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INFLUENCE OF CHROMIUM SUPPLEMENTATION ON THERMO-RESPIRATORY RESPONSE AND SOME BLOOD PARAMETERS OF SHEEP EXPOSED TO EXERCISE UNDER DIRECT SUNLIGHT

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SUMMARY

This study was carried out to investigate the effect of dietary Cr-supplementation on respiration rate (RR) rectal (RT) and skin (ST) temperatures and some blood parameters in sheep exposed to exercise under direct sunlight. Twenty eight Saidi ewes were used in this study. The animals were divided into two treatment groups. A control group with no Cr supplementation and a treated group, supplemented by 250 ppb of Cr as chromium picolinate in concentrate feed mixture. Both groups were fed according to the NRC allowances for 4 weeks. During the last week of treatment, the animals were exposed to exercise under direct sunlight from 11.00 to 13.00 h ,during two days. Respiration rate, RT and ST were recorded just before and after exposure. Also, blood samples were taken for Hb and serum concentrations of total protein, albumin, urea-N, glucose, cholesterol, aspartiate aminotransferase (AST) and alanine aminotransferase (ALT) determinations. Data were statistically analyzed using general linear model (GLM) procedure of SAS. Respiration rate, RT and ST revealed higher (p<.01) values after exposure to exercise than those before exposure in both groups. However, Cr supplemented animals tended to have high increase in RR (172 vs 165%) and low increase in rectal temperature (0.8 vs 1.1ºC) due to exercise compaired with controls. Hemoglobin and serum, total protein and urea-nitrogen were not significantly affected by treatment. However, serum albumin increased significantly after exercise, such increase was more pronounced in Cr-supplemented animals. Exercise decreased serum globulin in both groups. Serum glucose concentration increased by about 82% and 51% in control and Cr-pic supplemented groups, respectively. Both exercise and Cr supplementation decreased (P<0.05) serum cholesterol concentrations. Chromium supplementation decreased both AST and ALT concentrations. However, exercise increased AST concentration by about 2.9 and 2.0 folds in control and Cr-supplemented animals, respectively.

***Keywords**: Sheep, Cr feed supplement, blood, exercise, thermo-respiratory response.*

INTRODUCTION

Chromium activates the ability to regulate blood glucose by improving insulin function (Subiyatno *et al*. 1996, Depew *et al*. 1998 and Hayirli *et al*. 2001) and decreasing cortisol secretion (Chang and Mowat, 1992). According to this function chromium has anabolic effect on lean body mass and catabolic effect on body fat

(Etchalong *et al*. 1995). Calves fed Cr had high glucose disappearance indexes (Bunting *et al*. 2000). This result is mainly due to high insulin secretion in Cr-supplemented animals (Depew *et al*. 1998). Such results suggest a role for Cr in body homeostasis during heat stress. There is no available information on the effect of Cr during exercise. This study aims to investigate the effect of Cr picolinate on thermo-respiratory responses and some blood parameters in sheep subjected to heat stress, exercise under direct sunlight.

MATERIALS AND METHODS

***Animals and treatments**:*

Twenty eight Saidi (Upper Egypt sheep) ewes were classified into two treatment groups (14 each). A control group with no Cr supplementation and a treated group, supplemented by 250 ppb of Cr as chromium picolinate in concentrate feed mixture. Both groups were fed according to the NRC (1985) allowances for 4 weeks in june. During the last week of treatment, the animals were exposed to exercise under direct sunlight for two days. Exercise was by walking for 2 hours (4 km/h) from 11.00 to 13.00 h. In june, average ambient air temperature and relative humidity during exercise were 33.4^{o} C and 29.5%, respectively.

***Thermo-respiratory response**:*

Respiration rate (RR) was determined by counting the flank movements for one minute. Rectal temperature (RT) was measured by using a clinical thermometer. Skin temperature (ST) was measured by using telethermometer. All measurements were recorded just before and after exercise.

***Blood samples and analysis**:*

Blood samples were taken just before and after exercise and transfered to two vials, one without EDTA, and the other contained EDTA. Serum was then separated from the whole blood (vial without EDTA) by centrifugation at 4000 rpm for 15 min, frozen and stored at -20^{o}C until subsequent analyses. Hemoglobin (Hb) concentration (g/dl) was determined by using kits supplied by Diamond Diagnostics (Egypt). Serum total protein, albumin, urea-N, glucose, cholesterol, aspartate aminotransferase (AST) and alanine aminotransferase (ALT) concentrations were determined using test kits supplied by Diamond Diagnostics (Egypt). Serum globulin concentration was obtained by difference between serum total protein and albumin.

Data were statistically analyzed using general linear model (GLM) procedure of SAS (1981). The following model was used:

$Y_{ij}=\mu+A_i + B_j + AB_{ij} + E_{ij}$, where Y_{ij}= experimental observation, μ= general mean, A_i= effect of Cr, B_j = effect of exercise under solar radiation, AB_{ij}= effect of interaction between Cr and exercise under solar radiation and E_{ij} = error.

RESULTS AND DISCUSSION

Thermorespiratory response:

Exercise under solar radiation increased ($P<0.01$) RR, RT and ST in both Cr-treated animals and controls (Table 1). Such increase in RT was mainly attributed to the accumulation of heat in the body due to the incease in metabolic heat production

by muscular activity (exercise) and that added by solar radiation (sun exposure), consequently, increased core body temperature (Kobeisy *et al*., 1997). However, Cr - supplemented animals tended to have high increase in RR (172 vs. 165%) and low increase in RT (0.8 vs. 1.1 ^{o}C) due to exercise with sun exposure. This result means that dietary chromium picolinate may be useful during heat stress, since it increased blood glucose for rapid utilization by respiratory muscles during heat stress. This mechanism may be mediated through enhancement insulin secretion, consequently glucose clearance rate (Depew *et al*., 1998 and Bunting *et al*., 2000).

Table 1. Effect of chromium supplementation on thermorespiratory response of sheep exposed to exercise under direct solar radiation

Item	Control*		Cr-Picolinate		ANOVA		
	Before	After	Before	After	Cr	Ex	CrxEx
RR	87.1b	230.4a	80.8b	219.7a	.08	.01	.65
RT	39.1b	40.2a	39.3b	40.1a	.51	.01	.35
ST	36.0b	38.0a	35.3b	37.8a	.04	.01	.24

*Values are Least-square means (LSM)
Before = before exercise, after= after exercise, Cr=chromium, Ex=exercise
RR= respiration rate,breath/min, RT=rectal temperature, ºC
ST= skin temperature ºC
a,b, Means in the same raw with different superscripts are significantly different (P<0.01).

Some blood traits:

Exposure to exercise under direct sunlight had no significant effect on Hb concentration. However Cr treatment increased hemoglobin concentration (P<0.05, Table 2).

Table 2. Effect of chromium supplementation on some blood constituents of sheep exposed to exercise under direct solar radation

Item	Control*		Cr-Picolinate*		ANOVA		
	Before	After	Before	After	Cr	Ex	CrxEx
Hemoglobin,g/dl	8.6	9.1	9.7	9.6	.05	.66	.54
Total protein, g/dl	7.33	7.23	7.21	6.85	.36	.39	.61
Albumin, g/dl	3.71b	3.98a	3.67b	4.08a	.67	.01	.37
Globulin, g/dl	3.62a	3.25ab	3.55a	2.76b	.27	.02	.40
Urea-N,mg/dl	50.36	53.79	48.83	48.45	.08	.41	.33
Glucose,mg/dl	51.12c	93.13a	55.05c	82.84b	.27	.01	.01
Cholesterol,mg/dl	101.64a	80.18bc	88.03ac	81.93bc	.34	.02	.22
AST,u/l	18.14c	52.86a	16.62c	33.38b	.01	.01	.01
ALTu/l	5.21a	5.93a	4.00b	3.62b	.01	.64	.17

*Values are Least-square means (LSM)
Before = before exercise, After= after exercise, Cr=chromium, Ex=exercise
AST= aspartate aminotransferase and ALT= alanine aminotransferase.
a,b, c Means in the same raw with different superscripts are significantly different (P<0.05).

Chromium supplementation or exposure to exercise had no effect on serum total protein, however exposure to exercise under direct sunlight increased ($P<0.01$) serum albumin in both control and Cr-pico treated animals. This increase was more pronounced in Cr- treated animals (Table 2). Serum globulin decreased after exposure but such decrease was significant in Cr-treated animals. High albumin concentration in Cr- treated animals, particularly after exercise is a useful physiological mechanism during heat stress. Blood albumin concentration control the osmotic pressure of blood and compensate for the loss of water which occurre during evaporative cooling mehanism (Khalifa, 1996).

In Cr-treated animals, serum urea-N concentration tended to be lower than that of controls, both before and after exercise, however the difference was not statisticaly significant (Table 2). Similarly, Amoikon *et al*. (1995) found that plasma urea-N concentration was decreased in pigs fed cr-picolinate.

Serum glucose concentration increased by about 82% in control and in less level (51%) in Cr-supplemented group, in response to exercise under direct sunlight (Table 2). Depew *et al*. (1998) and Hayirli *et al*. (2001) attributed this chromium effects to increased insulin secretion, consequently enhanced glucose clearance rate. (Depew *et al*., 1998, Bunting *et al*., 2000 and Hayirli *et al*., 2001). In addition, Chromium supplementation decreased cortisol secretion as stated by Chang and Mowat (1992). However, high blood glucose after exercise under direct sunlight is a normal physiological reponse due to short exposure to heat stress and/or high cortisol secretion, to provide more metabolic substrates necessary for survival under such condition (Hadley, 1984 and Kobeisy *et al*., 1997).

Exercise under direct solar radiation decreased serum colesterol concentrations by about 21% and 7% in control and Cr- supplemented animals, respectively (Table 2), in agreement with Kobeisy *et al*. (2001) who reported that heat stress by solar radiation decreased serum cholesterol concentration by about 13% in Saidi sheep. The decrease of serum cholesterol concentration due to heat stress may be attributed to the increase of ACTH, during heat stress, resulting in enhanced adrenal steroid synthesis for which cholesterol is precursor (Harper *et al*., 1977). Before exercise, Cr-supplemented animals tended to have lower serum cholesterol concentration compared with controls. Chromium picolinate supplementation decreased serum cholesterol by about 13%. Also in lambs, Etchalong *et al*. (1995) found that plasma cholesterol concentration was decreased by about 17% ($P<0.01$) due to Cr–treatment. In addition, Bunting *et al*. (1994) found that total plasma cholesterol was lower ($P<0.05$) in Cr- fed animals, at wk 4 and wk 6 of the experimental period (about 8 weeks) in Holstein calves and heifers, respectively.

Serum transaminases (AST and ALT):

Exercise under solar radiation increased ($P<0.01$) serum AST concentration by about 2.9 and 2.0 folds for control and Cr-treated animals, respectively (Table 2). This increase may be a support to the increase of glucose demand or the metabolic reaction during heat stress to support high-energy cost of panting (More *et al*. 1980). Similarly, serum AST concentration increased due to direct exposure to solar radiation in sheep (Kobeisy *et al*. 2001) and in Jersey calves (Kobeisy, 1994). However, exposure to exercise under direct sunlight had no significant effect on serum ALT concentration in both group of animals. Although, Cr-pic-fed animals,

both before and after exposure, had lower ($P<0.01$) ALT concentration than controls. Chromium supplementation decreased both AST and ALT concentrations (Table 2).

REFERENCES

Amoikon, E. K., J. M. Fernandez, L. L. Southern, D. L. Thompson Jr., T. L. Ward and B. M. Olcott, 1995. Effect of chromium tripicolinate on growth, glucose tolerance, insulin sensitivity, plasma metabolities and growth hormone in pig. J Anim. Sci., 73:1123-1130.

Bunting, L. D., T. A. Tarifa, B. T. Crochet, J. M. Fernandez, C. L. Depew and J. C. Lovejoy, 2000. Effect of dietary inclusion of chromium propionate and calcium propionate on glucose disposal and gastrointestinal development in dairy calves. J. Dairy Sci., 83:2491-2498.

Bunting, L. D., J. M. Fernandez, D. L. Thompson, Jr, L. L. Southern, 1994. Influence of chromium picolinate on glucose usage and metabolic criteria in growing Holstein calves. J. Anim. Sci. 72:1591-1599.

Chang, X. and D. N. Mowat, 1992. Supplementation chromium for stressd and growing feeder calve. J. Anim. Sci., 70:559-565.

Depew, C. L. , L. D. Bunting, J. M. Fernandez, D. L. Thompson, Jr. and R. W. Adkinson, 1998. Performance and metabolic responses of young dairy calves fed diets supplemented with chromium tripicolinate. J. Dairy Sci., 81:2916-2923.

Etchalong, L. J. M. Fernandez, L. D. Bunting, 1995. Influence of chromium tripicolinate on glucose metabolism and nutrient partitioning in growing lambs. J. Anim. Sci.73:2694-2705.

Hadley, M. E. (Ed.), 1984. Adrenal hormones, In: Endocrinology, pp 344-374, Prentice-Hall, Inc., England Cliffs., New Jersy, UK.

Harper, M. A., V. W. Rodwell and P. A. Mayes, 1977. Review of Physiological Chemistry 16 th ed., Lange Medical Publications, California, pp.76-79, 454, 569-570.

Hayirli, A. , D. R. Bremmer, S. J. Bertics, M. T. Socha and R. P. Grummer, 2001. Effect of chromium supplementation on production and metabolic parameters in periparturient dairy cows. J Dairy Sci. 84:1218-1230.

Khalifa, H. H., 1996. The adaptive responses of local and Finn crossbred sheep. In symposium on : Use of exotic breeds in improving sheep production, finnsheep as a case study. April, 22-23, Cairo, Egypt.

Kobeisy, M.A., 1994. effect of exposure to solar radation on some physiological and hematological parameters in suckling Jersey calves fed ascorbic acid. Vet Med. J. Giza, Egypt, 42:285-291.

Kobeisy, M. A., G. A. Abd El-Hafez, F. F. El-Hommosi and H. S. Badawy, 2001. Influence of solar radiation and feeding level on feed and water intakes, digestibility, thermo-respiratory response and some blood constituents in sheep. 6 th Sci. Cong. Egyptian Society for Cattle Diseases, 4-6 Nov. 2001, Assiut, Egypt.

Kobeisy, M. A., I. A. Salem, M. Zenhom and M. Hayder, 1997. The effect of giving ascorbic acid on some physiological and hematological parameters of suckling lambs exposed to solar radiation and exercise. Assiut Vet. Med. J. 37:120-132.

More, T. , A. K. Rai and M. Singh, 1980. Note on the effect of thermal exposure on body fluid composition of different breeds and breed crosses of sheep. Indian J. Anim. Sci., 50:207-209.

NRC., 1985. Nutrient requirements of sheep (6 th Ed) National Academy of Sciences, National Research Council, Washington, D. C., USA.
SAS., 1981. SAS user's guide, Statistics. SAS Inst. Inc., Cary, NC.,USA.
Subiyatno, A. D. N. Mowat and W. Yang. 1996. Metabolite and hormonal responses to glucose or propionate infusions in periparturient dairy cows supplemented with chromium. J. Dairy Sci., 79:1436-1445.

تأثير أضافة الكروم على الأستجابة الحرارية والتنفس وبعض مقاييس الدم فى الأغنام المعرضة للأجهاد الرياضى تحت اشعة الشمس

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تبحث الدراسة تأثير الكروم فى العليقة على معدل التنفس وحرارة المستقيم والجلد وبعض مكونات الدم فى الأغنام المعرضة للأجهاد الرياضى تحت اشعة الشمس.ثمانية وعشرون من النعاج الصعيدى استخدمت فى هذة الدراسة. قسمت الحيوانات الى مجموعتين الأولى ضابطة والثانية غذيت على عليقة مركزة بها ٢٥٠ جزء فى البليون كروم فى صورة بيكولينات الكروم. غزيت المجموعتين طبقا لمعدلات (NRC) لمدة ٤ اسابيع. تم تعريض الحيوانات الى الأجهاد الرياضى تحت اشعة الشمس فى الاسبوع الأخير ومن الساعة ١١–١٣ ظهرا لمرتين .تم تسجيل معدل التنفس وحرارة المستقيم والجلد قبل وبعد التعرض. كما اخذت عينات دم لتقدير الهيموجلوبين ومكونات السيرم من البروتين الكلى والألبيومين واليوريا والجلوكوز والكولسترول وانزيمات الكبد الناقلة للآمين AST & ALT . تم تحليل البيانات بواسطة برنامج (SAS). أرتفع كل من معدل التنفس وحرارة المستقيم والجلد معنويا($P<0.01$) بعد التعرض للأجهاد فى المجموعتينز ولكن مجموعة الكروم كان معدل ارتفاع التنفس نتيجة للأجهاد اعلى (١٧٢% مقارنة ١٦٥%) فى حين انخفضت معدل الزيادة فى حرارة المستقيم (٠.٨ مقارنة ١.١م) . لم تتاثر بالمعاملة كل من الهيموجلوبين ومكونات السيرم من البروتين واليوريا. أزداد محتوى السيرم من الألبيومين نتيجة للأجهاد وكانت هذة الزيادة اكثر فى مجموعة الكروم. أدى الأجهاد الرياضى الى انخفاض فى تركيز الجلوبيولين فى المجموعتين. أزداد محتوى السيرم من الجلوكوز بواسطة ٨٢% و ٥١% فى المجموعتين الضابطة والمعاملة على التوالى. الأجهاد الرياضى واضافى الكروم ادى الى انخفاض ($P<0.05$) الكولستيرول فى السيرم. ايضا اضافة الكروم فى العليقة ادى الى انخفاض تكيز انزيمات الكبد الناقلة للأمين (AST & ALT). الأجهاد الرياضى ادى الى زيادة فى محتوى السيرم من AST بواسطة ٢.٩ و ٢ مرة فى الضابطة والمعاملة بالكروم على التوالى.