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# The Anatomical Studies of the Kidneys of Rhode Island Red (RIR) and White Leghorn (WLH) Chicken During Their Postnatal Stages of Growth and Development

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**Abstract:** The anatomical studies of the kidneys of Rhode Island Red (RIR) and White Leghorn (WLH) chicken during their postnatal stages of growth and development were investigated in the present study. The chicken were grouped into day old, day 30, day 90, day 180 and day 360.The gross structures of the kidney (weight, relative weight, length, breadth and thickness) during their growth period were estimated by using the measuring balance and scale. The histological structures of the kidney (the nephrons, the number of glumerulae and the presence of collagen and elastic fibers within the kidney) were also studied by light microscope using hematoxylin and eosin stain, Van Gieson and Verhoeff's stain. The gross structures were significantly higher in the RIR than the WLH chicken whereas the histological structure (number of glomerulae) were higher in WLH than RIR chicken. From these data it may be suggested that these differences did not depend on the developmental stages of growth and development but depend on the genetic variation of the chicken.

**Key words:** Kidney, RIR, WLH, postnatal stage

## Introduction

Bangladesh has a chicken population of 123 million (FAO, 1996) which consists of indigenous, Australop, Rhode Island Red, White Leghorn, and ISA Brown chickens. The kidney is an important organ, which produces urine. The available literature revealed a few anatomical studies of the kidney of both RIR and WLH chicken (Edwards, 1940; Feldotto, 1929; Hodges, 1974; Johnson, 1972). The research in this regard has not been observed in the available literature. Therefore the present study have been undertaken to clarify the anatomy of the kidney of RIR and WLH chicken during their postnatal stages of growth and development. This study will provide valuable information that will be helpful both to the poultry anatomists and breeders.

## Materials and Methods

In order to study the normal anatomy of the kidney's of RIR and WLH chicken at different ages, a total of 30 chicken from these two genetic breeds (15 from each breed) were subdivided into five age groups, viz. day old, day 30, day 90, day 180, and day 360 chicken (each group provided with six chickens) were investigated at the department of Anatomy and Histology, Bangladesh Agricultural University, Mymensingh. The chickens used in this research were collected from the poultry farm of Bangladesh Agricultural University. Body weight of each bird was recorded just prior to slaughter. The weight, relative weight, length, breadth and thickness of the kidney were recorded immediately after obtaining the kidneys from the healthy chickens. The relative weight of the kidneys were calculated according to the formula used by Federova (1987) as follows:

Relative weight of the kidney = weight of the kidney/ body weight.

The aseptic measure was taken during collection and processing of the samples for avoiding unusual contamination. The tissues from the kidneys were fixed in Bouins solution. All the tissues were dehydrated with a series of graded alcohol and routinely embedded in paraffin wax. The tissues were sectioned at 6 micrometer. Three stains were used; Mayer's hematoxylin and eosin for general histological studies. Weigerts elastica Van Gieson for collagen fibers and Weigert Verhoeff's stain for elastic fibers . All the tissues were observed with a light microscope and the photographs were taken for sampling the histological feature of the kidney.

## Results and Discussion

The gross anatomical parameters of kidney of both genetic breeds of chicken are presented in Table 1, 2, 3 and 4. The data revealed that at different ages, the mean weight and relative weight of the right and left kidney were significantly higher in RIR chicken ($p<0.01$) than WLH chicken (Table 1). Regarding the weight of the kidney, Johnson (1972) reported that the weight of the kidney of American golden plover, Ruddy turn stone, wandering tattler, Sooty turn, Brown noddy, white turn, Mourning, Dove, Budgerigar, common flicker were 0.68 gm, 0.59 gm, 0.64 gm, 1.54 gm, 1.29 gm, 0.94 gm, 0.35 gm, 0.12 gm and 0.49 gm at adult stages respectively. These differences of weight of both kidneys of RIR and WLH chicken in the present study with other birds

Table 1: Mean weight and mean relative weight of right and left kidney of RIR and WLH chicken at different ages of development (Mean±SD) (N=6 in each group)

| Age group | Genetic groups | Mean weight of right kidney (gm) | Mean weight of left kidney (gm) | Relative weight of right kidney | Relative weight of left kidney |
|---|---|---|---|---|---|
| Day old | RIR | 0.333±0.047 | 0.333±0.047 | 1.11±0.125 | 0.90±0.143 |
| | WLH | 0.366±0.047 | 0.3±0.00 | 0.90±0.108 | 0.89±0.044 |
| Day 30 | RIR | 1.53 ±0.309 | 1.53±0.385 | 0.661±0.1830 | 0.662±0.2076 |
| | WLH | 1.1±0.163 | 1.0±0.163 | 0.563±0.0768 | 0.511±0.0775 |
| Day 90 | RIR | 2.56±0.309 | 2.26±0.094 | 0.355±0.0516 | 0.307±0.0134 |
| | WLH | 1.83±0.124 | 1.8±0.141 | 0.289±0.0142 | 0.284±0.0160 |
| Day 180 | RIR | 4.93±0.329 | 5.3±0.424 | 0.264±0.0161 | 0.285±0.0171 |
| | WLH | 3.87±0.758 | 4.53±0.205 | 0.260±0.0167 | 0.279±0.0128 |
| Day 360 | RIR | 5.93±0.047 | 5.8±0.081 | 0.388±0.164 | 0.85±0.047 |
| | WLH | 3.96±0.047 | 3.96±0.047 | 0.264±9.428 | 0.264±0.055 |

Table 2: Mean length of right and left kidney of RIR and WLH chicken at different ages of development (Mean ±SD) (N=6 in each group)

| Age group | Genetic groups | Mean length of right kidney | Mean length of left kidney |
|---|---|---|---|
| Day old | RIR | 1.96±0.047 | 1.96±0.047 |
| | WLH | 1.93±0.047 | 1.86±0.047 |
| Day 30 | RIR | 4.1±0.141 | 4.1±0.082 |
| | WLH | 3.7±0.216 | 3.73±0.125 |
| Day 90 | RIR | 5.27±0.205 | 5.23±0.205 |
| | WLH | 4.83±0.125 | 4.8±0.141 |
| Day 180 | RIR | 7.05±0.262 | 7.1±0.330 |
| | WLH | 6.02±0.356 | 6.04±0.624 |
| Day 360 | RIR | 6.63±0.047 | 6.66±0.081 |
| | WLH | 5.96±0.047 | 5.76±0.047 |

Table 3: Mean breadth of right and left kidney of RIR and WLH chicken at different ages of development. Mmean ±SD) (N=6 in each group)

| Age group | Genetic groups | Mean breadth of right kidney | Mean breadth of left kidney |
|---|---|---|---|
| Day old | RIR | 0.4±0.0 | 0.36±0.047 |
| | WLH | 0.33±0.047 | 0.3±0.0 |
| Day 30 | RIR | 0.7±0.047 | 0.73±0.093 |
| | WLH | 0.66±0.047 | 0.7±0..0 |
| Day 90 | RIR | 0.86±0.047 | 0.86±0.094 |
| | WLH | 0.7±0.0 | 0.76±0.047 |
| Day 180 | RIR | 1.06±0.94 | 1.1±0.081 |
| | WLH | 0.96±0.047 | 1.03±0.047 |
| Day 360 | RIR | 1.26±0.047 | 1.2±0.0 |
| | WLH | 1.03±0.047 | 1.13±0.047 |

Table 4: Thickness of right and left kidney of RIR and WLH chicken at different ages of development (Mean±SD) (N=6 in each group)

| Age group | Genetic groups | Mean thickness of right kidney | Mean thickness of left kidney |
|---|---|---|---|
| Day old | RIR | 0.22±0.0 | 0.21±0.023 |
| | WLH | 0.18±0.023 | 0.18±0.023 |
| Day 30 | RIR | 0.53±0.047 | 0.53±0.047 |
| | WLH | 0.46±0.047 | 0.45±0.070 |
| Day 90 | RIR | 0.6±0.081 | 0.56±0.047 |
| | WLH | 0.5±0.0 | 0.53±0.047 |
| Day 180 | RIR | 0.76±0.047 | 0.76±0.047 |
| | WLH | 0.66±0.047 | 0.73±0.047 |
| Day 360 | RIR | 0.76±0.047 | 0.7±0.081 |
| | WLH | 0.7±0.0 | 0.61±0.0 |

Table 5: Different types of glomerular at different ages of RIR and WLH chicken (N=6) Mean±SD

| Days | RIR | | | WLH | | |
|---|---|---|---|---|---|---|
| Day old | Mammalian type | = | 0 | Mammalian type | = | 14±3 |
| | Intermediate type | = | 0 | Intermediate type | = | 1±0 |
| | Reptilian type | = | 35±4.2 | Reptilian type | = | 54±5.1 |
| Day 30 | Mammalian type | = | 1±0.1 | Mammalian type | = | 2±0.1 |
| | Intermediate type | = | 0 | Intermediate type | = | 0 |
| | Reptilian type | = | 2±0.1 | Reptilian type | = | 3±0.2 |
| Day 90 | Mammalian type | = | 10±1.2 | Mammalian type | = | 5±1.0 |
| | Intermediate type | = | 0 | Intermediate type | = | 2±o.1 |
| | Reptilian type | = | 24± 4.1 | Reptilian type | = | 68±8.2 |
| Day 180 | Mammalian type | = | 5± 0.11 | Mammalian type | = | 9±2.1 |
| | Intermediate type | = | 2±0.15 | Intermediate type | = | 2±0.01 |
| | Reptilian type | = | 30± 3.0 | Reptilian type | = | 14±1.2 |
| Day 360 | Mammalian type | = | 5±0.9 | Mammalian type | = | 10±1.7 |
| | Intermediate type | = | ±0.6 | Intermediate type | = | 6±0.9 |
| | Reptilian type | = | 6±1.1 | Reptilian type | = | 8±1.21 |

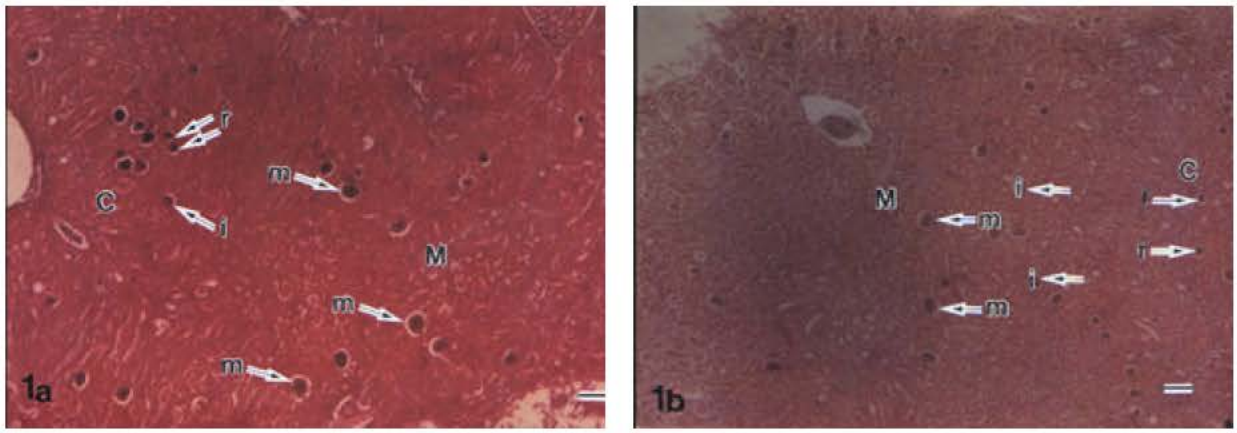


Fig. 1a, 1b: The kidney of RIR (1a) and WLH (1b) chicken at 360 days old showing different types of glomerulae. The reptilian type of glomerulae (r) is confined to the cortex (c), the intermediate type of glomerulae (i) is situated in between the cortex and medulla (M). The medullary type of glomerulae (m) is larger than the other type and lies close to the medulla. Verhoeff's and Van Gieson stain, 83.25x, bar 70µm

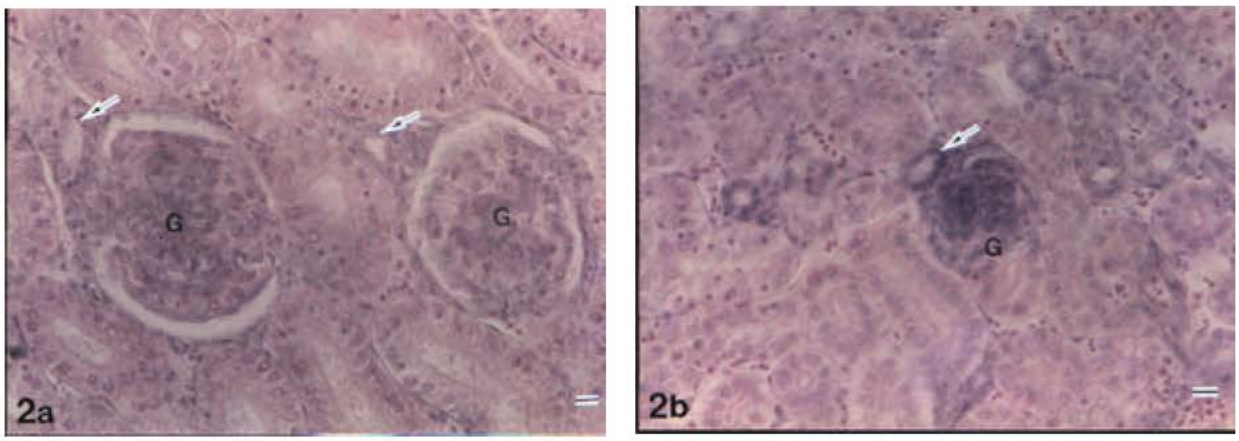


Fig. 2a, 2b: The kidney of RIR (2a) and WLH (2b) chicken at 90 days old. The macula densa (arrows) occurs at the point of the initial part of the distal convoluted tubule and are located close to the mammalian type of glomerulae (G). H&E stain, 33.3X, bar 150µm

possibly due to species variation and the size of the birds.

The length of the right and left kidney at different ages were significantly higher ($p<0.01$) in RIR than in WLH chicken in the present study (Table 2). In this context, King (1975) reported that the length of the kidney of bird was 7 cm. The report of king is similar to the report of the present study, although King did not mentioned the age and breed of chicken in his study.

The kidney of RIR and WLH has cranial, middle and caudal division This was similar to the report of Good child (1956). The present study indicated that the mean breadth of the right and left kidney of RIR were statistically higher than WLH chicken (Table 3). However, the mean breadth of the right and left kidney at different postnatal stages was not correspond to the report of King (1975) where he reported that the breadth of the kidney of chicken was 2 cm and 2.2 cm in the duck. This difference was due to the fact that King (1975) might use different size and breeds of chicken.

The present study revealed that the thickness of the right and left kidney were significantly higher in RIR than WLH chicken at different ages of postnatal development (Table 4).

The histological structures of the kidney (nephrons, glomerulae and macula densa and distribution of collagen and elastic fibers within the kidney) were investigated in the present study. There were three types of nephrons in both the kidneys of both the breeds of chickens considered in the present study. The cortical type of nephrons resemble the reptilian type possess a relatively small glomerulus, and was confined to the cortex. The medullary nephrons resemble the mammalian type possesses a large glomerulus and lies partly within the medulla. The intermediate type of nephrons was intermediate in structure between the reptilian and mammalian type was frequently seen in the present study (Fig. 1a,1b).These data were similar with the previous report (Hodges, 1974; Siller, 1981; Johnson, 1970).

The reptilian type of glomerulae were more numerous both in RIR and WLH chicken than that of the mammalian and intermediate type of glomerulae. The number of glomerulae were higher in WLH than RIR chicken ($p<0.01$) during their postnatal stages of growth and development (Table 5). With special stain it was found that the glomerulae were Verhoeff's positive stain. The tunica media of blood vessel and the collagen fibre around the thick and thin loop of Henle were also positive to Van Gieson stain.

The macula densa occurs at the point of the initial part of the distal convoluted tubule and were closely situated to the vascular pole of its parent glomerulus in both RIR and WLH chicken (Fig. 2a, 2b). From the above data it was found that the location, shape of the macula densa and the type of macula densa were similar with the previous findings (Edwards, 1940; Hodges, 1974).

From the present research findings it may be concluded that the gross anatomical parameters of the kidney were higher in RIR than WLH chicken whereas the histological parameter of the kidney (number of glomerulae) were higher in WLH chicken than RIR chicken. These differences did not depend on the developmental stages but depend on the genetic variation of the chicken.

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