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Study the Anatomical Descriptions, Histological Observation and Ultra-Structural of the Salt Glands in Domestic Duck (Anas platyrhynchos) (Review article)

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Abstract: The present study aimed to investigate anatomical, histological and ultra-structural study of salt glands in adult domestic ducks .Anatomically, The salt glands in domestic duck of both control and salt stressed were crescent in shape with two pointed anterior and posterior extremities. The dorsal boarder was carved while the ventral boarder which face the eye ball was concaved. The gland was firmly attached with supra orbital depression, the skin of the head directly covered the gland. when the ducks drinking salinated water, the salt glands are engorged, the color become dark red and increased in size and weight.

Histological changes of stressed salt glands were hypertrophied and highly vascular with decrease connective tissue when the ducks exposed to sustained osmotic stress by replacing the drinking fresh water to brackish water (salt water 3%). In ultra-structural study of salt glands, when the ducks drinking salinated water, the principal cells contain large spherical nucleus with (euchromatin) and numerous elongated oval mitochondria (large in size) with secretory granules and development of numerous basal folds generally invested the cytoplasm to the level of the nucleus with abundant ribosomes. Also between the principal cells there was clear occurrence of complex junction and desmosome between the lateral membranes of principal cells. Which prevent the transport of material and ions between the lumen and the under lining connective tissue and blood vessels.

Keywords: Salt glands; Duck; Anatomy; Histology; ultra-structure.

Introduction

Domestic Duck (Anas platyrhynchos) are aquatic birds and may be found in fresh water and sea water (17); (18).The salt glands are an active osmo-regulatory organ that regulates the amount of fresh water required by birds (4);(5);(6) . The ducks have salt glands, which are very important adaptive tool in many animal species which live in oscine, salty lacks and aired land such as water birds, snakes and crocodile (3);(7); (22). Salt gland is more essential than the kidney in removal and secretion of salt from the body (14); (15);(23).The salt gland was reported in many different avian orders (Sphenici formes, Charadriformes, Precelariformes, Anseriformes, Pelecaniformes, Phoenicopteriformes, (7);(13); (20);(21) . In bird kidneys are not sufficient in excreting salt and electrolytes to control body fluid homeostasis (12). The marine birds used post-renal transport mechanisms to eliminate the excess NaCl and conserve water, in which salt glands had the major role (16).This mechanisms enable many bird species to switch between freshwater and salty water.

Function of the Salt Gland:

The salt glands appear to function as an extra-renal mechanism for the preferential excretion of sodium chloride(NaCl) A secretion is evoked from the glands when the birds ingest hyper osmotic of

sodium chloride (NaCl) solutions or food stuffs which contain high concentration of sodium chloride(NaCl) (2). In Marine birds, the salt glands were produce excretion solutions more concentrated than seawater to eliminate excess salt. When birds drink saline water or consume salt-loaded preys, the osmolality of their body fluids increases. In order to maintain the osmotic equilibrium, they have to eliminate the excess of electrolytes ingested with preys or water (22).

The salt glands are one of the most efficient organs in the vertebrate kingdom, transporting ions (sodium and chloride) across the epithelial membrane against a steep concentration gradient. These glands are able to highly concentrate sodium (Na+) and chloride (Cl-) from the per fusing blood stream, salt glands with kidneys together to maintain avian-body fluids homeostasis (11); (19). In marine birds, Many from it non-mammalian vertebrates, use specialized extra renal salt-secreting tissues (salt glands) to help remove excess sodium and chloride ions. Orbital salt glands are used by marine birds (10);(14).

Material & Methods:

Ten apparently healthy, adult birds (domestic ducks) were chosen for this study (with no regard to sex). The birds were collected from local farmers of Basra provinces. The ducks were subdivided into control group and salt stressed group which five birds for each group. Each control group was watered fresh water, and each salt stressed group was watered salt water contain 3% sodium chloride for 10 days. The fresh water and salt water were given in plastic pools and replenished twice daily according to subgroups birds

Salt Gland in Duck Removing Procedure:

1-The movement of ducks were restricted by using sticker tape, the head hold carefully.

2- The supra orbital region locally anesthetized by injection 0.04 ml lidocaine subcutaneously (S/C).

3- The feathers of subjected area were detached carefully, the skin disinfected by using iodine.

4- Simple longitudinal incision was made by using surgical blade in the top of the head, the skin adducted then the gland were exposed then removed from both side.

Sampling Methods for Anatomical Study:

All birds were sacrificed by decapitation. Both left and right salt glands were quickly removed from birds.

Sampling Methods for Histological Study:

The salt glands samples washed with normal saline fixed with 10% formalin for 48 hours in two changes. Paraffin section of salt glands at (5-7) µm thickness were prepared and stained with Hematoxylin and Eosin stain (24). The stained sections were examined by compound light microscope. The microscopic images were captured using the digital camera with high characteristics.

Results:

Anatomical study

The salt glands in domestic duck of both (control and salt stressed groups) were crescent in shape with two pointed anterior and posterior extremities. The dorsal boarder was carved while the ventral boarder which face the eye ball was concaved. The gland was firmly attached with supra orbital depression, the skin of the head directly covered the gland (Fig.1).

The color of the gland(in control group) was red, while (in salt stressed group), was dark red (Fig. 1, 2).They found that the color of (salt stressed gland)was dark red. The current study suggested that the cause of such alteration in gland color due to the shaft and increase of blood fallow toward the gland when the bird drink salty water.The present study recorded that the mean salt gland size when ducks drink fresh water ,was (0.14±0.04) cm^3 while in saline water or consume

salt-loaded preys, was (0.33±0.11) cm^3, the mean salt gland weight when ducks drink fresh water was (0.13±0.02) gm, while insalt stressed or consume salt-loaded preys, was (0.14±0.02) gm.

Histological Study:

The salt glands were consists of two longitudinal lobes. Each lobe is divided into many polygonal lobules surrounded together by connective tissue capsule, and each lobule was composed of secretary tubules, that lined by two types of cells were peripheral cells and principle secretary cells. The peripheral cells located at the blind ends of the secretory tubules(Fig.3,4).

In histological section each lobule appeared as honey comps or polygonal structures, each of them surrounded by connective tissue blood capillaries were present within the connective tissue. Inside lobule numerous branched tubules runs in radical direction from the center to the margined. The center of this lobule were occupied by center canal (Fig. 3).The secretary tubes were branched with two ending the inner end opened directly in the center canal, the other end was blind forming the peripheral region of the secretary tube (Fig. 4). The lining cells of secretary tubules were of two types, the principle cells which were cuboidal in shape with rounded nucleus and stain cytoplasm. The principle cells occupied the majority of secretary tubules (Fig. 5,6).

The peripheral cells which located at the peripheral end of the secretary tubules, this cells was small and rounded in shape with esonophilic cytoplasm(Fig.7).

In (salt stressed group), showed the flowing changes, the shape of each polygonal structures lost to regular, and changed to oval or rounded shape (Fig. 8). The connective tissue which surrounded the lobules and the blood capillaries were congested (Fig. 9). Cellular changes noticed also, the principle cells which were cuboidal with esonophilic cytoplasm and dark stained nucleus in control. In salt stressed ducks, the principle cells changed to round in shape and hypertrophied with light stained cytoplasm and large and faint nucleus . Another important changes occurred in the peripheral region, proliferation and increase in the peripheral cells were noticed (Fig.10).

Ultra-Structural Study of Salt Glands in Domestic Duck:

The ultra-structural investigation in control group of Duck, shows the secretory tubules had two types of cells, peripheral and principal cells. The principal cells contained small rounded nucleus with condense chromatin (heterochromatin) (Fig. 11). There were small rounded to oval mitochondria with present of free ribosome's (Fig. 12),.In salt stressed group, the principal cells contain large spherical nucleus with (euchromatin) (Fig. 13), and numerous elongated oval mitochondria (large in size) with secretory granules and development of rough endoplasmic reticulum generally invested the cytoplasm to the level of the nucleus with abundant ribosome's (Fig.13). The current study showed that, between the principal cells there was clear occurrence of complex junction and desmosome between the lateral membranes of principal cells (Fig. 14). Which prevent the transport of material and ions between the lumen and the under lining connective tissue and blood vessels

Figure 1: Macro graphic of salt glands shows: R-right (Control salt glands) L-left (Stressed salt glands) S-salt gland sk-skull.(by Ali, M. A.(2021)).

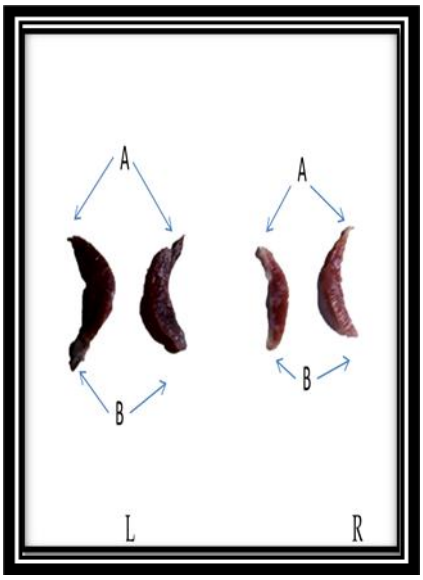

Figure 2: Macro graphic of salt glands shows: R-right control L-left salt stressed glands A-anterior part B-posterior part. (by Ali, M. A.(2021)).

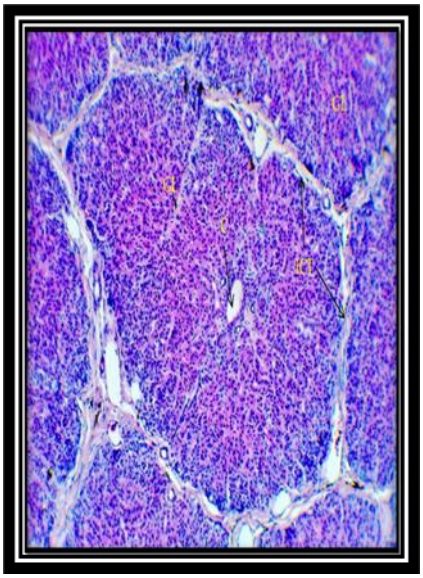

Fig.3: Micro graphic of salt glands (control) shows: GL-glandular lobules C-central duct ICT-inter lobular connective tissue with blood vessels (H&E stain X200) .(by Ali, M. A.(2021)).

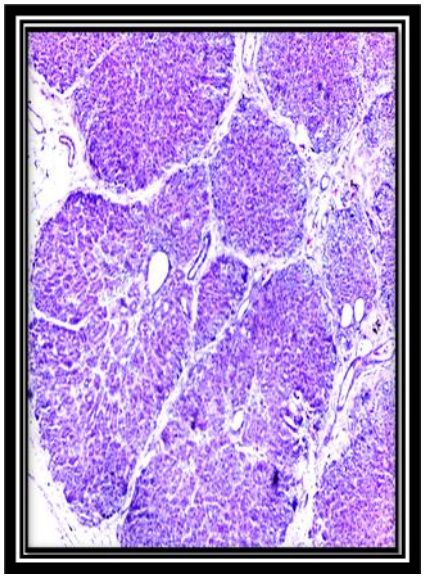

Fig.4: Micro graphic of salt glands (control) shows: GL-glandular lobules C-central duct ICT-inter lobular connective tissue with blood vessels (H&E stain X200) .(by Ali, M. A.(2021)).

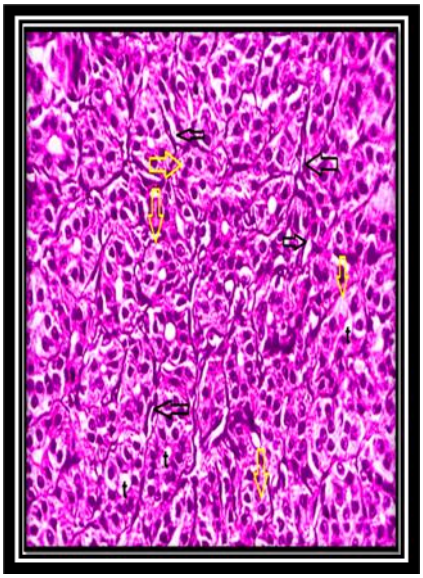

Fig.5: Micro graphic of salt gland(control) shows: t-secretary tubules Principle cells (yellow arrows) Blood capillaries (black arrows) (H&E stain X400).(by Ali, M. A.(2021))

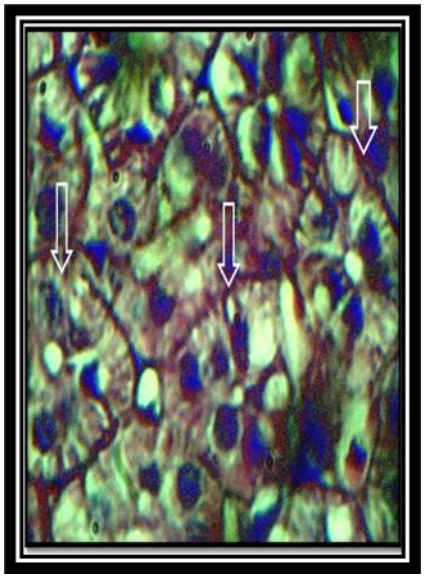

Fig.6: Micrograph of salt gland shows: Principle cells (white arrows) (H&E stain X1000)).(by Ali, M. A.(2021))

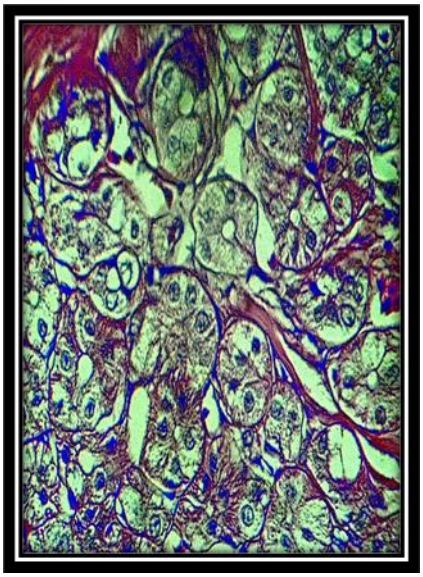

Fig.7: Micrograph of salt gland shows: Peripheral cells (H&E stain X1000)).(by Ali, M. A.(2021))

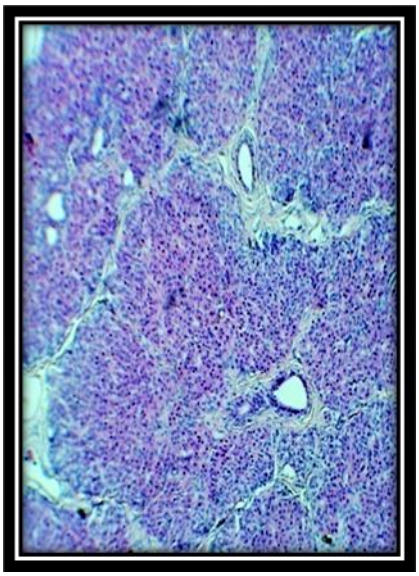

Fig..8: Micro graphic of salt glands (control) shows: GL-glandular lobules C-central duct ICT-inter lobular connective tissue with blood vessels (H&E stain X40)) (by Ali M.A.)

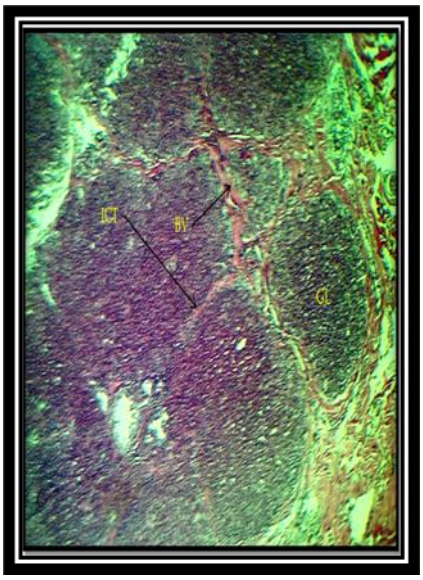

Fig.9:Micrographic of salt gland(stressed) Shows: GL-glandular lobules ICT-interlobular connective tissue BV-congested blood vessels (H&EstainX40) (by Ali M.A.)

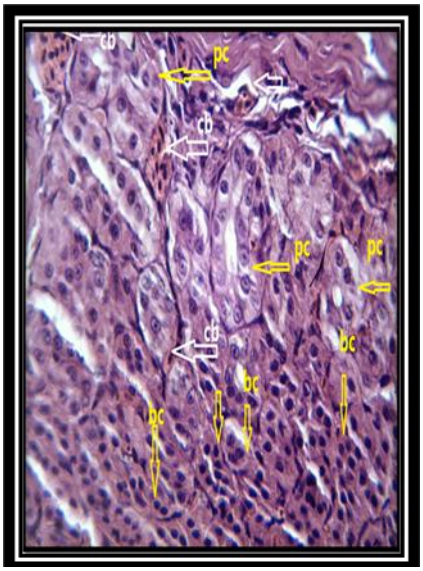

Fig.10:Micrographic of salt gland(stressed)shows: pc-principle cells bc-peripheral cells cb-blood vessels (H&E stain X400) (by Ali M.A.)

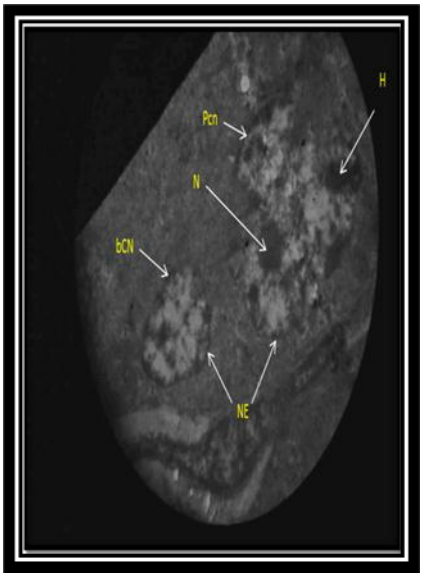

Fig.11: Transmission electron micrographs at the principal cell of the secretory tubules of (control) shows: PCN-principal cell nucleus bCN-peripheral cell nucleus N-nucleolus NE-nuclear envelope H-Heterochromatin(X200nm)) (by Ali M.A.)

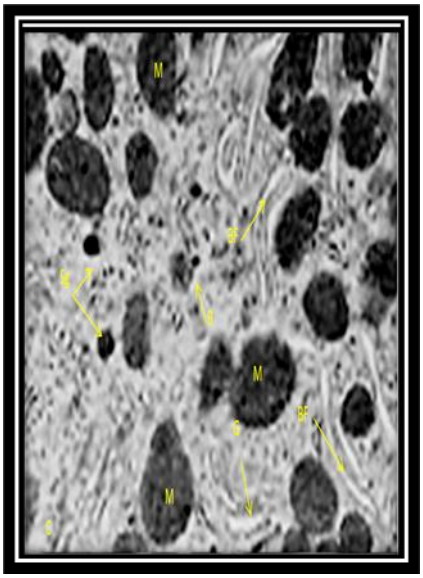

Fig. 12: Transmission electron micrographs at the principal cell of the secretory tubules (control) shows: C-cytoplasm M-numerous small rounded mitochondria G-Golgi apparatus(a stack of flattened sacs) Sg-secretary granules R-ribosome(small round organelles) BF-basal folds(X100nm)) (by Ali M.A.)

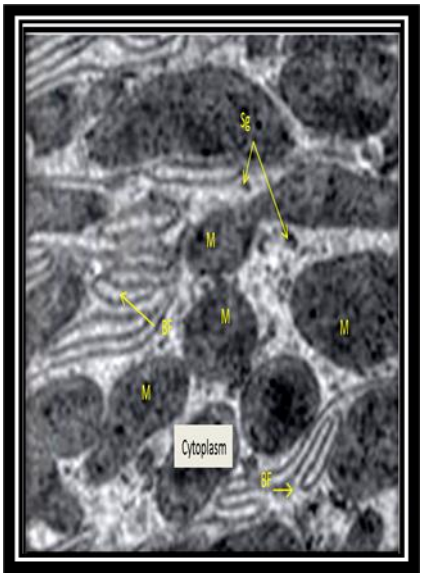

Fig.13:Transmission electron micrographs at the Principal cell of the secretory tubules of the salt gland(stressed)shows: M mitochondria(numerous and large size, oval in shape)Sg-secretary granules BF-basal folds(X200nm) (by Ali M.A.)

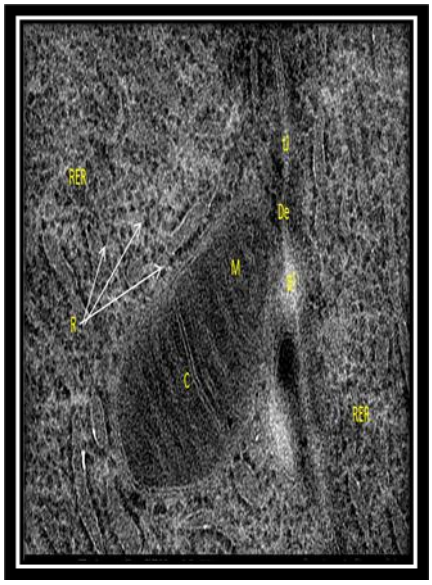

Fig.14: Transmission electron micrographs at the Mitochondrion of the Principal cell (stressed) domestic ducks showing: -M-mitochondrion. RER- rough endoplasmic reticulum R-ribosome TJ-tight-junction de-desmosome CJ-gap junction C-cristae(X200nm) (by Ali M.A.)

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