EFFECT OF SALT SUPPLEMENTATION METHOD ON THE PERFORMANCE OF BROILERS

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ABSTRACT

Different methods of giving supplemental NaCl, in liquid or solid forms, either mixed in the ration at required level or offered separately at *ad libitum*, did not significantly affect feed intake, weight gain, feed conversion efficiency, return above feed and chick cost, or feed cost per kg broiler produced. However, mortality-morbidity rate significantly differed among treatments and was highest in birds receiving *ad libitum* sea water.

Birds were found to have greater tolerance to larger amounts of salt offered dry than in solution form probably because assimilation of elements is faster using liquid than solid form. The availability of sea water at no cost makes it an economical salt supplement, but only when mixed in the ration rather than offered at free choice. However, the sea water level in the feed should be less than the amount needed to meet the salt requirement (143 ml/kg feed) so as to reduce mortality-morbidity rate, especially if some of the feed ingredients used contain considerable amounts of Na and Cl.

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INTRODUCTION

Profitable broiler raising largely depends upon the feeding of balanced rations supplying adequate amount of available energy, protein, vitamins, and minerals. Proper poultry rations can be derived only by applying the nutritional information known for the class of poultry to be fed. The application of these information to poultry feeding requires knowledge of the nutrients and their functions, the feedstuffs available to supply these nutrients, and the amount of each nutrient needed for a particular productive purpose.

Mineral elements most likely to be deficient in poultry rations are calcium (Ca), phosphorus (P), sodium (Na), chlorine (Cl), manganese (Mn), and zinc (Zn) (Card and Nesheim, 1972). Rations composed of normal feed ingredients may be deficient in these elements unless special sources are supplied. Na and Cl are important in maintaining acid-base and fluid balances of body tissues, thus, a deficiency of any of these elements may result in poor growth, dehydration, and, in severe cases, death.

Salt (NaCl) should be included in the feed mixture since plant materials used in animal feeding are quite low in sodium and chlorine (NRC, 1971). Offering salt licks or sprinkling salt over the ration at 0.5% of the total feed has been the cheapest method of providing Na (Allo, 1977). Although NaCl is necessary in small quantities, either mixed in the feed or as free NaCl, large percentages in the diet increase water consumption and have laxative effect (North, 1978). Generally, no more than 0.5% free NaCl should be added to the poultry ration, in many instances only 0.25%. NRC (1971) places the Na requirement at 0.15% of the ration which can be met by 0.37% NaCl in the diet.

While Na and Cl are very necessary in poultry rations made up mainly of plant materials, the ordinary table salt which readily supplies these elements is getting more expensive. A natural and most abundant source of NaCl at no cost is sea water. Besides NaCl, magnesium (Mg) is also present in sea water in sufficient amounts to meet the animal's requirement for this element. This study was conducted to test the effect of NaCl when supplied by sea water or dry salt, either mixed in the ration at required level or offered at free choice.

MATERIALS AND METHODS

Experimental set-up

A total of 100 four-day-old broiler chicks of the Peterson strain (RFM Corporation) were divided into 20 groups of five. Each group was randomly assigned to any of the 20 experimental units representing the treatments with 4 replications per treatment arranged in a completely randomized design (CRD). Experimental birds were raised inside the house so that climatic factors are held uniform across the following treatment groups:

A - Control

B - Sea water offered separately from the ration at *ad libitum*

C - Dry salt offered separately from the ration at *ad libitum*
D - Sea water mixed in the ration at 143 ml/kg feed
E - Dry salt mixed in the ration at 0.37%

The control group (A) received no salt either in the feed or in the drinking water. Fixed levels of sea water (143 ml/kg feed, Table 1) and dry salt (0.37% of ration), representing treatments D and E, respectively, were mixed with the basal ration to provide the required 0.15% Na (NRC, 1971).

Preparation of feed mixtures

Starter (for ages 1-4 wks) and grower (for ages 5-8 wks) rations were formulated according to the chicks' requirements for crude protein,

Table 1. Sea water elemental concentration, requirement per kg feed, and percentage of the requirement supplied.

Element	Concentration[1], mg/l Sea Water	Requirement[2], mg/kg Feed	ml Sea Water/ kg Feed[3]	Percent of Requirement Supplied by 143 ml/kg Feed[4]
Na	10500	1500*	143	100
Ca	400	10000	25000	0.57
P	0.07	7000	1×10^{8}	1.43×10^{-4}
K	380	2000	5263	2.71
Mn	0.002	55	2.75×10^{7}	5.19×10^{-4}
I	0.06	0.35	5833	2.45
Mg	1350	500	370	38.57

Total Salinity = 3.5%; Sea water used contains 35 mg NaCl per ml sea water.

[1]Source: McGraw-Hill Encyclopedia of Science and Technology. Vol. 12, 1977, pp. 128 and 135.

[2]Source: NRC. 1971. Nutrient Requirements of Poultry. *Equivalent to 0.37% NaCl in the diet.

[3]Sea water (ml) needed to meet requirements for each mineral per kg feed (Column 3 / Column 2) x 1000 ml per liter.

$$\frac{\text{mg/kg feed}}{\text{mg/l sea water}} = \frac{\text{liter sea water}}{\text{kg dry feed}} \times \frac{1000\ \text{ml}}{1\ \text{l}} = \frac{\text{ml sea water}}{\text{kg dry feed}}$$

[4]Including sea water in the ration at 143 ml/kg feed supplies 100% of the Na requirement and 38.57% of the Mg requirement. NRC (1971) does not list the requirement for Cl, but based on requirements of Cl for other species, it is expected that this level of sea water would be slightly but safely in excess of the requirement.

metabolizable energy, Ca and P given in the Nutrient Requirements for Poultry (NRC, 1971). Except for meat and bone meal, the ingredients used were of plant origin which were generally low in Na and Cl contents. The Na contribution of feed ingredients used, however, totalled to about 0.15% for both the starter and grower rations (Table 2). Mixing of ration ingredients was done manually and weekly allowances for each treatment were placed in bags.

Management of the birds

As environmental temperature was cold, brooding was done from the first day through the third week using kerosene lamps lighted at 1700 hr until 0700 hr the following day. Beddings made of empty cement bags or nylon sacks were changed everyday. Nylon sacks were also placed around the experimental area to minimize draft.

The chicks were fed *ad libitum*, twice daily through week 6, after which, they were fed three times daily. Feed was given dry to all treatment groups

Table 2. Nutrient composition of the starter and grower rations.

Ingredients	% Na Content	Percent in the Ration	
		Starter Ration	Grower Ration
Copra meal	-	30.36	-
Soybean oil meal	0.19	9.34	7.86
Meat and bone meal	0.72	18.48	15.73
Ipil-ipil leaf meal	0.01	5.00	5.00
Corn grits	0.01	30.37	35.43
Corn germ meal	0.04	-	11.81
Rice bran	0.07	-	23.62
Afsilin (vit-min premix)	-	0.55	0.55
Crude protein (%)		23.00	20.00
Metabolizable energy (kcal/kg)		2076.00	2183.30
Ca (%)		2.05	1.83
P (%)		1.14	1.16
Na (%)		0.15	0.15
Cl (%)		0.15	0.16
Price per kg mix, ₱		1.85	1.71

except D, in which sea water was mixed with the ration at the time of feeding. Mesh wires were placed over bamboo feed troughs to minimize feed waste through scratching. Fresh water was given *ad libitum* daily to all treatment groups.

Water-soluble Terramycin (Pfizer) or Terra-vite (Univet, United Laboratories, Inc.) were given at 10 ml per 4 L of drinking water to enhance the resistance of birds against stress and infection. These vitamin-antibiotic supplements were provided from the start to the end of the experiment.

RESULTS AND DISCUSSION

Intake, weight gain, and feed efficiency

As shown in Table 3, cumulative feed consumption, weight gain, and feed conversion efficiency of broilers were not significantly affected by the levels of supplemental salt, either in solid (dry salt) or in liquid (sea water) form, whether mixed in the ration at the required level or offered separately *ad libitum*.

Table 3. Monthly cumulative feed intake, weight gain, and feed conversion efficiency of birds given salt by different methods.

Treatments and Periods	Feed Intake (g)	Weight Gain (g)	Feed Efficiency
Cumulative over one-month period			
A - Control	1008	359	2.83
B - Sea water, *ad libitum*	1011	379	2.68
C - Dry salt, *ad libitum*	1016	379	2.68
D - Sea water, fixed	1093	391	2.82
E - Dry salt, fixed	1019	386	2.44
Cumulative over two-month period			
A - Control	3797	1246	3.05
B - Sea water, *ad libitum*	3847	1292	2.98
C - Dry salt, *ad libitum*	3820	1247	3.06
D - Sea water, fixed	3782	1236	3.08
E - Dry salt, fixed	3848	1260	3.06

The result on feed consumption was consistent with the statement of Ewing (1963) that intake is not appreciably influenced by salt levels in amounts from 0-10%. Similarly, North (1978) did not find support to some poultrymen's belief that the use of salt increases the palatability of the ration, thus increasing feed consumption.

Without impairment in the normal digestion, absorption, and assimilation of feed nutrients by the birds, weight gain is positively correlated to feed intake. In effect the slight differences in weight gain among treatment groups were attributed to the slight differences in their respective feed consumption.

Voluntary salt consumption

It was observed that the sea water consumed was only about 85% of the requirement while that of dry salt was almost double the NRC (1971) recommendation of 0.37% to meet the Na requirement of 0.15% of total feed intake (Table 4).

These results coincided with the conclusions of Sellye (1943) and Mohanty and West (1969) that fowls are extremely sensitive to comparatively small doses of NaCl in the drinking water, but have greater tolerance to dry salt either mixed in the feed or offered free choice.

The figures of actual sea water and dry salt consumption were obtained based on the assumption that the dietary ingredients used do not contain Na. The overall Na content was at 0.15% for each of the starter and grower diets. As a result even though the sea water consumption of the birds in treatment B was low, total Na intake (from sea water plus feed) was well beyond the requirement. Birds in treatment C had actual salt intake beyond 0.37% of the feed consumed.

Table 4. *Ad libitum* sea water and dry salt consumption of treatments B and C, respectively, as percent of requirement and of feed consumed.

Measures	Method of salt supplementation	
	Sea water (ml)	Dry salt (g)
Actual consumption	467.3	27.6
Required consumption	549.6	14.1
Actual (% of required)	85.0	194.6
Requirement (% of feed consumed)	14.3	0.37
Actual (% of feed consumed)	12.1	0.72

Mortality-morbidity percentage

The mortality-morbidity rate among treatment groups was significantly affected by the treatments applied and was highest in birds receiving *ad libitum* sea water (Table 5). This conclusion was based on the assumption that sickness and death rate, if unaffected by the method of salt supplementation, should be normally distributed and not significantly different from the control birds mortality-morbidity rate. However, this hypothesis is rejected with degree of certainty [computed $x^2 = 100.74$; $x^2(4,0.01) = 13.28$], indicating a clear overall treatment effect. Comparison of tabular chi-square at 1% level of significance (6.63) to the computed for individual treatment showed that mortality-morbidity of treatment E birds was not significantly different from the control, whereas other treatments showed highly significant differences from the control.

Morbid birds showed pale mucous membranes, ruffled feathers, loss of appetite, wet and watery feces, muscular weakness (inability to walk), and respiratory distress (as indicated by gasping for air). Observed lesions in dead birds from *ad libitum* sea water group were enlargement of the heart and liver with extremely red coloration. Hemorrhages in the gastro-intestinal tract (hemorrhagic enteritis), mucous in the proventriculus, and redness of the abdomen and kidneys were also observed. These clinical and pathological observations were similar to those attributed to salt poisoning reported by Mohanty and West (1969), Krista*et al.* (1961), and Biester and Schwarte (1965). Considering the NaCl contributed by the dietary ingredients, this result is closely related to the findings of Robbles and Clandinin (1961) that the high level of Na^+ salt in the water offered separately was toxic when offered simultaneously with a low level of NaCl in the diet.

Table 5. Average mortality-morbidity percentage of birds given salt by different methods.

Treatments	Total No. of Birds[1]	Mortality (%)	Morbidity (%)	Mortality-Morbidity (%)
A - Control	20	5.00	0	5.00
B - Sea Water, *ad libitum*	19	15.79	5.26	21.05
C - Dry Salt, *ad libitum*	16	0	12.50	12.50
D - Sea Water, fixed	16	6.25	12.50	18.75
E - Dry Salt, fixed	17	5.88	0	5.88

[1]Number of birds for treatments other than the control group were less than 20 (initial) since early deaths not due to treatment effects were excluded.

Table 6. Average feed cost per kg broiler and return above feed and chick cost of birds given salt by different methods.

Treatments	Feed Cost Per Kg Body Weight (₱)	Return Above Feed and Chick Cost (₱)
A - Control	5.26	8.21
B - Sea Water, *ad libitum*	5.14	8.70
C - Dry Salt, *ad libitum*	5.31	8.08
D - Sea Water, fixed	5.30	7.98
E - Dry Salt, fixed	5.28	8.19

Cost-benefit analysis

The feed cost per kilogram of broiler produced and return above feed and chick cost were not significantly affected by the treatments (Table 6).

This may be expected as there were no significant differences among treatments in feed consumption and weight gain, and ration prices did not differ greatly due to salt additions since amount required was negligible and the cost was low. Considering the present price of salt, however, it may be more economical to use sea water than dry salt, especially those engaged in broiler production along the sea coast.

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