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, 3.31 and 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

<table>
<thead>
<tr>
<th></th>
<th>Concentrate mixture</th>
<th>Fodder</th>
<th>Ground maize</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter</td>
<td>92.9</td>
<td>17.08</td>
<td>88.79</td>
</tr>
<tr>
<td>Crude protein</td>
<td>16.49</td>
<td>8.68</td>
<td>7.75</td>
</tr>
<tr>
<td>Crude fibre</td>
<td>7.14</td>
<td>34.69</td>
<td>2.04</td>
</tr>
<tr>
<td>Ether extract</td>
<td>2.91</td>
<td>3.05</td>
<td>2.80</td>
</tr>
<tr>
<td>Total ash</td>
<td>9.65</td>
<td>10.75</td>
<td>2.58</td>
</tr>
<tr>
<td>Nitrogen free extract</td>
<td>63.81</td>
<td>42.83</td>
<td>84.82</td>
</tr>
<tr>
<td>Acid insoluble ash</td>
<td>1.08</td>
<td>1.85</td>
<td>0.61</td>
</tr>
</tbody>
</table>

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, 3.31 and 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, 3.31 and 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

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

*mean of six animals

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

<table>
<thead>
<tr>
<th>Fortnight</th>
<th>Milk urea nitrogen, mg/dl</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group I</td>
<td>Group II</td>
</tr>
<tr>
<td>1</td>
<td>14.76 ± 1.20</td>
<td>18.21 ± 0.82</td>
</tr>
<tr>
<td>5</td>
<td>16.5 ± 1.61</td>
<td>19.3 ± 1.47</td>
</tr>
<tr>
<td>10</td>
<td>16.73 ± 1.20</td>
<td>18.95 ± 0.82</td>
</tr>
</tbody>
</table>

*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

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

*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.

Acknowledgement

The facilities provided by the Kerala Veterinary and Animal Science University and the Dean, College of Veterinary and Animal Sciences, Mannuthy, for conducting this study are gratefully acknowledged. We also thank all staff members of the livestock farm unit for their assistance in the care and feeding of the cows used in this research.

Reference


