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EFFECT OF DIETARY HYDROCHLORIC ACID (HCL) SUPPLEMENTATION ON PERFORMANCE AND PHYSIOLOGICAL RESPONSE IN COCKERELS

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ABSTRACT

Concentrated HCl of 11.6 molar concentrations was supplemented in cockrel feed at 0.0 (control) 0.25, 0.50, 0.75 and 1.00m1/kg feed in a 28 day experiment. The chicks were slaughtered on day 30, performance characteristic and physiological indices were investigated. There was no significant difference ($p>0.05$) between control and HCl treatment for feed intake, crude protein intake and feed: gain ratio. Significant difference ($p<0.05$) was observed between control and HCl treatment for water intake and daily weight gain. There was significant increase ($p<0.05$) in organ temperature with increase in HCl supplementation. However, organ pH and invivo protein content in crop and gizzard significantly decreased ($p<0.05$) in HCl supplementation. The result of this trial showed that HCl has the potential for improving feed utilization in *cockerels.*

KEYWORDS: cockerels, HCL, pH, performance, physiological response.

INTRODUCTION

The value of feed affects the course of digestion in the alimentary canal due to gastric acid secretion to lower the pH of the digesta. A low pH is important for several reasons. First, pepsin, the proteolytic enzyme of the stomach is only activated from pepsinogen at low pH (2-4). If the gastric pH remains high, protein breakdown in the stomach is impaired, which not only affect digestibility and utilization of nitrogen but also mineral (Mroz, 1997)

A low gastric pH is also essential to control the bacterial population in the stomach. Proliferation of pathogenic bacterial such as *E .coli* and *Klebsidla* species as well as bacteroids , diminishes in an acid environment. The antibacterial activity increases with a decrease in pH value; beneficial *Bifado* and *Lactobacilli* bacterial specie are more tolerant towards low pH (Bolduan, 1988). Also, in the stomach, the pH level affects gastric discharge and emptying. As a consequence of increasing concern about the potential for antibiotic resistant strain of bacteria and toxic effect of feed additives, so many non therapeutic alternatives including acids have been used as feed additives. However, organic acids have not gained much attention in poultry as in pig production (Langhout, 2000). The nutritive effect of organic acid is most pronounced in weanling pigs (Gabert, 1994) which often suffer from digesta disturbance. Problems of weaning are triggered by a number of factors including insufficient production of hydrochloric acid and high acid binding capacity of feed (Eidelsburger, 1977, Carolien, 2001).

Hydrochloric acid is present in the stomach of all domestic animals, and it is the major factor lowering the pH of the stomach content. Impaired hydrochloric acid secretion however, is seen in a variety of clinical conditions in human (Gregory and Kelly, 1997).While the therapeutic efficacy of oral administration of HCl is still equivocal largely due to a scarcity of outcome, focused clinical intervention studies and substantial body of evidence indicate the necessity of proper gastric pH for optimal health in humans. The evidence by which exogenous hydrochloric acid may affect chick utilization of feed and performance is lacking. This work therefore focuses on the effect of dietary HCl supplementation on performance and physiological indices in cockerels. The work is aimed at understanding the potential supplementary HCl holds in feed utilization in cockerel birds.

MATERIALS AND METHODS

Chicken and Treatment: A total of 120 day old cockerels were used for the experiment in a completely randomized design model for 4 weeks. At day 2 of age, the birds were weighed and distributed into five homogenous experimental groups of three replicates with 8 chicks per replicate. The birds were managed according to standard management practices. Corn based diet was formulated with 18% crude protein and 2600 kcal/kg energy (Table 1). The experimental diets were devoid of coccidiostat, exogenous enzymes or antibiotics. The diets were however, supplemented with concentrated HCl of 11.6 molar concentration at 0.0, 0.25, 0.5, 0.75 and 1.00ml/kg of feed representing the five treatments. The experimental feed and water were offered to the birds daily ad-libitum.

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Table 1: Percentage Composition of Experimental Diets

Ingredient	1	2	3	4	5
Maize	44	44	44	44	44
Corn bran	30	30	30	30	30
GNC	10	10	10	10	10
Soya bean	10	10	10	10	10
Fish meal	1.3	1.3	1.3	1.3	1.3
Bone meal	2.0	2.0	2.0	2.0	2.0
Limestone	2.0	2.0	2.0	2.0	2.0
Methionine	0.1	0.1	0.1	0.1	0.1
Lysine	0.1	0.1	0.1	0.1	0.1
Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
HCl ml/kg	0.00	0.25	0.50	0.75	1.00
Calculated Nutrients					
Crude protein (%)	18	18	18	18	18
Energy kcal/kg	2600	2600	2600	2600	2600

Data Collection

Samples of the experimental feed were analyses for crude protein according to AOAC (1995) and the metabolizable energy kcal/ kg was calculated based on the composition of the diets. The pH value of the experimental diets were measured using pH meter model PHs-3B, Sugi frieded medical England (Table 2). Performance characteristics which included feed intake, crude protein intake, water intake, weight gain and feed gain ratio were determined on daily basis per bird. At day 30, 4 birds per replicate per treatment were sacrificed using cervical dislocation method. The crop and proventiculus/gizzard were quickly excised and the temperature (0^0C) of these organs were measured using a Kris-Aloy digital thermometer. The pH values of these organs were also measured using the pH meter. The content of the crop and gizzard were later emptied into a pre-weighed plastic plate to determine the weight of the contents. The crude protein content of the crop and gizzard was analyzed according to AOAC (1995).

Table 2: pH Value of HCl Supplemented Feed

HCl treated feed ml/kg	pH
0.00	5.95 ± 0.21
0.25	5.83 ± 0.32
0.50	5.51 ± 0.25
0.75	5.32 ± 0.27
1.00	5.00 ± 0.30

Data Analysis

The complete randomized design model was used to analyze the data obtained using model procedure of SPSS package. Duncan multiple range test (p<0.05) was used to test the significance of difference between mean values.

RESULT AND DISCUSSION

The pH values of the HCl supplemented feed decreased with increase in the HCl supplementation (Table 2) as a result of increased acidity effect from the HCl. Table 3 summarizes the effect of HCl on performance characteristic of cockerels. There was no significant difference (p> 0.05) between control and HCl treatment for feed intake, crude protein intake and feed: gain ratio.

In spite` of the fact that domestic fowl does have a sense of taste, birds have a wide range of tolerance for acidity and alkalinity (Kare, and Rogers, 1976). This explains the reason for the feed intake among the birds. However, birds fed HCl treated feed had significantly ($p<0.05$) high water intake and live weight gain compared with the control. The dietary acidifications could have inhibited the intestine bacterial competing with the host for available nutrients and a reduction of possible toxic bacterial metabolite, thus improving weight gain. (Langhout, 2000). [10] as observed in this experiment.

Table 3: Influence of HCl concentration on the Performance Characteristics of Cockrels.

Parameters	**HCl Supplementation (ml/kg)**					
	0.00	0.25	0.5	0.75	1.00	SEM
Feed intake g/bird/day	35.89	37.10	36.25	36.29	38.50	0.38
Crude Protein Intake g/bird/day	7.18	7.42	7.25	7.26	7.70	0.25
Water intake m1/bird/day	40.71^{b}	47.63^{a}	43.33^{ab}	43.50^{ab}	42.39^{ab}	0.61
Weight gain g/bird/day	9.17^{c}	11.17^{ab}	10.24^{abc}	9.74^{bc}	11.83^{a}	0.87
Feed/gain ratio	3.91	3.32	3.54	3.73	3.25	0.50

a-d Means in the same row with different superscript are significantly different ($P<0.05$)

Table 4 presents the effect of HCl concentration on organ pH value. The pH value of crop and proventiculus/ gizzard significantly decreased ($p<0.05$) with increase in HCl supplementation. The low pH in crop of birds fed HCl treated feed is a reflection of complementary effect of HCl from feed and the host *lactobacilli* which predominate the crop yielding lactic acid and reducing the pH. The stomach of the birds (proventiculus/gizzard) requires a low pH for proteolytic digestion; gastric acid is secreted to lower the pH of the stomach. Moreover, the stomach pH of birds fed HCl treated feed is further enhanced by the HCl and low pH of the feed. More importantly, acids are helpful after ingestion of feed to lower the pH of gastric digesta. This result is in agreement with (Carolien, 2001. who has reported that feed with high pH causes digesta at the proximal digestive tract to remain high.

Table 4: Influence of HCl Concentration on Organ pH value

	HCl supplementation (ml/kg)					
Organ	0.00	0.25	0.50	0.75	1.00	SEM
Crop	4.40^{a}	4.05^{b}	3.80^{c}	3.50^{d}	3.20^{e}	0.07
Proventiculus/gizzard	3.26^{a}	3.18^{ab}	2.40^{d}	2.99^{bc}	2.90^{c}	0.03

a-d Means in the same row with different superscript are significantly different ($P<0.05$)

Gastrointestinal tract has a pH that is lowered between the mouth and stomach. The invitro/invivo pH ratio is adjusted by the influx of feed from the mouth and upper GIT for effective digestion due to acid dissociation from the feed and the stomach. There is a relationship between pH and the extent of acid dissociation. HCl dissociates completely and because of the effect of pH on the ionization of acid group in protein and biological molecules, the pH of the gastric digesta is maintained within the narrow limit in which enzyme systems have evolved. The HCl treated feed therefore reduces the means of natural pH buffer thus conserving energy that could be required in the process (Cyril and Eric, 1978). which further explains the increased weight gain of birds fed HCl treated feed.

Table 5 revealed the effect of HCl supplemented feed on invivo protein status. The protein in the crop and gizzard significantly (p<0.05) decreased with increase in the level of HCl supplementation. But the proteins in these organs are comparable because the gizzard combines activities of grinding with proteolysis to accomplish gastric digestion without any loss in protein, preparing the digesta for intestinal digestion and assimilation (Moran,1982). However, the loss in protein between intake and crop is a reflection of digestive activity on the feed in the crop which corroborates (Moran,1982) that digestive activity taking place in the crop is variable. The extent of variability is however enhanced in the crop of birds fed HCl supplemented feed indicating that HCl increases protein digestion and assimilation in the crop.

Table 5: Influence of HCl Concentration in Organ Temperature ^{0}C

Organ	HCl Supplementation ml/kg.. 0.00	0.25	0.5	0.75	1.00	SEM
Crop	40.5^{c}	42.0^{bc}	43.5^{ab}	44.00^{ab}	44.3^{a}	0.39
Proventiculus	40.0^{c}	40.5^{bc}	41.5^{ab}	41.5^{ab}	42.6^{a}	0.21
Gizzard	43.17^{b}	44.0^{b}	44.17^{b}	45.67^{a}	46.0^{a}	0.24

a-d Means in the same row with different superscript are significantly different (P<0.05)

Table 6 presents the influence of HCl supplementation on organ temperature. The temperature significantly (p<0.05) increased with increase in the HCl supplementation. Temperature increases with decrease in the pH of plasma protein in biological systems Eckert and Randle, 1978) and since crop is also a biological entity, the low pH resulting from HCl supplementation could have been responsible for the increase in temperature complemented with heat of dissociation from HCl. However, the relatively high temperature recorded from the gizzard is as a result of the presence of heavy concentration of mitochondria, grinding activity of the gizzard coupled with the low pH. The high temperature in the gizzard therefore indicate its functionality and it is more pronounced in the birds fed HCl treated feed, revealing that HCl improved the digestive activity of the gizzard which further explains the high weight gain recorded for birds fed HCl supplemented feed. The result from this work therefore, shows that inclusion of HCl in cockerels feeds holds a good promise in feed utilization and addition of 1ml/kg of feed is most beneficial.

Table 6: Influence of HCl Concentration on Invivo Protein (%) Status in Organs

Organ	HCl Supplementation (ml/kg) 0.00	0.25	0.5	0.75	1.00	SEM
Crop	16.47^{a}	15.43^{ab}	14.61^{abc}	14.02^{bc}	13.43^{c}	0.42
Gizzard	16.22^{a}	15.21^{ab}	14.25^{abc}	13.41^{bc}	12.75^{c}	0.5

a-d Means in the same row with different superscript are significantly different (P<0.05)

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