

PHYSIOLOGICAL RESPONSES OF BROILERS TO DIETARY SODIUM BICARBONATE DURING SUMMER SEASON

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SUMMARY

One-hundred and eighty one-day old Arbor Acres broiler chicks in six groups each of 30 birds were fed diets containing either sodium chloride or sodium bicarbonate. Each sodium source was supplemented at three levels of 0.2, 0.3 and 0.45 g sodium /100 g dry matter. Average environmental temperature was 32.5°C during the experimental period at summer season.

Feeding sodium bicarbonate in comparison with sodium chloride increased average body weight ($P < 0.05$), feed intake, water consumption ($P < 0.05$), plasma sodium concentrations, improved feed conversion and maintained body temperature and plasma potassium concentrations.

The high level of supplementary sodium (0.45%) from sodium chloride in comparison with the low (0.2%) or medium (0.3) level increased body weight ($P < 0.05$), feed intake, water consumption ($P < 0.05$) and plasma sodium concentrations but decreased body temperature, respiration rate, plasma potassium concentration and pH of digesta from crop, small and large intestine.

No mortality was observed in groups fed supplementary sodium bicarbonate and as well as the group fed 0.45% sodium from sodium chloride. However, groups fed 0.2% and 0.30% sodium from sodium chloride showed mortality of 10% and 6.7%, respectively.

Keywords: Broiler, sodium bicarbonate, sodium chloride

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INTRODUCTION

High mortality, depressed appetite and slower growth because of high environmental temperature (Dale and Fuller, 1980) remain the most constraints for broiler production in tropics. In hot environments, birds are subjected to alkalosis as a result of PCO_2 loss during panting. Substantial research and efforts have been directed toward alleviating the effect of high temperature through chemical manipulation of the blood acid-base balance. Teeter *et al.* (1985) used dietary ammonium chloride as a potential blood acidifier and sodium bicarbonate as a source of bicarbonate.

Sodium bicarbonate rather in drinking water (Bottje and Harrison, 1985a), in feed (Damron *et al.*, 1986) or infusion in the crop (Bottje and Harrison, 1985b) was reported to increase weight gain, feed intake, feed efficiency and decreased mortality of broiler chickens during heat exposure.

The objective of the present study was to evaluate the response of broiler chicks during summer season to low and high levels of dietary sodium from sodium chloride or sodium bicarbonate.

MATERIALS AND METHODS

One hundred and eighty one-day old Arbor Acres broiler chicks were randomly distributed into six groups, each of 30 birds. Chicks were housed in floor pens on rice straw litter. The experiment was carried out during summer season under ambient temperature averaged $32.5^{\circ}C$ during the six-week experimental period. Birds were exposed to continuous lighting.

Diets provided three supplemental sodium levels of 0.2, 0.3 and 0.45 percentage of diet on dry matter basis from 0.5, 0.76 and 1.14% sodium chloride or from 0.7, 1.1 and 1.65 sodium bicarbonate.

Feed and distilled water were free choice offered. Diets were formulated according to the NRC (1984) allowances to contain 32.5 % soybean meal, 57% yellow corn and 10% concentrates. Chemical composition of the experimental diets is presented in Table 1.

Individual live body weight and group feed intake were weekly recorded during the entire experimental period. However, group water consumption was daily recorded for

experimental groups. Moreover, low and medium supplementary levels of sodium was associated with better feed conversion. Teeter *et al.* (1985) found that addition of 0.5% dietary sodium bicarbonate increased growth rate by about 9%.

Table 2. Effect of dietary sodium source and level on final body weight, feed intake, feed conversion and water intake of broiler chicks

Sodium level (%)	Final body weight (g)	Feed intake (g/bird/day)	Feed conversion (feed/gain)	Water intake (ml/bird/hr)
NaCl				
0.20	1277 ^b	64.67	2.188	14.07 ^b
0.30	1247 ^b	64.78	2.195	14.53 ^b
0.45	1380 ^a	70.47	2.200	17.07 ^a
NaHCO				
0.20	1413 ^a	68.22	2.082	15.36 ^b
0.30	1438 ^a	68.86	2.063	17.50 ^a
0.45	1393 ^a	70.52	2.183	18.76 ^a
SE	34	17.73		1.06

a, b Means within a column with different superscripts differ ($P < 0.05$).

Moreover, Bottje and Harrison (1985a) observed better growth and feed conversion by broilers drank carbonated water under chronic heat stress condition. Improvements in feed intake and feed conversion of broiler chicks associated with high dietary sodium level up to 0.3% was also reported by Damron *et al.* (1986), Miles *et al.* (1993), Mills *et al.* (1993) and Fethiere *et al.* (1994).

Increasing dietary sodium level increased water intake (ml/bird/hr). No significant differences in water intake was found between sodium chloride and bicarbonate either at the low or high supplementary levels. However, higher ($P < 0.05$) water intake was associated with feeding diet supplemented with medium level (0.30%) sodium from sodium bicarbonate rather than that with sodium chloride (Table 2). An increase of 20% in drinking water was recorded for birds fed sodium bicarbonate diets (Damron *et al.*, 1986) or for those given water containing 0.63% sodium bicarbonate (Branton *et al.*, 1986). The significance of water consumption for broilers under hot environmental condition is that high water consumption limits broiler survival. Branton *et al.* (1986) found a

positive correlation ($r=0.72$) between bird survivability and water consumption.

Body temperature decreased as the supplementary sodium level increased and body temperature of birds fed bicarbonate was slightly lower than those fed sodium chloride. Lowest ($P<0.05$) body temperature was observed for birds fed the high level of sodium bicarbonate (Table 3). The decrease in body temperature associated with the high water intake by birds fed high sodium diets might be due to that water acts as a heat sink to reduce body temperature (Smith and Teeter (1987)).

Table 3. Effect of dietary sodium source and level on body temperature (C), respiration rate (per minute), mortality and blood plasma sodium and potassium (meq./L) of broiler chicks

Item	Na source	Sodium chloride			Sodium bicarbonate			SEM
	Na,%	0.2	0.3	0.45	0.2	0.3	0.45	
Body temperature		42.07a	41.99ab	41.82ab	42.03a	41.89ab	41.64b	0.12
Respiration rate		61.80	54.50	52.05	57.55	52.10	51.60	2.70
Plasma Na		170.24	207.40	195.87	174.40	209.32	209.32	15.32
Plasma K		7.10	6.73	6.61	6.61	6.99	7.36	0.76
Mortality,%		10.00	6.70	0.00	0.00	0.00	0.00	

a, b

Means within a row with different superscripts differ ($P<0.05$).

Increasing supplementary sodium level either from chloride or bicarbonate increased plasma sodium but slightly decreased plasma potassium concentrations of groups fed sodium chloride supplemented diets (Table 3). Cohen and Hurwitz (1974) reported a reduction in plasma potassium by feeding diets supplemented with high levels of sodium chloride. On the other hand plasma potassium concentration slightly increased or had not been affected by increasing dietary sodium bicarbonate levels. This might be related that bicarbonate would provide a source of hydrogen which is positively correlated with plasma potassium (Ganong, 1993).

Mortality rate was null in sodium bicarbonate groups as well as the high (0.45%) sodium chloride group. However, high mortality as 10.0 and 6.7% was recorded for the low and medium sodium chloride groups, respectively. This

might be due to that bicarbonate provided sodium, carbon dioxide and hydrogen which could result in partial correction in the acid-base balance (Bottje *et al.*, 1983). The null mortality of the high NaCl-group (0.45%) might be due to the higher water intake and low body temperature of birds in this group in comparison with those in low and medium sodium chloride groups (Smith and Teeter, 1987).

Respiration rate had not significantly influenced by sodium source or level averaging 56.12 for chicks fed sodium chloride and 53.75 for those fed sodium bicarbonate. The relative low respiration rates by birds fed sodium bicarbonate supplemented diets might decrease the depletion of carbon dioxide preventing the respiratory alkalosis. The low respiration rate could be also an indication for adaptation to stress of hot environment (Bottje and Harrison, 1985b and Branton *et al.*, 1986).

Digesta pH of small intestine significantly decreased as the supplementary sodium level increased from sodium chloride but the decrease was not significant in case of sodium bicarbonate. No significant differences due to sodium source or level on the digesta pH of crop or large intestine were detected.

It could be recommended to add sodium from sodium bicarbonate to broiler diets during summer season to improve body weight, feed intake and feed conversion, reduce mortality rate and maintain plasma potassium concentration, body temperature and respiration rate.

Table 4. Effect of dietary sodium source and level on digesta pH of broiler chicks

Item	Na source	Sodium chloride			Sodium bicarbonate			SEM
	Na, %	0.2	0.3	0.45	0.2	0.3	0.45	
Crop		6.28	6.22	5.84	5.82	5.88	6.04	0.19
Small intestine		6.64a	6.56ab	6.02b	6.18ab	6.04b	6.04b	0.18
Large intestine		6.70	6.36	6.16	6.44	6.34	6.44	0.19

a, b

Means within a row with different superscripts differ ($P < 0.05$).

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الإستجابة الفسيولوجية لدجاج التسمين المغذى على بيكربونات الصوديوم خلال فصل الصيف

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أجريت هذا الدراسة على عدد ١٨٠ كتكوت تسمين (أربر ايكرز). قسمت الكتاكيت عشوائيا الى ٦ مجاميع (٣٠ طائر فى كل مجموعة) • أضيف الى علائق ثلاث مجاميع كلوريد الصوديوم والثلاث الأخرى بيكربونات الصوديوم وكان مستوى الصوديوم فى كل مصدر كالآتى ٠,٢، ٠,٣، ٠,٤٥ جم صوديوم / ١٠٠ جم مادة جافة وكانت متوسط درجة حرارة البيئة ٣٢,٥°م خلال فترة التجربة فى فصل الصيف •

بمقارنة المجاميع المغذاه على كلوريد الصوديوم مع المغذاه على بيكربونات الصوديوم وجد أن التغذية على البيكربونات أدت إلى زيادة معنوية فى وزن الجسم كما زادت كمية الغذاء المأكول وكمية المياه التى يتناولها الطائر وحسنت من معدل الإستفادة من الغذاء. ارتفع تركيز الصوديوم فى البلازما وحافظت الطيور على درجة حرارة جسمها وتركيز البوتاسيم فى البلازما.

المستوى العالى من الصوديوم (٠,٤٥) فى حالة الطيور المغذاه على كلوريد الصوديوم أدى إلى زيادة معنوية فى وزن الجسم وزاد الغذاء المأكول وكمية مياه الشرب كما ارتفع مستوى الصوديوم فى البلازما وإنخفضت درجة حرارة الجسم ومعدل التنفس فى الطيور عن تلك المغذاه على مستوى منخفض (٠,٢%) أو متوسط (٠,٣%) من الصوديوم كما إنخفض تركيز البوتاسيم فى البلازما وتركيز أيون الهيدروجين فى محتويات الحوصلة والأمعاء الدقيقة والغليظة.

لم يحدث نفوق فى المجاميع المغذاه على بيكربونات الصوديوم أو المجموعة ذات مستوى الصوديوم العالى (٠,٤٥%) من كلوريد الصوديوم. بينما بالنسبة لمستوى الصوديوم المنخفض (٠,٢%) والمتوسط (٠,٣%) من كلوريد الصوديوم كانت نسبة النفوق ١٠%، ٦,٧٢% على التوالى.