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Effects of high-level chromium methionine supplementation in lambs fed a corn-based diet on the carcass characteristics and chemical composition of the *longissimus* muscle

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Abstract: Twenty-four male lambs (24.93 ± 0.93 kg) were used in order to evaluate the effects of chromium methionine (Cr) supplementation in high-energy finishing diets on the carcass characteristics and chemical composition of the *longissimus* muscle (LM). Treatments were 0.00, 0.60, 1.20, and 1.80 mg Cr/lamb daily. The experiment lasted 56 days. There were no effects of treatments on dry matter intake, feed to gain ratio, and final weight, which averaged 35.24 ± 1.01 kg. Supplemental Cr linearly decreased fat thickness enough to improve the estimated yield grade from 1.82 to 1.42 with no effect on the other carcass traits measured. Fat concentration in the LM decreased linearly as the level of Cr increased in diets, but protein concentration remain constant and so the protein/fat ratio in the LM increased. It is concluded that Cr supplementation has a modulating effect on carcasses by reducing fat; maximal response was reached at a daily dose of 1.80 mg Cr/head.

Key words: Chelated chromium, lambs, carcass, marbling, finishing diets

One of the main goals of the feedlot industry is to increase efficiency in the final stages of fattening. Therefore, the use of modulators of growth (hormones and beta-agonist agents) is widespread. The concern about the potential impact of the use of these growth promoters has furthered interest in the search for safe alternatives of modulating agents of growth in recent years. In this regards, the use of chelated minerals has shown interesting advantages in nonruminant species. In this sense, chromium (Cr) supplementation, as Cr propionate or Cr methionine, has shown increases in the percentage of carcass muscle and decreased carcass fat in pigs and poultries (1). In ruminants, Cr requirements have not been clearly established (2) and there is limited information available on the effects of Cr on carcass characteristics in feedlot cattle (3) and in feedlot lambs (4). In a recent study (5), linear decreases (P = 0.02) in kidney-pelvic-heart fat and fat thickness were observed in finishing steers supplemented with chelated Cr (as Cr-enriched yeast) at daily levels of 0, 5, 10, or 15 mg/head. According to the above study, the maximum response levels were observed when cattle were fed with levels three-fold what is currently recommended. There is limited information regarding the effects of high levels of Cr supplementation on carcass characteristics and chemical composition of muscle of finished lambs. Therefore, the aim of this trial was to evaluate the effects of feeding different levels of chromium methionine on the carcass characteristics and chemical composition of the *longissimus* muscle (LM) in hairy lambs fed a high-energy diet. Twenty-four Pelibuey × Dorper (initial weight at start of experiment: 24.9 ± 0.2 kg) were assigned (six lambs/treatment) in indoor facilities in collective pens of 16 m^2 with automatic waterers and 1.2 m fence-line feed bunks. Lambs were fed ad libitum with a finishing diet formulated as follows (dry matter basis): 61.2% ground maize, 14.5% soybean meal, 12.6% Sudan grass hay, 7.7% molasses cane, 2.5% mineral premix, and 1.5% zeolite. The calculated composition of the basal diet dry matter basis (6) was as follows: crude protein, 17 g/kg; metabolizable energy, 12.09 MJ/kg; ether extract, 29 g/kg; calcium, 98 g/kg; and phosphorus, 36 g/kg. Lambs were adapted to the basal diet and facilities 14 day

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before the start of the experiment. To determine carcass characteristics and chemical composition of the LM of representative lambs at the initiation of feeding Cr, four lambs were slaughtered at the beginning of the experiment. Treatments were: 1) 0.00 mg Cr/lamb daily, 2) 0.60 mg Cr/lamb daily, 3) 1.20 mg Cr/lamb daily, and 4) 1.80 mg Cr/lamb daily. The source of Cr was Cr methionine (Microplex, Zinpro Corp., USA). Fresh feed was provided twice daily at 0800 and 1400 hours in a 40:60 proportion (as-fed basis). Daily feed allotments to each pen were adjusted to allow minimal (<5%) feed refusals in the feed bunk. The doses of Cr were hand-weighed using a precision balance (Model AS612, Ohaus, USA). To ensure the consumption of the planned dose, the total daily dose of Cr of each treatments was mixed with 30 g of wheat bran and provided in the morning feeding using individual feeders. The experiment lasted 56 days. Lambs were individually weighed in the morning (0700 hours) before harvest. Hot carcass weights (HCWs) were obtained for all lambs at the time of slaughter. Because feed and water were not withdrawn for 12 h before weighing and slaughtering, the final weights were reduced (pencil shrink) by 4% to account for digestive tract fill (7). After carcasses were chilled in a cooler at –2 to 1 °C for 48 h, the following measurements were obtained: 1) carcass length (maximum distance between the edge of the ischiopubic symphysis and anterior border of the first rib at its midpoint); 2) chest depth (maximum distance between the sternum and the back of carcass, at the level of the sixth thoracic vertebra); 3) leg length (distance from the symphysis pubis to the tarsal-metatarsal joint); 4) fat thickness perpendicular to the *m. longissimus thoracis*, measured over the center of the ribeye between the 12th and 13th ribs; 5) LM surface area, measured using a grid reading of the cross-sectional area of the ribeye between the 12th and 13th rib; and 6) kidney-pelvic fat, which was removed from the hind saddle and weighed and reported as a percentage of carcass weight (8). Chest perimeter and leg circumference were measured based on methodology reported by Smith et al. (9). Estimated yield grade was performed according to the equation proposed by the USDA (8). For assessment of muscle protein and fat concentrations, muscle samples from the LM (12th rib cut) of each carcass were collected. LM samples were subjected to the following analysis according to AOAC (10) procedures: dry matter (oven drying at 105 °C until no further weight loss; method 930.15), Kjeldahl nitrogen (method 984.13), and ether extract (method 920.39). All animal management procedures were conducted within the guidelines of locally approved techniques for animal use and care. The trial was analyzed using the MIXED procedure of SAS (11) for a completely randomized design. Treatment is considered as the fixed effect and lamb as the random effect. Treatment effects were tested for linear, quadratic, and cubic components of the Cr supplementation level. Contrasts are considered significant at $P \leq 0.05$, and tendencies are identified at $0.05 < P \leq 0.10$.

The effects of treatments on performance, carcass characteristics, and chemical composition of the LM are presented in the Table. The average chemical compositions of the LM of the four lambs slaughtered at the initiation of the experiment were 22.71 ± 0.98% and 1.46 ± 0.15% protein and fat, respectively. This chemical composition is in agreement with previous reports in which lambs were slaughtered at lighter weights (12). After 56 days of fattening, controls lambs increased up to 11.9% in fat in the LM. Fat deposition is highly correlated to the energy density of diet, level of intake, and length of days of feeding (13,14). There were no effects of treatments on HCW, dressing percentage and size measures of components of carcasses. Similarly, Estrada-Angulo et al. (4) reported that daily supplementation up to 1.20 mg/head with Cr (from Cr-enriched yeast) did not affect ($P \geq 0.09$) carcass length, carcass width, or leg length of lambs. In contrast to the present study, Estrada-Angulo et al. (4) observed an overall positive effect of Cr supplementation on average daily gain and feed efficiency in lambs fed a corn-based diet. In contrast, in agreement with the present study, other studies have shown no benefits to either average daily gain or feed efficiency with chelated Cr supplementation on overall feedlot growth performance of finishing lambs (15,16).

Final weight was not affected by Cr supplementation, averaging 35.24 ± 1.01 kg. Even when there were no difference in energy intake between groups (average: 9.90 ± 0.67 MJ/day metabolizable energy, data not shown), supplemental Cr tended (linear, $P = 0.09$) to decrease kidney-pelvic fat and linearly decreased fat thickness (linear effect, $P = 0.01$) enough to improve the estimated yield grade from 1.82 to 1.42. Fat concentration in the LM decreased linearly ($P < 0.01$) as the level of Cr increased in diets, but protein concentration remain constant ($P \geq 0.41$) and so the protein/fat ratio in the LM increased ($P < 0.01$). In previous reports, the daily addition of 0.30 mg/head of Cr as Cr nicotinate decreased the internal fat weight in fat-tailed lambs (17). Domínguez-Vara et al. (15) observed decreases in carcass fat in finishing lambs supplemented daily with 0.35 mg/head of Cr plus 0.3 mg/head of selenium from Cr- and selenium-enriched yeast. In contrast, Kitchalong et al. (16) observed that daily supplementation

Table. Treatment effects on dressing percentage, carcass characteristics, and chemical composition of the LM of lambs supplemented with Cr-methionine.

Item	Cr-methionine level (mg/lamb daily)				P^a value			
	0.00	0.60	1.20	1.80	SEM	Linear	Quadratic	Cubic
Replications	5	5	5	5				
Initial weight (kg)	25.10	24.97	25.09	24.54	2. 04	0.86	0.92	0.92
Dry matter intake (kg)	0.825	0.805	0.799	0.846	0.040	0.76	0.42	0.86
Feed to gain	4.77	4.78	4.61	4.61	0.45	0.75	0.99	0.87
Slaughter weight (kg)	35.40	35.03	35.18	35.36	2.21	0.99	0.91	0.96
Hot carcass weight (kg)	19.85	19.61	20.21	20.03	1.49	0.87	0.98	0.81
Dressing percentage	56.01	56.04	57.41	56.68	0.47	0.13	0.43	0.13
Cold carcass weight (kg)	19.63	19.31	19.84	19.71	1.42	0.86	0.98	0.81
Carcass length (cm)	56.50	56.00	55.50	55.50	1.98	0.70	0.91	0.95
Leg length (cm)	25.40	24.60	23.50	23.80	1.20	0.28	0.65	0.76
Leg circumference (cm)	41.10	41.30	41.60	42.60	0.78	0.19	0.61	0.86
Chest perimeter (cm)	64.40	65.80	65.20	65.40	2.03	0.79	0.77	0.76
Chest depth (cm)	32.40	32.20	32.20	31.70	1.30	0.72	0.91	0.91
LM area (cm^2)	13.73	13.74	14.43	13.92	0.34	0.43	0.46	0.24
Fat thickness (cm)	0.36	0.30	0.26	0.26	0.02	0.01	0.18	0.84
Kidney-pelvic fat (%)	3.01	2.86	2.86	2.42	0.22	0.09	0.66	0.56
Estimated yield grade	1.82	1.58	1.42	1.42	0.08	<0.01	0.18	0.83
LM composition (%)								
Protein	21.13	21.34	21.22	20.85	0.34	0.54	0.41	0.96
Fat	11.92	11.45	9.35	9.93	0.43	0.01	0.25	0.04
Protein to fat ratio	1.78	1.89	2.27	2.10	0.08	<0.01	0.11	0.03

[a] *P* = Observed significance level for linear, quadratic, and cubic effects of supplementation level of Cr-methionine.
Yield grade was estimated as: YG = (Fat thickness, in × 10) + 0.4 (8), where 1 = most desirable, minimum fat and heavily muscled, and 5 = least desirable, fat and light muscled.

with 0.47 mg/head of Cr tripicolinate did not affect kidney or pelvic fat weight of feedlot lambs. Chromium appears to potentiate insulin action by enhancing its binding to target cell receptors and also by improving its postreceptor signaling, contributing to enhanced lean tissue growth (18,19). However, ruminants are more resistant to insulin than nonruminants (20), which could explain the absence of effects on growth performance and carcass in some studies.

It is concluded that Cr methionine supplementation has a modulating effect on carcass by reducing fat; maximal response to Cr supplementation was reached when Cr was supplemented at a daily dose of 1.80 mg/head.

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