

## **EFFECT OF DIFFERENT DIETARY LEVELS OF NaCl ON THE PERFORMANCE OF BROILER CHICKENS FED PRACTICAL AND PLANT DIETS**

By

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Received: **08/10/2009**

Accepted: **14/11/2009**

**Abstract:** *Two experiments were conducted to study the effect of the addition of graded levels of sodium chloride (NaCl) in practical and plant diets on performance and mineral status of broiler chickens. The 1<sup>st</sup> experiment was conducted to study the response of broiler chicks fed practical diets containing 0.14 Na level to supplement NaCl at 0.3 and 0.5 above recommended Na levels. Thus, NaCl levels were 0, 0.3 and/ or 0.5% (0.14, 0.26 and 0.34 Na, respectively). A total of fifty four unsexed one day-old Arbor-Acers broiler chickens were distributed into 3 dietary treatments of three replicate with 6 chickens each. The 2<sup>nd</sup> experiment was conducted to study the effect of adding various NaCl levels to plant diet which are not supplemented with NaCl level 0, 0.3 or 0.5% NaCl (0.03, 0.14 and 0.22 Na, respectively). A total of fifty four unsexed one day-old Arbor-Acers broiler chickens were distributed among 3 dietary treatments of three replicate of 6 unsexed chickens each. Chicks were fed the experimental diets ad-libitum from 3 to 56 days of age.*

*Results of the 1<sup>st</sup> experiment indicated that for the whole experimental periods, (3 to 56 d) FI was insignificantly affected, but with a significant FCR improvement by 12.5% at 0.5% NaCl (0.34% Na). No significant differences due to NaCl supplementation were shown on dressing, breast, thigh, heart, liver, kidney, pancreas, spleen, and gizzard percentage. Also, shearing force, bone breaking strength and plasticity were not affected by dietary treatments.*

*The 2<sup>nd</sup> experiment results indicated that, the optimum growth FI and the best FCR were recorded by broiler chickens fed diet supplemented with*

0.3% NaCl (0.14% Na). The highest dressing and breast meat percentages were observed of chickens fed diet containing 0.3% NaCl (0.14% Na) and 0.5% NaCl (0.22% Na). Shearing force, plasticity and bone breaking strength were not significant affected by NaCl supplementation.

*These results are suggested that supplement broiler chick plant diets (0.5% NaCl) and practical diet (0.3 and 0.5% NaCl) is sufficient to cover broiler requirements of Na and maintain maximum broiler performance.*

## INTRODUCTION

Mineral elements have been recognized for many years as essential dietary nutrients for domestic animals. There are 22 mineral elements that were believed to be essential for the forms of animal life (Underwood and Suttle, 2001). In most commercial diets salt (NaCl) is the major source of sodium and nearly the sole source of chloride. While, plant-based diets are almost always deficient in both sodium and chloride. The acid-base balance is influenced by a range of internal and external factors, including the diet, environmental conditions, and metabolism (Underwood and Suttle, 2001). Dietary electrolyte balance (**DEB**) manipulations significantly influenced BWG, FCR, AME<sub>n</sub>, digestibility and retention of N, ileal availability of Na and Cl, and total tract retention of Ca, P, Na, and Cl in broiler starters. The highest DEB level of 375 mEq/ kg generally had a negative impact on all assessed criteria, except the availability of Na, and appeared to be excessive, which is in general agreement with the recommendation of Johnson and Karunajeewa (1985) that the DEB of broiler diets should be maintained between 250 and 300 mEq/ kg. The optimum dietary DEB has been reported to be 220 to 270 mEq/ kg for broilers of all ages, with up to 0.40% for Na and 0.15 to 0.30% for Cl (Oviedo-Rondon *et al.*, 2001, Ahmad *et al.*, 2005 and Mushtaq *et al.*, 2005). Murakami *et al.* (2000) reported that Na level of 0.15% was sufficient to maintain maximum body weight, FCR, and tibia ash of male broilers grownup to 56 days. Oviedo-Rondon *et al.* (2001) concluded that the Na and Cl requirements for optimum performance of young broiler chickens were 0.28 and 0.25%, respectively. Mushtaq *et al.* (2007) suggested that the dietary requirements of 0.20 to 0.25% Na and 0.30% Cl during the finisher phase (29 to 42 d) of broiler chickens when the ambient temperature ranged from 32 to 40°C. Ravindran *et al.* (2008) indicated that feed intake was unaffected by DEB levels. Dietary electrolyte balance levels had no effect on the AME<sub>n</sub> and ileal N digestibility to 300 mEq/ kg, but significantly lowered both criteria at 375 mEq/ kg. The digestibilities of amino acids were unaffected when the DEB level was increased from 150 to 225 mEq/ kg of diet, but decreased at

the 300 and 375 mEq/ kg. Murakami *et al.*, (2001) suggested that DEB affects the absorption of monosaccharides and amino acids, and it follows that reduced intestinal uptakes of these nutrients would compromise broiler performance. Mushtaq *et al.*, (2005 and 2007) indicated a negative linear effect of dietary Na on breast yield and of abdominal fat, whereas increasing dietary Cl linearly decreased dressing weights. No significant effects of dietary Na, Cl, or Na x Cl were observed on feed intake, BWG, FCR, water: feed, or mortality. An improvement in litter condition, toe ash, blood parameters, and lowered abdominal fat yield was observed for the diet having 0.30% dietary Na. So, the objective of this experiment was to study the effect of different levels of sodium chloride (**NaCl**) on performance and mineral status of broilers fed practical and plant diets

## **MATERIALS AND METHODS**

### **Experiment 1:**

This experiment was conducted to study the response of broiler chicks fed practical diets containing 0.14 Na levels as supplemented with dietary NaCl levels at 0.3 and 0.5 above recommended (NRC, 1994) Na levels. A total of 54 Arbor Acres unsexed 3-days old broiler chickens were fed experimental diets from 3 to 56 days of age. Broilers were randomly distributed in battery brooders (40×45×60 cm) among 3 dietary treatments of 0, 0.3 and 0.5% NaCl (0.14, 0.26 and 0.34% Na, respectively) with 3 replicates containing 6 chickens each. The basal diet had 0.14 Na, and starter practical diet was formulated to contain 21.7% CP and 3000 kcal ME/ kg feed during the first 4 wks of age, then the finisher diet, (Table 1) was formulated to contain 17.0% CP and 3117.4 kcal ME/kg feed during the period of 4 to 8 wks of age.

### **Experiment 2:**

This experiment was conducted to study the effect of adding dietary NaCl levels to plant diet that doesn't have any NaCl levels. A total of 54 Arbor Acres unsexed 3-days old broiler chickens were fed experimental diets from 3 to 56 days of age. Chicks were randomly distributed in battery brooders similar to those mentioned earlier among 3 dietary treatments of three replicate each containing 6 unsexed chickens each. Dietary treatments included NaCl addition at 0, 0.3 and 0.5% (0.03, 0.14 and 0.22 % Na, respectively; Table 2). Basal starter diets were formulated to contain 21.7% CP and 2933 kcal ME/kg feed during the first 4 wks of age, and finisher diets were formulated to contain 17.5% CP and 3019 kcal ME/ kg feed during the period of 4 to 8 wks of age.

### **General Management:**

Experimental diets and water were offered *ad-libitum* over the entire experimental period. Chicks in all treatments were kept under similar managerial and hygienic conditions. Body weights (**BW**), weight gains (**BWG**), feed intake (**FI**) and feed conversion ratio (**FCR**) were determined every 4 weeks. At the end of each experiment, 3 random chicks from each treatment were slaughtered. Liver, spleen, heart and bursa were removed and weighed. Liver and kidney samples of each treatment were homogenated as a pool of 3 samples for each treatment and were chemically analyzed for macro-elements. Phosphorus was determined calorimetrically by the molybdenum yellow method (AOAC, 1984). Potassium and sodium were determined using the Flame Photometer. Magnesium was determined by using Atomic Absorption Spectrophotometer. Calcium was also determined by using Atomic Absorption Spectrophotometer (Emission mode).

### **Physico-chemical Properties of meat :**

Water holding capacity (**WHC**) and plasticity were measured according to Grau and Hamm (1957) as modified by Volovinskaia and Merkooolova (1958), shearing force was measured by the method of Lyon *et al.* (1985, 1989) as modified by Sams *et al.* (1992). Also, the bone breaking strength was measured following the method of Shafey (1991) and Watkins and Lee Southern (1991).

### **Statistical analysis:**

One way ANOVA of GLM procedure of SAS<sup>®</sup> (2001) software program was conducted for the statistical analysis for each experiment. Mean differences were tested by Duncan's New Multiple Range Test (Duncan, 1955).

## **RESULTS**

Minerals content (Ca, Na and Mg) of drinking water was presented in (Table 3), water quality was in acceptable range for farm animal use. Also Na and K content of basal diets during the growing and finisher periods were 0.14, 0.14, 0.76 and 0.55 in experimental 1 and 0.03, 0.03, 0.92 and 0.74 in experimental 2, respectively. The Na content was lower from the recommended level for broiler chickens (NRC, 1994), even when Na of the drinking water was in consideration.

**Experiment 1:**

Body weights significantly increased ( $P \leq 0.05$ ) as dietary NaCl increased at the end of the growing period (28 days of age), while BWG was insignificantly affected during the same period (3 to 28 days of age). However, at the end of the experimental period both BW and BWG were not affected by different dietary NaCl levels (Table 4). Although, feed intake was insignificantly affected during the growing period (3 to 28 days of age), while FCR was significantly improved ( $P \leq 0.05$ ) with increasing levels of NaCl supplementation. However, a contrary result was observed during the finisher period (28 to 56 days of age), as FCR was insignificantly affected and FI was significantly decreased ( $P \leq 0.05$ ) as NaCl increased. As for the whole experimental period (3 to 56 days of age) FI was insignificantly improved, while better FCR by 12.5% ( $P \leq 0.05$ ) was observed due to 0.5% of NaCl (0.34% Na) supplementation (Table 5).

No significant differences were shown on dressing, breast and thigh percentages due to NaCl supplementation (Table, 6). There were also no significant differences among dietary NaCl levels on heart, liver, kidney, pancreas, spleen, gizzard percentages and intestinal length (Table 6). Physico-chemical properties of meat response to feeding dietary NaCl levels indicated that there were no significant differences on shearing force, WHC, bone breaking strength and plasticity (Table, 7). Liver and kidney Na, K, Ca and Mg were significantly increased ( $P \leq 0.05$ ) by NaCl levels, as broiler diets supplemented with NaCl a gradual increase of liver Na (102 and 115.2%), K (108.6 and 123.8%) and Mg (107.4 and 119.3%) due to 0.3 and 0.5 % NaCl dietary supplementations, respectively. Concerning liver Ca, it was clear that liver Ca content decreased as NaCl supplementation increased (Fig 1). Generally, increasing dietary NaCl levels increased minerals kidney content (Fig 2).

**Experiment 2:**

Body weights, FI and FCR indicated similar trends throughout all experimental periods, since these parameters were significantly ( $P \leq 0.05$ ) affected by dietary NaCl levels. The lowest BW and FI were recorded by broilers fed the control diet without NaCl supplementation. However, the optimum BW and FI were recorded by chicks fed diet supplemented with 0.3% NaCl (0.14 % Na), and similar to the group fed diet containing 0.5% NaCl (0.22% Na; Table 8 and 9). Broiler diets supplementation with NaCl significantly improved ( $P \leq 0.05$ ) FCR. The best FCR (2.47 g./ g.) was recorded for those fed diet supplemented with 0.3% NaCl (0.14 % Na), with no significant differences between 0.3 and 0.5 NaCl levels.

Both dressing and breast meat percentages were significantly increased due to increasing NaCl supplementation, the highest values were observed of chickens fed diet supplemented with 0.3% and 0.5% NaCl (0.14, and 0.22% Na; respectively). On the other hand, thigh meat percentage was not affected by NaCl supplementation. Relative organ weights were insignificantly affected by dietary NaCl, except for pancreas percent which was significantly enlarged ( $P \leq 0.05$ ) due to feeding the un-supplemented (control) diet (Table, 9).

Shearing force, plasticity and bone breaking strength ranged from 136.7 to 173.9, 0.15 to 0.32 and 6.65 to 6.66, respectively, with no significant differences. Bound water (WHC) of chicks fed the control diet or fed diet with 0.5% NaCl (0.22 Na) were statistically similar, although they were significantly lower ( $P \leq 0.05$ ) than those fed diet supplemented with 0.3% NaCl (0.14% Na; Table 10).

Addition of NaCl induced slight increase in the percentage Na, K and Mg content in liver, while Ca content was significantly increased ( $P \leq 0.05$ ) with increasing NaCl supplementation compared with those fed un-supplemented diet (Fig 3). Kidney minerals (K and Mg) were significantly increased ( $P \leq 0.05$ ) with increasing NaCl supplementation as compared to those fed the control diet (Fig 4). Thus, K and Mg as a percentage of the control diet were 105 and 118 % and 110 and 116%, respectively due to 0.3 and 0.5% NaCl supplementation. On the other hand, kidney Na and Ca content significantly increased ( $P \leq 0.05$ ) due to 0.3% NaCl supplementation as compared to those fed the control or 0.5% NaCl.

## DISCUSSION

Results indicate that Na requirement for Arbor Acres broiler fed practical diets (using broiler concentrates) is more than 0.14% and for plant diet is about 0.14% (0.3% NaCl). These results agree with those of El-Deek and Shebl (1988) who reported that chick's response of to NaCl is dependent on the diet type. Also, Murakami *et al.* (2000) reported that Na level of 0.15% was sufficient to maintain maximum BW and FCR of male broilers grown to 56 days. This results under estimated NaCl requirement during the first four week of age and in agreement with other studies. McWard and Scott (1961) showed that the dietary Na requirements of chicks varied from 0.11% in a diet containing isolated soybean protein as a source of protein to 0.2% in a diet containing casein. NRC (1994) recommends Na level from 0.20, 0.15 and 0.12% for birds of 0 to 3, 3 to 6 and from 6 to 8 wk of age, respectively. The optimum Na dietary level was

up to 0.40% and 0.15 to 0.30% for Cl (Oviedo-Rondo'n *et al.*, 2001, Ahmad *et al.*, 2005 and Mushtaq *et al.*, 2005). These results indicated that Na requirement is dependent on the age of birds. Also, Na and Cl are important factors to stimulate feed intake especially during the first weeks of age and this is depended to stimulation of appetite for feed (Edwards, 1984; Britton, 1992). Ovido-Rondo'n *et al.* (2001) showed a quadratic effect of Na levels on BWG and determined that 0.26% Na gave maximum BWG in broiler chicks. Sayed *et al.* (2008) indicated that increasing Na level from 0.20 to 0.30 % insignificantly improved BWG and FCR.

Results of FI during 1<sup>st</sup> experiment indicated that increasing Na level above 0.26% significantly decreased ( $P \leq 0.05$ ) FI during 28 to 56 days of age, while significance disappeared as for the whole experimental period. On the other hand, a significant improvement in FCR ( $P \leq 0.05$ ) was recorded for the whole experimental period due to 0.5% NaCl (0.34% Na) supplementation. Results of the 2<sup>nd</sup> experiment using plant protein diet showed no differences between both of NaCl supplementation levels (0.3%; 0.14% Na and 0.5%; 0.22% Na). However, FCR was slightly increased when NaCl supplementation increased above 0.3% (0.14% Na). Britton (1992) found that FI / bird was low in chicks fed 0.2% dietary NaCl, but FI fluctuated among other levels, FCR was poor of chicks fed 0.2 and 0.4% while, it improved when 0.6, 0.8, 1.0 and 1.2 % dietary NaCl were fed. Curran (1965), Crane (1965) and Lee and Campbell (1983) reported that Na play an essential role in the processes leading to the absorption of sugars and amino acids in the intestine, which could influence tissues and subsequently organs weight. This observation may be clear the reason of pancreas enlargement in the 2<sup>nd</sup> experiment when the Na deficient diet was fed. This could be explained by adapted of chickens to overcome the Na deficiency.

Results indicate no significant differences due to dietary NaCl levels in practical diets on physical characteristics of broiler meat except bound water which was the lowest at the lowest and highest NaCl levels in the 2<sup>nd</sup> experiment. Also, dressing and breast percentages were significantly increased ( $P \leq 0.05$ ) by increasing NaCl during the 2<sup>nd</sup> experiment. Opposite results were reported by Mushtaq *et al.* (2005) that dressing weight was not influenced by dietary Na levels. Also, Sayed *et al.* (2008) indicated that carcasses characteristic were not significantly affected by different levels of Na. Results also indicated that bone breaking strength was not affected by NaCl supplementation during the two experiments. Similarly, Edwards (1984) showed that sodium sulfate supplementation did not affect the tibial dyschondroplasia. Also, Kornegay *et al.* (1991) reported

that Na intake did not consistently influence bone diminution and strength characteristics. On the other hand, Mushtaq *et al.* (2007) found that dietary Na at 0.30% significantly increased toe ash %. Sayed *et al.* (2008) indicated that increasing Na level from 0.20 to 0.30 % significantly reduced dried tibia weight, tibia ash, tibia Ca and P%. Results of the 1<sup>st</sup> experiment showed an increase ( $P \leq 0.05$ ) on liver and kidney Na, K and Mg with increasing NaCl level. Liver Ca showed step down decrease with increasing NaCl supplementation, whereas, kidney Ca showed narrow changes.

In conclusion result indicated that 0.30% NaCl supplementation to practical and plant diets for broiler chicks during the growth period from 3 to 56 day of age was adequate to optimum growth performance and mineral status.

**Table (1):** Composition of practical diets used in the 1<sup>st</sup> experiment

Ingredients, %	Starter diets			Finisher diets		
	NaCl Levels					
	0.0	0.3	0.5	0.0	0.3	0.5
Yellow corn	65.0	65.0	65.0	78.0	78.0	78.0
Soybean meal	25.0	25.0	25.0	12.0	12.0	12.0
Broiler concentrate <sup>1,2</sup>	10.0	10.0	10.0	10.0	10.0	10.0
Salt (NaCl)	0.0	0.3	0.5	0.0	0.3	0.5
Total	100.0	100.3	100.5	100.0	100.3	100.5
Total Na levels	0.14	0.26	0.34	0.14	0.26	0.34
<i>Calculated analysis, %</i>						
ME Kcal/Kg	3000	2989	2980	3117	3117	3106
Crude protein	21.70	21.65	21.57	17.10	17.04	16.96
C/P ratio	138.20	138.20	138.50	182.30	182.90	183.10
Methionine	0.45	0.45	0.45	0.43	0.43	0.43
TSAA	2.54	2.54	2.54	2.43	2.43	2.43
Lysine	1.10	1.10	1.10	1.21	1.21	1.21
Ether extract	3.12	3.12	3.12	3.69	3.69	3.69
Crude fiber	3.03	3.03	3.03	2.51	2.51	2.51
Calcium	0.83	0.83	0.83	0.80	0.80	0.80
Available phosphorus	0.43	0.43	0.43	0.41	0.41	0.41
Potassium	0.76	0.76	0.76	0.55	0.54	0.54
Sodium	0.14	0.26	0.34	0.14	0.26	0.34

<sup>1</sup>Broiler concentrate provides by kg: 2500 Me Kcal/Kg, 52 %CP, 1.5% Methionine, 2.00 TSAA, 2.9% lysine, 7.4 Ca, 3% Available phosphorus, 2% NaCl, 2.3% CF and 4% fat.

<sup>2</sup>Broiler concentrate provides by kg: Vit A, 5500 IU; Vit E, 11 IU; Vit D3, 1100 IU; riboflavin, 4.4 mg; Ca pantothenate, 12 mg; nicotinic acid, 44 mg; choline chloride, 191 mg; vitamin B<sub>12</sub>, 12.1 ug; vitamin B<sub>6</sub>, 2.2mg; thiamine (as thiamine mononitrate), 2.2 mg; folic acid, 0.55 mg; d- biotin, 0.11 mg. Trace mineral (mg /kg diet): Mn, 60; Zn, 50; Fe, 30; Cu, 5; Se, 0.3.

**Table (2):** Composition of plant diets used in the 2<sup>nd</sup> experiment

Ingredients, %	Starter diets			Finisher diets		
	NaCl Levels					
	0.0	0.3	0.5	0.0	0.3	0.5
Yellow corn	55.0	55.0	55.0	65.0	65.0	65.0
Soybean meal	38.0	38.0	38.0	27.0	27.0	27.0
Bone meal	2.5	2.5	2.5	2.70	2.70	2.70
Lime stone	0.5	0.5	0.5	0.47	0.47	0.47
Corn oil	2.55	2.55	2.55	2.50	2.50	2.50
Premix <sup>1</sup>	0.25	0.25	0.25	0.25	0.25	0.25
Salt (NaCl)	0.00	0.30	0.50	0.00	0.30	0.50
DL-Methionine	0.10	0.10	0.10	0.14	0.14	0.14
Sand	1.10	0.80	0.60	1.93	1.63	1.43
Total	100.0	100.0	100.0	99.99	99.99	99.99
Total Na levels	0.03	0.14	0.22	0.03	0.14	0.22
<i>Calculated analysis, %</i>						
ME Kcal/Kg	2933	2933	2933	3019	3019	3019
Crude protein	21.45	21.45	21.45	17.47	17.47	17.47
C/P ratio	136.70	136.70	136.70	172.80	172.80	172.80
Methionine	0.44	0.44	0.44	0.43	0.43	0.43
TSAA	0.77	0.77	0.77	0.71	0.71	0.71
Lysine	1.10	1.24	1.22	1.21	1.21	1.24
Ether extract	3.38	3.38	3.38	2.92	2.92	2.92
Crude fiber	5.03	5.03	5.03	5.27	5.27	5.27
Calcium	0.98	0.98	0.98	0.99	0.99	0.99
Available phosphorus	0.49	0.49	0.49	0.49	0.49	0.49
Potassium	0.92	0.92	0.92	0.74	0.74	0.74
Sodium	0.03	0.14	0.22	0.03	0.14	0.22

<sup>1</sup>Premix provides by kg of it: Vit A, 5500 IU; Vit E, 11 IU; Vit D3, 1100 IU; riboflavin, 4.4 mg; Ca pantothenate, 12 mg; nicotinic acid, 44 mg; choline chloride, 191 mg; vitamin B<sub>12</sub>, 12.1 ug; vitamin B<sub>6</sub>, 2.2mg; thiamine ( as thiamine mononitrate), 2.2 mg; folic acid, 0.55 mg; d- biotin, 0.11 mg. Trace mineral (mg /kg diet): Mn, 60; Zn, 50; Fe, 30; Cu, 5; Se, 0.3.

**Table (3):** Minerals contents\*of water supply of poultry research center

Mineral	Concentrate (mg/l)
Ca	51.70
Na	56.35
Mg	21.17

\* Source El-Seuof water station

**Table (4):** Effect of supplementing practical diets with gradual levels of aCl on body weigh (g) and body weight gain (g) in 1<sup>st</sup> experiment

NaCl level	Body weigh (g)			Body weigh gain (g)		
	3day	28 day	56 day	3-28 days	28-56 days	3-56 day
0.0	48.5	797.3 <sup>b</sup>	1807.2	748.8	1009.9 <sup>b</sup>	1758.7
0.3	48.9	902.4 <sup>a</sup>	1834.1	853.1	931.8 <sup>a</sup>	1784.9
0.5	48.3	886.9 <sup>a</sup>	1855.0	838.2	946.3 <sup>a</sup>	1806.3
SEM	1.05	29.64	59.96	29.43	53.20	59.95

<sup>ab</sup> Means within a column with no common superscript differ significantly ( $P \leq 0.05$ )

**Table (5):** Effect of supplementing practical diets with gradual levels of NaCl on feed intake (g/ period) and feed conversion ratio (g/g) in 1<sup>st</sup> experiment

NaCl level	Feed intake (g)			Feed conversion ratio (g/g)		
	3-28 days	28-56 days	3-56 days	3-28 day	28-56 day	3-56 day
0.0	1493.9	2867.2 <sup>a</sup>	4361.1	1.99 <sup>a</sup>	2.85	2.48 <sup>a</sup>
0.3	1520.8	2868.2 <sup>a</sup>	4389.1	1.78 <sup>ab</sup>	3.11	2.46 <sup>a</sup>
0.5	1366.4	2572.5 <sup>b</sup>	3938.9	1.63 <sup>b</sup>	2.70	2.17 <sup>b</sup>
SEM	59.6	67.1	122.2	0.07	0.15	0.06

<sup>ab</sup> Means within a column with no common superscript differ significantly ( $P \leq 0.05$ )

**Table (6):** Effect of supplementing practical diets with gradual levels of NaCl on carcass characteristics in 1<sup>st</sup> experiment

Parameter, %	NaCl Level			
	0.0	0.3	0.5	SEM
Dressing	70.44	73.50	73.40	2.43
Thigh	22.30	21.55	22.00	1.10
Breast	19.40	19.11	22.72	1.13
Heart	0.51	0.61	0.60	0.07
Liver	2.53	2.06	2.50	0.20
Kidney	0.60	0.63	0.70	0.11
Pancreas	0.30	0.30	0.25	0.03
Spleen	0.20	0.22	0.22	0.03
Gizzard	2.09	2.40	2.30	0.16
Intestinal length (cm)	195.0	180.0	185.0	6.03

**Table (7):** Effect of supplementing practical diets with gradual levels of NaCl on physical characteristic of meat of broiler chicks in 1<sup>st</sup> experiment

Parameter	NaCl Level			
	0.0	0.3	0.5	SEM
Shearing force (kg force/40g)	150.30	176.20	161.50	18.3
Bound Water	99.10	99.00	99.10	0.13
Plasticity	0.19	0.17	0.17	0.02
Bone breaking strength (kg force/kg)	6.69	6.69	6.32	0.18

**Table (8):** Effect of supplementing practical diets with gradual levels of NaCl on body weight (g) and body weight gain (g) in 2<sup>nd</sup> experiment

NaCl level	Body weigh (g)			Body weigh gain (g)		
	3day	28 day	56 day	3-28 day	28-56 day	3-56 day
0.0	48.7	308.0 <sup>b</sup>	493.1 <sup>b</sup>	259.3 <sup>b</sup>	183.0 <sup>b</sup>	444.5 <sup>b</sup>
0.3	48.0	781.6 <sup>a</sup>	1828.3 <sup>a</sup>	733.6 <sup>a</sup>	1046.8 <sup>a</sup>	1780.4 <sup>a</sup>
0.5	48.3	829.8 <sup>a</sup>	1739.4 <sup>a</sup>	781.3 <sup>a</sup>	909.7 <sup>a</sup>	1691.1 <sup>a</sup>
SEM	0.97	20.94	55.61	20.70	48.90	54.50

<sup>ab</sup> Means within a column with no common superscript differ significantly ( $P \leq 0.05$ )

**Table (9):** Effect of supplementing practical diets with gradual levels of NaCl on feed intake (g/period) and feed conversion ratio (g/g) in 2<sup>nd</sup> experiment

NaCl level	Feed intake (g)			Feed conversion ratio (g/g)		
	3-28 days	28-56 days	3-56 day	3-28 day	28-56 day	3-56 day
0.0	1063.6 <sup>b</sup>	1913.9 <sup>b</sup>	2977.5 <sup>b</sup>	4.16 <sup>a</sup>	12.00 <sup>a</sup>	7.04 <sup>a</sup>
0.3	1388.9 <sup>a</sup>	3015.0 <sup>a</sup>	4403.9 <sup>a</sup>	1.89 <sup>b</sup>	2.88 <sup>b</sup>	2.47 <sup>b</sup>
0.5	153.2 <sup>a</sup>	2940.0 <sup>a</sup>	4472.2 <sup>a</sup>	1.96 <sup>b</sup>	3.26 <sup>b</sup>	2.65 <sup>b</sup>
SEM	64.0	81.1	100.4	0.21	1.87	0.69

<sup>ab</sup> Means within a column with no common superscript differ significantly ( $P \leq 0.05$ ).

**Table (10):** Effect of adding gradual levels of NaCl to plant diet on carcass characteristics in the 2<sup>nd</sup> experiment

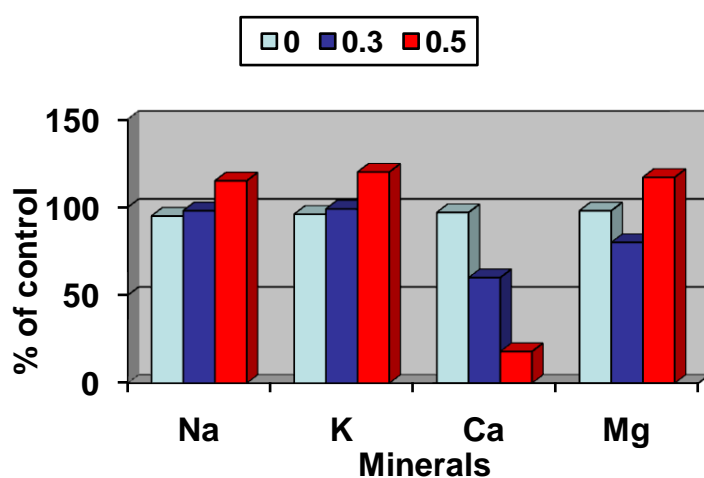
Parameters, %	NaCl Level			
	0.0	0.3	0.5	SEM
Dressing	61.53 <sup>b</sup>	72.72 <sup>a</sup>	72.90 <sup>a</sup>	1.43
Thigh	21.40	22.21	20.60	1.33
Breast	15.60 <sup>b</sup>	21.20 <sup>a</sup>	19.41 <sup>a</sup>	0.66
Heart	0.62	0.50	0.52	0.48
Liver	3.15	2.23	2.44	0.60
Kidney	0.81	0.65	0.74	0.05
Pancreas	0.52 <sup>a</sup>	0.22 <sup>b</sup>	0.32 <sup>b</sup>	0.04
Spleen	0.23	0.20	0.20	0.04
Gizzard	3.20	2.34	2.04	0.40
Intestinal length (cm)	170	176.7	176.7	11.93

<sup>ab</sup> Means within a column with no common superscript differ significantly ( $P \leq 0.05$ )

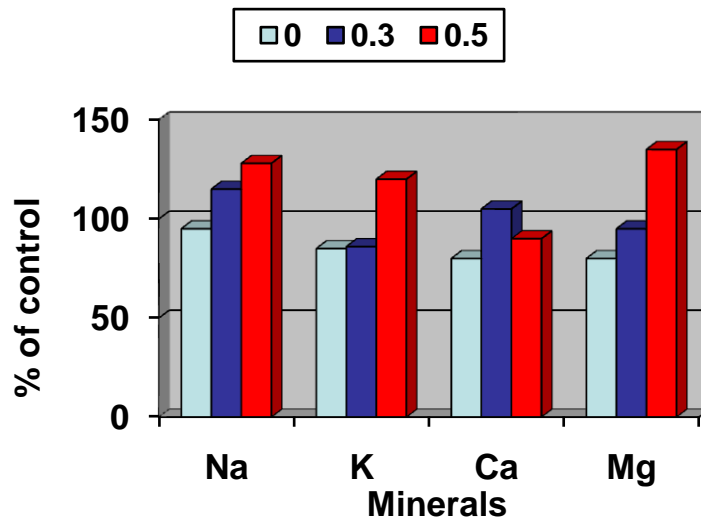
**Table (11):** Effect of adding gradual levels of NaCl to plant diet on physical characteristic of meat of broiler chicks in 2<sup>nd</sup> experiment

Parameters	NaCl Level			
	0.0	0.3	0.5	SEM
Shearing force (kg force/40g)	173.90	136.70	172.80	26.92
Bound Water	98.70 <sup>b</sup>	99.10 <sup>a</sup>	98.80 <sup>b</sup>	0.10
Plasticity	0.15	0.32	0.29	0.06
Bone breaking strength (kg force/kg)	6.65	6.66	6.66	0.03

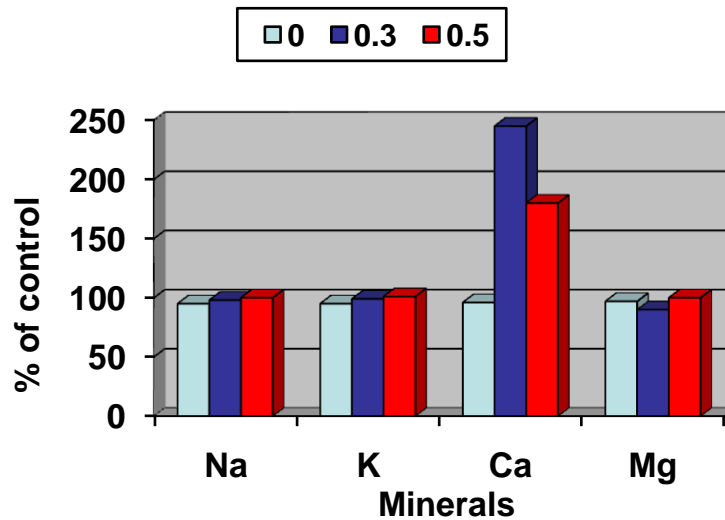
<sup>ab</sup> Means within a column with no common superscript differ significantly ( $P \leq 0.05$ )



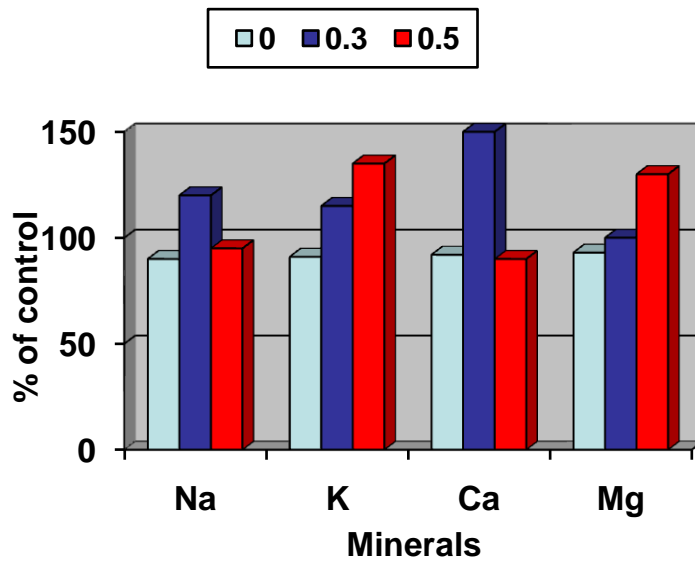
**Figure (1):** Effect of supplementing practical diets with gradual levels of NaCl on average liver sodium, potassium, calcium and magnesium contents of broiler chicks.



**Figure (2):** Effect of supplementing practical diets with gradual levels of NaCl on average kidney sodium, potassium, and calcium and magnesium contents of broiler chickens.



**Figure (3):** Effect of adding gradual levels of NaCl to plant diets on average liver sodium, potassium, calcium and magnesium contents of broiler chickens.



**Figure (4):** Effect of adding gradual levels of NaCL to plant diets on average kidney sodium, potassium, calcium and magnesium contents of broiler chickens.

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## الملخص العربي

### تأثير مستويات مختلفة من كلوريد الصوديوم على أداء كتاكيت اللحم المغذاة على أعلاف تجارية و أعلاف نباتية

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أجريت تجربتان لدراسة تأثير إضافة مستويات متدرجة من كلوريد الصوديوم الى الأعلاف التجارية و الأعلاف النباتية و ذلك على صفات الأداء لكتاكيت اللحم وحالة المعادن.

اجريت التجربة الأولى بهدف دراسة تأثير استجابة كتاكيت اللحم المغذاة على اعلاف تجارية والمحتوية على 0.14% من عنصر الصوديوم عند إضافة كلوريد الصوديوم بنسبة 0.3 و 0.5 % كنسبة أعلى من المقرارات من عنصر الصوديوم. تم توزيع عدد 54 كتكوت عمريوم (اربروايكر) الى ثلاث معاملات غذائية وتتضمن كل معاملة ثلاث مكررات وبكل مكررة 6 كتاكيت. وكانت نسبة كلوريد الصوديوم المضافة هي 0.0 و 0.3 و 0.5% للعلف.

اجريت التجربة الثانية بهدف دراسة تأثير استجابة كتاكيت اللحم عند إضافة مستويات مختلفة من كلوريد الصوديوم الى اعلاف نباتية لاحتوى على كلوريد الصوديوم بأى نسبة. تم توزيع عدد 54 كتكوت عمريوم (اربروايكر) الى ثلاث معاملات غذائية وتتضمن كل معاملة ثلاث مكررات وبكل مكررة 6 كتاكيت. وكانت نسبة كلوريد الصوديوم المضافة هي 0.0 و 0.3 و 0.5% للعلف. تم تقديم العلف والماء للأستهلاك بصورة حرة خلال فترة الدراسة من عمر 3 ايام الى 56 يوم.

أوضحت نتائج التجربة الأولى أنه خلال فترة الدراسة الكلية (3 -56 يوم) ان أستهلاك العلف لم يتأثر بينما تحسنت الكفاءة التحويلية للعلف بمعدل 12.5% عند إضافة 0.5% كلوريد الصوديوم (0.34% صوديوم). لا توجد فروق معنوية فى النسبة المئوية لكل من نسبة التصافى و لحم الصدر والأفخاذ و القلب و الكبد و البنكرياس و الطحال و القونصة وذلك نتيجة لإضافة كلوريد الصوديوم.

أوضحت نتائج التجربة الثانية أن أفضل وأعلى معدلات نمو وكذلك استهلاك للعلف وأفضل كفاءة تحويلية للعلف لوحظت عند استخدام كلوريد الصوديوم بنسبة 0.3% (0.14% صوديوم). قوة الشد وليونة الأنسجة وقوة الكسر للعظام لم تتأثر معنويا نتيجة لإضافة كلوريد الصوديوم .

أوضحت الدراسة أن إضافة 0.5% من كلوريد الصوديوم الى الأعلاف التجارية أو إضافة 0.3 او 0.5 % من كلوريد الصوديوم للأعلاف النباتية المستخدمة فى تغذية كتاكيت اللحم، هي معدلات ملائمة وتغضى الاحتياجات من عنصر الصوديوم وتحسن من كفاءة و معدل أداء كتاكيت اللحم.