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Histological and Histochemical Study of thyroid gland in camel (*Camelus dromedarius*) in Al- Muthanna province

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Abstract
The present study aims to identify the histological and histochemical features of the thyroid glands in adult A histological examination was conducted . Fifteen male camels were used in the current study male camels. to delineate the overall body structure of the thyroid gland, including microscopic measures of capsule thickness and the diameters of several thyroid follicles. Histological findings indicate that the thyroid glands in each animal were encased in a capsule composed of two layers of collagen fibers. The thyroid gland The .comprises follicles of varying forms and sizes, namely large and small follicles, inside each lobe histological examination identified the parafollicular cells in the camel, commonly known as C-cells. C-cells are large, spherical, and oval, with cytoplasm that is stained lighter than that of follicular cells. Their nuclei exhibited extensive staining. They originated as a singular cell or in pairs or groups. In the tissue part, it was seen that certain C-cells had been supported by a basement membrane, which served as the foundation for both follicular and parafollicular cells. Conversely, other cells were organized randomly inside the intermolecular tissue, isolating the C cells from the follicular wall. The parafollicular cells, detected in tissue slices either alone or in small clusters, possess an oval or rounded morphology, a spherical nucleus, and lightly Histochemical analysis revealed that the capsule, colloidal substance, basement .stained cytoplasm membrane, and parafollicular cells of the thyroid gland had pronounced responses. To do PAS staining All components of the thyroid glands displayed a favorable reactivity to PAS _ AB and Masson Trachoma stain. Conclusion, the camel's thyroid structure was similar to that of large ruminants. while had a thin capsule, only two types of follicular cells; parafollicular cells were very few, and a different type of colloid. All of these factors helped the camel adapt to hot, dry, and unfavorable climates.
Keywords: camels, thyroid, follicles, follicular cell, parafollicular cell

INTRODUCTION

The phrase "dromedary" originates according to the Greek term "dromos," which means roads. This phrase was used to describe the dromedary's initial role in transportation. Nevertheless, the term "camel" dromedary" is universally employed to refer to the one-humped camel, which is known as the dromedary. The camel is a ruminant that has adapted to thrive in dry, extremely hot, and challenging climates. In warm and dry regions, the internal state of a camel's body relies on the endocrine system, with the thyroid influencing various organs throughout the body (Abdussamad, *et al.*, 2011; Marisa, 2011; Ahmadpanahi and Yousefi, 2012).Camelus dromedaries is becoming increasingly economically valuable as a livestock animal due to its ability to adapt to hard climatic circumstances and its resistance to illnesses, The ability of this species to adapt to difficult desert circumstances is the primary reason for its reputation as being exceptionally capable among other large animals (Abdulzahra**,** 2020). The thyroid is a crucial endocrine gland that influences several bodily organs. Endoderm from the primitive pharynx occurs in the region of the first pharyngeal (branchial) pouch. The thyroglossal duct regresses as the thyroid gland expands, resulting in its caudal migration towards the neck and detachment from the floor of the oral cavity (Bello, *et al.*, 2014; Abubakar, *et al.*, 2015), may be specially stimulated by thyroid hormone. Additionally, thyroid hormone interacts with sympathetic nervous system on multiple levels and is crucial for facultative thermogenesis. Thyroid hormone increases the SNS's effects at adrenergic receptors and adenylyl cyclase complex levels in the periphery (Marisa, 2011; Ahmadpanahi and Yousefi, 2012; Hussein, *et al.*,2024). Only a few researches have been conducted on the properties of the camel thyroid gland. In order to provide information for further research, the purpose of this study is to examine the structure of the thyroid in adult one-humped camels. Brown adipocytes have thyroid hormone receptors, which can activate the thermogenic brown adipose tissue directly. Hypothalamic neurones also exhibit thyroid hormone receptors, which can stimulate the brown adipose tissue indirectly (Hussein, *et al.*, 2023).

MATERIALS AND METHOD

The morphological adult male camel (Camelus dromedarius) discreption of thyroid gland collected about thirty healthy. All samples have been collected from a local abattoir in Al-Muthanna province during (October _November and December 2024). The animals ages over 4years as adult permanent dental formula are 2(I I / 3, C 7 / l, P 3 / 2 and M 3 / 3) =34 (Misk, *et al.*, 2006) The thyroid gland has been gathered directly after slaughter in the morning. The thyroids were examined graphically in site to determine their position. The thyroid has been washed with normal saline solution then put the thyroid in labeled container filled with 10% formalin solution for 48hours to complete the mechanism of fixation.Tissue samples for histological sectioning are obtained from various regions of the thyroid gland. A histological examination is conducted on the thyroid glands of fifteen camels. Thyroid specimens measuring 0.5 to 0.8 cm in diameter were fixed for 48 hours in 10% formalin. To produce a 10% formalin solution, combine ten milliliters of 37.9% formalin with ninety milliliters of distilled water. The histological sections were stained with Hematoxylin-Eosin (H&E) for general morphological characteristics, Masson trichrome stain for the identification of connective tissue, PAS for the detection of carbohydrates, and PAS-AB (pH 2.5) stain to demonstrate the type of secretion.

RESULTS AND DISCUSSION

Capsule of thyroid gland

The thyroid gland was covered by a thin capsule composed of two-layer inner dense irregular connective tissue contains possessed strand of collagen and elastic fibers, spindle shape fibroblasts and thin external layer of adipose tissue which showed clear cellular limits interpose with collagenous fibers with a few elastic fibers. The function of the two layers; is adipose tissue, which stores energy, and collagen fibers for protection. (Fig.1,2,3). Agree this result with (Ahmadpanahi, 2019) camel, (Hussin and Altaay, 2009) buffalo, and disagree this result with (Adhikary, *et al.*,2003) goats, (Bacha and Bacha, 2012) sheep, who stated that the capsule that existed in to keep included three layers and in goats, which regarded the thyroid capsule had a single layer. These results may be because of under the hard environmental conditions experienced by the camel, a thin, rapidly exchanging vascular structure may be required to ensure efficient distribution of hormones and provide adequate protection without impeding the movement or functional performance of the gland. These finding results similar (Ahmadpanahi, 2019) camel, (Rahmoun, *et al.*, 2021) cattle, and (Bacha and Bacha, 2012) horse, disagree with (Adhikary, *et al.*, 2003; Pankowski, *et al.*, 2021) goats, that the capsule to keep it was slightly thicker. These results may be because of the complementary functions of the two layers include adipose tissue for energy storage and collagen fibers for protection. The mean thickness of capsule of the right lobe, left lobes and isthmus were (552.00) µm, (499.00) µm and (482.00) µm respectively. The present findings revealed that the capsule thickness of the right lobe was slightly higher than the left one but significant also revealed that the capsule thickness of the two lobes (Table 1).

Thyroid Follicles

Different forms of follicles were discovered that were spherical, oval, elongated, polygonal and irregular (Fig.1,3,4). This observation of this study follicles were only two sizes (large and small follicles), similar to (Abdel-Magied, *et al.*, 2000; Kausar and Shahid 2006; Ahmadpanahi, *et al.*,2012) camel, who mentioned the small (active) ones are found in the center of the gland, large (inactive) follicles are found in the periphery region of the gland (Fig.1.2.3) and disagree with the previous observations of (Altaay, 2007) in buffalo, who showed that the small follicles were diffused predominantly at the periphery while the large follicles found at their centers. These results may be because in animals, the capsule is thick and contracts and presses on the follicles, so the small ones are peripheral, but in camels, the capsule is thin.Follicular epithelial cells surrounded the follicles; however, the follicular cells of adjacent follicles often come into contact with one another, disrupting the continuity of the basal lamina observed within the follicles and lobules. The follicular cells are primarily inactive and exhibit a low cuboidal shape. The follicles are filled with colloids and display a smoother peripheral surface, accompanied by an increased presence of vacuoles (Fig.1.4.5), current findings were agreement with (Hussin and Altaay, 2009) who decided the follicles were irregular, polygonal, oval, spherical, and tubular in shape. There are follicles of varying sizes which compose up the thyroid gland, and they are separated from one another by interfollicular connective tissue. On the other hand, small follicles are bordered by high cuboidal or low columnar follicular cells, whilst the large follicles are lined by very low cuboidal or flattened squamous follicular. Findings well agreed with the previous studies in camel (AbdelMagied *et al.*, 2000; Kausar and Shahid 2006) and in cattle (Peksa *et al.*, 2011) Trabeculae divide the gland to clear lobes (Fig.8,9,13) this observation agree with (Casmir, 2015) cattle, and disagree with (Altaay, 2007) in buffalo in point, that the trabeculae divide the parenchyma into poorly defined lobules. These results may be because the trabeculae are an important element in the structure and anatomical composition of the thyroid gland in camels, as they contribute to improving the distribution of blood and nerve resources and providing a stable environment for thyroid cells. The central area of the capsule penetrated the parenchyma by traversing the trabecular septa, transporting large amounts of connective tissue, blood vessels, and lymphatic structures. The trabeculae partitioned the gland into very discernible lobules and (Adhikary, *et al.*, 2003) said from the capsule many septa are extended into the gland parenchyma dividing it into irregular lobules. These septa are contained many blood vessels and nerve fibers, but in sheep the thyroid gland is surrounded by a thin capsule of fibrous connective tissue and (Aughey and Frye, 2010; Arrangoiz, *et al.*,2018) said the thyroid gland is separated into tiny lobules by thin trabeculae strands that penetrated the gland from the capsule. The lining epithelium of the follicles was ranged from simple cuboidal epithelium with spherical nuclei to low and high simple columnar epithelium with spherical to oval nuclei. Very few follicles were lined by simple squamous epithelium with flattened nuclei (Fig.5). The thyroid gland also consisted of a thin network of interfollicular connective tissue rich in blood capillaries that were surrounded each follicle. One of most striking findings was the presence of flat dark nuclei which belongs to the myoepithelial cells that interposed between the follicular cells and the basement membrane (Fig.5). The mean diameters of the large, and small follicles were in the right lobe were (150.32μm, 61.48μm), while in the left lobe were (141.58 μm, 58.39 μm) while in the isthmus (119.82 μm, 52.31 μm) Table (2,3). The statistical analysis revealed significantly differences in the those mentioned parameters between the left and right lobes, and isthmus $p < 0.05$, Table (2,3). The results of the statistical analysis showed that the average diameter of large follicle in right lobe had higher significant increase in diameter when compared with those in the left lobe at $p < 0.05$(Table2,3).

Para follicular cells or C-cells

The present study of thyroid gland in camel showed the parafollicular cells had a rounded shape with spherical nucleus and light stain cytoplasm, which noted in as singly or in small groups (Fig.5). Their size was greater than that of the follicular cells. Some of these cells were situated between the basement membrane and follicular cells, and these cells were found in the interfollicular connective tissue (Fig.5). This result agree with (Ahmadpanahi and Yousefi, 2012; Ahmadpanahi, 2019) camel, (Khaleel and Salih, 2017) sheep and gazelle, and disagree with (Abdel-Magied et al., 2000; Atoji, *et al.,* 1999; Kausar and Shahid, 2006) studies reporting that parafollicular cells are absent in camel's thyroid. These results may be because the calcitonin synthesized by these C-cells regulates calcium homeostasis by decreasing osteoclast activity, which decreases bone resorption and lowers blood calcium levels and this function is crucial for preserving mineral equilibrium and skeletal health. The parafollicular cells in the thyroid gland play a vital role in secreting calcitonin, the hormone responsible for lowering calcium levels in the blood. The staining of these cells appears lighter compared to follicular cells. The number of these cells is considerably less than that of follicular cells, and they are more frequently observed between the small, active follicles located in the central region of the gland, attributed to the extensive vascular support in this area. The peripheral parts of the gland rarely contain these cells. Reports have also indicated the presence of ultimobranchial structure in the camel's thyroid gland (Mubarak and Sayed, 2005).

Colloid

There was a varying quantity of eosinophilic colloid material present in the intrafollicular compartments of each and every follicle. A uniformity or homogeneous and nonuniformly dyed colloid was seen, in which a large number of or a small number of peripherally apparent empty vacuoles developed in the stored colloid (Fig.6,7,8,9,10). The colloid has a degree of density that varies, and some follicles contain eosinophilic colloid material that is highly pigmented (Fig.6,7). A significant PAS positive appearance was seen in these clearly stained colloid particles, which seemed to be magenta in colour (Fig.6,7,8). There were some follicles that had colloid material that was just faintly stained.Similarly to that described by (Rejeb, *et al.*, 2011), The density of the colloid was varied, and some of the follicles had densely stained eosinophilic colloid material. This material exhibited a significant positive reaction with PAS stain and looked magenta in colour. Some follicles contained faintly stained colloid material so that the colloid in these follicles was strong reaction positive for PAS (Fig.6,7). These findings agree with the previous study in sheep and gazelle by (Salih, 2018). These results may be because the coloration depends on density, distribution of the colloid material and the activity of thyroid gland. Some follicles contain peripheral colloid vacuoles which indicate their metabolic activity. The parafollicular cells had a moderate to strong reaction to PAS stain (Fig.8). He current study showed the amount of eosinophilic colloid material in the intrafollicular spaces is varied in thickness and amount amongst all the follicles (Fig.7,8,9). This variation may be due to the differences in the activity of the thyroid gland (Stathatos, 2019). Thyroid follicles showed varying responses to PAS-AB stain; depending on the density of the colloid material, some follicles showed a weak and strong reaction (Fig.9,10).

Table (1) Microscopic measurement of Thickness capsule of Isthmus, right and left lobes in thyroid gland of camel.

Parts	Mean	Std. Deviation	T-test	Sig.
Isthmus	482.00c	7.527	151.686	0.000*
Right Lobe	552.00a	18.589		
Left Lobe	499.00b	9.944		
(P>0.05) significant, NS: Non-Significant.				

Shows thyroid gland thickness (cm) in camel. Values represent: (average ± SE). (*) significant differences (p>0.05) between different parameter.

Table (2) Microscopic measurement of Diameter of large Follicle of Isthmus, right and left lobes in thyroid gland of camel.

Parts	Mean	Std. Deviation	T-test	Sig.
Isthmus	119.82c	0.723	287.966	0.000*
Right Lobe	150.32a	3.541		
Left Lobe	141.58b	2.171		
(P>0.05) significant, NS: Non-Significant.				

Shows thyroid gland Diameter of large Follicle, in camel. Values represent: (average ± SE). (*) significant differences (p>0.05) between different parameter.

Table (3) Microscopic measurement of Diameter of small Follicle of Isthmus, right and left lobes in thyroid gland of camel.

Parts	Mean	Std. Deviation	T-test	Sig.
Isthmus	52.31c	1.701	121.383	0.000*
Right Lobe	61.48a	1.195		
Left Lobe	58.39b	1.772		
(P>0.05) significant, NS: Non-Significant.				

Shows thyroid gland Diameter of small Follicle, in camel. Values represent: (average ± SE).
(*) significant differences (p>0.05) between different parameter.

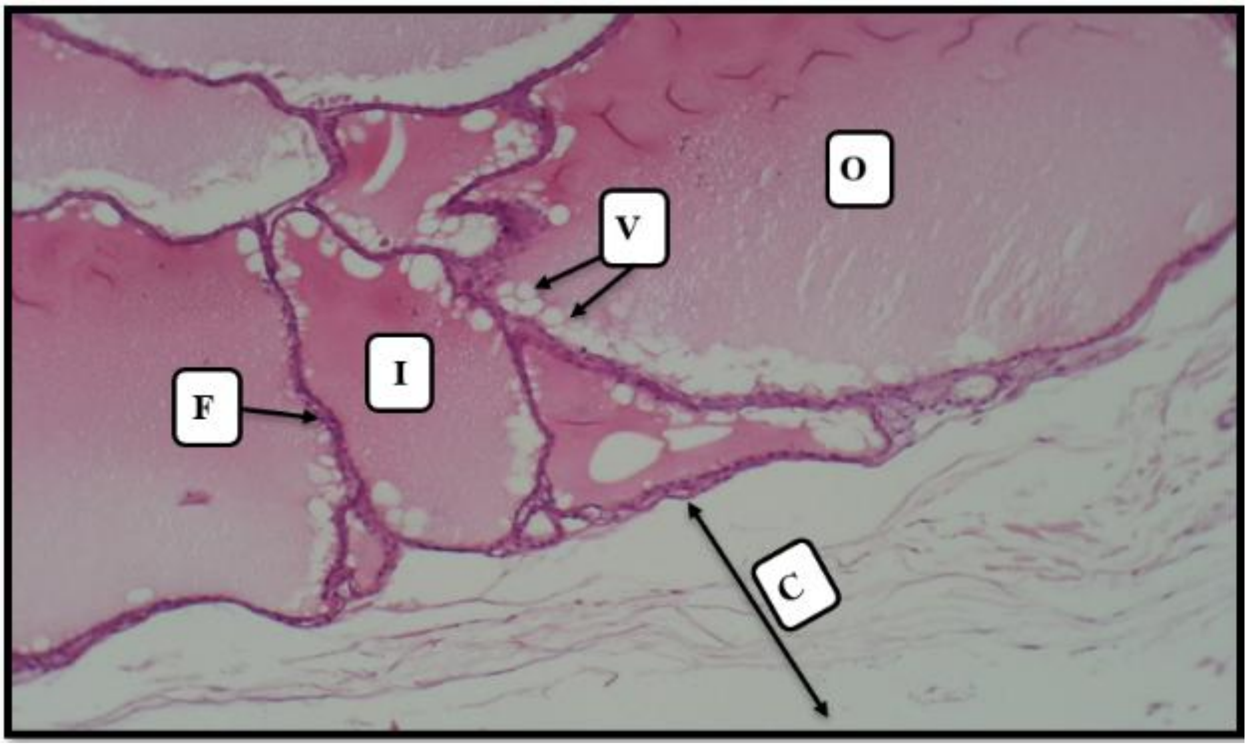

Fig.1.Longitudinal microscopic section of the lobe right of thyroid gland in camel shows: C. Capsule, F. Follicular cells, I. irregular follicles O. Oval follicles, V. vacuole; **H&E stain X100.**

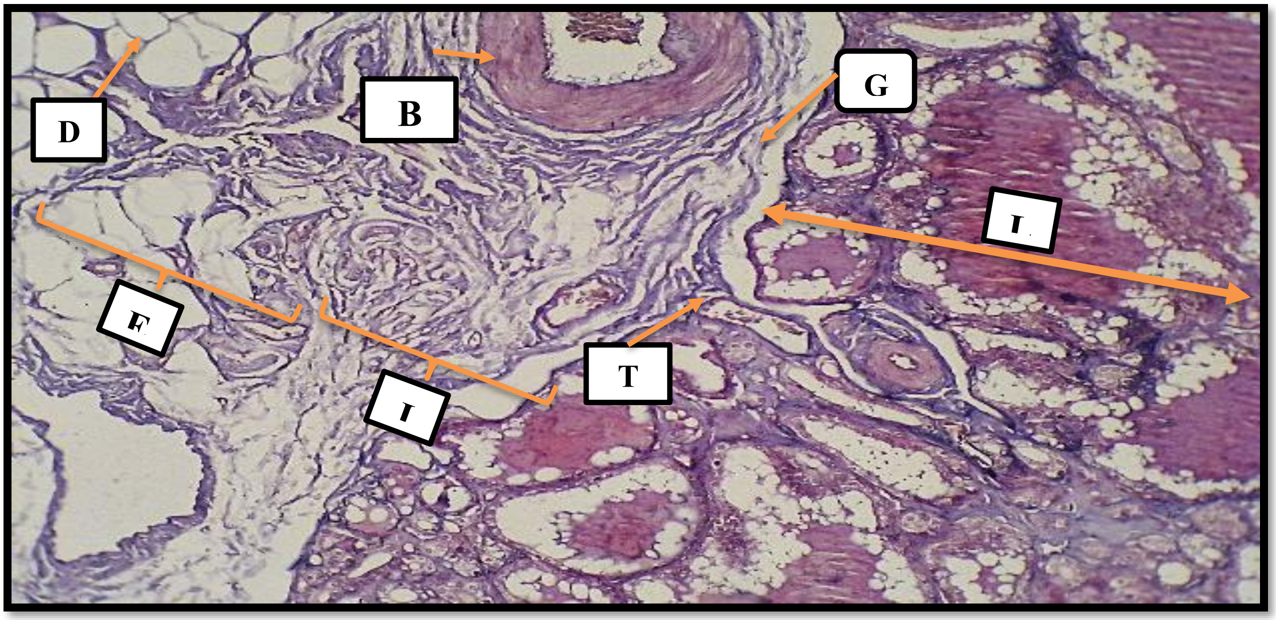

Fig.2. Cross microscopic section of the left lobe of thyroid gland in camel shows: B. blood vessel, D. adipose tissue E. External layer of Capsule (adipose tissue), G. Collagen fibers, I. Internal layer of Capsule (collagenous connective tissue), T. Trabeculae (Septa), L. Lobule; **Masson trichrom stain X40**

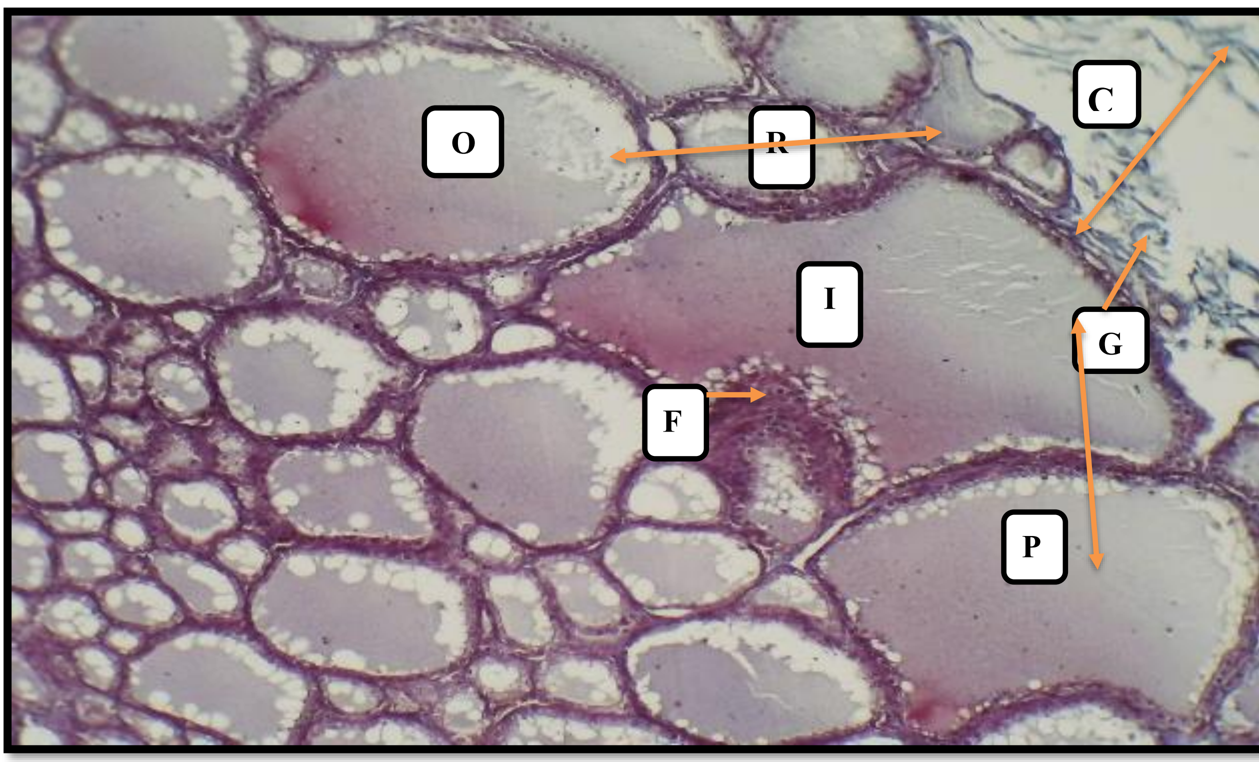

Fig.3.Cross microscopic section of the left lobe of thyroid gland in camel shows: C. Capsule, F. Follicular cells, G. Collagen fiber, R. Round follicle, O. Oval follicle, I. Irregular follicle, P.Polygonal follicle **;Masson trichrom stain X100**

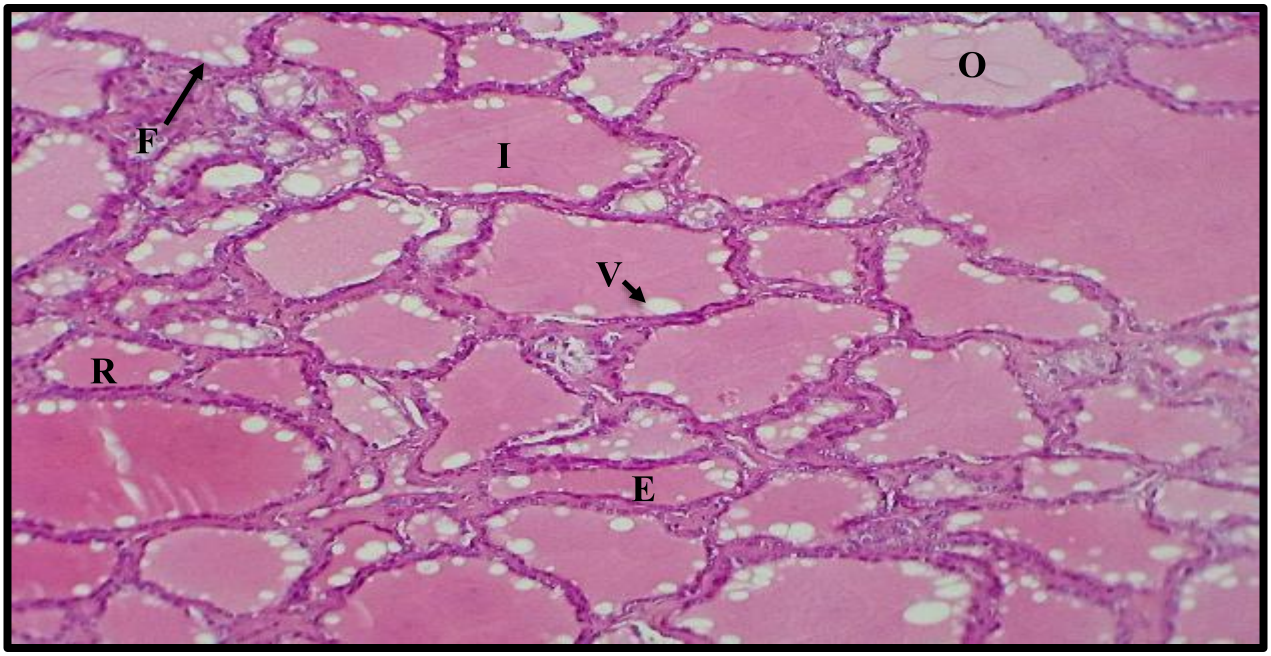

Fig.4.Cross microscopic section of the left lobe of thyroid gland in camel shows: E. Elongated follicle, F. Follicular cells, I. Irregular follicle, O. Oval follicle, R. Round follicle, V. Vacuoles; H**&E stain X100.**

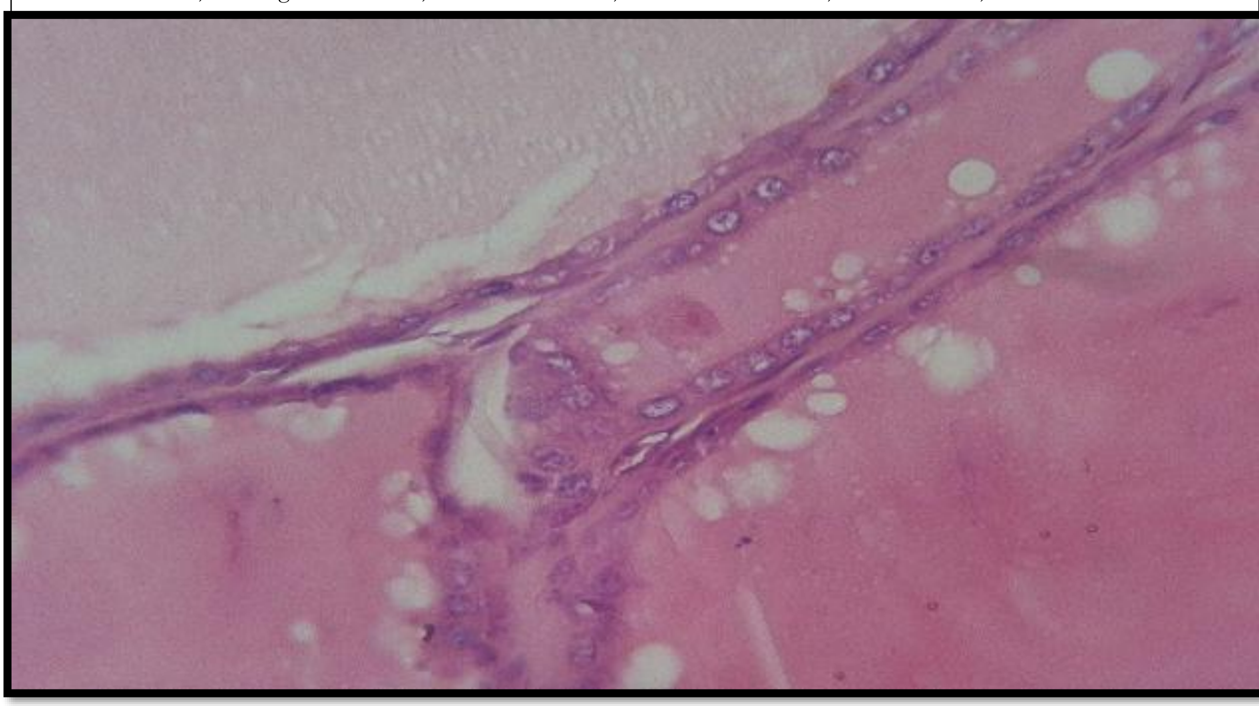

Fig.5. Longitudinal microscopic section of the left of thyroid gland in camel shows the: P. Parafollicular cells, F. Follicular cells, V. Vacuoles H. Thyroid follicles, U. Colloid; **H&E stain X400**

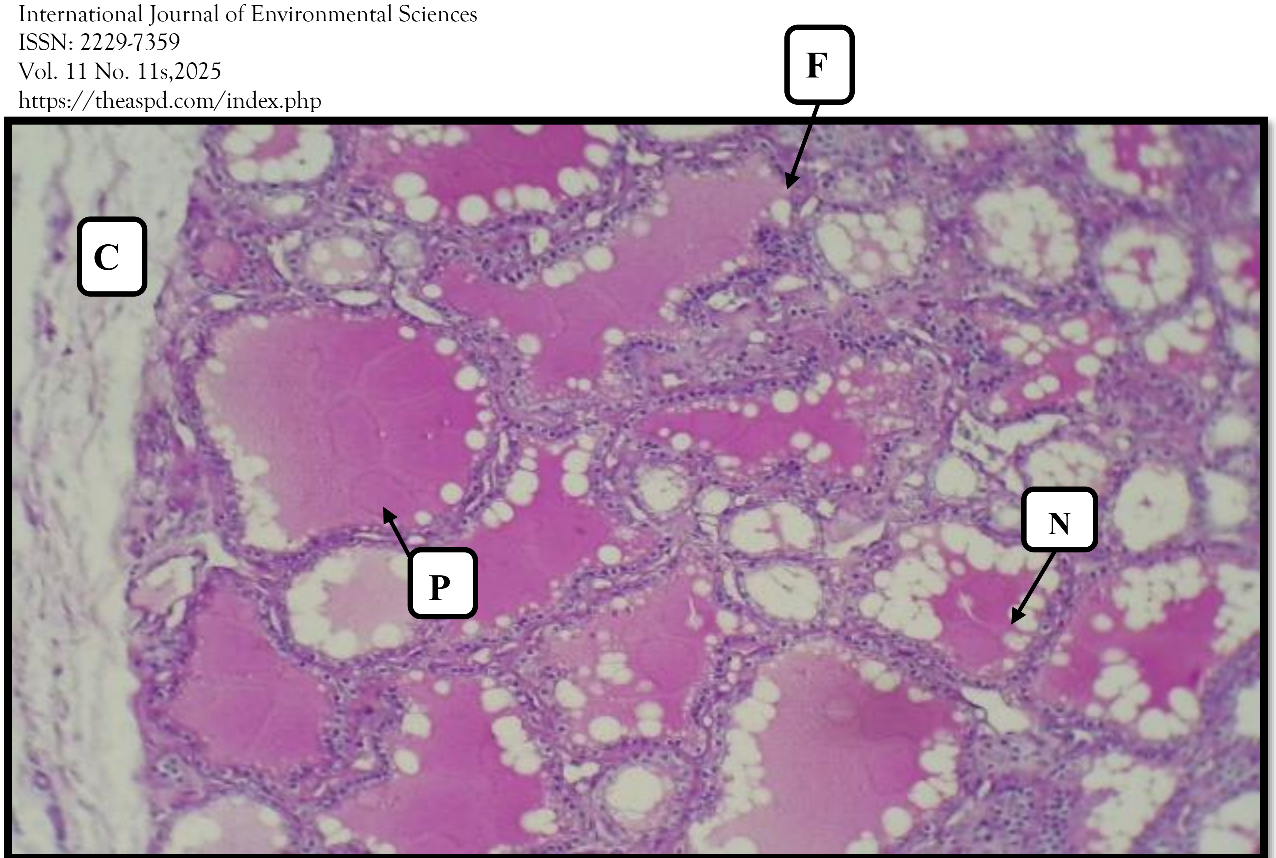

Fig.6. Longitudinal microscopic section of the right lobe of thyroid gland in camel shows: C. Capsule, F. Follicular cells, N. Interfollicular connective tissue, P. Para follicular cell; **PAS stain X100**

Fig.7. Cross microscopic section of the right lobe of thyroid gland in camel shows: U. Colloid, M. Basement membrane, V. vacuole; **PAS stain X400**

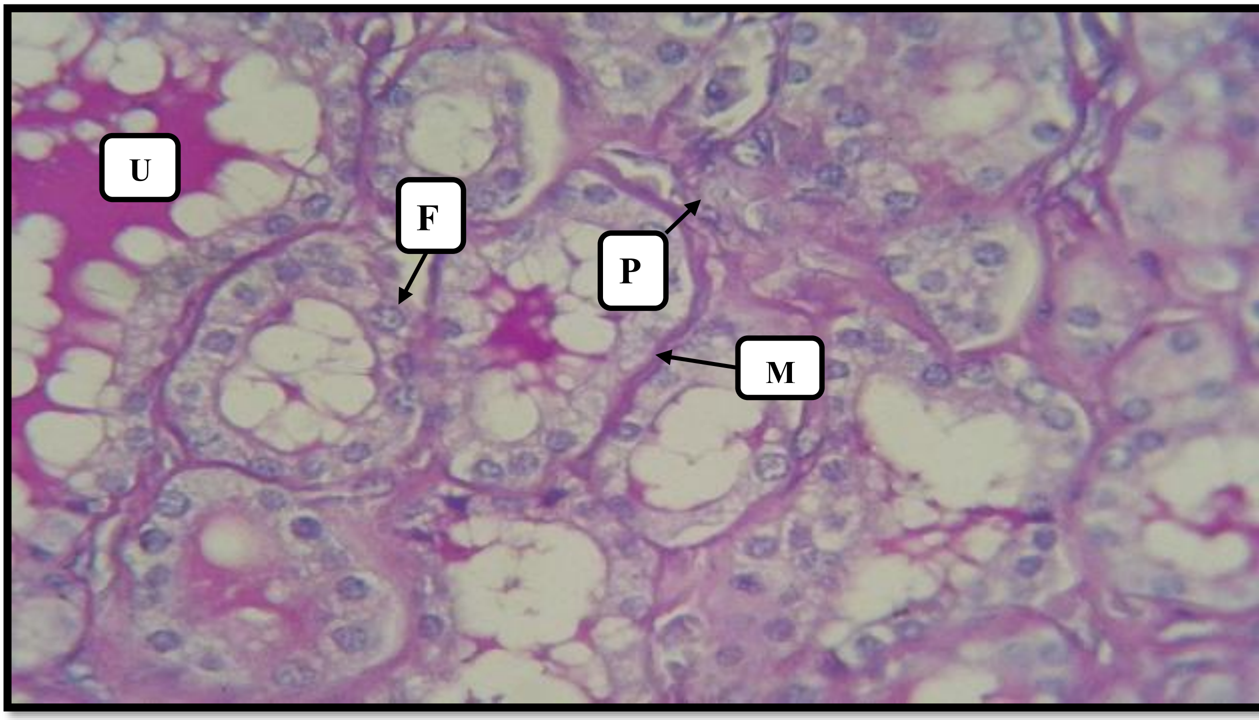

Fig.8. Cross microscopic section of the right lobe of thyroid gland in camel shows: F. Follicular cells, U. Colloid, M. Basement membrane, P. Para follicular cell; **PAS stain X400**

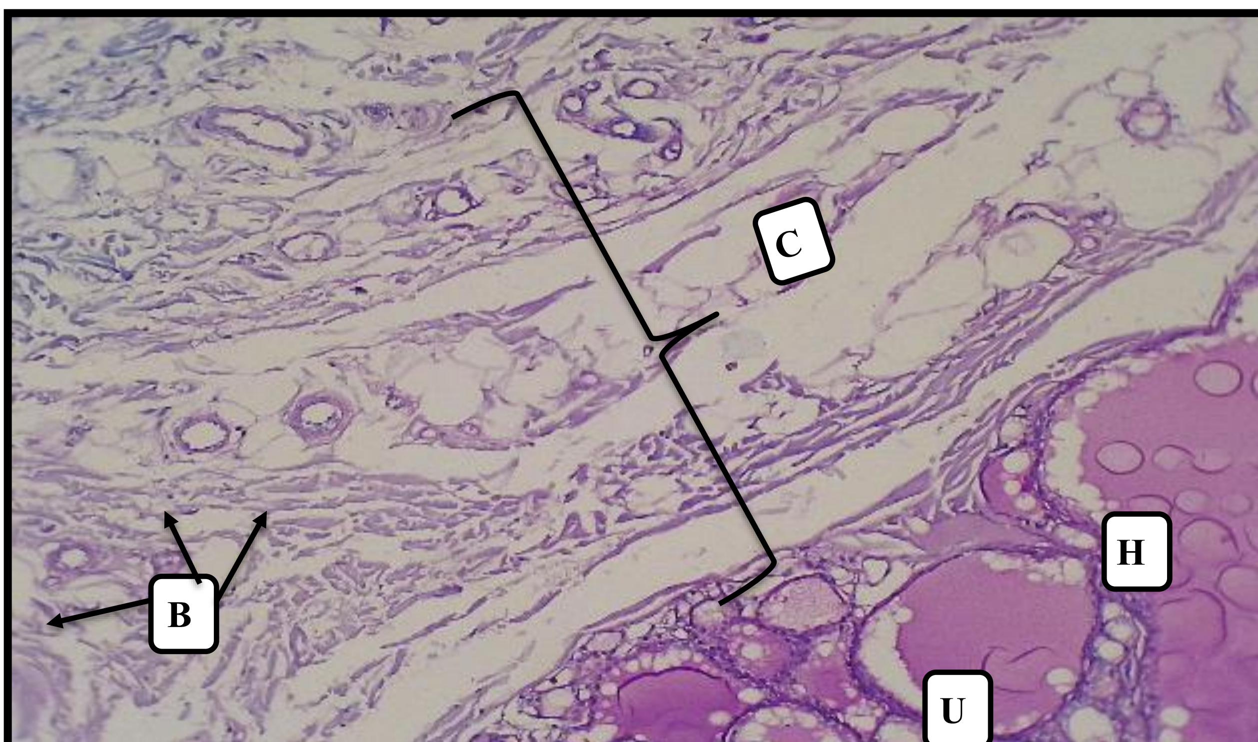

Fig.9. Longitudinal microscopic section of the left lobe of thyroid gland in camel shows: B. blood vessels, C. capsule, H. follicles U. Colloid with mucin; **PAS+AB stain X40**

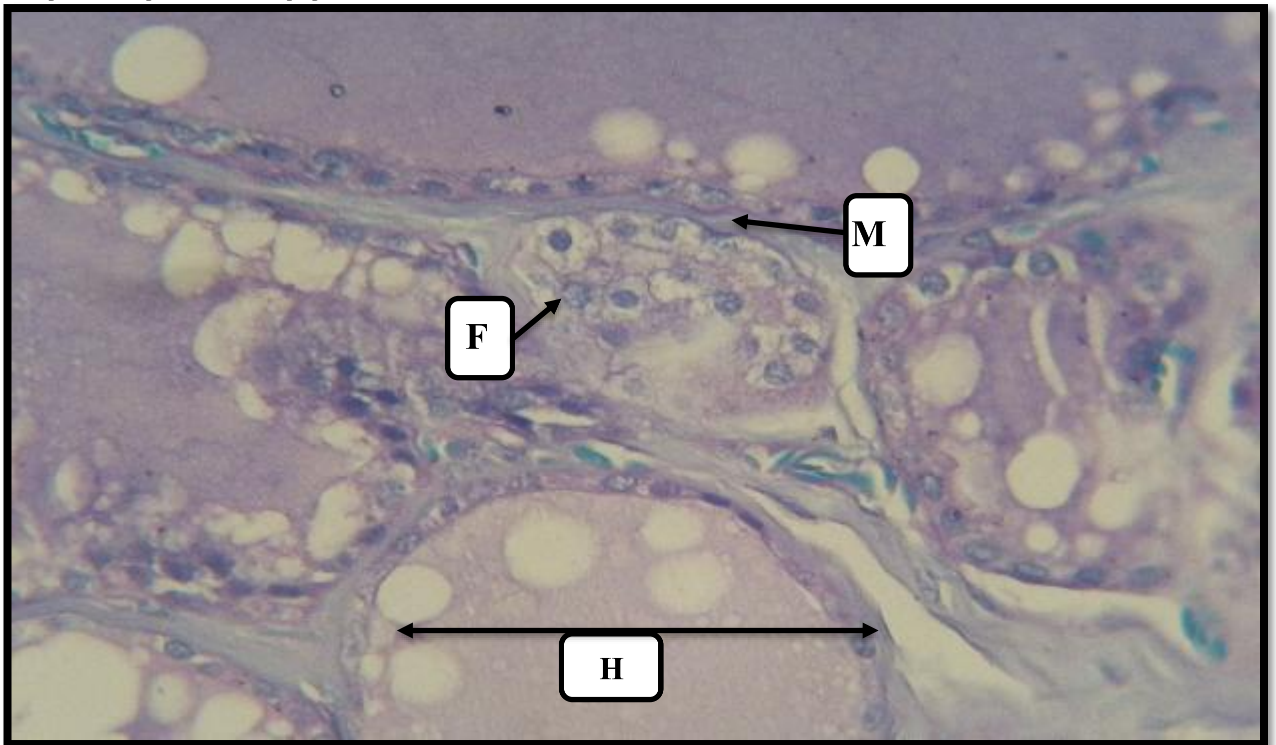

Fig.10. Cross microscopic section of the isthmus lobe of thyroid gland in camel shows: F. Follicular cells, M. Basement membrane, H. follicles; **PAS + AB stain X400**

CONCLUSION

the thyroid gland of an adult one-humped camel has a thin capsule, only two types of follicular cells, and parafollicular cells are rare and absent in many sections and the isthmus. The thyroid's colloid is different from that of other ruminants, which are adapted to hot, dry, and unfavorable climates. The thyroid gland of a camel helps to maintain water level by lowering pulmonary water loss and metabolism. These unique characteristics allow the camel to adapt to its physiology and harsh niche.

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