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EFFECTS OF FORMS FEED AND SODIUM CHLORIDE ON PERFORMANCE, BLOOD PROFILE AND CARCASS CHARACTERISTICS OF BROILERS CHICKS UNDER HOT CLIMATIC CONDITIONS

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ABSTARCT: The study was investigated to determine the effects of feed physical form and sodium chloride on performance, blood profile and carcass criteria of broiler chickens. One hundred and eighty, one day old Ross broiler chicks were randomly distributed into sex treatment groups. Each treatment group consisted of three replicates of 10 birds each. A factorial design (2×3) was used in which there were two feed forms (mash and pellet). Both mash and pellet diet groups were subdivided into three treatments each (drinking tap water; control group), 1500 ppm sodium chloride and 3000 ppm sodium chloride in drinking water, respectively. The results showed that Body weight, weight gain and feed intake of broilers fed pellet-diet was significantly greater than that of those fed mash diet at 2 and 6 weeks of age. However, Growth performance parameters such as body weight and weight gains were not significantly affected due to the supplementations of sodium chloride in water. Feed conversion ratio was also not significantly affected by the dietary physical form or sodium chloride. Water intakes of broilers were significantly affected by the dietary physical form or sodium chloride levels. Serum K and Ca of broilers fed mash-diet were significantly greater than that of those fed pellet-diet. There were significant differences on serum P and aldosterone concentrations of broilers drinking water supplemented with NaCl levels, but had no effect (P>0.05) on the other variables evaluated. Dressing percentage and internal organs such as liver and gizzard were not significantly affected due to feed physical form or the supplementations of sodium chloride in water, but had effect (P>0.05) on spleen and heart. Based on these results, it can be concluded that fed pellet-diet with or without sodium choride up to 3000 ppm improved productive performance but had no consistent effect on overall carcass traits of broilers.

Key words: Broilers – Forms Feed – NaCl –Performance- blood profile -Carcass-characteristics

INTERODUCTION

The poultry industry is the most dynamic sector within the global meat business during the last decade, with the greatest growth reflected in the food global demand increase (Neves et al., 2014). Recently, poultry feed industry continues to search for ways to optimize feed utilization, thereby improving production efficiency, with efforts being focused on changes in diets physical form (Kamphues, 2011). Feed physical form is considered to play a very significant role in improving broiler growth performance and feed intake (Dozier et al., 2010).

Today, commercial feed mills are producing different forms of broiler feed for birds at different ages. One disadvantage is that pelleting costs about 10% more than producing mash feed (Jahan et al., 2006). However, feed processing to change feed form increases the cost of feed it can be balanced out by improved performance (Mingbin et al., 2015). There are only limited studies that had been conducted using feed physical form on broilers and results were significant or insignificant on growth performance and carcass characteristics (Amerah et al., 2008; Chewning et al., 2012; Emmans and Kyriazakis, 2001; Hassanien et al., 2013; Mingbin et al., 2015). Partial differences in the results between those studies may be due to different opening sizes of screens used (Mingbin et al., 2015).There is a lack of scientific knowledge of the biochemical and physiological response of the bird feeding feed physical form.

Heat stress is a major problem that adversely effects on performance and physiological traits of poultry which induce many physiological, endocrine and performance responses (Khan et al., 2012). Several intervention strategies have been proposed for alleviating the negative effects of heat stress in poultry, including environmental management, nutritional manipulation, as well as inclusion of minerals in the diet or water, although the effectiveness of most of the interventions has been variable or inconsistent. Furthermore, one of the methods used to control heat stress is the chemical management of the acid-base balance in birds by compounds such as sodium chloride (NaCl), potassium chloride (KCl), calcium chloride (CaCl2) and ammonia chloride (NH4Cl) in water and/or feed (Borges et al., 2007). The blood contents are particularly sensitive to changes in temperature, being an important indicator of physiological responses in birds to heat stress. Sodium (Na^+) and chloride (Cl^-) are essential ions for the maintenance of osmotic pressure and acid-base balance of body fluids (Borges et al., 2007). Furthermore, water is an essential nutrient in poultry, especially during hot environmental temperature (Dai et al., 2009) due to the increase in water consumption benefits the bird by increasing amount of heat dissipated by evaporative cooling through the respiratory tract. Sodium chloride supplemented to the drinking water not only stimulates water intake, but also could compensate for mineral losses. Hence it may be applied as a means to prevent heat stress in broilers under hot climatic conditions in the hot regions. Due to the limitation of data conducted to study effects of combinations of feed physical forms and sodium chloride on

broilers performance and blood constituents under hot climatic conditions, the aim of the present study was to evaluate the interaction effects of feed physical form and sodium chloride on growth performance, serum biochemical parameters and carcass criteria of broilers.

MATERIAL AND METHODS

Experimental design and dietary treatments

The study was carried out at the Experimental Poultry Farm, Department of Animal and Poultry Production, Faculty of Agriculture, South Valley University, Egypt.

One hundred and eighty, one day old Ross broiler chicks were randomly distributed into sex treatment groups. Each treatment group consisted of three replicates of 10 birds each. A factorial design (2×3) was used in which there were two feed forms (mash and pellet). Both mash and pellet diet groups were subdivided into three treatments each (drinking tap water; control group), 1500 ppm sodium chloride and 3000 ppm sodium chloride in drinking water, respectively. The experimental periods were divided into two feeding phases; starter period (from1-21 days of age) and grower period (from 21-42 days of age). All diets were formulated to meet requirements of broiler chickens according to NRC (1994). The composition of the experimental diets are presented in Table 1.

Animal housing and management

Chicks were reared in three-tier wire floor battery in a closed house. The chicks of each replicate were allocated in a cage with slatted iron floor. The measurement of each cage was 97 × 50 × 45 cm for length, width, and height, respectively. Chicks had full access to feed and water during the experimental period. The average outdoor temperature was 36.3°C, and relative humidity during the experimental period was 25.2. The brooding temperatures (indoors) were 36.7, 34.7 and 28.7°C during 0–2, 2–4, and 4–6 weeks of age, respectively.

Experimental procedures and growth performance measurements

The experiments lasted for 6 weeks. Feed consumption, water consumption and body weight (BW) were measured on a pen basis on weeks (wk) 0, 2, 4, and 6. Mortality was recorded daily. Average total feed intake, average total BW gain, and the feed conversion ratio (FCR) were calculated every two weeks.

Blood sampling and laboratory analyses

At the end of the experimental period, 9 birds from each treatment were randomly selected (three birds per replicate representing the pen). The blood was drawn from wing vein using sterilized needles and syringes in vacutainer tubes for serum collection. Feed was withdrawn from the feeder 12 hrs. before blood was collected. After the serum was separated naturally, it was centrifuged for 15 min (3000 × g) at room temperature. Serum was collected in tubes and stored at -20^{o}C until further analysis. Serum potassium (K), calcium (Ca), magnesium (Mg), sodium (Na), phosphorus (P) and Aldosterone hormone were measured using commercial kits (Spectrum chemical company, Obour City- Cairo, Egypt).

Carcass characteristics measurements:-

At 42 days of age, birds were starved

overnight with access to water. Twenty birds per treatment (4 per replicate representing the pen) were individually weighed, sacrificed humanely, allowed to bleed and then plucked. After removal of the head, neck, viscera, shanks, spleen, digestive tract, liver, heart and gizzard, the rest of the body was weighed. Dressing percentage (carcass and giblets weight/live weight × 100) was calculated. Giblets weight was including liver, heart, and empty gizzard from each birds which were individually weighed and expressed as a percentage of live BW.

Statistical analysis

The statistical analysis was performed using a completely randomized design and all data collected were subjected to analysis using a two-way ANOVA procedure of SAS 9.2 software (SAS Institute, 2005). The statistical model included the effects of feed form (mash vs. pellet), sodium chloride levels (0, 1500 ppm and 3000 ppm), and their interactions. Pen was the experimental unit for all analysis. Significance was declared at $P<0.05$; P-values less than 0.001 are expressed as "<0.001" rather than the actual value. Differences among treatment means were calculated using Duncan multiple range test.

RESULTS AND DISCUSSION

Feed intake and growth performances

There was no mortality and the general health status of birds was good throughout the experimental periods. The effects of feed physical form and water supplemented with sodium chloride levels on BW, BWG, feed intake, and FCR of broilers under hot climatic conditions are presented in Table 2. Body weight, weight gain and feed intake of broilers fed pellet-diet was significantly greater than that of those fed mash diet at 2 and 6 weeks of age. This could be attributed to the reduced number of meals, resulting in a higher intestinal load associated with a faster rate of food transit and greater amount of chime in the intestine, which increases the need for oxygen in the small intestine (Neves et al., 2014). However, Growth performance parameters such as BW and BWG were not significantly affected due to the supplementations of sodium chloride in water. There were no interaction effects between feed physical form and sodium chloride levels on BW and BWG of broiler chickens. Feed conversion ratio was also not significantly affected by the dietary physical form or sodium chloride. These results are in agreement with those of Hassanien et al. (2013) who reported that the higher BW and BWG were observed in birds fed on mash diets in comparison to those fed pellet diets. Physical feed form is considered to have a very significant impact on growth performance and feed intake of broiler chickens (Dozier et al., 2010). On the other hand, the crumble-pellet diets improved BW, BWG, feed intake and FCR of broiler chickens (Mingbin et al., 2015). Some researchers report that broilers fed pelleted diets improved BW and FCR than those fed mash feed (Amerah et al., 2008; Chewning et al., 2012). Partial differences in the results between those studies may be due to different opening sizes of screens used (Mingbin et al., 2015). On the other hand Smith (1994) reported that male broilers at elevated temperatures (23.9 to 35°C) receiving 0.376% sodium chloride solution gained 10.5% more weight than those receiving no water additive. In current study, water

intakes of broilers were significantly affected by the dietary feed physical form or sodium chloride levels and their interaction under heat stressed. It could be stated that increased water intake could assist the birds to maintain their body temperature. Heat-stressed birds consuming 0.39% sodium chloride in drinking water increased water consumption by 35% over controls (Teeter and Smith, 1986). Addition of 0.25 g sodium chloride/l (Ross, 1979), 2.4 g sodium chloride /l (Balnave et al., 1989), in drinking water increased body weight of broiler in heat stress. Dai et al. (2009) reported that water intake of birds receiving 0.4% NaCl and KCl treatment was higher than in other groups and the birds maintained high water consumption from 4 to 7 weeks of age while the water consumption of birds receiving 0, 0.2% NaCl and 0.2% KCl declined in 7th week of age. The above research results have shown that feed physical form or sodium chloride supply in the drinking water improves the performance of chickens under heat stress. Nevertheless, there is still further research under more standardized condition needed to evaluate the beneficial effects on growth performance and water intake.

Blood profile

High ambient temperature could result in numerous physiological and metabolic changes in broilers, which adversely impact broiler performance (Borges et al., 2007), the use of salts in drinking water or in the feed is an alternative that is frequently used by broiler growers to reduce losses resulting from heat stress. In current study, results of serum biochemical parameters from chickens fed on feed physical form and water supplemented with sodium chloride under hot climatic conditions are summarized in Tables 3. Serum K and Ca of broilers fed mash-diet were significantly greater than that of those fed pellet-diet. There were significant differences on serum P and aldosterone hormone concentrations of broilers drinking water supplemented with 1500 ppm and 3000 ppm NaCl levels, but had no effect ($P>0.05$) on the other variables such as Ca, Mg and Na evaluated. There is a general lack of information and an apparently limited knowledge about effects of feed physical form on physiological ions responses of broilers. Salvador et al., (1999) observed a reduction in Cl- serum levels when broilers were subjected to heat stress. Ions serum levels could be also influenced by heat stress. K+ excretion is influenced by aldosterone hormone and K+ excretion rate by urine is variable, being connected to Na+ serum concentrations and the bird's hydration status, where losses can be caused by an increase in water consumption (Borges et al., 2007). Heat stress increases the excretion of minerals such as K, Na, Ca and Mg, and thus, disturbs the electrolyte balance of the birds (Smith and Teeter, 1987; Molero, 2007).

Carcass characteristics

The effects of either feed physical form or sodium chloride levels on dressing and internal organs percentages are shown in Tables 4. Dressing percentage and internal organs such as liver and gizzard were not significantly affected due to feed physical form or the supplementations of sodium chloride in water, but had effect ($P>0.05$) on spleen and heart. This supported the findings of Ebrahimi et al. (2010) and Sogunle et al. (2013), who

reported that broilers fed on feed physical forms, had no effect on the dressing percentage. In addition, the study showed that broilers fed mash diets had significantly larger relative intestine length compared to birds fed pelleted diets, which is similar to the finding of Chewning et al. (2012) and Mingbin et al., (2015). Smith (1994) reported that male broilers at elevated temperatures (23.9 to 35°C) receiving 0.376% sodium chloride solution had no effects on carcass characteristics

CONCLUSION

In conclusion, under hot climatic condition, sodium chloride supplementation in drinking water was more effective on feed intake of broiler than that of control. Birds fed on mash diet increased BW, BWG had better water intake and reduced feed intake, therefore fed mash diet to broilers may be a means to improve productivity of broiler under hot climatic conditions. However, growth performance was not affected by 1500 ppm NaCl and 3000 NaCl supplementation, but serum P and Aldosterone hormone concentrations were reduced by 3000 NaCl compared to 1500 ppm and control. Therefore, higher levels of sodium chloride concentration and economic aspect should be further studied under hot climatic conditions.

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

Ingredients,	Starter diet	Grower diet
Yellow corn	62.00	67.00
Soybean meal (44% CP)	27.80	20.00
Corn gluten meal (60% CP)	6.32	8.30
Veg. Oil	--	--
Di-Calcium Phosphate	1.90	1.93
Limestone	1.29	1.34
Salt (NaCl)	0.10	0.10
DL-Methionine	0.14	0.23
L-Lysine	0.19	0.48
Vit. & Min. Premix[1]	0.25	0.25
Filler (sand)	0.01	0.37
Total	99.78	100.00
Calculated Analysis, %		
ME (kcal/ kg)	3000	3152
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

[1]Premix 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_{12}, 12.1 ug; vitamin B_6, 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): Effects of feed physical form and sodium chloride on productive performance of broiler chickens.

Items	Feed form (F)		NaCl (mg/L Na/Cl)) (S)			SEM*	P-Value		
	Mash	Pellets	0	1500	3000		F	S	F*S
Body weight, g									
2 wk	514[b]	563[a]	536	538	540	9.15	0.006	0.976	0.292
4 wk	1478	1580	1534	1536	1517	35.49	0.050	0.934	0.052
6 wk	2448[b]	2600[a]	2595	2508	2469	35.74	0.029	0.269	0.450
Daily body weight gain, g									
0-2 wk	33.47[b]	36.98[a]	35.13	35.18	35.37	0.66	0.006	0.981	0.305
2-4 wk	68.88	72.67	71.27	71.29	69.76	2.27	0.283	0.913	0.054
4-6 wk	69.26	72.85	75.80	69.37	67.99	2.97	0.493	0.435	0.056
0-6 wk	57.21[b]	60.83[a]	60.75	58.61	57.71	0.85	0.030	0.265	0.457
Daily feed intake, g									
0-2 wk	54.40	55.83	54.76	56.19	54.40	0.62	0.252	0.454	0.219
2-4 wk	108.4[b]	110.9[a]	111.5[a]	110.1[ab]	107.1[b]	0.85	0.049	0.024	0.030
4-6 wk	174.0[b]	180.5[a]	180.1[b]	165.7[c]	186.0[a]	2.79	0.001	0.001	0.001
0-6 wk	112.2[b]	115.7[a]	115.4[a]	110.6[b]	115.8[a]	1.04	0.001	0.001	0.001
Daily feed conversion ratio, g/g									
0-2 wk	1.633	1.515	1.567	1.602	1.551	0.033	0.076	0.790	0.176
2-4 wk	1.591	1.558	1.601	1.558	1.565	0.048	0.673	0.881	0.010
4-6 wk	2.585	2.575	2.506	2.465	2.768	0.129	0.964	0.469	0.015
0-6 wk	1.969	1.908	1.908	1.891	2.016	0.033	0.279	0.160	0.052
Daily water intake, ml/day									
0-2 wk	134.4[a]	127.3[b]	138.1[a]	132.6[b]	121.8[c]	1.92	0.001	0.001	0.025
2-4 wk	256.1[a]	233.6[b]	253.6[a]	236.3[c]	244.6[b]	3.48	0.001	0.001	0.001
4-6 wk	282.1[a]	276.1[b]	291.8[a]	276.3[b]	269.1[c]	2.66	0.007	0.001	0.012
0-6 wk	224.2[a]	212.3[b]	227.8[a]	215.1[b]	211.8[c]	2.29	0.001	0.001	0.001

a-d Means not sharing a common superscript in a row are significantly different ($P<0.05$).
*SEM; Standard error of the means

Table (3): Effects of feed physical form and sodium chloride on serum metabolic profile of broiler chickens.

Items	Feed form (F)		NaCl (mg/L Na/Cl)) (S)			SEM*	P-Value		
	Mash	Pellets	0	1500	3000		F	S	F*S
K , (mmol/L)	4.81[a]	4.47[b]	4.39[b]	4.40[b]	5.14[a]	0.13	0.001	0.001	0.001
Ca , (mg/dL)	9.85[a]	9.35[b]	9.88	9.39	9.54	0.11	0.024	0.160	0.776
Mg , (mmol/L)	1.05	1.09	1.06	1.06	1.09	0.03	0.329	0.818	0.051
Na , (mg/L)	162.9	162.4	165.5	160.7	161.7	1.93	0.844	0.364	0.053
P , (mg/dL)	14.84	15.58	16.64[a]	16.62[a]	12.37[b]	0.69	0.199	0.001	0.071
Aldestron , (pg/mL)	65.51	65.67	51.87[c]	76.08[a]	68.82[b]	2.83	0.952	0.001	0.078

a-d Means not sharing a common superscript in a row are significantly different (P<0.05).
*SEM; Standard error of the means

Table (4): Effects of feed physical form and sodium chloride on dressing and internal organs percentages of broiler chickens.

Items	Feed form (F)		NaCl (mg/L Na/Cl)) (S)			SEM*	P-Value		
	Mash	Pellets	0	1500	3000		F	S	F*S
Dressing%	80.22	80.39	79.73	81.24	79.95	0.32	0.781	0.123	0.364
Liver %	2.593	2.630	2.640	2.557	2.637	0.075	0.812	0.883	0.168
Gizzard %	1.480	1.430	1.408	1.401	1.558	0.053	0.676	0.488	0.817
Heart%	0.645	0.608	0.551[b]	0.604[b]	0.724[a]	0.024	0.259	0.001	0.070
Spleen%	0.220[b]	0.614[a]	0.791[a]	0.250[b]	0.210[c]	0.142	0.001	0.001	0.001
Intestine, cm	213.9[a]	211.4[b]	219.0[a]	212.2[b]	206.8[c]	0.142	0.032	0.001	0.001
Cecum, cm	38.0	38.3	40.0	35.7	38.8	3.600	0.824	0.083	0.804

a-d Means not sharing a common superscript in a row are significantly different (P<0.05).
*SEM; Standard error of the means

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الملخص العربي

تأثير شكل العليقة وكلوريد الصوديوم على الاداء الإنتاجى وصورة الدم وقياسات الذبيحة فى كتاكيت اللحم تحت ظروف الجو الحار

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هذه الدراسة تهدف الى تحديد تأثير شكل العليقة و كلوريد الصوديوم على الاداء الإنتاجى وبعض مكونات سيرم الدم وقياسات الذبيحة فى بدارى التسمين. استخدم فى هذه الدراسة عدد 180 كتكوت عمر يوم من سلالة الروس وزعت عشوائياً على 6 معاملات. كل معاملة تتكون من ثلاثة مكررات بكل مكررة 10 كتاكيت فى تصميم عاملى (2 * 3) حيث استخدم نوعين من شكل العليقة (عليقة ناعمة و عليقة محببة) كل من العليقة الناعمة والمحببه قسمت الى ثلاث مجموعات المجموعة الاولى تأخذ مياه الصنبور واستخدمت للمقارنة ، المجموعة الثانيه تأخذ مياه بها 1500 جزء فى المليون من كلوريد الصوديوم ، المجموعة الثالثة تأخذ مياه بها 3000 جزء فى المليون من كلوريد الصوديوم ، على التوالى. تشير النتائج الى: وزن الجسم والزيادة فى وزن الجسم والغذاء المستهلك زادت بشكل معنوى فى الطيور التى غذيت على العليقة الناعمه فى كلا من الاسبوع الثانى والاسبوع السادس من العمر. قياسات الاداء الإنتاجى مثل وزن الجسم والزيادة فى وزن الجسم لم تتأثر معنوياً بمستوى كلوريد الصوديم فى مياه الشرب. معدل التحويل الغذائى لم يتأثر معنوياً بشكل العليقة او بمستوى كلوريد الصوديوم فى مياه الشرب ، كمية الاستهلاك من مياه الشرب تأثرت معنوياً بشكل العليقة ومستوى كلوريد الصوديوم فى مياه الشرب ، مستوى البوتاسيوم والكالسيوم فى سيرم الدم زادت زيادة معنويه فى العليقة الناعمه عن العليقة المحببه ، كما توجد اختلافات معنويه فى تركيزات الفسفور والالدستيرون فى مياه الشرب المحتويه على كلوريد الصوديم ، ولكن لا يوجد تأثير معنوي عند مستوى 0.05 لباقي الصفات الاخرى التى تم تقييمها. نسبة التصافى والاعضاء الداخلية مثل الكبد والقونصة لم تتأثر معنوياً بشكل العليقة ومستوى كلوريد الصوديوم فى مياه الشرب. بينما يوجد تأثير معنوى عند مستوى 0.05 على نسبة الطحال والقلب. وبناءً على هذه النتائج ، يمكن الاستنتاج أن تغذية علي العليقة المحببة مع أو بدون كلوريد الصوديوم حتى 3000 جزء في المليون حسن الأداء الإنتاجي دون اي اثار جانبية على صفات الذبيحة لدجاج التسمين.