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EFFECT OF SALINITY LEVEL AND VITAMINS IN DRINKING WATER ON PRODUCTIVE PERFORMANCE AND SOME BLOOD CONSTITUENTS OF BROILER CHICKS

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ABSTRACT: The experiment reported herein aimed to investigate whether sodium chloride (NaCl) provided through drinking water affected the body weight (BW), body weight gain (BWG), water intake (WI), feed intake (FI), feed conversion (FCR), carcass weight (CW) and dressing percentage of broiler chickens. In a complete randomized block experimental design, a total of 120 one-day-old Ross broiler chicks were allocated randomly into 4 treatment groups. Each treatment group consisted of three replicates of 10 birds each. The birds were offered ad libitum water and basal diets the composition of which was 23 and 21 % crude protein and 3010 and 3160 kcal ME/kg during starter and growing periods respectively. Treatments were drinking tap water (tap water; control group), 1500 ppm NaCl in drinking water (T1, salt stress group), 1500 ppm NaCl plus 100 IU/kg of feed DL- α-tocopherol (T2, 1500 ppm VE) and 1500 ppm NaCl plus 500 IU/L of water L-ascorbic acid (T3, 1500 ppm VC). At the end of the experimental period, no significant differences among the groups in terms of BW and BWG. Moreover, adding Vitamin E or C recorded the lowest BW and BWG. While, birds received salt supplemented with vitamin C recorded the highest WI and FI during experimental periods. Relative weights of edible organs for birds treated with 1500 mg/L NaCl plus 100 IU/kg of feed DL- α-tocopherol were increased significantly ($P<0.01$) compared with other experimental groups except heart. Additionally, there were a significant decrease ($P<0.01$) in Ca, Mg, and P of birds received Vita E or C compared to other treatments. While, there was no significant differences among treatments in K concentration. Furthermore, Aldosterone concentration was increased with vita C addition compared with other treatments. These results indicate that productive and physiological performance of broiler chicks was not adversely affected by 1500 ppm NaCl in drinking water

Key words: sodium chloride, broiler, L-ascorbic acid, DL- α-tocopherol, blood constituents

INTRODUCTION

Over large areas of the arid or semi-arid regions of Africa, Asia, America, and Australia millions of livestock subsist for many months of the year upon water supplies of high saline content. Under-ground waters drawn from wells or bores in these regions are frequently high saline, the principle salts being the chlorides, sulphates, or bicarbonates of sodium, with sodium chloride usually predominating.

The poultry farm must be managed to provide clean and cool water to all birds at all time (Lesson and Summers, 1997), while the nutritional importance of minerals in the diets has been examined extensively, the role of minerals in drinking water has received much less this attention. is surprising since underground water supplies are a common source of drinking water for poultry in many countries and such water often contains high concentration of dissolved mineral salts.

Excess minerals in feed or water above the nutritional requirement will cause increased water consumption and may result in wet manure.

.Watkins et al., (2005) reported that the level of Na and Cl in drinking water and in the diet significantly affected live performance in broiler, with significant interaction between dietary and water levels. Likewise,

water intake is a determinant of broiler performance, as it influences bird health and welfare status (Soares et al., 2007). Thus, water availability is essential to achieve efficient broiler production. However, there are many factors that may influence water intake by the birds, such as the intake of feed and minerals (Leeson and Summers, 1997). Moreover the amount of water intake is important, as it has a direct influence on feed intake (Viola et al., 2009; Soares et al., 2007). Considering the high metabolic rate of modern commercial broilers strains, water can be one of the means used by the birds for thermoregulation (Marks, 1985), and therefore it should be provided continuously to allow full development of the birds.

Drinking water itself contains NaCl at various concentrations. Therefore, when water is used in poultry feeding, the NaCl content of the water should be measured to ensure that an appropriate amount of NaCl is provided. Khalafalla et al. (1998) have reviewed the responses of newly hatched poultry (layer type and broiler chickens, turkey poults and ducklings) to mineral supplements in drinking water. These authors noted that salt levels in drinking water ranged from 2.6 to 10.6 g/l and showed that high concentrations of salt in drinking water were associated with reduced growth and increased mortality in newly hatched poultry. On the other hand, Afifi et al. (1992) noted that the main cause of high mortality is the toxic effect of NaCl when used at high levels in feeds or water. The authors noted also that broiler chicks could tolerate up to 2 g NaCl /100 ml in the drinking water, and live weight gains are decreased, water consumption and water to feed ratio are increased, and feed conversion ratio (g feed/g gain) is adversely affected beyond the 0.2% level.

Vitamin E has been reported as an excellent biological chain-breaking antioxidant that protects cells and tissue from lipoperoxidative damage induced by free radicals. Vitamin C limits the metabolic signs of stress and alleviates the physiological consequences of stress, resulting in improved performance, immunological competence and behavior of chickens. The antioxidative property of vitamin E in chickens is suggested to have significant role in the development of immune response through protection of the cells, such as lymphocytes, macrophages, and plasma cells from oxidative damage,

and enhances the function and proliferation of these cells to face the oxidative stress (Franchini, et al 1991 and Meydani and Blumberg, 1993).

Shanawany et al. (1989) examined the effect of NaCl in drinking water on Japanese quails. The authors used concentrations of 0, 500, 1000 or 1500 mg NaCl/l in the drinking water and noted that water intake increases and feed consumption decreases as salt concentration increases. Damron, (1998) added up to 800 ppm NaCl to the drinking water of White Leghorn hens and detected that daily feed and water intake and body weight change over the experimental period were not influenced by any level of waterborne NaCl. Balnave (1988) observed improvements in growth when three-to-six-week-old broilers were provided with up to 2.4 g NaCl/l of drinking water. Balnave (1989) and Khalafalla et al. (1998) reported that the toxicity of sodium chloride given in the drinking water was approximately the same as an equivalent intake from the diet. These authors also noted that a supplement of 3 g NaCl/l to the drinking water was not toxic to two-day old chicks. Therefore, relatively low concentrations of sodium chloride in drinking water may improve live weight gain in broilers, perhaps through a greater retention of water. The result of previous works on the tolerance of poultry to saline waters has apparently not been studied but there were less information on tolerance of broilers chickens to high salt with vitamins. Therefore the objectives of this study are to evaluate the effect of NaCl in the drinking water of this chicks on feed intake, growth rate , feed conversion ratio and water consumption of broiler chicks using water supplemented with or without Vita E or Vita C.

MATERIALS AND METHODS

Birds managements and Experimental design :The present experiment was carried out at the Experimental Poultry Farm, Department of Animal and Poultry production, Faculty of Agriculture, University of South Valley, during the period from 5 January, to 17 February, 2015. It was designed to determine the effect of Sodium Chloride (NaCl) addition in drinking water on the growth performance, carcass traits and some blood parameters in Ross broiler chicks. One hundred and twenty, one day-old Ross broiler chickens were wing-banded, individually weighed, and randomly assigned to four experimental groups, (control and 3 treatments). Each group included three replicates, each of 10 chicks. Birds in the T 1, which served as the control, were drinking tap water, Birds in T 2 were drinking tap water supplied with 1500 ppm NaCl (salt stress group). Birds in the T 3. drinking tap water Add to1500 ppm NaCl plus 100 IU/kg of diet DL- α-tocopherol T 4. drinking tap water Add to1500 ppm NaCl plus 500 IU/L of water L-ascorbic acid (T3). The light intensity was 15 Lux during the first three days and 5 Lux thereafter. Chicks were housed and raised in two tiers-wire floor, batteries with cages (width: 97 cm; length: 50 cm; height: 45 cm), located in a closed broiler house under controlled managerial and hygienic conditions. The interior temperature which started by about 32 ºC during the first week, was reduced by about 2 ºC every week to reach 24 ºC at the fourth week of age and remained constant in the presence of a relative humidity ranging between 55-60% up to the end of the experiment. The temperature values and the relative humidity percentages were daily recorded by using a thermo-hygrograph and the temperature humidity indices-THI values were calculated allover the experimental period. The birds were fed on starter and grower diets from 1 to 21 and 22 to 42 days of age, respectively and the feed and water were available all the time.

Growth performance :

Birds per each replicate were weekly weighed on individual basis. The body

weight gain BWG was calculated as the difference between final and the initial body weight. The average feed intake FI per each replicate was weekly calculated as the difference between the offered and remained amounts of feed. The mean feed conversion ratio FCR was weekly calculated by dividing total feed consumed by the total body weight gain of birds per each replicate.

Carcass criteria:

At the end of the experiment at 42 days of age, 18 fasted chicks, (for 8 hours), per each group i.e. three around the average weight / each replicate were slaughtered. After complete bleeding, they were scalded and mechanically plucked. The edible organs (heart, liver, empty gizzard and spleen) as well as the abdominal fat were gently removed, weighed and calculated as percentages of carcass weight. The dressing percentage was calculated, by dividing the carcass and giblets weights by the pre-slaughter live body weight of birds. Also, the lengths of intestines and Ceca were recorded.

Blood parameters:

Representative blood samples were collected from 9 hens randomly chosen from each treatment (3 from each replicate) at the end of the experiment and centrifuged. Serum was collected and stored at -20°C for determination of Potassium (K) ,calcium (Ca). magnesium (Mg), sodium (Na), phosphorus (P) and Aldosterone.

Statistical analyses:

Data were statistically analyzed by ANOVA, using the General Linear Model (GLM) Procedure of SAS software (SAS institute, version 9.1, 2005). Duncan's multiple range test (Duncan, 1955) was used to detect the differences among means of different groups.

RESULTS

Data reported in Table 2, shows that, salt stress without or with vitamins supplementation decreased broiler BW at 3 weeks of age comparing with control group. Whereas, there were no significant differences among control, salt and salt supplemented with vita C at 6 weeks of age. Moreover, birds received salt supplemented with vita E recorded the lowest BW compared with control group. As well as, BWG had the same trend as BW at 0-3 weeks of age. While, at 3-6 weeks of age BWG increased with salt stress compared with other groups. Moreover, there were no significant differences between control and salt stress at 0-6. Contrary, WI decreased at 0-3, 3-6 and 0-6 weeks of age compare with other groups. While, birds received salt supplemented with vita C recorded the highest WI and FI during experimental periods. Birds received vitamins E or C recorded the worst FC during the experimental periods.

Carcass measurements:,

The results presented in Table, 3 indicated the effect of treatments on dressed carcass, abdominal fat and relative weights of some edible organs such as gizzard, liver, heart, and spleen. Salt stress with or without vitamin addition increased dressed carcass and abdominal fat compared with control birds. Relative weights of edible organs for birds treated with 1500 mg/L NaCl plus 100 IU/kg of feed DL- α-tocopherol were increased significantly ($P<0.01$) compared with other experimental groups except heart. Additionally, it was observed that, birds received 500 IU/L of water L-ascorbic acid to broiler diet significantly ($P<0.01$) increased length of intestines and ceca compared with those fed 100 IU/kg of feed DL- α-tocopherol.

Blood parameters:

Concerning serum concentration of K, Ca, Mg, Na, P and Aldosterone at the end of the experiment period are shown (Fig. 1 and 2). It was found a significant decrease ($P<0.01$) in Mg, and P of birds fed diets supplemented with Vita E and C compared with salt stress group (T1); while salt stress treatment (T1), T2 and T3 decreased Ca

concentration compared with control group. Moreover, Na level increased ($P<0.05$) significantly in salt stress groups T1 and T3 while, birds, received T2 Na level decreased significantly compared with other groups. Additionally, there were no significant differences among treatments in K concentration. Furthermore, aldosterone concentration was increased with vita C addition compared with other treatments.

DISCUSSION

Sodium and Cl are minerals with important physiological functions. Optimum dietary balance of these minerals allows better chicken performance and may reduce leg problems. Sodium is an essential element for animals; the body contains approximately 0.2 % of sodium. About one – quarterof this amount is localized in the skeleton in an insoluble rather inert form, but the balance was found in the extra cellular fluids where it undergoes a very active metabolism. The element makes up 93 % of the bases of the blood serum, and thus it was the predominant basic element concerned in neutrality regulation . Sodium seems to be absent from blood cells, but it does occur in considerable amount in the muscles , where it is associated in some unknown way with their contraction . A lack of the elements also lowers the utilization of digested protein and energy and prevents reproduction.

Chloride is differing from sodium, it is found in large concentrations both within and outside of the cells of the body tissues. Blood cells contain about one – half as much as the plasma, approximately 15 to 20 % of the chlorides of the bloods, principally sodium chloride, make up two – thirds of its acidic ions. This indicates their large role in acid – base regulation. The gastric secretion contains chlorines as free acid and in the form of salts. The body has a certain capacity to store chlorine in the skin and subcutaneous tissues. Its excretion follows that of sodium, the body requirement is approximately half of that for sodium.

The requirement of these 2 ions varied from 0.15 to 0.40% for Na + and 0.15 to 0.30% for Cl − (NRC, 1994; Oviedo-Rondø´n et al., 2001; Murakami et al., 2001). Excessive dietary Na+ causes physiological responses such as increased water consumption, manure moisture, and urinary excretion and significantly decreases kidney glomerular filtration ratio, which is regulated by variation in the arginine-vasotocin secretion (Vena et al., 1990). Therefore, it is necessary to provide the Na + and Cl − in proper amounts to ensure minimum secretions through kidney. The results of the present study indicated that 1500 ppm NaCl in the drinking water had no adverse effects on chick's performance, caused no effect in feed intake compared with the control group. These results are similar to the results obtained by (Watkins et al., 2005). He found that in dietary NaCl level based on the amount of Na in the drinking water of combination of 500 mg Na/L in the water did not affect the feed intake. Total body weight gain was not affected by the treatment also was not affected by the different levels of NaCl in drinking water during the experimental period. These findings were in line with results obtained by (Ross 1979). However the results were found in the absence of dietary Na addition of 1500 ppm of Na to the drinking water significantly improved growth and feed efficiency. The variation may be due to the concentrations of mineral salt which significantly impaired performance are considerably higher than the concentrations normally found in drinking water including underground sources. In our study, the final body weight and body weight gain of broiler receiving 1500 ppm NaCl/l in the drinking water were numerically higher than those receiving 1500 ppm NaCl/l supplemented with vita E.

Gene et al. (1999) reported that, feed conversion ratio was not affected by the treatment during the experimental period except on week one and two with different

dietary sodium levels (0.1% - 0.3% - 0.7 % - 0.9% NaCl) show that about 0.4% added sodium chloride is necessary to achieve maximum fed conversion ratio. The variation in the results may be due to high level of NaCl for dietary source and the water source.

Water intake significantly differ with our treatments in contrast with Austic (1985) who indicated that, weekly water consumption was not affected by the different levels of NaCl in the experiment, except on week two . These findings agree with those reported by (??? Author ?) NaCl supplemen where ts of up to 2 g / 1 of drinking water or 4 g / kg of diet were given between (one and six weeks of age to broiler) chick receiving commercial diet containing 2.5g NaCl /Kg observed increase in the intakes of drinking water up to 15 % the variation may be due to environmental conditions of the study or they may include the palatability of the diet or any changes in water supply under hot climatic conditions.

Our results indicated that blood minerals significantly affected with salt stress with or without vitamin addition and this may be due to aldosterone mechanism of action. Aldosterone is a steroid hormone (mineralocorticoids) produced by the outer section (zona glomerulosa) of the adrenal cortex in the adrenal gland. It plays a central role in the regulation of blood pressure mainly by acting on the distal tubules and collecting ducts of the nephron, increasing reabsorption of ions and water in the kidney, to cause the conservation of sodium, secretion of potassium, increase in water retention, and increase in blood pressure and blood volume. Aldosterone tends to promote Na+ and water retention, and lower plasma K+ concentration by the following mechanisms: Acting on the nuclear mineralocorticoid receptors (MR) within the principal cells of the distal tubule and the collecting duct of the kidney nephron, it upregulates and activates the basolateral Na+/K+ pumps, which pumps three sodium ions out of the cell, into the interstitial fluid and two potassium ions into the cell from the interstitial fluid. This creates a concentration gradient which results in reabsorption of sodium (Na+) ions and water (which follows sodium) into the blood, and secreting potassium (K+) ions into the urine (lumen of collecting duct) Changlong et al., (2012). Lawrence and Gustavo (2000) said that, Aldosterone has been implicated in the regulation of both Na and K concentrations in the plasma. Release of the hormone is known to be stimulated by high plasma K, and infusion of aldosterone lowers plasma K. However, the correlation between changes in mineralocorticoid levels and rates of K secretion is not perfect, suggesting that other factors may be involved.

CONCLUSIONS

It could be stated that growth and physiological performance of broiler chicks was not adversely affected by 1500 ppm NaCl in drinking water

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Table (1): Composition and calculated analysis of experimental diets

Ingredients	Starter diet	Grower diet
Yellow corn	62.18	67.00
Soybean meal (44% CP)	27	20.30
Corn gluten meal (60% CP)	6.52	8.00
Di-Calcium Phosphate	1.92	1.9
Limestone	1.29	1.37
Salt (NaCl)	0.12	0.10
DL-Methionine	0.14	0.24
L-Lysine	0.19	0.48
Vit. & Min. Premix[1]	0.25	0.24
Filler (sand)	0.01	0.37
Total	100.00	100.00
Calculated Analysis, %		
ME (kcal/ kg)	3010	3160
Crude Protein	23	21
Calcium	1.00	1.00
Available Phosphorus	0.50	0.50
Lysine	1.16	1.28
Methionine	0.52	0.59
Choline (mg/ kg)	0.13	0.15

1Premix 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 B12, 12.1 ug; vitamin B6, 2.2mg; thiamine (as thiamine mononitrate), 2.2 mg; folic acid, 0.55 mg and d- biotin, 0.11 mg. Trace mineral (mg /kg diet): Mn, 60; Zn, 50; Fe, 30; Cu, 5 and Se, 0.3.

Table (2): Productive performance of broiler chicks as affected by treatments

	Treatments				SEM	P. value
	Control	**1500 ppm**	**1500 ppm VE**	**1500 ppm VC**		
Dressed carcass (including giblets) (%)	79.47^{ab}	81.76^{a}	81.19^{ab}	78.90^{c}	0.43	0.0190
Abdominal fat (%)	0.76^{d}	1.45^{a}	0.98^{c}	1.32^{b}	0.08	0.0001
Blood (%)	3.82^{b}	3.85^{b}	4.95^{a}	3.37^{c}	0.18	0.0001
Body organ weights (%)						
Gizzard	1.38^{c}	1.46^{bc}	1.62^{a}	1.52^{ab}	0.03	0.0038
Liver	2.75^{bc}	2.63^{c}	3.17^{a}	2.83^{b}	0.06	0.0001
Heart	0.61	0.57	0.59	0.58	0.01	0.0557
Spleen	0.18^{c}	0.24^{b}	0.31^{a}	0.23^{b}	0.01	0.0001
Body organs length (cm)						
Intestines	227.67^{a}	210.67^{b}	190.00^{d}	202.33^{c}	4.15	0.0001
Ceca	40.33^{a}	35.67^{c}	38.00^{b}	40.33^{a}	0.61	0.0001

Means a, b, c, in the same row without common superscripts are significantly different ($P < 0.05$)

Table (3): Slaughter traits of broiler chicks as affected by treatments

Items	Treatments				SEM	P. value
	Control (T1)	1500 ppm(T2)	1500 ppm VE(T3)	1500 ppm VC(T4)		
Body weight, g						
3 WK	852.00^{a}	820.33^{c}	815.50^{c}	833.33^{b}	4.43	0.0001
6 WK	2466.11^{a}	2473.33^{a}	2319.89^{b}	2343.33^{ab}	26.91	0.0480
Body weight gain, g/bird/day						
0 – 3 WK	38.42^{a}	36.84^{b}	36.63^{b}	37.49^{ab}	0.27	0.0480
3 – 6 WK	76.86^{b}	78.71^{a}	71.97^{c}	71.90^{c}	0.91	0.0421
0 – 6 WK	57.64^{a}	57.78^{a}	54.13^{b}	54.70^{b}	0.53	0.0001
Water intake/bird/day						
0 – 3 WK	125.02^{a}	120.92^{b}	126.06^{a}	127.28^{a}	0.813	0.0029
3 – 6 WK	279.70^{b}	243.77^{c}	281.47^{b}	285.42^{a}	0.912	0.0001
0 – 6 WK	254.33^{b}	228.98^{c}	256.09^{ab}	259.35^{a}	1.26	0.0001
Feed intake, g/bird/day						
0 – 3 WK	70.24^{a}	67.94^{b}	70.83^{a}	71.51^{a}	0.45	0.0003
3 – 6 WK	142.71^{b}	124.38^{c}	143.61^{b}	145.63^{a}	2.59	0.0029
0 – 6 WK	116.67^{b}	105.04^{c}	117.48^{ab}	118.97^{a}	1.69	0.0001
Feed conversion ratio						
0 – 3 WK	1.828^{b}	1.844a^{b}	1.934^{a}	1.910^{ab}	0.018	0.1043
3 – 6 WK	1.868^{b}	1.581^{c}	2.013^{a}	2.041^{a}	0.056	0.0001
0 – 6 WK	2.058^{b}	1.818^{c}	2.172^{a}	2.180^{a}	0.045	0.0001

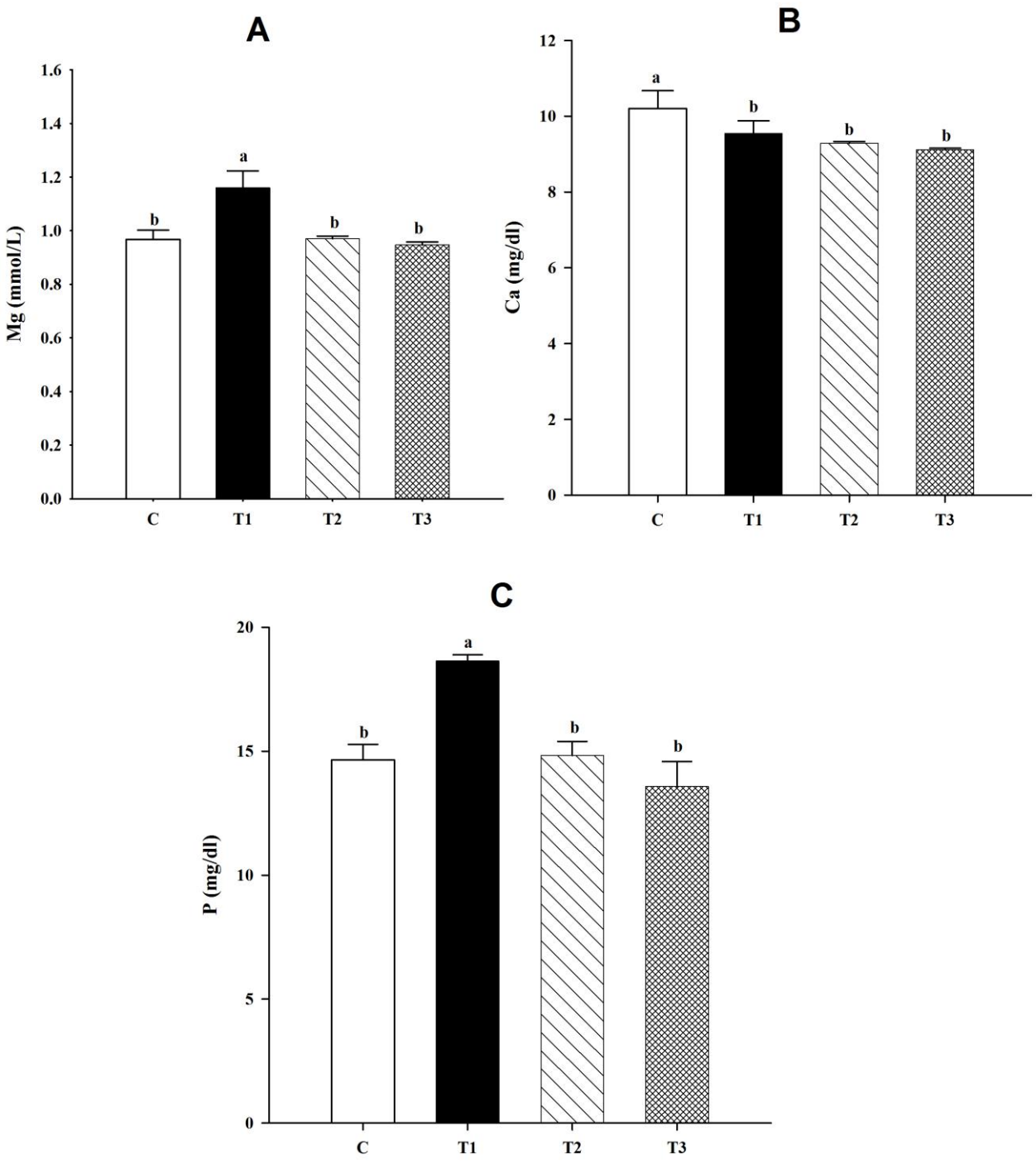

Fig. (1): Blood serum concentration of Mg, Ca and P levels as affected by different treatments

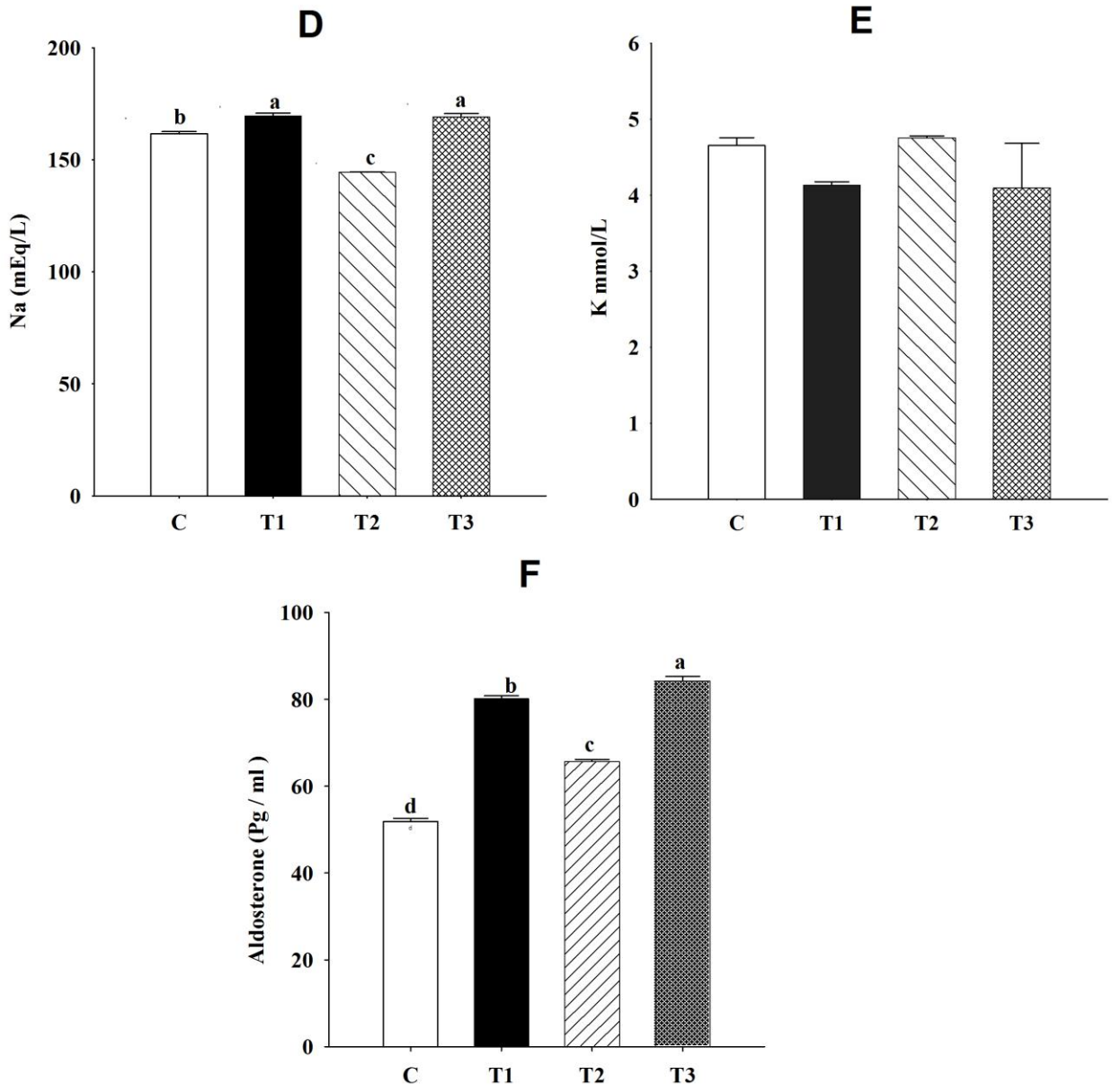

Fig. (2): Blood Na, K and Aldosterone levels as affected by treatments

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الملخص العربى

تأثير مستوى الملوحة والفيتامينات في مياه الشرب على الأداء الإنتاجي وبعض مكونات الدم في دجاج التسمين

حمدي احمد حسن محمود

قسم الإنتاج الحيواني - كلية الزراعة – جامعة جنوب – قنا

أجريت هذه التجربة لدراسة تأثير فيتامين سى و هـ على صفات الأداء الإنتاج وبعض مكونات الدم أثناء ظروف الإجهاد الملحي. تم استخدام عدد ١٢٠ كتكوت تسمين (روص) عمر يوم حيث تم تقسيمهم عشوائيا إلى أربع مجموعات كل مجموعة ثلاثة مكررات بكل من ١٠ طيور وكان تسكين الطيور في أقفاص من السلك المجلفن (٩٧ ×٥٠× ٤٥سم) وكان توزيع المجموعات كالتالي:

١. المعاملة الأولى تم إمداد الطيور بمياه الشرب (ماء الصنبور) بدون اى إضافات واستخدمت للمقارنة.
٢. المعاملة الثانية تم إمداد الطيور بمياه شرب نسبة كلوريد الصوديوم بها ppm ١٥٠٠
٣. المعاملة الثالثة تم إمداد الطيور بمياه شرب نسبة كلوريد الصوديوم بها ppm ١٥٠٠ مع إضافة فيتامين E في العليقة بنسبة. (100 IU/kg of feed DL- α-tocopherol).
٤. المعاملة الرابعة تم إمداد الطيور بمياه شرب نسبة كلوريد الصوديوم بها ppm ١٥٠٠ مع إضافة فيتامين C بنسبة.(500 IU/L of water L-ascorbic acid).

تم قياس كل من المأكول اليومي بالجرام و وزن الجسم و استهلاك المياه يوميا وكذا تم حساب الزيادة في الوزن و معدل التحويل الغذائى، كما تم عمل تجربة ذبح في نهاية التجربة وكذا تم قياس تركيزات كل من الكالسيوم و الصوديوم و البوتاسيوم و الفسفور و المغنسيوم والألدوستيرون في الدم.

تشير النتائج المتحصل عليها إلى وجود فروق معنوية بين المجموعات المختلفة في صفة وزن الجسم والزيادة في وزن الجسم كما ان المجموعات التى أعطيت فيتامين سى أو هـ سجلت اقل قيم. كما أن الطيور التى أعطيت فيتامين سى سجلت أعلى قيم في الاستهلاك اليومي من الغذاء والماء.

بالنسبة للأجزاء المأكولة سجلت الطيور التى تعرضت لـ ppm١٥٠٠ مع إضافة فيتامين هـ أعلى قيم بإستثناء وزن القلب. كما تشير نتائج تحليلات الدم إلى حدوث انخفاض معنوي في قيم كل من الكالسيوم والماغنسيوم والفسفور في الطيور التى عوملت بفيتامين سى وهـ مقارنة بباقي المجموعات. بينما لم يكن هناك فروق معنوية في قيم البوتاسيوم بين كل المجموعات أدت إضافة فيتامين سى إلى زيادة تركيز الالدوستيرون في الدم مقارنة بباق المجموعات.