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RESEARCH ARTICLE

Crop Morpho-Histological Peculiarities in Domesticated Pigeons (*Columba livia domestica*), Cattle Egret (*Bubulcus ibis*) and Domesticated Ducks (*Anas platyrhynchos domestica*)

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Abstract

The crop architecture varies among different avian species consistent with their feeding habits. Therefore, twenty-one of mature healthy male pigeons (granivorous), cattle egrets (carnivorous), and ducks (omnivorous), seven per species, were utilized for the histological, immunohistochemical, and ultrastructural analyses. Histologically, the mucosal folds were covered by non-keratinized stratified squamous epithelium in the three investigated species. The mucosal glands are only peculiar to the crops of the cattle egrets as well as the ducks, while the pigeons' crops were devoid of any secretory units. Morphometrically, the optical densities of the Alcian blue (AB) and periodic acid Schiff (PAS) reactions in the secretory glands, the area % of collagen fibers, the thickness of the tunica musculosa were measured and declared significant differences among the three studied avian species. Immunohistochemical reaction revealed ki-67 immuno-positive reactivity in the nuclei of basal cell layers of the crop epithelium in pigeons only. Regarding ultrastructure investigation, the covering epithelium of all studied species had been shown to be the basal layer of cuboidal to tall columnar cells with desmosomal junctions at the level of their cellular interdigitation, intermediate layers of large irregular polygonal cells with obviously increased cytokeratin filaments especially in the ducks and cellular interdigitation in between. The superficial layer of flat-shaped cells in the three investigated species manifested by desmosomal junctions in between but at the level of the surface squamous cells of the superficial layer, a fine lateral process is only inspected in the pigeons. In conclusion, the crop glands characterized by supranuclear electron dense secretory granules in the cattle egrets and electron-lucent in ducks.

Keywords: Crop, Histological, Morphometrical, Ki-67, Ultrastructure.

Introduction

The birds are the second in their number of species among the vertebrates, which have the ability to adapt their different environments reflecting their variable feeding habits [1] of each species, which shaped the digestive tract to be anatomically, structurally and functionally variable among the different species [2].

According to the type of diet consumed, avian species are classified into granivorous of a diet consists of seeds and grain as the dove, common quail**,** and pigeons [3-5]. The omnivorous species includes seeds, insects and fruits in their diets as the case in ducks and gulls [6]. The carnivorous birds; cattle egret (*Bubulcus ibis*) is fed on insects, frogs and fish [7]. These wide dissimilarities in the nature of the diet attributed to the presences of well-developed sizable crop, which enable the birds to consume a large meal [8].

The crop is a thin walled distendable diverticulum of the esophagus [9]. The topographic anatomy of the crop; shape, and structure are species-specific [10]. The crop is well developed in the granivorous species than carnivorous predators as there are three larger sacs in the pigeons, while in the parrots, there are only two sacs. Gulls, penguins and ostriches are devoided of crops but have a very distensible esophagus in which they can store their food [11].

Histologically, the crop sac wall consists of four tunicae; mucosa, submucosa, musculosa and serosa [12]. The tunica mucosa is characterized by parallel folds (*Plicae ingluviei*), which are covered with stratified squamous epithelium with species differences in the keratinization degree [13]. The lamina propria is a loose Connective tissue which may contain mucous glands [14]. Muscularies mucosa, submucosa and tunica musculosa was inner circular and outer longitudinal smooth muscles fibers [10].

The squamous epithelium is sharing in the formation of the pigeon crop milk [15]. So, it needs to be regenerated from the proliferated basal cells. The cell proliferating marker Ki-67 is an endogenous nuclear protein expressed in proliferating cells [16]. The Ki-67 represents a very effective tool in detecting cell proliferation efficacy [17].

Numerous investigations were concerned with studying the crops, for its importance on the performance and health status of the birds [18], but there is a paucity of information available about the histoarchitecture of the crops with reference to its function. Therefore, we spurred to elucidate the histoarchitectures variations of the crops in the domestic pigeon, cattle egret and domesticated duck avian species according to their food habits via comparing the crops' histological, immunohistochemical and ultrastructural analyses.

Material and Methods

Ethical statement

The research protocol has been reviewed and approved by the Institutional Animal Care and Use Committee, Zagazig University (ZU-IACUC/2/F/112/2018).

Species

The current study had been conducted on twenty-one mature healthy male birds of domestic pigeons (*Columba livia domestica*), cattle egrets (*Bubulcus ibis*), and domesticated ducks (*Anas platyrhynchos domesticus*) as models of granivorous, carnivorous, and omnivorous birds, respectively, n = seven per species.

Sample's collection

The birds were collected from the surrounding localities and transported to the Faculty of Veterinary Medicine, Zagazig University. Through transportation, the birds were kept in a well-ventilated cabinet. Thereafter, the birds were housed at the animal house of the Faculty of Veterinary Medicine in suitable cages under specific conditions of controlled temperature and humidity. Food and water were available ad libitum. Birds were allowed to adapt to their environment for two weeks before the beginning of the harvesting of the tissues. All birds were euthanatized under light anesthesia then the crop had been immediately dissected.

Tissue preparation

The histological and immunohistochemical analyses

For histological analysis, six crops' specimens from each studied species were immediately fixed in 4% paraformaldehyde overnight. The specimens were processed to obtain a desirable paraffin section of 4-5 µm thickness. Some obtained sections were stained with routine staining; Harris's hematoxylin and eosin (H & E), Crossman's trichrome, Alcian blue (AB) stain (pH 2.5) and periodic acid shiff (PAS) technique (El-gomhouria company). The method of

processing and staining was done as previously described [19].

For immunohistochemical analysis, the protocol for immunohistochemical with Ki 67 (Dako, clone M7240, 1:80) was performed according Ghaffari and coauthors (2019) **[**20].

Transmission electron microscopic examination

One specimen of about 1mm^3 from each studied avian species were immediately fixed in a buffered GA/FA fixative (El-gomhouria company), (3% glutaraldehyde and 10 % formaldehyde in 0.1M Phosphate buffer at pH. 7.4 and 4ºC) and processed to select desirable sectioned area for ultra-thin sections to be stained with uranyl acetate and lead citrate (El-gomhouria company), [21]. The ready ultra-thin sections were examined and photographed by a JOEL electron microscope (JEM 1200 EX II) operating at 80KV, at the Faculty of Agriculture, Mansoura University, Mansoura, Egypt.

Morphometric analysis

For the histomorphometrical analysis, six birds were utilized from each studied avian species. For each bird, the four representative non-overlapping fields were used. By using the AB and PAS-stained photomicrographs at 100X magnifications, the optical densities of these reactions in the secretory glands were measured. Also, the area % of collagen fibers in Crossman's trichrome-stained photomicrographs and the thickness of the tunica musculosa at 100X magnifications were measured. These measurements were done using image J analysis software **(Fiji image j; 1.51 n, NIH)** https://imagej.nih.gov/ij/ download. html.

Statistical analysis

The data were collected and tested for normality by the Anderson- Darling test and expressed as mean ±standard error (SEM). Statistical analysis was carried out using the SPSS software program (version 16.0; Chicago, USA). The independent T-test was done for the optical densities of secretory glands between cattle egrets and ducks. One-Way ANOVA followed by post hoc "Duncan's test" was done for the area percentage of collagen fibers between the three studied species, while the thickness of the tunica musculosa was done using the Kruskal–Wallis *H* test. The results were considered statistically significant when $P \leq 0.05$; n = 6 per each studied species**.**

Results

. Microscopical findings

. Histological observation

The examination of H & E-stained cross-sections of the crops from pigeons, cattle egrets, and ducks clarified that the crop wall comprised of four tunicae; mucosa, propria submucosa, musculosa and serosa. The tunica mucosa declared a well-developed mucosal fold (Figures 1a, b, c), which were covered with non-keratinized stratified squamous epithelium in the pigeons (Figure 1d), cattle egrets (Figure 1e**)** as well as in the ducks (Figure 1f). The well-developed rete pegs and superficial squamous cells with perinuclear hallow zone were unique characteristic features to the pigeons' crops (Figure 1d). The mucosal glands were only characteristic to the cattle egrets **(**Figure 1e) as well as the ducks (Figure 1f**)**. In the cattle egrets, the glands were detected beneath surface epithelium and open directly into it. Their lining secretory cells were columnar with basal oval nuclei, pale acidophilic vacuolated cytoplasm and clear cell boundaries (Figure 2a**)**. In the ducks, the glands were deeply detected in the propria submucosa and opened into the surface epithelium via -duct. Their lining secretory cells were tall columnar with flat basal nuclei resting on the basement membrane, pale foamy acidophilic cytoplasm and clear cell boundaries (Figure 2b). The secretory cells were positively reacted to AB (Figures 2c,

d) and PAS (Figures 2e, f) in both cattle egrets and ducks. Both AB and PAS optical densities were significantly higher in the cattle egrets than ducks (Figures 2 g, h**,** and Table 1).

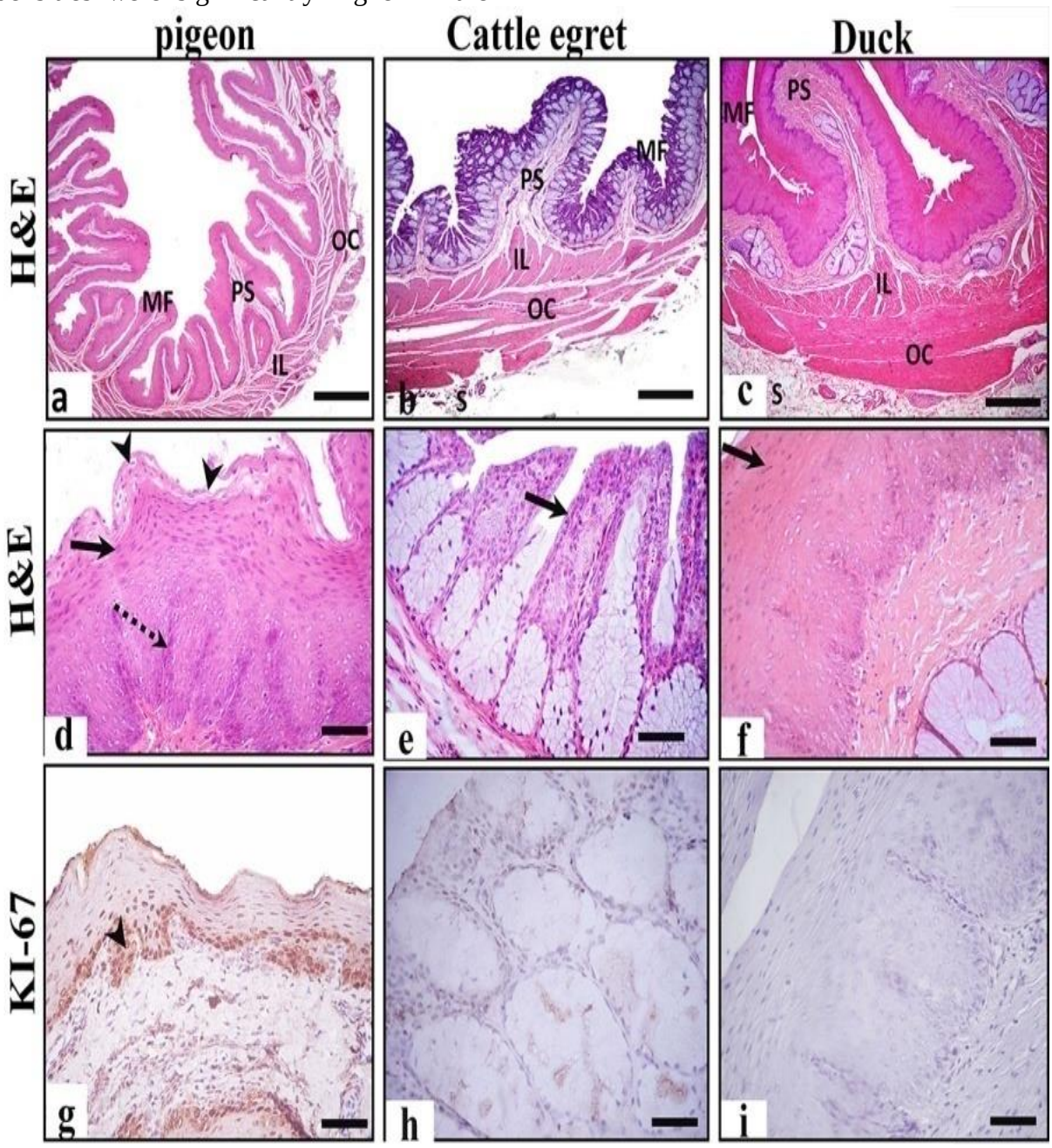

Figure1: Photomicrographs of H&E-stained crops, cross sections from pigeons (a and d), cattle egrets (b and e) and ducks (c and f) illustrating tunica mucosa with well demarcated mucosal folds (MF), propria submucosa (PS), tunica muscularis with inner longitudinal (IL) and outer circular (OC) smooth muscles fibers and tunica serosa (S). Lamina epithelialis of non-keratinized stratified squamous epithelium (arrows) in pigeons, cattle egrets and ducks was detected. Well-developed rete pegs (dashed arrow) and perinuclear hallow zone (arrow heads) were detected only in pigeon's epithelium. The ki-67 immunohistochemical stained crops, sections from pigeon (g), cattle egret (h) and duck (i) showing markedly immune-positive proliferating basal cell nuclei in pigeon (arrowhead) and hardly noticed in cattle egret and duck. Scale bars; a, b & c= 500 µm; d, e, f, g, h &i= 50 µm.

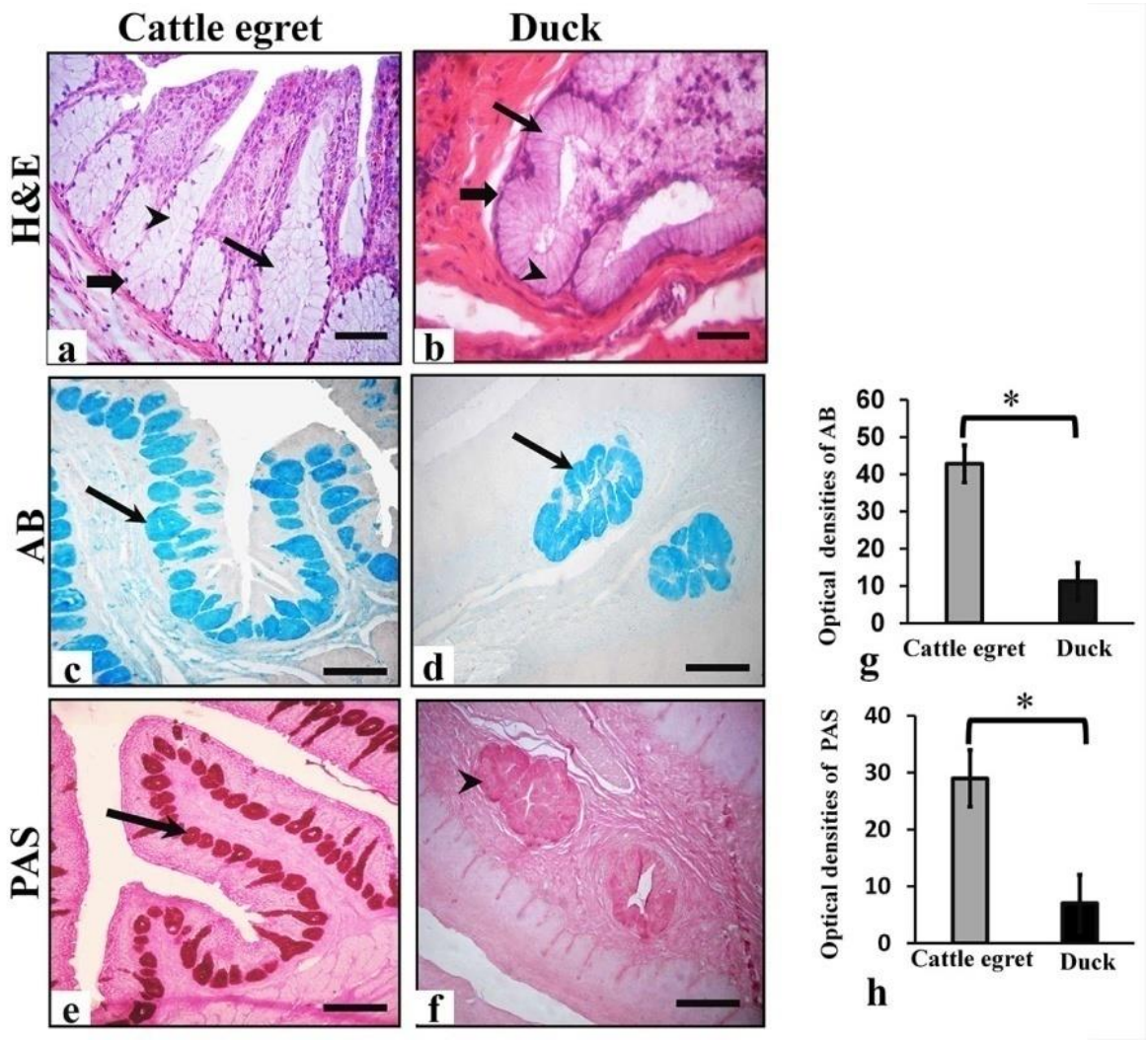

Figure 2: Photomicrographs of H & E, AB and PAS-stained sections from crops of cattle egret (a, c &e) and duck (b, d& f) showing the acinar cells of pale vacuolated cytoplasm (arrows), oval basal nuclei in cattle egret and flat basal nuclei in duck (thick arrows) and clear cell boundaries (arrow heads). Also, the AB (arrows) and PAS (arrowheads) positively stained mucous acini. Scale bars = 200 µm. Bar charts demonstrating optical densities of AB (g) and PAS (h)-positive reactions in mucous glands of cattle egret and duck. The data are expressed as the mean ± SEM (n = 6). The superscript symbol * illustrating the significance difference between groups at $P \leq .05$ (independent sample t test).

Table 1: Histomorphometrical measurements representing the mean values of the optical densities of AB and PAS reactions in the cattle egrets and ducks, the area percentage of the collagen fibers and the thickness of the tunica musculosa of the crops from pigeons, cattle egrets and ducks. Values are Mean ± SE, n = 6

Species / Parameters	Pigeons	Cattle egrets	Ducks	*P* Value
The optical densities of Alcian Blue	------	45.34±2.5*	11.23±0.5	0.02
The optical densities of periodic acid Schiff	------	27.16±1.2*	7.03±0.64	0.01
The area % of the collagen fibbers	11.83±0.830*	23.72±1.635	24.27±1.570	**0.01*/0.7**
The thickness of the tunica musculosa	189.8±1.2*	371.01±1.09*	478.08±1.62*	**0.005**

Note

* A significant difference in the above-mentioned parameters, the *P* value indicates a significant difference in the same raw between the three different species at $P \leq .05$. (The independent T-test, One-Way ANOVA followed by post hoc Duncan's test and Kruskal–Wallis *H* test, respectively were performed).

The propria-submucosa was dense irregular collagenous connective tissue (C.T.) in the pigeons (Figure 3a), cattle egrets (Figure 3b**)**, and the ducks (Figure 3c**)**. The area percentage of collagen fibers was statistically elevated in the ducks and cattle egrets than pigeons. However, there is no significant difference between the cattle egrets and the ducks (Figure 3d and Table1**)**. Tunica musculosa was inner longitudinal and outer circular smooth muscle fibers in the three investigated avian species (Figures 3a, b, c). The mean thickness of tunica musculosa was significantly thicker in the ducks than cattle egrets and pigeons (Figure 3e and Table 1). Tunica serosa was loose C.T. **(**Figures 1 and 3 a, b, c**)**.

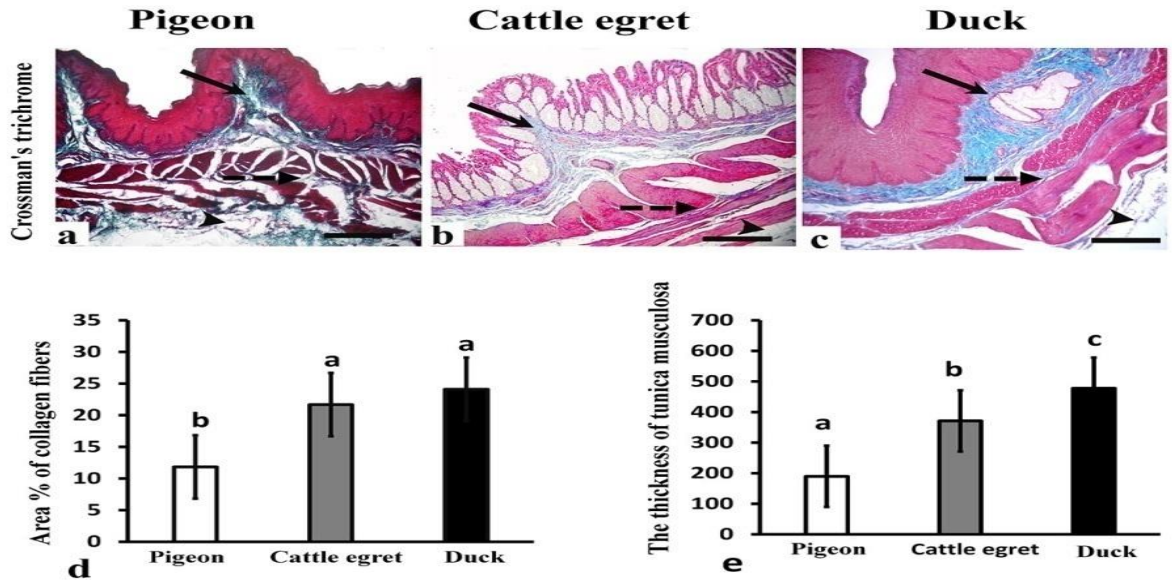

Figure 3: Photomicrographs from crops of pigeon (a) cattle egret (b) and duck (c) from Crossman's trichrome stained sections illustrating the collagen fibers' distribution; The collagen fibers are dense in propria submucosa (arrows) and defined between the muscle fibers (dashed arrows), as well as in serosa (arrow heads), scale bars = 200 µm. Bar charts demonstrating the area percentage of the collagen fibers (d) and the thickness of the tunica musculosa (e) from the three studied species. The data are expressed as the mean ±SEM (n = 6). The superscript letters (a, b & c) illustrating the significance difference between groups at *P*≤ .05 (one way a nova test and Kruskal–Wallis *H* test, respectively).

Immunohistochemical observations

The immunopositive reaction for ki-67 was obviously detected in proliferating basal cells, nuclei of pigeons (Figure 1g**)**. Meanwhile, this reaction was hardly detected in both cattle egrets (Figure 1h**)** and ducks (Figure 1i).

Ultrastructural observations

The observed epithelium of the investigated crops from the three studied species was non-keratinized stratified squamous epithelium of basal, intermediate, and superficial cell layers (Figures 4, 5 and 6). The basal cells were cuboidal in shape with relatively large oval nuclei of ill- distinct nucleoli in the pigeons **(F**igure 4b**)**, as well as in the cattle egrets (Figure 5b), while in the ducks, the nuclei had prominent one or two nucleoli **(**Figure 6c). The cytoplasm was manifested by numerous mitochondria with a few bundles of cytokeratin filaments in pigeons (Figure 4b) and ducks (Figure 6c), while few free ribosomes were detected in the cattle egrets (Figure 5b). These cells rested on a well-developed basal lamina and connected with each other by cellular interdigitation. Additionally, a few desmosomes of a high electron density thickened areas were seen in pigeons (Figure 4b). However, the lateral junctional complex from base to apex was detected in the duck as the following: cellular interdigitation, desmosomes, and zonula adherence (Figure 6c).

The intermediate cells were polygonal-shaped cells of centrally located, large rounded nuclei with a roughly indented nuclear membrane and prominent nucleoli (Figures 4c, 5c and 6b, d). The remarkable bundles of cytokeratin filaments were occupying a great part of the cytoplasm especially in the ducks (Figures 6b, d). These cells are kept in contact with each other's by cellular interdigitation in the pigeons and the cattle egrets (Figures 4c,5c), but the duck's cells exhibited several desmosomal junctions at the level of their cellular interdigitation (Figure 6b, d).

The superficial cells of flat-shaped cells had large oval nuclei with distinct nucleoli in pigeons (Figure 4d), and ducks (Figure 6e) and apically located microvilli in the cattle egrets (Figure 5d). The cytoplasm was characterized by abundant mitochondria especially in the pigeons **(**Figure 4d). The cells were mainly connected with desmosomal junctions in the pigeons (Figure 4a). Characteristically, the surface epithelial cells of the superficial cell layer were kept in contact with each other via lateral fine processes in pigeons (Figure 4d). However, they were predominately connected with desmosomal junctions at the levels of the cellular interdigitation in the ducks (Figure 6c).

The ultrastructure features of the glandular secretory acini of both cattle egrets (Figures 7a, b) and ducks (Figure 7c, d) showed the tall columnar lining epithelial cells of basally located oval nuclei (Figure 7a, c). The nucleoli were ill distinct (Figure 7b) in the cattle egrets and prominent in the ducks (Figure 7d). Large homogenous secretory granules of variable sized and electron densities with associated ribosomes were occupied the supranuclear cytoplasm in the cattle egret's acinar cells (Figure 7b). While the supranuclear cytoplasm packed with homogenous electron-lucent secretory granules in the ducks (Figures 7c, d). Myoepithelial containing myofilament's cell was frequently observed surrounding the acini (Figure 7c).

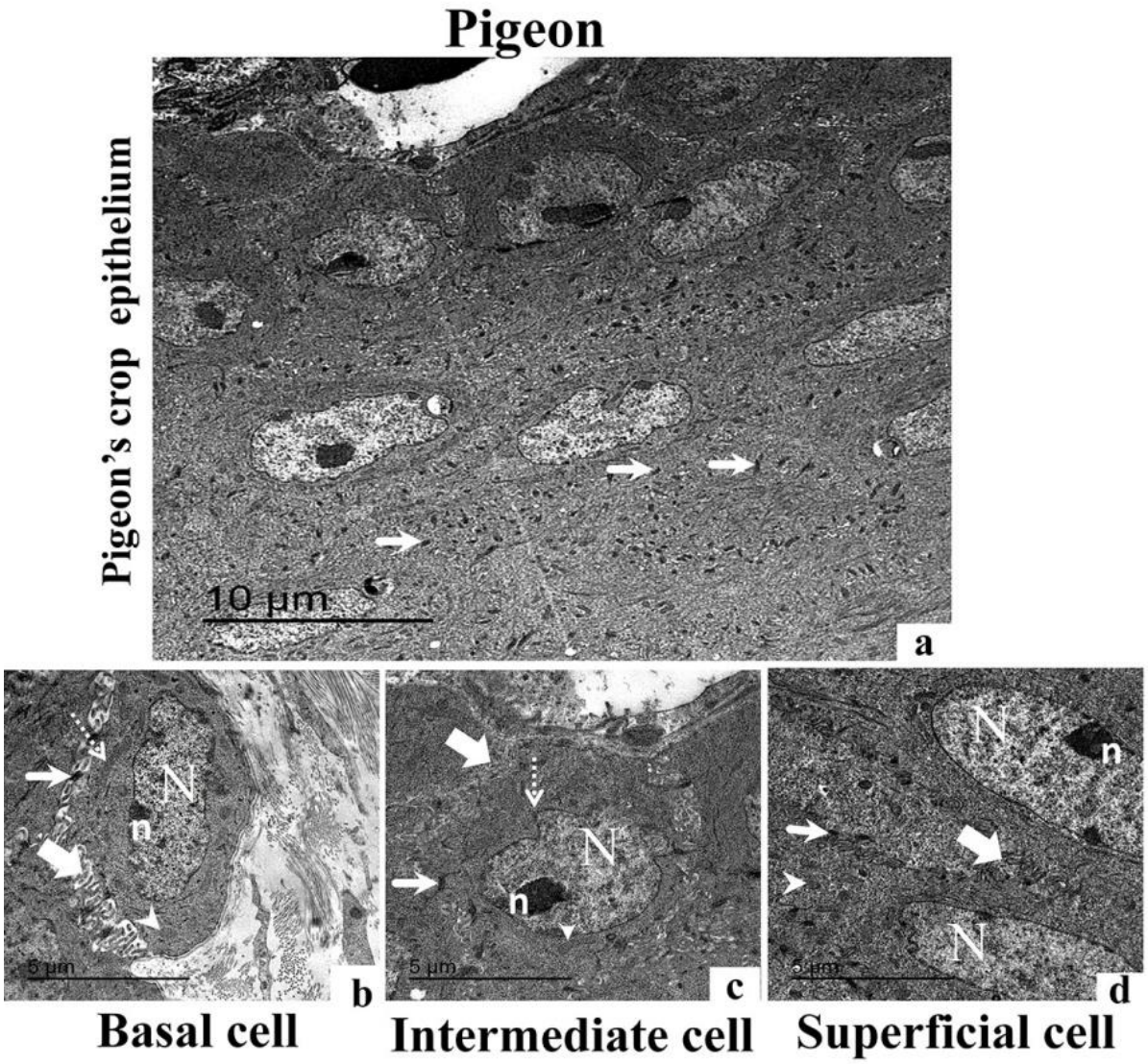

Figure 4: Electron micrographs illustrating the ultrastructural features of the crop'scovering epithelium of the male pigeon; (a) the epithelium at low magnification showing deeper layer of the superficial epithelium with markedly desmosomal junctions in-between (Thin white arrows). (b) The basal cell is cuboidal with a relatively large oval nucleus (N) with ill-distinct nucleolus (n), mitochondria (arrow head), few bundles of cytokeratin filaments (dashed- arrow), intercellular digitations (white thick- arrow) and few desmosomes are also detected (Thin white arrow). (c) The intermediate cell is a polygonal shaped of a centrally rounded nucleus (N) with indented nuclear membrane (dashed- arrow) and a prominent nucleolus (n). Mitochondria (Arrow head), intercellular digitations (thick white -arrow) with a few desmosomes (Thin white - arrow) are also detected. (d) The most superficial cell is a flat-shaped with oval nucleus (N), distinct nucleolus (n), mitochondria (arrow head), few desmoses (Thin white- arrow) and many intercellular digitations (thick white- arrow) are also detected.

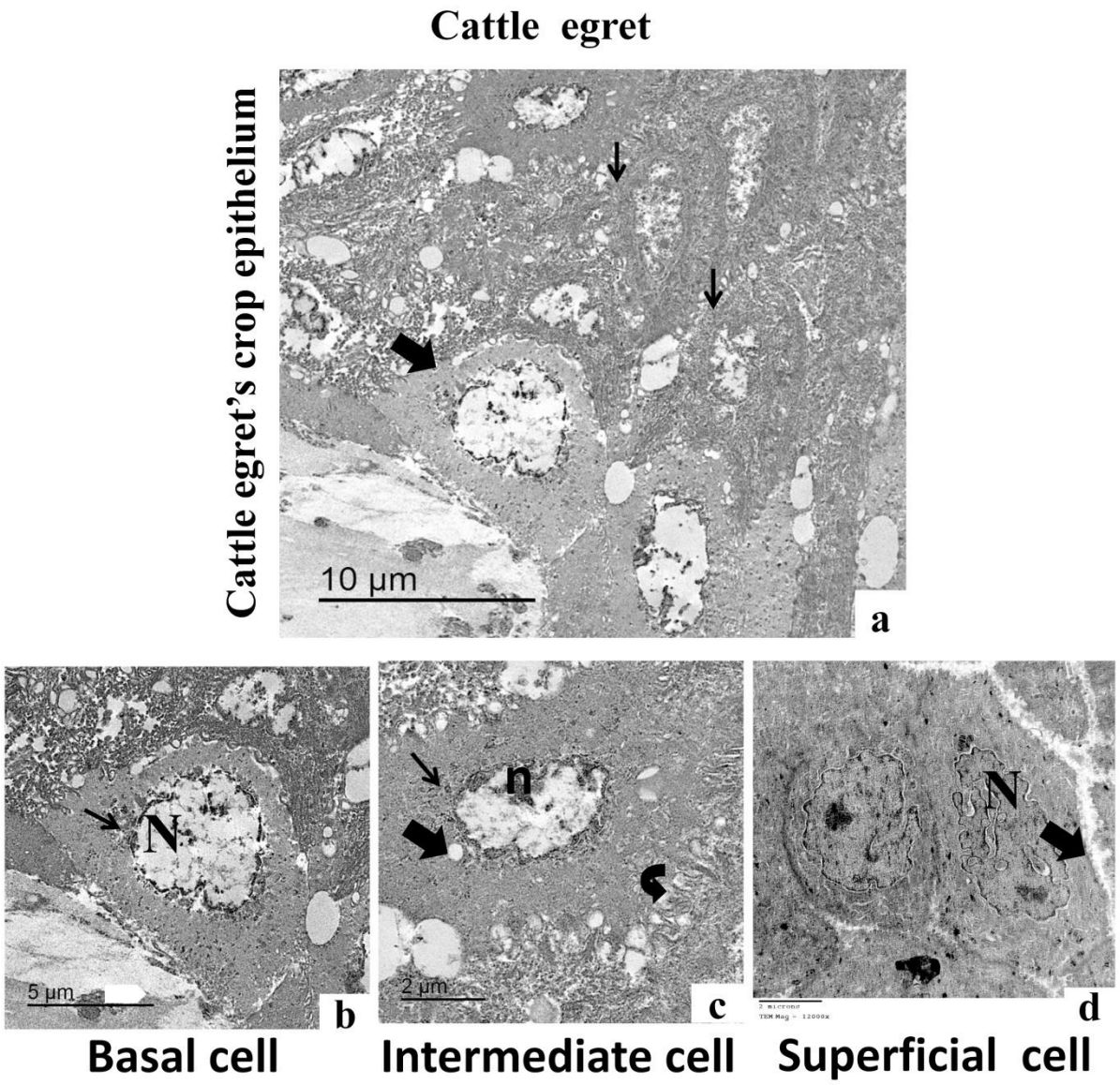

Figure 5: Electron micrographs illustrating the ultrastructural features of the crop's epithelium from the cattle egret; (a) The epithelium at low magnification showing the basal cell layer of low electron density (thick -arrow) followed by the intermediate cell layer of high electron density (thin- arrows). (b) The basal cell is cuboidal -shaped with a central large euchromatic spherical nucleus (N) and dispersed ribosomes in the cytoplasm (thin-arrow). (c) The intermediate cell is a polygonal-shaped with a centrally located a spherical nucleus and a prominent nucleolus (n). Its cytoplasm has few vacuoles (thick- arrow) and ribosomes (thin -arrow). The cellular interdigitation (curved -arrow) are observed. (d) The superficial cell is flat-shaped with a central euchromatic nucleus (N). The irregular shape microvilli (thick arrow) are observed.

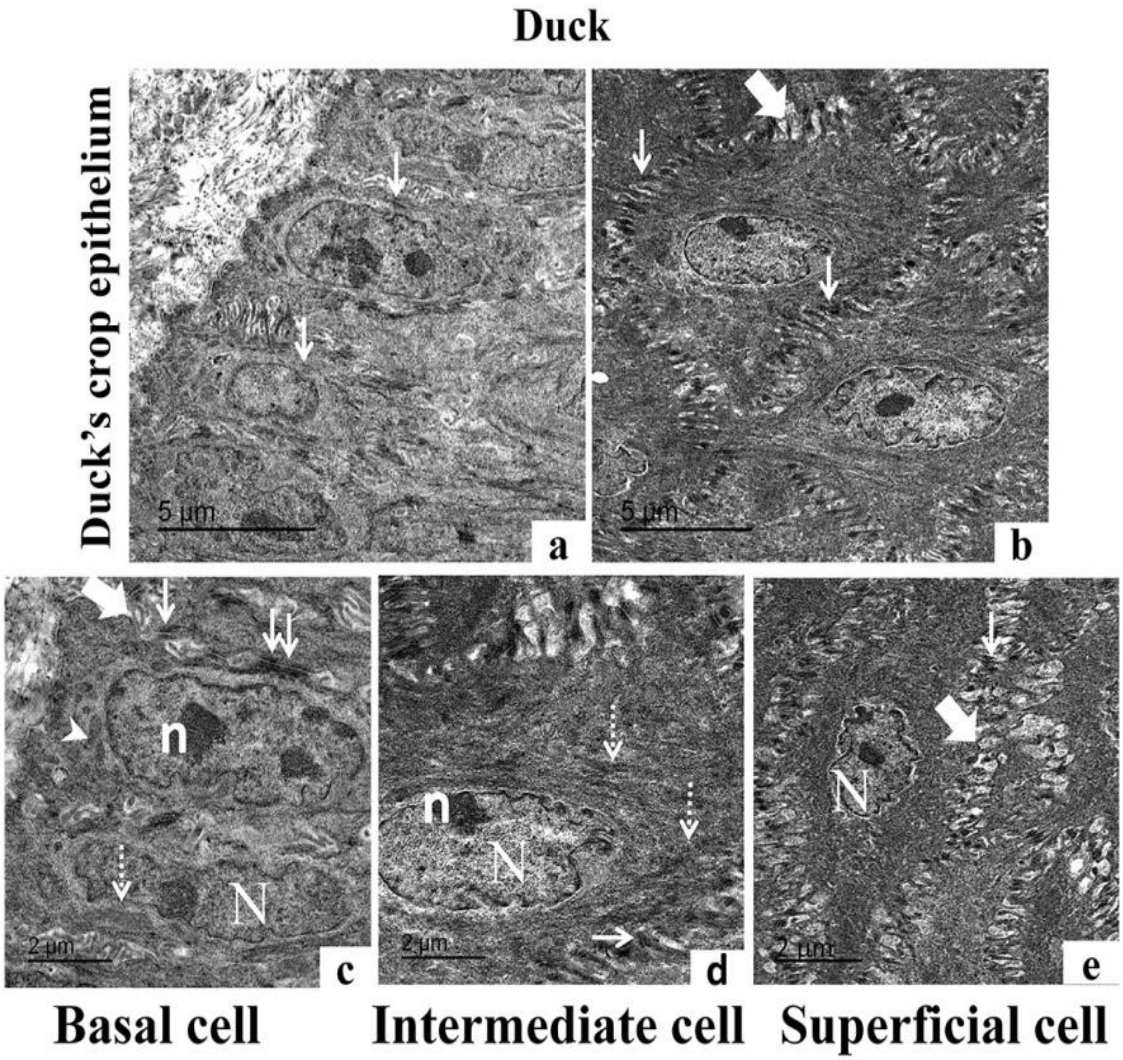

Figure 6: Electron micrographs illustrating the ultrastructural features of the crop's epithelium from the duck. (a) Basal cell layer (thin white- arrows) is tightly connected to the basement membrane. (b) The intermediate cell layer with conspicuousness of desmosomal junctions (thin white -arrows) at the levels of the cellular interdigitation (thick white- arrow). (c) The basal cells are columnar-shaped with large oval nuclei (N) and prominent one or two nucleoli (n). Abundant mitochondria (arrow head) and few cytokeratin filaments (dashed arrow) are observed. Their lateral junctional complexes from base to apex are the following; cellular interdigitation (thick white- arrow), desmosomes (thin white- arrow) and zonula adherence (double arrow). (d) The intermediate cells are polygonal-shaped with a spherical nucleus (N) and a prominent nucleolus (n). The cytokeratin bundles of different orientations in the cytoplasm (dashed-Arrows) and desmosomal junctions (thin white- arrow) are detected. (e) The superficial cell is a flattened-shaped cell with oval nucleus (N) and connected predominately with desmosomal junctions (thin white -arrow) at the levels of the cellular interdigitation (thick white- arrow).

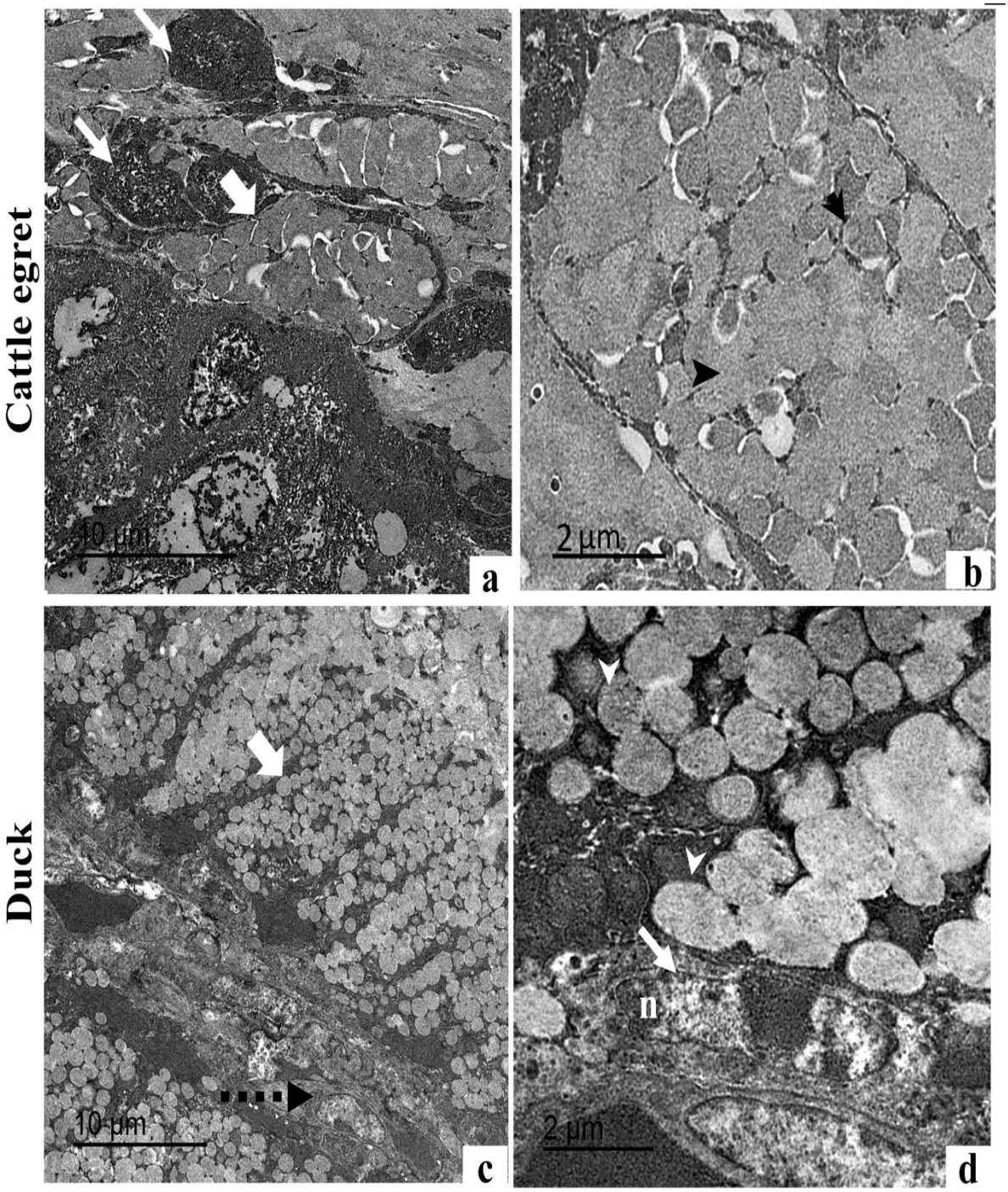

Figure 7. Electron micrographs illustrating the ultrastructural features of the secretory acini; from cattle egrets (a, b) and ducks (c, d). The acinar cells of both cattle egrets and ducks (thick white arrows) are tall columnar with basal oval nuclei (thin white -arrows). Their cytoplasm is packed with secretory granules of low electron density (black head-arrow). Ribosomes are associated with secretory granules (arrow-head). (c, d) The tall columnar cells of the duck (thick white- arrow) of basal flat nuclei (thin white- arrow) with prominent nucleoli (n) are enveloped with myoepithelium (dashed- arrow). Their cytoplasm is packed with electron lucent secretory granules (white arrow- heads).

Discussion

In many avian species, food storage is the prior functions of the crop, furthermore its role as a functional barrier against many gastrointestinal tract pathogens as mentioned by Kierończyk and coauthors [10]. Species-dependent structural variations are noticed in the crops of different avian species according to the type of the diet consumed. Interestingly, the crop of the pigeons is a specialized for its role in crop milk production as documented previously [22]. Therefore, we compared the histoarchitecture of the crops from three different species according to type of consumed foods.

The stratified squamous non-keratinized epithelium was the lining epithelium of the crops from, pigeons, cattle egrets as well as the ducks which come in accordance with homing pigeons the median egrets' duck's emu birds and Japanese quails [8, 23-26]. However, the stratified squamous keratinized epithelium is pronounced in the common wood pigeon**,** demostic fowl and wild birds [14, 27,28].

Despite of the pigeon was classified as granivorous birds, their epithelium was a non-keratinized one. This was attributed to the swallowed food is previously wrapped by the mucus from the esophageal glands, which make it slippery and easily transported to the crop for transitional storage and processing [23]. The same results were noticed in the cattle egret especially the adult one, which has the ability to eat a whole snake, grasshoppers as pointed out in a previous work [29], but the non-keratinized epithelium here is compensated by the considerable amount of the secreted mucous; the mucous as a whole lubricating the crop lumen as well as the swallowed food and eases its delivery to the proventriculus. In addition to the impact of its acidic contents, which provide a protective coat to the crop epithelium against any fractions [30]. The well-developed rete pegs with obvious perinuclear hallow zone of the superficial squamous cells were unique characterization to the pigeon's epithelium for its role in the crop milk production not only through the energy derived from the stored fat and glycogen droplets in the superficial squamous cells, which come in accordance with Ma team [31]. Additionally, through the desquamated superficial cells, that need be recommunicated regularly from the proliferating basal cells. So, our study indicated that the marked positivity of the basal cells' nuclei for the ki-67 is a strong indicator on the marked proliferative activities of the basal cells [17].

The crops` glands were only detected in the investigated cattle egrets and ducks. In the cattle egret, they were simple branched alveolar glands that found beneath surface epithelium, which come in accordance with Taki-El-Deen and coauthors [13] in Whimbrel but in the contrary to the barn owl of compound tubualveolar glands [27] and emu bird of simple tubular glands [25]. While compound tubualveolar glands that were deeply situated in propria submucosa were seen in the investigated ducks. These findings come in accordance with a previous work [13] in the duck; *Anas platyrhnchos*. The glandular secretory cells showed a high affinity to the AB as well as PAS, which indicating their content of the acidic and neutral mucopolysaccharides so it’s a typical mucus gland, which coincided with homing pigeons, the median egrets, ducks and Sparrows [12,14,23,24]. in the conntrarey to the kestrel and rose-ringed parakeet of only acidic mucopolysaccharides [14].

The optical densities of the AB and PAS reactions were statistically higher in the cattle egrets than the ducks. This attributed to the overcrowded glands, which distributed along the crop's walls in cattle egrets rather than the intermittently distributed ducks ' glands. In addition, the nature of the gland secretions was mainly sulfated mucopolysaccharides in cattle egrets rather than the ducks, which exhibit an important role in the digestion especially in the carnivorous species of a

predominately protein- based diet [32**]** in the cattle egret [33] and in many wild and domestic birds**.** In contrast, the investigated pigeons' crops showed no glands similar to that stated previously [23,34] in the homing pigeons**.** The propria submucosa was dense irregular collagenous C.T. in the three species. The same results were recorded previously in domesticated ducks [13]. While the loose C.T. is documented in the granivorous macaw and *Coturnix coturnix* [4,35], respectively. The area percentage of collagen fibers was statistically higher in the ducks for giving the wall strengthen against any mechanical load of the consumed food especially in ducks [36]. Tunica musculosa was inner longitudinal and outer circular smooth muscle fibers in the three studied species. The thickness of the tunica musculosa was statistically thicker in the ducks correspondingly for the reason of its forceful contraction aids in the propelling the food to the proventriculus and subsequent the remaining GIT segments [37].

Our most ultrastructural observations in the basal cells were numerous mitochondria, bundles of cytokeratin filaments and the markedly cellular interdigitation in pigeons whereas, free ribosomes and mitochondria were the most detected in the cattle egrets and ducks. We assumed that may facilitate the movement of the cells from the basal (germinal) layer either to compensate the desquamated superficial cells or to become larger and polygonal to give the subsequent intermediate cell layer [38]. On the other hand, there was a junctional complex between the studied duck's basal cells. We hypothesized that this junctional complex was indeed for maintenance the epithelial**.**

The intermediate cell layer was mainly manifested by remarkable bundles of the cytokeratin filaments only in the investigated ducks. In our theory, these filaments were essential to provide a mechanical resistance and withstand any strains, which resulted from the large food boluses swallowed by domesticated ducks [39] and desmosomes at the levels of their cellular interdigitation in all studied species [40]. The superficial layer of a unique criterion in the pigeon is the most outer surface cells showing fine cellular processes rather than the desmosomes that are characteristics to the remaining superficial cells. We assumed that these cellular processes facilitate the desquamation process of the superficial cells to share in the crop milk production, which coincided with Motta and Fujita [41], besides the obviously increased mitochondria which may be described for its role as an energy source [40,42].

Ultrastructurally, the mucous secretory units were tall columnar cells of basally located oval nuclei filled with apically secretory granules of variable electron densities in the cattle egrets in contrary to the homogenous electron-lucent secretory granules in the ducks. This difference in the electron densities may be attributed to the protein components, which are related to the enzyme production. The secretory granules with light lucent matrix are of low enzyme concentration, reciprocally to that of dense matrix are usually of high enzymes concentrations as documented out by Junqueira and coauthors [43]. Interestingly, this explain why the ribosomes are characteristically associated to the cattle egret's secretory granules rather than the ducks so, the secreted mucus showed a functional difference with reference to the various diet. The mucus released from cattle egret's granule sharing in the partial digestion of the food through its passage in the esophagus but in the duck, it concerned mainly with the mucosal lubrication and protection [44-45].

Conclusion

We could conclude that there are structural variations among the three investigated species attributed to the variation in the function of the crop in each one of them correlated with different dietary habits of each species. These variations including the crop epithelium of

the pigeons of a well-developed rete pegs and perinuclear hallow zone. Moreover, the crops' mucous glands were only clarified in the cattle egrets and ducks. Cytologically, the most prominent features of the surface epithelium were cytokeratin filaments in ducks and the fine cellular process with few desmosomes in pigeons. In addition, secretory granules of lining glandular secretory cells had variable electron densities in the cattle egrets in contrary to the homogenous electron-lucent in the ducks.

Conflict of interest: No conflict of interest.

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الملخص العربي

الخصائص النسجومورفولوجيه للحوصله في الحمام المحلي وأبوقردان والبط المحلي

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يختلف نسيج الحويصلة في الطيور المختلفة بإختلاف طبيعه الأكل الذي يتناوله كل طائر.لقد أجريت هذه الدراسة علي واحد وعشرون طائر ذكر بالغ وسليم صحياً من الحمام المحلي وأبو قردان والبط المحلي , سبعة طيور لكل فصيلة لإجراء الدراسات النسيجية والنسجوكيمائية والدراسات الدقيقة لنسيج الحويصلة. وقد تبين من هذه الدراسة أن النسيج الظاهري للحويصلة يتكون من نسيج مصفف حرشفي غير مقرن في الثلاث اجناس من الطيور التي تم دراستهم. وقد تبين أن هناك عدد من الغدد المخاطية والتي تمت ملاحظتها في طائري ابو قردان والبط المحلي. كما تبين ان رد الفعل المناعي الموجب لل كي اي 67 قد كان اكثر تطوراً في انوية الخلايا القاعدية لنسيج حويصلة الحمام فقط. وأظهرت الدراسات الدقيقة لنسيج الحويصلة,انه مكون من ثلاث طبقات وهم الطبقة القاعدية والتي تتكون من مجموعة من الخلايا العمودية والتي تتصل مع بعضها البعض من خلال كلا من الأجسام الرابطة مع بعض التشابكات الخلوية ثم عدد من الطبقات والتي تتكون من خلايا عديده الأوجه والتي تتميز بخيوط السيتوكيراتين خاصة في البط المحلي وأخيرًا الطبقة الحرشفية ذات الخلايا المسطحة والمرتبطة مع بعضها من خلال الأجسام الرابطة. وأيضا تبين من خلال الدراسة الدقيقة لغدد المرئ والحوصيلة ان الخلايا المبطنة لهذه الغدد تتكون من طبقة واحدة من الخلايا العمودية او القاعدية ويتميز سيتوبلازم هذه الخلايا بالحبيبات الإفرازيه ذات الكثافة الالكترونية المختلفة الثلاث طيور التي تم دراستهم طبقاً لاختلاف طبيعة الأكل.