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RESEARCH ARTICLE

Effect of supplementation of rumen bypass fat with chromium on milk yield and milk fat per cent in dairy cow

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Abstract : The present study was undertaken with the objective to evaluate the effect of rumen bypass fat with chromium supplementation on milk yield and milk fat per cent in dairy cows. Total 12 normal healthy advanced pregnant cows (1 week before expected parturition) was selected and divided randomly into two equal groups. One group (Group I) was kept without supplementation of bypass fat and given only basal diet as a control group. The second group (Group II) was supplemented with rumen bypass fat @ 100 g per animal per day along with basal diet for one week prepartum and upto the period of 4 weeks after parturition. The milk yield and milk fat per cent recorded before supplementation ('0' day) and on 7th, 14th, 21st and 30th day after supplementation of bypass fat, respectively. The milk yield was increased by 12.73 per cent in group supplemented with bypass fat (Group II) as compared to control group (7.02%) on 30th day post supplementation. The milk fat per cent was higher (4.18%) in group supplemented with bypass fat (Group II) as compared to control group (3.75%) on 30th day of post supplementation. The study concluded that, the supplementation of rumen bypass fat @ 100 g per cow per day for one week before expected parturition and upto 4 weeks after parturition improved milk yield and milk fat per cent and proved to be beneficial in fulfilling the energy demand for milk production.

Key words : Dairy cows, Bypass fat, Milk yield, Milk fat per cent, Chromium, Parturition

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INTRODUCTION

In India majority of the diets fed to milch animals are dominated by crop residues, which are low in energy, protein and minerals. Energy is the major limiting nutrient that affects the production potential of lactating animals and the animals are not able to get sufficient energy from their diets resulting in a lower productive performance. During the early post partum period, milk production increases dramatically, while energy intake may not be adequate to sustain the higher production level. This results in negative energy balance and cows metabolize fat to meet their

energy needs (Barley and Baghel, 2009). As a result, most of the cows loss a considerable amount of weight to meet energy demand. Severe weight loss can lead to ketosis, fatty liver formation, reduced reproductive performance and decreased milk yield. Productivity of lactating animas can be enhanced by strategic supplementation with energy and energy density can be measured by incorporating fat in their diet (Sirohi *et al.*, 2010). However, fats which are not protected causes physical and chemical changes in the microbial fermentation of feed that are generally negative and feeding of free or unprotected fat above 1 per cent level has a depressing effect on rumen cellulolytic microbial activity (Palmquist, 1991). This can be overcome by feeding rumen bypass fat which is resistant to biohydrogenation by the rumen microbes and also reduces the risk of metabolic acidosis. Therefore, an attempt was made to access the effect of dietary supplementation of bypass fat on milk yield and milk fat per cent of dairy cows.

RESEARCH METHODOLOGY

In the present study, total 12 advanced healthy pregnant crossbred cows (one week before expected parturition) were selected from Dairy farm of Agricultural University, Akola and divided randomly into two equal groups. One group (Group I) of 6 cows kept without supplementation of bypass fat and given only basal diet as a control group. Second group (Group II) of 6 cows was supplemented with bypass fat ("Extra Energy Plus"– each kg containing - Pure bypass fat - 200 g, Fermented live yeast culture-50 g, Calcium propionate- 10 g and Chromium chelated with Amino Acid- 40 g) @ 100 g per animal per day along with normal diet for 1 week prepartum and upto 4 weeks after parturition. The milk yield was recorded before treatment ('0' day) and daily after treatment. Milk fat per cent was estimated by Gerber method (Richmond, 2004) using Gerber's butyrometer before supplementation ('0' day) and on 7th, 14th, 21st and 30th day after supplementation of bypass fat. The data collected during the present study was analyzed statistically by using two ways Factorial Randomized Block Design (FRBD) as described by Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

The effect of supplementation of bypass fat on milk yield and milk fat per cent in cross bred cows is presented in Table 1.

The group (II) supplemented with bypass fat showed significant ($P<0.05$) improvement in milk yield as compared to the control group kept without supplementation of bypass fat (Table 1). In Group II milk yield was significantly ($P<0.05$) improved on 14th, 21st and 30th day of parturition as compared to milk yield on '0' day (on day of parturition) and showed increasing trend in milk yield (Table 1). The control group (Group I) showed increasing trend in milk yield initially (7th and 14th day), thereafter, it did not sustained the increasing trend in subsequent period of lactation. It might be attributed to low energy supplementation which brings the animals in negative energy balance. The average milk yield was increased by 12.73 per cent in group II supplemented with bypass fat than that of control group (7.01%) on 30th day of parturition (Table 1). The findings of the present study are in accordance with the findings of Garg and Mehta (1998); Ben Salem and Bouraoui (2008); Barley and Baghel (2009); Tyagi *et al.* (2009); Tyagi *et al.* (2010); Zhang *et al.* (2011); Garg *et al.* (2012); Wadhwa *et al.* (2012); Dhulipalla *et al.* (2013) and Patil *et al.* (2013) who also recorded rise in milk yield in lactating dairy animals after supplementation of bypass fat. In contrast, Lounglawan *et al.* (2006) reported no improvement in milk yield by lactating dairy animal by supplementation of rumen bypass fat, which might have been due to the cows being in early mid lactation and in positive energy balance, therefore, a large milk production response to supplemented fat was not observed.

The technology of bypass fat protects the nutrient from degradation and bio-hydrogenation in rumen with increase in the energy density of the diet, enabling the animals to meet their energy and essential fatty acid requirements expressing their milk production potential to the fullest extent (Krishna Mohan and Reddy, 2009). Increased milk yield observed in bypass fat supplemented group may be attributed to enrichment of ration with bypass fat that increased energy density of the ration resulting in preventing the deleterious effect of negative energy balance (Tyagi *et al.*, 2010; Shelke and Thakur, 2011; Zhang *et al.*, 2011; Garg *et al.*, 2012 and Dhulipalla *et al.*, 2013). The improvement in milk yield in bypass fat supplemented group might also be due to its content *viz.*, Chromium chelated with amino

Table 1: Mean values of milk yield (kg) and milk fat (%) before ('0' day) and at different intervals after bypass fat supplementation in group I (control group) and group II

Parameters	Groups	Intervals					Pooled mean
		On day of parturition	Different intervals after parturition				
		0th Day	7th Day	14th Day	21st Day	30th day	
Milk yield (kg)	Group I	3.58^{ac} ±0.11	3.82^{bcd} ±0.11 (6.28)	3.95^{bd} ±0.07 (9.37)	3.83^{bd} ±0.13 (6.53)	3.85^{b} ±0.06 (7.01)	3.81^{p} ±0.05
	Group II	3.77^{c} ±0.06	3.93^{cd} ±0.07 (4.07)	3.97^{d} ±0.06 (5.04)	4.00^{d} ±0.05 (5.75)	4.32^{e} ±0.05 (12.73)	4.00^{q} ±0.04
	Pooled mean	3.68^{A} ±0.06	3.88^{B} ±0.06	3.96^{BC} ±0.04	3.92^{B} ±0.07	4.08^{C} ±0.08	
Milk fat (%)	Group I	3.53^{ad} ±0.06	3.92^{bc} ±0.09	3.88^{bc} ±0.11	4.05^{e} ±0.09	3.75^{ab} ±0.13	3.83 ±0.05
	Group II	3.57^{d} ±0.07	3.68^{bcd} ±0.09	3.82^{bcde} ±0.10	3.98^{cef} ±0.06	4.18^{f} ±0.07	3.85 ±0.05
	Pooled mean	3.55^{A} ±0.04	3.80^{B} ±0.07	3.85^{BC} ±0.07	4.02^{C} ±0.05	3.97^{BC} ±0.10	

Similar superscript indicates non-significant variation within each parameter

acids, calcium propionate and live yeast culture, supplemented in the present study. Chromium enhances the cellular uptake of glucose through linkage of chromodulin (chromium binding protein) with the insulin receptors and glucose transporters. Thus, chromium increased the synthesis of fat in the adipose tissue (lipogenesis) and reduced the rate of mobilization of fatty acids from adipose tissue. Such an effect of reduced lipolysis would presumably allow a greater increase in feed intake, stabilize hepatic fat metabolism and reduce hepatic ketogenesis, all working resulted into increase in milk yield. The calcium propionate, which may reduce net lipolysis allowing increase feed intake, resulted into increase milk production (Mc Namara and Valdez, 2005).

The average milk fat (%) in Group I and Group II on '0' day and on 7th, 14th, 21st and 30th day post parturition are given in Table 1. The statistical analysis revealed significant variation ($P<0.05$) in milk fat (%) between different intervals. However, no significant difference was observed between the supplemented (Group II) and control group (Group I). In group II, average fat per cent showed increasing trend during subsequent intervals. However, inconsistent increase in fat per cent was observed in control group. The group (Group II) supplemented with bypass fat shown significant increase ($P<0.05$) in milk fat per cent on 21st and 30th day of parturition as compared to milk fat per cent on '0' day (Table 1). The fat per cent was significantly higher (4.18 ±0.07) on 30th day in bypass fat supplemented group than control group (3.75 ±0.13). Similar to our results, earlier studies reported a clear cut rise in milk fat due to supplementation of bypass fat in lactating dairy animals (Barley and Baghel, 2009; Zhang *et al.*, 2011; Garg *et al.*, 2012; Dhulipalla *et al.*, 2013 and Patil *et al.*, 2013).

In the present study, the fat per cent of milk was increased significantly during the period of early mid lactation when compared to initial milk fat per cent. It was due to correction of energy balance (Barley and Baghel, 2009). The response of milk fat concentration to supplemental fat seems to be dependent upon many factors including the fat concentration and composition in the basal diet and in the supplement as well as forage source and amount. One possible reason is that supplemental fat increased dietary energy. Moreover, about 50 per cent of the fat found in milk is synthesized is the mammary gland from acetate and butyrate, while 40-45 per cent from the dietary source and less than 10 per cent are derived from the mobilization of adipose tissue (Palmquist and Jenkins, 1980). So, supplemental fat source can increase milk fat of dairy cows (Zhang *et al.*, 2011). According to Ashes *et al.* (1997) the effect of fat supplementation on milk fat and fatty acids composition are influenced by the type and amount of dietary fat degree of inertness or protection in the rumen.

Conclusion :

The present study concluded that the rumen bypass fat @ 100 g per cow per day along with normal diet from 1 week expected parturition and upto 4 weeks after parturition found effective in improving milk yield and milk fat per cent and proved to be beneficial in fulfilling the energy demand for milk production and preventing the cows entering into negative energy balance during early mid-lactation.

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Short Communication

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Efficacy of bypass fat in management of Ketosis in dairy cows

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Abstract

The objective of the present study was to assess the therapeutic effect of rumen bypass fat for management of ketosis in dairy cows. Total 12 cows positive for ketosis on the basis of Modified Rothera's test and Keto-Diastix strip test in urine were selected and divided randomly into two equal groups. One group (Group I) of 6 ketotic cows was kept without treatment as a control. Second group (Group II) of 6 ketotic cows was treated with bypass fat @ 100 gm per day per animal for the period of 4 weeks. Blood biochemical parameters such as plasma glucose, serum cholesterol, serum triglyceride, serum calcium and serum phosphorus were determined in all the animals under experiment before treatment ('0' day) and on 7th, 14th, 21st and 30th day after treatment. The group (Group II) treated with rumen bypass fat showed complete recovery in ketotic cows with improvement in altered levels of plasma glucose, serum cholesterol, serum triglyceride and serum phosphorus within 30th day of post treatment, whereas cows in Group I (control group), without treatment were remain positive for ketosis throughout the experimental period. The milk yield was increased in bypass fat treated group (Group II) as compared to control group (Group I), moreover, the milk yield was dropped in control group (Group I). The present study concluded that the rumen bypass fat corrected the negative energy balance and thus found effective in treatment of ketosis with improvement in altered levels of blood biochemical parameters and milk yield within 30th day post treatment.

Keywords: Bypass fat, biochemical parameters, dairy cows, ketosis, milk yield.

Ketosis is a common metabolic disorder frequently observed in dairy cows during the early lactation period. A widely accepted key factor in the etiology of ketosis is the inadequate supply of energy necessary for milk production, which leads to negative energy balance, increased fat mobilization and increased hepatic ketogenesis.It is characterized by relatively high concentration of ketone bodies with a concurrent decrease of blood glucose level (Radostitis *et al.* 2000). The wide ranges of treatments have been recommended for ketosis. Most of these are intended to alleviate the hypoglycemia and increase the glycogen content of liver, thereby, restoring the carbohydrate metabolism and aims to provide an energy boost to overcome negative energy balance for optimizing the milk production. It is stated that supplementing ration to lactating animals with bypass fat enhances energy intake in early lactation which reduces deleterious effect of acute negative energy balance on lactation (Tyagi *et al.*, 2010). Therefore, in the present investigation an attempt was made to assess the therapeutic effect of bypass fat on ketotic dairy cows.

Materials and methods

In the present study, total 63 lactating cows in early-mid lactation from Dairy farm of Agriculture University, Akola were screened for ketosis by Modified Rothera's test and Keto-Diastix strip test in urine. Out of which 12 cows positive for ketosis were selected and divided randomly into two equal groups. One group (Group I) of 6 ketotic cows was kept without treatment and given only basal diet as a control. Second group (Group II) of 6 ketotic cows was treated with bypass fat ("Extra Energy Plus" – each Kg containing - Pure bypass fat - 200 gm, Fermented live yeast culture- 50 gm, Calcium propionate- 10 gm and Chromium chelated with Amino Acid- 40 gm) @ 100 gm per animal per day along with normal diet for the period of 4 weeks.

Blood biochemical parameters such as plasma glucose, serum cholesterol, serum triglyceride, serum calcium and serum phosphorus were estimated by using reagent kit (Span Diagnostic Ltd.) on auto-analyzer (Model Span Autochem-2011) before treatment ('0' day) and on 7th, 14th, 21st and 30th day after treatment. The data collected during the present study in respect of different parameters was analyzed statistically by using standard statistical methods as described by Snedecor and Cochran (1994).

Results and discussion

In the present investigation Modified Rothera's test and Keto-Diastix strip test in urine were used for the detection of ketosis in all animals on day '0' (before

treatment) and on 7th, 14th, 21st and 30th day after treatment. The group (Group I) kept without treatment with bypass fat, all the animals were showed positive reaction to ketosis by Modified Rothera's test and Keto-Diastix strip test on 7th, 14th, 21st and 30th day post treatment. However, group (Group II) treated with bypass fat, one animal showed positive reaction for ketosis on 14th and 21st day post treatment and thereafter all the ketotic cows were showed negative reaction for ketosis on day 30th post treatment.

The plasma glucose level was significantly ($P<0.05$) improved in Group II, treated with bypass fat as compared to control group (Group I). In control group (Group I), plasma glucose concentration was remain lowered throughout the experimental period (Table 1). These results suggested the insufficient glucose supply in ketotic cows of control group (Group I). The low plasma glucose level in control group, could be attributed to negative energy balance reflecting greater demands for glucose in mammary glands and due to the insufficient carbohydrate supplementation leading to fat mobilization resulting into decrease glucose level and increase in ketone body levels simultaneously in these animals (Zhang *et al.*, 2009). In the present investigation the improvement in plasma glucose level in group II could be attributed to supplementation of bypass fat containing pure bypass fat and calcium propionate which might have provided the precursors for gluconeogenesis, thereby, increase in plasma glucose concentration. Another possible reason might be the inhibition of glycolysis by supplementation of bypass fat in order to improve energy level (Goff *et al.*, 1996; Mc Namara and Valdez, 2005 and Zhang *et al.*, 2011). The treatment also tended to reduce plasma NEFA and â-hydroxybutyrate, suggested that propionate supplied some glucose to these cows, thus, improved the energy balance of these cows (Goff *et al.*, 1996).

The statistical analysis revealed non-significant variation in serum cholesterol level between groups and different intervals (Table 1). In contrast to our findings Tyagi *et al.* (2010), Zhang *et al.* (2011) and Ranjan *et al.* (2012) reported significant increase in cholesterol level after supplementation of bypass fat. Many workers reported increase in cholesterol level in ketosis (Jadhav, 2003; Sivaraman *et al.* 2003; Mahajie, 2006; Sahoo *et al.* 2010), which can be attributed to lipolysis of adipose tissues of ketotic animals resulting in elevation of free fatty acids and other lipids.

When animal suffers from ketosis, there is increase in serum triglyceride level. The increase in serum triglyceride level in ketosis could be attributed to negative energy balance and low serum concentration of glucose, resulted into mobilization of adipose tissue with consequent increase in serum triglyceride level (Borghese, 1994). Analysis of variances revealed significant ($P<0.05$) improvement in serum triglyceride level in Group II on 14th, 21st and 30th day post treatment as compared to pre treatment level ('0' day). The group (Group II) treated with bypass fat, significantly (P

Table 1: Blood biochemical parameters (Mean +S.E.) at different intervals after treatment

Parameters	Groups	Intervals					Pooled mean
		0th Day	7th Day	14th Day	21st Day	30th day	
Plasma Glucose (mg/dl)	Group I	45.38^{ac} ±1.05	45.88^{a} ±1.09	43.97^{a} ±1.09	44.60^{a} ±2.08	43.75^{a} ±1.43	44.72^{p} ±0.60
	Group II	46.67^{c} ±1.87	50.92^{d} ±1.89	54.50^{de} ±2.18	55.70^{e} ±0.63	57.05^{e} ±1.25	52.97^{q} ±0.98
	Pooled mean	46.03^{A}± 1.04	48.40^{AB}± 1.29	49.23^{B}± 1.97	50.15^{B}± 1.97	50.40^{B}± 2.20	
Serum Cholesterol (mg/dl)	Group I	177.32 ±4.50	179.27 ±2.74	185.83 ±7.47	180.83 ±5.05	189.70 ±8.84	182.61 ±2.68
	Group II	182.12 ±3.34	180.77 ±17.58	184.32 ±12.86	181.12 ±5.14	190.27 ±14.15	183.72 ±5.00
	Pooled mean	179.72± 2.76	180.02± 8.48	185.08± 7.10	181.03± 3.43	189.98± 7.95	
Serum Triglycerides (mg/dl)	Group I	30.48^{a} ±1.21	30.53^{a} ±1.33	31.92^{a} ±1.22	35.75^{a} ±3.00	34.78^{a} ±3.25	32.69^{q} ±1.00
	Group II	27.32^{ac} ±3.73	26.62^{ac} ±2.71	24.70^{b} ±1.67	23.23^{b} ±1.05	19.70^{b} ±1.44	24.31^{p} ±1.09
	Pooled mean	28.90± 1.93	28.58± 1.55	28.31± 1.46	29.49± 2.42	27.24± 2.84	
Serum Calcium (mg/dl)	Group I	7.52 ±0.20	7.68 ±0.17	7.43 ±0.37	7.42 ±0.17	7.30 ±0.16	7.47^{p} ±0.10
	Group II	7.83 ±0.14	8.02 ±0.21	8.05 ±0.17	8.10 ±0.29	8.37 ±0.44	8.07^{q} ±0.12
	Pooled mean	7.68± 0.12	7.85± 0.14	7.74± 0.21	7.76± 0.19	7.83± 0.28	
Serum Phosphorus (mg/dl)	Group I	4.88^{c} ±0.06	4.70^{bcd} ±0.04	4.45^{abc} ±0.08	4.27^{ab} ±0.07	4.08^{a} ±0.09	4.48^{p} ±0.06
	Group II	4.85^{cd} ±0.16	4.93^{d} ±0.24	4.97^{d} ±0.26	5.00^{d} ±0.16	5.08^{d} ±0.20	4.97^{q} ±0.09
	Pooled mean	4.87± 0.08	4.82± 0.12	4.71± 0.15	4.63± 0.14	4.58± 0.18	

Similar superscript indicates non-significant variation within each parameter

<0.05) improved the serum triglyceride level as compared to control group (Group I) kept without treatment with bypass fat (Table 1). The improvement in serum triglyceride level could be due to supplementation of bypass fat as a energy source which might have decrease the degree of adipose tissue mobilization and stimulation of hepatic gluconeogenesis (Borghese, 1994).

The serum calcium level was low in ketotic cows. Low level of serum calcium in ketotic cows might be due to increase loss of base in urine to compensate ketosis induced acidosis (Fatur, 1994; Radostitis *et al.*, 2000). Another reason might be the high concentration of â-hydroxybutarate (BHBA) in ketosis, which impairs the absorption and utilization of calcium in dairy cows during the early lactation period (Zhang *et al.*, 2009). The statistical analysis revealed significant improvement (P<0.05) in serum calcium level in Group II treated with bypass fat as compared to Group I (control group) kept without treatment (Table 1). The findings of the present study are in agreement with the findings of Wadhwa *et al.* (2012), who also reported improvement in serum calcium level after supplementation of bypass fat in crossbred cows. Bypass fat contains calcium propionate and chromium. The calcium propionate provides calcium which might have attributed to improvement in serum calcium level in Group II treated with bypass fat as compared to Group I (control group).

The statistical analysis revealed significant (P<0.05) improvement in serum phosphorus level in group II treated with bypass fat as compared to control group (group I). Phosphorus metabolism is closely related with carbohydrates metabolism. It is mostly stored in bones in compounds with calcium. Lots of it is found in the form of energy rich esters, essential for energy storing and release. The lower level of serum phosphorus in ketosis might be due to compensation of ketosis induced acidosis, which triggers excretion of phosphorus via urine. Zhang *et al.*, 2009 and Padmaja and Rao (2013) reported non-significant change in level of serum phosphorus in ketosis and normal healthy dairy animals.

The group (Group II) treated with bypass fat, showed increasing trend in milk production from 3.82 ± 0.12 (Kg) to 4.50 ± 0.19 (Kg) during the period of lactation (Table2). The milk yield was significantly (P<0.05) increased in group II after treatment as compared to milk yield on '0' day (before treatment). In control group (Group I), the milk yield showed decreasing trend, during the subsequent period of lactation, moreover, the milk yield was dropped by 13.90% on 30th day, whereas, the average milk yield was increased by 15.11% in group treated with bypass fat (Table 2). This trend of improvement in milk yield in ketotic cows could be attributed to high energy supplementation by way of bypass fat which might have brought the animals out of negative energy balance. Earlier workers (Tyagi *et al.*, 2010; Zhang *et al.*, 2011; Dhulipalla *et al.*, 2013) also showed the positive effect of rumen bypass fat in increasing milk yield during early mid lactation by correcting the negative energy balance of the animals.

Increase in milk yield observed in bypass fat supplemented group might be attributed to increased energy density of ration resulting in reducing the deleterious effect of negative energy balance (Tyagi *et al.*, 2010; Zhang *et al.*, 2011 and Dhulipalla *et al.*, 2013). The improvement in milk yield in treated group (Group II) could also be attributed to the chromium and calcium propionate incorporated in the bypass fat supplement. The propionate acts as a gluconeogenic precursor at a time when the cow is in negative energy balance. Chromium, known to increase glucose use by cells, thus increase glucose entry to adipocytes, increase the lipogenesis from acetate and decrease net fatty acid release from the cell resulted into increase milk

Table 2: Average Milk Yield (Kg) in different groups of ketotic cows before treatment and at different intervals after treatment.

IntervalsGroups	Before Treatment	After Treatment				Pooled Mean (A)
	'0' day	7th day	14th day	21st day	30th day	
Group I	3.85^{b} ±0.09 (-2.12%)	3.77^{bcd} ±0.08 (-6.35%)	3.62^{ab} ±0.07 (-8.45%)	3.55^{ab} ±0.11 (-13.9%)	3.38^{a} ±0.11	3.63^{a} ±0.05
Group II	3.82^{bc} ±0.12 (1.31%)	3.87^{cd} ±0.10 (3.78%)	3.97^{cd} ±0.12 (7.95%)	4.15^{d} ±0.07 (15.11%)	4.50^{e} ±0.19	4.06^{a} ±0.07
Pooled Mean(B)	3.83 ±0.07	3.82 ±0.06	3.79 ±0.09	3.85 ±0.11	3.94 ±0.20	

Similar superscript shows non significant differences (P<0.05)

production (Mc Namara and Valdez, 2005). Yang *et al.* (1996) postulated that increase milk yield might be the result of the indirect effect of chromium on hepatic glucose production (gluconeogenesis).

Based on the observations of the present study it is concluded that rumen bypass fat is effective in correcting negative energy balance in ketotic cows with improvement in milk yield and altered levels of plasma glucose, serum cholesterol, serum triglycerides and serum phosphorus within 30th day post treatment.

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