Full Length Article

INFLUENCE OF WHOLE PADDY GRAIN FEEDING ON HAEMATOLOGICAL AND INTESTINAL HISTOMORPHOLOGY OF COMMERCIAL BROILER CHICKEN

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ABSTRACT

A biological experiment was conducted to evaluate the effect of feeding of whole paddy grain on the haematological and intestinal histomorphology studies in broiler chicken. A total of 144 broilers were individually weighed, wing banded and randomly allotted on a weight equalization basis to 4 treatment groups with 3 replicates in each treatment group with 12 chicks in each replicate. Four isocaloric and isonitrogenous treatment rations containing whole paddy grain at levels of 0 % (T1), 5 % (T2), 10% (T3) and 15% (T4) of the total ration at the expense of maize were formulated. No significant (P>0.05) difference was observed in packed cell volume %, haemoglobin concentration, total erythrocyte count and total leucocyte count among treatment groups and control. There was no significant difference (P<0.05) in intestinal length and weight between control and treatment groups. Intestinal histomorphology of duodenum recorded significantly (P<0.05) higher villi height in T4 (692.02 µm) than T1 (534.12 µm) and significantly (P<0.05) higher villi height: crypt depth ratio was recorded in T4 (18.88 µm) than T2 (12.77 µm) however, no significant (P>0.05) difference was recorded in villi width, crypt depth, villi surface area. In jejunum, no significant (P>0.05) difference was observed in villi height, villi width, crypt depth and villi surface area but villi height: crypt depth ratio recorded significantly (P<0.05) higher values in T3 (14.51 µm) than T1 (8.57µm) group. In ileum, no significant (P>0.05) difference was recorded in villi height, crypt depth, villi surface area and villi height: crypt depth ratio but villi width recorded significantly (P<0.05) higher value in T2 (53.66µm) than T1(32.74 µm) group. The findings of this study indicated more favourable outcomes in the treatment groups compared to the control group, suggesting that inclusion of whole paddy grain up to 15% in broiler chicken ration had no negative effect on intestinal and haematological parameters.

Keywords: Whole paddy grain, histomorphology, haematological studies, commercial broiler chicken

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INTRODUCTION

The supply and demand of the different feed ingredients in recent times has brought an interesting change among the researchers to find alternative feed ingredients which can replace to some extent the major sources such as maize which has got the global demand rapidly for its utilization in agricultural feed and fuel industry (Edgerton, 2009). To overcome this demand, poultry researchers have started to study the use of paddy rice as a feed ingredient (Kita and Okuten (2013); Sittiya and Yamauchi, 2014).Raw rice, also called paddy rice, is the whole rice grain with the hulls (about 20% of the grain) (Ffoulkes, 1998). In many countries, feeding of whole grains to poultry has become common practice to reduce cost of grinding (Cumming, 1992; Svihus *et al.,* 2004) and to increase use of locally grown grains (Nanto *et al.,* 2012). Chicken has the ability to process and digest whole grains, primarily due to their gizzard function (Banfield and Forbes, 2001). It was also been reported that the physiological function of the gastrointestinal tract was affected by the particle size of feed like whole grains (Svihus *et al.,* 1997; Wu *et al*., 2004). Although paddy rice and corn are similar in energy and crude protein content, they differ in their starch and protein composition. Rice contains higher amylopectin and smaller starch granule sizes than corn, making it more easily digested by animals than corn (Tester *et al.,* 2014; Svihus *et al.,* 2005). The predominant protein in corn is prolamin while that in rice is glutelin (Li, 2013). Glutelin is easier to digest and exhibits better antioxidant capacity than prolamin (Wang *et al.,* 2016). Some researchers have demonstrated that dietary fiber causes physiological and histological changes (Jankowski *et al.,* 2009; Juskiewicz *et al.,* 2009). The changes in the intestinal morphology of the birds will determine its extent of utilization of the paddy grain and also its effect on growth, digestibility and level of inclusion in poultry diet.

MATERIALS AND METHODS

The experiment was conducted in the Poultry house of ICAR - Experiential Learning on broiler production located at Madras Veterinary College, Chennai, India.

Experimental design

The study was carried out as per guidelines and approval of institutional animal ethical committee (IAEC). A six-week duration biological experiment was conducted to evaluate the effect of paddy on the haematological and intestinal histomorphology in commercial broilers. The experimental period divided into three phases namely, pre-starter (0-7 days), starter (8-21 days), and finisher (22-42 days).

A feeding trial was carried out with 144 day-old straight-run commercial broiler chicks (Ven cobb 430 Y) and all the birds were allotted to four treatment groups viz. T1, T2, T3 and T4 with three replicates in each treatment with 12 chicks in each replicate.

Experimental diets

Four isocaloric and isonitrogenous broiler pre-starter (0-7 days), starter (8-21days) and finisher (22- 42 days) treatment rations containing whole paddy grain at levels of 0 % (T1), 5 % (T2), 10% (T3) and 15% (T4) of the total ration at the expense of maize were formulated.

Housing and management

Randomization of pen was done by the procedure described by Jayaraman (2000) and allotment of chicks was done on weight equalization basis to four treatment groups, namely, T1, T2, T3 and T4 with 3 replicates in each treatment with 12 chicks in each replicate. The birds were reared up to six weeks of age in an open-sided, deep litter house. Brooding was done for 6 days and the chicks were provided with uniform brooding facilities. The birds were reared by feeding appropriate rations and following the standard management practices. The birds were vaccinated against Ranikhet disease and Infectious Bursal disease.

Collection of blood

Three millilitres of blood was collected at 42 days of age from one male and one female from each replicate in EDTA vacutainer vials for blood analysis.

Estimation of haematological parameters

Total Erythrocyte Count (TEC) and Total Leucocyte Count (TLC) were estimated by Neubauer counting chamber by using Nambiar's diluting fluid. While, haemoglobin concentration in blood was examined by Sahli's acid haematin method and PCV by Win Trobe's microhematocrit method (Bancroft and Marilyn, 2008).

Intestinal length and weight

A total of 12 birds comprising of three birds per treatment were randomly selected for measuring length and weight of small intestine. The collected intestines were flushed with Phosphate Buffer Saline (PBS) to remove all the feed contents. The total intestinal length was measured using a measuring tape in centimetre scale and weighed in grams.

Intestinal histomorphology

Small intestine samples were taken from middle part of jejunum, duodenum, ileum from three birds per treatment after the experimental period of 42 days and were flushed with phosphate buffer saline and preserved in 10 % neutral buffer formalin for processing. The tissue sections were stained with Haematoxylin and Eosin stain as described by Bancroft and Marylin (2008) using image analysis software (Mag vision). Six measurements of height and width of villi and crypt depth were measured in µm per sample and mean values were used in statistical analysis. The villus height (VH) was measured from the tip of the villus to the villus crypt junction, crypt depth (CD) was defined as the depth of the invagination between adjacent villi, and epithelial thickness (ET) was considered as the distance from the epithelial surface to the basement membrane of the epithelial cell (Xu *et al.,*

2017; Abdollahi *et al.,* 2019). Villus width (VW) was measured at the widest area of each villus, whereas the VH:CD was determined as the ratio of VH to CD. Villus surface area (VSA) was calculated using the following formula (Emami et al., 2017).

$$VSA\ (\mu m)2 = [2\pi \times (VW/2) \times VH]$$

Where VW= villus width and VH = villus height.

Statistical Analysis

The data pertaining to various parameters were analysed statistically using Analysis of Variance (ANOVA) using software (IBM SPSS version 25.0 for windows) as per Ridgman (1990). Significant mean differences were determined at 5% probability level ($P<0.05$) to identify the fixed effect of treatment using Duncan's Multiple Range Test (DMRT) as modified by Kramer (1956).

RESULTS AND DISCUSSION

Haematological parameters

All the haematological parameters were within normal range and statistical analysis of the data revealed that there was no significant ($P>0.05$) difference recorded in PCV, Haemoglobin, TEC and TLC between T1 (Control) and treatments T2, T3, T4 (Table 1). But significantly ($P<0.05$) higher total erythrocyte count was observed in T3 compared T2. Similar finding, except TEC was reported by Yudiarti *et al.* (2020) who have observed no significant difference in erythrocyte count, leucocyte count, haemoglobin and haematocrit (PCV) value in broilers fed with fermented used rice which was in accordance with the present study.

Intestinal length and weight

The present study showed that inclusion of whole paddy grain in broiler chicken had no influence on intestinal weight and length (Table 2). This is in accordance with results of Preston *et al.* (2000) and Wu *et al.* (2004), who found no significant difference in relative length and weight of the intestine by feeding whole wheat grain. This may be due to the ability of the birds to efficiently digest whole grain through effective grinding in their gizzard. Similar, results were observed in intestinal length and weight of Sanuki Cochin Chicken s fed with 0, 20 and 40% of diluted untreated whole grain paddy rice (Sittiya and Yamauchi, 2014), Marshall Chunky male broiler chicken fed with whole paddy grain with or without enzyme (Sittiya *et al.*, 2014),Yangzhou geese fed with ground maize, ground hulled rice and rice husk (Wang *et al.,* 2014), White Leghorn birds fed with 650g/kg of corn, polished rice, brown rice and paddy rice (Murai *et al.,* 2018). However, Gabriel et al. (2003) and Nir *et al.* (1994) have shown alteration in the relative size of intestinal segments based on the grain particle size.

Intestinal histomorphology

In the present study, broilers fed with 15% whole paddy grain diet recorded significantly ($P<0.05$) higher duodenal villi

height compared to those on control diet and also villi height : crypt depth ratio was recorded significantly (P<0.05) higher in birds fed with 15% whole paddy grain diet compared to those 5% whole paddy grain fed birds, where as, significant (P<0.05) increase in villi height: crypt depth ratio of jejunum was observed in 10% whole paddy grain diet fed broilers and significant (P<0.05) increase in villi width of Ileum was observed in 5% whole paddy grain supplied group compared to control group (Table 3). For evaluation of intestinal morphology, villus height and crypt depth are useful parameters indicative of gut health in animals (Xu *et al.,* 2003). Increased values of these parameters are directly correlated with an increased epithelial turn over (Fan *et al.,* 1997). Some researchers have demonstrated that dietary fibre causes physiological and histological changes (Jankowski *et al*., 2009; Juśkiewicz *et al.,* 2009).

Histologically, increased villus height and cell mitosis number in intestine are indicators of active villus function (Langhout *et al.,*1999). Awad *et al.* (2006) found that greater villus height contributed to increase in surface area for greater absorption of available nutrients. Sittiya *et al.* (2014) observed no significant difference in villus height of all the intestinal segments but ileal and duodenal surface area were recorded significantly (P< 0.05) higher in 50% whole paddy grain rice (WPR) group in Marshall male broiler chicken containing 25% WPR, 50% WPR and 50% WPR + enzyme.

The villi surface area has shown no changes when supplemented with whole paddy grain at 5, 10 and 15%. Similarly, Sittiya and Yamauchi (2014) observed no significant difference duodenum villi surface area both at 20 and 40% WPR groups. In contrast to the present findings, Sittiya *et al.* (2015) observed no significant difference in intestinal histology of duodenum and jejunum but significantly (P<0.05) higher ileum crypt depth was observed in control group compared to treatments and also ileal villus height: crypt depth ratio was significantly (P<0.05) higher in 50 % whole grain paddy rice + 50 % brown rice group in Marshall Male broiler chicken. Nanto *et al.* (2015) observed no significant difference in villus height: crypt depth ratio, crypt depth of intestinal segment in thermoneutral and heat stress groups of broiler chicken fed with whole grain paddy rice (43%).

CONCLUSION

The results recorded in this study give more positive outcome in treatment groups compared to control, which suggests that inclusion of whole paddy grain up to 15% in broiler chicken ration had no negative effect on intestinal and haematological parameters.

Table 1. Effect of feeding different level of whole paddy grain on blood parameters of commercial broiler chicken at 6th week of age (Mean ± SE)

Sl. No	Parameters	Blood Parameters (n=6)				F Value
		T1 (Control)	T2 (5%)	T3 (10%)	T4 (15%)	
1	PCV (%)	30.33±0.97	27.61±1.86	28.10±2.19	25.46±1.88	1.24^{NS}
2	Haemoglobin (g/dl)	12.00±0.43	11.04±0.76	11.70±1.00	10.43±0.74	0.83^{NS}
3	Total Erythrocyte Count (106/µl)	2.34^{ab}±0.06	2.11^{b}±0.12	2.67^{a}±0.15	2.40^{ab}±0.05	4.33*
4	Total Leucocyte Count (103/µl)	25400.00 ±654.72	24000.00 ±1349.81	24856.66 ±1357.15	26833.33±1137.73	1.05^{NS}

Means bearing different superscripts within a row differ significantly (P<0.05)
*Significant (P<0.05), NS-Not Significant

Table 2.Effect of feeding different levels ofwhole paddy grain on small intestinal morphology of commercial broiler chicken at 6th week of age (Mean ± SE)

Sl. No	Parameters	Intestinal Morphology (n= 3)				F Value
		T1 (0%)	T2 (5%)	T3 (10%)	T4 (15%)	
1	Intestinal length (cm)	94.32±0.33	92.44±5.61	98.00±7.02	91.02±4.29	0.36NS
2	Intestinal Weight (g)	0.030±0.00	0.028±0.00	0.030±0.00	0.028±0.00	0.25NS

Table 3. Effect of feeding different levels of whole paddy grain on intestinal histomorphology of commercial broilers from at 6th week of age (Mean ± SE)

Sl. No	Parameters	Intestinal Histomorphology (n = 3)				F VALUE
1	**Duodenum**	**T1 (0%)**	**T2 (5%)**	**T3 (10%)**	**T4 (15%)**	
	Villi height (µm)	534.12^{b}±33.38	432.63^{c}±40.39	625.00^{ab}±27.37	692.02^{a}±16.24	13.50**
	Villi width (µm)	39.08±3.79	33.01±2.63	43.09±3.82	44.40±11.05	0.66^{NS}
	Crypt depth (µm)	36.82±1.64	35.00±1.04	38.08±2.74	37.57±1.62	0.51^{NS}
	Villus height: Crypt depth	14.99^{ab} ±0.22	12.77^{b} ±1.05	16.80^{ab} ±2.04	18.88^{a} ±0.99	4.28*
	Villus surface area (µm)	68091.59±9889.78	45788.43±7459.40	83761.83±11460.96	94406.82±22687.86	2.23^{NS}
2	**Jejunum**	**T1 (0%)**	**T2 (5%)**	**T3 (10%)**	**T4 (15%)**	-
	Villi height (µm)	326.14±22.36	508.72±87.05	497.00±13.52	439.56±61.02	2.32^{NS}
	Villi width (µm)	40.70±3.16	37.97±2.22	38.22±7.22	31.45±4.03	0.74^{NS}
	Crypt depth (µm)	38.88±1.28	37.33±2.67	36.12±1.16	36.71±0.96	0.50^{NS}
	Villus height: Crypt depth	8.57^{b}±0.90	13.84^{a}±1.67	14.51^{a} ±0.32	12.26^{ab}±1.87	3.90*
	Villus surface area (µm)	41212.65±4895.71	60253.40±10075.84	60117.34±11892.60	45127.71±10838.29	1.03^{NS}
3	**Ileum**	**T1(0%)**	**T2(5%)**	**T3(10%)**	**T4(15%)**	-
	Villi height (µm)	300.46±41.97	314.72±53.55	419.30±70.09	306.96±49.62	1.05^{NS}
	Villi width (µm)	32.74^{b}±1.63	53.66^{a}±8.31	33.55^{ab}±1.26	42.15^{ab}±6.66	3.21*
	Crypt depth (µm)	35.67±2.62	37.55±0.91	42.11±2.36	35.73±2.44	1.89^{NS}
	Villus height: Crypt depth	8.44±0.57	8.53±1.23	10.20±1.84	8.67±0.84	0.46^{NS}
	Villus surface area (µm)	30944.20 ±5415.81	50070.45 ±1701.19	43552.59 ±5497.32	42218.03 ±12035.84	1.21^{NS}

Means bearing different superscripts within row differ significantly (P<0.05).
**Significant (P<0.01), *Significant (P<0.05), NS-Not Significant

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