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Impact of Synbiotic and Antibiotic growth promoter (AGP) Supplementation on Duodenal Morphology in Broiler Chicken

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ABSTRACT

Under present investigation, ninety (n=90) day-old broiler chicks were reared and assigned to 03 treatments groups consisting of three replicates of 10 birds in each pen. It was divided into three groups viz; Group-I (control/basal diet feed), Group-II (antibiotic growth promoter-AGP treatment) and Group-III (synbiotic treatment) comprised of 30 birds in each group. A ventro-abdominal incision was made, and dissection was performed and different biometrical measurements of the duodenum were taken on the empty duodenum. Duodenum was the first segment of the small intestine which originated from the right antero-dorsal surface of the gizzard. In all age groups and experimental treatments, two bile ducts and two pancreatic ducts opened close to each other in the ascending part of the duodenum near its termination. The supplementation with synbiotics significantly increases weight, length and width of duodenum in broiler chickens as compared to control and AGP group. This increment in morphometric parameters might be corelated with the composition of the diet and the supplements used.

Key words: Duodenum, Morphology, Supplement

INTRODUCTION

The poultry industry is one of the fastest growing industries of global livestock production (Mottet *et al.,* 2017). The production of sufficient amount of food for the global population is one of the major current challenges. In poultry industries the antibiotics (ABs) have been used for prevention and treatment of infectious diseases and when added at sub-therapeutic level in the diet may act as a growth promoter commonly called Antibiotic growth promoter (AGP). The antibiotics (ABs) exhibits negative effects on animals and human health when used continuously at subtherapeutic dose for long time cause antimicrobial resistance (AMR) (Grenni *et al.,* 2018). Therefore, the importance of using alternative of antibiotic growth promoters such as prebiotic, probiotic and their combination, the synbiotic is evident. The synbiotics were envisaged to combine both prebiotics and probiotics. Intestine plays an important role in absorption, digestion of nutrients from food and passes the digested food into blood-stream. The duodenum is largely responsible for the breakdown of food using enzymes (Verma *et. al.,*2020). The aim of this project was to explore the changes in anatomy of duodenum of broiler chicken after supplementation of Antibiotic growth promoter (AGP) and synbiotic with a logical and sequential approach. Hence, the present work has been designed.

MATERIALS AND METHODS

For the proposed work ninety (n=90) day-old Cobb-400 strain broiler chicks were reared under ideal husbandry conditions in Poultry Farm, DUVASU, Mathura and randomly assigned to 03 treatments groups consisting of three replicates of 10 birds in each pen. It was divided into three groups viz; Group-I (control/basal diet feed), Group-II (antibiotic growth promoter-AGP treatment) and Group-III (synbiotic treatment) comprised of 30 birds in each group. Each group was subdivided into 3 replicates, with 10 birds per pen. The birds had free access to water and feed. Climatic conditions and the lighting program were maintained according to commercial recommendations. Two birds were sacrificed from each replicate of each group (with humane method) at different age groups viz. 2, 4, and 6 weeks of age. A ventro-abdominal incision was made, and dissection was performed and different biometrical measurements of the duodenum were

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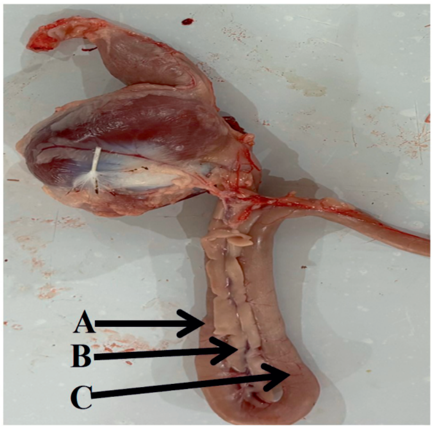

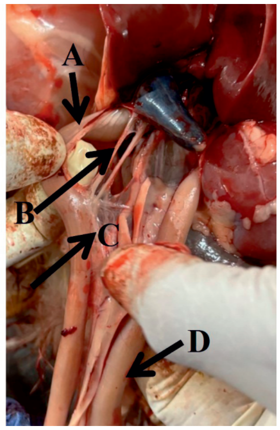

Fig. 1: Photograph of 04-week-old chicken (Control group) showing Descending duodenum (A), Pancreas (B), and Ascending duodenum ©
Fig. 2: Photograph of 06-week-old chicken (Synbiotic group) showing Ascending duodenum (A), bile duct (B), pancreatic duct (C), and Descending duodenum (D)
Fig. 3: Photograph of 06 week old chicken (Synbiotic group) duodenum under stereo zoom microscope showing mucosal surface (Arrow).

taken on the empty duodenum. Length, width and weight of duodenum were measured using a digital vernier calliper and a weighing balance. The data generated by the biometrical observations was subjected to statistical analysis.

RESULTS AND DISCUSSION

Duodenum was the first segment of the small intestine which originated from the right antero-dorsal surface of the gizzard. It extended caudoventrally along with the right abdominal wall towards the pelvic inlet, forming an elongated U-shaped loop with a proximal descending portion and a distal ascending portion that encircled the pancreatic tissue between its loops. (Fig. 1). The morphology of duodenum in broiler chicken in different treatment groups was identical as the descriptions of Bradley and Grahame (1960) in fowl, McLelland (1975), Nickel *et al.* (1977) in avian species, Dyce *et al.* (2009) in fowl, and Hamdi et al. (2013) in the black-winged kite. In all age groups and experimental treatments, two bile ducts and two pancreatic ducts opened close to each other in the ascending part of the duodenum near its termination similar with those reported by Getty (1977) in fowl and Igwebuike and Eze (2010) in the African pied crow (Fig. 2). Both the ascending and descending part of the duodenum were connected by a narrow fold of mesentery. The descending portion of the duodenum was the most ventral segment of the intestine. The presence of pancreatic tissue in U-shaped loop was similar to the findings of Dyce et al. (2009) in fowl. The mucous membrane of duodenum has a velvety appearance due to presence of villi as reported by Khaleel and Aetia (2017) in indigenous ducks (Fig.3).

Biometric Analysis:

Weight (gm): In this study, duodenum weight at 2, 4, and 6 weeks showed a highly significant 'F' value difference (P<0.01) between age and treatment group, and maximum weight was gained by synbiotic feed group (Table 1). Similar to the Kalita (2009) in fowl observed significant (p<0.05) increase in terms of duodenum weight from day 1 to day 56, Aslam (2010) in Giriraj and BV 300-layer breeds of poultry observed that the weight of duodenum increased with the advancement of age, Levi *et al.* (2013) in anak and marshal quail breed of poultry show a significant (P<0.05) increase in duodenum weight from 2 to 8 weeks, Ahmad *et al.* (2012) in Japanese quails observed significant (P<0.05) difference in duodenum weight from 3^{rd} week to or 6^{th} week, Kalita et al. (2012) in kadaknath fowl observed significant (p<0.05) increase in terms of duodenum weight from 1^{st} week to 6^{th} week, Nasrin *et al.* (2012) in broiler postnatal growth observed that the weight of duodenum was significantly greater at 4^{th} week as compared to 2^{nd} week, with differences statistically significant (P<0.01), Karad *et al.* (2024) in Japanese quail noticed that duodenum weight from 1^{st} week to 6^{th} week were significantly increased (p<0.05). Fernandes *et al.* (2014) observed significant increase in weight (p<0.05) after treatment of probiotic, prebiotic products (synbiotics) as compare to antimicrobial agent in broilers.

Length (cm): In current work the duodenum length at 2, 4, and 6 weeks showed a highly significant 'F' value difference (P<0.01) between age and

Table 1: Table showing the morphometric analysis of duodenum in different groups

Parameter			Weight of duodenum (gm)	Length of duodenum (cm)	Width of duodenum (mm)
Group-I	**Range**	**2 week**	2.14-3.15	15-17.8	1.5-2.03
		4 week	7.19-7.99	22.5-26	3.45-4.18
		6 week	9.88-11.25	25-27.4	2.2-3.3
	Mean	**2 week**	$2.49^{C}\pm0.15$	$16.41^{c}\pm0.36$	$1.81^{b}\pm0.084$
		F-value	18.84**	19.77**	8.44**
		4 week	$7.40^{c}\pm0.12$	$24.66^{c}\pm0.62$	$3.84^{b}\pm0.09$
		F-value	180.31**	11.44**	6.73**
		6 week	$10.42^{c}\pm0.18$	$26.11^{c}\pm0.39$	$2.84^{c}\pm0.15$
		F-value	11.34**	16.74**	13.46**
Group-II	**Range**	**2 week**	3.05-4.01	17.3-18.5	1.79-2.59
		4 week	8.76-9.42	24.5-28	3.2-4.91
		6 week	10.54-13.35	26.25-30	3.2-3.91
	Mean	**2 week**	$3.55^{b}\pm0.15$	$17.93^{b}\pm0.20$	$2.24^{b}\pm0.12$
		F-value	18.84**	19.77**	8.44**
		4 week	$8.97^{b}\pm0.12$	$26.33^{b}\pm0.57$	$3.89^{b}\pm0.27$
		F-value	180.31**	11.44**	6.73**
		6 week	$11.91^{b}\pm0.48$	$27.92^{b}\pm0.57$	$3.50^{b}\pm0.12$
		F-value	11.34**	16.74**	13.46**
Group-III	**Range**	**2 week**	3.31-5.15	18.5-22.5	2.01-3.62
		4 week	10.72-11.89	27.5-30	4.05-5.28
		6 week	10.9-14.5	28.5-30.4	3.26-5.07
	Mean	**2 week**	$4.19^{a}\pm0.26$	$20.36^{a}\pm0.65$	$2.76^{a}\pm0.23$
		F-value	18.84**	19.77**	8.44**
		4 week	$11.24^{c}\pm0.18$	$28.33^{a}\pm0.40$	$4.73^{a}\pm0.16$
		F-value	180.316**	11.447**	6.73**
		6 week	$13.24^{a}\pm0.50$	$29.65^{a}\pm0.26^{a}$	$4.30^{a}\pm0.28^{a}$
		F-value	11.34**	16.74**	13.46**

*n= 90, Figures in parenthesis, a, b, c, superscript showed the significant difference between groups. *in superscript representing significant difference between the groups. ; ** in superscript representing highly significant difference between the groups*

treatment group, and maximum length was gained by synbiotic feed group (Table 1). Aslam (2010) in Giriraj and BV 300-layer breeds of poultry observed that the length of duodenum increased with the advancement of the age, Kalita (2009) in fowl observed a significant ($p<0.05$) increase in duodenum length from a day 1 to day 7 and day 7 to day 14, Kalita *et al.* (2012) in post hatch kadaknath fowl observed significant ($p<0.05$) increase in duodenum length from day 21/week 3rd to day 42/ 6th week while non-significant ($p>0.05$) from day 7 or 1st week to day 14 or 2nd week to day, Nasrin et al. (2012) in broiler postnatal growth observed that the length of the duodenum was significantly greater at day 28 / 4th week compared to days 1 and day 14 / 2nd week, with difference statistically significant ($P<0.01$), Ahmad *et al*. (2012) in Japanese quails observed significant ($P<0.05$) difference in terms of duodenum length from day 21 / 3rd week to day 42 / 6th week, Mandal *et al*. (2012) in broiler at 48th day showing significant ($P<0.05$) difference in duodenum length, Levi *et al*. (2013) in anak and marshal quail breed of poultry showed a significant ($P<0.05$) increase in duodenum length from 2 to 8 weeks, Saini (2018) in broiler after supplementation of feed additives (Prebiotic and Probiotic) at 1st week or day 7 found significant ($P<0.05$) while at day 35 or 5th week of age found non-significant ($P>0.05$) in duodenum length, Karad *et al*. (2024) in Japanese quail noticed that duodenum length was maximum at day 42 / 6th week showing significance ($p<0.05$) while no significant difference was observed at day 7 / week 1 and day 14 / 2 week ($p>0.05$) and showed significant ($p<0.05$) difference at day 21 / week 3.

Width (mm):

The duodenum width at 2, 4, and 6 weeks showed a highly significant 'F' value difference ($P<0.01$) between age and treatment group, and maximum width was gained by synbiotic feed group (Table 1). Aslam (2010) in Giriraj and BV 300 layer breeds of poultry observed the parameters such as diameter of duodenum was increased with the advancement of the age. Kalita (2012) in post hatch kadaknath fowl observed significant ($p<0.05$) increase in terms of duodenum weight from day 7 or 1st week to day 14 / 2nd week to day 21/week 3rd to day 42 / 6th week, Ahmad *et al*. (2012) in Japanese quails noticed significant ($P<0.05$) difference in terms of duodenum width from day 21 / 3rd week to day 42 / 6th week, Karad *et al*. (2024) in Japanese quail noticed significant ($p<0.05$) increase of duodenum width from 2nd week to 3rd week and to 6th while non-significant difference ($p>0.05$) from 1st week to 2nd week.

The above results also conicide with the results of Saini (2018) in broilers supplemented with prebiotic and probiotic. This increment in morphometric parameters were directly correlated with the composition of the diet and the supplements used (Bogucka *et al*,2018 and Wang *et al.* 2016).

From this study we concluded that the supplementation with synbiotics significantly increased various parameters of duodenum in broiler chickens as compared to control and AGP group.

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