EVALUATION OF DEVELOPMENTAL MORPHOLOGY OF THE SMALL INTESTINE OF LIGHT ECOTYPE NIGERIAN INDIGENOUS CHICKEN

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Abstract
The aim of this study was to evaluate the developmental morphology of the ileum of Nigerian indigenous chicken using histological and transmission electron microscopic techniques. Thirty fertile eggs of light ecotype Nigerian indigenous chicken were used for this study. Samples of the duodenum, jejunum and ileum were obtained from 6 randomly selected birds on embryonic days 14 (ED 14), 19 (ED 19) and post-hatch day 1 (PD 1) after ketamine euthanasia. At ED 14, the lamina epithelialis mucosae of the small intestine of Nigerian indigenous chicken exhibited low columnar enterocytes with irregularly shaped surface microvilli, lamina propria-submucosa, and poorly defined basal lamina. In the ileum, areas of cuboidal-like enterocytes were also observed. At ED 19, the tunica mucosa comprised of low columnar-shaped enterocytes, few Goblet cells, microfold cells (M-cells), enteroendocrine cells and well formed basal lamina. Areas of lamina muscularis mucosae were occasionally seen in the tunica mucosa of the jejunum at ED 19. At post-hatch day 1, distinct lamina propria mucosae and submucosal areas were observed. In addition, areas of lymphocyte infiltration were present in the connective tissue of the lamina propria mucosae and submucosa. Acidic mucin which predominated and neutral mucin areas were demonstrated by Periodic Acid Schiff - Alcian blue histochemistry. It was concluded that the ileum of light ecotype Nigerian indigenous chicken exhibit certain unique features which highlights that the functional and structural maturation of the ileum may occur just before hatch.

Keywords: ileum, morphological development, Nigerian indigenous chicken,

Introduction

The small intestine consists of three segments: duodenum, jejunum and ileum in both mammals and birds. These segments which are strategically positioned are important in the digestion of food and absorption of nutrients (Bacha and Bacha, 2000). In each of the segments, four tunics have been documented: tunica mucosa, tunica submucosa, tunica muscularis and tunica serosa. Variations in the structural and functional features of the digestive tracts of avians have been documented (Parchami and Dehkordi, 2011; Udoumoh et al., 2016). These variations may be related to the evolutionary events, species and habitats of the birds among other factors. Information on the structural features of the small intestine of mature chicken exist (Bacha and Bacha, 2000). However, there is paucity of information on the developmental features of the small intestine of Nigerian indigenous chicken. The present study aims to investigate the morphological features of the small intestine of light ecotype Nigerian indigenous chicken using histological,

histochemical and transmission electron microscopic techniques as described by Sheehan and Hrapchak (1980) and Igwebuike and Ezeasor (2014).

Results and Discussion

At embryonic day 14, the lamina epithelialis mucosae of the small intestine exhibited low columnar epithelial cells, indistinct lamina propria mucosae and submucosal areas and circularly arranged smooth muscle cells in the tunica muscularis (Fig. 1). In the ileum, the cuboidal-shaped or low columnar shaped entrocytes showed irregularly shaped surface microvilli (Fig. 2). The cuboidal-like enterocytes observed in this study varied from the reports of previous investigators (Bacha and Bacha, 2000). Moreover, the lamina epithelialis mucosae of the ileum rested on a basal lamina and exhibited lamina densa, lamina lucida without well defined hemi-desmosomes, a common feature of the basal lamina. The lamina propria-submucosa was a mesenchymal connective tissue that contained fibroblastic reticular cells, isolated lymphoblasts, heterophils and blood capillaries (Figs 1, 2). Whereas fibroblastic reticular cells may form the framework of the small intestine, the heterophils are similar to mammalian neutrophils in structure and functions while the isolated lymphoblasts could act as seeds in the development of gut lymphatic tissues (Fig. 1).

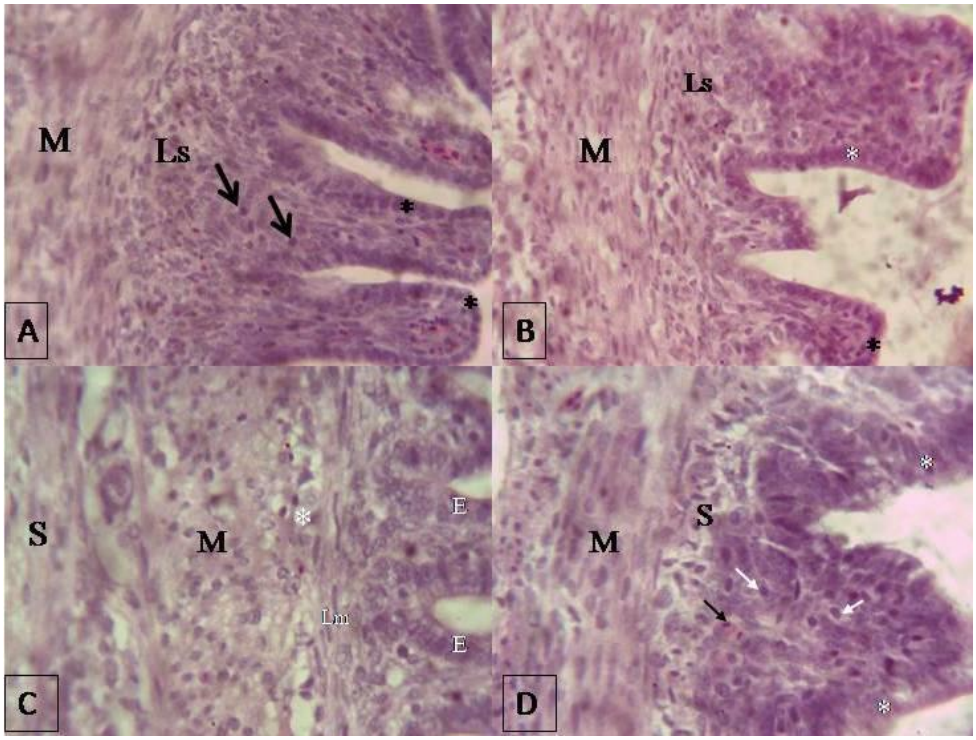


Figure 1: Photomicrographs of the ileum of light ecotype Nigerian indigenous chicken. H&E stain: 1A; ileum at embryonic day 14 showing cuboidal-like cells (black asterisks), isolated lymphoblasts (black arrows), lamina propria-submucosa (Ls) and tunica muscularis (M) x400. 1B; ileum at embryonic day 19 showing cuboidal-like (black asterisk) and columnar-shaped cells (white asterisk), lamina propria-submucosa (Ls), tunica muscularis (M) x400. 1C; Jejunum at embryonic day 19 showing low columnar epithelial cells (E), lamina muscularis mucosae (Lm), submucosa (asterisk), tunica muscularis (M) and tunica serosa (S) x400. 1D; Jejunum at post-hatch day 1 showing simple columnar epithelium (white asterisk), tunica submucosa (S), lymphocytes (white arrows), Blood capillary (black arrow) and tunica muscularis (M). x400.

At embryonic day 19, the lamina epithelialis mucosae exhibited low columnar-shaped enterocytes, few Goblet cells, M cells and entero-endocrine cells (Figs. 1, 2, 3). These cells may be fully differentiated at about ED 19 in this species. Several signaling pathways influence the differentiation of intestinal stem cells into enterocytes, Goblet cells, endocrine cells, paneth cells and tuft cells (Noah, 2011). At ED 19 the basal lamina exhibited well formed hemi-desmosomes. Lamina muscularis mucosae which we occasionally observed in the jejunum at ED19 may reflect the variations that may occur within this hardy breed of chicken.

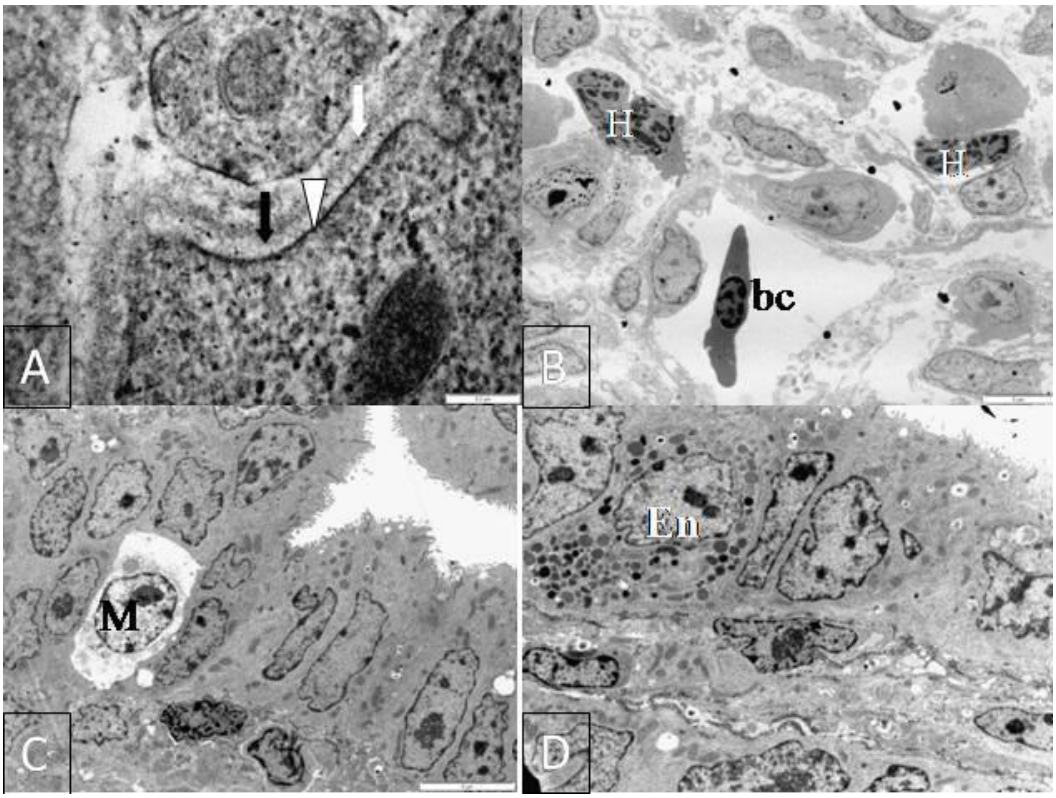


Figure 2: Transmission electron micrographs of the ileum of light ecotype Nigerian indigenous chicken: 2A; basal lamina at embryonic day 14 showing lamina densa (arrow head), lamina lucida (black arrow) and poorly formed hemidesmosome area (white arrow). TEM x 64000. 2B; lamina propria-submucosa at embryonic day 14 showing heterophils (H) and blood capillary (bc). TEM x2400. 2C; lamina epithelialis mucosae at embryonic day 19 showing M-cell (M). TEM x3400. 2D; lamina epithelialis mucosae at embryonic day 19 showing enteroendocrine cell (En). TEM x4400.

At post-hatch day 1, the morphology of the ileum of Nigerian indigenous chicken was similar to that of mature birds. Distinct lamina propria mucosae and tunica submucosal areas were present. In addition to the presence of fibroblastic reticular cells, reticular fibres, nerve and nerve plexuses, lymphocytes which suggest the participation of the ileum in immune defense of the gut were observed in the loose connective tissue of the lamina propria mucosae and submucosa of the ileum (Fig. 1D). Moreover, histochemical evaluation of the small intestine at embryonic day 19 and post-hatch day 1 revealed the presence of neutral mucin on the surface lining of the lamina epithelialis mucosae as well as acidic and neutral mucin Goblet cell areas (Fig. 3). Although the mucin may act as lubricants, the acidic environment of the small intestine may also be necessary for the protection of the embryo from pathogens, since their immune system is poorly developed at this time.

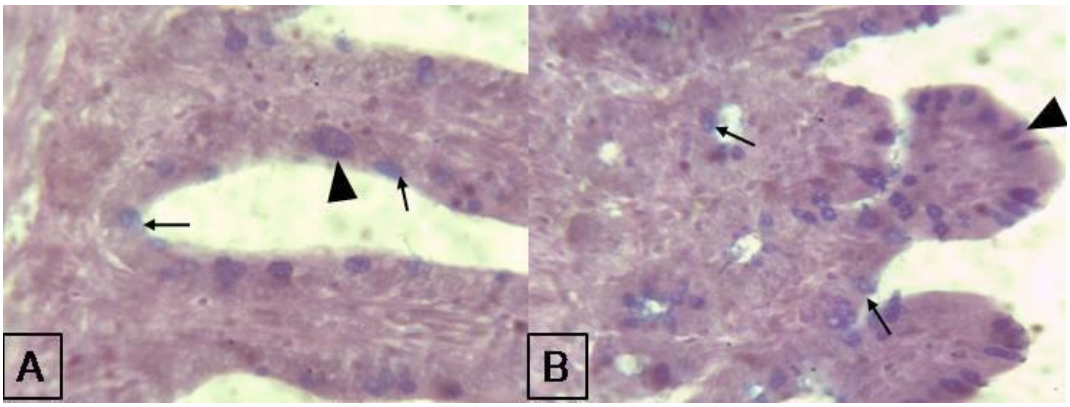


Figure 3: Photomicrograph of the small intestine of Nigerian indigenous chicken. 3A (duodenum at ED 19) and 3B (jejunum at PD1) showing areas of acidic mucin (arrows) and neutral mucin (arrow heads). PAS-Alcian blue x400.

Conclusion and Recommendations

The study has demonstrated that the ileum of light ecotype Nigerian indigenous chicken exhibit certain unique features of the gut which highlights that the functional and structural maturation of the ileum may occur at about embryonic day 19. These features further reveal the hardy nature of Nigerian indigenous chicken. Hence, the Nigerian indigenous chicken should be employed for breed development and improvement of other chicken breeds.

Funding: This work was partly supported by the Tertiary Education Trust Fund (TETFund) of Nigeria through the Academic Staff Training and Development (AST&D) intervention of 2015-2016 and Institution Based Research (IBR) intervention of 2015-2016.

Acknowledgement: The technical assistance of Dr Lizette duPlessis and Ms Antoinette Buys of the EM unit of Department of Anatomy and Physiology, Faculty of Veterinary Science, University of Pretoria is deeply appreciated.

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