

# Interrenal-Chromaffin Tissue Ratio in the Adrenal Gland of Kuttanad Ducks (*Anas Platyrhynchos Domesticus*) During Post Hatch Development

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**Abstract:** *The interrenal- chromaffin tissue ratio (IC ratio) in the adrenal gland of Kuttanad ducks was studied during post hatch development in 78 female birds of 13 age groups from day-old to 24 weeks of age at fortnightly intervals. The measurement was read out from the pictures by the use of "ImageJ software". The proportion of interrenal tissue in the whole gland was least at sixth week of age (1.15:1). However, the highest percentage of interrenal tissue in all the three zones (subcapsular, inner and central zones) was noticed at 18 weeks of age. Interrenal-chromaffin tissue ratio in the whole gland revealed that the interrenal tissue predominated the chromaffin tissue throughout the post hatch period in Kuttanad ducks. The functional significance of higher proportion of cortex is not fully understood, but one possible explanation could be the increased need to regulate water and electrolyte balance in ducks. The highest IC ratio of 2:1 was attained in 18 weeks-old birds when all the birds started laying eggs. This might be due to the fact that when the bird is exposed to stress (egg laying), the adrenal glands release corticosterone and catecholamines into the blood, which help the bird to adapt to new conditions.*

**Keywords:** Interrenal-chromaffin ratio, adrenal gland, post hatch development, Kuttanad ducks

## 1. Introduction

Adrenal glands are important endocrine glands having vital functions such as metabolism; homeostasis and stress. The avian adrenal gland synthesizes hormones such as epinephrine, norepinephrine, cortisol, cortisone and testosterone and small amounts of estradiol during embryonic period. The relative proportion of interrenal tissue and chromaffin tissue was studied in chicken [1]. But the related studies in ducks during post hatch development are not available. Therefore, a comprehensive study on this aspect in this species seems to be a relevant area of research. This will form a basis for correlating the possible functions of adrenal gland in relation to age and for further physiological, pathological and endocrinological studies.

## 2. Literature Survey

"ImageJ software" is recently used software for scientific image reading. Morphometric study of the adrenal gland of the adult Sudanese chicken and ducks were already studied [2]. Kuttanad ducks are reared extensively in Kerala and are well adapted to the climatic conditions of the Kerala. Although extensive research has been conducted on the adrenal gland of domestic fowl and Japanese quail by researcher's information regarding adrenal gland of Kuttanad duck is scanty. Therefore, comprehensive study in this species seems to be a relevant area of research.

## 3. Materials and Methods

The study was carried out in 78 female Kuttanad ducks of different age groups, ranging from day-old to 24 weeks.

The adrenal glands of both sides were collected from six birds in each age group at fortnightly intervals up to 24 weeks and were fixed in 10 per cent neutral buffered formalin and Bouin's fluid. After fixation, the materials were processed for paraffin embedding and sections of 5 µm thickness were taken for histological studies. Haematoxylin and Eosin (H&E) technique was carried out for histological studies. The image was processed by the scientific image reading software ImageJ version 1.47i (National Institute of Health, USA). The interrenal-chromaffin ratio (IC ratio) in the whole gland as well as in different regions of the gland was measured by using the software.

## 4. Results and Discussion

The relative proportion of interrenal and chromaffin tissue in the adrenal gland was measured using "ImageJ software" in different zones and in the whole gland. The adrenal gland was indistinctly divided into three zones, viz., subcapsular, inner and central zones. Percentage distribution of interrenal and chromaffin tissue in these zones of the adrenal gland is presented in table 1. The proportion was measured in randomly selected sections that included the whole adrenal gland (Fig. 1). Relative proportion of cortico-medullary tissue in the whole gland is summarized in table 2.

There was no definite pattern of distribution in the cortico-medullary tissue of adrenal during the post hatch period. The proportion of interrenal tissue in the whole gland was least at sixth week of age (1.15:1). However, in the subcapsular, inner and central zones, the overall mean percentage of interrenal tissue was the highest at 18 weeks

of age ( $76.05 \pm 0.03$  %,  $79.90 \pm 2.81$  % and  $67.14 \pm 3.72$  %, respectively). Interrenal and chromaffin tissue ratio (IC ratio) in the whole gland revealed that the interrenal tissue predominated the chromaffin tissue throughout the post hatch period (Table 2). [1] reported that cortico-medullary ratio will aid in understanding the functional significance of the adrenal gland. Adrenal glands of birds were known to respond to stress conditions via interrenal hyperplasia as reported [3]. Stress activated the secretion of corticotropin and resulted in sustained increase in size and function of interrenal cells in all vertebrates [4].

In the present study, during sixth week, the proportion of interrenal tissue was less, which depicts that the birds were more comfortable and less stressed at this stage. Active growth and comfortable environmental temperature during this period also added the effect. There was report that the environmental factors afforded stress on birds[5]. However, in the subcapsular, inner and central zones, the overall mean percentage of interrenal tissue was the highest at 18 weeks of age. This increase might be due to higher demand of the interrenal hormones for the ovulation and formation of eggs. Hydroxycorticosterone and desoxycorticosterone are reported to be essential for ovulation in fowl [6]. They hypothesized that adrenal corticosteroid played a role in the release of LH, 14 hours prior to ovulation. In pigeons, adrenal hypertrophy began at 108 hours before ovulation and disappeared after another 108 hour period. This also supported the role of interrenal hormones in ovulation[7].

Interrenal and chromaffin tissue ratio (IC ratio) in the whole gland revealed that the interrenal tissue predominated the chromaffin tissue throughout the post hatch period. The result is in total agreement with the findings in adult Sudanese chicken and duck [2]. Proportion of chromaffin tissue was comparatively more in day-old and six weeks-old birds when compared to other age groups (Fig. 2). The avian adrenal gland produced steroids such as cortisol and cortisone during embryonic and prenatal periods [8]. This increased cortisone level further predisposed to the increase in concentration of medullary amines. [9] reported that in chicken, cortisone induced hypertension is possible as cortisone increases the production of epinephrine presumably through increased norepinephrine methylation.

Highest IC ratio of 2:1 was attained in 18 weeks-old birds when all the birds started laying eggs. Cortico-medullary ratio varied from zone to zone in adult chicken and the cortico-medullary ratio in the peripheral zone and central zone were 3:1 and 1:1, respectively and the gland as a whole, it was 1.6:1 [1].

The functional significance of higher proportion of cortex is not fully understood, but one possible explanation could be the increased need to regulate water and electrolyte balance in ducks. It is known that the adrenal cortex produces glucocorticoids and mineralocorticoids that aid in water and electrolyte balance; thus a larger cortex is the

adaptation to its habitat. The highest IC ratio of 2:1 attained in 18 weeks-old birds in this study can be correlated to the physiological status. When the bird is exposed to stress (egg laying), the adrenal glands release corticosterone and catecholamines into the blood, which help the bird to adapt to new conditions.

## 5. Conclusion

The interrenal tissue predominated the chromaffin tissue throughout the post hatch period in Kuttanad ducks. The highest IC ratio of 2:1 was attained in 18 weeks-old birds when all the birds started laying eggs and the proportion of interrenal tissue in the whole gland was least at sixth week of age (1.15:1).

## 6. Future Scope

There still exists controversy regarding the interrenal-chromaffin tissue ratio in different species of birds. This study will add strong basis to support the findings of [2] and [3]. Thorough knowledge of anatomy of adrenal gland will form a basis for correlating the possible functions of adrenal gland in relation to age and for further physiological, pathological and endocrinological studies. These observations will form a basis for the further ultra structural and immune histochemical studies.

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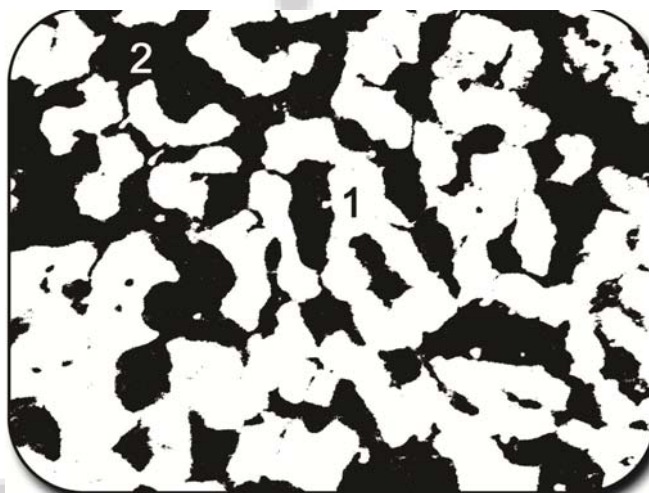
Tables and Figures

**Table 1:** Mean per cent values of interrenal and chromaffin tissue in subcapsular, inner and central zones of the adrenal gland of Kuttanad ducks (Mean ± SE)

Age	Subcapsular zone		Inner zone		Central zone	
	Interrenal tissue %	Chromaffin tissue %	Interrenal tissue %	Chromaffin tissue %	Interrenal tissue %	Chromaffin tissue %
Day-old	52.03±0.35	47.97±0.35	55.17±0.43	44.83±0.43	50.14±0.26	49.86±0.26
2 weeks	56.67±0.28	43.33±0.28	71.16±1.42	29.43±0.50	59.03±0.79	40.97±0.56
4 weeks	57.64±1.26	42.36±1.26	72.9±1.84	27.55±1.10	65.03±3.42	34.97±3.42
6 weeks	61.22±1.31	38.78±1.31	61.47±1.39	38.53±1.84	66.42±2.18	41.50±2.18
8 weeks	56.07±1.59	43.93±1.59	54.12±1.39	42.50±1.39	45.73±1.06	54.27±1.06
10 weeks	58.91±0.93	41.50±0.93	59.41±0.19	40.60±0.19	44.42±1.06	55.58±1.06
12 weeks	55.12±2.16	44.88±2.16	53.78±2.42	46.22±2.42	54.01±0.06	45.50±0.06
14 weeks	66.33±0.32	33.67±0.32	66.24±0.44	46.50±0.44	56.76±1.41	43.24±1.41
16 weeks	58.71±0.97	41.30±3.97	59.38±1.10	40.62±1.10	61.01±0.34	38.99±0.34
18 weeks	76.05±0.03	23.95±0.03	79.90±2.81	20.10±2.80	67.14±3.72	32.86±3.72
20 weeks	72.58±3.18	27.42±3.18	78.42±0.70	21.50±0.70	64.97±1.44	35.03±1.44
22 weeks	62.64±1.74	51.50±1.74	66.49±0.66	33.51±0.66	49.82±0.24	50.18±0.24
24 weeks	47.37±0.43	52.63±0.38	70.18±0.42	29.82±0.42	49.13±1.02	53.50±1.02

**Table 2:** Interrenal and chromaffin tissue ratio (IC ratio) in the whole gland at different ages

Age	Interrenal tissue %	Chromaffin tissue %	IC ratio
Day old	54.19±1.02	45.81±1.02	1.18:1
2 weeks	59.40±0.49	40.61±0.49	1.46:1
4 weeks	59.50±1.40	40.50±1.40	1.47:1
6 weeks	53.44±1.83	46.56±1.83	1.15:1
8 weeks	56.46±1.00	43.54±0.71	1.30:1
10 weeks	56.51±0.71	44.01±0.71	1.28:1
12 weeks	57.79±0.59	42.21±0.59	1.37:1
14 weeks	55.45±0.32	44.55±0.32	1.24:1
16 weeks	59.98±4.93	40.50±4.93	1.48:1
18 weeks	66.70±0.88	33.30±0.88	2.00:1
20 weeks	60.60±3.71	39.40±3.71	1.54:1
22 weeks	58.67±2.99	42.00±2.99	1.40:1
24 weeks	63.80±0.62	36.20±0.63	1.76:1



**Figure 1:** C. S. of adrenal gland showing interrenal and chromaffin tissue (24 weeks). ImageJ version 1.47 i  
1. Interrenal tissue 2. Chromaffin tissue

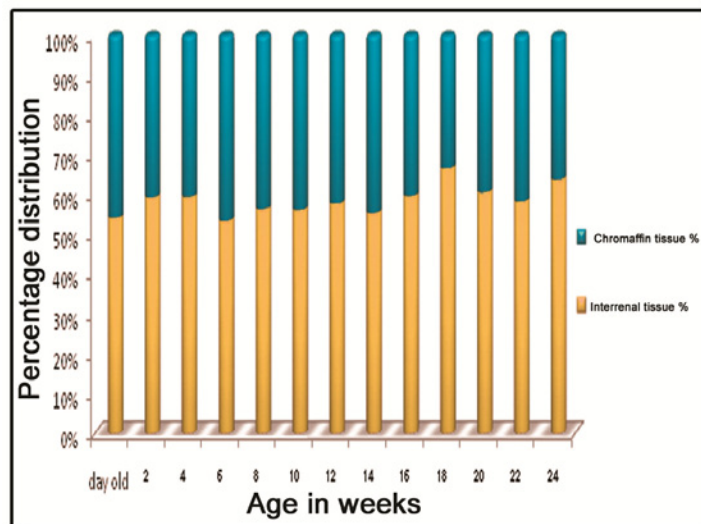


Figure 2: Percentage distribution of interrenal tissue and chromaffin tissue in the whole gland at different ages

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