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EFFECT OF DIFFERENT DIETARY CALCIUM AND PHOSPHORUS RATIO ON URINARY SYSTEM AND INCIDENCE OF GOUT IN BROILER CHICKS

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ABSTRACT

Sultana S, Ali MZ, Rahman MT (2012) Effect of different dietary calcium and phosphorus ratio on urinary system and incidence of gout in broiler chicks. *J. Innov. Dev. Strategy.* 6(2), 19-23.

An experiment was conducted evaluate the effects of different dietary calcium and phosphorus ratio on urinary system and incidence of gout in broiler chicks on One hundred and twenty healthy broiler chicks that were selected and randomly divided into three groups as group A, B and C in which group A was control. The different groups were given three experimental ration containing calcium and phosphorus ratio as 1.50:0.5 (control), 2.50:0.5 and 3.5:0.5 were given for group A, B and C respectively for 28 days of experimental period. The biological parameters like serum calcium and phosphorus concentrations, FCR, kidney: body weight ratio was studied. Pathological examination of urinary system, pericardium, liver and visceral organ surfaces were performed. Chicks fed with high dietary calcium and phosphorus ratio showed hypercalcaemia, hypophosphataemia and increase incidence of visceral gout. In treatment groups the FCR and mean kidney: body weight ratio was higher. The ureters also showed occlusion and distention. The kidneys showing gross pathological lesions revealed common histopathological changes in glomeruli, tubular cells and interlobular veins. In general the urinary system of the treated birds, displayed inflammatory lesions, showing abnormalities of colour, size, shape and texture of kidneys and ureters. The rate of uric acid, urea, total protein, albumin, creatinine, calcium and alkaline phosphatase had meaningful changes compared control with group ($p<0.05$). Deposition of urates in kidney, on heart serous surfaces, liver, mesenteric and peritoneum were displayed in treatment group.

***Key words**: calcium, gout, broiler chicks, phosphorus, urinary system*

INTRODUCTION

The urinary system produces, stores, and eliminates urine. In bird it includes two trilobed kidneys, one on each side of the ventral surface of the vertebral column. Ureters carry the urinary waste to the cloaca (Samad 2005). Kidney is one of the vital organs with many functions in birds that affected by some disease and disorders; the most important of them is gout syndrome (Suryashe and Deshmukh, 1997). Gout is a common metabolic disorder that results in abnormal accumulation of urates in domestic birds (Damodaran *et al.* 1978). Calcium is the mineral with the highest concentration in the body of poultry, consisting of 1.5% of its body weight. It is more than one third of total mineral body content of an adult bird (Klasing and Kirk, 1998) and represents one third of egg shell components. Likewise, phosphorus is an essential element for all living organisms. Next to its major impertinence as a constituent of the skeleton, phosphorus is also an essential component of organic compounds and thereby involved in every aspect of metabolism (Soares 1995). Phosphorus in broiler feed originates mainly from plant feedstuffs, fish meal and inorganic feed phosphates. But, about 70% of the phosphorus found in plant feedstuffs is present as phytate phosphorus and was previously considered completely unavailable to poultry, while phosphorus from animal and in organic origins was considered to be 100% available (Van der kils and Versteegh, 1999). The deficiency or excess of calcium or phosphorus can interfere with the proper utilization of the other due to they are very closely related each other. Both calcium and phosphorus are eliminated from body in secretions and excretions; however, kidney and intestine remove most of the excess (Coles 1986). The kidney performed its normal physiological functions only when calcium and phosphorus are maintained in a specific ratio of 2:1 that necessitates maintenance of different physiological mechanisms including secretions, excretions and resorption etc. The disturbed balance of these minerals in diet can result in various pathological conditions including renal failure and development of gout in chicken (Chang and Fun, 1992). High dietary calcium concentration causes nephrosis and visceral gout in broilers (Page *et al.* 1979). Mineral imbalance, particularly of calcium and phosphorus, is one of such problems responsible for economic losses to farm holders, who often formulate the poultry rations themselves in Bangladesh. The study demonstrated the effect of dietary high calcium and low phosphorus ratio on urinary system and incidence of visceral gout in broiler chicks and determined clinical signs.

MATERIALS AND METHODS

Experimental Design

One hundred and twenty day-old Cobb-500 broiler chicks were randomly divided into three equal groups A, B and C each containing 40 chicks. All chicks are reared up to 31 days (experimental period) with three experimental rations. Ration containing calcium and phosphorus ratio as 1.50:0.50 (control), 2.50:0.50 and 3.5:0.50 for group A, B and C respectively. All three rations contain same ME as 3000 kcal/kg of feed,

3100kcal/kg of feed and 3200kcal/kg of feed for broiler starter, grower and finisher respectively and same CP% as 22%, 20% and 18% for broiler starter, grower and finisher respectively. Managemental factors including brooding, day-light, temperature (95^0F for 1^{st} week and reduce by 5^0F every successive week), vaccination (MD Vaccine at day-old, BCRDV at 3^{rd} days, IBD Vaccine at 10^{th} and 17^{th} days and RDV at 21 days), ventilation and stock density were identical for all three groups.

Sample Collection Design

Without anticoagulant about 2-3 ml of blood was collected at five days interval from five birds in each group by wing venipuncture prior to morning feeding at 8:00pm. Blood samples were centrifuged immediately after collection transferred to clean, sterile eppendorf tubes and stored at -20°C till used. Birds were weighed and slaughtered to examine urinary system, liver surface, pericardium and visceral organ surfaces and collect the kidneys; ureters were processed for histopathological studies, at the end of experiment.

Clinical Observation

The chicks were inspected daily for depression, loss of appetite, gradual emaciation, diarrhoea, intense thirst, dehydration and body weight by 31 days of experiment.

Histopathology

Tissue samples from kidneys were taken from treated and control birds and fixed in 10% neutral buffered formalin. Tissue samples were processed routinely for paraffin embedding followed by sectioning and staining with haematoxylin and eosin (HE), the technique described by Drury and Wallington (1980).

Study Parameters

The following parameters were studied-

Serum calcium and phosphorus concentrations

The serum calcium and phosphorus concentrations were determined by colorimetric method, using double beam spectrophotometer with commercial kit of RANDOX-Co., UK (Cat. No. CA590) and AMTEC- Co., UK (Cat. No. 112-2100), respectively.

Feed conversion ratio

At the end of the experiment, feed conversion ratio (FCR) was calculated, using the formula of Singh and Panda (1992).

Kidney:body weight ratio

All experimental birds were weighed and slaughtered at the end of the experiment. Their kidneys were removed and weighed for calculation of kidney: body weight ratio (Giamborne and Closser, 1990).

Pathological examination of organs

After slaughtering, all the birds were examined for the presence of gross lesions in the ureters, kidneys, urinary system, liver surface, pericardium and visceral organ surfaces (Nabipour *et al.* 2009).

Statistical analysis

The data obtained were statistically analyzed by applying one way analysis of Variance and Least Significant Difference test (Steel and Torrie, 1982).

RESULTS AND DISCUSSION

The Table 1&2 showed the result of different parameters that is significantly higher ($P<0.05$) serum calcium concentration in group C fed high calcium & phosphorus ratio that is 3.5:0.50. These findings are strongly agree with Ansar *et al.* (2004), who detected fed the broiler chicks with different ratios of calcium-phosphorous 1:0.50, 2:0.50 and 3:0.50 from 1st-42^{nd} days. They reported that the chicks fed by high calcium dietary (2 and 3%) revealed the increase of serum calcium concentration, decrease of serum phosphorous concentration, increase of the ratio of kidney's weight to total body weight and ureter dilation that caused by urate accumulation and another author Ismail (1989), who observed higher serum calcium concentrations in birds fed high dietary calcium: phosphorus ratios. These findings also support the results of Chang and Fun (1992), who gave higher dietary concentration of calcium to birds and observed hypercalcaemia. Likewise, the work of Growth and Frey (1996) correlate strongly to the results of the present study, as they reported that even small deviation from optimal supply of calcium and phosphorus in diet produced changes in their respective levels in serum.

Serum phosphorus level was significantly higher ($P<0.05$) in chicks of group A fed normal calcium: phosphorus ratio that is 1.50:0.50 that shown this study. These results indirectly indicate that a diet with increased calcium ratio induces hypophosphataemia. These results are in agreement with the findings of Ansar *et al.* (2004), Chang and Fun (1992) and Ougra (1981) observed decrease in serum phosphorous in broiler birds as a result of increasing dietary calcium.

Table 1. Serum calcium (mean ± SE) levels of chickens (mg/dl) of three groups

Experimental days	Experimental groups/dietary Ca : P ratio		
	A/1.50:0.0	B/2.50:0.50	C/3.50:0.0
1st	$8.00^{a} \pm 0.235$	$9.15^{ba} \pm 0.372$	$9.26^{ca} \pm 0.330$
7th	$9.09^{a} \pm 0.290$	$10.31^{ba} \pm 0.186$	$10.34^{ca} \pm 0.225$
13th	$9.15^{a} \pm 0.334$	$12.26^{b} \pm 0.222$	$13.30^{c} \pm 0.260$
19th	$9.12^{a} \pm 0.296$	$13.32^{b} \pm 0.253$	$13.21^{c} \pm 0.261$
25th	$9.13^{a} \pm 0.346$	$12.41^{b} \pm 0.302$	$13.34^{c} \pm 0.246$
31st	$9.15^{a} \pm 0.353$	$12.30^{b} \pm 0.284$	$13.82^{c} \pm 0.174$

Values bearing different superscripts in a row differ significantly (P<0.05)

Table 2. Serum phosphorus (mean ± SE) levels of chickens (mg/dl) of three groups

Experimental days	Experimental groups/dietary Ca : P ratio		
	A/1.50:0.50	B/2.50:0.50	C/3.50:0.50
1st	$6.84^{a} \pm 0.235$	$5.07^{ba} \pm 0.356$	$5.00^{ca} \pm 0.339$
7th	$7.32^{a} \pm 0.204$	$5.76^{ba} \pm 0.327$	$4.88^{ca} \pm 0.329$
13th	$7.17^{a} \pm 0.327$	$5.87^{b} \pm 0.163$	$4.92^{c} \pm 0.298$
19th	$7.15^{a} \pm 0.442$	$5.73^{b} \pm 0.171$	$4.78^{c} \pm 0.134$
25th	$7.39^{a} \pm 0.159$	$5.38^{b} \pm 0.138$	$4.81^{c} \pm 0.108$
31st	$7.29^{a} \pm 0.183$	$5.36^{b} \pm 0.945$	$4.65^{c} \pm 0.149$

Values bearing different superscripts in a row differ significantly (P<0.05)

In the group C after postmortem the kidney lobules, ureters, urethra shows edematous, larger than normal size due to deposition of uric acid and entire urinary system covered with scattered whitish chalky granules, shown in Fig. 1,2. Plastic color urets deposited also over the pericardium, liver and viscera. These findings are supported with the findings of Patel *et al.* (2007); the broiler chicks were fed by high calcium (1/7%) dietary from 1st day. They observed plasma uric acid triple the normal rate on 15th day also some plaster color urate deposition in viscera and supported by Feizi *et al.* (2011), they concluded that the physiologic process of kidneys encountered some disorders and consequently resulted in urates depositions on serous surfaces of viscera especially kidneys which are the symptoms of gout syndrome that makes vast mortality in herd. These findings were agreed with the findings of Chang and Fun (1992), who studied pathology of chicken gout induced by high dietary calcium and low phosphorus. Similar results have been reported by Ismail (1989), and Ogura (1981), who studied pathology of the high dietary level of calcium in broiler chicks. In group B and C kidneys of experimental birds were abnormalities of color, shape, size and texture with haemorrhages that was more marked in group C than group B fed a dietary calcium & phosphorus ratio 3.50:0.50.

Fig 1. Chaulk-like urate deposits on pericardial sac and liver capsule

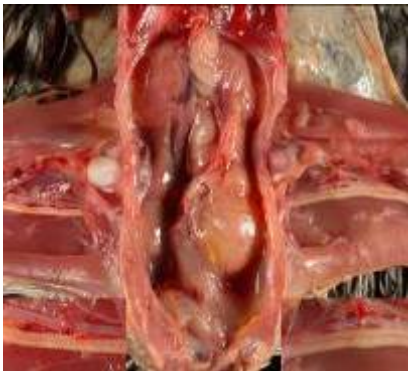

Fig. 2. Enlarge kidneys

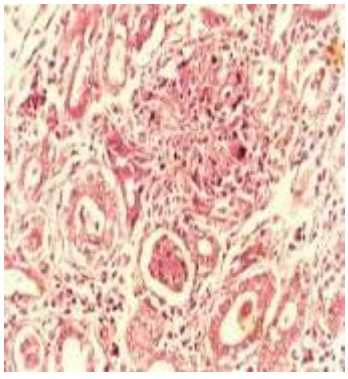

Fig. 3. Kidneys: urates deposition (HE stain, 150×)

Shane *et al.* (1968) reported renal and parathyroid changes in growing pullets fed high calcium in diet. Similarly, Glahn *et al*. (1988, 1989) observed gross kidney damage in birds fed high dietary calcium and low phosphorus.

The result of histopathology was appreciable changes in kidney parenchyma and substantial deposits of urate in glomeruli. Kidney pathological changes were ischemic nature of glomeruli with decreased cellularity and infiltration of mononuclear cells. Likewise, tubular cells were swollen with varying degrees of degenerative changes. Interlobular veins were dilated and multiple areas of petechial haemorrhages were observed in renal cortex shown in Fig. 3.

CONCLUSION

This study on dietary calcium and phosphorus ratio and gout has focused the dietary high calcium and phosphorus ratio causes hypercalcaemia and hypophosphataemia that interfere the physiologic process of kidneys encountered some disorders and consequently resulted in urates depositions on serous surfaces of viscera especially kidneys which are the typical symptoms of visceral gout. So, it is very important in forming broiler ration specially the ratio of calcium and phosphorus for preventing gout.

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