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PERFORMANCE AND CARCASS YIELD OF CHICKENS FED ON THREE DIFFERENT SOURCES OF SODIUM

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ABSTRACT

This study aimed to evaluate the effect of three different sources of sodium for broilers' performance and carcass yield. In total 414 female Ross broilers were fed on dietary treatments from one up to 42 days of age. A completely randomized experimental design was used. Broilers were distributed into a total of 6 replicates per treatment. Treatments consisted of T1- sodium chloride, T2-sodium bicarbonate with Ammonium chloride and T3-sodium formate with Ammonium chloride. Average body weight (ABW), feed consumption (FC), body weight gain (BWG), feed conversion (FE), viability (V) and European efficiency factor (EEF), preslaughtering body weight (PSBW), carcass yield (CY), thigh yield (TY) and drumstick yield (DY) were evaluated. Broilers fed on T1 and T2 showed higher feed conversion than those fed on T3 from 1 to 21, 1 to 28 and 1 to 35 days of age. Dietary treatments did not effect the remaining variables up to 35 days of age on the carcass yield. In conclusion, it is possible to substitute the traditional sodium for sodium bicarbonate and sodium formate, both supplied with Ammonium chloride, without affecting the performance or carcass yield.

KEY WORDS: Consumption, HCOONa, $NaCl^-$, $NaHCO_3^-$; NH_4Cl^-.

RESUMO

DESEMPENHO E RENDIMENTO DE CARCAÇA DE FRANGOS ALIMENTADOS COM DIFERENTES FONTES DE SÓDIO

Para avaliar os efeitos de diferentes fontes de sódio sobre desempenho e rendimento de carcaça, utilizaram-se 414 fêmeas de corte Ross, de um a 42 dias de idade. O delineamento experimental foi inteiramente ao acaso, com seis repetições e três tratamentos, que consistiam de: T1 – cloreto de sódio; T2 – bicarbonato de sódio com cloreto de amônia; e T3 – formiato de sódio com cloreto de amônia. As variáveis analisadas foram: consumo de ração (CR), ganho de peso (GP), conversão alimentar (CA), viabilidade (VB) e índice de eficiência produtiva (IEP), peso corporal pré-abate (PCPa), rendimento de carcaça (RC), peso da coxa (PCx) e peso de sobrecoxa (PSCx). As aves do T1 e T2 consumiram mais ração ($p<0,05$), nos períodos de 1 a 21, 1 a 28 e 1 a 35 dias de idade, quando comparadas às do T3. As demais variáveis de desempenho, bem como as de rendimento de carcaça não apresentaram diferença significativa entre os tratamentos. Conclui-se que é possível substituir a fonte clássica de sódio por bicarbonato de sódio e formiato de sódio, fornecidos em conjunto com cloreto de amônia sem prejudicar o desempenho e a qualidade de carcaça de frangos de corte.

PALAVRAS-CHAVES: Consumo, HCOONa, $NaCl^-$, $NaHCO_3^-$, NH_4Cl^-.

INTRODUCTION

Broiler chicken´s diet is composed of vegetal ingredients, which present some minerals deficiency, specially Na+. Because of this, feed supplementation is necessary. Sodium chloride is the mineral supplement most commonly used, owing to its availablility, low cost, and efficiency in filling the Na+ poultry need (BUTOLO et al., 1995). Nevertheless, this product shows some disadvantages, concerning mainly the ration industries, for instance, great storage volume, corrosion loss due to its hygroscopic characteristics, and loss of its oxidative property related to the ration fat-soluble vitamins.

An alternative supplement that researchers have been studying is the sodium bicarbonate. The sodium bicarbonate advantage is the reduction of electrolyte balance alterations, avoiding yield loss, and the increase of the mortality rate due to heat stress.

Another alternative to the sodium chloride is the sodium formate, which, besides being a supplement of Na+, shows antibacterial activity on the intestinal microflora considering it is a formic acid derivative (FRANÇA, 2008).

The objective of this study was to analyze two alternative sources to the sodium chloride, and to evaluate their influence on carcass yield and characteristics of broilers slaugthered at 42 days of age.

METHODS AND MATERIALS

The experiment was carried out at the Experimental Aviary of the Zootechny Department, Faculty of Agronomy Eliseu Maciel/UFPEL, from July 29th to Septemper 9th 2005, within the temperature interval of 20.4ºC and 10.4ºC.

In total 414 one-day-old female Ross broilers were accomodated in 18 boxes, 23 poultry/box, with starter weight between 42 and 50g. A completely randomized experimental design was carried out with three treatments and six replicates. The experimental unit was represented by the box with 23 broilers. The lighting program recommended by the strain manual (AGROCERES ROSS, 2004) was used.

The treatments consisted of three different Na+ sources: T1-sodium chloride (NaCl-), T2-sodium bicarbonate (NaHCO3-) with ammonium chloride (NH4Cl-), and T3-sodium formate (HCOONa) with ammonium chloride NH4Cl-. The NH4Cl- was added to adjust the eletrolyte balance. Mash corn-soybean meal composed the experimental diets offered ad libitum during the intervals of 1 to 21 days and 22 to 42 days of age (Table 1).

Both broilers and the leftover diet were weighed weekly. At the same time, feed consumption (FC), body weight gain (BWG), feed conversion (FE), viability (V) and European efficiency factor (EEF) were evaluated.

At 42 days of age, two broilers per box were selected, according to mean body weight in each box (± 5%), they were weighed, banded and taken to the Conjunto Agrotécnico Visconde da Graça/UFPEL slaughterhouse. The carcass characteristics evaluated were preslaughtering body weight (PSBW), carcass yield (CY), thigh yield (TY) and drumstick yield (DY). The data were statistically analyzed by ANOVA procedure, with the Statistics Analysis System (SAS, 1999), and the averages were compared, two by two, by the Tukey test, with 5% level of significance.

RESULTS AND DISCUSSION

As it can be seen in Table 2, the feed consumption was smaller ($p<0.05$) in the treatment with sodium formate, during all intervals, except from 1 to 42 days. These results comply with FRANÇA (2008) who observed the decrease of feed consumption with the growing use of sodium diformate in the diet. In FRANÇA´s study (2008), sodium levels were growing and close to ideal. Because of that, the consumption decrease was attributed to the Cl- deficiency and to the acid-basic imbalance, influenced by the Na+, K+ and Cl- ions in the diet. The author also observed that when the ammonium chloride was combined to the diformate there were no performance losses.

In this study, besides the sodium formate, the ammonium chloride was also added to the diet. For this reason, no significant differences were observed in the broilers´performance, except in the feed consumption in the period before 42 days of age (Table 2).

Table 1: Percentage composition and nutritional levels of experimental diets offered to broilers from 1 to 21 days and from 22 to 42 days of age

Ingredients (%))	1 to 21 days of age			22 to 42 days of age		
	Sodium chloride	Sodium bicarbonate	Sodium formate	Sodium chloride	Sodium bicarbonate	Sodium formate
Corn	52.76	52.76	52.76	57.00	57.00	57.00
Soybean meal	36.74	36.74	36.74	31.52	31.52	31.52
Soybean oil	4.35	4.35	4.35	6.44	6.44	6.44
Dicalcium phosphate	1.85	1.85	1.85	1.61	1.61	1.61
Limestone	0.90	0.90	0.90	0.82	0.82	0.82
Common salt	0.49	-	-	0.44	-	-
Sodium bicarbonate	-	0.71	-	-	0.63	-
Ammonium chloride	-	0.45	0.34	-	0.40	0.30
Sodium formate	-	-	1.16	-	-	1.08
Kaolin	1.47	0.80	0.46	1.38	0.79	0.44
DL–Methionine 98,9%	0.10	0.10	0.10	0.08	0.08	0.08
L-Lys 78,8%	0.20	0.20	0.20	0.10	0.10	0.10
L-Treo	0.14	0.14	0.14	0.01	0.01	0.01
Vit + Min Supplement	1.00[1]	1.00[1]	1.00[1]	0.60[2]	0.60[2]	0.60[2]
Calculated Nutritional Levels						
AMEn. kcal/kg	3000	3000	3000	3200	3200	3200
Crude protein. %	21.20	21.20	21.20	19.00	19.00	19.00
Calcium. %	0.90	0.90	0.90	0,80	0.80	0.80
Digestible phosphorus, %	0.45	0.45	0.45	0.40	0.40	0.40
Potassiom. %	0.82	0.82	0.82	0.73	0.73	0.73
Chlorine. %	0.33	0.33	0.33	0.31	0.31	0.31
Sodium. %	0.21	0.21	0.17	0.19	0.19	0.16
EB. meq/Kg	195	195	177	180	178	165
Digestible arginine. %	1.36	1.36	1.36	1.20	1.20	1.20
Digestible lysine. %	1.20	1.20	1.20	1.00	1.00	1.00
Digestible methionine. %	0.62	0.62	0.62	0.48	0.48	0.48
methionine+digestible Cystine. %	0.90	0.90	0.90	0.74	0.74	0.74
Digestible threonine. %	0.85	0.85	0.85	0.65	0.65	0.65
Digestible tryptophan. %	0.23	0.23	0.23	0.20	0.20	0.20
Choline. mg/kg	1292	1292	1292	1167	1167	1167
Crude fiber. %	2.90	2.90	2.90	2.70	2.70	2.70
Ether extract. %	6.64	6.64	6.64	8.70	8.70	8.70

[1]Vitaminic and mineral supplement (guarantee): Vitamin A: 1.670.000U.I., Vitamin D3: 335.000U.I., Vitamin E: 2.500mg, Vitamin K3: 417mg, Vitamin B1: 250mg, Vitamin B2: 835mg, Vitamin B6: 250mg, Vitamin B12: 2.000mcg, Folic Acid: 100mg, Biotin: 9 mg, Niacin: 5.635mg, Calcium Pantothenate: 1.670mg, Copper: 1.000mg, Cobalt: 17mg, Iodine: 170mg, Iron: 8.335mg, Manganese: 10.635mg, Zinc: 7.500mg, Selenium: 35mg. Choline Chloride: 5.835mg, Methionine: 250.000mg, Coccidiostatic: 13.335mg, Growth Promoter: 13.335mg, Antioxidant: 2.000mg.

[2]Vitaminic and mineral supplemnt: Vitamin A: 1.335.000U.I., Vitamin D3: 300.000U.I., Vitamin E: 2.000mg, Vitamin K3: 335mg, Vitamin B1: 167mg, Vitamin B2: 670mg. Vitamin B6: 170mg, Vitamin B12: 1.670mcg, Folic Acid: 67mg, Biotin 7mg, Niacin: 4.670mg, Calcium Pantothenate: 1.870mg. Copper: 1.000mg, Cobalt: 17mg, Iodine: 170mg, Iron: 8.335mg, Manganese: 10.835mg, Zinc: 7.500mg, Selenium: 35mg, Choline Chloride: 41.670mg, Methionine: 235.000mg, Coccidiostatic: 10.000 mg. Growth Promoter: 10.000mg, Antioxidant: 2.000mg.

Table 2: Feed Consumption (FC), Body Weight Gain (BWG), Feed Conversion (FE) and viability (V) of broilers fed with different sodium sources during the intervals from 1 to 21 days, 1 to 28, 1 to 35 and 1 to 42 days of age.

Period	Variables	Treatment				
		Sodium chloride	Sodium bicarbonate	Sodium formate	Prob	CV (%)
1 to 21 days	CR (g)	1248.00[a]	1244.17[a]	1126.83[b]	0.0124	5.72
	GP (g)	749.17	781.17	733.00	0.1648	5.57
	CA	1.67	1.59	1.55	0.4203	10.08
	VB (%)	97.83	98.50	97.50	0.7830	2.55
1 to 28 days	CR (g)	2111.00[a]	2067.67[ab]	1951.83[b]	0.0391	4.90
	GP (g)	1359.50	1345.50	1337.50	0.7444	3.69
	CA	1.55	1.54	1.46	0.0678	4.56
	IEP	314.23	318.67	331.67	0.48543	7.89
	VB (%)	96.83	98.33	97.50	0.7043	3.15
1 to 35 days	CR (g)	3278.50[a]	3187.00[ab]	3044.50[b]	0.0351	4.43
	GP (g)	1992.67	1961.67	1966.50	0.6474	3.09
	CA	1.64	1.62	1.55	0.0695	4.19
	IEP	343.67	348.33	363.83	0.3943	7.38
	VB (%)	96.67	97.67	97.50	0.8764	3.70
1 to 42 days	CR (g)	4161.67	4038.83	3969.33	0.1544	4.04
	GP (g)	2333.50	2312.17	2344.83	0.9413	7.07
	CA	1.79	1.76	1.70	0.6124	8.60
	IEP	309.50	318.67	330.17	0.7534	14.78
		96.67	97.50	97.50	0.9054	3.83

[ab]Averages at the same line with different letters differ from Tukey test (P<0.05)

PENZ et al. (1993) stated that the organic acids can improve significantly diet nutrients use. Sodium formate could affect the results, owing to its anion buffer capacity with diet cations (Ca++, Mg++, Fe++, Cu++, Zn++), increasing these elements digestibility and retention in the organism. The organic acids could reduce the pH of the gastrointestinal tract (PARTANEN et al., 2001), what could increase certain enzymes activity and improve some diet nutrients digestibility (PENZ et al., 1993).

In this experiment, the different responses that could confirm this statement, such as broilers´ diet and digestive tract pH were not analyzed. But the inexistence of significant differences among the treatments indicates that those properties were not enough to improve broilers´performance.

Another organic acid property is that it could inhibit the microbian development, affecting vital functions such as macromolecules synthesis, cytoplasmatic pH and substrate transport (CHERRINGTON et al., 1991).

FRANÇA (2008) verified that the use of sodium diformate as the sole source of Na+, at 7 days of age, decreased water consumption, and from 1 up to 21 days it also damaged the broilers´ performance.

According to MAIORKA et al. (1998), food consumption increases with water intake, which increases with the sodium amount in the diet. In this sense, BORGES et al. (1999) explained that the water consumption increases because the broilers try to satiate the thirsty sensation generated by the increased sodium intake.

These researchers´ statements could not be confirmed because the water intake in was not evaluated this study. But it is likely that the strong acid odor that may reduce the diet palatabillity could explain the decrease of the consumption of diets with formates. CANIBE et al (2001) reported that the acid physical-chemical properties can affect the diet palatability for pigs, limiting its insertion level. YAJIMA (2002) also observed the reduction of 4.1g in daily feed consumption in laying hens that were fed with diet with the

addition of 0.1% of acidifier.

According to the data in Table 2, it can observed that the addition of formate and sodium bicarbonate did not damage the EEF, supporting the idea that the different sources of sodium did not affect the most important performance variables: viability, live weight, slaughter age and feed conversion. Therefore, the results indicate that the products could be economically viable alternatives to the use of the traditional sodium chloride.

The viability was within the recommendations of the management guide for the studied broiler strain. BRANTON et al. (1986) observed that feeding the broilers with NaHCO3- diet reduced the mortality rate of the animals exposed to heat stress. Sodium bicarbonate has been used to increase water consumption as well as to increase the ingestion of specific ions, avoiding changes in the acid-basic balance, and relieving the high temperature negative effects on broilers´ performance and survival (MACARI et al., 2002). In this experiment, such differences were not found because there was no heat stress, owing to the fact that the experiment was carreid out in winter.

It is also possible to provide sodium bicarbonate with NaCl- without reducing broilers´ performance at 21 up to 42 days of age (FISHER DA SILVA et al. 2000).

The sodium formate (0.17% sodium) supply did not affect carcass yield variables (Table 3). These results are compatible with the ones found by MURAKAMI et al. (2000). By evaluating sodium and chlorine requirement for broilers at 42 and 56 days of age, and providing two sodium sources (NaCl- and NaHCO3-), the author observed that the level of 0.15 % was enough to supply the animals´ requirements, keeping the maximum body weight and providing a better feed conversion.

Table 3: Preslaughtering body weight (PSBW,g), carcass yield (CY,%), thigh yield (TY,g) and drumstick yield (DY,g) variable avareges for different sources of sodium.

Treatment	PSBW	CY	TY	DY
NaCl- (T1)	2433.83	81.96	239.50	257.50
NaHCO3- (T2)	2400.83	81.17	233.00	251.17
Na+ Formate (T3)	2409.50	82.01	232.67	257.67
Prob	0.8270	0.3788	0.4335	0.7019
CV (%)	3.96	1.40	4.27	5.90

BARROS et al. (2004) found sodium requirement of 0.197% for male broilers and of 0.317% for the females in the growing phase, and for the final phase they were of 0.216% and 0.245%, respectively. These requirements were higher than the ones observed in this experiment.

The organic acids results observed comply with the ones found by IZAT et al., (1990); GARCIA et al. (2000); RIBEIRO et al. (2001); CAMPOS et al. (2004), MAIORKA et al. (2004); CUNHA et al. (2006), who have not observed losses in any performance variable when the organic acids were used solely or combined in broilers´ diets.

CONCLUSION

It is possible to substitute the classical sodium source (NaCl-) for sodium bicarbonate (NaHCO3-) and sodium formate (HCOONa), both supplied with ammonium chloride, without affecting the broilers´ performance or carcass yield.

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