Tikrit Journal for Agricultural Sciences
ISSN:1813-1646 (Print); 2664-0597 (Online)
Journal Homepage: http://www.tjas.org
E-mail: tjas@tu.edu.iq
DOI: https://doi.org/10.25130/tjas.25.4.20

TJAS
Tikrit Journal for Agricultural Sciences

Comparative histological and histochemical study of the ovary in laying hens(*ISA Brown*) and broiler chickens(*Broilers Rose 308*) at different ages

Marwa AHameed[1], Muna S. Rasheid[1], and Ayad H. Ibraheem[2]
[1]Department of Biology, College of Science, Tikrit University, Iraq
[2]Department of Anatomy and Histology, College of Veterinary Medicine, Tikrit University, Iraq

***Correspondence:** **marwa.mm155@tu.edu.iq**

KEY WORDS:
laying hens, broiler chickens, Masson's trichome stain

Received: 02/06/2025
Revision: 28/08/2025
Proofreading: 10/10/2025
Accepted: 22/09/2025
Available online: 31/12/2025

ABSTRACT
The study aimed to compare the histology and histochemistry of the female reproductive system between two chicken species laying hens (ISA Brown) and broiler chickens (Broilers Rose 308). Histologically, using routine stains (hematoxylin and eosin (H&E), the ovary at the age of 2 months in both chicken species was covered by the germinal layer, which consists of simple cuboidal epithelium. Towards the inside of the cortex, there were primary and secondary ovarian follicles, but the number of follicles was greater in laying hens than in broiler chickens. The ovary of laying hens was more clearly visible than in broiler chickens. The ovarian cortex in both chicken species contained primary, secondary, and tertiary ovarian follicles, but in broiler chickens, it showed atrophy, depressions, and an irregular shape. The ovary of a 6-month-old laying hen contains mature ovarian follicles in the center of the ovary, indicating sexual maturity and readiness for ovulation. This is in contrast to the ovary of a broiler, where the follicles were few, appeared atrophied, and were close to the ovarian cortex. The results of histochemistry using Masson's trichrome stain revealed that the ovaries of both laying hens and broiler hens exhibited a positive reaction at different ages, with the cytoplasm of the ovarian follicles and connective tissue fibers showing a red color. Collagen fibers, however, took on a green color from the stain and were abundant in the ovaries of broiler hens of different ages, compared to the ovaries of laying hens, which showed a lower reaction to the stain.

دراسة مقارنة نسجية وكيميائية نسجية للمبيض في الدجاج البياض والدجاج اللحم بأعمار مختلفة

مروة عادل حميد[1]، منى صلاح رشيد[1] ، اياد حميد إبراهيم[2]
[1]قسم علوم حياة- كلية العلوم – جامعة تكريت- العراق.
[2]فرع التشريح والانسجة - كلية الطب البيطري -جامعة تكريت- العراق.

الخلاصة

هدفت هذه الدراسة إلى مقارنة التركيب النسيجي والكيميائي النسيجي للجهاز التناسلي الأنثوي بين نوعين من الدجاج البياض ISA) (Brownوالدجاج اللحم (Broilers Rose 308) تم اجراء الفحوصات النسيجية باستخدام صبغة الهيماتوكسيلين والإيوسين(H&E) ، حيث أظهرت النتائج أن المبيض في عمر شهرين لدى كلا النوعين مغطى بطبقة جرثومية تتكون من خلايا طلائية مكعبة بسيطة، تحت هذه الطبقة تم ملاحظة وجود جريبات مبيضية أولية وثانوية، مع ملاحظة أن عدد الجريبات كان أكبر في الدجاج البياض مقارنة بالدجاج اللحم, كما كان المبيض في الدجاج البياض أكثر وضوحًا مقارنة بالدجاج اللحم . عند عمر ستة أشهر، احتوى مبيض الدجاج البياض على جريبات ناضجة في لب المبيض، مما يشير إلى النضج الجنسي والاستعداد للتبويض، بالمقابل أظهر مبيض الدجاج اللحم عددًا قليلًا من الجريبات المبيضية بدت ضامرة وكانت قريبة من قشرة المبيض. أما فيما يتعلق بالكيمياء النسيجية، فقد أظهرت صبغة ماسون ثلاثية الألوان (Masson's trichrome stain)) تفاعلًا إيجابيًا في مبايض كلا النوعين في أعمار مختلفة، حيث ظهر اللون الأحمر في سيتوبلازم الجريبات المبيضية الناضجة والألياف النسيجية الضامة .ومع ذلك، كانت الألياف الكولاجينية تأخذ اللون الأخضر من الصبغة وكانت وفيرة في مبايض الدجاج اللحم مقارنة بمبايض الدجاج البياض، التي أظهرت تفاعلًا أقل مع الصبغة.

الكلمات المفتاحية: الدجاج البياض، الدجاج اللحم ، صبغة ماسون ثلاثية الألوان.

INTRODUCTION

The ovary is typically a paired female reproductive organ in mammals, serving as the site for follicular development and hormone secretion, specifically estrogen and progesterone. In most avian species, except for prey birds, only the left genital primordium develops into a functional organ (Jacob & Bakst 2007). In domestic fowl, both the left and right ovaries begin to grow approximately 72 hours after incubation commences (Ishimaru,et al, .2008). Oocytes and spermatogonia generally originate from the development of primordial germ cells (PGCs), which represent the initial germ cell population formed during development. In birds, unlike in other species, these cells are transported to the gonadal ridge via the circulatory system (Tagami et al.2017).

Domestic and wild birds share similar anatomical and histological features of the reproductive system, although there are numerous behavioral and morphological adaptations that birds have evolved to facilitate reproduction in different environments. In general, the reproductive organs of birds are adapted to their reproductive pattern, a characteristic important for the survival and reproduction of these animals. Female birds, including poultry, are characterized by having only one functioning left ovary due to the process of gonadal regression that occurs during embryonic development [Morais, *et al*.2012].

The female reproductive system in domestic chickens consists of the ovary and its associated oviduct. While the chicken embryo has two sets of reproductive organs, only one, the left one, remains and matures to produce eggs. The single remaining ovary in laying hens is located directly in front of the kidneys in the abdominal cavity and is tightly attached to the cavity wall. The ovary contains blood vessels that ensure unimpeded transport of nutrients to the developing yolk. A hen reaches sexual maturity when it lays its first egg (Parkhurst &Mountney.1988 ؛ North, Mack & Bell .1990؛YORO, *et al*.2021). Healthy reproductive organs are essential for the formation and production of high-quality, healthy eggs. It is essential to examine the structure and functions of the female reproductive system to gain a deeper understanding of the oogenesis mechanism. The oviduct is responsible for the formation of eggs, while its unique function of storing sperm for long periods is performed within its own tissue. Thus, the reproductive organs of birds

have unique functions, not only in egg formation, but also in the immune system, which is essential for preventing infection and producing healthy eggs (Yoshimura & Barua.2017).

The ovary is anatomically and functionally divided into the cortical region, which houses all the oocytes, and the medullary region, composed of connective tissues, vascular systems, and nerves that facilitate rapid follicular maturation during oogenesis. In hen egg production, there exists a hierarchy of developing yellow yolk follicular oocytes, with the largest classified as F1 and next to ovulate, followed by the second largest, F2, continuing down to follicular oocytes approximately 1 cm in diameter. The follicles are in the rapid development phase of oocyte maturation (Blendea,et al .2012) The purpose of crossbreeding between chicken breeds and types is to improve desirable traits by mating individuals with different genetic backgrounds to produce offspring with better characteristics than the parents (Dzungwe et al., 2024). Crossbreeding between exotic and indigenous chickens to achieve genetic variation can be utilized by producers to develop new productive lines that are adapted to harsh environments while producing a moderate amount of both eggs and meat (Taye et al., 2022).

MATERIAL AND METHODS

Animals

The study included two types of laying chickens ISA Brown) and Broilers Rose chickens, with 45 chickens of each type at different ages (2 months, 4 months, and 6 months) obtained from one of the local breeding fields.

Preparation of Microscopic Slides

The dissection was carried out after anesthetizing the chickens with strong doses of chloroform. After that, each bird was dissected directly after anesthesia. Special blades were used in the dissection. The dissection began from the beginning of the exit opening from the ventral side to the end of the thoracic region, and the female organ was completely removed. Then, they were transferred to special containers containing physiological solution (sodium chloride 0.75%).

Then, they were washed in this solution (3-5) times to get rid of any blood residue, and with extreme caution, in order to avoid affecting the tissue structure of the female organ. Then, the tissue samples were taken for study in the shortest possible period of time to ensure that they were not damaged.

The staining process was then carried out with Hematoxylin and Eosin and Masson's trichome stain (MTC).

RESULTS AND DISCUSSION

The histological sections of the current study showed that the ovarian cortex contained ovarian follicles of different sizes, some of which appeared as small primary ovarian follicles, others as medium-sized and large-sized ovarian follicles. These follicles contained homogeneous follicular fluid covered with simple cuboidal follicular epithelial cells, as in Figure 1, at 4x and 10x.

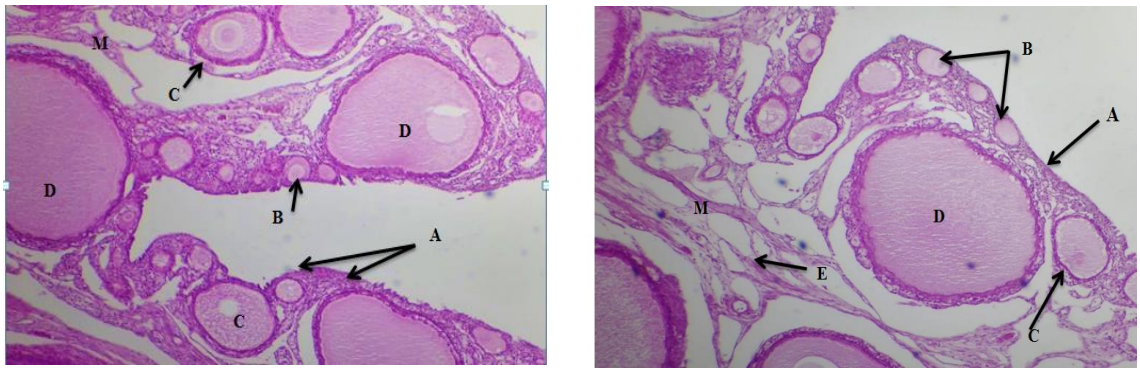

Fig. 1. of the ovary in laying hens(ISA Brown) at the age of 2 months shows the ovarian cortex (A), secondary follicle (C), primary follicle (B), tertiary follicle (D), ovarian medulla (M), loose connective tissue, H&E stain, at 4X & 10X power

Figure 2 shows that the surface of the ovary in this age of immature broiler chickens (Broilers Rose 308) contains a small number of inactive primary and secondary ovarian follicles near the ovarian cortex. These follicles contain homogeneous follicular fluid with poor clarity of the nuclei and are accompanied by loose connective tissue fibers and many white blood cells. This result is consistent with (Apperson *et al*.. 2017), who studied the ovary in domestic chickens.

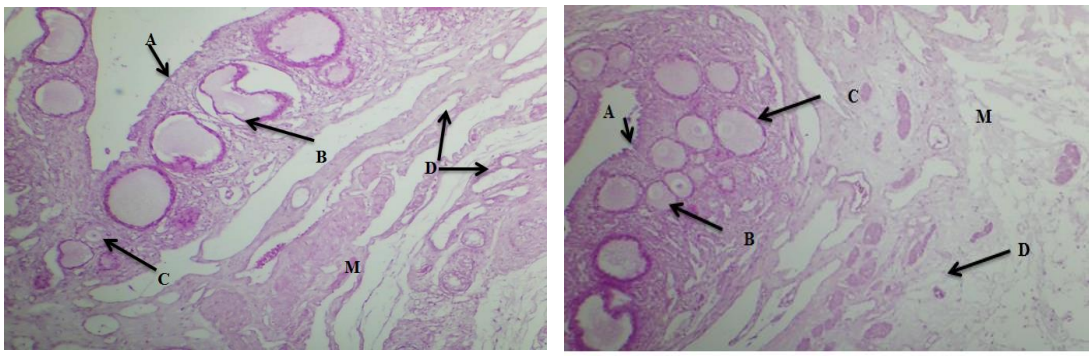

Fig. 2. of the ovary in broiler chickens (Broilers Rose 308) at the age of 2 months shows the ovarian cortex (A), secondary follicle (C), primary follicle (B), ovarian medulla (M), and loose connective tissue (D). H&E stain, at 4X power and 10X.

The results of the histological sections obtained from the ovaries of 4-month-old laying hens (ISA Brown) showed the chicken ovary contained a cortex with large numbers of ovarian follicles at different age stages (primary, secondary and tertiary) lined with follicular cells studies have confirmed that the growing follicles, upon maturation, leave the surface of the shell and move towards the medulla of the ovary until ovulation occurs (Shokry,*et al* .2016). Small primary follicles were also found in large numbers. The ovarian medulla contained colloidal connective tissue in the form of bundles of different directions, and in it were blood vessels, which is consistent with (Bradley, 1960؛ Gilbert,*et al*.1979) in domestic poultry. Most of these blood vessels appeared in a spiral shape and had winding walls devoid of blood, as shown in Figure (3) and (4), this result is consistent with

(Mfoundou,*et al*.2021) in their study of the ovary in chickens at different ages, except that the difference that occurred is that the ovarian cortex in broiler chickens at the age of 4 months became less clear.

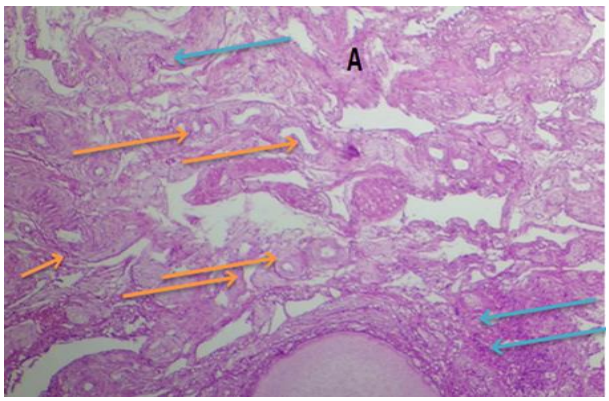

Fig. 3. shows the ovary in a laying hens(ISA Brown) at the age of 4 months, ovarian medulla (A), blood vessels and capillaries (orange arrows), connective tissue fibers (blue arrows), (H&E stain, 10X).

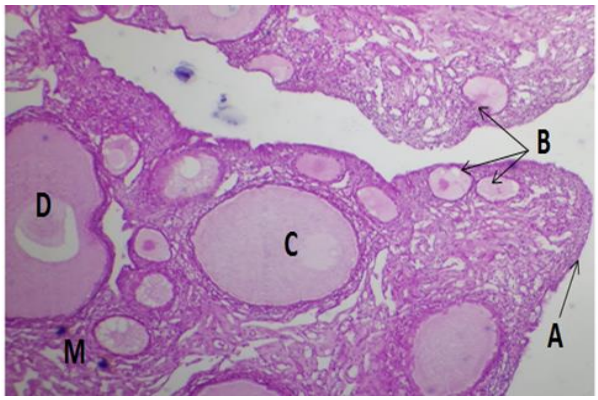

Fig.4. shows the ovary in laying hens (ISA Brown)at the age of 4 months, ovarian cortex (A), primary ovarian follicles (B), secondary ovarian follicle (C), tertiary ovarian follicle (D), ovarian medulla (M), (H&E stain, 4X).

The histological section in Figure (5) shows that the ovarian cortex contained a small number of small, shrunken ovarian follicles that do not contain a clear nucleus in the section. The cytoplasm of these follicles appeared shrunken and unclear, while the ovarian medulla was found to be devoid of mature ovarian follicles, but rather consists of fibrous connective tissue. This could be due to hormonal, genetic, or physiological reasons in this type of chicken. This result is consistent with Alshammary& Mirhish.2024) in their study of the female system of laying and non-laying peacocks and (Akinloye,*et al*.2014) in quails.

As in Figure (6) of the inactive ovary in broiler chickens at the age of 4 months shows that the surface of the ovary contains a small number of inactive ovarian follicles that do not contain nuclei inside them. These follicles are small in size and close to the surface of the ovarian cortex. The medium-sized follicles appeared irregularly with atrophy and depressions in them. As for the interior of the ovarian cortex, according to the results mentioned in the current study, developing ovarian follicles appeared near the surface of the cortex at both ages (2 months and 4 months). This result is consistent with (Ribeiro,*et al*.1995؛ Aughey & Fryedric. 2011؛ Blendea, *et al*.2012) in their study of the ovary in birds (*Columbidae columbiformes*), domestic chickens and domestic poultry, respectively.

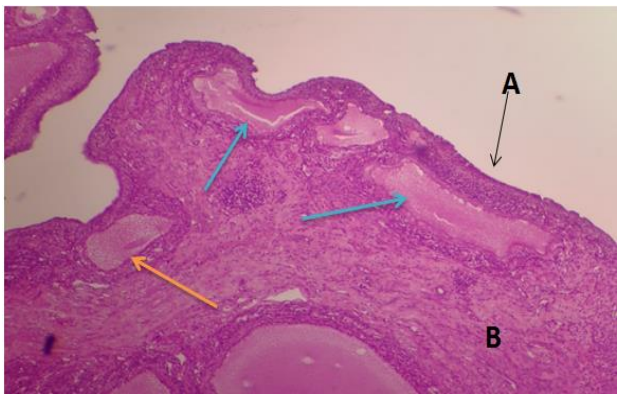

Fig. 5. Shows the ovary in broiler chickens at the age of 4 months, ovarian cortex (A), ovarian medulla (B), nucleus of the secondary ovarian follicle (orange arrow), degenerated ovarian follicles (blue arrows), (H&E stain, 10X).

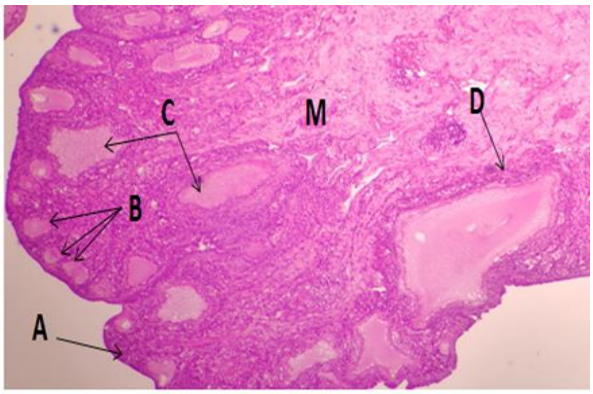

Fig. 6. shows the ovary in broiler chickens at the age of 4 months, ovarian cortex (A), primary ovarian follicles (B), degenerated secondary ovarian follicle (C), degenerated tertiary ovarian follicle (D), ovarian medulla (M), (H&E stain, 4X)

Histological findings of the ovary in a laying hens (ISA Brown) at the age of 6 months revealed that the surface of the ovary was covered with simple cuboidal epithelial cells. This result is consistent with (Ribeiro,*et al*. 1995), Columbia liwia (*Columbidae columbiformes*) and (Bhavna & Geeta, 2010) Jungle babbler. Beneath the epithelium were ovarian follicles lined with follicular cells, and the cavity contained homogeneous follicular fluid with the nucleus in its center, as shown in Figure 7. Figure 8, also shows that the ovarian cortex contained mature ovarian follicles, and around these follicles appeared immature primary follicles. Between these follicles, numbers of leukocytes were distributed, along with the spread of capillaries in the ovarian cortex and in the loose connective tissue, which this result is consistent with (Mfoundou,*et al*.2021).

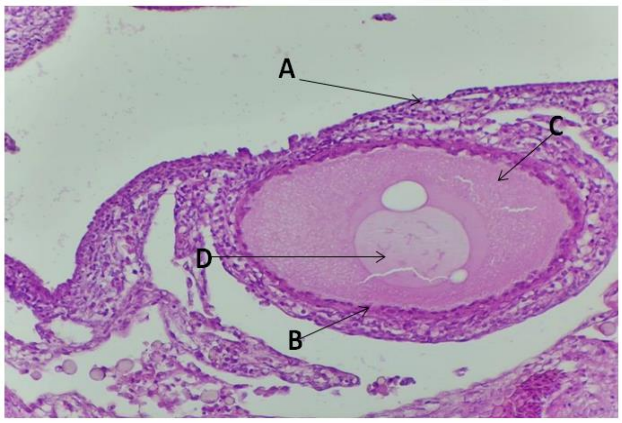

Fig.7 shows the ovary in a laying hens at the age of 6 months, ovarian cortex (A), adult follicle surrounded by follicular cell membrane (B), follicular fluid (C), nucleus (D), (H&E stain, 10X)

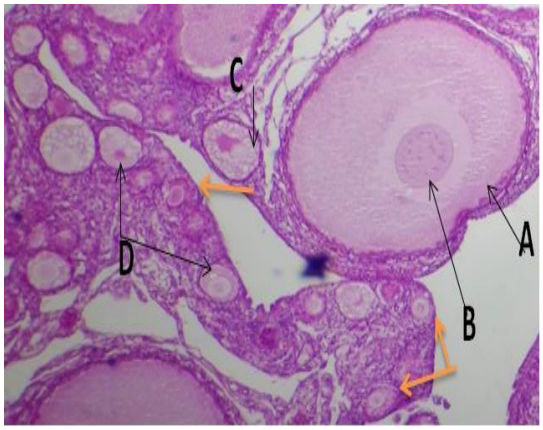

Fig.8. shows the ovary in a laying hens at the age of 6 months, an adult follicle surrounded by a follicular cell envelope (A), a nucleus (B), a tertiary ovarian follicle (C), a secondary ovarian follicle (D), primary oocyte follicles (orange arrows), (H&E stain, 4X).

Figure (9) shows histological sections of a dormant ovary at the age of 6 months in a broiler chicken, which shows the medulla of the ovary, which consists of colloidal fibers that surround the blood vessels and have thick walls. Figure (10) shows the cortex and medulla of the ovary, which contains a few ovarian follicles of varying sizes, showing signs of degeneration and atrophy, as they were spread among the loose connective tissue found in the medulla of the ovary. This may be due to genetic reasons between different breeds and species, as confirmed by (Hmeshe.2012) in his study of two chicken breeds, where he showed Sexual maturity in Syrian local chickens is 159 days, while in Egyptian Fayoumi chickens, sexual maturity is reached at 201 days after hatching.

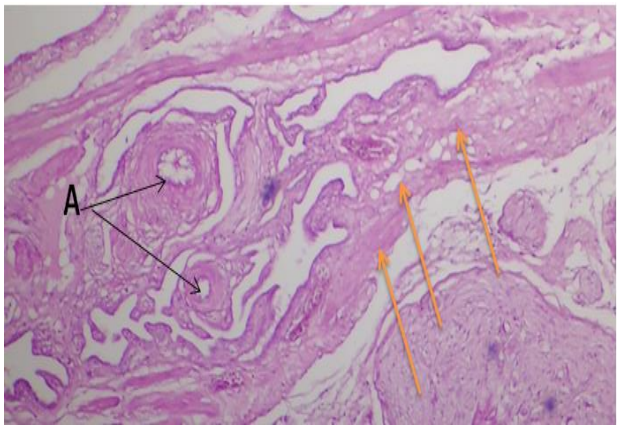

Fig. 9. Shows the ovary in a broiler chicken at the age of 6 months, blood vessels (A), connective tissue fibers (orange arrows), (H&E stain, 10X).

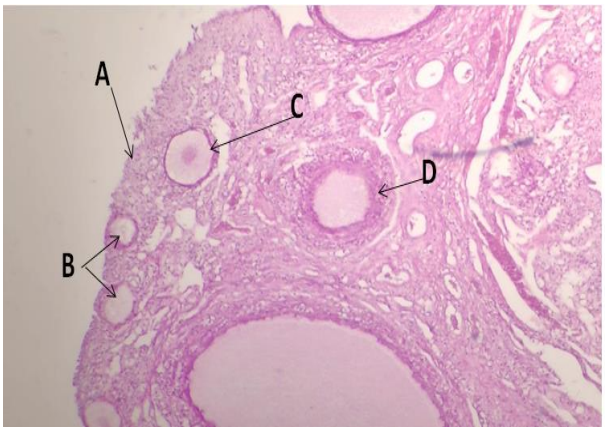

Fig. 10. shows the ovary in a broiler chicken at the age of 6 months, ovarian cortex (A), primary ovarian follicles (B), secondary ovarian follicle (C), degenerated tertiary ovarian follicle (D), (H&E stain, 4X).

Histochemical results of the ovary of laying hens at the age of 2 months using Masson's trichrome stain (MTC) showed that the cortex and medulla of the ovary contained primary and secondary ovarian follicles that reacted positively with the stain in terms of the cytoplasm of the follicles, which took on a light red color, and the absence of green color in the tissue due to the lack of collagen fibers in abundance in the ovary, which takes the green color from the stain MTC, as in Figure (11).

As for the ovary of broiler chickens at the age of 2 months, Figure (12) and (13) of the ovary of broiler chickens at the age of 2 months, it shows the ovarian cortex and primary follicles surrounded by darkly stained germ cells that were positively reactive, and surrounded from the outside by collagen fibers that were positively reactive.

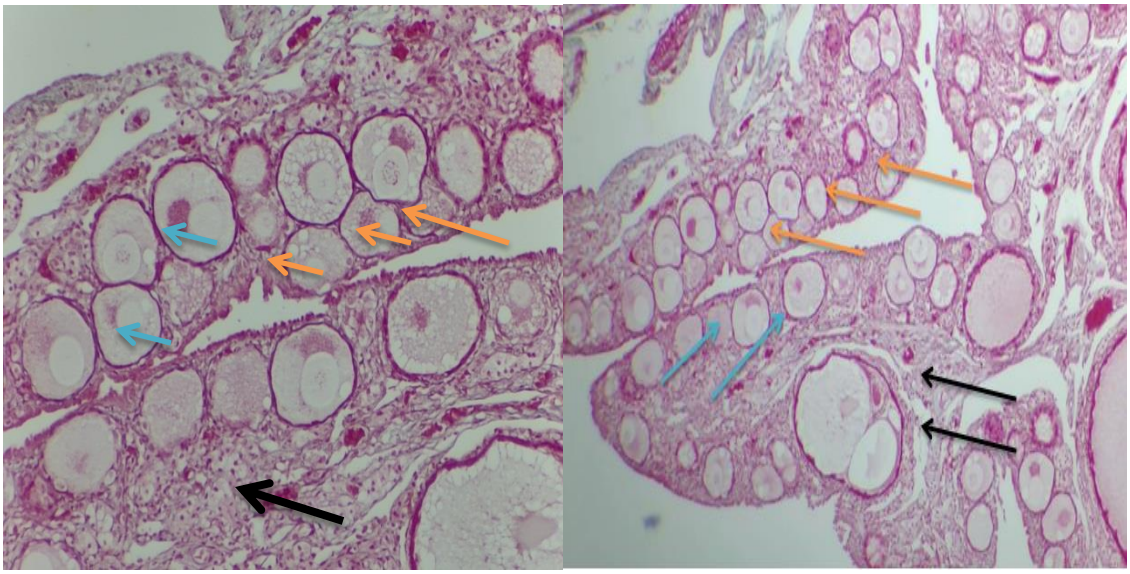

Fig.11. shows the ovary laying hens, primary follicles (orange arrows), secondary follicles (blue arrows), ovarian pulp fibers (black arrows), MTC stain, 4x ,10 X strength.

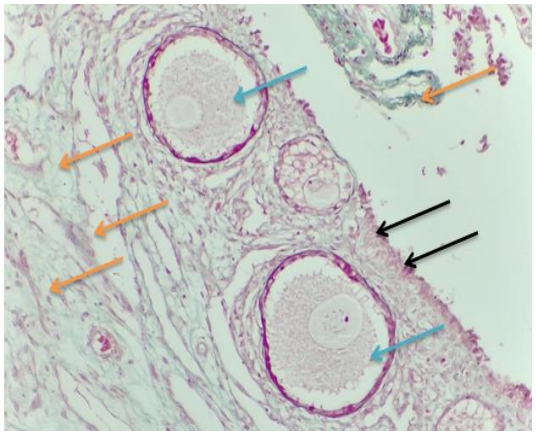

Fig.12. shows the ovary broiler chicken, primary ovarian follicles (blue arrows), ovarian medulla fibers (orange arrows), ovarian cortex germ cells (black arrows), (MTC stain, 10X).

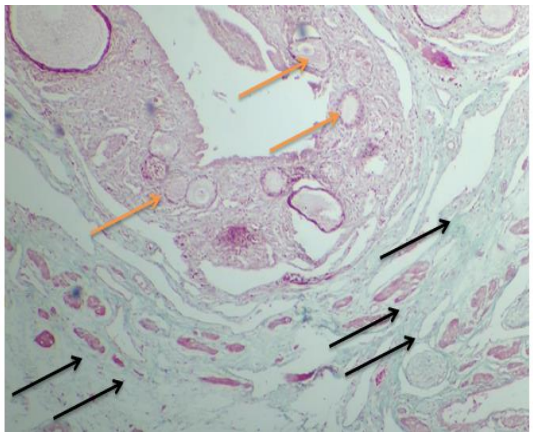

Fig 13. shows the ovary broiler chicken, primary follicles (orange arrows), ovarian pulp fibers - collagen fibers - (black arrow), (MTC stain, 4x)

The results of the histochemical sections of the ovary in laying hens at the age of 4 months, as shown in Figure (14), the mature ovarian follicle in which there is dense follicular fluid and in which there is a spherical nucleus with a medium reaction to the special stain, surrounded by cytoplasm that reacted positively to MTC. The ovarian follicle was surrounded by connective tissue that reacted positively with the red color and appeared in a zigzag shape, with the presence of loose connective tissue. The cortex and medulla of the ovary contained ovarian follicles of different sizes, containing nuclei and cytoplasm that reacted positively with the special stain. These follicles were surrounded by connective tissue that took the red color from the special stain, with the presence of a small number of collagen fibers that reacted negatively with the special stain, as shown in Figure (15).

Figure (16) of a broiler ovary at the age of 4 months showed an irregular ovarian follicle, and its cavity contained lipid droplets surrounded by egg cytoplasm. The follicular cells lining the follicle cavity showed a high reaction to the dye based on the basement membrane. The follicle was surrounded from the outside by collagen fibers that reacted positively with the MCT,this is also the case with studies by [Bekele,et al.2010؛, Chebo,et al .2022؛ Mokoena et al,2025), on the productive capacity of various chicken breeds. Therefore, these studies are consistent with the results obtained from histological studies of the ovaries at the age of 6 months in laying hens and broiler chickens.

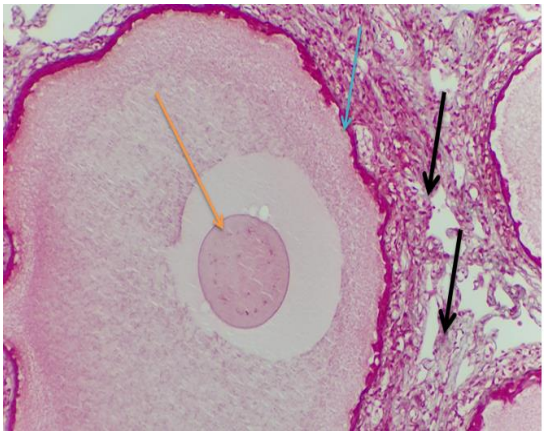

Fig. 14. shows the ovary of laying hens, mature ovarian follicles (blue arrow), positively reacting connective tissue fibers (black arrow), nucleus (orange arrow), (MTC stain, 10x).

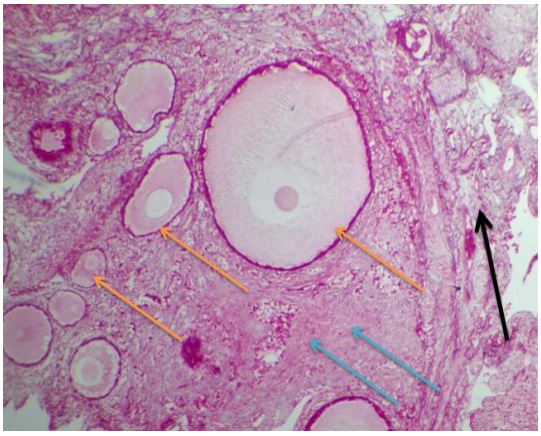

Fig. 15. shows the ovary of laying hens, primary, secondary and tertiary ovarian follicles (orange arrows), positively reacting connective tissue fibers (blue arrows), collagen fibers (black arrows), (MTC stain, 4x).

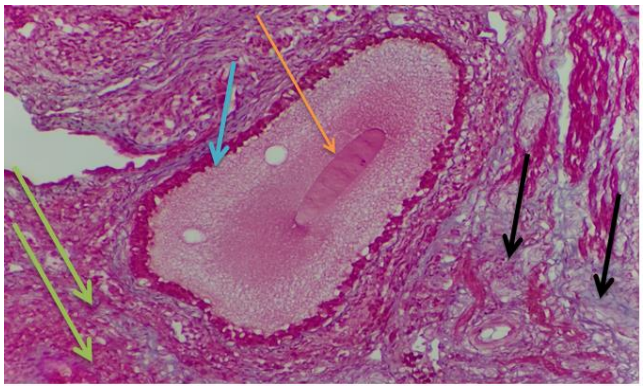

Fig.16. shows the ovary of broiler chicken, ovarian follicles (blue arrow), positively reacting connective tissue fibers (green arrow), collagen fibers (black arrows), (MTC stain, 10x)

Figure (17) shows the histochemical sections of the ovary in laying hens at the age of 6 months, and through the use of MTC dye, the presence of mature ovarian follicles lined with germ cells that strongly react with the dye, in addition to the presence of a positive reaction with the cytoplasm of the cell in the pink color of the dye, with the presence of a nucleus in the center of the ovarian follicle that has a strong affinity for the dye. As for the ovarian medulla, it appeared in the form of thin bundles of connective tissue fibers, pink to

red in color, and a small number of collagen fibers, which showed a negative reaction with the dye.

While Figure (18) and (19) show a histochemical section of the ovary in broiler chickens at the age of 6 months using MTC, the ovarian cortex contains few scattered ovarian follicles lined with dark-stained, degenerated cells, and there is shrinkage of the follicular cells at the surface of the ovary and the disappearance of the nuclei of the egg cells, with the presence of bundles of blue-green collagen fibers that react positively with the special dye in the ovarian cortex and medulla and surround the inactive ovarian follicles,this result is consistent with (Wani,*el al* .2017) when they used the special stain for the female reproductive system in chickens

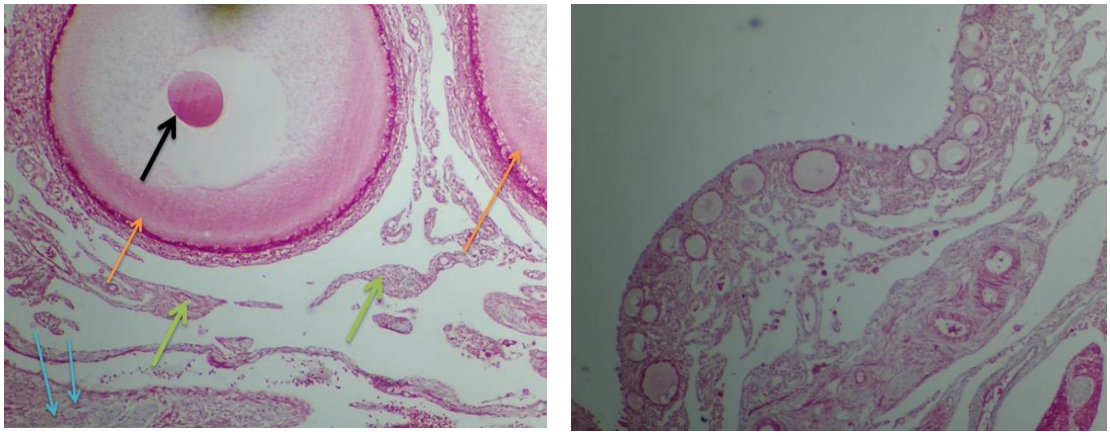

Fig. 17. Shows the ovary of a 6-month-old laying hens, a mature ovarian follicle (orange arrows), positively reacting connective tissue fibers (green arrows), collagen fibers (blue arrows), egg cell nucleus (black arrow), (MTC stain, 10X, and 4X)**.**

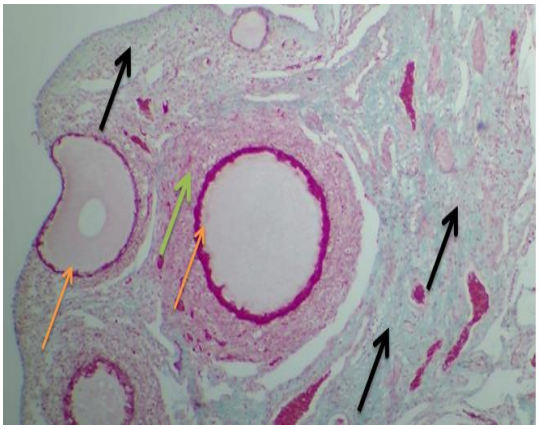

Fig. 18. Shows the ovary of a broiler chicken, ovarian follicles (orange arrows), positively reacting connective tissue fibers (green arrows), and collagen fibers (black arrow), (MTC stain, 10x).

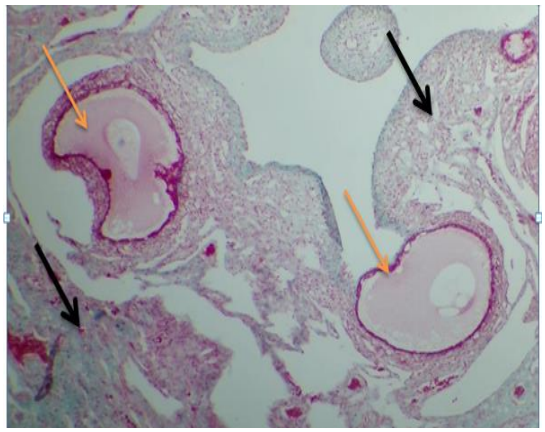

Fig. 19. Shows the ovary of broiler chicken, ovarian follicles (orange arrows), collagen fibers (black arrow), (MTC stain, 4x).

CONCLUSION

Histological and histochemical analyses of the reproductive systems of two chicken species demonstrated that the ovary comprises the cortex and medulla, in addition to blood vessels. The ovaries of both species exhibited variations in shape, size, and number of folds, along with differences in muscle content, thereby enhancing the birds' adaptation to the physiological requirements of egg transport through the oviduct, as confirmed by routine histological staining.

CONFLICT OF INTEREST

The authors declare no conflicts of interest associated with this manuscript.

ACKNOWLEDGMENTS

We want to express our sincere gratitude to all the staff of the College of Science, Department of Biology for their invaluable assistance.

REFERENCES

Akinloye, A. K., Oyenekan, I. O., Okandeji, M. E., Mustapha, O. A., Olude, M. A., & Adebayo, A. O. (2014). Gross morphometric study on the reproductive system of Japanese quail (Coturnix coturnix japonica). *Tropical Veterinarian*, 32(3-4), 87-96.

Alshammary, H. K., & Mirhish, S. M. (2024). Morphological study of laying and non-laying female genital system in peacock (Pavo cristatus). *Iraqi Journal of Veterinary Sciences*, *38*(1), 45-53.

Apperson, K. D., Bird, K. E., Cherian, G., & Löhr, C. V. (2017). Histology of the ovary of the laying hen (Gallus domesticus). *Veterinary Sciences*, 4(4), 66.

Aughey, E. and Fryedric, F. L. (2011). Comparative veterinary histology with clinical correlates. Manson Publishing Can Vet J. 2002 Feb; 43(2): 104

Bekele, F., Adnoy, T., Gjoen, H. M., Kathle, J., & Abebe, G. (2010). Production performance of dual purpose crosses of two indigenous with two exotic chicken breeds in sub-tropical environment. *International Journal of Poultry Science*, 9(7), 702-710.

Bhavna,B.andGeeta,P.(2010).Histological and histomorphometric study of gametogenesis in breeder and helpers of sub-tropical, co-operative breeder jungle babbler, Turdoides striatus. Journal of Cell and Animal Biology, 4(5):81-90.

Blendea, A., Cazimir, I., Cornilă, N., Irimescu, I., & Damian, A. (2012). Anatomohistological study regarding the ovary and oviduct in different age groups in the chicken (Gallus domesticus). *Veterinary Medicine J*, 8, 18-27.

Bradley, OC (1960) The Structure of the Fowl, 4th Edition, Tom Grahame ed, Oliver and Boyd, London, UK

Chebo, C., Betsha, S., & Melesse, A. (2022). Chicken genetic diversity, improvement strategies and impacts on egg productivity in Ethiopia: a review. *World's Poultry Science Journal*, 78(3), 803-821.

Dzungwe, J. T., K. Tozo, C. A. M. Chrysostome, R. A. Tankouano, O. E. Oke, and K. Tona. 2024. "Effect of Crossbreeding on Egg Quality, Incubation, and Hatching Activities of the Pure and Reciprocal Cross Between the Sasso and Wassache Chickens." *Poultry Science* 103:103406. https://doi.org/10.1016/j.psj

Gilbert, A. B.; Hardie, M. A.; Perry, M. M.; Dick, H. R. and Welles, J. W.(1979). Cellular change in the granulose layer of the maturing ovarian follicle of the domestic fowl. *Br. Poult. Sc.*, 21:257-263.

Hmeshe, M. (2012). Study of Some Production Indicators of Syrian Local Poultry in Coastal Conditions. *International Journal of Poultry Science*, 11(2), 108-113.

Ishimaru, Y., T. Komatsu, M. Kasahara, Y. Katoh-Fukui, H. Ogawa, Y. Toyama, M. Maekawa, K. Toshimori, R. A. Chandraratna, K. Morohashi, and H. Yoshioka. 2008. Mechanism of asymmetric ovarian development in chick embryos. Development. 135(4):677-85

Jacob, M., and M. R. Bakst. 2007. Development anatomy of the female reproductive tract. Pages 149–179. In: B. G. M. Jamieson, ed. Reproductive biology and physiology, (Vol. 6A), Science Publishers. USA.

Mfoundou J. D. L., Guo, Y. J. Liu, M. M. Ran, X. R. Fu D. H., Yan Z. Q., Li, M. N. and Wang X. R. (2021). The morphological and histological study of chicken left ovary during growth and development among Hy-line brown layers of different age 2021 *Poultry Science* 100:101191.

Mokoena, K., Mbazima, V., & Tyasi, T. L. (2025). A literature review on effect of chicken crossbreeding on egg production traits. *World's Poultry Science Journal*, 81(1), 151-167.

Morais, M. R. P. T., Velho, A. D. S., Dantas, S. E. S., & Fontenele Neto, J. D. (2012). Morphophysiology of avian reproduction I: Embryonic development, anatomy and histology of the reproductive system.

North, Mack O and Bell, D (1990) Commercial Chicken Production Manual, 4th Edition, AVI Publishing Company, USA.

Parkhurst, CR and Mountney, GJ (1988) Poultry Meat and Egg Production, Von Nostrand Reinbold Company, Melbourne, Australia.

Ribeiro, M. D.; Teles, M. E. O. and Maruch, S. M. G.(1995). Morphological aspects of the ovary of Columba livia (Columbidae-columbiformes). *Revta bras. Zool.*,12(1):151-157

Shokry, D. N., Amin, M. E., Karkoura, A. A., Alsafy, M. A., & El-Gendy, S. A. (2016). Post-hatching development of the chicken ovary (Alexandria breed). *Alexandria Journal for Veterinary Sciences*, 50(1), 57-64.

Tagami, T., D. Miyahara, and Y. Nakamura. 2017. Avian Primordial Germ Cells. Adv Exp Med Biol. 1001:1–18.

Taye, S., G. Goshu, M. Alewi, and S. Abegaz. 2022. "Egg Production Performance of Improved Horro Chicken Crossed with Koekoek and Kuroiler Breeds." Global *Journal of Animal Scientific Research* 10 (1): 99–108.

Wani, H., Darzi, M. M., Kamil, S. A., Wani, S. A., Munshi, Z. H., Shakoor, A., ... & Shah, A. (2017). Histological and histochemical studies on the reproductive tract of Kashmir faverolla chicken. *Journal of Etnomology and Zoology Studies*, 5(6), 2256-2262.

Yoshimura, Y., & Barua, A. (2017). Female reproductive system and immunology. *Avian Reproduction: From Behavior to Molecules*, 33-57.

YORO, C. M., YOE, G. E., Anne, M., & DJAMAN, J. A.(2021). Histological Study of the Ovary of the Gallus Gallus Hen (Of Dzaye Breeds) In Cote D'ivoire. *IOSR Journal of Biotechnology and Biochemistry* (IOSR-JBB) ISSN: 2455- 264X, Volume 7, Issue 4 (Jul. – Aug. 2021), PP 45-51.