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RESPONSES OF BROILER CHICKS TO GRADED LEVELS OF DIETARY SODIUM CHLORIDE (COMMON SALT) IN A HUMID TROPICAL ENVIRONMENT

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Target Audience: Poultry farmers and animal scientists

ABSTRACT

Graded levels (0, 0.4, 0.8 or 1.2%) of sodium chloride (common salt) were incorporated into isocaloric and isonitrogenous broiler starter and finisher diets which were fed to Anak broiler chicks from 1 day old to 8 weeks of age. During the experimental period, body weight gain, feed intake, feed efficiency and conversion were recorded as indices of production or performance. Ten chickens from each treatment were randomly selected from the replicates and bled for plasma sodium and packed cell volume measurements at the end of the 8th week.

Results showed that NaCl effectively potentiated body weight gain of the broilers up to the 0.8% levels and that thereafter body weight was depressed. The 0 and 1.2% NaCl did not significantly influence plasma sodium and PCV, probably because of the incorporated 5% fishmeal in the 0% diet and the activity of salt glands in the 1.2% NaCl diet. It was demonstrated that NaCl may not be fed above 0.8% in broiler chicken diets.

Keywords: Sodium chloride, intake, broiler chicks, tropical environment

DESCRIPTION OF PROBLEM

The effective utilisation of sodium chloride (common salt) has confounded production or performance and physiological implications. Some researchers found no effect of dietary NaCl on growth and feed intake of chicks at level between 0.12 to 0.40% of the diet (1, 2) while others found positive effects on broilers fed at 0.38% NaCl in mash and reported growth depressive effects when the rate of inclusion was 1.3% (3). However, it has been reported that young chicks effectively utilised 0.8 to 1.2 % NaCl in diets (4), and recently, it was found that 0.8% NaCl was required by chickens for maximum body weight gain (5) without excessive water intake, and the accompanying loose droppings and the need for high poultry house ventilation (3). Nonetheless, it has been reported that very low or very high levels of NaCl in diets or water have resulted in salt toxicosis which include adverse effects on packed cell volume (PCV), plasma sodium concentration, decreased rate of weight gain, increased mortality, diarrhoea, oedema, increased heart size, nervousness

and degenerative changes in kidney, liver, spleen, adrenal, lung, central nervous system, and the gastro-intestinal tract, (3,6). The utilization of NaCl in feeds is also essential for the operation of certain enzyme systems, the maintenance of blood pH, electrolyte balance, stimulation of salivary secretion and promotion of the action of diastatic enzymes (7, 8, 9). It has been reported that the bird would metabolise high doses of NaCl through the secretion of its salt glands by the adrenal hormone, corticosterone (10), hence the need to test high doses in broiler diets.

Accordingly, graded levels of NaCl were fed in diets to broiler chicks to determine the optimum level for best broiler production or performance, plasma sodium concentration (11) and PCV (12) in the humid tropical environment.

MATERIALS AND METHODS

Four hundred 1-day old broiler chicks (Anak) were wing banded and allocated randomly to 20 pens so that each pen contained 20 unsexed chicks which were group weighed, having an initial average body weight of 40 g. The pens were randomly assigned to four dietary treatments in a completely ramdomised design, and therefore, each treatment was replicated five times. The pens measuring 1m x 3m each, were equipped with wood-shaving on the floor, chick drinkers, feeders, and incandescent electric bulbs of 200 watt to provide heat. Adult feeders and drinkers replaced the chick types after three weeks, while the bulbs were raised to supply light during the night in an open-sided house.

Graded levels of sodium chloride, 0, 0.4, 0.8 or 1.2% in the basal diet formed the dietary treatments A, (control) B, C and D respectively (Tables 1 and 2). In Table 1 the starter diets (mash) isocaloric and isonitrogenous were fed to the broilers for the first 4 weeks, and the four finisher diets which were also isocaloric and isonitrogenous were fed to the birds during the last four weeks of the study. The levels of sodium chloride (NaCl) an iodinized common salt of Dicon salt (Nigeria) Limited was the only difference in the dietary treatments.

Experimental diets and water were provided *ad libitum* to the birds . Feed was added to feed troughs in a way to avoid feed wastage by birds. At the end of each period of seven days, the birds were weighed individually and the remaining feeds weighed to determine body weight gain, feed intake, efficiency of feed utilization (gain: feed ratio), and feed conversion (feed: gain ratio). Final body weights were taken in each replicate at 8 weeks of age. Blood was taken by heart puncture from 2 birds, randomly, in each replicate, and therefore ten birds were bled per treatment for the determination of plasma Na^+ concentration and PCV.

Each replicate maintained 20 birds from the first day of the experiment. Thereafter, each dead bird was weighed on the day it died to adjust for feed efficiency and feed conversion. Postmortem examination was performed on

each dead bird to ascertain cause of mortality.

All data were subjected to analysis of variance and orthogonal polynominal contrasts were used (13) to compare the means of each measurement using the model:

$$Yij = u+Ti+ E(i)j$$

Where,

Yij	represents each observable measurement.
U	represents the general mean.
Ti	represent treatment effect.
E(i)j	represent residual random term.

Tables 1: Ingredients and chemical composition of experimental broiler starter diets.

Ingredients (%)	A	B	C	D
Maize	43.0	43.0	43.0	43.0
Palm Kernel Cake	19.0	19.0	19.0	18.0
Soya bean meal	20.7	20.7	20.7	20.7
Fish meal	5.0	5.0	5.0	5.0
Wheat bran	10	9.6	9.2	9.6
Vit/Trace mineral[1]	0.25	0.25	0.25	0.25
Bone meal	2.0	2.0	2.0	2.0
DL Methionine	0.03	0.03	0.03	0.03
Salt (39% Na^{+} , 54% Cl^{-})	0.00	0.4	0.8	1.2
Lysine	0.02	0.02	0.02	0.02
Composition of nutrient (%)				
Crude Protein (analysed)	20.58	19.75	19.29	20.15
ME (calculated, (kcal/kg)	2661.32	2653.20	2645.07	2641.75
Fat (analysed)	3.60	3.40	3.00	3.40
Crude fibre (analysed)	1.23	2.28	2.10	1.93
Sodium (analysed)	4.0	5.03	5.13	5.20
Chloride(analysed)	0.05	0.05	0.04	0.04
Lysine (calculated)	1.15	1.14	1.14	1.14
Methionine (calculated)	0.46	0.46	0.46	0.46

[1]Containing per kg vitamin and mineral mixtures:
0.127g retinol, 20g cholecalciferol, 1.8gl & tocopherol, 1g menadione bisulphite, 2.5 riboflavin, 10g nicotinic acid, 4.4g pantothenic acid, 0.5g pyridoxine , 0.2g folic acid, 4mg cobalamin, 100g choline chloride, 62.5g antioxidant, 12.5 Fe, 40g Mn, 25g Zn, 1g Cu, 0.06g I_2, 0.1g Co, 0.05 Se.

and PCV. However there was slight numerical increase in plasma sodium as well as in PCV as the level of NaCl increased.

Table 3: Effect of NaCl on body weight, feed intake, feed conversion, and feed efficiencey and mortality[1]

	Dietary sodium chloride (NaCl) %			
Measurements	0.0	0.4	0.8	1.2
Body intake (kg)	$1.71^{a} \pm 0.58$	$1.81^{b} \pm 0.61$	$1.98^{c} \pm 0.65$	$1.81^{b} \pm 0.61$
Feed intake (kg)	$4.72^{a} \pm 1.21$	$5.14^{b} \pm 1.52$	$5.4^{c} \pm 1.46$	$5.2^{b} \pm 1.56$
Feed Conversion	$2.83^{a} \pm 0.24$	$2.87^{a} \pm 0.25$	$2.79^{a} \pm 0.26$	$2.81^{b} \pm 0.26$
Feed efficiency	0.36 ± 0.01	0.35 ± 0.1	0.36 ± 0.01	0.36 ± 0.01

[1]Data are means ± SEM of 5 replicates of 20 broilers each

[a,b,c,d] means within the same row with different superscripts are significant ($P<0.05$).

The observed significant ($P<0.05$) quadratic body weight tended to indicate that NaCl effectively potentiated growth of the broilers up to 0.8% level and thereafter growth depressive effect was exhibited. This result corroborated with that of (5) who found 0.8% NaCl yielded maximum body weight and that of (3) who found depressive growth effects when the inclussion level was 1.3%. However, the recommended level of NaCl for basal broiler diets by (14) has been 0.4% although this level was not specific for any ecological zone. In this study no growth depressive effect was observed in the 0% NaCl diet, probably, because of the 5% fish meal included in all the dietary treatments. This suggestion agrees with the report that little or no salt may be required in diets containning ingredients of animal origin (15.) On the other hand the high level (0.8 and1.2%) beyond the 0.4% (14) recommendation did not cause drastic growth depression because of the probable activity of the birds' salt glands which cause extra renal excretion of NaCl (10).

The observed quadratic ($P<0.05$) feed intake pattern coincided with that observed in the body weight measurements, falling slowly beyond 0.8% on the curve. Considering that the diets were isocaloric and isonitrogenous, the significantly low intake of the 0% NaCl diet compared with the others tended to indicate that the broilers had a craving for NaCl (15) and also confirmed that adequate inclusion of NaCl in broiler diets induced feed intake (16) Again, the observable toxicosis of NaCl deficiency such as decreased growth rate and cannibalism were not markedly observed because of the considerable high plasma concentration in the 0% diet (Table 4), probably derived from the incorporated fish meal.

Table 4: Effect of NaCl on plasma Sodium concentration and packed cell volume (PCV)[1]

	Dietary Sodium Chloride (NaCl) %			
Measurement	0.0	0.4	0.8	1.2
Plasma Sodium (g/L)	3.17±0.31	3.22±0.33	3.22±0.35	3.24±0.36
Packed Cell Volume (%)	26.0±1.58	26.5±1.55	27.40±1.61	30.65±1.42

[1]Data are means ± SEM of 5 replication of 20 broilers each
[a,b c,d] Means within the same row with different superscript are significant (P<0.05)

Indeed, the observed no significant feed conversion and feed efficiency in this study tends to satisfy the true isocaloric and isonitrogenous states of the diets and that Na^+ and Cl were in the dietary treatments even though NaCl was not included in the 0% NaCl diet. However higher levels beyond 0.4% have been found to improve feed utilisation efficiency (5,17) in laying birds. Nonetheless such trend of feed efficiency was found in this study (Table 3) in the higher % NaCl diets.

Post mortem examination of the dead birds showed that mortality was not due to the dietary treatments. Moreover, the birds died within the brooding period which could be caused by stress as has been previously found (15).

The observed non significance in plasma NaCl concentration and PCV (Table 4) tended to demonstrate that plasma NaCl concentration did not influence PCV in this study. This finding agreed with that of (18) who found that graded levels of NaCl fed to broiler chickens had no significant effect on plasma sodium concentration and PCV. In this study the plasma sodium concentration measured was in the range of 3.17- 3.24g/l which was below that (3.4g/l) reported by (15) . However the PCV obtained in this study (26-30.6%) agreed with that of (19) . Considering that these birds were not water deprived but had equal access to water *ad libitum* , salt gland secretion was stimulated in the birds, if they had functional salt gland. The results tend to demonstrate that the broiler chickens had power, within these limit of NaCl levels to maintain sodium balance in the face of an osmotic stress which had been found to enhance adrenal hypertrophy and plasma corticosterone concentration in birds (10) . Corticosterone (10) arginine vasotocin (20) and prolactin (21) have been found to cause changes in plasma osmolarity extra-cellular fluid (ECF) tonicity or volume which induces extrarenal excretion of NaCl in birds which possess functonal salt glands (10) since the control of salt gland function is sensitive to both ECF tonicity and volume (22). The extrarenal activity of the salt glands might be the reason there was no significant effect of the dietary NaCl treatments on plasma sodium concentration and PCV in this study.

CONCLUSION AND APPLICATIONS

1 The inclusion of NaCl in broiler diets up to 0.8% potentiated weight gain and feed intake.

2 The effeciency of NaCl utilisation by broiler chicks declined when inclusion level went beyond 0.8%.

3 With the incorporation of fishmeal, the 0 and 1.2% NaCl did not significantly influence plasma sodium and packed cell volume

4 Sodium chloride may not be fed to broiler chickens beyond 0.8% of the diets.

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