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SHORT COMMUNICATIONS

Evaluation of the effects of chromium supplementation on growth and nitrogen balance of camel calves under summer conditions

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Abstract One of the most important problems in the production of camels in arid and semi-arid zones is the reduced feed intake and consequent low growth rate during summer. Under these stressful environmental conditions, chromium (Cr) supplementation to the diet of growing camel calves may be beneficial. Therefore, the objective of this study was to evaluate the effects of feeding a diet supplemented with different levels of Cr on growth performance of camel calves reared in a hot arid environment. A total of 15 male camel calves (4–5-month-old, 123±7 kg body weight) were used in this study. The animals were divided into three equal groups (A, B, C), 5 animals each, and housed individually under shelter. Camel calves were fed ad libitum on either total mixed ration (TMR) without Cr supplementation (group A), TMR supplemented with 0.5 mg Cr/kg DM (group B), or TMR supplemented with 1.0 mg Cr/kg DM (group C). Supplementation of 0.5 mg Cr/kg DM to the diet of camel calves did not alter feed intake, however, increased not significantly (P=0.086) average daily gain (ADG) and N retention. Plasma cortisol level was reduced by 10 %, and feed utilization efficiency was improved by 12 % in 0.5 mg Cr/kg DM-supplemented group compared to the control. Thus, 0.5 mg Cr/kg DM dietary supplementation to camel calves reared under hot summer condition increased weight gain by 17 % and reduced feeding cost of producing a unit of weight by 11 %.

Keywords Chromium · Dromedary · Feed efficiency · Hot environment

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Introduction

One of the most important problems in the production of camels is the low growth rate and high mortality rate of camel calves (El-Waziry et al. 2012; Al-Ruwaili et al. 2012). Beneficial effects of supplemental Cr for farm animals, especially under stressed conditions are well known. It had been demonstrated that organic chromium supplementation could improve performance, decrease morbidity, and alleviated the negative effects of stress in newborn calves (Ghorbani et al. 2012). The benefits of Cr in the metabolism of nutrients such as carbohydrates, fats, protein, and nucleic acids have been demonstrated (Zhou et al. 2013). Previous studies have shown the positive effects of Cr supplementation on the immune response and production performance of transportation-stressed sheep (Kraidees et al. 2009). Moreover, Cr supplementation improved growth performance during fattening stage and resulted in higher average daily weight gain in lambs (Arvizu et al. 2011).

However, to our knowledge, the effect of the inclusion of Cr to the diet of growing camels on growth performance is lacking. Therefore, the objective of this study was to evaluate the effect of dietary Cr supplementation on growth performance of camel calves reared under hot arid environment.

Material and methods

Fifteen Mejaheem 5–6-month-old male camel calves (*Camelus dromedarius*) with an average body weight of 123 ±7 kg were used in this study which is conducted during dry summer season. Camel calves were divided into three groups (A, B, C), each group with five animals and were housed individually under shelter. During the experimental period (12 weeks), camel calves were fed TMR without Cr

supplementation (group A), TMR supplemented with 0.5 mg Cr/kg DM (group B), or TMR supplemented with 1.0 mg Cr/kg DM (group C), in the form of Cr-yeast. TMR contained on DM basis: 13 % CP, 9 % CF, 50.8 % NDF, 16.3 ADF, 2 % EE, 1.2 % Ca, 0.5 % P, 0.7 % NaCl, and 2.95 MJ/kg digestible energy. Feed was offered ad libitum and camel calves had free access to fresh clean tap water.

Ambient temperature (T_a) and relative humidity (RH) were recorded using data loggers (HOBO Pro Series, ONSET, USA). Temperature-humidity index (THI) was calculated according to the equation of Nienaber and Hahn (2007), where THI is calculated as:

$$0.8\ \text{dry bulb temperature(dbT)} + \%\ \text{relative humidity(RH)} \times (\text{dbT} - 14.4) + 46.4$$

Live body weight was recorded before the morning meal at the start of the experiment, and every 2 weeks thereafter using a large animal balance (Weighing System Company Limited, Shanghai, China), then the average daily gains (ADG) were calculated. Feed offered to camels and the residual feeds were weighed weekly using a top balance (Acuweigh Corporation, Taipei, Taiwan), then the average daily feed intakes were calculated. ADG and feed conversion ratio (FCR) were calculated according to the equations: ADG=mass increase (kg)/number of days; FCR=average daily feed intake (g)/average daily weight gain (g). Blood samples were collected from all animals every 4 weeks by jugular venipuncture into EDTA-coated tubes for determination of plasma cortisol using ELISA kit (HUMAN GmbH, Wiesbaden, Germany).

A metabolic trial for a period of 7 days was conducted after 84 days of dietary treatments. All camel calves were housed in individual-shaded metabolic stalls with their respective dietary treatments and free access to fresh clean tap water. The diet was weighed daily and then offered to each animal with 4 days adaptation period followed by 3 days collection period. During sample collection period, urine was collected via a funnel below the crate in a plastic container containing 100 ml 6 N HCl to maintain a pH below 3.0 in order to prevent nitrogen volatilization. Urine volume was recorded daily at 9.00 a.m., and 50-ml samples were collected and frozen for laboratory analysis. Total feces weights were recorded daily at 9.00 a.m., and 200-g samples of freshly voided feces were collected daily and frozen for N analysis. Feed intakes were estimated by calculating the difference between offered and residual feed everyday, and feed subsamples were retained for N analysis. Samples of feed, urine, and feces were proximately analyzed for N contents using Kejeldahl method. N balance was calculated according to the equation:

$$\text{N balance} = [\text{N intake g/d} - (\text{fecal N g/d} + \text{urine N g/d})]$$

Table 1 Effects of dietary chromium supplementation on growth performance and feed conversion ratio in dromedary camel calves reared in hot arid environment

	0.0 mg Cr/Kg DM	0.5 mg Cr/Kg DM	1.0 mg Cr/Kg DM	*P* value
Exp. period (days)	84	84	84	
iBW (kg)	124±10	124±13	122±14	0.995
fBW (kg)	187±13	199±14	181±19	0.105
ADG (g/day)	757±49	889±46	702±80	0.086
ADFI (kg/day)	3.3±0.2	3.5±0.1	3.0±0.3	0.331
FCR (kg/kg)	4.4±0.2	3.9±0.3	4.3±0.3	0.408

iBW=initial body weight; fBW=final body weight; ADG=average daily gain; ADFI=average daily feed intake; FCR=feed conversion ratio

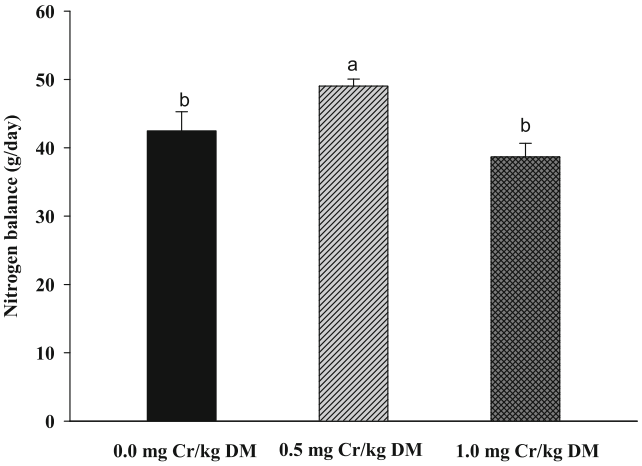

Fig. 1 Effects of dietary Cr supplementation (0.0, 0.5, 1.0 mg/kg DM) on nitrogen retention in dromedary camel calves reared in hot arid environment (bars with different superscripts are different at $P=0.086$)

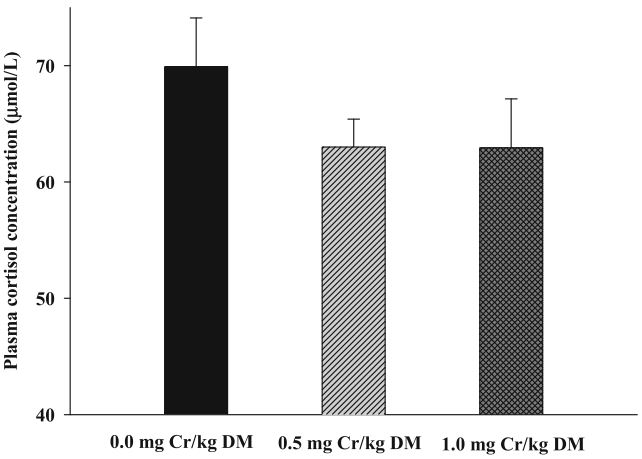

Fig. 2 Effects of dietary Cr supplementation (0.0, 0.5, 1.0 mg/kg DM) on plasma cortisol levels in dromedary camel calves reared in hot arid environment

Statistical analysis

Data were subjected to general linear model (GLM) procedure (SAS Institute). The comparison of means at 0.05 level of significant was conducted using Holm-Sidak test.

Results and discussion

Camel calves were exposed to high average ambient temperature (T_a=35±0.1 °C) with a minimum value of 21 °C and a maximum value of 46 °C and an average relative humidity of 13±0.3 %. This resulted in temperature humidity index (THI) of 73±0.3, with a minimum value of 57 and a maximum value of 86. Thus, camel calves used in this study were exposed to hot arid environment.

Chromium supplementation to the diet of camel calves at 0.5 mg Cr/kg DM did not alter (P=0.331) feed intake, however, showed a trend to increase (P=0.086) average daily gain (ADG) from 757±49 g (control) to 889±46 g in the Cr-supplemented group (Table 1). This was reflected in a higher (P=0.086) total body weight gain of 75±4 kg in Cr-supplemented group compared to 64±4 kg in the control. The calculated feed conversion ratio was improved by 12 % (3.95 vs. 4.42) in 0.5 mg Cr/kg DM-supplemented group compared to the control (Table 1). This clearly indicates that dietary Cr supplementation at 0.5 mg Cr/kg DM increased weight gain by 17 % and reduced feeding cost of producing a unit of weight by 11 %. Chromium inclusion in the diet of camel calves at 0.5 mg Cr/kg DM also showed a trend of increasing (P=0.086) daily nitrogen retention from 43±3 g/day (control) to 49±1 g/day in Cr-supplemented group (Fig. 1). It is worth to mention that dietary Cr supplementation at 0.5 mg Cr/kg DM has reduced plasma cortisol concentration in camel calves by 10 % compared to the control (Fig. 2). The increase in ADG and nitrogen retention at 0.5 mg Cr/kg DM dietary supplementation could be due to the observed reduction in plasma cortisol, and the reported increase in plasma insulin and insulin-like growth factor in Cr-supplemented calves (Soltan et al. 2012). This could have consequently improved energy and protein metabolism and utilization, which are known to be disturbed on exposure to hot environment (Baumgard and Rhoads 2013). This is confirmed by the observed efficient feed utilization in camel calves supplemented with 0.5 mg Cr/kg DM.

On the other hand, 1.0 mg Cr/kg DM dietary supplementation tended to reduce feed intake, N utilization, and body weight gain without affecting feed conversion ratio (Table 1 and Fig. 1). This could be attributed to the reported reduction in both N absorption and utilization at higher dietary Cr supplementation (Kraidees et al. 2009). In conclusion, the impacts of hot arid environment on growth performance of camel calves can be mitigated by dietary supplementation of 0.5 mg Cr/kg DM.

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Conflict of interest The authors declare that they have no conflict of interest.

Statement of animal rights All procedures described in this experiment were approved by the Faculty Research Ethics Committee at King Saud University, Riyadh, Saudi Arabia

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