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MORPHOLOGICAL DEVELOPMENT OF THE DIGESTIVE TRACT AT PRE AND POST HATCH PERIOD

IN BROILER CHICKS (*Gallus gallus domesticus*)

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Abstract

The objective of this study was to evaluate the morphological development and growth of different segments of the digestive tract at pre and post hatch period of broiler chickens. A total sixty birds divided into: thirty of embryos at the days 10^{th} , 15^{th} and 20^{th} of incubation period and thirty of chicks at the days 1^{st} , 15^{th} , 30^{th} of post hatch period were used, as ten for each age. The live body weight taken of each bird and after careful evisceration, their digestive tracts segments (esophagus with crop, proventriculus, ventriculus, small intestine and large intestine) were dissected. The location, shape and weight of the collected organs were recorded. Morphological results showed that esophagus divided into two regions by crop cervical esophagus and thoracic esophagus. Stomach was divided into two parts, glandular stomach (proventriculus) and the muscular stomach (ventriculus). Small intestine divided into three parts these are represented by duodenum, jejunum and ileum. Large intestine represented by cecum and colon. Data of the absolute weight of each organ separately, showed increasing with age, were the increasing significantly different between ages ($p \leq 0.05$), while the data of the weight of each organ separately relative to body weight showed increasing at pre hatch period and at hatch day, but these values decrease at 15th day of post hatch period.

Keywords: Gross Morphology, Digestive organ, Chicken

I. INTRODUCTION

The Gallus gallus species usually known as the broiler chicken has a fast development rate that is affected by intestine development. The digestive system in birds has went out of a multitude of changes through the development to become a unparalleled anatomical and physiological composition compared to mammals and introduction a number of specific countenance between the various avian species and breeds on the other (Hassan & Mousa, 2012) with large evolutionary adaptations intended to facilitate flight (Tomar., 2015). The gastrointestinal tract morphology and digestive strategy has been significantly intertwined during development to correspond the nutrient content of foods obtainable in its natural habitat (Majeed et al., 2009; Kadhim et al., 2011). The purpose of this study is to describe the morphological changes in different segments of the digestive tract structure (Esophagus, proventriculus, gizzard, small and large intestine) in embryo, newly hatched and progressively develop chick of the broiler chicken.

II. MATERIALS AND METHODS

Thirty fertilized eggs, 10 for each group of days 10, 15 and 20 of incubation period and thirty chicks, 10 for each group of day 1st ,15th , 30th post hatch period used for this study were obtained from Basra healthy poultry farming (Fadak company) (figure 1). Embryos were extracted from the eggs by breaking the shell gently at wide side by small scissors according the methods described by Peebles et al. (1998). The embryos and chicks body were opened through the ventral cut into the thoracic-abdominal cavity. The digestive canal was carefully removed from the adhering structures. Photographs of organs: esophagus with crop, proventriculus, gizzard, small and large intestines were taken as soon as they were identified and were studied for morphometric features and measurements (shape, color and weight). Data's recorded were encoded in data base conceive on the spreadsheet programmer Excel 2010. The data obtained were expressed as Mean ± SEM (Standard Error of Mean) and subjected to statistical analysis using Statistical Package for the Social Sciences (SPSS) version 26.0. One-Way Analysis Of Variance (ANOVA) at 95% confidence interval (CI) was used to determine the level of significant difference in mean values among the ages. Values of ($P \leq 0.05$) were considered significant. Where there were differences in means, they were separated by the least significant difference (LSD) method. The mean weight for each region represented as absolute and relative to body weight and.

III. RESULTS

Morphological results showed that (Figure 2) the esophagus was a long, thin- walled muscular tube connecting the oropharynx cavity to the proventriculus and it divided into two regions: cervical esophagus which expands to form crop and thoracic esophagus. Stomach was located in the left lower quadrant of the abdominal cavity and it was divided into two parts, glandular or true stomach (proventriculus) and the muscular stomach or gizzard (ventriculus). The proventriculus appeared as cone in shaped, separated from the gizzard by isthmus, lining with number of macroscopically visible low wide papillae projecting into the lumen. Gizzard appeared as biconvex lens in shaped bluish-red in colour, lining with yellow tissue (koilin), the ventriculus wall is consists of four smooth muscle regions, each one arises and terminates at *annular tendinous* area (Figure 3). Small intestine divided into three parts these are represented by duodenum, jejunum and ileum. The duodenum is arranged as a narrow U-shaped loop with

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descending and ascending parts encloses the pancreas. The jejunum is arranged in loops occupying the right caudal quadrant of the body cavity .The ileum was the last small intestinal segment located among the caeca. The jejunum and ileum are arranged in garland-like coils. Large intestine represented by cecum and colon. The ceca is paired (right and left) elongated blind pouches began at the transition between ileum and colon. Each cecum consisting of three parts: (a) Base or neck, the proximal, short part with thick wall and narrow lumen. (b) Body, long middle part which is ampulliform in shape and has thin wall with wide lumen, grayish-brown to green according to the contents. (c) Apex, the final short part is spreads to a pointed end. The colon is the final, straight segment of the large intestine that extends between the ileo-cecal junction and the cloaca and it was relatively short and had thick, muscular walls.

The absolute weight of organs (esophagus with crop, stomach, small and large intestine) separately showed an increase with age and the statistical analysis of biometrical results revealed that the mean of absolute weight values differed significantly ($P < 0.05$) among all ages (figure 4, 6, 8 (A, B and C) and 9 (A, B)) . The weight of organs separately relative to body weight increase with age within the ages (10th Ed, 15th ED, 20th ED, 1st PD), the clearly increased was at the day 1st post hatch, while the values drops clearly at the day 15th post hatch and continues slightly to the day 30th and the statistical analysis of biometrical results revealed that the mean weight relative to body weight values differed significantly ($P < 0.05$) among all pre and post hatch groups (figure 5, 7, 8 (D, E, F) and 9 (C, D)).

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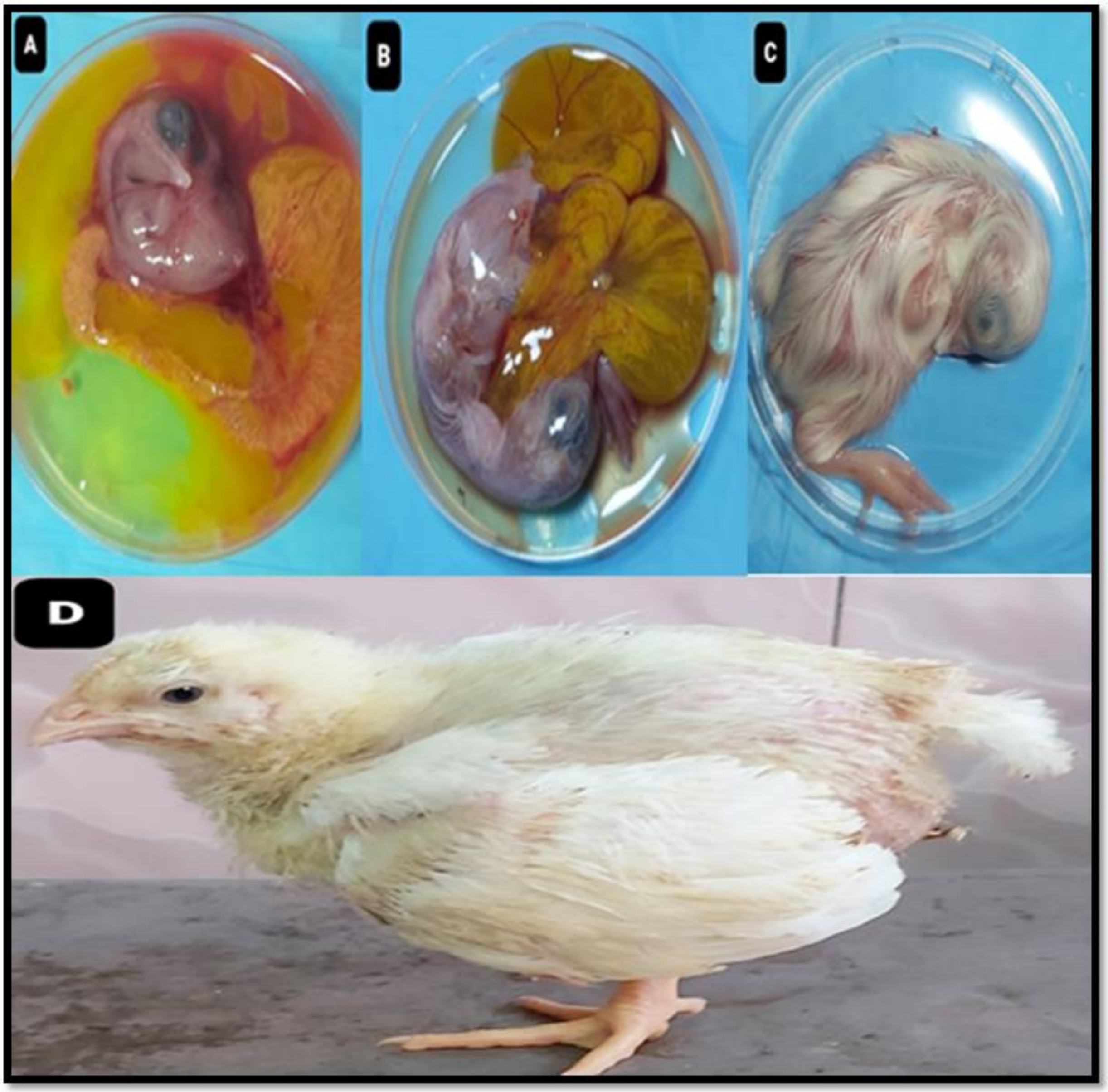

Figure 1: Embryo of chicken at ages (A) 10th day, (B) 15th day and (C) 20th day; (D) chick at age 15th day post hatch.

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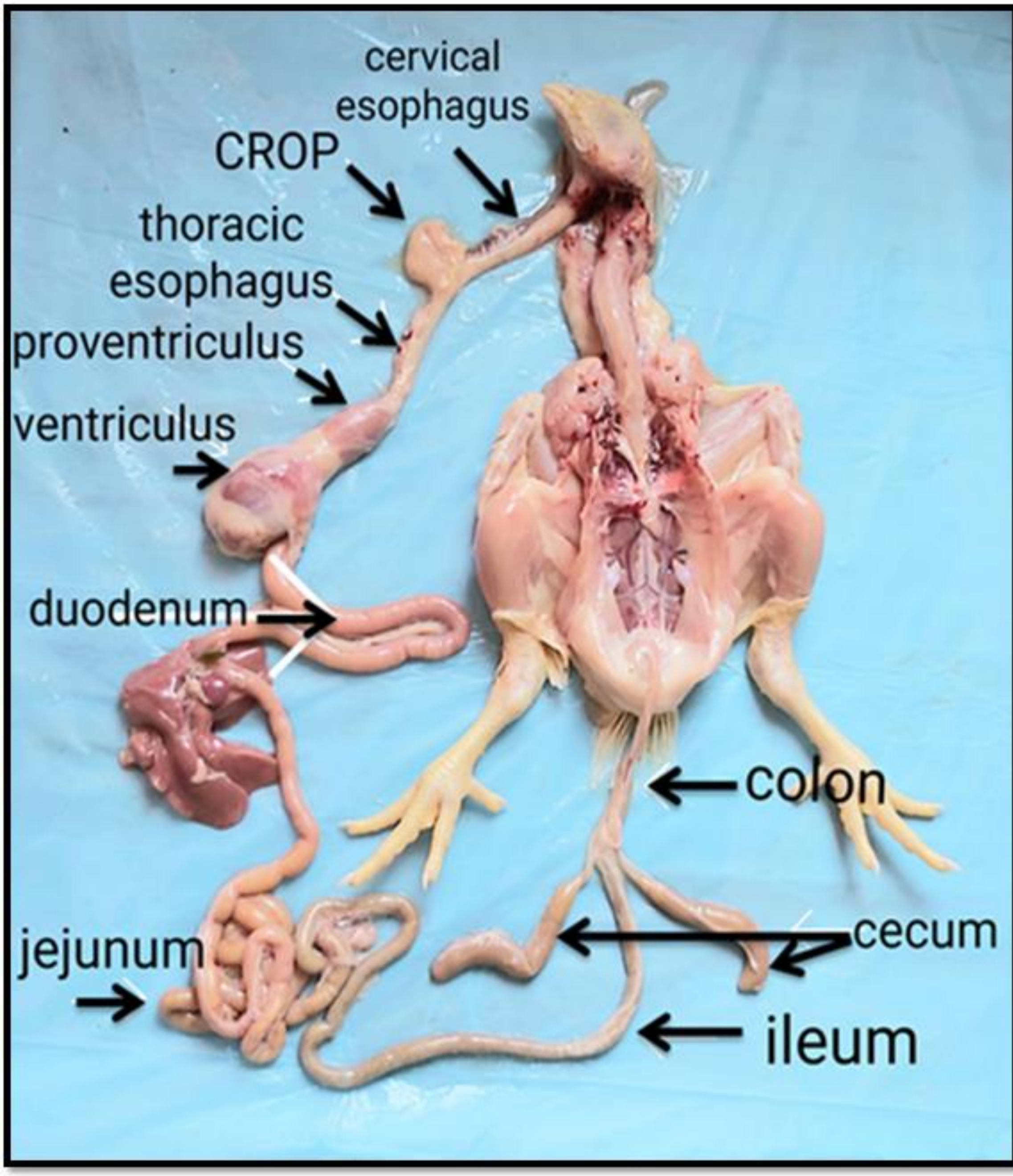

FIGURE 2: Digestive system of broiler chicken

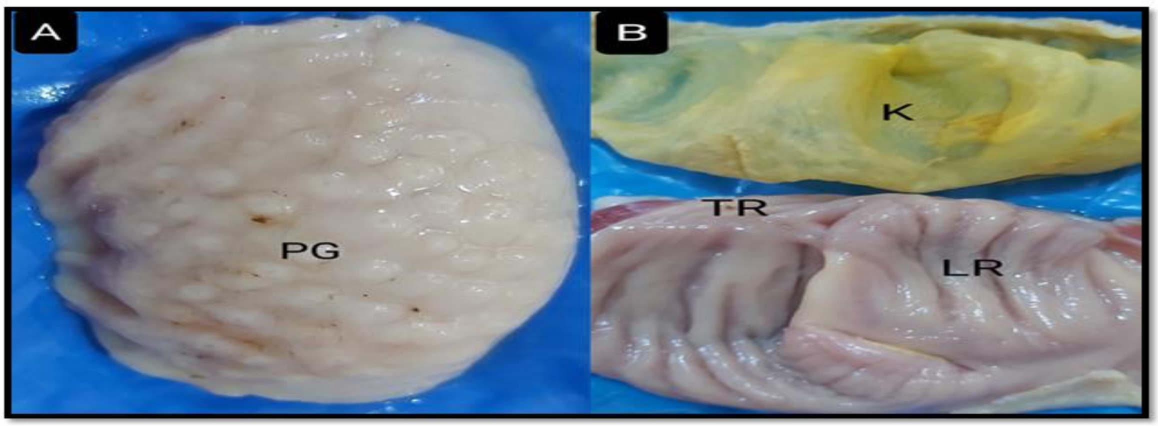

Figure 3: Proventriculus (A) showing the papillae of proventriculus glands (PG); Ventriculus (B) showing the lining folds which are arranged in longitudinal rows (LR) and transverse rows (TR) and koilin (K).

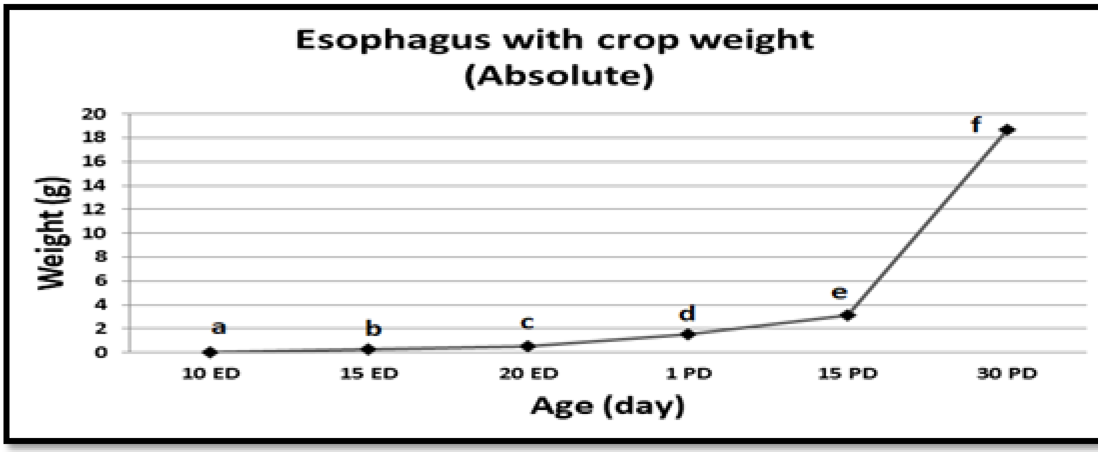

Figure 4: The esophagus with crop weight at d10, d15 and d20 of pre hatch age (ED) and at d1, d15 and d30 of post hatch age (PD). Values are means ± SE, N=10, Where a, b, c, d, e and f significant differences at level P<0.05 between the ages.

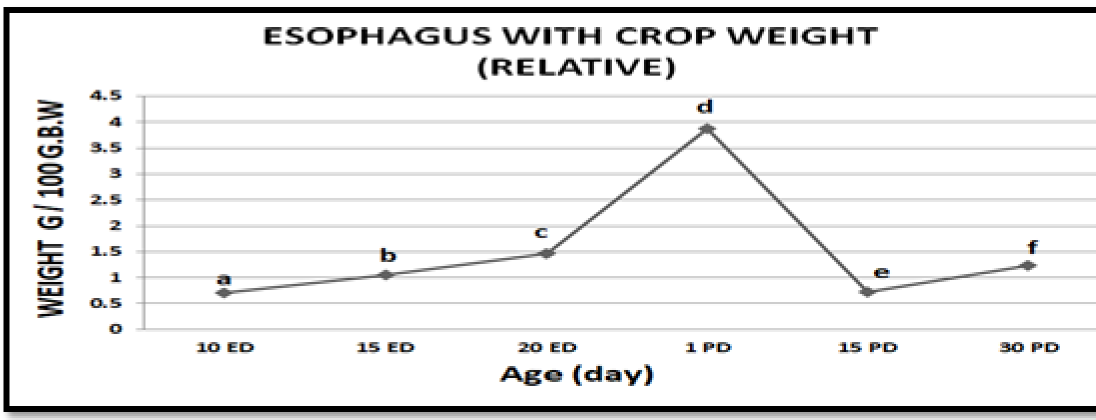

Figure 5: The esophagus with crop weight relative to body weight (g organ/100 G.B.W) at d10, d15 and d20 of pre hatch age (ED) and at d1, d15 and d30 of post hatch age (PD). Values are means ± SE, N=10, Where a, b, c, d, e and f significant differences at level P<0.05 between the ages.

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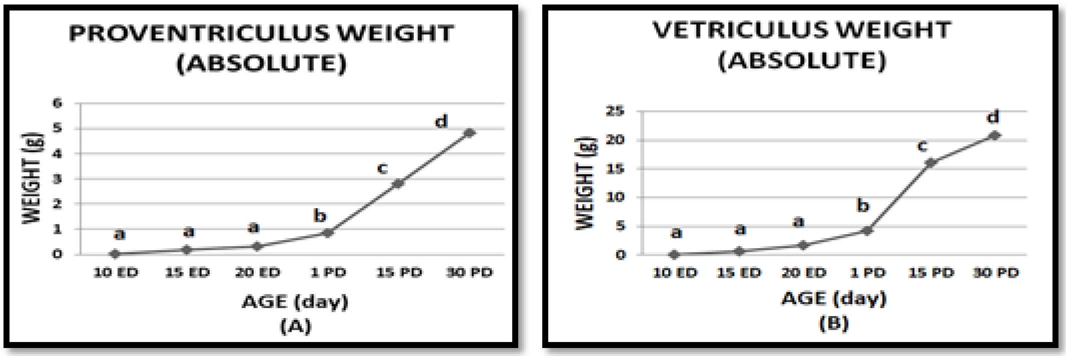

Figure 6: The weight of (A) proventriculus and (B) ventriculus, at d10, d15 and d20 of pre hatch age (ED) and at d1, d15 and d30 of post hatch age (PD). Values are means ± SE, N=10, Where a, b, c and d significant differences at level P<0.05 between the ages.

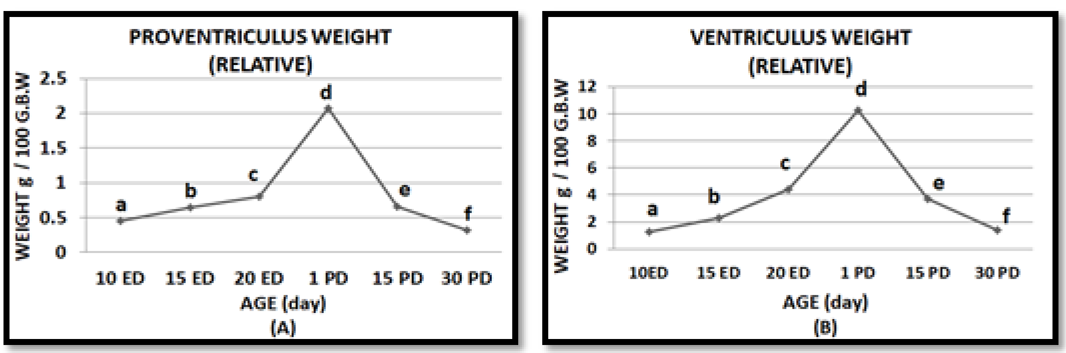

Figure 7: The weight of (A) proventriculus and (B) ventriculus relative to body weight (organ G/ 100 G.B.W), at d10, d15 and d20 of pre hatch age (ED) and at d1, d15 and d30 of Figure post hatch age (PD). Values are means ± SE, N=10, Where a, b, c, d, e and f significant differences at level P<0.05 between the ages.

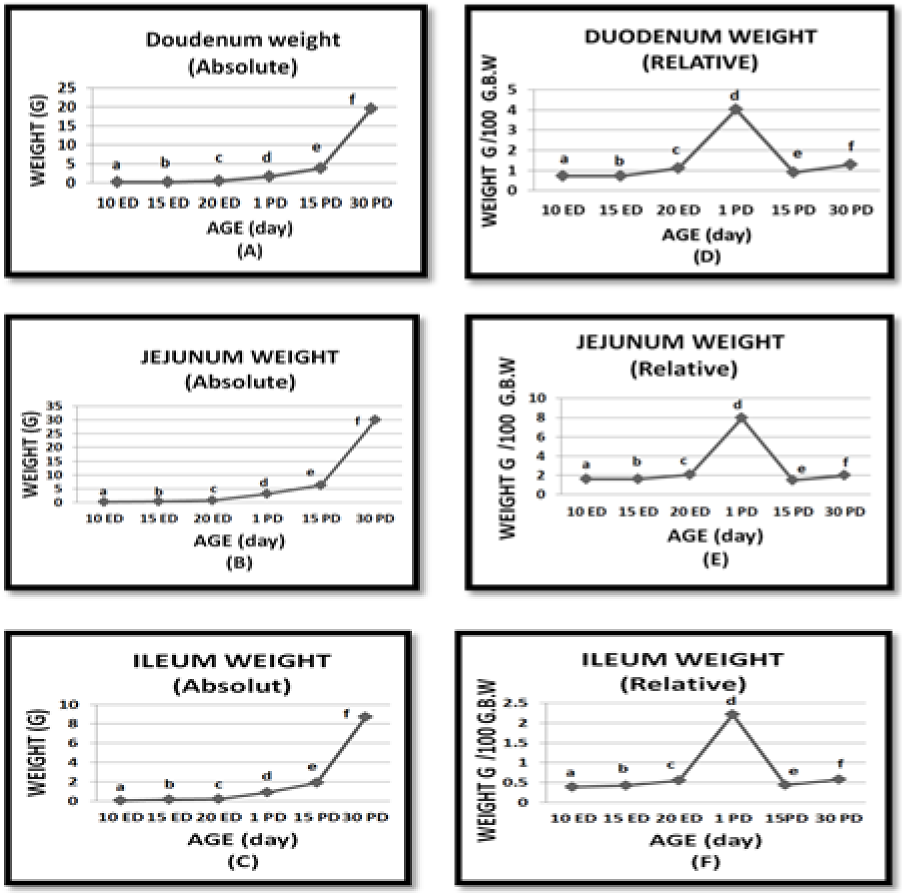

Figure 8: The weight of small intestinal segments, Left (A, B, C) absolute weight and Right (D, E, F) relative weight to body weight (g organ/ 100G.B.W.) at d10, d15 and d20 of pre hatch age (ED) and at d1, d15 and d30 of post hatch age (PD). Values are means ± SE, N=10, Where a, b, c, d, e and f significant differences at level P<0.05 between the ages.

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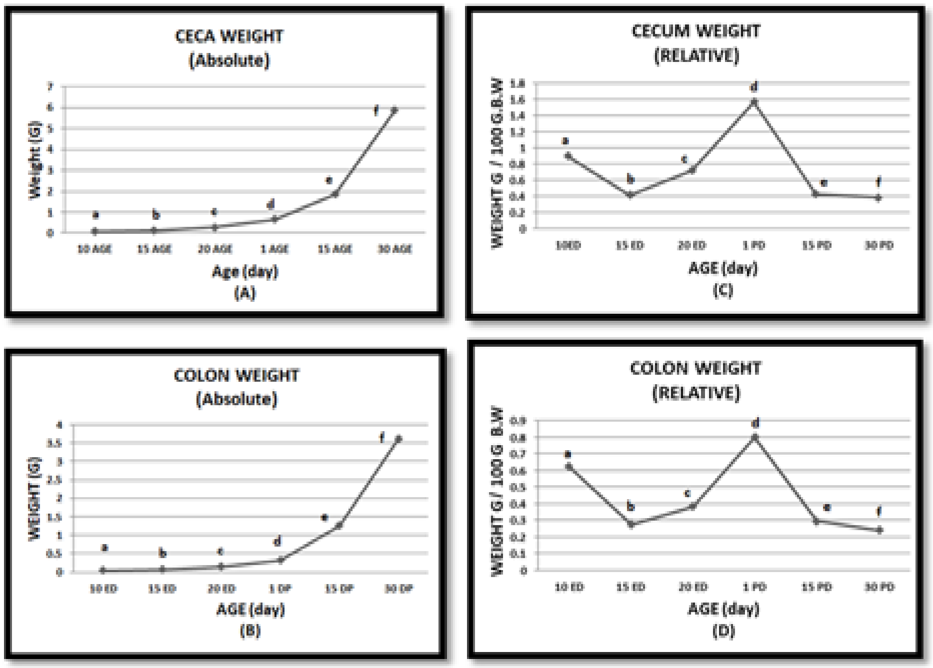

Figure 9: The weight of large intestinal segments, Left (A, B) absolute weight and Right (D, E) relative weight to body weight (g organ / 100 G.B.W.), at d10, d15 and d20 of pre hatch age (ED) and at d1, d15 and d30 of post hatch age (PD). Values are means ± SE, N=10, Where a, b, c, d, e and f significant differences at level P<0.05 between the ages.

IV. DISCUSSION

(McGeady ,2017) indicated that in vertebrates the esophageal development begins by extending as a fusiform dilation of the foregut and then separated into the cervical and thoracic parts by the appearance of out-pouch called the crop. The current study showed that in chicken the esophagus appears as a long tube on the right side of neck, as in other birds (Kadhem et al., 2013; Muhammad et al, 2015; Taha and AL-Duleemy, 2020). In some birds, the esophagus is missing a crop (Umar et al., 2021), while in other birds the crop appear as two-lobed pear-shaped or appear as fusiform in shape (Shehan, 2012), This difference came from the discrepancy in the feeding pattern that is reflected in the anatomical construction plan based on function (Rossi J.R. et al., 2006).

Stomachs, both within and between species of avian, are have great morphological and functional variance. The stomach of chicken composed of two parts: small proventriculus and large, well-developed muscle gizzard with a distinct narrow region called the Isthmus separated the two parts, these results are in agreement with what has been indicated by studies on birds are insect eaters, grain eaters, and herbivores, including domestic birds (Eman S. J.2016; Al-yasery, 2017; Madkour et al., 2018; Al-Kinany, 2019; Ibrahim et al., 2019), While in Elanus caeruleus (Hamida et al., 2012) observed that the two segments of the stomach form one large pear-shaped cavity with no evidence of isthmus. In birds characterized by fish-eating, Piscivores and Carnivores, the glandular stomach was large in size, more adapted for storage, whereas the gizzard is similar to sac and mostly difficult to distinguish the isthmus region from the outside (Hussein et al., 2020).

According to the previous studies (Alshamy., 2018; Cruz et al., 2019; Sohel et al., 2019) and the current study, the small intestine in chicken is a thin tube consists of three segments, but there is no clear morphological demarcation to differentiate between them. In the present study, the large intestine in chicken have paired blind pouches (ceca) while, in other birds the large intestine holds a very small pair of ceca called, lymphoid ceca (Hamdi et al, 2012) or holds a short single, left and not well developed ceca (Al-Agele et al., 2020) or have paired ceca but not developed (Udoumoh et al., 2021). According to (Abadi et al,.2019; Wedegaertner, 2021), there is a strong a correlation between diet and cecal mass: herbivores have larger ceca than carnivores, but omnivores are intermediate.

In the embryo, the digestive organs were among the fastest growing organs (Sarfraz et al., 2019). During embryogenesis, extra embryonic membranes (yolk sac, amnion, chorion, and allantois) are important for development and survival of embryo (Filho et al., 2020). In the initial growth, at first week of incubation, small glucose stores are used to maintain metabolism (Moran, 2007). Later, the extra embryonic membranes are completely developed (Bauer et al., 2013) and lipids are used as the main energy substrate (De Oliveira et al., 2007), faster phase of embryonic development. In the final, significant shifts in embryonic metabolism occur as a result of the internal environment changes considerably (Omede et al., 2017). At hatch, nutrients are obtainable from an exogenous diet, while the limited nutrient stores are used to stimulate the gastrointestinal tract development, morphologically and physiologically (Uni. et al, 2012). Also, the maximal developmental rate is at the first day post hatching and then declined rapidly with age until the decrease became insignificant at a specific time. At this time point a balance had been established between the growth rates of gastrointestinal segments to the body weight.

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