METABOLISM AND NUTRITION

The Utilization of Sodium in Sodium Zeolite A by Broilers[1]

R. FETHIERE, R. D. MILES,[2] and R. H. HARMS

Institute of Food and Agricultural Sciences, Department of Poultry Science, P.O. Box 110930, University of Florida, Gainesville, Florida 32611-0930

ABSTRACT Two identical experiments were conducted with 1-d-old broiler chicks to determine whether the Na in sodium zeolite A (SZA) was utilizable. Three male and three female chicks were randomly assigned to each of eight replicate pens per treatment. A corn-soybean meal basal diet was formulated to contain supplemental levels of 0, .02, .04, .06, .08, and .16% Na from either SZA or NaCl. The diets were isocaloric and isonitrogenous. The Cl level within each dietary Na level was kept constant. Feed and deionized water were offered for *ad libitum* consumption throughout each 21-d experiment.

In both experiments, broiler body weight was increased with each addition of Na from either NaCl or SZA. In Experiment 1, the addition of Na, whether from NaCl or SZA, resulted in an improvement in feed consumption and feed conversion compared with birds fed the control diet. In Experiment 2, body weights of birds fed .04 to .08% Na from SZA were heavier than those fed the same levels from NaCl. Overall the addition of Na from SZA or NaCl resulted in an improvement in body weight, increased feed consumption, and improved feed conversion. Data from these experiments indicated that the Na in SZA was able to be utilized by broilers as efficiently as the Na from NaCl.

(*Key words*: sodium zeolite A, sodium availability, broiler, growth, feed efficiency)

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INTRODUCTION

Sodium zeolite A (SZA)[3] is a synthetic aluminosilicate with a crystalline lattice structure having a large surface area and pore value occupied by exchangeable Na ions and water (Pond and Mumpton, 1984). The SZA contains 12.6% Na; and Ca, Zn, Mg, K, and other biologically significant cations are known to exchange readily with the Na associated with SZA (Breck, 1974). Several studies have been conducted using SZA with laying hens, broiler breeders, and broilers to determine its influence on eggshell quality, egg production, growth, mineral balance, bone strength, and feed efficiency (Roland *et al.*, 1985; Edwards, 1986, 1987; Miles *et al.*, 1986; Ingram *et al.*, 1987; Harris *et al.*, 1988; Roland and Dorr, 1989; Frost *et al.*, 1992). In these studies some investigators have taken the Na furnished from SZA into consideration and adjusted their feed formulas accordingly, whereas others have not considered the Na from SZA. No experiments have been conducted to verify whether or not the Na in SZA is able to be utilized. Therefore, the experiments reported herein were conducted to determine whether broilers could utilize the Na in SZA when compared with the Na furnished by NaCl.

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[2]To whom correspondence should be addressed.

[3]Sodium zeolite A (Ethacal® feed component) is a product of the Ethyl Corp., Baton Rouge, LA 70801.

MATERIALS AND METHODS

In each of two experiments, 1-d-old Cobb, feather-sexed broiler chicks were housed in electrically heated battery brooders.[4] Chicks were maintained on a 24-h constant light schedule in a temperature-controlled room. Three male and three female chicks were placed in each of eight replicate pens per treatment. Feed and deionized water were offered for *ad libitum* consumption to all chicks during the entire 21-d experimental period. A corn-soybean meal basal diet was used (Table 1). Sodium levels of 0, .02, .04, .06, .08, and .16% were provided by NaCl or SZA. The calculated Na level in the supplemental basal diet was .02% (NRC, 1984). Hydrochloric acid was included in the diets containing SZA to keep the Cl level constant within each Na level. All experimental diets were isocaloric and isonitrogenous. At 21 d of age all chicks were individually weighed. Total pen feed consumption was determined.

Data from both experiments were analyzed using the General Linear Models (GLM) procedure of the SAS Institute (1985). Those data are presented as separate experiments because the treatment by experiment interaction was significant. Data were then analyzed by two-way ANOVA with the main effects of the Na source and Na level and their interaction. Multiple linear regression was done with GLM using either body weight or feed consumption as the dependent variable and total milligrams of Na intake for 21 d as the independent variable. Slope ratios and their standard errors were calculated as described by Finney (1978).

RESULTS AND DISCUSSION

Experiment 1

Body weight increased ($P \leq .0001$) with addition of Na from NaCl or SZA (Table 2). This increase in body weight agreed with data published by Damron *et al.* (1986). These authors fed various Na levels from either NaCl or $NaHCO_3$ and reported improvements in body weight and feed conversion with each Na source up to 588 ppm supplemental Na. There was a Na source by level interaction ($P \leq .0001$) in which birds fed lower levels of Na as SZA were heavier than those fed NaCl, but this difference decreased as dietary Na reached .08%. The multiple linear regression equation calculated was

$$\begin{aligned} \text{Body weight} &= 201 + (.308 \pm .022)\,\text{NaCl} \\ &\quad + (.331 \pm .022)\ \text{SZA}; \\ R^2 &= .78;\ \text{SD} = 92; \end{aligned}$$

where body weight was in grams and the regression coefficients were expressed as total milligrams of Na intake for 21 d. The relative bioavailability value of SZA compared with NaCl was 107 ± 7.8%. There was also an interaction ($P \leq .0001$) on feed consumption in which birds fed SZA consumed significantly more feed at the three lowest supplemental Na levels than those fed NaCl. The addition of Na whether from NaCl or SZA resulted in an improvement ($P \leq .0001$) in feed consumption compared with birds fed the control diet. A relative bioavailability value of 111 ± 9.5% for SZA compared to NaCl was calculated from the equation

TABLE 1. Composition of basal diet

Ingredients and analysis[1]	Percentage
Ground yellow corn	54.55
Soybean meal (dehulled) (48.5% CP)	37.00
Dicalcium phosphate	1.70
Ground limestone	1.00
Microingredients[2]	.50
DL-methionine	.25
Corn oil	2.50
Variables[3]	2.50
Total	100.00
Calculated analysis[4]	
CP	22.80
ME, kcal/kg	2,950.00
Calcium	.85
Total phosphorus	.65

[1]As-fed basis.

[2]Ingredients supplied per kilogram of diet: vitamin A palmitate, 6,600 IU; cholecalciferol, 2,200 ICU; menadione dimethylpyrimidinol bisulfite, 2.2 mg; riboflavin, 4.4 mg; pantothenic acid, 13 mg; niacin, 40 mg; choline chloride, 500 mg; vitamin B_{12}, .022 mg; ethoxyquin, 125 mg; Mn, 60 mg; Fe, 50 mg; Cu, 6 mg; Zn, 36 mg.

[3]Variables consisted of white, washed builder's sand, sodium chloride, or sodium zeolite A in proportions specified in the dietary treatment.

[4]According to values in NRC (1984).

[4]Petersime Incubator Co., Gettysburg, OH 45328.

$$\text{Feed consumption} = 396 + (.356 \pm .030)\,\text{NaCl} + (.398 \pm .029)\ \text{SZA};$$
$$R^2 = .72;\ SD = 125;$$

where feed consumption was in grams and regression coefficients were expressed as total milligrams of Na intake for 21 d. Supplementation of Na as either source improved ($P \leq .0001$) feed conversion. There was an interaction ($P \leq .002$) on feed conversion in which birds fed SZA had poorer conversion than those fed NaCl at .02% added Na, but improved with subsequent additions.

Experiment 2

Similar results were obtained in this experiment as were observed in Experiment 1. Body weights of birds fed .04 to .08% Na from SZA were heavier ($P \leq .0001$) than those fed the same Na levels from NaCl but not those fed .02 or .16% (Table 3). This improvement in body weight was accompanied by an improvement ($P \leq .0046$) in feed consumption. The addition of Na from SZA or NaCl resulted in an overall improvement in body weight, increased feed consumption, and improved feed conversion. Regression equations were

$$\text{Body weight} = 211 + (.292 \pm .021)\,\text{NaCl} + (.301 \pm .021)\ \text{SZA};$$
$$R^2 = .77;\ SD = 94;$$
and
$$\text{Feed consumption} = 449 + (.357 \pm .031)\,\text{NaCl} + (.381 \pm .032)\ \text{SZA};$$
$$R^2 = .69;\ SD = 141;$$

where body weight and feed consumption were in grams and regression coefficients were expressed as total milligrams of Na intake for 21 d. The slope ratios resulted in relative bioavailability values for SZA compared with NaCl of 103 ± 7.6 and 107 ± 9.4% for body weight and feed consumption, respectively. The overall availability from both experiments was 107% for SZA relative to NaCl. Thus, the Na in SZA was utilized by the chick as well as that from NaCl.

Several sodium containing mineral compounds, sodium sulfate, sodium bicarbonate, and sodium acetate, have been subjected to Na availability assays by Damron (1982) in a low-Na diet. In these experiments the test sources each supplied 393 ppm (.04%), and the Na was found to be

TABLE 2. Performance of broiler chicks fed five sodium levels furnished by NaCl or sodium zeolite A (SZA), Experiment 1

Na source	Na level[1]	Body weight	Feed consumption[2]	Feed conversion
	(%)	(g)	(g)	(g:g)
Control	0	89	195	2.20
NaCl	.02	165	329	1.99
	.04	289	543	1.88
	.06	430	672	1.56
	.08	556	808	1.45
	.16	642	892	1.39
SZA	.02	216	433	2.10
	.04	383	656	1.71
	.06	555	827	1.49
	.08	595	850	1.43
	.16	625	897	1.44
Pooled SE		3.0	4.5	.01
ANOVA	Probability			
Na source		.0001	.0001	.0297
Na level		.0001	.0001	.0001
Source × level		.0001	.0001	.0020

[1]Basal diet contained .02% Na.

[2]Expressed as grams of total mean feed consumption for 21 d.

TABLE 3. Performance of broiler chicks fed five sodium levels furnished by NaCl or sodium zeolite A (SZA), Experiment 2

Na source	Na level[1]	Body weight	Feed consumption[2]	Feed conversion
	(%)	(g)	(g)	(g:g)
Control	0	97	224	2.30
NaCl	.02	218	443	2.07
	.04	327	643	1.97
	.06	459	777	1.70
	.08	594	902	1.52
	.16	670	995	1.49
SZA	.02	197	445	2.26
	.04	393	715	1.83
	.06	522	873	1.67
	.08	617	954	1.55
	.16	603	920	1.53
Pooled SE		4.4	7.2	.02
ANOVA		Probability		
Na source		.1726	.0542	.5566
Na level		.0001	.0001	.0001
Source × level		.0001	.0046	.0337

[1]Basal diet contained .02% Na.

[2]Expressed as grams total mean feed consumption for 21 d.

as utilizable as that from NaCl. Normally, these compounds as well as SZA are not supplemented to the diet for the sole purpose of supplying Na. However, when the availability of the Na is known, nutritionists should consider this Na in their feed formulations. When using SZA in the diet of broilers the Na in SZA should be considered to be utilized as efficiently as the Na from NaCl.

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