Anatomical Changes of Akar Putra Chicken Digestive System after Partial Ablation of Uropygial Gland

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Abstract: The current study proposes anatomical changes in the digestive system of 120 Akar Putra chicken after surgical removing of uropygial gland. The experiment comprised of five treatments (24 chicken/treatment), with 3 replicates (8 chicken/replicate). The experimental treatments consist of a control treatment T1; partial ablation of the uropygial gland were applied on T2, T3, T4 and T5 treatments at 3, 4, 5 and 6 weeks of age respectively. The results presents that Partial Uropygialectomy (PU) treatments in males had (p<0.01) longer esophagus 9.9-16.2%, proventriculus 11.1-34.4%, gizzard 26.7-220%, pancreas 0-20.4%, jejunum 4.9-26.1 and colon 18.1-60.6 than the control group counterparts. Furthermore, females of PU treatments had (p<0.01) longer esophagus 6.8-22.3%, pancreas 8.3-33.3% and cecum 13-26% compared with females in control. In contrast, total GIT weight were 21.2 to 78.8% heavier (p<0.01) in males of PU treatments, mainly in the esophagus, duodenum, pancreas, jejunum, ilium and cecum. No significant impact (p>0.05) between treatments was recorded in the total females’ Gastrointestinal Tract (GIT) weight; however, females of PU treatments had 5.9-41.2% heavier ilium (p<0.01) and 11.1-77.8% heavier cecum (p<0.01). Total GIT density, show no significant different (p>0.05) between treatments in females. Nevertheless, it was highly significant different (p<0.01) for males of PU treatments, mainly in esophagus (p<0.05), gizzard (p<0.05), pancreas (p<0.01) and cecum (p<0.05). In conclusion; the results of current study investigated that partial ablation of the uropygial gland had positive effects on the anatomical observations of most digestive system parts.

Keywords: Avian Gland, Uropygial Gland, Akar Putra Chicken

Introduction

Akar Putra is a local Malaysian chicken, created in the University of Putra Malaysia by Assoc. Prof. A.B. Kassim. It has a robust growing process than their parents because the maturation period is shorter (less than 13 weeks). It can lay 120-200 eggs per year and it has more resistance to diseases (Jawad et al., 2015).

The digestive tract of chickens conveys food to the stomach: This system comprises, the crop, an expansion of the esophagus, located in the lower neck area, the glandular stomach (proventriculus), the muscular stomach (gizzard) and intestines. The length and weight of the small intestine varied between the different species of birds (Hassouna, 2001). Differential development of the absorptive epithelium may be responsible for changes in absorption capacity of birds (de Verdal et al., 2010).

Uropygial gland is the only subcutaneous gland in bird's body (Mclelland, 1993). It is located on the base of the tail, dorsally between the fourth caudal vertebrae and the pygostyle (Lucas and Stettenheim, 1972; Sawad, 2006). The function of the uropygial gland is still a subject of controversy. There are many accepted functions of gland secretions like conferring water-repellent properties on the feather coat and maintaining...
the suppleness of it. Furthermore, it’s proposed to be associated to pheromone production, control of plumage hygiene, thermal insulation and defense against predators (Jacob, 1992; Montalti et al., 2006; 1998; Soler et al., 2012; Vincze et al., 2013). Uropygial gland is completely absent in Struthionidae, Rheidae, Casuaridae, Dromaiidae and in a few species of Columbidae and Psittacidae (Johnston, 1988). Montalti and Salibián (2000) mentioned that the oil of uropygial gland is not important to the birds who do not have it and uropygial gland in some of the birds is non active (Goodwin, 1983). Moyer et al. (2003) explained that the birds which do not have uropygial gland use dusters bath to keep and clean their feather.

Many studies confirmed that meat chicken breeds nowadays characterized by super-fast growth and a high efficiency of the feed conversion ratio because of intense genetic election. Wepruk and Church (2003) observed that the mean body weight of a broiler at the age of 63 days in 1976 was two kg, while the same average body weight was arrived at by the age of 35 days in 2001. These improvements in the growth rate will be reflected negatively on the disease resistance and immune response of these birds, because a negative genetic link coefficient was observed between the growth speeds and immune response (Qureshi and Havenstein, 1994). In this context, mortality ratio increased in these strains of birds has happened due to increase their susceptibility to bacterial diseases and metabolic diseases. These occurred as a consequence of irregular metabolous processes, an imbalance in the acid-base balance-baseband Acid-base balance of body fluids, such as ascites disease, Sudden-Death Syndrome (SDS) and increased skeletal disorders like leg abnormalities. It has been scientifically proven that highest rates of those pathological conditions were shown in flockand individual rapid growth chickens at 3 and 4 weeks of age (Robinson et al., 1992; Leeson and Summer, 1997; Julian, 1997; 1998; Gonzales et al., 1998). Based on the limitation of the problem, the researcher innovating a safe technique to raise the level of digestive system anatomy in poultry generally and local Malaysian chicken (Akar Putra) particularly without using genetic improvement methods. Furthermore, this research another two significances: (1) To identify the information regarding the anatomy of Akar Putra chicken digestive system because it’s new specious of chicken. (2) To identify the scientific information about PU treatment operation effect on the digestive system anatomy of the chicken.

**Materials and Methods**

**Research Design**

The research design conducted with Complete Random Sampling Design (RAL) with 5 variables, divided into two groups: 1 control group and 4 treatment variables with different ages of applying Partial Uropygial'ectomy. The research were conducted in University of Putra Malaysia (UPM) from 15th December 2014 to 15th March 2015. This study was approved by Institutional Animal Care and Use Committee (IACUC) certificate number R070.

Research variables: The variables which were observed during this research were.

Independent variables: The variation of Partial Uropygial'ectomy (PU) in following requirements:

- T1: Group without PU operation (control group)
- T2: Group which was PU applied at week 3
- T3: Group which was PU applied at week 4
- T4: Group which was PU applied at week 5
- T5: Group which was PU applied at week 6

**Dependent Variable**

The esophagus, proventriculus, gizzard, duodenum, pancreas, jejunum, ilium, cecum, colon and rectum were excised, cleaned and separately weighed. In addition, their lengths were measured individually. The weight: Length ratios of each part was calculated as an indicator of its density. In the same regard, the relative weight and length of each part of GIT with the total weight and length of GIT were compared between treatments. Moreover, the relative weights of these parts with the total live body weight were calculated.

**Population and Sample of the Research**

- Research populations were a Local Malaysian chicken (Akar Putra)
- Research samples were 120 Akar Putra chicken randomly assigned to five treatment groups by 24 (12 male and 12 female) chickens per treatment and each treatment consist of three replicates of 8 chickens (4 males and 4 females)

**Tools and Materials**

Lidocaine, 70% Alcohol, Iodine, scalpels and blades were used to apply during PU operation. An electronic balance (precision = 1g) was used to measure the live body weight and GIT parts weight of the experimental birds. The lengths of GIT parts were measured with a tape measure (+1 mm).

The materials used in this research consisted of a Day-Old Chick of Local Malaysian chicken (Akar Putra) Strain. The birds were given ad libitum access to feed and water. The birds were reared in cages with 8 birds (4 males and 4 females) per pen (5” × 4” × 1.5”). Feed was offered ad libitum (1-13 days: Starter; 14 day-slaughter: finisher) and water was freely available at all times during the trial period. Furthermore, constant lighting
and continuous ventilation were provided and all the birds were kept under uniform management conditions throughout the experimental period of 12 weeks.

Procedure of the Research

This research was conducted in several stages as follows:

- Partial Uropygialectomy operation was applied as the following steps: (A) Bird's restraint. (B) Local anesthesia using lidocaine HCL (4 mg kg⁻¹) SQ. (C) Removing the uropygial gland partially (half lobes, half isthmus and papillae) by scalpel which sterilized by 70% alcohol before use. (D) After removing the gland, the incision area was sterilized with Iodine
- On the last day of experiment, 12 birds (closest to the mean treatments’ body weight) were selected from each treatment group (2 males and 2 females/replicate) and withdrawn from feed overnight to facilitate gut clearance. After obtaining the live body weight, the birds were euthanized by an intravenous (cutaneous ulnar vein) injection of sodium pentobarbitone (80 mg kg⁻¹) (Mitchell and Smith, 1991). The digestive tract segments from the esophagus to the rectum was carefully excised, identified and analyzed based on Nasrin et al. (2012) as following:
  - Esophagus extends from the glottis at the posterior end of the pharynx, through the neck and thorax to join with the glandular stomach
  - Proventriculus located caudal to the crop
  - Gizzard placed partly between the lobes and to some extent behind the left lobe of the liver
  - Duodenum extends from pylorus to the end of the pancreatic loop
  - Pancreas located in the duodenal fold
  - Jejunum extends from the pancreatic loop to Meckel’s diverticulum
  - Ilium extends from Meckel’s diverticulum to the ileo-caeca junction
  - Cecum: The two caeca were blind pouches and extend along the line of the small intestine towards the liver having proximal and distal part and were closely attached to the small intestine along their length by the mesentery
  - Colon and rectum: They are passing between the ileo-cecal junction and the cloaca

Digestive segments were cleaned, separately weighed and their lengths were measured individually. The weight: Length ratio of each part was calculated as an indicator of its density (Taylor and Jones, 2004). In the same regard, the relative weight and length, of each part of GIT with the total weight and length of GIT, were compared with the treatments. Further more, the relative weights of these parts with the total live body weight were calculated.

Variation ratio of the GIT morphometrical characteristics had recorded based on the formula which reported by (Jawad et al., 2015):

\[(\frac{(A-B)}{B}) \times 100\]

A: Treatment data
B: Control group data

Data Analysis

Data generated from experiment was carried out in a complete randomized design (Steel and Torrie, 1980). These data were subjected to ANOVA using Genstat (2003). If the treatment significantly affected the chicken, LSD and Duncan (1955) Multiple Range would be applied (DRMT) (Gaspers, 1991). The significant differences among means were determined by using Duncan (1955) multiple range tests. Differences among treatment means were compared at p<0.01 and p<0.05 levels.

Results

GIT Parts’ Length

Table 1 shows the linear measurements' descriptive statistics of males' GIT parts in PU treatments and control group. Males in T4, T3, T2 and T5 treatments showed highly significant (p<0.01) effect compared with the control group in esophagus length. T4 treatment recorded higher (p<0.01) esophagus length 21.5 cm. The males' proventriculus of PU treatments was longer compared with the control group, especially in T2 treatment, which recorded 4.033 cm. However, no significant impact was indicated between T2, T5, T3 and T4. High significantly affect (p<0.01) in gizzard length capacity was reported in T5 (4.8 cm). The pancreas was longer in T3 (10.833 cm), T4 (10.333 cm) and T2 (10.267 cm) compared with T5 (9 cm) and the control (9 cm). Whereas, all PU treatments recorded higher values in jejunum length and colon length also in the total GIT length compare with the control group. Although there is no perceptible difference (p>0.05) between T5, T2 and T3 treatments in jejunum length and between T2, T4 and T3 in colon length, moreover, between T5, T2 and T4 in complete GIT length.

Relative length of males GIT parts than the total GIT length was presented in Table 2. Only the esophagus, gizzard and pancreas revealed (p<0.01) significant different between the treatments. The superiority order in the relative esophagus length trait was T4, T3, T1, T2 and T5 and the values were as following: 10.464, 10.321, 10.028, 9.596 and 9.215 cm correspondingly. While, in relative gizzard’s length trait was T5, T2, T3, T4 and T1 and the values were: 2.183, 1.061, 1.052, 0.925 and 0.813 cm respectively.
Lowest value in relative pancreatic length was reported in T5 (4.079 cm) and the highest value was in T3 (5.325 cm) followed by T4 (5.032 cm), T1 (4.879 cm) and T2 (4.744 cm). However, no significant different between T3, T4, T1 and T2 was indicated.

Table 3 shows the length variation in females’ digestive tract segments between the treatments. The effect of the surgical removing of the uropygial gland at week 6 of age was prominent through relevant (p<0.01) superiority in esophagus length over the rest of the transactions. Not as much value for the pancreas length trait was recorded in T4 and T5 treatments despite the absence of a significant difference between them and the value of the pancreas length in the control group. While the cecum length was prominent in T2, T5 and T4 treatments and less pronounced in T3 treatment compared with the control treatment. Regarding on the females’ relative length of GIT parts than the total GIT length was shown in Table 4. Only pancreas revealed significantly different in T2 (5.442) and T3 (5.103) then followed by T1 (4.913), T4 (4.672) and T5 (4.398) respectively.

Table 1. Mean (±S.E.) males GIT parts length (cm) of partial uropygialectomy treatments.

| GIT parts | T1 (control) | T2 | T3 | T4 | T5 |
|-----------|--------------|----|----|----|----|
| Eso.      | 18.5±0.764abc | 20.767±0.145abc | 21.5±0.577abc | 21.5±0.289abc | 20.333±0.333abc |
| Pro. V.   | 3±0.289abc   | 4.033±0.145abc | 3.833±0.167abc | 3.333±0.167abc | 3.933±0.296abc |
| Giz.      | 1.5±0abc     | 2.3±0.153abc | 2.133±0.318abc | 1.9±0abc | 4.8±0.458abc |
| Deu.      | 22±1.155     | 26.2±1.8     | 25±0.577     | 24.833±1.364 | 23.333±0.333 |
| pancreas  | 9±0abc       | 10.267±0.267abc | 10.833±0.726abc | 10.333±0.167abc | 9±0abc |
| Juj.      | 43.833±1.641abc | 52.367±2.709abc | 48.667±1.856abc | 46±1abc | 55.267±3.688abc |
| Ilium     | 48.666±2.404abc | 56.667±2.455abc | 50.833±4.285abc | 54±3.786abc | 60.567±1.598abc |
| Cecum     | 29±0.577     | 33±0.577     | 30.9±2.951   | 33±1     | 31.067±0.581abc |
| Colon     | 5.167±0.333abc | 6.667±0.333abc | 6.1±0.208abc | 6.133±0.696abc | 8.3±0.351abc |
| Rectum    | 3.833±0.167abc | 4.2±0.651abc | 4.3±0.7     | 4.5±0.5abc | 4.167±0.167abc |
| Total     | 184.5±2.021abc | 220.767±3.775abc | 205.533±4.218abc | 216.467±3.039abc | 203.6±4.212abc |

Mean values with common superscript in row differ significantly (p<0.01)

Table 2. Relative length (%) of males GIT parts than total GIT length of partial uropygialectomy treatments.

| GIT parts | T1 (control) | T2 | T3 | T4 | T5 |
|-----------|--------------|----|----|----|----|
| Eso.      | 10.028±0.412abc | 9.596±0.103abc | 10.321±0.325abc | 10.464±0.074abc | 9.215±0.197abc |
| Pro. V.   | 1.626±0.157 | 1.865±0.079 | 1.886±0.103 | 1.623±0.088 | 1.786±0.162abc |
| Giz.      | 0.813±0.009abc | 1.061±0.057abc | 1.052±0.167abc | 0.925±0.052abc | 2.183±0.247abc |
| Deu.      | 11.914±0.506abc | 12.117±0.515abc | 12.292±0.409abc | 12.099±0.752abc | 10.58±0.331abc |
| Pancreas  | 4.879±0.053abc | 4.744±0.134abc | 5.325±0.364abc | 5.032±0.131abc | 4.079±0.07abc |
| Juj.      | 23.775±1.061abc | 24.167±0.946abc | 23.887±0.478abc | 22.382±0.23abc | 24.992±1.272abc |
| Ilium     | 26.367±1.162abc | 26.166±0.896abc | 24.914±1.68abc | 26.221±1.326abc | 27.427±0.298abc |
| Cecum     | 15.721±0.336abc | 15.254±0.404abc | 15.227±1.649abc | 16.069±0.588abc | 14.086±0.45abc |
| Colon     | 2.799±0.165abc | 3.081±0.164abc | 2.995±0.06abc | 2.994±0.384abc | 3.761±0.164abc |
| Rectum    | 2.077±0.085abc | 1.949±0.329abc | 2.1±0.307abc | 2.191±0.248abc | 1.891±0.108abc |

Mean values with common superscript in row differ significantly (p<0.01)
Table 3. Mean (±S.E.) females GIT parts length (cm) of partial uropygialectomy treatments.

| Treatments | Eso. | Pro. V. | Giz. | Deu. | pancreas | Juj. | Ilium | Cecum | Colon | Total |
|------------|------|---------|------|------|----------|------|-------|-------|-------|-------|
| T1 (Control) | 15.667±0.333c | 3.667±0.333 | 1.5±0 | 20.333±1.333 | 8±0 | 39.667±0.667 | 40.333±0.333 | 24.667±0.333 | 20.333±1.333 | 162.867±1.593 |
| T2 | 16.733±0.176b | 3.733±0.145 | 1.867±0.067 | 25.067±1.933 | 10.667±0.333a | 47.3±4.077 | 48.5±3.617 | 25.062±1.532 | 5.5±0.173 | 196.7±11.663 |
| T3 | 18±0.577a | 3.2±0.115 | 2.833±0.601 | 23.833±0.441 | 9.567±0.296a | 45.667±1.833 | 45.6±0.703 | 23.833±0.601 | 4.933±0.567 | 187.433±2.714 |
| T4 | 3.333±0.167 | 3.2±0.115 | 1.5±0 | 23.833±1.364 | 8.833±0.441bc | 47.3±2.179 | 25.033±0.413 | 23.833±1.364 | 4.667±0.167 | 189.067±8.02 |
| T5 | 18.333±0.882m | 3.333±0.167 | 1.5±0 | 25.267±2.267 | 8.667±0.333bc | 46.5±2.291 | 50.667±4.055 | 25.267±2.267 | 7.6±2.201 | 197.467±9.828 |

Mean values with common superscript in row differ significantly (p<0.01)

Table 4. Relative length (%) of females GIT parts than total GIT length of partial uropygialectomy treatments.

| Treatments | Eso. | Pro. V. | Giz. | Deu. | pancreas | Juj. | Ilium | Cecum | Colon | Rectum | Total |
|------------|------|---------|------|------|----------|------|-------|-------|-------|--------|-------|
| T1 (Control) | 9.625±0.295 | 2.245±0.219 | 0.921±0.009 | 12.471±0.692 | 4.913±0.048b | 24.352±0.179 | 24.765±0.056 | 15.76±0.158 | 2.887±0.089 | 3.333±0.167 | 162.867±1.593 |
| T2 | 8.559±0.435 | 1.903±0.052 | 0.96±0.094 | 12.72±0.363 | 5.442±0.171a | 23.966±0.696 | 24.622±0.562 | 16.493±0.544 | 2.82±0.21 | 5±1 | 196.7±11.663 |
| T3 | 9.603±0.266 | 1.706±0.037 | 1.519±0.342 | 12.72±0.349 | 1.572±0.125b | 24.539±0.289 | 25.033±0.413 | 15.479±0.544 | 2.633±0.306 | 4.4±0.379 | 187.433±2.714 |
| T4 | 9.72±0.484 | 1.772±0.135 | 0.796±0.035 | 12.601±0.392 | 4.672±0.123bc | 25.135±0.688 | 25.033±0.413 | 15.51±0.228 | 2.472±0.078 | 4.4±0.666 | 189.067±8.02 |
| T5 | 9.72±0.484 | 1.772±0.135 | 0.796±0.035 | 12.601±0.392 | 4.672±0.123bc | 25.135±0.688 | 25.033±0.413 | 15.51±0.228 | 2.472±0.078 | 4.4±0.666 | 189.067±8.02 |

Mean values with common superscript in row differ significantly (p<0.01)

Table 5. Mean (±S.E.) males GIT parts weight (g) of partial uropygialectomy treatments.

| Treatments | Eso. | Pro. V. | Giz. | Deu. | pancreas | Juj. | Ilium | Cecum | Colon | Rectum | Total |
|------------|------|---------|------|------|----------|------|-------|-------|-------|--------|-------|
| T1 (Control) | 6.833±0.167 | 5.333±0.333 | 0.921±0.01 | 3.667±0.333 | 1.333±0.333 | 6.333±0.667 | 19±1.528 | 3.667±0.333 | 2.333±0.333 | 6.333±0.667 | 57.5±0.764 |
| T2 | 10.5±0.866 | 6.333±0.333 | 26±1.732 | 8.333±1.453 | 3±0 | 13±1.732 | 21±1.332 | 8.333±1.453 | 5±1.528 | 90.167±6.772 | 90.167±6.772ab |
| T3 | 9.603±0.266 | 6.333±1.333 | 26±0.577 | 7±0.577 | 2.167±0.167 | 9.333±0.667 | 21±1.332 | 6.333±1.333 | 3±0 | 79.667±4.177bc | 90.167±6.772ab |
| T4 | 8±0 | 5.333±0.333 | 1.519±0.342 | 6.333±1.333 | 2±0.577 | 9.333±1.667 | 0.921±0.009 | 5±1.528 | 3.333±0.333 | 1.667±0.333 | 69.667±2.728cd |
| T5 | 9.667±0.333m | 7±1 | 3±0 | 10.333±0.882 | 9.167±0.601 | 9.167±0.601 | 0.921±0.009 | 5±1.528 | 3.333±0.333 | 1.667±0.333 | 79.667±4.177bc |

Mean values with common superscript in row differ significantly (p<0.01)

Males in T5 treatment exceeded other treatments (p<0.01) in the weight of duodenum, pancreas, jejunum, ilium and cecum and the values were 10.333, 9.167, 13±1.732 and 5.333 gm respectively. All the males of PU treatments have outperformed the control group in the total GIT weight property and the highest value was in the fifth treatment (102.833 gm) and followed by T2 (90.167 gm), T3 (79.667 gm), T4 (69.667 gm) and control group (57.5 gm).
Ilium weights. And their values were 0.559, 0.874 and 0.732 in the same order.

Table 8 shows that the effect of partial ablation of the uropygial gland reflected on four GIT parts weights in females, namely esophagus, duodenum, ilium and cecum weights. The highest values in these traits were in T2 (9 gm), (7.167 gm), (8 gm) and (5.333 gm) respectively. Duodenal relative weight than the total GIT weight was (p<0.01) significant different between treatments (Table 9) and the high value reported in T2 (9.659). While in colon relative weight, the T5 shows significantly higher value (p<0.01) than the rest of the treatments. Live body weights in T2, T4 and T5 treatments were significantly (p<0.01) higher means values than T3 and control groups. However, females live body weights in T3 treatment were heavier than those in the control group but not at a significant level. The treatments' live body weights from higher to lower value were: T2 (1189.3 gm), T4 (1187.3 gm), T5 (1182.3 gm), T3 (977.6 gm) and T1 (937.3 gm). Table 10 duodenum was the only part achieved important effect (p<0.01) in the relative weight than the total live body weight. However, no significant different between T2, T4, T5 and T1 also between T4, T5, T1 and T3 were observed.

**GIT Parts Density**

In males, the treatments were significantly different in the density of the following parts: Esophagus, gizzard, duodenum, pancreas, jejunum and cecum. Nevertheless, in females they were: Esophagus, gizzard, duodenum and rectum.

With regard to the males, Table 11 shows the statistical comparison of all studied GIT parts density. T5 treatment predominated on the rest treatments in the following density parts: Duodenum, pancreas, jejunum, ilium and cecum. Males of PU treatments were outperformed (p<0.05) than the control group’s males in esophagus density values. Based on an order of priority, they were as following: T2 (0.505), T5 (0.475), T3 (0.444), T4 (0.372) and T1 (0.371). It is worth mentioning that the males in T5 and T2 treatments achieved (p<0.01) biggest values in the total GIT density compared with the rest of the transactions.

### Table 6. Relative weight (%) of males GIT parts than total GIT weight of partial uropygialctomy treatments.

| GIT parts | T1 (Control) | T2 | T3 | T4 | T5 |
|-----------|--------------|----|----|----|----|
| Eso.      | 11.883±0.224<sup>b</sup> | 11.633±0.217<sup>b</sup> | 11.67±0.536<sup>b</sup> | 11.518±0.438<sup>b</sup> | 9.4±0.018<sup>a</sup> |
| Pro. V.   | 9.264±0.455  | 7.073±1.042  | 7.824±1.202  | 7.643±0.19  | 6.787±0.849 |
| Giz.      | 33.12±3.029  | 28.873±0.454 | 32.748±1.153 | 32.381±4.198 | 27.225±0.585 |
| Deu.      | 9.244±1.413  | 9.107±0.918  | 8.773±0.445  | 9.143±0.769 | 10.058±0.821 |
| pancreas  | 2.305±0.543<sup>b</sup> | 3.364±0.244<sup>b</sup> | 2.713±0.065<sup>b</sup> | 2.834±0.734<sup>b</sup> | 8.964±0.839<sup>a</sup> |
| Juj.      | 11.009±1.129 | 14.297±0.92  | 11.729±0.742 | 13.386±2.353 | 13.927±0.595 |
| Ilium     | 11.023±0.642 | 12.183±0.379 | 11.735±0.191 | 10.598±1.526 | 11.628±0.803 |
| Cecum     | 6.369±0.534  | 5.93±0.163   | 5.871±0.416  | 5.759±0.219 | 5.188±0.279 |
| Colon     | 1.74±0.023   | 1.768±0.573  | 2.079±0.387  | 1.93±0.508  | 2.768±0.448 |
| Rectum    | 4.044±0.52   | 5.771±2.119  | 4.858±0.441  | 4.809±0.559 | 4.055±0.142 |

Mean values with common superscript in row differ significantly (p<0.01)

### Table 7. Relative weight (%) of males GIT parts than total live body weight of partial uropygialctomy treatments.

| GIT parts | T1 (Control) | T2 | T3 | T4 | T5 |
|-----------|--------------|----|----|----|----|
| Eso.      | 0.492±0.014  | 0.628±0.054 | 0.585±0.06  | 0.507±0.004 | 0.59±0.021 |
| Pro. V.   | 0.383±0.019  | 0.379±0.056 | 0.397±0.087 | 0.338±0.021 | 0.428±0.066 |
| Giz.      | 1.37±0.128   | 1.555±0.11  | 1.62±0.044  | 1.44±0.22   | 1.708±0.066 |
| Deu.      | 0.382±0.058  | 0.499±0.088 | 0.438±0.038 | 0.401±0.018 | 0.631±0.057 |
| Pancreas  | 0.095±0.022<sup>b</sup> | 0.179±0.002<sup>b</sup> | 0.136±0.011<sup>b</sup> | 0.126±0.036<sup>b</sup> | 0.559±0.035<sup>a</sup> |
| Juj.      | 0.454±0.043<sup>a</sup> | 0.778±0.106<sup>b</sup> | 0.585±0.045<sup>b</sup> | 0.59±0.102<sup>b</sup> | 0.874±0.051<sup>a</sup> |
| Ilium     | 0.456±0.035<sup>a</sup> | 0.658±0.06<sup>c</sup> | 0.584±0.025<sup>b</sup> | 0.464±0.052<sup>a</sup> | 0.732±0.073<sup>a</sup> |
| Cecum     | 0.264±0.024  | 0.319±0.02  | 0.292±0.021 | 0.254±0.002 | 0.325±0.019 |
| Colon     | 0.072±0.001  | 0.1±0.04    | 0.105±0.021 | 0.085±0.022 | 0.173±0.026 |
| Rectum    | 0.167±0.022  | 0.297±0.088 | 0.24±0.009  | 0.212±0.023 | 0.254±0.012 |
| Total     | 4.135±0.045  | 5.393±0.42  | 4.989±0.298<sup>b</sup> | 4.417±0.182<sup>b</sup> | 6.273±0.215<sup>a</sup> |

Mean values with common superscript in row differ significantly (p<0.01)
Table 8. Mean (±S.E.) females GIT parts weight (g) of partial uropygialectomy treatments.

| Treatments | GIT parts | T1 (Control) | T2 | T3 | T4 | T5 |
|------------|-----------|--------------|----|----|----|----|
| Eso.       | 6.667±0.167b | 9±1a         | 5.333±0.667b | 7.333±0.667bc | 7±0.577bc |
| Pro. V.    | 4±0       | 5.667±0.333  | 4±0.577     | 4.333±0.333     | 5.333±0.882 |
| Giz.       | 19±0      | 22±1.155     | 18.667±0.333 | 21±1           | 2.333±3.547 |
| Deu.       | 4.667±0.333bc | 7.167±0.441a | 6.667±0.333 | 6±0.577bc     | 6±0.577bc |
| pancreas   | 1.667±0.333b | 3±0          | 1.5±0.289   | 2.333±0.333     | 2.833±0.601 |
| Juj.       | 8.333±0.667 | 9.667±1.202  | 8±0.577     | 8.667±0.333     | 8.333±1.202 |
| Ilium      | 5.667±0.333b | 8±0.577a    | 6.333±0.333 | 6±0.577ab      | 8±1a       |
| Col.       | 1±0       | 1.267±0.371  | 1.1±0.208   | 1±0            | 2.167±0.441 |
| Rectum     | 2±0       | 3±0.577     | 3±0         | 3±0.577        | 3.433±0.233 |
| Total      | 56±1.5    | 74.1±3.121   | 54.933±0.233 | 63±1.528       | 70.1±10.027 |

Mean values with common superscript in row differ significantly (p<0.01)

Table 9. Relative weight (%) of females GIT parts than total GIT weight of partial uropygialectomy treatments.

| Treatments | GIT parts | T1 (Control) | T2 | T3 | T4 | T5 |
|------------|-----------|--------------|----|----|----|----|
| Eso.       | 11.939±0.634 | 12.08±0.936 | 9.71±1.22 | 11.603±0.803 | 10.176±0.676 |
| Pro. V.    | 7±0.197   | 7.682±0.613 | 7±0.155 | 6.878±0.49 | 7.579±0.292 |
| Giz.       | 33.979±0.935 | 29.842±2.264 | 33.986±0.724 | 33.451±2.445 | 31.124±3.448 |
| Deu.       | 8±0.383ab  | 9.659±0.24a | 6.67±0.583 | 9.493±0.706a | 8.772±0.942a |
| pancreas   | 2.948±0.53 | 4.063±0.175 | 2.733±0.535 | 3.691±0.466 | 4.11±0.81 |
| Juj.       | 14.838±0.815 | 13.011±1.308 | 14.558±1.017 | 13.79±0.789 | 11.881±0.398 |
| Ilium      | 10.101±0.334 | 10.769±0.334 | 11.525±0.567 | 9.493±0.706 | 11.498±0.673 |
| C ECM       | 5.365±0.148 | 7.194±0.275 | 6.064±0.585 | 5.28±0.446 | 6.645±0.903 |
| Colon      | 3.649±0.28  | 6.064±0.585 | 5.28±0.446 | 6.645±0.903 | 6.45±0.903 |
| Rectum     | 3.577±0.098 | 3.997±0.616 | 5.46±0.023 | 4.733±0.844 | 5.171±1.049 |
| Total      | 56±1.5    | 74.1±3.121   | 54.933±0.233 | 63±1.528       | 70.1±10.027 |

Mean values with common superscript in row differ significantly (p<0.01)

Table 10. Relative weight (%) of females GIT parts than total live body weight of partial uropygialectomy treatments.

| Treatments | GIT parts | T1 (Control) | T2 | T3 | T4 | T5 |
|------------|-----------|--------------|----|----|----|----|
| Eso.       | 0.713±0.034 | 0.759±0.091 | 0.548±0.076 | 0.619±0.064 | 0.592±0.046 |
| Pro. V.    | 0.427±0.01 | 0.476±0.024 | 0.407±0.052 | 0.365±0.029 | 0.451±0.073 |
| Giz.       | 0.209±0.048 | 0.185±0.111 | 1.909±0.017 | 1.767±0.062 | 1.887±0.459 |
| Deu.       | 0.497±0.029ab | 0.603±0.044b | 0.375±0.035b | 0.507±0.056ab | 0.506±0.042ab |
| pancreas   | 0.177±0.033 | 0.252±0.003 | 0.154±0.03 | 0.197±0.031 | 0.238±0.048 |
| Juj.       | 0.887±0.055 | 0.812±0.01 | 0.818±0.053 | 0.73±0.02 | 0.70±0.097 |
| Ilium      | 0.604±0.025 | 0.673±0.052 | 0.649±0.045 | 0.507±0.056 | 0.675±0.078 |
| C ECM       | 0.32±0.008 | 0.449±0.028 | 0.342±0.04 | 0.282±0.032 | 0.393±0.07 |
| Colon      | 0.107±0.003 | 0.107±0.033 | 0.112±0.021 | 0.084±0.001 | 0.183±0.037 |
| Rectum     | 0.214±0.005 | 0.253±0.05 | 0.307±0.006 | 0.253±0.05 | 0.291±0.023 |
| Total      | 5.974±0.078 | 6.236±0.311 | 5.623±0.113 | 5.312±0.204 | 5.919±0.819 |

Mean values with common superscript in row differ significantly (p<0.01)

The densities of female digestive system in Table 12 shows that T2 treatments achieved to (p<0.05) consequentially exceed in the density of the esophagus. The values according to the sequence of priorities were as following: T2 (0.538), T1 (0.426), T4 (0.399), T5 (0.368) and T3 (0.295). No significant difference was indicated between T3 and T4 also between T4, T5 and T3. Females' gizzards were more density in T4, T1 and T2 treatments than those in the T5 and T3 at a significant level (p<0.01). The duodenums' densities of treatments from higher to lower value were: T2 (0.289), T4 (0.251), T5 (0.241), T1 (0.23) and T3 (0.154). Furthermore, the females' rectum densities in PU treatments were morally (p<0.01) higher than females within the control group as following: T5 (1.168), T4 (0.699), T3 (0.0692), T2 (0.607) and T1 (0.603).
Table 11. Mean (±S.E.) males GIT parts density (g/cm) of partial uropygialectomy treatments.

| GIT parts | T1 (Control) | T2 | T3 | T4 | T5 |
|-----------|---------------|----|----|----|----|
| Eso.      | 0.37±0.02     | 0.505±0.04 | 0.444±0.04 | 0.372±0.005 | 0.475±0.014 |
| Pro. V.   | 1.83±0.29     | 1.56±0.17 | 1.64±0.308 | 1.60±0.088 | 1.76±0.124 |
| Giz.      | 12.67±1.01    | 11.31±1.24 | 12.77±1.963 | 11.80±1.196 | 5.92±3.524 |
| Deu.      | 0.247±0.052   | 0.322±0.066 | 0.28±0.021 | 0.255±0.003 | 0.442±0.32 |
| Pancreas  | 0.148±0.037   | 0.293±0.007 | 0.201±0.018 | 0.194±0.055 | 1.019±0.067 |
| Juj.      | 0.146±0.025   | 0.246±0.023 | 0.193±0.019 | 0.202±0.035 | 0.262±0.023 |
| Ilium     | 0.131±0.013   | 0.193±0.007 | 0.187±0.021 | 0.136±0.014 | 0.199±0.024 |
| Cicum     | 0.127±0.012   | 0.162±0.013 | 0.152±0.004 | 0.121±0.004 | 0.172±0.014 |
| Colon     | 0.195±0.013   | 0.246±0.092 | 0.273±0.054 | 0.212±0.031 | 0.34±0.045 |
| Rectum    | 0.607±0.074   | 1.014±1.073 | 0.936±0.136 | 0.765±0.131 | 1.00±0.014 |
| Total     | 0.312±0.007   | 0.416±0.020 | 0.392±0.029a | 0.339±0.009c | 0.466±0.022 |

Mean values with common superscript in row differ significantly (p<0.05)
Mean values of pancreas density and total GIT density rows differ significantly (p<0.01)

Table 12. Mean (±S.E.) females GIT parts density (g/cm) of partial uropygialectomy treatments.

| GIT parts | T1 (Control) | T2 | T3 | T4 | T5 |
|-----------|---------------|----|----|----|----|
| Eso.      | 0.426±0.041   | 0.538±0.064 | 0.295±0.031 | 0.399±0.026 | 0.368±0.038 |
| Pro. V.   | 1.11±0.11     | 1.517±0.556 | 1.26±0.215 | 1.317±0.175 | 1.579±0.309 |
| Giz.      | 12.66±10.4    | 11.778±3.399 | 7.117±1.258 | 14±0.667 | 7.278±1.299 |
| Deu.      | 0.23±0.016    | 0.289±0.026 | 0.154±0.015 | 0.251±0.012 | 0.241±0.032 |
| Pancreas  | 0.208±0.042   | 0.282±0.009 | 0.156±0.028 | 0.265±0.036 | 0.333±0.085 |
| Juj.      | 0.21±0.016    | 0.204±0.013 | 0.175±0.016 | 0.183±0.012 | 0.182±0.032 |
| Ilium     | 0.14±0.008    | 0.166±0.012 | 0.139±0.006 | 0.126±0.008 | 0.157±0.013 |
| Cicum     | 0.117±0.002   | 0.165±0.01 | 0.115±0.011 | 0.113±0.006 | 0.155±0.029 |
| Colon     | 0.213±0.005   | 0.231±0.068 | 0.222±0.027 | 0.215±0.007 | 0.3±0.039 |
| Rectum    | 0.603±0.032   | 0.607±0.074 | 0.692±0.062 | 0.699±0.151 | 1.168±0.056 |
| Total     | 0.344±0.008   | 0.379±0.027 | 0.293±0.005 | 0.334±0.006 | 0.333±0.041 |

Mean values of esophagus and duodenum density rows differ significantly (p<0.05)
Mean values of gizzard and rectal density rows differ significantly (p<0.01)

**Discussion**

Present research observed that the uropygial gland located on the base of the tail, dorsally to the levator caudal muscle. It can be evidenced by palpation above the last sacral vertebra and the first caudal vertebra. These results are coincident with those reported by (Nickel et al., 1977; Montalti and Saliban, 2000; Gezici, 2002) and pointed out with (Aslan et al., 2000) who reported that the gland is lying on the pygostyl muscle. Uropygial gland in Akar Putra chicken has heart shape and held two openings for their canals. In chickens the papilla is long and thin while in turkey, the papilla is wide on the other hands some birds such as Musk duck lacks the uropygialwike.

The results showed that the partial ablation of the uropygial gland did not have any serious consequence for the survival of akarputra chicken and no mortality had happened during the trial period. That agree with (Jacob, 1976; Chen et al., 2003) whom considering the physiological role of the uropygial gland, it appears that the gland is not necessarily present in all groups of birds. This fact, observed in a number of species, together with the lack of a clear-cut ecological correspondence suggests that, when present, the function of the gland may be diverse but not essential. In this regard, it is interesting that the extirpation of the gland was not dangerous on survival of goslings, hens and passerine birds.

The results of present study improve that the removing of the uropygial gland has highly significantly effect on survival of goslings, hens and passerine birds.

The results of present study improve that the removing of the uropygial gland has highly significantly effect on survival of goslings, hens and passerine birds. Figure 1 shows that the males of Partial Uropygial (PU) treatments had longer and held two openings for their canals, in chickens the papilla is long and thin while in turkey, the papilla is wide on the other hands some birds such as Musk duck lacks the uropygialwike.

The results of present study improve that the removing of the uropygial gland has highly significantly effect on survival of goslings, hens and passerine birds. Figure 1 shows that the males of Partial Uropygial (PU) treatments had longer
esophagus, proventriculus, gizzard, pancreas, jejunum and colon than their control group counterparts and their variation ratios than control values were: 9.9-16.2%, 11.1-34.4%, 26.7-220%, 0-20.4%, 4.9-26.1 and 18.1-60.6 respectively. Whereas, females of PU treatments as shown in Fig. 2 had longer esophagus, pancreas and cecum compared with females in control and their variation ratio were 6.8-22.3%, 8.3-33.3% and 13-26%. Figure 3 presents that total GIT weight were 21.2 to 78.8% heavier in males of PU treatments, mainly in the esophagus, duodenum, pancreas, jejunum, ilium and cecum. However, no significant impact (p>0.05) between treatments was recorded in the total females GIT weight; moreover, females of PU treatments had 5.9-41.2% heavier ilium and 11.1-77.8% heavier cecum as shown in

![Fig. 1. Variation ratio (%) of males’ GIT parts length of PU treatments than control group](image)

![Fig. 2. Variation ratio (%) of females’ GIT parts length of PU treatments than control group](image)
Fig. 3. Variation ratio (%) of males’ GIT parts weight of PU treatments than control group

Fig. 4. Variation ratio (%) of females’ GIT parts weight of PU treatments than control group

Fig. 5. Variation ratio (%) of males’ GIT parts density of PU treatments than control group
Some previous studies have touched on the study of morphometrical measurements of the digestive system in some birds, such as chickens, ducks, geese, pigeons and turkeys (Rosenberg, 1941; Hodges, 1975; Muelling and Buda, 2002). These studies have indicated that the length range of the duodenum was 22-35 cm in chicken, 40-49 cm in goose, 22-38 cm in duck, 12-22 cm in pigeon and 29-39 cm in turkey. This observation was similar with Hassouna (2001), where, the author stated that the length of the duodenal loop and its parts as well as its shape and extension varied in birds. Furthermore, the previous studies were recorded that the length range of the jejuno-ileum was 98-138 cm in chicken, 170-213 cm in goose, 100-158 cm in duck, 53-84 cm in pigeon and 200-250 cm in turkey. This finding was agreed with Hassouna (2001) who stated that in all bird species, the jejunum was the longest part of the small intestine and the author found that lowest mean percentage of the length of the ileum to the total length of the small intestine in chicken (2.7%). In terms of caeca range length was 12-25 cm in chicken, 22-34 cm in goose, 10-20 cm in duck and 2-7 cm in pigeon. These results were similar with Hassouna (2001) who proved that caeca were long cylindrical expansions in chickens. And regarding to the rectum-cloacal range length, the values was 8-11 cm in chicken, 16-22 cm in goose, 8-13 cm in duck and 3-4 cm in pigeon. Finally, they reported the total GIT length range of the chicken, goose, duck, pigeon and turkey, the values were as following: 152-234, 279-352, 150-250, 72-125 and 390-500 cm respectively.

**Conclusion and Suggestion**

Based on the research result and discussion, it can be concluded that stopping the function of the uropygial gland by partial surgical removal technique caused significant improvement in the morphological characteristics of Akar Putra chicken digestive system. Morphometrical characteristics of male and female GIT segments 12-week-old measurements demonstrate with impossible doubt that the PU operation has a high and explicit impact on the exploratory birds. The PU operation reflection appears prominently on the live body weight and the length, weight and density of most GIT segments. It is assumed that the oil of the uropygial gland had a positive impact on the body’s performance after removing the gland. Based on the conclusion, the research team creates several suggestions, as follows:

- Developing the research about removing the uropygial gland in one week-old chicks so that it can increase the effect of the uropygial gland oil on the body’s performance
- Developing the research about the oil of uropygial gland biochemistry so that the mechanism of enhancing the body’s performance after removing the gland can be precisely identified

**Acknowledgment**

This paper was supported by University of Putra Malaysia in 2015. We thank Prof Saad A. Naji, Poultry Science scientist, Department of Animal Resources, Dean of Agriculture faculty, University of Al-qadisiya (Iraq), for the technical assistance.

**Author’s Contributions**

Hasan, S.A. Jawad: DESIGNED the study, collected all the data, analysed all the data, advised on data analysis and prepared the paper.

I.H Lokman: Designed the study and prepared the paper.

A.B.Z. Zuki: Designed the study and advised on data analysis.
A.B. Kassim: Designed the study and advised on data analysis.

Ethics

This article is original and contains unpublished material. The corresponding author confirms that all of the other authors have read and approved the manuscript and no ethical issues involved.

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