IMPACT OF ORGANIC CHROMIUM ON SOME PRODUCTIVE PERFORMANCES AND PHYSIOLOGICAL RESPONSES OF GROWING BARKI LAMBS

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SUMMARY

This study was conducted to evaluate the effect of chromium methionine on some productive performances and physiological responses of growing Barki lambs. Thirty-three lambs averaged 35.37 kg body weight; 5 months old were divided into 3 similar groups of 11 animals according to their live weight. The three groups were assigned at random to the three experimental groups as follow: G1: control ration without chromium, G2: control ration with 1.50 mg chromium/head/day, G3: control ration with 3 mg chromium/head/day. The growth trial was conducted for 90 days. Lambs were weighed every two weeks before morning feeding after 15 h of fasting. Body weight gain was recorded and daily feed intake was calculated. Dry matter (DM), total digestible nutrients (TDN) and digestible crude protein (DCP) intake were calculated. Feed efficiency ratio was calculated. Results indicated that, either G2: 1.50 mg /head/day or G3: 3 mg /head/day Cr supplementation had no effects on the digestibility of DM, OM, CP , EE and DCP, but G3 (3 mg /head/day). But had significant (P<0.05) increase on digestibility of CF, NFE and TDN compared with G2 and control group. At the same time Cr supplementation did not affect on globulin, creatinine, ALT and AST in blood plasma. Furthermore, no effect on urea. At the same time G3 (3 mg /head/day) Cr supplementation led to increase protein, albumin and blood glucose compared with G2 and control group. In addition, Cr supplementation had no effects on rumen pH, Total volatile fatty acids (TVFA's) and ammonia concentrations at zero time and at 4 hours post feeding. At the same time G2 (1.50 mg /head/day) or G3 (3 mg Cr/head/day) had significant (P<0.05) increase total weight gain and average daily gain. Thus, Cr supplementation in G2 and G3 improved feed efficiency. From the present results it can be concluded that supplementation of Cr in organic form led to positive effect on deferent performances as a result of improving physiological responses.

Keywords: chromium methionine**,** blood performance**,** Physiological responses, Barki lambs.

INTRODUCTION

Trace minerals required by farm animals at low doses, but it have an important role in the metabolic process and prevents many health problems. Chromium (Cr) as trace mineral required as an essential nutrient. However, its daily requirements are not established yet, but it seems that they increase under certain stress conditions like exercise, transport and sickness. (Anderson, 1987 and NRC, 2007).

Functions and effects of Cr involve an increment in cellular sensibility to insulin, which influences on the metabolism of carbohydrate, lipids and protein (Mertz, 1993) and on the sensitivity of cells to insulin and glucose metabolism (NRC, 1989 and NRC, 2007). In addition, chromium is necessary in protein synthesis and corporal growth and also, improves productivity due to a better energy metabolism (Jacques and Steward, 1999). However, the magnitude of the metabolic response of Cr apparently depends on the chemical form. Organic forms are more effective than inorganic ones (Page *et al.*, 1993), since the level of absorption of these is very low from 0.4 to 3.0% (Anderson *et al.*, 1997). Lindemann *et al. (*1995) suggested that the use of organic sources of Cr as an alternative for their increased biological availability to be more soluble in all the digestive tract and reduce the risk of negative interactions with other minerals. According to that Cr considered as a metabolic manipulator with the potential to improve growth rate, enhance feed efficiency and profitability of livestock production (Dikeman, 2007).

The predominant physiological role of Cr is as an integral component of the organo-metallic molecular complex called glucose tolerance factor (GTF), which facilitates the cellular binding and actions of insulin and promotes the utilization of glucose and other metabolites by cells (Vinson and Hsiao, 1985). Glucose tolerance factor is the most biologically active form of Cr, but is usually low in plant-origin diets. However, organic Cr such as Cr picolinate (CrPic), Cr nicotinate (CrNic), amino acid-chelated Cr, and high-Cr yeast has demonstrated

Sheep studies have focused on evaluating the effect of Cr in nutrients metabolism (Da Rocha *et al.*, 2013 and Zhou *et al.*, 2013), immunological status and carcass characteristics (Domínguez-Vara *et al.*, 2009 and Yan *et al.*, 2010). Therefore, the objective of this study was to evaluate the effects of different levels of Cr supplementation in organic form on some performances and physiological responses in lambs.

MATERIALS AND METHODS

Experimental design:

A growth trial was conducted for 90 days. Thirty three Barki lambs averaged 35.37kg body weight; 5 months old were divided into 3 similar groups of 11 animals according to their live weight. The three groups were assigned at random to the three experimental groups as follow: G1: control ration without chromium, G2: control ration with 1.50 mg chromium/head/day, G3: control ration with 3 mg chromium/head/day. Chromium used in this experiment was in organic form (Availa® Cr 1000) chromium methionine from ZINPRO Company. The formulation and chemical composition of basal ration is presented in Table (I).

Table (1): Formulation and chemical composition of basal ration.

Ingredient	%	Chemical composition	%
Alfaalfa hay (16% CP)	40	Dry matter (DM)	93.15
Yellow corn	36	Organic matter (OM)	89.59
Soybean meal (44%CP)	3.6	Ash	10.41
Sunflower meal(36% CP)	6	Crude protein (CP)	15.80
Wheat bran	12	Crude fiber (CF)	14.39
Limestone	1.5	Nitrogen free extract (NFE)	56.30
Salt	0.66	Ether extract (EE)	3.10
*Premix	0.18	Acid detergent fiber (ADF)	42.20
Anti-toxin	0.06	Neutral detergent fiber (NDF)	28.71

**Each 3 kg contained 7500000 IU vit. A, 2000000 IU vit. D_3, 25000 mg vit. E, 40g zinc, 40g manganese, 50g iron, 15g copper, 8g iodine, 4g cobalt, 3g selenium and carrier $CaCo_3$ up to 3 kg.*

The growing lambs were fed concentrate feed mixture and clover hay twice daily to cover their total requirements of sheep according to NRC (1985), animals were fed in groups. Orts were collected just before offering the next day feed. Fresh water was allowed all the day round time. Lambs were weighed every 15 days after 15 h of fasting before morning feeding. Body weight gain was recorded and daily feed intake was calculated. Dry matter (DM), total digestible nutrients (TDN) and digestible crude protein (DCP) intake were calculated. The feed efficiency ratio was calculated as follow daily gain g / daily feed intake as DM. At 90 day from beginning 5 animals from each group were used in digestibility trials to evaluate the experimental rations for TDN and DCP, according to Van Keulen and Young (1977).

Sampling and analytical procedures:

Chemical analyses:

Dried feeds, orts, feces samples were ground through a wiley mill using a 1 mm screen. Samples were analyzed according to AOAC (2000), fiber fractionations (NDF and ADF) were completed according to Van Soest *et al*. (1991). Nitrogen free extract was calculated by difference.

Rumen liquor sampling:

Just before morning feeding rumen liquor samples were taken (four hours post feeding). Samples of rumen liquor were strained through two layers of cheesecloth and its pH was immediately measured after collection. The pH value of rumen liquor samples was determined using pH meter. Quantitative analysis of Total volatile fatty acid and ammonia concentration were carried out according to Szumacher-Strabel and Potkanski (2002).

Blood parameters:

Blood samples were taken from 5 animals at the end of the digestibility trials. Blood plasma parameters were analyzed using commercial kits obtained from Stanbio Laboratory, Boerne, Texas, USA. Total protein and creatinine were determined according to Tietz (1986) and Tietz and Saunders (1990), respectively. Albumin was determined according to Doumas *et al*. (1971). Blood plasma urea was determined according to **Patton and Grouch (1977)**. Alanin amino transferase (ALT) and aspartate amino transfearse (AST) activities were colorimetrically determined according to Young (1997). Glucose was executed according to Trinder (1969).

Statistical analysis:

Data were analyzed using the general linear model procedure of SAS (2001). One way ANOVA procedure used to analyze data according to the next model; $Y_{ij}=\mu+T_{ij}+ e_{ij}$, were: μ is the overall mean of Y_{ij}; T_{ij} is the treatment effect; the e_{ij} is the experimental error. Differences among means were separated according to Duncan New Multiple Range Test **(Duncan, 1955).**

RESULTS AND DISCUSSION

Digestion coefficients and nutritive values:

Results in Table (2) indicated that, either G2 (1.50 mg /head/day) or G3 (3 mg /head/day) Cr supplementation had no effects on the digestibility of DM, OM, CP , EE and DCP, but G3 had significant (P<0.05) increase in digestibility of CF, NFE and TDN compared with G2 and control group.

Table (2): Digestion coefficients and nutritive values of the experimental groups.

Item	Treatments			±SE
	G1	G2	G3	
DM	83.25	83.49	83.84	0.38
OM	84.39	85.13	84.93	0.37
CP	78.92	80.82	78.93	0.53
EE	84.43	84.08	82.05	0.81
CF	74.50^{b}	75.51^{ab}	77.28^{a}	0.53
NFE	69.45^{b}	71.73^{b}	75.12^{a}	0.95
Nutritive values %				
TDN	72.93^{b}	73.30^{ab}	74.24^{a}	0.52
DCP	12.47	12.78	12.47	0.90

a, b :Means in the same row with different superscript are significantly differ (P<0.05). G1: Control group without chromium, G2: Control ration with 1.5mg chromium/head/day, G3: Control ration with 3mg chromium/head/day, TDN: Total digestible nutrients and DCP: Digestible crude protein.

Rumen parameters:

Results in Table (3) illustrated that, G2 (1.50 mg /head/day) and G3 (3 mg /head/day) Cr supplementation had no effects on rumen pH, TVFA and ammonia concentrations at zero time and at 4 hours post feeding. These results are agreement with Besong *et al.* (2001) they found that the effects of supplemental Cr 0.8 mg/kg of Cr as chromium picolinate had no effects on rumen TVFA's concentrations at 12 and 24 hours for Holstein steers.

Table (3): Rumen parameters of the experimental groups.

Item	Treatments			±SE
	G1	G2	G3	
Rumen pH				
At zero time	6.78	6.81	6.92	0.09
At 4 hours post feeding	6.22	6.25	6.35	0.08
Mean	6.50	6.53	6.64	0.08
Rumen Ammonia (mg/100 ml)				
At zero time	10.29	9.94	9.53	0.26
At 4 hours post feeding	11.21	11.69	12.10	0.24
Mean	11.19	10.82	10.73	0.22
Total volatile fatty acids (meq/100 ml)				
At zero time	6.94	6.78	6.94	0.08
At 4 hours post feeding	8.51	8.77	8.83	0.10
Mean	7.80	7.33	7.66	0.09

G1: Control group without chromium, G2: Control ration with 1.5mg chromium/head/day, G3: Control ration with 3mg chromium/head/day.

Blood parameters:

Data in Table (4) illustrated that Cr supplementation led to no significant effect on globulin, creatinine, ALT and AST in blood plasma. Furthermore, no effect on urea and total protein. Similar results were reported by Sung *et al.* (2015) in steer**.**

Also**,** similar results were reported by Kitchalong *et al*. (1995) in lambs. At the same time G3 (3 mg /head/day Cr supplementation) had significant ($P<0.05$) increase on albumin and blood glucose compared with G2 and control group. Also, the present results are agreement with Domínguez-Vara *et al.* (2009). They fund that using 0.25mg Cr/d increase plasma glucose concentrations as the Cr-yeast supplemented in lambs ration. Cr-yeast might have acted indirectly on glucose metabolism as results effect on insulin secretion. Chromium has potentiated insulin action by enhancing its binding to target cell receptors and also by improving its post-receptor signaling. Insulin has increased protein synthesis, efficiency of amino acid transport, reduced protein degradation rate and increased carbohydrate and lipid utilization. The present results indicated that, there are increases in the total protein ($P>0.05$) and albumin ($P<0.05$) in G2 and G3 as a result of supplementation of Cr in comparison with control group. The increase in previous parameters may be due to the positive effect of Cr supplementation in insulin secretion. Debski *et al*. (2004) reported that, supplementation of Cr-yeast led to positive effect of protein synthesis.

Although the physiological mechanism by which insulin function is purportedly enhanced by organic chelates of Cr is unknown, it may be due to the direct action of this trace element on insulin-sensitive tissues in response to changes in circulating insulin and glucose levels. For instance, in human and rat tissues, Cr disappearance from the blood and uptake by insulin-sensitive tissues is enhanced by insulin and glucose (Morris *et al*., 1993).

Table (4): Blood parameters of the experimental groups.

Item	Treatments			±SE
	G1	G2	G3	

Total proteins, g/dl	5.95	6.27	6.52	0.13
Albumin, g/dl	2.80[b]	2.80[b]	3.10[a]	0.06
Globulin, g/dl	3.15	3.47	3.42	0.13
Urea, mg/dl	37.00	35.75	38.00	0.70
Creatinine, mg/dl	1.05	1.12	1.05	0.03
ALT, IU/L	43.50	45.50	47.00	0.84
AST, IU/L	46.50	44.75	44.75	0.62
Glucose, mg/dl	63.00[b]	71.00[ab]	76.75[a]	2.45

[a, b]:Means in the same row with different superscript are significantly differ (P<0.05), G1: Control group without chromium, G2: Control ration with 1.5mg chromium/head/day, G3: Control ration with 3mg chromium/head/day.

Growth performance and feed efficiency

Results in Table (5) showed that**,** G2 (1.50 mg /head/day) or G3 (3 mg /head/day) Cr supplementation had significant (P<0.05) increase in total weight gain and average daily gain. Generally, Cr supplementation in G2 and G3 improved feed efficiency.

Several authors suggest that chromium supplementation improve the growth performance of lambs. Domínguez-Vara *et al.* (2009) used 0.0, 0.25 and 0.35 mg kg–1 dry matter of organic Cr in Rambouillet sheep, they found that supplementation of Cr led to positive effect on dry matter intake and feed efficiency and linear increment in final live weight, total gain weight and daily weight gain as doses of Cr increased. Likewise, Estrada *et al.* (2014) to assess different levels of Cr-enriched yeast (1, 2 or 3 g d–1) increased the growth of sheep. Also, Chang and Mowat (1992) and Moonsie- Shageer and Mowat (1993) found that chromium-nicotinic acid complex supplementation in ration of calves increased average daily gain and improved feed intake and feed efficacy. In addition Moonsie-Shageer and Mowat (1993) found that, chromium supplementation of stressed calves also has improved or at least tended to improve gain and feed efficiency.

Table (5): Growth performance and feed efficiency of the experimental groups.

Item	Treatment			±SE
	G1	G2	G3	
Initial body weight, kg	35.33	35.42	35.37	2.70
Final body weight, kg	49.82	51.44	52.92	4.38
Total weight gain, kg	14.94[b]	16.02[ab]	17.55[a]	2.96
Average daily gain, g	166[b]	178[ab]	195[a]	5.61
Feed efficiency	107	113	121	---
Average Dry matter Intake (g/head/day)	1545	1576	1602	---
Improvement in feed efficiency	100	105	113	---

[a, b:] Means in the same row with different superscript are significantly differ (P<0.05), G1: control group without chromium, G2: control ration with 1.5mg chromium/head/day, G3: control ration with 3mg chromium/head/day, FCR: feed conversion ratio.

CONCLUSION

From the previous result it can be concluded that supplementation of Cr in organic form led to positive effect on different productive performances as a result of improving physiological responses.

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تأثير الكروميوم العضوي علي بعض الخصائص الانتاجية والاستجابات الفسيولوجية علي الحملان البرقي النامية

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اجريت هذه الدراسة لتقييم تأثيراستخدام الكروميوم مثيونين علي بعض الخصائص الانتاجية والاستجابات الفسيولوجية علي حملان البرقي النامية. استخدم في هذه الدراسة عدد 33 حمل نامي متوسط اوزانها 35.37 كجم وعمرها 5 شهور، وقد تم تقسيم الحملان الي ثلاثة مجموعات كل مجموعة 11حيوان وقد تم التقسيم تبعا لوزن الجسم وكانت المجموعات كالاتي: المجموعة الاولي ج$_1$ تم تغذيتها علي العليقة الكنترول مع عدم اضافة الكروميوم اما المجموعة الثانية ج$_2$ تم تغذيتها علي العليقة الكنترول مع اضافة 1.5 ملجرام كروميوم لكل راس يوميا و المجموعة الثالثة ج$_3$ تم تغذيتها علي العليقة الكنترول مع اضافة 3 ملجرام كروميوم لكل رأس يوميا واستمرت التجربة لمدة 90 يوما وتم وزن الحملان كل اسبوعين صباحا بعد فترة صيام لمدة 15 ساعة وقد تم في هذه التجربة تسجيل وزن الجسم وكمية الغذاء المأكول وحساب كمية المادة الجافة المأكولة وايضا حساب مجموع المادة الغذائية المهضومة وكمية البروتين المهضومة كما تم حساب الكفاءة الغذائية بقسمة الزيادة اليومية بالجرام علي كمية الغذاء المأكول يوميا بالجرام كمادة جافة. وقد اظهرت النتائج ان اضافة 1.5ملجرام كروميوم في ج$_2$ او اضافة 3 ملجرام كروميوم في ج$_3$ اظهرت عدم التاثير علي معاملات الهضم لكل من البروتين الخام والمادة العضوية والمادة الجافة والبروتين الخام المهضوم والمستخلص الاثيري ولكن في ج$_3$ (اضافة3 ملجرام كروميوم لكل راس يوميا) ادي الي زيادة معنوية لهضم كل من الالياف الخام والمستخلص الخالي من النيتروجين ، ومجموع المواد الغذائية المهضومة بالمقارنة بالمجموعة الاولي والمجموعة الثانية (ج$_2$) وفي نفس الوقت لم يكن هناك تأثير لاضافة الكروميوم علي تركيز كلا من الجلوبيولين والكرياتينين وانزيمات الكبد وعلاوة علي ذلك لم يكن هناك تاثير للمعاملات علي اليوريا في الدم. وقد اوضحت النتائج ايضا ان المعاملة الثالثة (ج$_3$) ادت الي زيادة في تركيز كلا من البروتين والالبيومين والجلكوز في الدم بالمقارنة بالمجموعة الاولي (الكنترول ج$_1$) والمجموعة الثانية (ج$_2$). بالاضافة الي ذلك وجد ان اضافة الكروميوم لم يكن له تاثير علي الحموضة وعلي مجموع الاحماض الدهنية الطيارة و تركيز الامونيا في سائل الكرش عند وقت الصفر وبعد 4 ساعات وقد اظهرت النتائج ايضا ان اضافة 1.5ملجرام كروميوم (ج$_2$) او اضافة 3 ملجرام كروميوم (ج$_3$) ادي الي زيادة معنوية في الوزن الكلي المكتسب و الزيادة اليومية في الوزن وبالتالي يتضح ان اضافة الكروميوم كان له اثر ايجابي لتحسين الكفأة الغذائية. ومن هذه الدراسة يمكن استنتاج ان اضافة الكروميوم في الصورة العضوية ادي الي تأثير ايجابي في خصائص الانتاج المختلفة كنتيجة لتحسين الاستجابات الفسيولوجية.