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Effect of Energy Supplementation During Early Lactation on Milk Composition and Rumen Fermentation Parameters of Crossbred Dairy Cows

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Abstract

Supplementation of the dairy cattle ration with energy supplements may be beneficial to correct the negative energy balance that occurs during the early lactation. But supplementation may alter the composition of milk like fat, protein and solid not fat content (SNF) or the rumen fermentation pattern of the cow. So a study was conducted to assess the effect of high energy diet on milk composition and rumen fermentation parameters in crossbred cows in early lactation. Eighteen crossbred cows in early lactation were selected and divided into three groups of six each. All the animals were fed with concentrate mixture containing 65 per cent of total digestible nutrient and 17 per cent crude protein with 35 per cent of CP as undegradable protein. The animals in the second and third group were supplemented daily with one and two kg of energy supplement (ground maize) respectively. The average milk composition was 3.66, 3.31and 3.43 per cent of fat; 12.69, 12.08 and 12.76 per cent of total solids; 9.03, 8.77 and 9.33 per cent of SNF and 2.79, 2.88 and 2.92 per cent of protein. There was no significant difference in any of these parameters between treatments. The average milk urea nitrogen concentrations were 14.76, 18.21 and 15.83 mg/dl in the beginning and 16.73, 18.95 and 16.70 mg /dl at the end of the experiment for animals of group I, II and III respectively and were not significantly affected by the maize supplementation. There was no

significant effect (p□0.05) of maize supplementation on rumen fermentation parameters like rumen pH, total volatile fatty acids (TVFA) and rumen ammonia concentration. From the overall evaluation of results it could be concluded that the supplementation of energy in the form of ground maize did not change neither the composition of the milk nor the rumen fermentation parameters significantly.

Keywords: energy supplement, ground maize, early lactation, milk composition, rumen fermentation parameters

1. Introduction

Operation Flood', initiated by Dr. V. Kurien, brought about a major transformation in India's dairy industry, propelling India to become world's No. 1 milk producer. But there are many shortcomings that need to be corrected to take the industry further forward. A major shortcoming is the low average per animal productivity due to the improper nutritional management. Energy is one of the most important nutritional factors that limit production in dairy cattle. During early lactation cows are unable to consume enough energy from the feed to meet their energy demand for lactation. Thus the body reserves are mobilized, leading to the negative energy balance. Maximizing energy intake by increasing the energy density of the diet is a logical feeding strategy for early lactating cows. For this increasing the level of concentrate in the ration will result in increased cost of production. Supplementation of the ration with energy supplements such as maize, dried tapioca or molasses may be beneficial to correct the energy deficiency. But supplementation may alter the composition of milk like fat, protein and solid not fat content (SNF) or the rumen fermentation pattern of the cow. Hence this study was conducted to assess the effect of energy supplementation in the form of ground maize on milk composition in the early lactating cross bred dairy cattle.

2. Materials and Methods

Eighteen healthy crossbred cows in early lactation (within 10 to 15 days of lactation) were selected from the University Livestock Farm and Fodder Research and Development Scheme (ULF&FRDS), Mannuthy. They were divided into three groups of six each, as uniformly as possible with regard to age, parity, previous lactation yield and body weight and allotted randomly to experimental rations. All the experimental animals were fed concentrate mixture containing 65 per cent of total

digestible nutrient (TDN) and 17 per cent crude protein (CP) with 35 per cent of CP as undegradable protein (UDP). Green grass (Hybrid Napier) was offered as the sole roughage. All the experimental animals were fed as per ICAR (1998) standards for period of 150 days. The animals in the second and third group were supplemented daily with one and two kg of energy supplement (powdered maize) respectively. The quantity of feed given was revised fortnightly according to milk production. The animals were fed twice daily before milking. Milk samples were collected fortnightly from each animal and analyzed for total solids (TS) and protein (AOAC, 1990), fat (IS: 1224, 1977) and milk urea nitrogen (Bector *et al.* 1998). Rumen liquor was collected from the animals using stomach tube at the beginning and the end of the feeding trial and was analyzed for pH (pHelp® pocket pH meter), total volatile fatty acids (Barnett and Reid, 1957) and rumen ammonia (Beecher and Whitten, 1970).

Table 1. Chemical composition of feed, green grass and ground maize fed to experimental animals, % on DM basis

	Concentrate mixture	**Fodder**	**Ground maize**
Dry matter	92.9	17.08	88.79
Crude protein	16.49	8.68	7.75
Crude fibre	7.14	34.69	2.04
Ether extract	2.91	3.05	2.80
Total ash	9.65	10.75	2.58
Nitrogen free extract	63.81	42.83	84.82
Acid insoluble ash	1.08	1.85	0.61

3. Results

The per cent chemical composition of the concentrate mixtures, ground maize and fodder fed to the experimental animals are presented in the Table 1. The CP content of the concentrate mixture was 16.49 per cent while that of fodder used for feeding was 8.68 per cent on dry matter basis. The total solids, fat, solid not fat, protein of the milk collected fortnightly from experimental animals are given in Table 2. The urea nitrogen content of the milk collected in the first fortnight, fifth fortnight and towards the end of the feeding trial is given in Table 3. The average milk composition was 3.66, 3.31and 3.43 per cent of fat; 12.69, 12.08 and 12.76 per cent of total solids; 9.03, 8.77 and 9.33 per cent of SNF and 2.79, 2.88 and 2.92 per cent of protein. The average milk urea nitrogen concentrations were 14.76, 18.21 and 15.83 mg/dl in the

beginning and 16.73, 18.95 and 16.70 mg /dl at the end of the experiment for animals of group I, II and III respectively.

The data on the rumen fermentation parameters namely pH, rumen ammonia and total volatile fatty acids (TVFA) levels of the rumen liquor collected from the animals of three dietary treatments towards the end of the experiment is given in Table 4. The initial values of pH, rumen ammonia, and TVFA in the rumen liquor collected before the beginning of the experiment were 7.03, 24.83 mg/dl and 63.92 meq/l, respectively. The average value for pH of rumen liquor collected at the end of the feeding trial was 6.95, 6.73 and 6.94 respectively, in animals of group I, II and III. The average rumen ammonia and total volatile fatty acids (TVFA) concentration was 24.18, 26.5 and 24.39 mg/ dl and 74.06, 81.65, and 80.9 meq/l, respectively.

4. Discussion

4.1 milk composition

The average fat per cent in the milk from animals of group I, II and III were 3.66, 3.31and 3.49 per cent respectively. A higher value of 4.32 per cent and 4.06 and comparable value of 3.48 per cent were reported by Sathian (2001), Joseph (2005) and Ally *et al.* (2007), respectively in the cross bred dairy cattle in early lactation. The results obtained in this study are in accordance with the work done by Andrew *et al.* (1991) who found no significant difference in milk fat content in lactating cows supplemented with CSFA. Similarly Ruppert *et al.* (2003) and Lounglawan *et al.* (2011) found no significant difference in the milk fat level in dairy cows supplemented with energy in the form of tallow and glycerol at different levels respectively. In contrary to the present result, Misra *et al.* (2004) found an increase in the milk fat per cent in cows fed with Ca salts of mustard oil. However Onetti and Grummer (2004) reported a decrease in milk fat content and yield when lactating cows were fed diet supplemented with tallow at 3.1 per cent.

The average total solids (TS) in the milk from the animals of the group I, II and III were 12.69, 12.08 and 12.76 per cent, respectively, while solids not fat (SNF) were 9.03, 8.77 and 9.33 per cent, respectively. The observed values of TS and SNF are comparable with the values of 12.56, 8.39 and 12.9, 8.61 per cent as reported by Sathian (2001) and Hareesh (2007) respectively in lactating crossbred cows of University Livestock farm. The result obtained in this study is similar to the result reported by Naik *et al.* (2007) who found no significant difference in the SNF and TS content in lactating cows supplemented with bypass fat compared to that of control without supplementation. However Strusinska *et al.* (2006) reported a significant

decrease in SNF level when early lactating Holstein cows were fed with a fat protein supplement at the level of one kg per day compared to that of control without supplementation.

The average protein content of the milk from the animals of the group I, II and III were 2.79, 2.88 and 2.92 per cent, respectively and statistical analysis did not reveal any significant difference between the groups. Similar milk protein levels were reported by Joseph (2005), Ally *et al.* (2007) and Augustine (2008) in early lactating cows fed concentrate mixture with 17 per cent CP. Mandebuvu *et al.* (2003) and Bork *et al.* (2010) reported no significant difference in the milk protein level in lactating cows fed with Ca- LCFA and rolled flaxseed, respectively. But Reis *et al.* (2001) observed an increase in the milk protein percentage with the corn supplementation in cows fed alfalfa legume as sole roughages, while Hoffman *et al.* (1991) reported a decrease in milk protein when early lactating cows were fed with supplemental fat at the level of 2.8 per cent in the diet.

The average milk urea nitrogen (MUN) concentrations of the experimental animals were 14.76, 18.21, and 15.83 mg/dl in the beginning and 16.73, 18.95 and 16.70 mg /dl at the end of the experiment for group I, II and III respectively and the levels were non significant. Melendez *et al.* (2000) reported that high concentrations of MUN (>18mg/dl) indicate a higher protein intake by the animals or deficiency in rapid fermentable carbohydrates. The observation made in the present study is comparable with the level reported by Kauffman and St-Pierre (2001) and Noftsger and St- Pierre (2003) with 17 per cent CP and they observed MUN ranging from 6.09 to 19.09 mg per 100ml in early lactation. In agreement to the present result Mandebuvu *et al.* (2003) noted no difference in milk urea nitrogen level when cows were fed with Ca-LCFA from palm fatty acid distillate and soya bean oil. Similarly Strusinska *et al.* (2006) also reported the lack of effect of increased dietary levels of both energy and protein in early lactating cows on milk urea nitrogen concentration. In contrary to the result, Delahoy *et al.* (2003) reported a decrease in milk urea nitrogen level when cows were fed with steam flaked corn. Similarly Gowda *et al.* (2009) also reported a decrease in milk urea nitrogen when powered ragi grain was supplemented (one kg/cow/day) to dairy cows.

Table 2. Composition of milk* from animals maintained on three experimental rations

Parameters	**Group I**	**Group II**	**Group III**	**p value**
Total solids (%)	12.69± 0.18	12.08±0.18	12.76±0.17	0.27
Fat (%)	3.66±0.32	3.31±0.84	3.49±0.1	0.68
Solids not fat (%)	9.03±0.19	8.77±0.13	9.33± 0.16	0.30
Protein (%)	2.79±0.19	2.88±0.18	2.92±0.16	0.17

**mean of six animals*

Table 3. Milk urea concentration (MUN)* of animals maintained on three experimental rations

Fortnight	**Milk urea nitrogen, mg/dl**			**P value**
	Group 1	**Group II**	**Group III**	
1	14.76 ± 1.20	18.21 ± 0.82	15.83 ± 0.50	0.95
5	16.5 ± 1.61	19.3 ± 1.47	17.05 ± 0.82	0.76
10	16.73 ± 1.20	18.95 ± 0.82	16.70 ± 0.50	0.55

**mean of six animals*

4.2 Rumen fermentation parameters

Rumen liquor from all the animals was collected three hours after feeding. The average value for pH of rumen liquor collected at the end of the feeding trial was 6.95, 6.73 and 6.94 respectively, in animals of group I, II and III and there was no significant difference between treatments (P>0.05). This observation made in the present study is in agreement with that of Elliot *et al.* (1996) who also observed that rumen pH was not affected when lactating cows were supplemented with Ca - LCFA or prilled fat or hydrogenated palm fatty acid distillate compared to those fed the control diet. Similarly Bargo *et al.* (1998) also found no difference in ruminal pH

when lactating dairy cows were fed high energy diet. However Reis *et al.* (2001) observed a significant decrease on rumen pH when corn was supplemented to cows in the form of finely ground dry shelled corn or coarsely ground high moisture corn. Similarly Khampa and Wanapat (2006) also found that supplementation of cassava chips at two per cent level lowered the rumen pH.

The average rumen ammonia concentration was 24.18, 26.5 and 24.39 mg/ dl respectively, for the animals maintained on three experimental rations. The mean ammonia concentrations on all diets remained above the 5mg per 100 ml, as the minimum requirement for the maintenance of rumen microbial growth (Roffler and Satter, 1975). Statistical analysis showed no significant difference ($P>0.05$) in the rumen ammonia concentration between treatments. This is in agreement with that of Robinson and burgess (1990) who did not find any difference in rumen ammonia nitrogen concentration among mid lactation dairy cows fed oats or corn as energy supplements. In contrast Mc Cormick *et al.* (2001) found a lowered rumen ammonia level in dairy cattle when supplemented sucrose at five per cent level in corn based ration.

The average total volatile fatty acids (TVFA) concentrations of rumen liquor collected from animals maintained on three dietary treatments were 74.06, 81.65, and 80.9 meq/l, respectively. The levels were within normal range of 70 to 150 meq /l as cited in Animal Nutrition by McDonald et al., (2002) and were not significantly different ($P>0.05$) between treatments. The observation in the present study is in agreement with Reis *et al.* (2001) who found no significant difference in TVFA in lactating cows fed high energy diet compared to control. Similarly Ruppert *et al.* (2003) also reported lack of effect of energy supplementation on TVFA concentration in Holstein cows when supplemented tallow at two and four per cent levels. In contrary to the observed result Sridhar *et al.* (1999) observed a significantly higher TVFA concentration in the rumen liquor of lactating cattle fed high energy (20 per cent more than NRC) and standard energy diet (NRC standard) compared to those fed low energy diet (20 per cent less than NRC standard). Similarly Mishra *et al.* (2004) also observed significantly higher TVFA concentration in cows supplemented with calcium salts of mustard oil compared to control group.

Table 4. Rumen fermentation and haematological parameters * of experimental animals maintained on the three experimental rations

Parameters	Group I	Group II	Group III	p value
pH	6.95±0.11	6.73±0.58	6.94±0.67	0.125
Volatile fatty acids (meq/l)	74.06±3.58	81.65±2.75	80.9±2.64	0.202
Ammonia (mg/100ml)	24.18±2.71	26.5±4.84	24.39±2.91	0.875

**Mean of six values*

5. Conclusion

From the overall evaluation of results obtained during the course of the investigation it could be concluded that the supplementation of energy in the form of ground maize in early lactation did not change the milk composition as well as the rumen fermentation parameters significantly.

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Reference

[1] A J G Barnett and R L Reid (1957), Studies on the production of volatile fatty acids from grass by rumen liquor in an artificial rumen. 1. The volatile fatty acids production from fresh grass, *J. Agric. Sci. Camb*, **48**, pp. 315-321.

[2] A J Kauffman and N R St- Pierre (2001), The relationship of milk urea nitrogen to urine nitrogen excretion in Holstein and Jersey cows, *J. Dairy Sci*, **84**, pp. 2284- 2294.

[3] AOAC (1990), *Official Methods of Analysis*, (15th Ed.), Association of official analytical chemists, Washington, D.C, 587p.

[4] B S Bector, M Ram and O P Singhal (1998), Rapid platform test for the detection of added urea in milk, *Indian Dairyman*, **50**(4), pp. 59-62.

[5] C T Sathian (2001), Somatic cell count and its influence on the quality of milk in crossbred cows, Ph.D. thesis, Kerala Agricultural University, Trichur, 109p.

[6] D Strusinska, D Minalowski, B Pysera and J Kaliniewicz (2006), Effects of fat protected supplementation of diets for cows in early lactation on milk yield and composition, *Czech J. Anim. Sci*, **51**(5), pp. 196-204.

[7] F Bargo, G A Pieroni and D H Rearte, (1998), Milk production and ruminal fermentation of grazing dairy cows supplemented with dry ground corn or steam-flaked corn, *J. Dairy Sci*, **81**, pp. 250-254.

[8] G P Beecher and B K Whitten (1970), Ammonia determination: Reagent modification and interfering compounds, *Analyt. Biochem*, **36**, 243p.

[9] ICAR (1998), Cited in *Nutrient Requirements of Llivestock and Poultry by* S. K. Ranjhan, (2nd Ed.), Indian Council of Agricultural Research, New Delhi. 5p.

[10] IS: 1224 (1977), *Determination of fat by Gerber's method*. Part I. Milk (first revision), Indian Standards Institution, New Delhi, 18 p.

[11] J E Delahoy, L D Muller, F Bargo, T W Cassidy and L A Holden (2003), Supplemental carbohydrate sources for lactating dairy cows on pasture, *J. Dairy Sci*, **86**: 906-915.

[12] J P Elliott, J K Drackley and D J Weigel (1996), Digestibility and effects of hydrogenated palm fatty acid distillate in lactating dairy cows, *J. Dairy Sci*, **79**: 1031-1039.

[13] K Ally, A D Mercy and T V Viswanathan (2007), Effect of dietary crude protein levels on the performance of lactating cows, *Indian J. Anim. Nutr*, **24**, pp. 84-87.

[14] L D Ruppert, J K Drackley, D R Bremmer and J H Clark (2003), Effects of tallow in diets based on corn silage or alfalfa silage on digestion and nutrient use by lactating dairy cows, *J. Dairy Sci*, **86**, pp. 593–609.

[15] M E McCormick, D D Redfearn, J D Ward and D C Blouin (2001), Effect of protein source and carbohydrate addition on rumen fermentation and lactation performance of Holstein cows, *J. Dairy Sci*, **84**, pp. 1686-1697.

[16] N K S Gowda, D T Pal, T Chandrappa, S Verma, V Chauhan, G Maya, K T Sampath and C S Prasad (2009), Supplementation of ragi (*Eleucine coracana*) grain as a locally available energy source for lactating cows: A field study, *Indian J. Anim. Sci*, **79** (6), pp. 594–598.

[17] N R Bork, J W Schroeder, G P Lardy, K A Vonnahme, M L Bauer, D S Buchanan, R D Shaver and P M Fricke (2010), Effect of feeding rolled flaxseed on milk fatty acid profiles and reproductive performance of dairy cows, *J. Anim. Sci*, **88,** pp. 3739-3748.

[18] P C Hoffman, R R Gruymer, R Shaver, A Broderick and T R Drendell (1991), Feeding to early supplemental fat and undegraded intake protein lactation dairy cows, *J. Dairy Sci*, **74**, pp. 3468-3474.

[19] P D Hareesh (2007), Effect of dietary supplementation of organic chromium in lactating cows, M.V.Sc. thesis, Kerala Agricultural University, Thrissur, 73p.

[20] P H Robinson and P L Burgess (1990), Energy supplementation of high forage diets for mid-lactation dairy cows, *Can. J. Anim. Sci*, **70**, pp.867- 874.

[21] P K Naik, S Saijpaul and Rani (2007), Preparation of rumen protected fat and its effect on nutrient utilization in buffaloes, *Indian J. Anim. Nutri*, **24**, pp. 212–15.

[22] P Lounglawan, W Lounglawan and W Suksombat (2011), Effects of feeding glycerol to lactating dairy cows on milk production and composition, *World Acad. Sci. Engng. Technol*, **51**, pp. 481-483.

[23] P Mandebuvu, C S Ballard, C J Sniffen, D S Tsang, F Valdez, S Miyosh and L Schlatter (2003), Effect of feeding an energy supplement prepartum and post partum on milk yield and composition, and incidence of ketosis in dairy cows, *Anim. Feed Sci. Technol*, **105,** pp. *81-93.*

[24] P McDonald, R Edwards, C A Morgan and J F D Greenhalgh (2002), *Animal Nutrition* (6^{th} Ed.), Longman Singapore publishers Pvt. Ltd, Singapore, 693p.

[25] P Melendez, A Donovan and J Hernandez (2000), Milk urea nitrogen and infertility in Florida Holstein cows, *J. Dairy Sci*, **83**, pp. 459-463.

[26] Q Liu, C Wang, W Z Yang, W W Zhang, X M Yang, K H Dong and Y X Huang (2009), Effects of feeding propylene glycol on dry matter intake, lactation performance, energy balance and blood metabolites in early lactation dairy cows, *Anim*, **10**(3), pp. 1420–1427.

[27] R Augustine (2008), Energy supplementation on production performance of cows under field condition, M.V.Sc. thesis, Kerala Agricultural University, Thrissur, 83 p.

[28] R B Reis, F San Emeterio, D K Combs, L D Satter and H N Costa (2001), Effects of corn particle size and source on performance of lactating cows fed direct-cut grass-legume forage, *J. Dairy Sci*, **84**, pp. 429–441.

[29] R E Rofler and L D Satter (1975), Relationship between ruminal ammonia and non protein nitrogen utilization by ruminanats. Development of a model for predicting non protein nitrogen utilization by cattle, J. *Dairy Sci*, 58, pp.1880-1898.

[30] S G Onetti and R R Grummer (2004), Response of lactating cows to three supplemental fat sources as affected by forage in the diet and stage of lactation: a meta analysis, *Anim. Feed Sci. Technol*, **115**, pp.65-82.

[31] S Joseph (2005), Effect of urea as a source of rumen degradable protein on milk production of cross bred cows in early lactation, M. V. Sc. Thesis, Kerala Agricultural University, Thrissur, 87p.

[32] S Khampa and M Wanapat (2006), Influences of energy sources and levels supplementation on ruminal fermentation and microbial protein synthesis in dairy steers, Pakist. *J. Nutr*, **5** (4), pp. 294-300.

[33] S M Andrew, H F Tyrrell, C K Reynolds and R A Erdman (1991), Net energy for lactation of calcium salts of long chain fatty acids for cows fed silage based diets, *J. Dairy Sci*, **74**, pp. 2588-2600.

[34] S Mishra, S S Thakkur and R Rakesh (2004), Milk production and composition in crossbred cows fed calcium salts of mustard oil fatty acids, *Indian J. Anim. Nutr*, **21**, pp. 22-25.

[35] S Noftsger and N R St-Pierre (2003), Supplementation of methionine and selection of highly digestible rumen undegradable protein to improve nitrogen efficiency for milk production, *J. Dairy Sci*, **86**, pp. 958-969.

[36] V Sridhar, T R Janardhana, T R Raghava and N P Purushotham (1999), Effect of varying energy levels on biochemical changes in the rumen of Deccani sheep, *Indian J. Anim. Sci*, **69** (4), pp. 268-269.