digesta viscosity, decreases transit rate, and ultimately decreases nutrient utilization (Jha and Berrocoso, 2015). Contrarily, IDF has a non-viscous structural component, and recent research in chicken has shown that moderate doses (2–3%) of IDF improve gastrointestinal growth and enzyme secretion, which in turn improves nutrient utilization (Jha *et al.,* 2015; and Mateos *et al.,* 2012). According to research by Gonzalez-Alvarado *et al.,* (2010) insoluble fiber sources such as rice hulls, oat hulls (OH), sunflower hulls, wheat bran ((WB), and soybean hulls can improve broilers' nutrient utilization and live performance, as well as insoluble fiber's good effects on the gizzard and gastrointestinal tract (GIT), which increase nutrient utilization (Hetland *et al.,* 2004). There have been some findings on the impact of soluble and insoluble non-starch polysaccharides on the physiology and morphology of the digestive system of broilers (Banfield *et al.,* 2002; Iji *et al.,* 2001; and Jimenez Moreno *et al.,* 2011). Dietary fiber (DF) can be digested by enzymes depending on carbohydrates composition, relations, and chain length. Based on the chemistry and accessibility of specific DF to microbiota groups and consortiums, DF presents huge potential to modulate gut microbiota (Hamaker and Tuncil, 2014).

Wheat bran a byproduct of the milling process, is rich in insoluble fiber, consisting mainly of arabinoxylans and, to a lesser extent, cellulose and β-glucans (Kamal-Eldin *et al.,* 2009). The unique aptitude of fiber to leak digestion and absorption provides the break to regulate intestinal morphology (Miao *et al.,* 2005; and Mbuza *et al.,* 2016), interact with nutrients of the digesta (Goromela *et al.,* 2007), interact with intestinal microflora (Alabi *et al.,* 2013; and Raphulu *et al.,* 2015), and moderate general digestive organ action (NRC, 1994), resulting in changes in nutrient digestion and performance. It has also been described that different components of crude fiber (CF) can moderate the physiological structure and functionality of the digestive system differently (Choct, 2015; NRC 1994; and Pickering, 2011). All these changes present an overall inflection of the nutrient metabolism that might result in impacts on performance.

The beneficial effects of DF on nutrient digestibility might also be related to the effects of DF on gizzard development and the concomitant increase in HCl and digestive enzyme secretion. It has been suggested that a large, well-developed gizzard, as occurs with DF inclusion, improves GIT motility, favors gastroduodenal refluxes, and increases cholecystokinin release, which in turn may stimulate the secretion of pancreatic enzymes (Jha *et al.,* 2019; and Yadav and Jha, 2019).

All these activities affect the functioning of the gut and may modify microbial growth at specific digestive organ sites. Dietary fiber affects gut development in different ways, depending not only on the type of fiber used but also on its particle size. Jiménez-Moreno *et al.* (2011) reported that, in general, the effect of DF on the relative weight or length of the full gut was more evident with the inclusion of sugar beet pulp (SBP) than with OH, probably because of the higher water-holding capacity of the pectin fraction of the SBP. Shang *et al.* (2020) found that birds were fed on WB had a greater relative weight of gizzard and improved the activities of amylase and trypsin in the pancreas and jejunum mucosa and increased the amylase activity in the pancreas and jejunum mucosa. In another poultry study (Miao *et al.,* 2005) it was shown that feeding on crude fiber from 2.8 to 9% to turkeys resulted in an increase in the number and size of villi in all sections of the small intestine with higher fiber-containing diets. Similar results have been reported in quails when Mbuza *et al.* (2016) fed 1.5% micronized wheat fiber to quails and reported results of an increase in the relative length of intestinal segments, villi height, villus thickness, and villi-to-crypt proportions.

Dietary fibers could modulate gut microbiota by increasing the proportion of *Bacteroidetes* and *Firmicutes* (Han *et al.,* 2018; and Li *et al.,* 2016), inhibit the growth of *Salmonella* (Kumar *et al.,* 2012), and stimulate the growth of butyrogenic bacteria and *Verrucomicrobia* (Li *et al.,* 2016). Six of the eight studies (Costabile *et al.,* 2008; Neacsu *et al.,* 2017; and Salonen *et al.,* 2014) showed significant effects on gut microbiota from wheat fiber or bran fiber consumption, and two showed no effect (Deroover *et al.,* 2017; and Walker *et al.,* 2011).

The aim of the trial was to evaluate the effects of inclusion different levels of crude fiber from WB without and with enzymes in broiler diets on gut length, intestinal enzymes activity, and cecum microbiology and gut morphology.

MATERIALS AND METHODS

The present experiment was implemented in Poultry Nutrition Farm, Poultry Production Department, Faculty of Agriculture, Ain Shams University, Qalyubia, Egypt, to investigate the effect of different high CF levels from wheat bran WB with and without enzymes in broiler diets on intestine enzymes, composition blood parameter, microbiology and intestine histology.

Regarding experimental diets, the chemical composition of Wheat Bran (WB) used in feed formulations was as follows: (Dry matter 86.60%, Ash 4.50%, Metabolizable energy 1810 Kcal/Kg, crude protein 15.10% and Crude fiber 9.07%). Also, enzymes as feed additives (B-mannanase 200U/g, Xylanase 9000 U/g, B-glucanase 250U/g and Cellulase 750 U/g).

Experimental design:

The study comprised of 210 Indian River (IR) unsexed one-day old chicks, were randomly distributed into 6 treatments (in addition to control group), each treatment contained 3 replicates each replicate included 10 chicks. The chicks were grown in electrics heated batteries and kept under similar environmental and managerial condition during a 35 days experimental period. The experimental design and composition and calculated analysis of the basal diet (starter 1-21 days and finisher 22-35 days of age) are presented in Table (1). The treatments (T_{1-6}) were groups of birds fed on WB at levels (5, 7.5 and 10%) without and with enzymes in addition to control group (basal diets). The lighting program was controlled to provide 23-hour light and one-hour dark daily by fluorescent tube lighting. The temperature was controlled and gradually reduced from 32°C to 20°C on day 35. Feed was offered *ad-libitum* in mash form according to experimental diets in stainless steel feeders. Fresh water was accessible all the time by automatic nipple drinkers.

Measurements and procedures:

Digestive enzymes activity (U/dl):

Enzymes analyses of some intestinal continents were conducted in medical analysis Laboratory, Faculty of medicine, MANSAURA University. Quantitative determination of Amylase, lipase, Trypsin, Chymotrypsin, Cellulase and Xylanase. All digestive enzymes activity of samples was determined according to Nitsan *et al.* (1991).

Cecum microbiology:

Content of cecum was collected to determine the microbiological flora in (microbiological laboratory, Faculty of Agriculture, Ain Shams University) for enumeration of total bacteria*, coliforms* and *lactic acid bacteria*.

Small intestine (Ileum) histopathological:

Morphometric analyses of digital photos of light microscopy were performed by image analysis program (ImageJ software) according to Abràmoff *et al.* (2004). Villus height, Villus Width, Crypt Depth, Muscular Layer Thickness, and Goblet Cells Number were determined and calculated. All sections were examined under an electric microscope provided with computerized camera. The values were measured with a coulometer at a magnification of 5x under a light microscope fitted with the stage micrometer and using an image analyzer (Leica Microsystems Co., Ltd., Germany) connected to a light microscope.

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

Ingredients (%)	**Starter 0- 21 days**				**Finisher (22 – 35 days)**			
	Control	**5% wheat bran**	**7.5% wheat bran**	**10% wheat bran**	**Control**	**5% wheat bran**	**7.5% wheat bran**	**10% wheat bran**
Yellow corn	53.85	49.34	47.21	45.14	55.06	51.20	49.18	47.20
Soybean meal (46 CP%)	33.00	33.00	33.00	33.00	32.10	31.00	31.00	31.00
Corn gluten meal (60 CP%)	6.80	6.08	5.75	5.35	5.00	4.97	4.50	4.04
Wheat bran	**0.00**	**5.00**	**7.50**	**10.00**	**0**	**5.00**	**7.50**	**10.00**
Soybean oil	2.10	2.40	2.40	2.40	3.70	3.70	3.70	3.70
Monocalcium phosphate	1.75	1.64	1.59	1.53	0.88	0.93	0.96	0.96
Limestone	1.32	1.36	1.38	1.41	2.18	2.05	1.98	1.90
HCL- Lysine	0.28	0.27	0.26	0.25	0.21	0.25	0.26	0.26
D-L Methionine	0.30	0.31	0.31	0.32	0.27	0.30	0.32	0.34
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Premix*	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated composition**								
Metabolizable energy (Kcal/kg)	**3017.48**	**2955.83**	**2918.90**	**2881.85**	**3100**	**3040**	**3003**	**2965**
Crude protein (%)	23.07	23.01	23.03	23.03	21.50	21.50	21.50	21.50
Crude fiber (%)	2.53	2.91	3.09	3.27	2.51	2.85	3.05	3.21
Calcium (%)	0.97	0.97	0.97	0.97	0.87	0.87	0.87	0.87
Available phosphors (%)	0.49	0.49	0.49	0.49	0.43	0.43	0.43	0.43
Lysine (%)	1.04	1.04	1.04	1.04	1.29	1.29	1.29	1.29
Methionine (%)	0.56	0.56	0.56	0.56	0.51	0.51	0.51	0.51
Methionine+ cysteine (%)	1.09	1.09	1.09	1.09	0.99	0.99	0.99	0.99

Each 3 Kg of premix contains: 15000000 I.U. Vit, A, 3000000 I.U VIT. D 50g. VIT E, 3000 mg VIT. K3. 3000 mg VIT. B1, 8000 mg. VIT B2, 4000 mg. VIT B6, 20 mg. vit. B12, 15000 mg pantothenic acid, 60000 mg. niacin, 1500 mg. folic acid, 200 mg. biotin, 200000 mg VIT C, 700 gm. choline chloride, 80 gm. Mn, 80 gm. zinc, 60 gm. iron, 10 gm. CU, 1 gm. Iodine, and 0.2 gm, where CaCo3 was taken as a carrier up to 3 kg, the inclusion rate was 3 Kg premix/ ton feed.
*** Calculated analysis of the experimental diets was done according to (Brazilian feed stuffs, (Horacio, 2017)).*

Statistical analysis:

Data were statistically analyzed using the General Linear Model Procedure of analysis (SAS, 2001). Duncan's multiple range test (Duncan, 1955) was used to test differences within means of treatments, while level of significance was set typically at minimum ($P \leq 0.05$). The statistical model used for analyzing data was as follows:

$$Y_{ij} = M + T_i + e_{ij}$$

Where:
Y_{ij} = observation of the parameter measured. M = overall mean.
T_i = effect of treatment.
e_{ij}= random error.

RESULTS AND DISCUSSION

Effect of dietary treatments on digestive tract length:

Results presented in Table (2) showed significant differences between chicks fed different dietary treatments in total length of digestive tract and length of small intestine (cm). The corresponding values for digestive tract length ranged between 219.52 and 249.62 cm compared with control 217.5cm. While values for the length of the small intestine ranged between 181.25 and 212.33 cm. Data showed a significant effect between treatments; birds fed WB 10% with enzymes were the taller in total length of digestive tract and small intestine compared to other treatments. While the smaller length was seen in control group. These results agree with **(**Shang *et al.*, 2020; and Rezaei *et al.*, 2018) they reported that using WB in birds' diets increased total digestive tract and small intestinal length. This may be because birds respond rapidly to changes in DF content by changing the intestinal length and weight of the digestive organs and the rate of passage through the different segments of the gut (Svihus, 2011**;** and Hetland and Svihus, 2001)**.** Data showed that cecum length (cm) and width (mm) were significantly affected by dietary treatments, where it was found that there was a significant increase in cecum length (cm) and width (mm) in birds fed WB with or without enzymes (T_{1-6}) by (17.56, 18.62, 19.07, 17.37, 17.50, and 20.01) respectively, compared to control group (17.18 cm). While cecum width saw the same result, birds were fed on WB without or with enzymes increase the width by increasing WB in diets, thus showing the lowest width and length for cecum in control group. The reasons may be due to the size of their sources or their manufacture in diets. Results, which are recorded in Table (2), proved that there was an increase in the size of the cecum in birds fed high levels of fiber WB. The reasons for these results may be that DF components are not digested by digestive enzymes and thus are substrates for bacterial fermentation in the distal part of the gut. The main products of fermentation are short-chain fatty acids (SCFAs), predominantly lactate, acetate, propionate, and butyrate. The SCFA may assist in developing the size of the cecum as well as increasing the activity of epithelium cell production (Montagne *et al.,* 2003).

Table (2): Effect of dietary treatments on some of lengths of digestive gut parts on broiler chicks.

Items	Treatments							S.E.	Sig.
	Control	T1	T2	T3	T4	T5	T6		
Total digestive tract	217.50b	219.52b	232.60ab	243.00ab	222.50ab	233.34ab	249.62a	3.53	*
Small intestine	181.25b	187.25b	195.00ab	212.33ab	187.50b	192.61ab	195.60a	2.70	*
Cecum	17.18b	17.56b	18.62ab	19.07ab	17.37b	17.50ab	20.01a	0.35	*
Cecum width (mm)	9.35c	10.17abc	10.21abc	11.75ab	9.93bc	10.41ab	12.02a	0.41	*

a, b and c; means in the same raw with different superscripts in the same raw are significantly (p>0.05) different, N.S.: non-significant.
Control: basal diet, T1: feed with 5% wheat bran (WB), T2: feed with 7.5% WB, T3: feed with 10% WB, T4, T5 and T6, 5%, 7.5% and 10% WB with enzymes.

Effect of dietary treatments on intestine enzymes activity (U/dl) of broiler chicks:

The data presented in Table (3) showed the effects of using different levels of WB without or with enzymes compared with a basal diet on amylase, lipase, trypsin, and chymotrypsin. cellulase and xylanase. Data in Table (3) showed that using different levels of WB without or with enzyme supplementation led to and significantly increased in amylase activity (U/dl) in birds fed on WB (T_{1-6})

(33.19, 34.17, 36.61, 38.80, 37.67, and 39.72 (U/dl)) compared to those birds fed on basal diets (31.02) (U/dl).

The activity of lipase is not affected by the treatments. The corresponding value ranged between 11.08 and 12.88 (U/dl). While the activity of trypsin and chymotrypsin was improved in birds fed on diets containing WB compared to control group, the corresponding values ranged in treatments (T_{1-6}) between 28.15 and 30.60 U/dl for trypsin activity and 26.61 U/dl for control. And (21.38: 25.86 (U/dl)) and control (20.59 (U/dl)) for chymotrypsin activity However, these differences failed to be significant.

The results showed that the activity of cellulase and xylanase in birds fed on diets with WB (T_{1-6}) showed a significant increase with increasing the level of WB in diets; the level of cellulase activity in treatments (T_{1-6}) began at 50.76, 56.30, 65.28, 60.63, 61.51, and 65.29 U/dl compared to control group at 44.58 U/dl. In the same order, activity of xylanase treatments (T_{1-6}) begin (53.86, 65.18, 73.54, 68.58,74.50 and 79.60 (U/dl)) compared to control group (37.38 (U/dl)).

These results agree with **(**Hetland *et al.,* 2004**;** and Shang *et al.,* 2020), who found that high levels of fiber in broiler diets stimulated intestinal or pancreatic enzyme secretion.One possible reason for the increased enzyme activity was that DF could stimulate enzyme secretion by regulating the production of hormones such as cholecystokinin, secretin, and gastrin produced in the digestive tract (Svihus, 2011).

Table (3): Effect of dietary treatments on intestinal enzymes activity of broiler chicks.

Items	Treatments							SE	Sig.
	Control	T1	T2	T3	T4	T5	T6		
Amylase	31.02c	33.19ab	34.17ab	36.61ab	34.80ab	37.67a	39.72a	0.85	*
Lipase	12.41	12.72	12.88	11.39	11.80	11.08	12.14	0.25	N. S
Trypsin	26.61	28.15	29.54	30. 58	28.50	29.36	30.60	0.91	N. S
Chymotrypsin	20.59	21.38	23.48	23.15	23.92	24.68	25.86	0.69	N. S
Cellulase	44.58c	50.76c	56.30bc	65.28ab	60.63bc	61.15ab	65.29ab	2.10	*
Xylanase	37.38c	53.86c	65.18bc	73.54ab	68.58bc	74.50ab	79.60ab	2.52	*`

a, b and c; means in the same raw with different superscripts in the same raw are significantly (p>0.05) different, N.S.: non-significant.
Control: basal diet, T1: feed with 5% wheat bran (WB), T2: feed with 7.5% WB, T3: feed with 10% WB, T4, T5 and T6, 5%, 7.5% and 10% WB with enzymes.

Effect of dietary treatments on cecum microbiology (CFU/G) of broilers chick:

Numerically, the obtained results in Table (4) showed that using WB in broiler diets (T_{1-6}) clearly gave higher counts for total count and counts of lactic acid bacteria than control, while the *coli forms* were highest value recorded in control group compared to other treatments.

In general, the lowest figures of total counts of bacteria were seen when control group were incorporated into diets, and the corresponding values were 82 x 10^5, while another treatment (T_{1-6}) saw an increase in the count of total count bacteria, an increase in the level of WB, and the addition of enzymes to diets containing WB (T_{4-6}) led to an increase in total count bacteria. While the results showed that the highest count of coliforms was seen in control group ($164*10^4$) compared to other treatments (T1-6), adding enzymes to diets with WB (T_{4-6}) decreased the count of *coliforms*. On the data recorded, the lowest count of *lactic acid bacterium* was seen in control group ($840*10^5$), while another treatment (T_{1-6}) mildly increased the count of lactic acid bacterium with an increase in WB, and the addition of enzymes in diets with WB (T_{3-6}) improved the count of *lactic acid bacterium* compared to WB without enzymes (T_{1-3}).

Many researchers agree with this result (Sadeghi *et al.*, 2015; Rajendran *et al.*, 2017; Dunislawska *et al.*, 2017; Yadav & Jha, 2019; Jha, 2019). They indicated that DF improved digestive microbiology as well as were used as prebiotics in feedstuffs, directly promoting the growth of beneficial gut microflora and the production of SCFA. Similarly, insoluble fibers also act as a general nutrient diluent, which can be both helpful and harmful, potentially impacting the colonization of beneficial gut microbes (Jiménez-Moreno *et al.,* 2011).

Table (4): Effect of dietary treatments on cecum microbiology (CFU/G) on broiler chicks

Items	Treatments						
	Control	T1	T2	T3	T4	T5	T6
Total bacterium * 10^5	82	116	185	368	188	234	467
Coli forms *10^4	164	84	89	116	42	27	26
Lactic acid bacterium * 10^5	840	876	900	912	919	926	942

Control: basal diet, T1: feed with 5% wheat bran (WB), T2: feed with 7.5% WB, T3: feed with 10% WB, T4, T5 and T6, 5%, 7.5% and 10% WB with enzymes.

Effect of dietary treatments on Histological and morphometric analysis of the ileum villi:

Table (5) showed that the T4 and T1 treatments had significantly wider, higher villi and crypt depth, respectively, compared to the control and other treatments. In the present study, increased villus height of the ileum in broilers fed a diet containing only 5% WB with or without enzymes suggests an increase in the surface area that would be capable of greater absorption of the available nutrients.

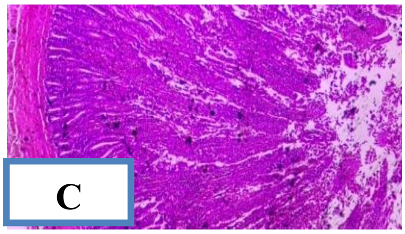
Moreover, the 5% WB with or without enzyme supplementation increased the villus width and crypt depth of the ileum, confirming the better intestinal absorptive capacity. On the other hand, the T3 treatment ileum villi histological structure was negatively affected, as they had significantly lower villi length compared to the rest treatments. However, there were no significant differences between the villi width of T3, T6 and the control, there was no significant difference between the crypt depth values of chicken raised on a diet containing 10% WB (T3) and the crypt depth of a chicken raised on a control diet..

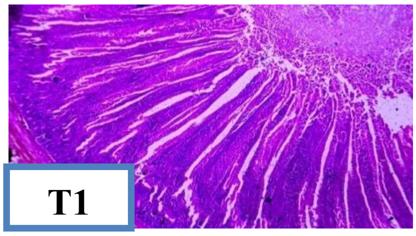
Feeding a diet containing 10% WB (T3) or 10% WB supplemented with enzymes had the same significant effect on the crypt depth value. Ileum villi length was not significantly affected by feeding a diet containing 7.5% WB or 7.5% WB with enzymes compared with feeding a control diet. However, the Ileum villi length was significantly lower at chicken group feed with a diet containing 10% WB (T3) or 10% WB supplemented with enzymes (T6) compared with the 7.5% WB diet group.

Table (5): Effect of dietary treatments on intestinal morphology of broiler chicks.

Items	Treatments							SE	Sig.
	Control	T1	T2	T3	T4	T5	T6		
Ileum villi length	1245.69^{ab}	1271.50^{ab}	1255.25^{ab}	1200.00^{c}	1337.71^{a}	1269.00^{ab}	1196.09^{c}	15.41	*
Ileum villi width	64.81^{c}	97.78^{a}	72.97^{bc}	60.38^{c}	93.10^{ab}	76.35^{ab}	62.43^{c}	3.52	*
Crypt depth	83.88^{d}	164.50^{ab}	120.01^{bc}	114.00^{cd}	181.88^{a}	139.25^{bc}	116.50^{bc}	6.96	*
Muscle thickness	142.50	102.50	138.75	148.75	128.57	106.52	135.67	5.94	N. S

a, b and c; means in the same raw with different superscripts in the same raw are significantly (p>0.05) different, N.S.: non-significant. Control: basal diet,
Control: basal diet, T1: feed with 5% wheat bran (WB), T2: feed with 7.5% WB, T3: feed with 10% WB, T4, T5 and T6, 5%, 7.5% and 10% WB with enzymes.





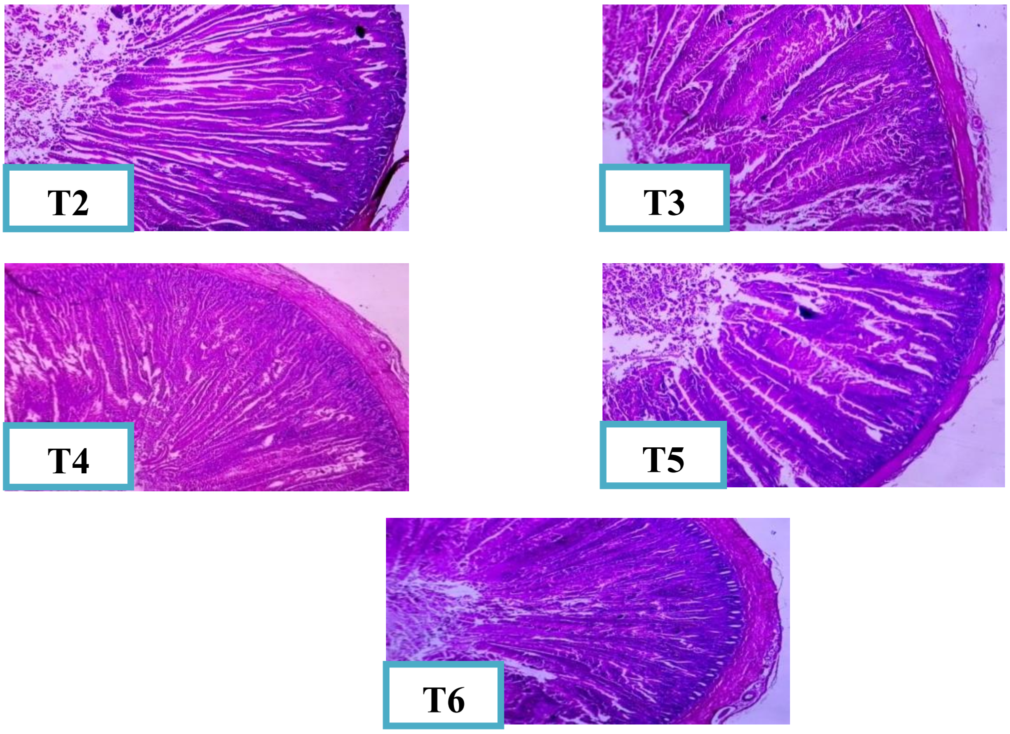


Figure (1): Transverse section through small intestine ileum villi from birds of different treatments at 35 DOA. (H & E ×400).

Control: basal diet, T1: feed with 5% wheat bran (WB), T2: feed with 7.5% WB, T3: feed with 10% WB, T4, T5 and T6, 5%, 7.5% and 10% WB with enzymes.

CONCLUSION

From the previous results it could be concluded that using WB in broiler chicken diets has a positive effect on intestinal length, enzymes activity, cecum microbiology and intestinal histology.

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تأثير نخالة القمح مع أو بدون أضافة الإنزيمات على أطوال القناة الهضمية ونشاط إنزيمات وهيستولوجى الأمعاء الدقيقة وميكروبات أعور بدارى التسمين

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أجريت هذه الدراسة لتقييم استخدام ردة القمح (WB) على اطوال الامعاء مورفولوجيا الأمعاء الدقيقة ونشاط الإنزيمات وميكروبيولجيا الاعورين علي دجاج التسمين. تم استخدام 210 من كتاكيت دجاج التسمين Indian River IR غير مجنس من عمر يوم حتي عمر 35 يوم. تم توزيع هذه الكتاكيت عشوائيًا على سبع مجموعات كل مجموعة 30 كتكوت، في ثلاث مكررات (10 كتاكيت لكل مكرر). تم تغذية المجموعة الأولى على عليقة قاعدية (الكنترول)، بينما تم تغذية المجموعات (T1-6) علي علائق يحتوي على 5٪ و7.5٪ و10٪ نخالة القمح على التوالي بدون وبإضافة إنزيمات. أظهرت النتائج أنه بعد خمسة أسابيع كان هناك تأثير كبير بين الطول الكلي للجهاز الهضمي وطول الأمعاء الدقيقة والأعور مقارنةً بالمجموعة الكنترول، وكان هناك تحسن كبير للطيور التي تم تغذيتها على WB (T1-6) على نشاط إنزيمات أميليز وسليوليز وزيلاناز بالإضافة إلى زيادة كبيرة في طول وعرض الخملات وعمق الخلايا الكأسية. أدى استخدام WB في دجاج اللحم (T1-6) إلى زيادة في العدد الإجمالي للبكتيريا مقارنة بالمجموعة الكنترول، وزيادة في عدد بكتيريا حمض اللاكتيك، وانخفاض في عدد البكتريا الضارة Coliforms.

الخلاصة:

استخدام نخالة القمح في علائق دجاج التسمين له تأثير إيجابي علي كل من طول القناة الهضمية والأمعاء الدقيقة والأعور وأعداد البكتريا النافعة والتركيب الهيستولوجي للامعاء.