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Comparative studies on the morphometry and percent organ weights of digestive tract in commercial broiler and layer chicken

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Abstract

The weight of different components of digestive tract relative to the body weight of birds were studied in broiler and layer chicken of the same age group. The morphometric studies of the digestive tract were also carried out. The average weight of digestive tract found was 127.7 ± 25.05 grams and 37.42 ± 6.9 grams and the mean percent weight of digestive tract in the broiler chicken and layer chicken were 6.04 ± 0.74 and 14.7 ± 2.71 respectively. The present study revealed that the mean percent weight of digestive tract of the broiler chicken and layer chicken were significantly different and it was significantly higher in layer chicken than in broiler chicken of the same age group. The broiler chickens are sustained with improved dietary supplementation for the expanded bulk; in making the benefit to overall meat generation. While the layers are fed with a lowered dietary supplementation as compared to broilers, which is required to meet the metabolic activities and production of egg.

Keywords: Broiler chicken, layer chicken, digestive tract, percent organ weight

Introduction

In India, commercial chicken production has registered a steady growth in the last three decades and its contribution for animal protein requirement of ever growing population is remarkable. The constant efforts in genetic improvement, standardized package of practices on nutrition, housing, management, disease control etc. and application of new technologies paved the way for the multifaceted growth in poultry and allied sectors. As a result of advances in genetic selection, management and nutrition, the modern day commercial broiler chicken have fast growth rates, high feed conversion ratios and metabolic rates, thereby putting an increased workload on the digestive system and other vital organs which resulted in metabolic disorders and sudden death and an increased rate of mortality in broiler chicken (Cheriyann, 2007) [1]. Also the broilers are highly susceptible to various non-infectious causes of mortality including metabolic and cardiac diseases when compared with the layer breeds of chicken and prevalence rate is much higher in them (27%) than in layers (1%) (Olkowski, 2007) [4]. This is likely associated with the genetic selection of broilers for growth and feed conversion efficiency, while neglecting basic anatomical and physiological aspects of internal organs especially vital organs (Scheele, 1997) [6]. Understanding the percent organ weights in commercial broiler chicken and comparing it with layer chicken of the same age group will provide a baseline anatomical data in this regard.

Materials and methods

The materials for the present study, the digestive tract of commercial broiler and layer chicken were collected from the birds slaughtered at the Meat Technology Unit, Kerala Veterinary and Animal Sciences University, Mannuthy. Samples were collected from a total of 12 birds comprising of six commercial broiler birds and six layer birds belonging to the same age group (45 days post hatch). Prior to slaughter, live body weights of each birds were recorded to the nearest 0.1 g using a digital weighing balance.

Immediately after slaughter and evisceration, digestive tract (without digesta) from the level of pharynx to cloaca were collected. Weight of entire digestive tract and different components separately were recorded to the nearest 0.001g using a monopan balance. The length of the oesophagus and crop, small intestine, both caeca and large intestine were recorded using a measuring tape to the nearest of 0.1 cm. The percent weight of digestive tract relative to the body weight were calculated using Microsoft Excel spread sheet software 2013.

The independent sample t test was performed to compare the mean percent weight of digestive tract in commercial broiler chicken and layer chicken and the analysis were carried out using Statistical Product and Service Solutions (SPSS) software version 20.

Results and discussion

Weight of digestive tract

The mean live bodyweight respectively in 45 days old broiler and layer birds were 2100±192.3 and 254±2.9 grams. A tremendous change can be observed in the digestive tract of modern chicken due to intensive breeding for the number of eggs in layer and growth rate for broilers (Shivus, 2014) [7]. The average weight of digestive tract found was 127.7±25.05 and 37.42±6.9 respectively in 45 days broiler and layer chicken. The weight of digestive tract in broiler chicken ranged from 90 to 165.98 grams whereas in layer chicken the range was from 30 to 48.53 grams (Tab.1). Nasrin *et al.*,

(2012) [3] reported that the average added weight of different components of digestive tract in 28 days old broiler chicken was 135.57 grams. Martinez *et al.*, (2015) [2] observed the percent organ weight in laying pullet is 2.60 g/kg of BW in a 16 weeks of age.

The mean percent digestive tract weight in the broiler chicken and layer chicken were 6.04±0.74 and 14.7±2.71 respectively. There was a significant difference in the mean percent digestive tract weight of commercial broiler chicken and layer chicken (t -6.917, p< 0.05) indicating that the mean percent digestive tract weight in layer chicken is more than that in broiler chicken (Tab. 2). The broiler chickens are sustained with improved dietary supplementation for the expanded bulk; in making the benefit to overall meat generation. While the layers are fed with a lowered dietary supplementation as compared to broilers, which is required to meet the metabolic activities and production of egg.

Table 1: Weight of gastrointestinal tract (GI tract) and percent GI weight recorded in commercial broiler and layer chicken.

Bird no	Boiler chicken		Layer chicken	
	GI weight in grams	Percent GI weight	GI weight in grams	Percent GI weight
1	90	4.86	30	11.62
2	120	6.00	35.97	14.39
3	119.4	6.12	48.53	19.06
4	165.98	7.21	45.1	17.58
5	136.7	5.94	33.6	13.17
6	134.2	6.10	31.32	12.42
Mean±SD	127.7±25.05	6.04±0.74	37.42±6.9	14.7±2.71

Table 2: Comparison of percent GI weight of commercial broiler and layer chicken

Bird type	Percent GI weight	't' value	P-value
Broiler	6.04±0.4	-6.917	p < 0.05
Layer	14.7±2.71		

Weight of different parts of digestive tract

The average oesophagus weight of broiler and layer was found to be 4.43±0.67grams and 1.88±0.33 grams respectively. Nasrin *et al.* (2012) [3] reported that the average weights of oesophagus was 7.45±0.341 gm, at day 28 post hatch in broiler chicken. Average weight of crop was 3.78±0.82 grams in broilers and 1.70±0.50 grams. The average weight of proventriculus in broilers was 7.24±0.48 grams while in layer chicken, 1.35±0.20 grams. According to Nasrin *et al.* (2012) [3] the average weights of proventriculus was 6.25±0.028 gm, at day 28 post hatch in broiler chicken which agrees with the findings of present study. The broiler gizzard have an average weight of 38.4±6.8 and in layers it was found to be 10.10±0.34 grams whereas the reports of Nasrin *et al.* (2012) [3] claims that the average weight of gizzard was 40.2±0.048 gm, at day 28 post hatch in broiler chicken.

The average weight of duodenum was 11.20±1.57 and 3.92±0.19 grams respectively in broiler and layer. Similar to this findings the average weights of duodenum was 13.02±1.361 gm, at day 28 post hatch in broiler chicken (Nasrin *et al.*, 2012) [3]. The average weight of jejunum was found to be 21.40±3.17 and 6.57±0.40grams. In broilers the average weight of ileum was 17.20±3.00 and that of layer are 6.36±0.64 grams. The average weight of caecum was found to 10.07±1.48 and 2.43±0.19 grams respectively in broilers and layers. The average weight of colon and rectum of broiler and layer is found to be 2.67±0.32 and 1.40±0.30. When compared

to the broiler chicken the weight of each gastrointestinal organ was found to be higher than that of the layer line. (Tab.3 & 4).

Nasrin *et al.* (2012) [3] reported that the average weight of jejunum was 46.53±0.242 grams, ileum weighed 11.75±0.882 grams, caeca weighed 5.53±0.787 grams and coloretum weighed 4.66±0.018 grams in 28 days old broiler birds.

The percent weight of oesophagus in broiler and layer is found to be 0.21±0.03 and 0.74±0.13 respectively. Percent weight of crop in broiler and layer chicken was measured to be 0.18±0.05 and 0.66±0.20. Percent weight of proventriculus was measured to be 0.34±0.05 and 0.53±0.08. The percent weight of gizzard in broiler chicken was 1.81±0.16 and that of layer chicken is found to be 3.97±0.14. The percent weight of duodenum in broiler and layer chicken is found to be 0.53±0.08 and 1.54±0.08. The percent weight of jejunum in broiler and layer chicken was measured as 1.02±0.14 and 2.59±0.14. The percent weight of ileum in broiler and layer was found to be 0.81±0.10 and 2.50±0.23. The percent caecum weight in broiler and layer was found to be 0.48±0.08 and 0.95±0.08 and percent colorectal weight was found to be 0.12±0.01 and 0.55±0.12 (Tab.5& 6). From these observations it is clear that each organ in the gastrointestinal tract of layer contributes more to the bodyweight which is greater than the broilers chicken. Similar observations were made by Plavnik and Hurwitz (1982) [5]. It may be concluded that growth is limited by the relative size of the intestine or that the size of the intestine changes to accommodate growth rate as modified by either age or genetic makeup.

Length of digestive tract in broiler and layer

The average length of oesophagus in broiler chicken was 13.95±1.75 cm while the average length in layer was 8.16±1.40 cm. The average length of crop respectively in

broiler and layer was 3.79±0.75 and 1.93±0.37 cm. The average proventriculus length was 4.91±0.65 and 2.48±0.39 cm. The average diameter of broiler gizzard was 4.93±0.55 cm and in layer it was 4.05±0.54 cm. The average thickness was 2.80±0.74 and 1.58±0.32 cm respectively in broiler and layer. The average duodenum length was 33.45±3.32 and 23.30±1.00 cm in broiler and layer. The average length of jejunum was 71.5±6.82 and 38.4±3.20 cm. The length of ileum was 70.6±53.61 and 41.93±3.57 cm respectively. The average length of single caecum was 16.91±1.05 and 8.7±0.46 cm respectively in broilers and layers. The length of paired caecum in broiler chicken was 33.83±2.11 and in layers the length was 17.5±0.93cm. The average length of colorectum in broiler was 7.95±0.80 cm and that of layer was 4.1±0.65 cm (Tab. 7).

Nasrin *et al.* (2012) [3] found that the length of different components of digestive tract in 28 days old broiler chicken was as follows - oesophagus- 13.75±0.478 cm, proventriculus- 3.70±0.122 cm, gizzard- 5.32±0.128 cm,

duodenum- 34.13±1.477 cm, jejunum- 123.5±3.663 cm, ileum- 31.3±3.663 cm, each caeca- 18.125±1.732cm and colorectum- 8.83±0.037 cm and the observations were in agreement with the present study.

Plavnik and Hurwitz (1982) [5] reported that the average body weight of broiler chicken of six weeks of age was around 1.5 kilograms and the broilers of that time had the relative digestive tract weight close to that of layer birds of same age group. But the genetic and nutritional advancement in growth performance did not much concentrated on weight of internal organs in par with body weight. The scientists who could evolve stains of birds which can grow up to 2.5 to three kilograms within a short span of 35 to 40 days can definitely think of strains with internal organs also growing at such faster rates to compensate with the increasing metabolic requirements. This will mitigate the huge economic loss of broiler industry due to the sudden death syndrome and other non-infectious causes of mortality.

Table 3: Deigestive tract weight recorded in broiler chicken

Weight in grams									
Bird No	Oesophagus	Crop	Proventriculus	Gizzard	Duodenum	Jejunum	Ileum	Caecum	Colorectum
1	4.20	4.90	6.70	29.8	9.00	16.7	12.6	9.55	2.12
2	5.27	4.00	7.75	34.1	11.80	24.1	18.16	9.45	3.00
3	3.90	2.82	7.93	32.97	12.98	22.07	16.73	12.31	2.57
4	4.00	4.50	6.73	45.46	12.07	25.03	21.87	11.52	2.75
5	5.30	3.00	6.50	44.13	11.86	21.81	16.38	8.75	3.00
6	3.91	3.50	7.88	44.13	9.51	18.74	17.80	8.86	2.60
Mean ± SD	4.43±0.67	3.78±0.82	7.24±0.48	38.4±6.8	11.2±1.5	1.4±3.17	7.2±3	10±1.4	2.6±0.32

Table 4: Digestive tract weight recorded in layer chicken

Weight in grams									
Bird No	Oesophagus	Crop	Proventriculus	Gizzard	Duodenum	Jejunum	Ileum	Caecum	Colorectum
1	1.72	1.36	1.16	9.66	3.72	7.22	7.00	2.23	1.82
2	2.01	2.36	1.57	10.44	3.98	6.32	5.38	2.60	1.06
3	2.4	1.99	1.58	10.22	4.14	6.18	6.68	2.45	1.00
4	1.87	2.2	1.50	10.40	3.80	6.58	6.87	2.76	1.51
5	2.00	1.00	1.20	10.33	4.20	7.00	6.7	2.20	1.72
6	1.30	1.30	1.10	9.60	3.70	6.17	5.56	2.34	1.30
Mean±SD	1.88±0.33	1.70±0.50	1.35±0.20	10.10±0.34	3.9±0.197	6.5±0.4	6.3±0.64	2.43±0.19	1.40±0.31

Table 5: Digestive tract percent weight recorded in broiler chicken

Percent weight of									
Bird No	Oesophagus	Crop	Proventriculus	Gizzard	Duodenum	Jejunum	Ileum	Caecum	Colorectum
1	0.22	0.26	0.36	1.61	0.49	0.90	0.68	0.52	0.11
2	0.26	0.20	0.38	1.705	0.59	1.21	0.91	0.47	0.15
3	0.20	0.14	0.40	1.69	0.67	1.13	0.85	0.63	0.13
4	0.17	0.19	0.29	1.97	0.53	1.10	0.95	0.50	0.12
5	0.23	0.13	0.28	1.91	0.52	0.95	0.71	0.38	0.13
6	0.17	0.15	0.35	2.00	0.43	0.85	0.81	0.40	0.12
Mean±SD	0.21±0.34	0.18±0.048	0.34±0.05	1.81±0.16	0.53±0.81	1.02±0.14	0.81±0.10	0.48±0.08	0.12±0.013

Table 6: Digestive tract percent weight recorded in layer chicken

Percent weight of									
Bird No	Oesophagus	Crop	Proventriculus	Gizzard	Duodenum	Jejunum	Ileum	Caecum	Colorectum
1	0.66	0.53	0.45	3.74	1.44	2.79	2.71	0.86	0.70
2	0.81	0.94	0.63	4.18	1.59	2.53	2.15	1.04	0.42
3	0.94	0.78	0.62	4.01	1.63	2.43	2.62	0.96	0.39
4	0.73	0.85	0.58	4.05	1.48	2.56	2.67	1.07	0.58
5	0.78	0.39	0.47	4.05	1.64	2.75	2.62	0.86	0.67
6	0.50	0.50	0.44	3.81	1.46	2.45	2.20	0.92	0.52
Mean±SD	0.74±0.13	0.66±.201	0.53±0.81	3.97±0.14	1.54±0.08	2.59±0.14	2.50±0.23	0.95±0.08	0.55±0.11

Table 7: Dimension of gastrointestinal tract

S. No	Gastrointestinal organs	Average Length Mean±SD		t value	p value	
		Broiler	Layer			
1	Oesophagus	13.95±1.75	8.16±1.40	-8.771	p <.05	
2	Crop	3.79±0.75	1.93±0.37	-5.27	p <.05	
3	Proventriculus	4.91±0.65	2.48±0.39	-4.39	p <.05	
4	Gizzard	Diameter	4.93±0.55	4.05±0.54	-22.44	p <.05
		Thickness	2.80±0.74	1.58±0.32		
5	Duodenum	33.45±3.32	23.30±1.00	-20.38	p <.05	
6	Jejunum	71.5±6.82	38.4±3.20	-18.39	p <.05	
7	Ileum	70.6±5.64	41.93±3.57	-15.05	p <.05	
9	Caecum	16.91±1.05	8.7±0.46	-9.14	p <.05	
10	Paired caecum	33.83±2.11	17.5±0.93			
11	Colorectum	7.95±0.80	4.1±0.65	-8.00	p <.05	



A. GI tract of broiler

B. GI tract of layer

- | | |
|-------------------|----------------|
| 1. Oesophagus | 2. Crop |
| 3. Proventriculus | 4. Gizzard |
| 5. Pancreas | 6. Duodenum |
| 7. Jejunum | 8. Ileum |
| 9. Caecum | 10. Colorectum |

Fig 1: Comparison between GI tract of broiler and layer chicken

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