Full Length Article

GROSS MORPHOLOGY AND MORPHOMETRIC STUDIES OF FEMALE REPRODUCTIVE TRACT OF *SIRUVIDAI* CHICKEN DURING LAYING AND BROODY PHASES

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ABSTRACT

Avian species reproduce sexually by the fusion of male and female gamete spermatogonia and oogonia-produced by differentiated testes and ovaries. Fertilization is internal and all birds are oviparous. Reproduction in birds entirely varies from other animals. The two essential reproductive organs are the ovary and oviduct which are involved in the synthesis of egg in adult laying hen. Gross and morphometrical studies were carried out on the female reproductive tract in twelve Siruvidai chicken of which six at laying phase and six at broody phase. The birds were reared in Poultry Research Station, Madhavaram, Chennai-51. In laying phase, the left ovary showed mature ovarian follicles whereas the ovary during broodiness phase was in the form of a bunch of grapes with no hierarchical follicles. There was no significant difference in the body weight of the bird during laying and broodiness. The mean length, weight and width of ovary and oviduct had a highly significant difference during laying and broodiness. Gross morphology revealed that only the left female reproductive tract was well-developed both during laying and broodiness phase and the morphometric data analyzed will provide a baseline for subsequent studies and also for comparison with other avian species.

Key words: *Siruvidai*, Morphology, Morphometry, Ovary and Oviduct.

Received : 07.05.2024 Revised : 29.08.2024 Accepted : 29.08.2024

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INTRODUCTION

The ovary and oviduct are the female reproductive organs in birds. Ovary is involved in the synthesis of ovum; whereas yolk being manufactured within the oocyte from raw materials synthesized by the liver (King., 2012). The oviduct carries the ovum to the cloaca and adds successively the albumen, two shell membranes and the shell. During developmental stages there were both right and left gonads but, in many birds, only the left ovary reaches full development. In fowl the right ovary was atrophied at the seventh day of incubation (Nickle *et al.,* 1977). The female avian reproductive system was regulated by the hypothalamus-pituitary-gonadal axis (Ottinger and Baskt,1995). Domestic chickens are continuous breeders and under optimal condition they are reproductively active throughout the year (Backwell *et al.,* 2013). Reproduction in birds entirely varies from other animals.

Siruvidai and *Peruvidai* are the major indigenous chicken ecotypes of Tamil Nadu state, India (Jamima *et al.*, 2020)**.** Indigenous chicken contributes to more than 20% of total egg production in India. These birds are also known for their adaptive superiority in terms of their resistance to endemic diseases and other harsh environmental conditions (Nwakpu *et al.*, 1999). Chicken is the most common species of domestic poultry. These birds are believed to have descended from Red jungle fowl found in Southeastern Asia (Backwell *et al.,* 2013). *Siruvidai* chicken, an indigenous ecotype of Tamil Nadu is prevalent in Ariyalur district of Tamil Nadu. The phenotypic characters of *Siruvidai* roosters exhibit golden-yellow hackles, while their breast, abdomen, tail feathers and wing primaries are black. Their body is adorned with red feathers. Whereas, in females the neck is covered with lustrous brown feathers intricately laced with golden-yellow colour (Churchil *et al.,* 2023). Reproductively active female birds have only one active oviduct and ovary. During development the right oviduct regresses by hormone-controlled apoptosis, while the left oviduct doesn't regress by elevated concentrations of estrogen (Assersohn *et al.,* 2021).

MATERIALS AND METHODS

In the present study six *Siruvidai* chicken during laying phase and six *Siruvidai* chicken during broodiness phase were procured from Poultry Research Station, Madhavaram, Chennai-51. The birds were slaughtered by using Halal method and the female reproductive tract was eviscerated with utmost care to study its gross morphology both in laying and broody phases. The appropriate period of broodiness for slaughter was assessed based on the previous history of laying pattern in six birds. Colour, consistency and attachment with other organs of ovary and oviduct were observed. In morphometrical study, the number of follicles in the ovary were counted and weight, length and diameter of the ovary and all the segments of oviduct (infundibulum, magnum, isthmus, uterus and vagina) both during laying and broodiness phase were recorded and statistically analysed

using t-test for comparing laying and broodiness phase.

RESULTS AND DISCUSSION

Ovary

The ovary and oviduct in *Siruvidai* chicken were pinkish white in colour whereas Pollock and Orosy (2002) reported that the colour of ovary in laying birds was pinkish yellow and Mahajan *et al.,* (2021) reported that the colour of ovary in Kadaknath chicken was grey in colour. The consistency of female reproductive tract was soft and fragile, and only left female reproductive tract was present as reported by King (2012). In adult birds, the presence of right ovaries was recorded in long-eared owls, common buzzards, sparrows, hawks, fight less Kiwis and goshawks (Johnson, 2015).The mature ovary resembled a bunch of grapes with numerous follicles of various sizes which projected from the surface of the ovary and attached by a pedicle as mentioned by Blendea *et al.* (2012) and Islam *et al.* (2021) in turkey. Kheawkanha *et al.* (2021) mentioned that, in mature Thai native hen, large number of ovarian follicles were observed. Growth and maturation of ovary in quails occurs fast at the age group from eight weeks to twenty weeks. At the time of egg-laying the number of follicles in ovary were more than 900 (Foromo *et al.,* 2022). The ovary had an irregular surface located in the abdominal cavity extending cranial to the caudal extremity of lung and ventrally to the abdominal air sac as it was observed by Alshammary *et al.* (2017) in Geese and Islam *et al.* (2021) in Turkey.

The number of hierarchical follicles in the present study was four whereas it was five to six in laying chicken. Small yellow follicles, small and large white follicles were also noticed as it was described by Norman (1987). The important function of ovary is production of sex hormones and germ cells (Berg *et al.*, 2000). The left ovary and oviduct were situated at the left abdominal cavity in association with the left kidney as reported by Burke (1977) at its dorsal side, gizzard and small intestine at its ventral side, colon on the right and body wall on the left during laying (Fig 1). In broodiness phase the retarded growth in maturing follicle and resorption of smaller and larger follicles and oviduct were completely atrophied as reported by Nickle *et al.* (1977), the resorption of hierarchical follicle was also observed as it was mentioned by Heryanto *et al.* (1997) in broody chicken. The entire female reproductive tract was located in the left abdominal cavity with no association with other organs (Fig 2).

Oviduct

The oviduct had five segments the infundibulum which was funnel shaped, the longest segment of oviduct was magnum, shortest segment was isthmus, broader uterus and the last segment vagina (Fig 3 and 4) as reported by Wani *et al.* (2017). Highly convoluted muscular oviduct extendes from ovary to the cloaca and was suspended in the left abdominal cavity by the dorsal mesentry as mentioned by Nabil *et al.* (2022) in Turkey and Essam *et al.* (2016) in duck., whereas, in Nigerian indigenous laying chicken the

oviduct was less complex and highly vascular (Mahmud *et al.,* 2017). The colour of oviduct was pinkish to yellow in *Siruvidai* chicken; whereas, in White Leghorn and the colour of oviduct was whitish and it is greyish in Kadaknath hens (Mahajan *et al.,* 2021).

Infundibulum

In the present study, the infundibulum had two parts namely the funnel and the tubular part, as reported by Mohammadpour and Keshtmandi (2008) in pigeons and ducks. Moraes *et al.,* (2010) reported three regions, namely infundibular fimbriae, funnel and tubular. The funnel was thin- walled opens into the thick-walled tubular region, the second part of infundibulum. The colour of the funnel part was transparent and the tubular portion was highly vascularized reddish because of the tubular glands as recorded by Rahman (2013).

Magnum

The magnum was the longest segment in the oviduct (Mahmoud *et al.*, 2018) and was differentiated from infundibulum by its thicker wall (Nabil *et al.*, 2022). It had thick longitudinal folds and differentiated from isthmus by a thin narrow constricted transparent membrane as it was reported by Wani *et al.* (2017) in Kashmir faverolla chicken.

Isthmus

The isthmus was similar to the magnum (Nabil *et al.,* 2022) but shorter and less coiled than magnum and separated from magnum by a thin, bright, constricted translucent zone as described by Alshammary *et al.,* 2017 in Geese.

Uterus

The uterus was pouch like thick-walled and forms the widest part of the oviduct as it was found by Mahmoud *et al.* (2018) in ducks. Fourth segment of the oviduct, located between the isthmus in front and the vagina behind as it was described by Islam *et al.* (2021) in turkey. Its mucosal folds were arranged in longitudinal orientation forming leaf-like lamellae intersected by circular directions (Alshammary *et al.,* 2017); whereas, the mucosal fold had an oblique orientation with slight spiral pattern with in the cranial two-thirds of the uterus but gradually changed to a longitudinal orientation in the caudal one-third of the uterus in Emu (Robert *et al.,* 2011).

Vagina

The vagina was the shortest part of the oviduct that appeared straight, narrow, S- shaped muscular tube and opened into the cloaca as it was observed by Alshammary *et al.* (2017) in geese. Transverse folds were present in vagina throughout its length in the present study whereas, in Egyptian Balady Duck transverse folds disappeared for about 1 cm at its termination (Mahmoud *et al.,* 2018). Vagina was studded with folds and were separated from the shell gland by the utero-vaginal sphincter muscle and finally terminated at the cloaca as it was recorded by Wani *et al.* (2017) in Kashmir Faverolla chicken.

Morphometry

The mean body weight of the bird during laying was 1.39±0.08 kg and broodiness was 1.19±0.04 kg, the mean weight of ovary during laying and broodiness was 40.03±0.53 and 2.66±0.14 gm respectively. The percent ovary weight during laying was 2.92±0.188 g and during broodiness was 0.22±0.01 gm. The length of ovary in laying and broody birds was 5.58±0.20 and 3.26±0.08 cm; while the, width of ovary during laying was 4.51±0.29 cm and during broodiness was 2.53±0.14 cm. The diameter of F1, F2, F3 and F4 follicles were 3.70±0.29, 3.01±0.366, 2.01±0.166 and 1.316±0.25 cm respectively and number of follicles of small white follicle was 21.50±0.92 during laying and 22.83±1.72 during broodiness. The number of large white follicles was 16.66±0.49 during laying and 15.16±0.83 during broodiness, small yellow follicle was 25.50±1.60 during laying and 23.50±1.47 during broodiness and large yellow follicle was 4.00±0.00 during laying and 0.00±0.00 during broodiness.

There was no significant difference in the body weight and number of follicles in laying and broody phases but, there was a significant difference in the weight of ovary, percent ovary weight, length of ovary, width of ovary between laying and broody hens. The weight of ovary was 39.31±1.55 gm and the mean length and width of ovary was 5.739±0.42 and 5.194±0.29 cm respectively. The diameter of ovarian follicle was 15.181±1.25 mm and the percent ovarian weight to body weight was 2.763±0.16 in White Leghorn and in Kadaknath the weight of ovary was 21.47±0.85 gm. The mean length and width of ovary was 4.176±0.19 cm and 3.142±0.17 cm respectively, and the diameter of ovarian follicle was 6.088±0.65 mm and the percent ovarian weight to body weight was 1.592±0.05 (Mahajan *et al.,* 2021).

The weight of oviduct was 46.87±0.49 and 8.11±0.19 gm during laying and broody phases. The length of oviduct was 43.60±0.48 cm during laying and 20.33±0.49 cm in broody phase. The percent oviduct weight was 3.43±0.22 and 0.67±0.02 during laying and broody phases (Table 2). The mean length and weight of left oviduct in Kadaknath was 21.95±1.2 cm and 14.69±1.5 gm; whereas in White Leghorn it was 38.55±2.0 cm and 57.87±6.2 gm respectively. The percent oviduct weight to body weight was 3.95±0.36 and 1.074±0.09 in White Leghorn and Kadaknath hens respectively (Mahajan *et al.,* 2021). The length, circumference and diameter of infundibulum, magnum, isthmus, uterus and vagina during laying and broodiness phase were also recorded and presented in Table 3. The mean lengths of infundibulum in indigenous, Sonali and Rhode Island Red (RIR) breeds at laying stage were 9.57±0.85, 15.63±1.16 and 15.67±3.53 cm respectively and the breadth were 0.93±0.15, 1.2±0.2, and 1.57±0.15 cm respectively. The mean weight was 1.87±0.30, 2.83±0.25 and 3.2 ± 0.6 g respectively. The mean lengths of infundibulum in indigenous, Sonali and Rhode Island Red (RIR) breeds at regressing stage were 7.83±1.33, 11.03 ± 0.91 and 14.97±0.38 cm respectively and the breadths

Table 1. Morphometry values (Mean±SE) of ovary during laying and broody phases

Parameters	Laying phase	Broody phase	t - value	Significance
Body weight	1.39±0.08	1.19±0.04	2.06	NS
Percent ovary weight	2.92±0.188	0.22±0.01	14.33	**
Weight of ovary	40.03±0.53	2.66±0.14	67.07	**
Length of ovary	5.58±0.20	3.26±0.08	10.35	**
Width of ovary	4.51±0.29	2.53±0.14	6.07	**
Number of small white follicle	21.50±0.92	22.83±1.72	-1.15	NS
Number of large white follicle	16.66±0.49	15.16±0.83	1.54	NS
Number of small yellow follicle	25.50±1.60	23.50±1.47	-0.91	NS
Number of large yellow follicle	4.00±0.00	0.00±0.00		
Diameter of large yellow follicle F1	3.70±0.29		F-value 14.05	**
Diameter of large yellow follicle F2	3.01±0.366			
Diameter of large yellow follicle F3	2.01±0.166			
Diameter of large yellow follicle F4	1.316±0.25			

NS -Not significant; ** - Significant (P<0.01)

Table 2. Morphometry values (Mean±SE) of Oviduct during laying and broody phase

Parameters	Laying phase	Broody phase	t-value	significance
Weight of oviduct	46.87±0.49	8.11±0.19	73.508	**
Percent oviduct weight	3.43±0.22	0.67±0.02	12.245	**
Length of oviduct	43.60±0.48	20.33±0.49	33.614	**

** - Significant (P<0.01)

Table 3. Morphometry values ((Mean±SE) of different segments of Oviduct during laying and broody phase

Parameters	Laying phase	Broody phase	t-value	significance
Infundibulum length	7.27±0.09	1.93±0.07	45.808	**
Infundibulum circumference	1.82±0.04	0.85±0.06	13.101	**
Infundibulum diameter	0.85±0.02	0.43±0.03	11.825	**
Magnum length	21.7±0.43	11.72±0.42	16.481	**
Magnum circumference	4.05±0.02	2.07±0.03	49.412	**
Magnum diameter	2.1±0.06	1.03±0.02	16.309	**
Isthmus length	7.25±0.12	2.25±0.08	35.064	**
Isthmus circumference	2.85±0.06	2.07±0.03	11.140	**
Isthmus diameter	1.44±0.08	1.03±0.02	5.265	**
Uterus length	4±0.15	2.8±0.08	7.171	**
Uterus circumference	8.47±0.06	3.93±0.09	43.444	**
Uterus diameter	4.13±0.09	1.97±0.04	21.509	**
Vagina length	3.38±0.09	1.63±0.18	8.467	**
Vagina circumference	2.62±0.03	2.27±0.07	4.498	**
Vagina diameter	1.26±0.07	1.13±0.03	1.672	**

** - Significant (P<0.01)

were 0.67±0.1, 1.1±0.26 and 1.16±0.18 cm respectively (Khanam *et al.,* 2023). The thin-walled isthmus was involved in the production of egg shell membrane. The weight (5.76 ± 1.84 g), width (12.33 ± 1.40 mm) and length (14.05 ± 4.34 cm) of isthmus were greater in hen than in duck (Mohammadpour *et al.,* 2012).

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Fig 1. Female reproductive tract during laying phase

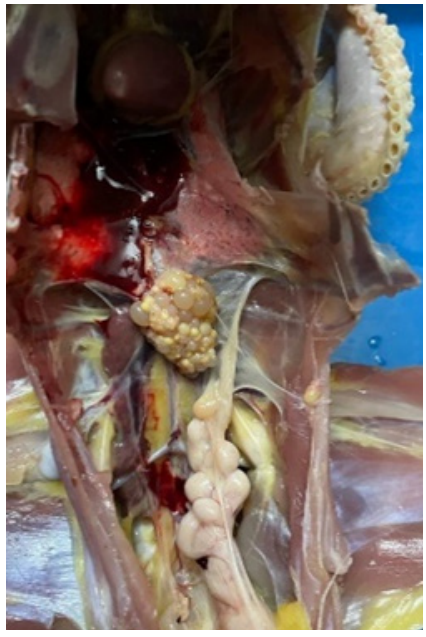

Fig 2. Female reproductive tract during broody phase

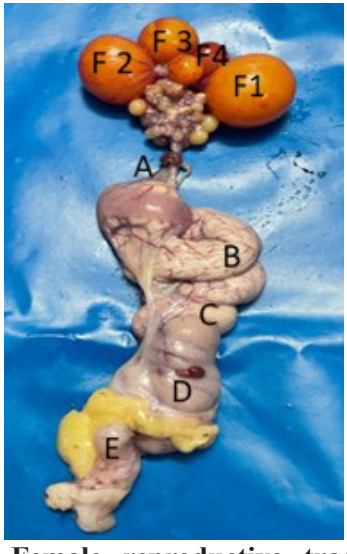

Fig 3. Female reproductive tract with hierarchical follicles (F1, F2, F3 and F4) during laying phase; A-Infundibulum, B- Magnum, C- Isthmus, D-Uterus and E- Vagina

Fig 4. Female reproductive tract without hierarchical follicles during broody phase; A-Infundibulum, B-Magnum, C- Isthmus, D-Uterus, E-Vagina and O- Ovary

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