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Dept. of Food Hygiene,
Fac. of Vet. Medicine, Assiut University,

EVALUATION OF MICROELEMENTS IN MUSCLES AND SOME ORGANS OF BROILERS FED WITH EXCESSIVE DIETARY MINERAL MIXTURE

(With 4 Tables)

By

A.M. NASSAR; H. SHOEIB* **and *WAFFA, HUSSEIN IMAM*****

* Animal Health Research Institute, Assiut,
** National Research Centre, Doki, Cariro.

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تقييم مستوى العناصر الدقيقة فى لحم وبعض أعضاء بدارى التسمين المغذاه على علائق بها تركيزات عالية من المعادن

أحمد نصار ، حسين شعيب ، وفاء حسين إمام

يعتبر مستوى العناصر الدقيقة (المنجنيز ، الحديد ، النحاس ، الكوبلت ، الكادميوم ، الزنـك والسيلينيوم) فى لحم وأعضاء الدواجن ذو أهمية قصوى بالنسبة لصحة الانسان. لـهذا تـم تقدير هذه العناصر فى عضلات وبعض الأعضاء (الكبد ، القونصـة ، القلـب) لبـدارى التسمين. تم تقسيم البدارى موضوع التجربة الى ثلاث مجموعات : الأولى ضابطة والثانيـة والثالثة تم تغذيتها بتركيزين مختلفين من خليط العناصر. أظهرت النتائج أن إضافة زيادة مـن مخلوط المعادن للعلائق أدى الى تناقص معدل الزيادة فى أوزان الطيور الى جـانب زيـادة إستهلاك العلف وكذا إنخفاض الكفاءة فى إستهلاك الغذاء. كذلك كانت تركـيزات العنـاصر المختلفة فى اللحم والأعضاء واضحة التأثير. أيضاً كان مستوى المنجنـيز والنحـاس فـى المجموعة الثانية والثالثة أقل من المجموعة الضابطة بينما كان الحديد أقـل فـى عضـلات المجموعة الثانية والثالثة وقوانص المجموعة الثالثة. فقـط إزداد مسـتوى السـيلينيوم فـى المجموعة الثانية والثالثة .

SUMMARY

The levels of microelements Mn, Fe, Cu, Co, Cd, Zn and Se in muscles and organs of broiler chickens were estimated. Sixty samples of breast muscles, gizzard, heart and liver were choosen for this purpose. The samples were obtained from three groups at time of slaughter; control one and other two groups fed on diets having high level of mineral mixture. The results revealed that adding excessive mineral mixture adversely affect food utilization efficiency manifested by increased feed intake and decreased weight gain development. The levels of Mn and Cu were significantly decreased in the examined samples of groups (2) and (3) while Fe was only decreased in group (1). Selenium level was increased as the dietary level increased. Other elements; Fe, Co, Zn and Cd were more or less changed. The public health significance of these microelements was discussed.

***Key Words:** Microelements, Muscles, Organs, Broilers, Mineral Mixture*

INTRODUCTION

The concentration of trace and heavy metals in poultry tissues is very important to public health, it takes great attention especially in recent years. Cupper and zinc are essential elements and when given in excess are also toxic to man and animals (Pond, 1975). Cupper has a vital role in hematopoiesis and for many enzymes activity (Underwood, 1977). An excess of cupper can be extremly toxic because of its affinity for sulphydryl groups (Evans, 1971).

Zinc is an essential element for human beings where it is involved in protein synthesis and is a constituent of many metaloenzymes (Underwood, 1977). Ferrous play a role in haemoglobin, red blood corpuscules, mean corpuscular haemoglobin and mean corpuscular value, therefore, iron deficiency in fowl produced microcytic, hypochromic anaemia (Bafundo et al., 1984). The situation concerning the adverse effects of excessive dietary ferrous is equally unclear (Southern and Baker, 1982).

Cadmium and lead are toxic heavy metals which are widely distributed in the environment (Fulkerson and Goeller, 1972).

Salisbury and Chan (1991) reported that the mean values of cadmium, cupper, lead and zinc in livers of poultry were found to be 0.03 ± 0.04, 3.97 ± 0.90, 0.70 ± 0.06 and 29.5 ± 5.90 μg of fresh weight in liver respectively.

Selenium is an essential nutrient but its toxicity was found in a number of seleniferous regions of the world. It is also of interst because the mechanism of toxicity may be related to the carcinostatic activity of certain selenium compounds (Spallholz, 1994). Several dietary factors have been shown to alleviate selenium toxicity. These include both cupper and source of cyanide.

The effect of cupper and selenium on the growth performance was studied by Jensen, 1975; Elzubeir and Davis, 1988 and Davis et al., 1996. Whereas, the effect of dietary ferrous content on the broiler body weights was investigated by Vahl and Van T Klooster, 1987).

As the poultry breeder, believed that increasing the amount of mineral mixture in poultry diet in promissed, the present study was conducted to determine the levels of trace minerals usually found in mineral mixture "manganese, iron, cobalt, cupper, cadmium, zinc, and selenium" in muscles, livers, gizard and hearts of broilers chickens fed on diet supplemented with two levels of mineral mixture.

MATERIALS and METHODS

Sixty, broiler chickens one day old of the Arbor Acres line were randomly assigned to three experimental groups, each of 20 chicks, which was placed in an individual pen in an environmentally controlled room with feed and water provided adlibitum.

The control group (G1) was fed on starter basal diet for the first three weeks (1-21 days) and grower-finisher diet for the end of the experiment (42 days of age), that contained nearly the required nutrients for growing meat type chickens recommended by N.R.C (1994), showed in table 1. However, groups 2 & 3 were fed the basal diet supplemented with additional mineral broiler premix by 1 kg and 2 kg/tonne, respectively. The mineral premix contained the following elements per 1 kg: zinc 60 gm, manganese 60 gm, iron 25 gm, cupper 4 gm, iodine 350 mg, selenium 100 mg, and cobalt 100 mg.

Chickens were individually weighed at the begining of the experiment and at 42 days of age. Feed intake of each group was calculated. Feed consumption of each bird was also calculated dividing the total amount of feed consumed by the number of chickens in each group considering the died birds. Feed efficiency was calculated.

At the end of the experiment (42 days) five chickens randomly taken from each group were slaughtered and samples of breast muscle, gizzard, heart and liver were weighed, placed in polythene bags and kept for estimation of the studied metals.

Data for the performance response variables were statistically analyzed by Snedecor and Cochran (1980).

The samples were digested and prepared as the method cited by AOAC (1985). The estimation of Mn, Fe, Co, Cu, Cd and Zn, was done by using chimadzu atomic absorption A.A. 6301.

RESULTS

The obtained data are presented in tables (2 - 4).

DISCUSSION

According to the National Research Council (1994), the dietary trace mineral requirements of broilers are: 60 mg Mn; 8 mg Cu; 0.15 mg Se; 40 mg Zn; and 80 mg Fe/ Kg diet. In this study the amount of the mineral elements in the used basal diet was sufficient to cover the requirements and consequently maximal growth (Table 2), as obtained by group 1 which fed on the basal diet containing trace elements little excessed the broiler equirements (1470 gm at 42 days of age). While addition of high dietary trace mineral supplements to diets of groups 2 & 3 added: 67 mg Mn/ 13.5 mg Cu; 0.17 mg Se, 107 mg Zn and 62 mg Fe / Kg feed, more to the optimum requirements of the starting period and 65 mg; 12.8 mg; 0.17 mg; 104 mg and 53 mg, respectively to the growing-finishing diet of group 2; and 127 mg Mn, 17.5 mg Cu; 0.27 mg Se; 167 mg Zn and 87 mg Fe and 125 mg, 16.8 mg, 0.27 mg, 164 mg and 78 respectively to group 3; and these treatments depressed body weight gain than that of group 1 by 62.5 and 91.3 gm for groups 2 & 3 respectively (Table 3).

Inspite of increased feed intake by 181 and 368 gm/chick for groups 2 & 3 respectively,as a result of adding excessive mineral mixture, the efficiency of food utilization was decreased where the birds of groups 2 & 3 consumed more feed to gain 1 kg body weight (2.681 kg and 2.879 kg, respectively) comparing to 2.438 kg for group 1 (Table 3).

These results support the conclusion of Vahl and Van T Klooster (1987), that extra dietary ferrous sulphate depressed growth performance, while low inclusion rates of Fe increased body weights and the efficiency of food utilization decreased linearly with increasing dietary Fe content, and Diaz et al. (1994) who recorded adverse effects of high levels of dietary cobalt chloride on growth rate and feed consumption. Also decrease in body weight gains are well documented in chicken exposed to excessive levels of Se (Soffietti et al., 1983 and Von Jahn, 1976).

Since cobalt interacts with dietary amino acids and iron, the adverse effect on performance reported in this study as well as in the literature may be due to the high level of cobalt and iron, where amino acids and sulfhydryl groups are known to complex with cobalt ions (Elinder and Friberg, 1990).

Conflicting results have been published for some mineral elements content as iron may produces adverse effects in animals (Markus et al., 1970; Harry, 1979; Farrow et al., 1982; and Bafundo et al., 1984).

The adverse effect on feed efficiency observed in this experiment may be related to the bad effect of some elements as cobalt on pancreas as also reported by Elinder and Friberg, 1990), where the digestive enzymes were affected.

The results listed in table (4) show that the mean values of Mn, Fe, Co, Cu, Cd, Zn and Se in the breast muscles of the control group were 4.8 ± 0.49, 53.0 ± 5.86, 15.0 ± 1.14, 3.6 ± 0.25, 28.2 ± 2.40, 331.6 ± 42.06 and 6.92 ± 0.35 µg/g respectively. In comparison with that findings in livers a little high levels of these elements were reported in heart and gizzard. Higher results of Cu and Zn and lower Cd were recorded in broiler livers by Mousa and Samaha (1994).

In group (2) which fed with an excessive mineral dietary ration, the levels of the aforementioned elements in muscles were 4.6 ± 0.81, 37.8 ± 7.07, 15.6 ± 1.47, 4.2 ± 0.25, 23.1 ± 0.95, 345.6 ± 49.17 and 7.0 ± 0.40 µg/g respectively. Highly significant levels of iron content in the liver were reported as a result of increased dietary Fe supplementation. This finding agreed with Vahl and Van T. Klooster (1987). According to the National Research Council (1994) the minimal dietary Fe requirements of broiler is about 80 mg/kg. However, in group 3 of this study, the dietary level was not sufficient for maximal growth. The increase of Fe content in liver was correlated with Zn increase and this may be due to minerals interaction. From table (4), a high significant decrease in Zn level was observed in gizzards and heart of the examined broilers. In the same time a significant decrease of Cd level in the gizzard of broiler could be detected.

The levels of 6.4 ± 0.87, 45.8 ± 9.23, 12.6 ± 0.51, 4.8 ± 0.86, 23.6 ± 0.81, 356.6 ± 68.25 and 8.33 ± 0.85 µg/kg for Mn, Fe, Co, Cu, Cd, Zn and Se in muscle were recorded (Table 4). These findings are higher than that of group (2). High significant increase of Se level in liver, heart and gizzard of broilers while significant increase in the muscles noticed, a matter which comply with those recorded by Shan and Davis (1994).

Agri-Food Safety Division of Agriculture Canada does, however, have action levels above which inspectors may make onsite investigations to assist the producer in identifying the source of contamination and correcting the problem. These action levels are (in µg/g tissue on wetbasis): cadmium, 1; coper, 150; lead 2 and zinc, 100.

In conclusion, the results indicated that some trace elements are accumulated in the organs of broiler's and consequently constitute a public health hazard.

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Table (1): Composition of the basal diets.

Ingredients (%)	Starter diet	Grower-finisher diet
Yellow corn, ground	67.40	72.90
Soybean meal (44%)	21.30	18.30
Fish meal (72%)	4.00	3.00
Meat meal (60%)	5.84	4.30
Bone meal	0.08	0.10
Dicalcium phosphate	0.15	0.10
Limestone, ground	0.79	0.94
Salt	0.17	0.17
Methionine	0.12	0.04
Premix*	0.15	0.15
Calculated analyses:		
Crude protein (%)	21.50	19
ME (Kcal/kg)	2989	3040
C / P ratio	139.02	160.00

* Broiler premix: furnishing the following ingredients per kg of feed: vit. A 12000 IU., vit. D_3 2000 IU, vit. E 10 mg, folic acid 1 mg, niacin 20 mg, pantothenic acid 10 mg, vit. K 2 mg, vit. B_1 1 mg, vit. B_2 4 mg, vit. B_6 1.5 mg, vit. B12 10 µg, iron 30 mg, copper 10 mg, zinc 55 mg, Mn 55 mg, iodine 1 mg, Se 0.1 mg, choline chloride 500 mg.

Table (2): Calculated mineral content of the experimental fed diets (mg/kg of feed).

Groups	Mn		Fe		Cu		Zn		Se	
	St*	G/F**	St*	G/F**	St*	G/F**	St*	G/F**	St*	G/F**
1	67	65	117	108	17.5	16.8	87	84	0.22	0.22
2	127	125	142	133	21.5	20.8	147	144	0.32	0.32
3	187	185	167	158	25.5	24.8	207	204	0.42	0.42

* St: Starter diet

** G/F: Grower - finisher diet

Abb: Mn: Manganese, Fe: Iron, Co: Cobalt, Cu: Copper, Cd: Cadmium, Zn: Zinc, Se: Selenium

Table (3): Growth performance parameters of the experimental groups of chicks.

Item	Groups		
	1	2	3
Body weight at 42 (g/chick)	1470 ± 47.65	1408 ± 37.24	1379 ± 45.70
Weight gain (g/chick)	1430	1368	1339
Feed intake (1 - 42 days) (g/chick)	3487	3668	3855
Feed conversion	2.438	2.681	2.879

Table (4): Statistical analysis of microelements in muscle and organs in the examined samples, µg/gm (mean ± SE).

Elements	Groups / Samples	G1	G2	G3
Mn	M	4.8 ± 0.49	4.6 ± 0.81	6.4 ± 0.87
	G	15.2 ± 1.28	6.2 ± 0.86**	5.8 ± 0.73**
	H	6.6 ± 0.4	6.4 ± 0.68	5.6 ± 1.17
	L	6.0 ± 0.55	4.4 ± 0.75	6.4 ± 1.36
Fe	M	53.0 ± 5.86	37.8 ± 7.07	45.8 ± 9.23
	G	45.4 ± 3.97	49.2 ± 4.11	38.8 ± 3.31
	H	44.0 ± 3.66	50.2 ± 3.07	49.4 ± 7.68
	L	53.0 ± 3.99	55.2 ± 7.23**	56.0 ± 1.98
Co	M	15.0 ± 1.14	15.6 ± 1.47	12.6 ± 0.51
	G	13.2 ± 0.86	13.2 ± 0.97	12.8 ± 0.73
	H	13.8 ± 1.24	13.4 ± 0.67	13.8 ± 0.66
	L	15.8 ± 1.16	13.2 ± 0.38	13.0 ± 1.05
Cu	M	3.6 ± 0.25	4.2 ± 0.25	4.8 ± 0.86
	G	3.6 ± 0.51	5.6 ± 0.81	4.4 ± 0.51
	H	4.2 ± 0.37	6.8 ± 0.86*	6.2 ± 0.97
	L	3.8 ± 0.37	5.4 ± 0.87	6.2 ± 0.73*
Cd	M	28.2 ± 2.40	23.1 ± 0.95	23.6 ± 0.81
	G	25.0 ± 1.55	20.4 ± 0.93*	25.8 ± 0.38
	H	22.6 ± 0.51	26.0 ± 2.00	21.0 ± 0.77
	L	27.8 ± 2.55	25.6 ± 0.75	24.0 ± 0.45
Zn	M	6.92 ± 0.35	7.0 ± 0.40	8.33 ± 0.85
	G	611.6 ± 47.72	375 ±14.53**	454.4 ±128.53
	H	526.8 ± 59.03	1328.8±105.72**	311.4 ± 8.9**
	L	328.8 ± 13.25	368 ± 54.16	359.4 ± 17.81
Se	M	6.92 ± 0.35	7.0 ± 0.40	8.33 ± 0.85
	G	6.07 ± 0.09	7.44 ± 0.58	8.12 ± 0.36**
	H	6.0 ± 0.26	6.74 ± 0.29	8.83 ± 0.20**
	L	7.62 ± 0.03	8.89 ± 0.28*	8.08 ± 0.03**

M : muscle, G : gizzard. H : heart. L : liver

* Significant at P< 0.05

** Significant at P< 0.01