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Pathological effects of *Curcuma zedoaria* (shoti) flour feeding in growing broilers

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ABSTRACT

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Curcuma zedoaria (shoti), is one of the underexploited natural bounty which is considered as a good source of food and or feed for humans and as well as birds. In the present study, we investigated the effects of shoti meal as a primary source of carbohydrate in the growing broiler diet. The birds were fed with the shoti meal @ 10, 20, 40% raw and 20% autoclaved meal/ Kg and fed for 19 days. The diet was estimated to have contributed to 83 g crude protein and 750 g starch/ Kg dry flour. The results have shown that although there had been no deaths, however, broilers fed on different levels of flour grew slowly. Gross changes included lesions of necrotic enteritis and varying degrees of alterations in the gut and coxo-femoral joints. Entire articular cartilage was separated from the sub-chondral bone. The mesentery was depleted of fat, so was the abdominal and the fat pad from the thighs. The experimental birds appeared to be leaner than the corresponding control. The liver showed fatty changes and chronic inflammatory changes with non-specific granuloma in the parenchyma. The results suggested that more research should be carried out before considering *Curcuma zedoaria* as a feed source for the poultry.

Keywords: Broilers, *Curcuma zedoaria,* pathology

INTRODUCTION

Rhizomes of *Curcuma zedoaria* (Shoti), a tuber was used to be extensively incorporated in to food to save hungry people during famine in 1975 in Bangladesh, and later used as a source of starch for infants. A member of the ginger family of plants (*Zingiberacea*), grows in abundance on the rail tracks of Bangladesh as well as in the fallow lands. Unprocessed shoti was reported to be eaten as raw, after washing, by poorer section of the society during food scarcity and its tender buds are eaten as salad[1]

Conventional extraction method has been reported to yield 800 g raw starch/ Kg of rhizome while dried rhizome may have approximately 500 g starch/ Kg. Thus, this enormous quantity of starch from natural bounty shows a picture of an under-exploited and potentially valuable source of energy for humans and other monogastric including poultry. Thus, the aim of the present investigation was to determine the nutritional quality of shoti powder as feed for the growing broilers.

MATERIALS AND METHODS

Shoti meal preparation

Curcuma zedoaria (Shoti) from Bangladesh Agricultural University campus was collected and sorted on the basis of white color of the rhizome. Then they were chopped into pieces, sun dried and pulverized in a flour mill. Aliquot samples were autoclaved at 120 C under 15 lbs of pressure per square inch for 30 min. Autoclaved samples were stored in tightly lid container for future use. The procedure followed was essentially the as that used by Latif et al., (1979). The crude protein content of the shoti meal thus prepared was found to be 83g/Kg.

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Maize starch, corn oil, soybean meal, amino acids, minerals and vitamins were bought locally and were of general purpose grade. Test and control diets were formulated by substitution of maize starch. The composition of four test diets is shown in Table. 1.

Experimentation and observations

One hundred 1-day-old Cob 500 broiler chicks were obtained from local hatchery through a local agent in Mymensingh and were housed on rice husk until 14 day of age. They were fed commercial broiler starter diet *ad-libitum* and reared on husk floor. Water was supplied *ad-libitum* in plastic water trough. The body weight was monitored daily.

A total of 24 growing broilers, weighing about 525 ± 18.4 g on day 15, were randomly divided into six groups (four birds in each group) and allocated to cages at density of two broiler birds per cage. These six groups comprised of four experimental and two control (positive and negative non-protein control) diet groups. Diets were fed *ad-libitum* from day 15 for a period of 18 d (conventional slaughter weight). Water was available *ad-libitum* throughout the study period. Body weight, feed intake, feed refusal and fecal weights were recorded every day. Cumulative feed efficiency per bird was calculated as the ratio of weight gained to feed consumed. Dry matter of excreta was determined from the last 10 d of feeding trial by drying aliquots of every day's droppings by drying for 6 h at 105°C. The number of chicks with sticky droppings adhering to the cloaca area was noted on the same days of excreta collection.

No mortality among the experimental birds till completion of the experiment. On day 19, the experimental birds were sacrificed by humane slaughter

and the carcasses were examined systematically. The abdomen was opened to examine various organs in-situ and the gastro-intestinal tract was excised and examined for abnormalities if any. The gut contents were flushed with 0.9% saline. The gross pathological changes and the extent of damage in individual organs were noted. The duodenum was taken distally from the gizzard to the end of the pancreatic loop, jejunum from distal duodenum to Meckel's diverticulum, the ileum from Meckel's diverticulum to the caecal junction, and colo-rectum from the caecal junction to the cloaca. Representative tissues from liver, kidneys and intestine (duodenum, jejunum, ileum, caecum and colon) were collected in 10% neutral buffered formalin and processed for paraffin embedding. Sections were cut at 5-6µ thickness and stained with hematoxylin and eosin (H&E) stain[7].

RESULTS

The health status of the experimental birds throughout the study period was good and grew well without any addition of supplement or feed additives. However, birds fed on diets containing shoti meal (Table 1) were generally stunted and appeared lethargic than the control birds. Sticky and wet droppings were seen, especially in birds fed with autoclaved shoti meal in the diet. There were no mortalities and all the experimental and control groups underwent complete feeding trials. Nitrogen analysis of each diet revealed that the CP contents were similar in each formulation, being in the range of 156 to 188 g/ Kg.

Under the present experiment, the body weight gains observed upon feeding of raw and autoclaved shoti meal were in similar pace. However, the weight gain achieved on the non-protein control diet, as expected, was much less than those observed under *ad libitum* feeding condition (Fig. 1). Furthermore, after 19 days, the birds on maize-soybean meal diet were heavier than any other groups.

The results summarized in Table 2 show cumulative data over the 19-d period of the feeding trials. Each value represents the Mean ± S.E for 4 birds. Analysis of variance for the above feeding trial reveals that at day 19 the weight of the broiler chicken fed shoti 100g, 200g, 300 g and 200g (autoclaved shoti meal)/ Kg diet was significantly different from the weight of the chicken fed on a maize-soybean diet. The birds given shoti meal consumed less feed than those provided with a maize diet. Feed efficiency or weight gain to feed ration over 19-day period was poorest when fed 300 g shoti/ Kg diet. Intake picked up when the shoti meal was incorporated after having been autoclaved and there was slight improvement in body weight gain as compared to that of other shoti fed group. However, feed efficiency and body weight gain as percentage of initial weight remained significantly lower than the maize-soybean control.

Birds fed on different levels of shoti did not grow well as compared to those of control birds fed on maize-soy meal. Broilers fed on 300 g shoti meal showed stunted growth (Fig. 2) and orange discoloration of breast, which was uncommon from other shoti meal fed as well as the control groups.

Post-mortem examination showed severe depletion of abdominal fat and the color of the breast meat appeared paler than those of the control. Petechiae haemorrhages in the serosa were invariably found in most birds sacrificed that extended up to the end of mid intestine beyond duodenum with focal, multi-focal, locally extensive, or disseminated distribution throughout various parts of duodenum, jejunum and ileum. Gut lesions were assessed after having opened the whole length of the intestine from pylorus to cloaca. Birds fed 100g shoti meal showed brownish mucus contents in the mid intestine (Fig. 1). Scattered petechiae in the anterior intestine (duodenum) with lesions extending along the axis of the intestinal wall were found in birds fed all levels of shoti as compared to those of control. However, severity was accentuated in 200 g autoclaved shoti meal group than the corresponding experimental groups. Lesions extending up to end of the mid intestine beyond duodenum in birds fed on 300 g shoti meal (Fig .2) and its mucous surface had orange coated appearance with thickened wall with the lumen containing watery contents. In one case, the entire mucosa appeared bright red with typical ring like lesions in the mid intestine, and the intestine was filled with orange coloured mucus with thickened intestinal wall.

Table 1. The composition (g/kg) of experimental diets for growing broilers.

Ingredients	Control diets		Test diets			
	Maize-Soyprotein	Non-protein control	*Curcuma zedoaria* (CZ) Shoti(10%)	*Curcuma zedoaria* (CZ) Shoti (20%)	*Curcuma zedoaria* (CZ) Shoti (30%)	*Curcuma zedoaria* (CZ) Shoti (20%) autoclaved
Shoti meal	0	0	100	200	300	200
Ground maize	590	105	478	355	232.5	355
Soya-bean meal	358	0	353	355	353	355
Maize oil	15	147	32.10	53.1	78	53.1
Di-calcium phosphate	28.8	0	28.5	28.3	28.3	28.30
Sodium chloride	3.7	3.0	3.7	3.70	3.7	3.70
Vitamin-mineral premix	3.0	10	3.0	3.0	3.0	3.0
Methionine	1.50	0	1.70	1.90	1.90	1.90
Maize starch	0	735	0	0	0	0

Table 2. Performance of Cob-500 birds fed ad libitum on *Curcuma zedoaria* (shoti) meal diets or control diets.

Dietary groups	Non-protein control (4)	Soy-maize (Control Group)(4)	*Curcuma zedoaria*: CZ (Shoti-100 g/ Kg) (4)	*Curcuma zedoaria*: CZ (Shoti-200gm/Kg) (4)	*Curcuma zedoaria:* CZ (Shoti-200 g/Kg autoclaved) (4)	*Curcuma zedoaria*: CZ (Shoti-300g/Kg) (4)	P.S.D.
Starting body wt. (g)	530.4 ± 3.6	555.3 ± 37.2	547.75 ± 2.5	525.5 ± 3.2	533.7 ± 35.24	533.6 ± 3.6	18.41
Final body wt. (g)	397.8 ± 21.2	1,483 ± 37.9	904.6 ± 33.6	555.3 ± 47.9	579.5 ± 48.9	557.8 ± 50.1	41.7
Weight gain (g)	-132.6	927.7	356.8	29.8	45.8	24.2	
Total feed intake(g)/ 4 birds	3,568	8,078	4,527	2,613	2,846	2,773	
Feed efficiency (gain/ feed/chicken)	-	0.46	0.32	0.04	0.06	0.03	
Body weight gain as % of initial weight (g)	- 25	+167.1	+ 65.2	+ 5.7	+ 8.6	+ 4.5	

Note: P.S.D. = Pooled Standard deviation; NPC = Non protein control; Soy-maize = Soybean meal-maize; CZ = *Curcuma zedoaria* (shoti) meal

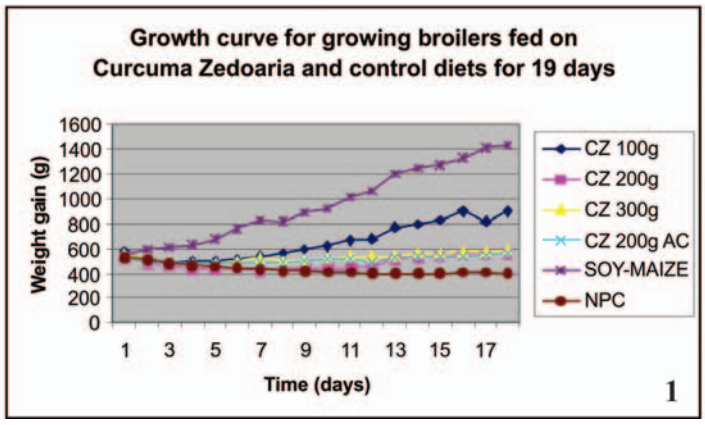

Fig.1. Growth curve for broilers fed *ad libitum* on reference control or test diets; **Fig.2.** Broiler fed 300 g shoti meal/ Kg diet had stunted growth (right) as compared to those of control (right).

The femoral head on postmortem examination was found to be normal in broilers fed on control diet. On the other hand, birds fed on shoti meal (autoclaved) revealed disarticulation of the coxo-femoral joint accompanied by cartilaginous epiphyseal plate separation with loss of the sub-chondral bone and marked eburnation. The entire articular cartilage was separated from the sub-chondral bone, presumably indicating more advanced stage. The mesentery was depleted of fat and so did the abdominal and the fat pad from the thighs. The carcass appeared to be paler than the corresponding control and lean.

Representative sections liver slices from growing broilers fed on 100g shoti meal/ Kg diet showed engorgement of blood sinusoids and formation of non-specific nodule (granuloma) in the parenchyma. In 200 g/ Kg shoti meal fed group, the liver sections revealed patchy necrosis of hepatic parenchyma adjacent to portal veins. Non-specific granulomatous changes were noticed in hepatic parenchyma of those birds that were fed on 200 g/Kg autoclaved shoti meal.

Representative sections of liver from birds that consumed 300g/Kg raw shoti meal showed distinct engorgement of central veins and sinusoidal congestion. Congestion of portal veins and mononuclear cell (plasmocytic) infiltration was a feature in observed in this particular group. The portal triad appeared thick where newly formed bile ducts were found. Hepatocytes that are lined adjacent to the hepatic vein showed fatty changes and the nucleus of hepatocyte appeared to be pyknotic. Congestive lesions were more prominent in birds fed 300 g shoti meal /Kg than other groups. Newly formed fibrous connective tissues were found to be extended from the portal triad replacing affected parenchyma.

The mucosal thickness and crypt depths in the gut were greater than the representative control. The duodenal epithelium of the villi tips obtained from birds fed on 300 g shoti meal/ Kg diet suffered the most severe effects and the tip of the villi demonstrated mild, moderate, and advanced degenerative to necrotic changes affecting matrix and cellular elements of the lamina propria, as well as enterocytes. Matting of the villi was found to a common alteration in the duodenal villi in birds fed 200 g autoclaved shoti/ Kg diet. The crypt depth was found to be increased in 300 g shoti meal/ Kg diet.

Representative sections from colon from growing broilers fed on 100 g shoti meal/ Kg diet showed hyper

activity of goblet cells in the villi. More severe changes occurred in the colon fed 200 g raw, 300 g raw and 200 autoclaved shoti meal/ Kg diet and mainly characterized by proliferation goblet cells. The muscularis mucosa appeared to be hypertrophied as compared to those of colon from control birds.

The present study examines the responses of broiler chickens to a short-term exposure of 100 g, 200 g, 300 g raw and 200g autoclaved *Curcuma zedoaria* (shoti) meal/ Kg diet. Pathological changes in the intestinal tissue were pronounced in shoti meal fed group in comparison to those of maize-soy protein diet. Although, all the broilers survived till the completion of experiment, the body weight, feed intake and efficiency of feed conversion were decreased with increase in the level of shoti meal in the diet. A similar conclusion has been drawn in relation to *Curcuma zedoaria* feeding trial earlier[1]. The feed conversion efficiency (g weight gain/ g food intake) was 0.516 and 0.498, when shoti meal was incorporated at the level of 100 g/ Kg diet in 20 days.

The results of the experiment have indicated that both qualitatively and quantitatively most of the deleterious effects of raw shoti meal feeding to the birds could be accounted for the toxic protein components present in the shoti meal. Other studies pointed to the complexity of the interactions of lectins in the intestine[2]. There is evidence that the un-degraded lectins by an unknown mechanism, alters the bacterial ecology of the gut. The disturbed microflora in the small intestine as well as the secondary effects of lectins, in part, might account for the decline in condition of the birds. The combined effects of decreased absorption of nutrients, local and systemic reactions and disturbed microflora might have adversely affected the performance of broilers fed with raw shoti meal.

The lesions observed in the present study were consistently reproduced in all four challenge trials, and hence these responses may signify newly emerging patterns of sub-clinical enteric disorders in the poultry fed on shoti meal. The pathological changes observed in broilers fed with shoti meal in the present study has never been reported in the past and must be clearly differentiated from those described in cases of necrotic enteritis (NE) or ulcerative enteritis. The nature of these lesions suggests that shoti meal feeding in broilers has significant negative effects on the digestive physiology and on intestinal mucosa.

In the present study, degenerative changes of the femoral bone has been found in broilers fed on 100 g, 200 g, 300 g raw and 200 g autoclaved shoti meal. Similar alterations were recorded in commercial setting and considered traumatic events due to overcrowding, antagonistic behavior, or may be associated with various management activities such weighing, sorting, and catching as high risk[3,4,5]. However, in the present experiments, birds were housed on a cage with wire mesh floor. Thus, likelihood of having any traumatic events remains at minimum.

From the above observations, structural weakness of the femoral bone in some rapidly growing broilers may be considered in the context of stress that heavy body mass puts on the developing bone, which can be described as a micro-injury. Rapid growth gain over a relatively short time, metabolic and structural weaknesses in the trabecular bone may be viewed as predisposing factors, whereas from the present feeding trials with shoti, birds that suffered degenerative changes were not heavy and thus femoral bone degeneration in broilers cannot easily be alleviated by simple measures such as control of growth rate by dietary restriction.

The aetiology of femoral bone degeneration in broilers is more complex than previously thought, and definitely involves metabolic disturbances. In particular, present study has provided several, previously not recognized, important details on the pathogenesis of femoral bone degeneration indicating that: pathological changes occur in proximal femur, but insufficiency in protein metabolism is most probably a primary factor associated with the pathogenesis. However, it is important to stress that the present findings do not negate the importance of bacterial infection in the evolution of this condition, as pathogens play a critical role in the pathogenesis of femoral head necrosis[6].

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