MEAT MINERAL CONTENT IN BROILERS FED DIETS WITHOUT MINERAL AND VITAMIN SUPPLEMENTS[1]

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ABSTRACT - A study was conducted to verify the effect of trace mineral and vitamin supplement (MVS) withdrawal from the diet of broilers on meat mineral content. Birds received the following feed treatments: control diet with MVS from day 21 to day 42; diet without MVS from day 21 to day 42; diet without MVS from day 28 to day 42 and diet without MVS from day 35 to day 42. Mineral composition was assessed in light and dark meat from male and female birds. Calcium level was lower in meat from birds fed diet without MVS from day 21 to day 42 as compared to the other treatments. Potassium level was higher in meat from birds fed diet without MVS from day 28 to day 42 than in that from other treatments. Removal of dietary MVS did not affect the meat levels of Na, Fe, Zn and Mn. The meat from female birds showed higher contents of K and Fe than that from male birds. Dark meat was found higher in Ca, Na, Fe and Zn contents and lower in P, Mg and K levels than light meat.

Index terms: light meat, dark meat, poultry nutrition.

CONTEÚDO DE MINERAIS NA CARNE DE FRANGOS ALIMENTADOS COM DIETAS SEM SUPLEMENTAÇÃO DE MINERAIS E VITAMINAS

RESUMO - Este estudo teve como objetivo verificar o efeito da retirada do suplemento de minerais e vitaminas (MVS) da dieta sobre o conteúdo de minerais na carne de frango. As aves receberam os seguintes tratamentos alimentares: dieta-controle contendo MVS de 21 a 42 dias; dieta sem MVS de 21 a 42 dias; dieta sem MVS de 28 a 42 dias; dieta sem MVS de 35 a 42 dias. A composição mineral foi analisada na carne branca e escura de machos e fêmeas. O nível de Ca foi mais baixo na carne das aves alimentadas com dietas sem MVS de 21 a 42 dias do que nas dos demais tratamentos. O conteúdo de potássio foi mais elevado na carne das aves em que o MVS foi retirado no período de 38 a 42 dias que na das aves dos demais tratamentos. A retirada do MVS não afetou os níveis de Na, Fe, Zn e Mn das carnes. As fêmeas apresentaram carne com teores mais altos de K e Fe que os machos. A carne escura dos frangos mostrou níveis mais altos de Ca, Na, Fe e Zn e mais baixos de P, Mg e K do que a carne branca.

Termos para indexação: carne branca, carne escura, nutrição de frango.

INTRODUCTION

Vitamins and minerals are important ingredients used to formulate poultry diets. These nutrients are included as supplement in appropriate amounts to satisfy the nutrient requirements for a healthy and productive performance of birds as meat or egg producer animals.

The need for vitamin and minerals, however, may be more crucial at certain stages of body development than others. In this way some authors tend to agree that a short period of vitamin and mineral restriction during the growing phase of broilers may not affect the performance characteristics of birds

[1] Accepted for publication on May 22, 1998.
Research funded by Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Brazil.

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with consequent saving in ration costs. (Teeter & Deyhim, 1994). This might be also important in tropical areas were broilers are grown in warm and humid weather conditions without strict environmental control.

Although several studies have been conducted to evaluate the growing performance of broilers fed restricted diets (Deyhim & Teeter, 1993; Teeter & Deyhim, 1994; Christmas et al., 1995) just a few of them focus on the effect of this type of feeding on carcass yield and or dressing characteristics (Skinner et al., 1992).

This study, conducted in Northeast Brazil, was planned to assess the effect of mineral and vitamin supplementation removal from final broiler diets on meat mineral content.

MATERIAL AND METHODS

The broiler feeding experiment

A feeding trial was conducted at the Experimental Poultry Unit, Department of Animal Science, Universidade Federal do Ceará, Fortaleza, CE, Brazil, during the months of January and February with ambient temperatures oscillating between 23.8°C and 33.9°C and average relative humidity of 78.7%.

The experiment used 112 broilers from a commercial breed, half male and half female, with 21 days of age. Birds were initially weighed and then randomly distributed in individual cages. Four treatments were applied to four groups of 28 birds (half of each sex) as follows: control diet with MVS from day 21 to day 42; diet without MVS from day 21 to day 42; diet without MVS from day 28 to day 42 and diet without MVS from day 35 to day 42. Diets with or without MVS were formulated according to the National Research Council (1984) with identical levels of protein, metabolizable energy, calcium, available phosphorous, methionine and lysine (Table 1).

Preparation of meat samples

At the end of the experimental period eight birds from each group (half of each sex) were slaughtered, the carcass identified and then frozen at -20°C for further analysis. After thawing carcasses were separated by sex and hand boned to collect light meat from the breast and dark meat from the legs. Meats were then comminuted in a domestic food cutter (Bendix Food Processor, IL, USA).

Sample preparation for mineral analysis proceeded by weighing 1 g meat in appropriate glass vials, adding 5 mL concentrated nitric acid (min. 65%) and allowing to digest for 12 hours at room temperature. Then samples were taken to a microwave oven (CEM MW Sample Preparation System), preheated for 5 minutes at 630 MHz, and digested according to a 26 minutes program in which power increased from 75 W to 95 W and the internal pressure increased from 25 psi to 130 psi. After decompression, samples were taken out of the oven and added of 1,000 µL hydrogen peroxide 30%. Samples were taken again to the oven and the digestion program repeated. Digested material was then transferred to a 25 mL vol. flask with nitric acid 5% and taken to volume with the same solution.

Mineral analysis

The contents of Ca, P, Mg, K, Na, Fe, Zn, Mn and Cu were measured in this solution in an Inducted Coupled Plasma Emission Spectrophotometer (Baird Anal. Instr. Div., Model ICP 2000, Bedford, MS), according to the procedure described by Angelucci & Mantovani (1986) and standardized as follows: power: 1,050 W; coolant fluid: 60 mL/min; auxiliary fluid: 70 mL/min; sample aspiration

TABLE 1. Composition and calculated analysis of diets fed to broilers in their final growing period (21 to 42 days).

Ingredient	Diet with MVS[1]	Diet without MVS
Corn	60.00	60.40
Soybean meal	31.10	31.10
Soybean oil	5.00	5.00
Limestone	1.75	1.75
Dicalcium phosphate	1.30	1.30
Salt	0.35	0.35
DL-Methionine	0.10	0.10
Vitamin supplement[2]	0.30	-
Mineral supplement[3]	0.10	-
Total	100.00	100.00
Calculated analysis[4]		
Protein (%)	19.00	19.00
Met. energy (kcal ME/kg)	3250	3250
Calcium (%)	0.90	0.90
Avail. phosphorous (%)	0.40	0.40
Methionine (%)	0.45	0.45
Lysine (%)	1.00	1.00

[1] Mineral and vitamin supplement.
[2] Per kg mix: vitamin A, 2,170,000 IU; vitamin D_3, 740,000 IU; vitamin E, 4,000 mg; vitamin K_3, 670 mg; vitamin B_1, 500 mg; vitamin B_2, 1,350 mg; vitamin B_6, 670 mg; vitamin B_{12}, 4,000 µg; calcium pantothenate, 4,000 mg; niacin, 10,650 mg; folic acid, 270 mg.
[3] Per kg mix: manganese, 65,000 mg; iron, 40,000 µg; copper, 10,000 mg; zinc, 50,000 mg; iodine, 1,000 mg.
[4] Values from National Research Council (1984)

flux: 2.0 mL/min. The following emission lines were selected: Na, 589.59 nm; K, 766.49 nm; Fe, 2598.94 nm; Ca, 317.93 nm; P, 178.28 nm; Mg, 279.08 nm; Mn, 257.67 nm; Cu, 324.75 nm; Zn, 213.86 nm.

Statistical analysis

Data were submitted to analysis of variance in a cross factorial design with four feeding treatments, two bird sex (male and female) and two types of meat (light and dark). Mean separation was made through the Tukey's test (Montgomery, 1976). Significance levels were established at 5% and 1%. Mathematics were made by using SPSS and Quatro Pro spreadsheet packages.

RESULTS AND DISCUSSION

The effect of vitamin and mineral restriction

Calcium content in broiler meat was significantly ($P<0.05$) lower in birds fed the diet without MVS from day 21 to day 42 than in birds from all other treatments (Table 2). Although calcium level was the same in all diets the interactions with other minerals for a longer period of time might affect the metabolism of this element in broiler muscle.

Phosphorous content was found significantly low (174.59 mg/100 g meat) in meat from birds fed the diet without MVS from day 35 to day 42. All other birds showed levels of this element in meat above 200 mg/100 g (Table 3).

Magnesium level was significantly ($P<0.05$) higher in meat from birds on treatment without MVS from day 35 to day 42 (Table 4). Potassium content, on the other hand, was significantly ($P<0.05$) higher in birds from treatment without MVS from day 28 to day 42 than in those from all the other treatments (Table 5).

The content of sodium in the broiler meats was not affected by mineral and vitamin restriction (Table 6). Copper was not detected in most of the analyzed meats. Female birds in treatment with MVS from day 21 to day 42, however, showed 0,20 mg copper per 100 g meat.

In spite of the mineral supplement being constituted by Fe, Zn, Mn, Cu and I, the absence of this mix in the diet did not affect the contents of Fe, Zn and Mn in the meats (Tables 7, 8 and 9).

Effect of sex and type of meat

Bird sex had no detectable effect on mineral content of the meat. Potassium and iron levels, however, were significantly ($P<0.05$) higher in female (313.97 mg K/100 g meat and 0.69 mg Fe/100 g meat) than in male (294.25 mg K/100 g meat and 0.59 mg Fe/100 g meat) birds (Tables 5 and 7).

Type of muscle seemed to be the most important factor determining mineral content in broiler meat. Dark meat from broiler legs was significantly higher in Ca, Na, Fe and Zn (Tables 4, 8, 9 and 10) and lower in P, Mg and K (Tables 3, 4 and 5) than light meat from the breast. The higher content of calcium in dark meat may be associated with a greater demand of muscle contraction in these parts of the broiler as compared to that in light muscle (Addis, 1986).

Calcium, Na, Zn and Cu levels in broiler meat were generally lower than those reported by McCance & Widdowson (1991) for the edible parts of chicken. The levels of P, Mg, K and Fe were similar to those

TABLE 2. Calcium content (mg/100 g) in meat from chicken fed diets without mineral and vitamin supplements (MVS) in their final growing phase[1].

Treatment	Female		Male		Treatment
	Dark meat	Light meat	Dark meat	Light meat	average
With MVS(21 to 42 d)	6.06	4.82	5.82	6.55	5.57a
Without MVS (21 to 42 d)	5.05	4.33	5.21	4.03	4.66b
Without MVS (28 to 42 d)	6.39	4.99	5.59	4.29	5.32a
Without MVS (35 to 42 d)	5.72	4.84	5.59	4.80	5.24a
Meat type average	5.81a	4.75b	5.56a	4.67b	
Bird sex average	5.28a		5.12a		

[1] Means with different letter in the same column or line are significantly ($P<0.05$) different by Tukey's test.

TABLE 3. Phosphorous content (mg/100 g) in meat from chicken fed diets without mineral and vitamin supplements (MVS) in their final growing phase[1].

Treatment	Female		Male		Treatment
	Dark meat	Light meat	Dark meat	Light meat	average
With MVS (21 to 42 d)	209.84	274.22	159.41	176.96	205.11a
Without MVS (21 to 42 d)	214.94	274.18	221.73	285.58	249.11a
Without MVS (28 to 42 d)	179.41	214.18	176.33	243.17	203.28a
Without MVS (35 to 42 d)	162.67	115.15	187.09	210.75	174.59b
Meat type average	191.74b	219.44a	191.81b	229.12a	
Bird sex average	205.58a		210.47a		

[1] Means with different letter in the same column or line are significantly (P<0.05) different by Tukey's test.

TABLE 4. Magnesium content (mg/100 g) in meat from chicken fed diets without mineral and vitamin supplements (MVS) in their final growing phase[1].

Treatment	Female		Male		Treatment
	Dark meat	Light meat	Dark meat	Light meat	average
With MVS (21 to 42 d)	21.82	27.94	21.06	26.60	24.36b
Without MVS (21 to 42 d)	19.33	27.51	18.74	27.17	23.19b
Without MVS (28 to 42 d)	20.36	27.56	20.06	27.37	23.84b
Without MVS (35 to 42 d)	22.61	32.65	20.96	31.82	27.02a
Meat type average	20.13b	28.92a	20.21b	28.25a	
Bird sex average	24.98a		24.23a		

[1] Means with different letter in the same column or line are significantly (P<0.05) different by Tukey's test.

TABLE 5. Potassium content (mg/100 g) in meat from chicken fed diets without mineral and vitamin supplements (MVS) in their final growing phase[1].

Treatment	Female		Male		Treatment
	Dark meat	Light meat	Dark meat	Light meat	average
With MVS (21 to 42 d)	317.47	373.48	234.13	285.54	302.65b
Without MVS (21 to 42 d)	267.24	355.55	257.30	319.50	299.90b
Without MVS (28 to 42 d)	262.80	353.16	331.97	348.22	324.07a
Without MVS (35 to 42 d)	273.92	308.02	296.98	218.04	289.82b
Meat type average	280.39b	347.55a	280.10b	308.41a	
Bird sex average	313.97a		294.25b		

[1] Means with different letter in the same column or line are significantly (P<0.05) different by Tukey's test.

TABLE 6. Sodium content (mg/100 g) in meat from chicken fed diets without mineral and vitamin supplements (MVS) in their final growing phase[1].

Treatment	Female		Male		Treatment
	Dark meat	Light meat	Dark meat	Light meat	average
With MVS (21 to 42 d)	72.26	42.99	68.37	25.21	58.78
Without MVS (21 to 42 d)	68.58	43.65	64.34	40.33	54.23
Without MVS (28 to 42 d)	71.27	51.13	70.00	45.33	59.44
Without MVS (35 to 42 d)	57.99	47.47	56.03	47.61	53.41
Meat type average	67.53a	46.32b	64.69a	47.33b	
Bird sex average	56.92		56.01		

[1] Means in each sex with different letter are significantly (P<0.05) different by Tukey's test.

TABLE 7. Iron content (mg/100 g) in meat from chicken fed diets without mineral and vitamin supplements (MVS) in their final growing phase[1].

Treatment	Female		Male		Treatment
	Dark meat	Light meat	Dark meat	Light meat	average
With MVS (21 to 42 d)	0.93	0.72	0.73	0.38	0.69
Without MVS (21 to 42 d)	0.81	0.47	0.74	0.41	0.61
Without MVS (28 to 42 d)	0.83	0.58	0.75	0.42	0.65
Without MVS (35 to 42 d)	0.76	0.43	0.70	0.55	0.62
Meat type average	0.84a	0.55b	0.74a	0.45b	
Bird sex average	0.69a		0.59b		

[1] Means with different letter in the same line are significantly (P<0.05) different by Tukey's test.

TABLE 8. Zinc content (mg/100 g) in meat from chicken fed diets without mineral and vitamin supplements (MVS) in their final growing phase[1].

Treatment	Female		Male		Treatment
	Dark meat	Light meat	Dark meat	Light meat	average
With MVS (21 to 24 d)	2.22	0.97	2.16	0.78	1.54
Without MVS (21 to 42 d)	2.30	0.74	2.24	0.80	1.52
Without MVS (28 to 42 d)	2.20	0.89	2.27	0.81	1.54
Without MVS (35 to 42 d)	2.51	0.84	2.23	0.98	1.64
Meat type average	2.31a	0.86b	2.23a	0.84b	
Bird sex average	1.59		1.54		

[1] Means in each sex with different letter are significantly (P<0.05) different by Tukey's test.

TABLE 9. Manganese content (mg/100 g) in meat from chicken fed diets without mineral and vitamin supplements (MVS) in their final growing phase[1].

Treatment	Female		Male		Treatment
	Dark meat	Light meat	Dark meat	Light meat	average
With MVS (21 to 42 d)	1.65	2.27	1.25	1.54	1.70
Without MVS (21 to 42 d)	2.52	1.57	1.30	0.86	1.60
Without MVS (28 to 42 d)	1.50	0.95	1.46	1.00	1.20
Without MVS (35 to 42 d)	1.21	0.97	1.21	2.78	1.50
Meat type average	1.70a	1.40a	1.30a	1.50b	
Bird sex average	1.60		1.40		

[1] Means in each sex with different letter are significantly (P<0.05) different by Tukey's test.

reported by these authors. Manganese level (Table 9), however, was higher than the levels reported by Bodwell & Anderson (1986) and McCance & Widdowson (1991). Most of the mineral values found in this study were similar or higher than those reported by Hamm & Searcy (1981) for chicken light and dark meat.

CONCLUSIONS

1. The withdrawal of minerals and vitamin from final diets of broilers does not affect uniformly the content of minerals in the meat.

2. The content of calcium in the meats, however, is adversely affected by the withdrawal of mineral and vitamin supplements.

3. The effect of bird sex on meat mineral composition seems to be minimal; the type of muscle, however, influences the mineral content of the meat in different directions; dark meat is higher in Ca, Na, Fe and Zn and lower in P, Mg and K than light meat.

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