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The Effect of Supplemental Dietary Chromium on Performance, Some Blood Parameters and Tissue Chromium Contents of Rabbits*

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Abstract: The aim of the present study was to evaluate the effect of supplemental dietary chromium (Cr) on average daily gain, feed intake, feed efficiency and several serum constituents and tissue chromium contents of pregnant does, newborns and weaned growing rabbits. At the beginning of the study, 36 rabbits were randomly divided into three treatment groups as follows: 0, 200 and 400 ppb. Supplemental chromium was provided by Cr chloride incorporated into a basal diet containing 539.17 ppb Cr. Blood and tissue were collected at the end of study and analyzed for serum glutamic oxalate transaminase (SGOT), serum glutamic pyruvate transaminase (SGPT), Ca, P, Na, K, total immunoglobulins and tissue Cr contents. Supplemental Cr had no effects (P>0.05) on average daily gain, feed intake or feed efficiency of the weaned rabbits. Supplemental Cr also did not affect (P>0.05) serum total cholesterol, SGOT, SGPT, Ca, P, Na, K, or tissue Cr contents in any rabbit types. However, supplemental Cr increased (P<0.05) total serum immunoglobulin levels in all rabbits. The results of this investigation indicate that supplemental Cr had no effect on performance, serum contituents or Cr content in various tissues, but increased total serum immunoglobulin.

Key Words: Chromium, Performance, Cholesterol, SGOT, SGPT, Ca, P, Na, K, Immunoglobulins, Tissue, Rabbits

Tavşanlarda Diyete Krom İlavesinin Performans, Bazı Kan Parametreleri ve Doku Krom Düzeyleri Üzerine Etkisi

Özet: Bu çalışmanın amacı, diyete krom ilave edilmesinin gebe, yavru ve genç tavşanlarda ortalama canlı ağırlık artışı, yem tüketimi, yemden yararlanma, bazı serum metabolitleri ve doku krom düzeyi üzerine etkisinin belirlenmesidir. Araştırmanın başlangıcında, 36 tavşan rasgele üç deneme gurubuna ayrılmıştır. 539.17 ppb Cr içeren basal diyete 0, 200, 400 ppb krom kloritten sağlanan krom ilave edilmiştir. Araştırma sonunda, kan ve doku örnekleri alınıp, serum glutamik oksalat transaminaz (SGOT), serum glutamik piruvat transaminaz (SGPT), Ca,P,Na,K, total immunoglobulin ve doku krom düzeyleri için analiz edilmiştir. Genç tavşanlarda, krom ilavesiyle ortalama günlük canlı ağırlık artışı, yem tüketimi ve yemden yararlanma etkilenmemiştir (P>0.05).Yine, bütün tavşanlarda Serum total kolesterol, SGOT, SGPT , Ca,P,Na,K, ve doku krom düzeyleri etkilenmezken(P>0.05), serum immunoglobulin düzeyi artmıştır (P<0.05). Sonuç olarak, yeme krom ilave edilmesi performans, serum metabolitleri ve doku krom düzeyini etkilememiş ancak, total immunoglobulin düzeyini artırmıştır.

Anahtar Sözcükler: Krom, Performans, Kolesterol, SGOT, SGPT, Ca, P, Na, K, Immunoglobulinler, Doku, Tavşanlar

Introduction

Chromium is an essential element required for carbohydrate, lipid, protein and nucleic acid metabolism (1,2). Chromium is thought to be a glucose tolerance factor and increases insulin activity in rats (3), pigs (4) and humans (1). Schwarz and Mertz (5) showed that chromium increased serum glucose and later research established chromium as a cofactor with insulin, necessary for normal glucose utilization and for animal growth (6,7). In rats and calves, chromium supplementation increased serum insulin, glucose, total protein and albumin (3,7,8). However, Şahin et al. (9) reported that dietary chromium did not affect insulin, cortisol or alkaline phosphatase in pregnant does, newborns or weaned growing rabbits. In addition, supplemental chromium seems to improve the immune

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status of stressed ruminants (8,10). However, supplemental chromium resulted in accumulation of Cr in the liver of mice (11) and turkeys (1) and could therefore alter the liver functions. There are some contradictions in results among the studies about supplemental chromium. In particular, there is no recommendation for Cr in pregnant does, newborns or weaned growing rabbits.

The aim of this study was to investigate specifically the effect of chromium supplementation in various amounts to the basal diets on performance, serum immunoglobulin, cholesterol, SGOT, SGPT, Ca, P, K, levels and chromium contents in various tissues of pregnant does, newborns and weaned growing rabbits.

Materials and Methods

Animals

Thirty-six New Zealand white rabbits, (not pregnant) 2 years of age, were assigned to three treatments in a completely randomized design at the start of the study and they were mated after 3 months. In each treatment, 12 pregnant does, 12 newborns, and 10 weaned growing rabbits were used. This study was approved by the Veterinary Control and Research Institute of the Agriculture Ministry. Ten weaned growing rabbits selected randomly were fed until 4 month of age to determine the effect of Cr on growth performance.

Dietary Treatments

In the experiment, various levels of Cr provided by chromium chloride ($CrCl_3$ .6 H_2O) were given. The treatments consisted of 0 (Control), 200 ppb (Treatment I) and 400 ppb (Treatment II) of supplemental Cr. The basal diet was formulated using Meyer guidelines (12) and contained 539.17 ppb Cr kg of dry matter (DM). Ingredients and chemical analysis of the experimental diets are summarized in Table 1.

Growth Measures

Ten weaned growing rabbits were fed until 4 months of age for determining the effect of chromium on growth performance. Gain and feed consumption were recorded every 2 weeks until the end of the experiment. The rabbits were deprived of feed and water for 24 h before each weighing. At all other times, they had free access to feed and water.

Samples Collection and Laboratory Analysis

In each treatment and in each group, 6 randomly selected rabbits were sacrificed for tissue analysis. Tissue and blood samples were collected at the end of pregnancy, weaning, and 120 days of age. Following exsanguination, samples of liver, lung, kidney, spleen, heart and muscle were obtained. These samples were freeze dried and ground in a blender. Subsamples were stored at -4°C for subsequent analysis. Blood samples were centrifuged at 3000 x g for 10 min and serum was collected and stored at -20°C. Serum total immunoglobulin was determined using Moonsie-Shageer and Mowat's procedures (10). Feed ingredients of nutrients were analyzed after grinding using AOAC (13) procedures, and crude fiber was determined as described by Crampton and Maynard (14). For Cr content analysis, feed ingredients and tissue were wet-digested as described by Chang et al. (15) using graphite furnace atomic absorption spectroscopy and graphite tubes (Shimadzu AA-660-GFA-4B-P/N 204-03154-02). Serum samples were analyzed for total cholesterol, SGOT

Table 1. Dry matter composition of basal diet fed to rabbits

Item	%
Alfalfa meal	28.00
Fish meal	6.00
Soybean meal	21.00
Wheat bran	40.50
Soybean oil	3.00
Mineral + Vitamins mix *	0.50
Salt	0.40
Limestone	0.60
Chemical analysis, % DM basis	
Dry matter	89.95
Ash	7.60
Organic matter	82.35
Crude fiber	10.61
Crude protein	20.18
Ether extract	5.08
Nitrogen free extract	46.48
DE, MJ/kg	14.19
Cr, ppb	539.17

Provided : 12000000 IU Vit A, 2400000 IU Vit D3, 30000 mg Vit E, 2000 mg K3, 2000 mg B1, 6000 mg B2, 3000 mg B6, 15 mg B12, 8000 mg Cal. D. Panth. 40000 mg Nicotinamide, 800 mg folic acid, 50 mg biotin, 125 000 mg Cholin chloride, 80000 mg Mn, 40000 Fe, 60000 mg Zn, 5000 mg Cu, 500 mg Co, 2000 mg I, 150 mg Se, 10000 mg antioxidant, 50 mg Zinc bacitracin / per 2.5 kg of premix.

(serum glutamic oxalate transaminase), SGPT (serum glutamic pyruvate transaminase), Ca, P, K and Na using a biochemistry analyzer (Technicon RA-XT).

Statistical Analysis

For each group (pregnant does, newborns and weaned growing rabbits), differences among treatments for growth performance, total immunoglobulins and blood metabolites data were analyzed by analysis of variance procedures and by a Duncan multiple-range test (16).

Results

Supplemental chromium did not affect the average daily gain and dry matter intake of weaned growing rabbits (P>0.05) (Table 2). Total serum cholesterol concentration was not affected (p>0.05) by Cr supplementation in pregnant does, newborns or weaned growing rabbits (Table 3). Supplemental Cr had no effect (P > 0.05) on levels of SGOT, SGPT, Ca, P, Na or K in serum. Serum total immunoglobulin profiles were affected in the three groups of rabbits (p<0.01) by supplemental Cr (Table 3). Serum total Ig increased as dietary Cr content increased from 0 to 200 pbb. However, a 200 ppb or a 400 ppb dietary supplementation had similar effects.

Cr contents in liver, lung, kidney, heart, spleen and muscle were not affected (P>0.05) by Cr supplementation (Table 4).

Table 2. Effect of supplementation Cr on performance of weaned growing rabbits

Item	Level of Cr, ppb 0	200	400	S E M
No. of rabbits	10	10	10	-
Live wt, g				
Initial	582.13	578.80	594.80	13.46
Final	2238.20	2262.40	2238.00	16.89
Daily gain, g	32.91	33.44	33.40	0.66
DMI, g/d	123.28	121.46	122.51	2.03
DMI/ Gain	3.79	3.67	3.66	0.79

Discussion

The results of this study indicate that 200 or 400 ppb of Cr supplemented in the diet did not affect daily gain, feed intake, or feed efficiency of weaned growing rabbits. These results are in agreement with other studies conducted in pigs and calves (17-20). However, other studies have shown that a 200 ppb Cr supplementation from chromium picolinate affected daily gain and feed intake in pigs (21). Total cholesterol concentration was not affected in the present study conducted in rabbits. In other species, the effect of chromium supplementation on total cholesterol content is rather controversial, with reports of no effect in calves (8,22), a decrease in humans (2), and in calves (19) or an increase in pigs (20), and in lambs (23), depending on the species considered and on what source of chromium is used (chloride or picolinate).

In the present study, SGOT and SGPT were measured to determine the effect of supplemental chromium on the liver function tests. During generations, Cr had no effect on the serum level of SGOT, SGPT or Cr content in the tissue. However, Şahin et al. (24) reported that high level chromium affected serum SGOT and SGPT of sheep grazed around Elazığ Ferrochromium Factory. Chang et al. (15) reported that Cr supplementation from high-Cr yeast of steers did not affect Cr contents in rib lean, liver, rib fat or kidney. However, Anderson et al. (25) reported that Cr supplementation of turkeys showed that Cr concentrations of breast, liver, kidney were linearly increased with the increase in organic Cr dietary supplementation. This difference may be due to the high supplementation Cr level, (25, 100, 200 ppm). Therefore, in this study, the absence of a significant effect of Cr supplementation may be due to the low supplemental Cr level. Supplementation of Cr in the diet did not result in toxic accumulation in any tissue. It is shown that Cr levels are not toxic for a long period and have no effect on the liver. Cr supplementation did not affect levels of serum Ca, P, Na or K. Chang and Mowat (8) reported that the same parameters were not affected by supplemental Cr from high-Cr yeast (Chemeast). Moonsie-Shageer (10) reported that Cr from a high-Cr yeast source (Chemast) had no effect on serum K in cattle. However, Lindemann et al (17) reported that serum K was increased with supplemental Cr in the form of chromium picolinate.

Serum total immunoglobulin levels increased supplemental Cr in rabbits (P<0.01). Similarly, Chang and Mowat (8) reported an improvement in IgM and total immunoglobulin levels with supplemental chromium from

Table 3. Effect of supplemental chromium on serum profile of rabbits

	Pregnant does Cr Level, ppb				Newborns Cr Level, ppb				Weaned Growing Rabbits Cr Level, ppb			
Item	0	200	400	SEM	0	200	400	SEM	0	200	400	SEM
Rabbits (n)	6	6	6		6	6	6		10	10	10	
Cholesterol (mg/dl)	81.05	80.45	79.14	12.39	71.83	69.50	70.33	15.89	74.50	73.33	72.45	16.94
SGOT (U/L)	75.12	77.54	77.38	8.56	60.59	59.33	61.67	7.24	67.83	70.33	71.33	8.68
SGPT (U/L)	39.78	41.38	42.00	10.21	38.00	37.67	34.17	1.72	39.00	38.67	41.52	9.36
Tot. Ig (g/dl)	9.45^b	10.50^a	10.44^a	0.14	11.32^b	14.25^a	14.48^a	0.14	10.48^a	12.71^a	12.43^a	0.11
Ca, (mg/dl)	14.25	14.51	14.32	0.47	12.76	13.13	13.46	0.31	16.68	16.53	16.9	1.39
P, (mg/dl)	8.21	8.62	8.91	1.24	7.26	7.58	7.28	0.66	8.63	8.50	8.68	1.34
Na, (MEQ/L)	144.08	148.52	140.32	15.21	143.83	140.00	140.00	1.85	191.55	186.23	189.36	17.83
K, (MEQ/L)	5.42	4.91	4.38	1.21	4.35	3.75	3.95	0.30	4.11	6.27	4.04	1.67

a,b : Means in the same row with different superscripts differ ($p<0.01$) for each group of rabbits.

Table 4. Chromium concentrations of tissue (dry matter basis) of rabbits,(mg/kg^{-1}, dry matter basis)

	Pregnant does Cr Level, ppb				Newborns Cr Level, ppb				Weaned Growing Rabbits Cr Level, ppb			
Item	0	200	400	SEM	0	200	400	SEM	0	200	400	SEM
Rabbits (n)	6	6	6		6	6	6		10	10	10	
Liver	0.18	0.26	0.31	0.17	0.24	0.28	0.35	0.25	0.26	0.38	0.40	0.20
Lung	0.18	0.22	0.30	0.22	0.14	0.18	0.21	0.25	0.18	0.19	0.24	0.15
Kidney	0.40	0.42	0.48	0.11	0.44	0.43	0.47	0.14	0.45	0.48	0.47	0.12
Heart	0.09	0.12	0.18	0.10	0.11	0.14	0.17	0.12	0.12	0.15	0.17	0.10
Spleen	0.10	0.14	0.15	0.12	0.11	0.13	0.14	0.16	0.12	0.16	0.17	0.12
Muscle	0.20	0.22	0.24	0.18	0.32	0.34	0.37	0.12	0.33	0.35	0.39	0.12

$P>0.05$.

high-Cr yeast in stressed calves. Burton et al. (26) reported that Cr supplementation from chelated Cr (Metalosate, 2.68% Cr) affected the production of IgG and but not IgM in dairy calves. Cr may be an element participating in certain enzymes activities. Immunoglobulin production is thought to be regulated by specific enzymes that have a trace element at their core, the most common being Cu and Zn (27). Cr may have influenced Cu and Zn metabolism, indirectly affecting immunoglobulin production.

Implications

The results of current study indicated that supplemental chromium in young rabbits did not improve performance, and supplemental Cr had no effect on serum contituents (total cholesterol, SGOT, SGPT, Ca, P, Na, K) or Cr content in various tissues, but increased total serum immunoglobulin of pregnant does, newborns and weaned growing rabbits.

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