Lactation Performance and Serum Biochemistry of Dairy Cows Fed Supplemental Chromium in the Transition Period

M. Khalili1[1*], D. Foroozandeh[1] and M. Toghyani[1]

[1]Department of Animal Science, Khorasgan Branch, Islamic Azad University, Esfahan, Iran.

*corresponding Author: m_khalili1362@yahoo.com.

Tel: +989133682542, Fax: +983115354038

This experiment was conducted to study the effect of supplemental chromium on performance and blood serum biochemistry of dairy cows. Thus twenty multiparous Holstein cows (parity 3) were equally divided into two groups. Group one, control, which received no chromium supplementation and group two, treatment group, received 5mg/day chromium methionine from week 5 prior to parturition until 12 weeks thereafter. Milk production and milk composition were evaluated on weeks 4, 8 and 12 after parturition. Serum biochemistry concentrations (serum glucose, cholesterol, triglyceride, total protein, cortisol and insulin concentration) were measured on weeks 2 and 5 prior to parturition and 1 and 4 weeks thereafter. Results indicated that milk production was significantly affected by chromium methionine supplementation during the entire period ($P<0.01$) but no significant effect on milk composition was found. Supplemental chromium had no significant effect on serum glucose, cholesterol, triglycerides and insulin concentration and blood hematology parameters($P>0.05$). However, chromium supplementation tended to increase significantly serum total protein concentration and decrease cortisol concentration ($P<0.05$). The results of this experiment showed that chromium methionine supplementation in multiparous dairy cows diet may improve their Milk yield in transition period.

Keywords: Dairy cow, Transition period, Chromium methionine, Milk yield, Serum biochemistry.

INTRODUCTION

Chromium is a transitional element with an atomic number “24” and an atomic weight of 51.996. Chromium was first shown to be essential in swine by Schwarz and Mertz (1957) when isolate “glucose tolerance factor” (GTF) from swine kidney. Furtheremore, this element has been reported to play essential roles in activity of certain enzymes, metabolism of protein and nucleic acids, as well as impact on immune functions (Beitz et al., 1997). However, only its function as related to glucose metabolism is sufficiently understood. Chromium also aids in the conversion of thyroxin to triodothyronine, increasing the metabolic rate (Burton., 1995).

Potential benefits of supplementing Chromium to livestock have been shown to improve performance in growing and finishing swine and ruminants (Chang and Mowat., 1992; Kejly et al., 1997; Moonsie-Shageer and Mowat., 1993). In studies conducted in dairy cows, chromium supplementation has been shown to increase dry matter intake (Besong et al., 1996; Hayirli et al., 2001; Smith et al., 2002), increase milk yields (Besong et al., 1996; Hayirli et al., 2001; Smith et al., 2002), reduce blood nonesterified fatty acid (NEFA) concentration (Brayan et al., 2003; Depew et al., 1998; Hayirli et al., 2001; Yang et al., 1996), improve fertility (Yang et al., 1996; Bryan et al., 2003; Pechova et al., 2003) and decrease placental retention, and udder edema in older cows (Hayirli et al., 2001; Yang et al., 1996; Villalobos et al., 1997; Stahlhut et al., 2003; Brayan et al., 2003; Burton et al., 1993; Besong et al., 1996).

Since there is no adequate measure of chromium status, establishing dietary requirement for livestock and human is difficult. While the recommended intake for chromium is 50-200 µg per day (National Research Council, 1989) in human; currently there is no established chromium requirement for ruminant. Improvement in impaired glucose tolerance after chromium supplementation is the most sufficient means to determine deficiency.

The aim of the currents study was to assess the effect of supplemental chromium for dairy cows, from 5 wk preparturient through 12 wk postpartum on performance, blood serum biochemistry.

MATERIALS AND METHODS

Animals and dietary treatments

Twenty multiparous Holsteins (parity 3) housed in free stalls at the Esfahan-Kesht farm (near the Esfahan - Iran) were randomly allocated across two treatment group: Ten cows were supplemented once a day with 5 mg/ day Cr from Cr-Met via ball dough corn after the a.m. milking, whereas the other 10 cows received no Cr supplementation. Shortly after the study was initiated, one cow from the Cr-supplemented group suffered a john disease and was removed from the study. Cows received dietary treatments from 5wk prepartum (wk-5) through 12wk postpartum once a day (wk+12). From wk-5 to wk+12 a total mixed diet (NRC, 2001, Table1) was offered to all cows (ad libitum intake). Random samples were taken of these TMR diets which were sent to laboratory for analysis. Also the amounts of chromium of diets were determined by atomic absorption system (Table1).

Production Data

All cows were milked four times per day. At three time points, at 4wk intervals, milk yield was determined and milk samples collected for determination of milk composition. Fat, protein, lactose, solid nonfat, total solid percentages and 4% FCM were evaluated by SOSS 4000 unit.

Blood Sampling

Blood samples were collected from all of the cows, at 5 and 2 wk before expected calving and 1 and 4 week post calving. Blood samples were obtained by 20 ml vein puncture of the coccygel vein during the A.M. milking. After blood was collected, 2 ml of each sample was poured into tubes containing EDTA for determining blood hematology and then remainded sample was centrifuged at 3500 × g for 10 min and the serum stored at 4ºC until further analysis (within 24h). Samples were analyzed for serum glucose, total cholesterol, triglyceride, total protein, insulin and cortisol concentrations.

Glucose, total cholesterol, triglyceride, and total protein, of serum were measured by RA1000 unit. Insulin and cortisole of serum were measured by hormonal insulin and cortisol kits using gamacounter (Kon Pron) system.

Results and Discussion

Milk yield and composition

In present research, Cr supplementation diet had increased milk yield (Table2) which agreed to results of Besong et al., (1996); Hayirli et al., (2001) ; Smith et al., (2005) and Yang et al., (1996). However, Bryan et al., (2004) and Pechova et al. (2002a; 2003) had reported Cr supplementation has no effect on milk yield. At the most studies which increase of milk production has been reported, increase at dry matter intake is also seen (Besong et al., 1996; Hayirli et al., 2001; Smith et al., 2005). Hayirli et al., (2001) reported, diet supplementation with Cr-Met during the periparturient period may increase pre and postpartum DMI and yields of milk in multiparous cows and increase DMI as well as milk yield in primiparous cows.

In our study although possibility of measuring of the rate of dry matter intake was not possible, maybe Cr supplementation has increased dry matter intake. Consequently it caused increase in milk production.

As it is shown in Table 2, milk composition has not affected by Cr supplementation. The composition of milk with regard to Cr supplementation was studied by relatively few authors (Pechova et al., 2003). In most cases they found no difference between the experimental and control group (Besong et al., 1996; Yang et al., 1996; Simek et al., 1999). Hayirli et al., (2001) reported increased fat production and lactose levels in milk after Cr supplementation, which corresponds to our finding.

Serum biochemistry parameters

The effects of Cr methionine supplementation on serum biochemistry parameters in the entire period of experiment and during different experimental periods are shown in Table 3. As shown, glucose and insulin concentration had not been effected by Cr supplementation that is maybe because of inability of chromium on insulin secretion of pancreas gland. Previous studies by Besong et al., (1996); Bryan et al., (2004); Burton et al., (1995) on cow and Gentry et al., (1999) and Kitchalong et al., (1995) on sheep have shown that Cr supplementation has no effect on serum glucose and insulin concentration. However, Chang and Mowat., (1992) and Kegley et al., (1997b; 2000) on calves and Bunting et al., (1994) on cows had reported that Cr supplementation causes decrease in glucose concentration and increase of serum insulin concentration.

In our study Cr supplementation decreased serum cortisol concentration in the entire period of experiment but it was not significant (P>.005) at different experimental periods (Table-3). How chromium affects cortisol production is unknown, but it is clear that glucocorticoids inhibit excretion of insulin (Munck et al., 1984). Because GTF Cr potentates the action of insulin it may inversely inhibit cortisol excretion (Chang and Mowat., 1992).

Chang and Mowat., (1992); Moonsie-Shageer and Mowat (1993)., had reported that Cr supplementation causes decrease in serum cortisol concentration. However, Depew et al., (1998) and Kegley et al., (1997b) did not observe any effect of Cr supplementation on serum cortisol supplementation. As it is shown in Table 3, serum total cholesterol and triglyceride concentration were not affected by Cr supplementation. This can be because of disability of chromium on insulin concentration in our experiment. The role of insulin is proved of lipogenesis stimulus and lipolysis inhibition (Kegley et al., 2000).

Previous studies by Besong et al., (1996); Depew et al., (1998); Kegly et al., (1997b) and Moonsie-shageer and Mowat., (1993) had shown Cr supplementation has no effect on concentration of serum total cholesterol and triglyceride. However, Bunting et al., (1994); Page et al., (1993); Riales et al., (1981) and Subiyatno et al., (1996) had reported Cr supplementation causes reduction in serum total cholesterol and triglyceride concentration.

The present study, using chromium supplementation resulted in some increase in total protein of serum (Table-3). This could be due to the decrease of serum cortisol concentration or an increase of sensitivity tissue to insulin. The role of insulin is proved at increase of synthesis of proteins (Roginski and Mertz., 1969).

These results are in accordance with studies reported by Bunting et al. (1994), Roginskey and Mertz., (1969) and Chang and Mowat., (1992). However, Kitchalong et al., (1995) and Kegley et al., (1997a) reported Cr supplementation has no effect on serum total protein concentration.

In conclusion results of this experiment showed that milk production was significantly affected by chromium methionine supplementation during the entire period, but it had no significant effect on milk composition. Supplemental chromium had no significant effect on serum glucose, cholesterol, triglycerides and insulin concentration. However, chromium supplementation tended to increase serum total protein concentration and decrease cortisol concentration. The results of this experiment also showed using chromium methionine supplementation in multiparous dairy cows diet may improve their Milk yield in transition period.

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Table1. Dry matter composition of base diets fed to non lactation or lactation cows

Diet content	dry off(%)	close up(%)	Lactating(%)
Corn silage	50	48	44.6
Alfalfa hay	19.3	22.8	14.5
Wheat straw	15	13.5	-
Concentrate	15.7	16.7	28.9
Concentrate content (%)			
Corn grain	-	15	26
Barely grain	16	18	23
Cotton seed	-	8	11
Wheat bran	54	10.4	-
Cotton seed meal	6	-	5
Rapeseed meal	13	10	5.5
Soya been meal	8.4	15	20
Fish meal	-	4	1.5
Corn gluten meal	-	4	2
Fat meal	-	4	2.5
Animal supplementation	1	1	1.2
Urea	0.3	-	-
Feso4	-	0.1	-
Caco3	0.3	-	-
DCP	-	0.3	0.4
NH4Cl	-	1.7	-
NaCl	0.4	0.3	0.5
NaHCo3	-	-	1.2
Mg2o	0.6	0.45	-
Mycosorb	-	0.3	0.1
Protoxin	-	6	0.01
Calculated composition			

Protein(%)	12.97	16.09	18.87
NDF(%)	40.25	43.26	48.12
ADF(%)	38.29	32.23	30.26
Ca **(%)**	0.27	0.31	0.35
P**(%)**	0.26	0.16	0.27
Cr (mg/kg)	9	8	8

Table 2. The Effect of Cr-Met supplementation on milk production and composition

Lactation period	Experimental treatment	Milk (kg/d)	Fat (%)	Protein (%)	Lactose (%)	Total solid(%)	SolidNon Fat (%)	FCM %4 (kg/d)
Wk 4 of Lactating	Chromium	46.94 ^{a}	41.7 ^{a}	8.39 ^{a}	11.68 ^{a}	4.58 ^{a}	2.68 ^{a}	3.53 ^{a}
	Control	42.42 ^{a}	41.61 ^{a}	8.16 ^{a}	11.67 ^{a}	4.47 ^{a}	2.55 ^{a}	3.79 ^{a}
	SEM	66.43	2.78	0.12	0.39	0.024	0.092	0.41
Wk 8 of Lactating	Chromium	54.18 ^{a}	42.21 ^{a}	8.48 ^{a}	11.16 ^{a}	4.61 ^{a}	2.74 ^{a}	2.78 ^{a}
	Control	45.68 ^{a}	39.98 ^{a}	8.55 ^{a}	10.44 ^{a}	4.69 ^{a}	2.73 ^{a}	3.78 ^{a}
	SEM	88.7	2.54	0.122	0.52	0.016	0.093	0.14
Wk 12 of Lactating	Chromium	51.28 ^{a}	36.41 ^{a}	8.38 ^{a}	10.84 ^{a}	4.65 ^{a}	2.61 ^{a}	2.63 ^{a}
	Control	44.66 ^{a}	36.8 ^{a}	8.49 ^{a}	10.68 ^{a}	4.27 ^{a}	2.69 ^{a}	2.34 ^{a}
	SEM	86.36	2.45	0.096	0.249	0.281	0.062	0.195
Total experimental period	Chromium	50.80 ^{a}	40.84 ^{a}	8.42 ^{a}	11.22 ^{a}	4.61 ^{a}	2.68 ^{a}	2.98 ^{a}
	Control	44.25 ^{b}	38.80 ^{a}	8.40 ^{a}	10.93 ^{a}	4.48 ^{a}	2.66 ^{a}	2.97 ^{a}
	SEM	2.57	2.59	0.115	0.4	0.054	0.084	0.27

$^{a-b}$ Means in the same column with no common superscripts are significantly different ($P<0.05$)

Table3. The Effect of Cr-Met supplementation on serum biochemistry parameters

Blood sampling periods	Experimental treatment	Glucose (mg/dl)	Total cholesterol (mg/dl)	Triglyceride (mg/dl)	Total protein (mg/dl)	Insulin (µ UA/L)	Cortisol (µ UA/L)
weeks 5 prior to parturition	Chromium	49.89 [a]	34.22 [a]	6.94 [a]	69.11 [a]	155.67 [a]	77.56 [a]
	Control	77.1 [a]	21.3 [a]	7.05 [a]	68.6 [a]	191.2 [a]	63.7 [a]
	SEM	5.16	23.08	0.115	5.47	16.73	6.66
weeks 2 prior to parturition	Chromium	18 [a]	16 [a]	7.09 [a]	55.56 [a]	106 [a]	40.67 [a]
	Control	18.1 [a]	20.3 [a]	6.76 [a]	58.5 [a]	117.2 [a]	35.8 [a]
	SEM	2.6	2.7	0.17	5.16	6.5	2.8
1 week after parturition	Chromium	27.89 [a]	7.89 [a]	7.43 [a]	36.78 [a]	128.2 [a]	48 [a]
	Control	33.1 [a]	11.2 [a]	7.1 [a]	38.3 [a]	120.2 [a]	49.9 [a]
	SEM	2.5	3.5	0.2	2.5	10.7	4.2
4 week after parturition	Chromium	17.11 [a]	7.89 [a]	8.1 [a]	43.22 [a]	182.89 [a]	45.11 [a]
	Control	25.3 [a]	11.4 [a]	7.33 [a]	44.9 [a]	157.4 [a]	43.6 [a]
	SEM	1.46	3.95	0.21	2.2	16.6	2.54
Total experimental priod	Chromium	26.2 [a]	16.5 [a]	7.39 [a]	51.17 [a]	143.2 [a]	52.83 [a]
	Control	38.4 [b]	16.05 [a]	7.06 [b]	52.58 [a]	146.5 [a]	48.25 [a]
	SEM	11.91	3.22	0.181	4.11	14.22	4.37

[a-b] Means in the same column with no common superscripts are significantly different ($P<0.05$)