



Lactation performance and milk quality in crossbred cows fed chromium supplemented ration

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ABSTRACT

Lactating crossbred cattle (16) were divided into 4 groups of 4 each to study the effects of varying levels of Cr supplementation on milk yield, milk composition and nutrient utilization in lactating crossbred cattle. The animals were fed on a basal diet comprising the R: C in the ratio of 1: 1.15 and CP levels of 17%. Chromium picolinate was supplemented to animals under different treatments. DMI/100 kg body weight and per kg metabolic body size among the treatment groups given chromium picolinate was significantly highest in lactating crossbred cows of T4 compared with control group (without Cr supplementation) but did not differ among the chromium supplemented groups. The digestibilities of dry matter, organic matter, crude protein, ether extract, crude fibre and nitrogen-free extract were not affected by chromium supplementation in the ration. Dietary chromium supplementation tended improvement in milk yield as well as 4% FCM, fat and SNF yields. The milk fat, protein, lactose and gross energy contents also increased in milk of cows supplemented with chromium in the ration however differences were nonsignificant. Higher energetic and nitrogen utilization efficiencies were observed for chromium supplemented groups. The Cr supplementation in ration also increased total unsaturated fatty acid concentration in milk fat of all the chromium supplemented groups and it was significantly higher in T2 (0.5 mg Cr/kg DM supplemented group) than control. Dietary supplementation of chromium in lactating crossbred cows was found crucial in improving milk yield and milk quality in terms of milk constituents and unsaturated fatty acids concentration which in turn would be beneficial for cardiac health of milk consumers.

Key words: Chromium, Crossbred lactating cows, Milk composition, Milk quality, Milk yield, Nutrient utilization

Chromium, an essential trace element in laboratory animals, is widely distributed throughout the body as an organometallic molecule and is known as glucose tolerance factor (GTF), which itself get activated by Cr^{+3} ; and is composed of Cr^{+3} , nicotinic acid, glutamic acid, glycine and cysteine (Toepfer *et al.* 1977). The glucose tolerance factor potentiates the effect of insulin on tissues and also showed antioxidative properties *in vivo* (Tezuka *et al.* 1991). Chromium is required for normal metabolism of carbohydrates, proteins and lipids. Chromium received attention in animal nutrition and its dietary supplementation markedly improve dry matter intake and growth rate in stressed feeder and beef calves (Chang and Mowat 1992) along with improvement in milk yield in lactating cattle (Yang *et al.* 1996, Hayirli *et al.* 2001, Smith 2004). The present study was therefore conducted to discern the effects of varying

levels of Cr supplementation on milk yield, milk composition and nutrient utilization in lactating crossbred cattle.

MATERIALS AND METHODS

Animals, diet, management and treatments: Lactating crossbred cattle (12; Holstein × Sahiwal × Jersey) in mid stage of lactation with an average milk yield of 8.92 l/day were selected from Instructional Dairy Farm of the University and divided into 4 groups of 4 animals each. All the experimental animals were housed in a well ventilated shed having cemented floor with facilities of individual feeding. All the cows were offered weighed quantity of chaffed mixed fodder (wheat straw, green oats, green mustard and green berseem in variable ratio) *ad lib.* at 8.00 AM daily. The concentrate mixture was given as per NRC requirements (2001). The roughage: concentrate ratio was 1: 1.15 with CP level of 17%. The concentrate mixture was offered in 2 installments to cows at the time of milking in morning and evening. The Cr as chromium picolinate was fortified into 100g mustard cake in varying proportions, viz. 0, 42, 84 and 126 mg to achieve the 0 (T1, control), 0.5 mg (T2), 1.0 mg (T3) and 1.5 mg (T4) chromium/kg DM, respectively. Finally

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mustard cake fortified with respective levels of chromium picolinate as top dress was offered to respective groups immediately after offering the first installment of the concentrate mixture. The feeding trial lasted for 90 days and during experimental period feed offered and residue left was quantitatively recorded on daily basis. The animals were offered fresh and clean drinking water twice daily. Digestion trial of 6 days duration was conducted after 60 days of feeding trial during which records of daily feed intake and faeces voided were kept. Body weight of each animal was recorded at the start and end of experimental period for 3 consecutive days. The samples of feeds, residue and faeces were analyzed for proximate principles (AOAC 1990).

Milk recording, sampling and analysis: Daily milk yield (litre/day) of each animal in the group was recorded throughout the experimental period. Representative milk samples were taken separately from both morning and evening milking at fortnightly intervals and then pooled in the plastic bottles. Milk samples were subjected to slow thawing for achieving the temperature as 25–30°C and analyzed for fat using Gerber's method (ISI 1962), total solids, protein (N×6.38) and ash content as per Gupta *et al.* (1992). Solids-not-fat (SNF) content was calculated by difference between total solid and fat content, however, lactose content was determined by subtracting the sum of protein and ash content from SNF content. Gross energy (Kcal) of milk was calculated by the formula of Tyrell and Reid (1965).

Efficiency of energy and nitrogen utilization for milk production: The gross and net energetic efficiency for milk production was calculated as per the following formula presuming that 1 kg of TDN contained 4400 kcal of digestible energy (NRC 1989):

$$\text{Gross energetic efficiency (\%)} = \frac{\text{Gross energy of total milk/day (kcal)}}{4400 \times \text{TDN intake (kg/day)}} \times 100$$

The net energetic efficiency of milk production was calculated by subtracting the TDN required for maintenance (35.2 g/kg W^{0.75}) as per NRC (1989) from the total TDN intake as per the formula given below:

$$\text{Net energetic efficiency (\%)} = \frac{\text{Gross energy of milk produced/day (kcal)}}{4400 \times \left[\text{TDN intake (kg/day)} - \text{TDN required for maintenance as } 35.2 \text{ g/kg W}^{0.75} \right]} \times 100$$

The gross and net efficiencies of nitrogen utilization for milk production were calculated using the following formulae:

$$\text{Gross efficiency of nitrogen utilization (\%)} = \frac{\text{Milk nitrogen secreted}}{\text{Feed nitrogen intake}} \times 100$$

$$\text{Net efficiency of nitrogen utilization (\%)} = \frac{\text{Milk nitrogen secreted}}{\text{Digestible nitrogen intake}} \times 100$$

Milk fatty acids profile: Fatty acids were estimated in the ghee (milk fat) prepared from the milk samples collected individually from the animals at the end of feeding trial. The milk collected was converted into ghee by creamery method and then stored in refrigerator for further analysis.

The fatty acid methyl esters of ghee (milk fat) were prepared by base-catalyzed transmethylation reaction using sodium methoxide method (Christie 1982). Samples of milk fat (ghee) and 0.025 N sodium methoxide were taken in glass stoppered test tubes in the ratio of 1: 4 (100 µl of ghee and 400 µl of sodium methoxide). The test tubes were sealed and the contents were mixed using vortex mixer. The tubes were then kept in oven at 80°C for esterification of fatty acids until a uniform layer was formed. The quantification of fatty acid methyl esters was done using a gas chromatograph fitted with flame-ionization detector (FID). The diethyl-glycosuccinate packed column was used with a 10 feet length. The oven temperature was initially 80°C then was increased @ 3°C/min to 220°C and maintained for 5 min. Injector and detector temperatures were 270°C and 275°C, respectively. The carrier gas used was nitrogen @ 30 ml/min. H₂ gas flow rate was 33 ml/min and air flow was 330 ml/min. Sample (1 µl) of fatty acid methyl ester was injected for analysis and the fatty acid peaks were identified using GCMS. The GCMS data was obtained at 70eV and 250°C. Specifications of GC column used for GCMS were fused Silica capillary column 0.25 mm × 50 M with film thickness of 0.25 micron. Carrier gas used was helium @ 2 ml/min. The scan obtained was identified for individual fatty acid by comparing with standard spectrum of methyl esters of individual fatty acid as given in 8 peak mass spectrum index.

Total cholesterol in milk fat: The total cholesterol in milk fat (ghee) was estimated by Liberman-Burchard method (Sabir *et al.* 2003).

Statistical analysis: The data were analyzed for variance and treatment means, and were compared using completely randomized design (CRD) to find out the significance of difference among different treatment groups as per the procedure described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Chemical composition of feeds and fodder: The chemical composition of experimental feeds and fodder is presented in Table 1. The mixed roughage (wheat straw, green oats, green mustard and green berseem in variable ratio) contained 12.60% crude protein whereas concentrate mixture contained 20.88% crude protein on DM basis.

Feeds and nutrients intake, feed efficiency and body weight change: During the entire experimental feeding period the average daily dry matter intake/100 kg body weight was higher (P<0.05) in chromium supplemented groups than

Table 1. Chemical composition of experimental feeds and fodder (% DM basis)

Proximate principles	Mixed fodder (wheat straw + green oats + green mustard + green berseem)	Concentrate mixture	Mustard cake
Organic matter	91.06	87.84	93.69
Crude protein	12.6	20.88	35
Ether extract	1	2.2	7.59
Crude fibre	26.5	11.9	3.12
Nitrogen-free extract	50.96	52.86	47.98
Total ash	8.94	12.16	6.31
Acid insoluble ash	1.69	3.02	0.52

control while dry matter intake per kg metabolic body size was 121.35, 131.95, 135.80 and 146.73 g for respective treatment groups, which was higher ($P<0.05$) with 1.0 and 1.5 mg chromium supplementation/kg diet dry matter than other treatment groups (Table 2). The increase in DM intake in chromium supplemented groups might be due to increased secretion and activity of insulin. The results corroborated with the findings of Hayirli *et al.* (2001) who reported linearly and quadratically increase in dry matter intake in lactating cows during the prepartum and postpartum periods, respectively, with increasing dietary supplemental chromium (as chromium-methionine) levels from 0.03 to 0.12 mg/kg metabolic body weight. Moonsie-Shageer and Mowat (1993) also observed increased ($P<0.05$) dry matter intake with 0.2 and 1.0 ppm chromium supplementation in crossbred steer calves. However, Bailoni and Simonetto (2001) did not find any effect on dry matter intake due to chromium supplementation in heavy lambs. Although highest feed efficiency for milk production was observed in T4 (1.5 mg Cr/kg dry matter), however, no significant difference in feed

efficiency was noticed among various treatments. All the cows in different groups gained body weight during the experimental period which differed significantly ($P<0.05$) among groups (Table 2). The cows in treatment group T1 gained significantly ($P<0.05$) highest body weight.

Dry matter intake/100 kg body weight and per kg metabolic body size during digestion trial was similar among different treatment groups, however it was higher in cows given ration supplemented with chromium (Table 3). Digestible crude protein (DCP) and total digestible nutrients (TDN) intakes per 100 kg body weight or per kg metabolic body size also did not differ significantly in lactating crossbred cows among the different treatment groups due to chromium supplementation, however higher DCP and TDN intakes per unit body weight were observed in chromium supplemented groups of lactating crossbred cows (Table 3). Biswas *et al.* (2006) also reported increased total digestible nutrients intake with supplementation of chromium in prepubertal anoestrus dairy heifers.

Nutrient digestibility: The digestibilities of different proximate principles, viz. dry matter, organic matter, crude protein, ether extract, crude fiber and nitrogen-free extract did not differ significantly among different treatments due to chromium supplementation (Table 3). Kornegay *et al.* (1997) reported that Cr supplementation improved N absorption and dry matter digestibility in growing finishing pigs. Similarly Young *et al.* (2004) also reported that organic matter and energy digestibility for gestating sows fed carnichrome diet were significantly ($P<0.05$) greater. No significant effect on nutrient digestibility due to chromium supplements might be the species effect as in the present study lactating cows were used.

Milk yield and milk composition: The overall average daily milk yield during 90 days of experimental feeding period was similar in different treatment groups of cows, however,

Table 2. Average daily dry matter intake, feed efficiency and live weight change in experimental crossbred lactating cows fed ration supplemented with different levels of chromium during feeding trial of 90 days

Attributes	Treatments/groups			
	T1 (Control, no supplemental chromium)	T2 (0.5mg Cr/ kg DM)	T3 (1.0mg Cr/ kg DM)	T4 (1.5mg Cr/ kg DM)
Average body weight (kg)	422	380.85	381.83	348.853
Roughage DM intake (kg)	5.12±0.25	5.55±0.71	5.44±0.35	5.54±0.37
Concentrate DM intake (kg)	6.16±0.24	6.12±0.15	6.29±0.21	6.29±0.17
Roughage: concentrate : ratio	01:01.2	01:01.1	01:01.1	01:01.1
otal dry matter intake (kg)	11.29±0.47	11.68±0.82	11.74±0.44	11.84±0.54
DM intake/100kg body weight (kg)*	2.68 ^{ab} ±0.07	3.08 ^{ab} ±0.25	3.07 ^{ab} ±0.06	3.39 ^a ±0.04
M intake/kgW ^{0.75} (g)*				
Feed efficiency	121.35 ^c ±2.68	131.95 ^{bc} ±8.01	135.80 ^{ab} ±3.27	146 ^a .73±1.34
(kg milk yield /kg DM intake)	0.73±0.06	0.70±0.09	0.72±0.08	0.75±0.02
Live weight change (g/d)*	392.5 ^a ±78.29	261.39 ^b ±25.69	131.39 ^c ±76.30	186.94 ^{bc} ±31.91

a, b, c Values bearing the different superscripts in a row differ significantly from each other. *($P<0.05$).

Table 3. Average daily dry matter, nutrients intake and digestibility in experimental crossbred lactating cows fed ration supplemented with different levels of chromium during digestion trial

Attributes	Treatments/groups			
	T1	T2	T3	T4
DM and nutrients intake				
Roughage DM intake (kg)	5.98±0.35	6.03±0.60	5.91±0.56	5.81±0.17
Concentrate DM intake (kg)	6.42±0.33	6.09±0.29	6.44±0.43	6.44±0.35
Roughage: concentrate : ratio	1:1.16	1:1.01	1:1.09	1:1.10
Total DM intake (kg)	12.49±0.49	12.22±0.83	12.45±0.79	12.35±0.49
DM intake/100kg body weight (kg)	3.09±0.07	3.33±0.28	3.30±0.16	3.64±0.08
DM intake/kgW ^{0.75} (g)	138.69±2.68	145.55±11.37	145.56±7.49	156.04±1.89
DCP intake (kg)	1.53±0.07	1.49±0.09	1.53±0.11	1.57±0.09
DCP intake /100kg body weight (kg)	0.38±0.01	0.41±0.03	0.41±0.02	0.46±0.01
DCP intake /kgW ^{0.75} (g)	16.99±1.29	17.82±0.64	17.89±0.69	19.86±1.28
TDN intake (kg)	7.36±0.35	7.13±0.51	7.14±0.61	7.19±0.47
TDN intake /100kg body weight (kg)	1.82±0.03	1.94±0.18	1.89±0.13	2.11±0.05
TDN intake /kgW ^{0.75} (g)	81.62±1.63	85.08±7.42	83.46±6.22	90.59±2.56
Nutrients digestibility				
Dry matter	65.39±1.18	64.96±1.34	63.69±1.86	64.20±1.41
Organic matter	68.17±1.06	67.73±1.26	66.74±1.69	67.12±1.41
Crude protein	72.93±1.91	73.51±1.12	72.47±0.62	75.43±1.31
Ether extract	75.99±2.26	66.27±7.79	61.91±4.35	68.46±2.99
Crude fibre	56.35±0.96	52.91±3.09	49.49±1.88	53.37±2.27
Nitrogen-free extract	63.33±1.39	64.33±1.36	63.83±2.17	62.76±1.61

the highest milk yield (8.92 kg) was recorded for cows in group T4 supplemented with 1.5 mg Cr/kg dry matter during all the fortnights and lowest in group T1 without chromium supplementation (Table 4). FCM (4%), fat and SNF yields were also not influenced due to dietary supplementation of chromium in the ration of lactating crossbred cows, however, there was numerically linear increase in 4% FCM, fat and SNF yields with increase in the level of chromium in the ration. The increased dry matter intake in chromium supplemented groups could be the feedback effect of increased milk production in the present study. Chromium supplementation might have increased milk yield due to altered glucose metabolism by altering insulin secretion and in turn increasing lactose synthesis (Subiyanto *et al.* 1996). Yang *et al.* (1996) also observed that supplemental chromium tended to increase milk yield in primiparous cows but had no effect on milk yield in multiparous cows. Hayirli *et al.* (2001) reported increased milk, fat and lactose yields in periparturient dairy cows due to supplementation of 0.03 to 0.12 mg of chromium as chromium-met/kg of BW^{0.75}. Al-Saiady *et al.* (2004) also found increased milk yield in dairy cows fed the diet supplemented with chromium as chromium yeast. However, Pechova *et al.* (2003) and Bryan *et al.* (2004) did not find any significant effect of chromium supplementation on milk yield in dairy cows.

The overall composition of milk was not influenced significantly due to chromium supplementation, however, all milk components, viz. total solids, SNF, fat, protein and lactose and gross energy contents of milk numerically

increased in the groups fed diet supplemented with chromium (Table 4). Yang *et al.* (1996) also observed that the chromium supplementation tended to increase the milk lactose content in primiparous cows. Hayirli *et al.* (2001) reported increased fat and lactose production after chromium supplementation in periparturient dairy cows which corroborated with our findings. Bonomi *et al.* (1997) reported an increase in total protein production by 4.7 to 5.0% due to chromium supplementation in dairy cows.

Energetic efficiency for milk production: The average gross and net energetic efficiencies for milk production ranged from 22.39 to 28.52% and 35.10 to 41.47%, respectively (Table 4). Gross and net energetic efficiencies for milk production were similar among different treatment groups, however, gross energetic efficiency was numerically higher in cows fed ration supplemented with chromium. The values for gross and net energetic efficiency for milk production obtained in present study were more than those reported by Singh *et al.* (2003) in lactating Murrah buffaloes which ranged from 13.15 to 14.03% and 19.88 to 21.60%, respectively. However, Lade *et al.* (2007) reported gross energetic efficiency in crossbred lactating cows ranging from 17.92 to 25.93% and Kumar *et al.* (2005) and Lade *et al.* (2007) reported the values of net energetic efficiency ranging from 31.52 to 35.50% and 31.67 to 51.27%, respectively, in crossbred lactating cows fed ration consisted of wheat straw, concentrate mixture and green berseem and their findings were similar to that observed in the present study.

Efficiency of nitrogen utilization for milk production: The

average gross efficiency of nitrogen utilization for milk production ranged from 15.23 to 17.99% and was not influenced significantly due to chromium supplementation in the diet. Whereas the net efficiency of nitrogen utilization for milk production ranged from 20.76 to 23.87% and remain unchanged due to chromium supplementation, however, efficiency of nitrogen utilization was numerically higher in treatment groups T3 and T4 than in T1 and T2 (Table 4). The gross efficiency of nitrogen utilization recorded in present investigation was lower than those observed by Lade *et al.* (2007) ranging from 22.71 to 29.43% in crossbred lactating

cows. Similarly, net efficiency of nitrogen utilization for milk production observed in the present study was lower than those of Kumar *et al.* (2005) and Lade *et al.* (2007) in crossbred lactating cows ranging from 25.82 to 36.28 and 34.79 to 50.91%, respectively.

Milk fatty acids profile: The concentration of butyric acid, caproic acid, caprylic acid, capric acid, myristic acid, lauric acid, palmitic acid, stearic acid, linoleic acid and linolenic acid in milk fat of different treatment groups showed no significant difference due to supplementation of chromium, however, there was decrease in long chain saturated fatty

Table 4. Average daily milk yield, milk composition and gross and net efficiencies of energy and nitrogen utilization in lactating crossbred cows fed ration supplemented with different levels of chromium during whole experimental period

Particulars	Treatments/groups			
	T1 (Control, no supplemental chromium)	T2 (0.5 mg Cr/ kg DM)	T3 (1.0 mg Cr/ kg DM)	T4 (1.5 mg Cr/ kg DM)
Butyric acid	2.17±0.47	2.56±0.25	3.68±0.65	3.58±0.49
Caproic acid	3.29±0.34	2.63±0.25	2.37±0.21	2.41±0.32
Caprylic acid	1.26±0.19	1.10±0.05	1.22±0.26	0.97±0.08
Capric acid	4.47±0.82	2.83±0.24	3.39±0.47	3.12±0.13
Lauric acid	2.62±0.35	3.26±0.17	3.56±0.30	3.17±0.14
Myristic acid	7.99±1.01	7.82±0.68	7.73±0.26	8.55±0.28
Palmitic acid	21.02±1.31	20.19±1.69	19.51±0.86	18.97±0.48
Stearic acid	8.53±1.14	8.02±0.91	8.23±0.48	7.82±0.26
Oleic acid*	16.54 ^b ±0.54	18.75 ^a ±0.23	16.99 ^b ±0.56	16.96 ^b ±0.57
Linoleic acid	1.01±0.29	1.07±0.08	1.18±0.16	1.03±0.11
Linolenic acid	0.66±0.13	0.76±0.05	0.78±0.12	0.77±0.05
Total saturated fatty acids (%)	51.36±1.94	48.40±2.31	49.69±1.19	48.58±0.67
Total unsaturated fatty acids (%) **	18.21 ^b ±0.29	20.58 ^a ±0.28	18.94 ^b ±0.55	18.76 ^b ±0.42
Total cholesterol (mg/g)	2.97±0.15	2.75±0.07	2.68±0.12	2.99±0.06
Milk yield (kg/ d)	8.27±0.83	8.28±1.40	8.44±1.05	8.92±0.58
4% FCM yield (kg/ d)	8.49±0.83	8.78±1.46	8.99±0.97	10.44±0.54
Fat yield (kg/ d)	0.35±0.04	0.36±0.06	0.37±0.04	0.46±0.02
SNF yield (kg/ d)	0.77±0.07	0.78±0.13	0.81±0.09	0.87±0.06
Total solids (%)	13.50±0.54	13.86±0.47	14.22±0.44	14.87±0.43
Solid-not-fat (%)	9.33±0.23	9.39±0.07	9.73±0.23	9.70±0.26
Fat (%)	4.22±0.32	4.48±0.35	4.49±0.24	5.16±0.21
Protein (%)	3.97±0.16	3.86±0.14	4.00±0.12	4.22±0.07
Lactose (%)	4.58±0.16	4.83±0.02	4.97±0.10	4.75±0.19
Total Ash (%)	0.74±0.02	0.69±0.01	0.75±0.02	0.74±0.02
Gross energy (kcal/kg)	791.01±40.43	818.18±35.73	836.41±31.59	896.35±29.26
Metabolic body size	90.09	84.19	85.36	79.18
Milk yield (kg/d)	8.27±0.83	8.28±1.0	8.44±1.05	8.92±0.58
TDN intake (kg/d)	7.35±0.35	7.13±0.51	7.14±0.61	7.19±0.47
TDN used for maintenance (kg/d)	3.17±0.11	2.96±0.07	3.00±0.04	2.79±0.12
TDN available for milk production (kg/d)	4.19±0.25	4.17±0.55	4.14±0.57	4.40±0.36
Gross energy of milk production (kcal/kg)	791.01±40.43	818.18±35.73	836.41±31.59	896.35±29.26
Gross energetic efficiency (%)	22.39±1.33	23.53±2.76	25.05±1.76	28.52±0.99
Net energetic efficiency (%)	35.10±1.89	36.16±2.97	39.59±3.75	41.47±1.81
Feed nitrogen intake (g/d)	336.16±12.86	325.61±20.26	337.32±21.51	333.33±14.59
Faecal nitrogen excreted (g/d)	90.96±7.14	86.46±7.11	92.59±4.84	81.39±1.59
Digestible nitrogen intake (g/d)	245.20±11.91	239.15±14.52	244.73±16.92	251.95±15.29
Total nitrogen secreted in milk (g)	51.99±8.74	50.59±1.20	53.49±2.41	60.05±5.36
Gross efficiency of nitrogen utilization (%)	15.41±0.66	15.23±1.66	15.78±0.92	17.99±0.46
Net efficiency of nitrogen utilization (%)	21.16±0.98	20.76±2.31	21.76±1.15	23.87±0.57

a, b Values bearing the different superscripts in a row differ significantly from each other. * P<0.05, *P<0.01.

acids (palmitic and stearic acids) concentration as the level of supplemental chromium was increased. Oleic acid was significantly ($P < 0.05$) higher in the milk fat of the cows of T2 followed by the treatments T3, T4 and T1. Higher concentration of total unsaturated fatty acids in milk was observed in cows fed ration supplemented with chromium. The values reported for various saturated and unsaturated fatty acids were concordant with the findings of Purushothman *et al.* (2008) and Mewara *et al.* (2008) in lactating crossbred cows supplemented with protected fat or vegetable oil in the ration. The values for various fatty acid concentration reported by Chouinard *et al.* (1998) also supports the present observation. The total cholesterol concentration in milk fat of lactating crossbred cows varied from 2.68 to 2.99 mg/g milk fat in treatments T1 to T4 and did not differ significantly among the groups. The values reported in present study for total cholesterol in the milk fat were similar to Sabir *et al.* (2003) who reported 3.5 mg/g cholesterol in milk fat.

From the findings of the present study, it is concluded that supplementation of trace amount of chromium (up to 1.5 mg/kg diet dry matter) in the ration of lactating cows could be beneficial for improvement in milk yield as well as the milk quality in terms of milk constituents and unsaturated fatty acids concentration which would be beneficial for cardiac health of milk consumers.

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