Dietary Manipulations for Enhancing Cardio-Protective Fatty Acids in the Milk of Dairy Cows

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Abstract

The ruminants milk contains a higher proportions of saturated fatty acid (SFA), which is a risk factor related to cardiovascular disease. The mono and polyunsaturated fatty acid (MUFA, PUFAs), decreasing the risk of heart disease, are low in milk fat. The crossbred cows have been a major source of milk for human consumption. This study was conducted to investigate the effect of protected palm fats feeding on milk fatty acids profiles of crossbred cows. A total of 15 of Crossbred and 15 of Holstein Friesian cows were selected and protected palm fats were supplemented as: PF-0, PF-25, PF-50, PF-100 and; PF-150; the number representing the quantity (g) of fats/day. Milk sample were collected, analyzed and the study continued for 8 weeks. SFA was significantly ($P<0.05$) decreased from 70.80 to 67.45 g/100g while MUFA and PUFA increased with the increasing supplementation. It appears that hypercholestermic properties of the milk were reduced and cardio-protective properties were enhanced by feeding protected palm fats. It was also associated with increased milk yield and progesterone level reflecting better fertility and productivity. In early lactation 150 g/day palm protected fat may be supplemented for maximum yield, better reproductive performance and healthier milk.

Keywords: Hypercholestermic; cardio-protective; milk; dairy; nutrition; cattle; diet

1. Introduction

Crossbreed cows are kept for milk production by the peri urban dairy farmer and small scale rural farmer in Pakistan. These animals have emerged through genetic improvement of local non-discriptive cows leading to gradual improvement in milk yield. Resultantly they require improved feeding and management practices [1]. The improvement of ruminant milk quality has in many ways, been made possible by dietary manipulation [2]. Researchers have attempted to obtain milk fat with healthier properties increasing its content in polyunsaturated fatty acids (PUFAs) which have unquestionable beneficial effects on human lipid metabolism [3]. Many attempts have been made, therefore, to alter the fatty acid composition of milk fat from lactating cows in order to improve its nutritional value. From these studies, it has been deduced that the fat used should be protected from ruminal microbial actions so that PUFAs reach the small intestine and their potentially toxic effect on rumen micro-organisms is minimized [2, 4]. Cows have high energy demands in early lactation to sustain milk secretion; hence one logical strategy for sustaining milk production is maximizing energy intake by increasing energy density of diet. Flaked, prilled fatty acids, calcium salts, formaldehyde and many other treated protected fatty acids are insoluble in the rumen [2].

The present study was conducted to explore response the changes in milk fatty acid profiles with protected fats diets in various cattle breeds.

2. Materials and methods

Selection of Animals and treatments: Thirty lactating cows (Holstein Friesian and Crossbred) during 3rd week of lactation were selected at University Dairy Farm. The animals were housed in open paddock with free access to water from a tank. Milking was practiced at 3 AM and 3 PM and concentrate feed was provided during the milking time. Experimental period was for 8 weeks, with 3 days of adaptation. The cows were allotted randomly to the five dietary treatments as follows: PF0 (concentrate mixture, 1kg/ 3L milk); PF25, PF100, PF150 (concentrate mixture + Protected fats 25, 50, 100, 150g/day). The fats was protected through the method described as by Strohmaier et al. [5].

Milk recording, sampling and analysis: A total of 80 samples of milk were collected in each week and daily milk yield was recorded. Weekly milk samples were collected at the rate of 50 ml and stored at -20ºC until analyzed. The milk fat was separated and analysed for fatty acids [6].

Statistical Analysis: The data were analysed through SPSS 11 for Windows XP. Analysis of variance was used for means comparison through general liner model procedures. Correlation analysis was used for detecting changes in protected fats levels affected milk yield and fatty acids. Means were subsequently ranked using Duncan Multiple Range Test.

3. Results

Milk Fatty acids concentrations: The mean values of milk yield and milk fatty acids and milk progesterone are reported in Table 1. Saturated fatty acid (SFA) showed the highest concentration out of the total milk fatty acids with an mean ± SE of 68.72±0.41 g/100 ranging from 62.3 to 78.4 g/100g. Within SFA the highest concentration was recorded for C16:0 (26.87 g/100g) followed by C14:0 (13.96 g/100 g). The sum of three hypercholestremic fatty acids (C12:0, C14:0 and C16:0) was 44.0 g/100g. Average concentration of unsaturated fatty acids (UFA) was 30.27 g/100g out of which the highest concentration was recorded for C18:1 (23.89 g/100). The concentration of monounsaturated fatty acids (MUFA) was 26.87 and polyunsaturated fatty acids (PUFA) were 3.41 g/100 g in the total milk fatty acid.

Effect of protected palm fats: In Holstein dairy cows fats supplementation affected concentration of C14:0 and C16:0 significantly decreasing with the increasing levels of fat intake from PF25 to PF150 /day (Table 2). Polyunsaturated fatty acids were higher in PF100 and PF150 groups. The highest concentration was recorded for C18:3 ($P<0.05$). In crossbred dairy cows fat supplementation had no significant effect on overall SFA; however with increasing fat intake from PF0 to PF100 a decreasing trend was observed in SFA from 71.36 to 66.50 g/100 g (Table 3). Concentration of C14:0 significantly decreased with the increasing the level of dietary protected fats. In polyunsaturated fatty acids C18:3 was significantly increased (P=0.042) in PF100 and PF150 supplemented groups, while C18:2 was not effected significantly however, highest concentration was observed in PF150 group.

Correlation analysis showed that changes in C8:0, C10:0 and C12:0 were positively correlated with the PUFA. Milk progesterone was negatively correlated with the saturated fatty acids but showed strongest correlation with the C12:0 (r = -0.379). Daily milk yield correlated negatively with C12:0 and positively with C19:0 (-0.224 and 0.250 respectively, P<0.05).

Figure 1 shows constant decrease in the level of SFA from 71 to 67% with increasing intake of protected fats from PF0 to PF100, however, further increased was not effective. The increasing level of protected fat from PF0 to PF50 did not effect the unsaturated fatty acid. Further increased up to PF150 g/day increased the later from 32.7 g/100g all these changes were significant.

Effect of protected fats on milk yield and progesterone: Figure 2 shows changes for progesterone and milk yield with different supplemented levels of protected palm fats. Highest milk yield (13.31±0.81 kg/day) was recorded in PF150 group, followed by 12.66±0.79 kg/day in PF100 supplemented group (P<0.05).

4. Discussion

Effect of Protected Palm fats on Milk fatty acids: Supplementation of palm protected fats to dairy cows

Parameters	Minimum	Maximum	Mean ±SE
Milk Yield kg/day	6	18	12.12±0.49
Progesterone ng/ml	0.22	2.78	1.80±0.06
Milk Fatty acid (g/100g)			
C12:0	0.8	9.3	3.25±0.17
C14:0	10	18.9	13.96±0.28
C16:0	22.8	32	26.87±0.24
C18:0	13	21.7	16.41±0.19
C14:1	0.1	1.6	0.415±0.03
C16:1	0.1	3.7	0.79±0.08
C18:1 *trans*	0.2	6.2	1.77±0.14
C18:1	14.3	33	23.89±0.51
C18:2	0.3	6.3	0.415±0.03
C18:2 *trans*	0.4	1.2	0.79±0.08
C18:3	0.2	2.8	1.77±0.14

Parameters	Minimum	Maximum	Mean ±SE
SFA	62.3	78.4	68.72±0.41
UFA	17.4	45.1	30.27±0.70
MUFA	15.9	37.5	26.87±0.59
PUFA	0.5	8.1	3.41±0.17

Table 1. Descriptive statistics for various parameters in dairy cows (mean ± SE)

SFA (saturated fatty acid), MUFA (monounsaturated Fatty acid), PUFA (polyunsaturated fatty acid)

Milk fatty acids	Protected palm fats					
	PF0	PF25	PF50	PF100	PF150	P vaule
C14:0	15.81±0.34	15.46±0.53	14.10±0.60	11.40±0.45	11.82±0.7	0.000
C16:0	24.79±0.87	25.49±0.64	26.69±0.92	27.82±0.40	28.57±0.4	0.002
C18:3	0.83±0.15	1.06±0.18	0.83±0.14	1.53±0.22	1.74±0.2	0.003
SFA	70.22±0.93	70.21±1.30	68.39±1.60	66.20±0.76	68.47±1.3	0.129
MUSFA	25.77±1.31	24.20±1.92	25.62±1.17	27.42±2.25	29.47±2.8	0.332
PUSFA	3.04±0.54	2.74±0.54	2.69±0.31	4.32±0.85	4.36±0.61	0.089
USFA	28.81±1.55	26.93±2.10	28.03±1.41	31.74±2.80	33.82±2.72	0.191

Table 2. Effect of protected fats intake on milk fatty acids (g/100g) in Holstein dairy cows (Mean±SE)

Milk fatty acids	Protected palm fats					
	PF0	PF25	PF50	PF100	PF150	P value
C14:0	15.85±0.60	15.36±0.71	16.17±0.52	12.56±0.52	11.42±0.4	0.000
C18:2	1.82±0.40	1.46±0.23	1.87±0.26	2.05±0.27	2.41±0.3	0.546
C18:2 *trans*	0.279±0.03	0.24±0.49	0.16±0.04	0.19±0.36	0.24±0.7	0.720
C18:3	0.94±0.24	1.18±0.20	1.01±0.10	1.51±0.14	1.65±0.1	0.042
SFA	71.40±0.96	69.37±1.0	68.11±1.50	68.37±0.9	67.49±0.8	0.085
MUSFA	26.16±1.46	27.80±2.6	26.68±2.08	28.07±1.93	28.45±1.2	0.952
PUSFA	3.07±0.3	2.89±0.45	3.05±0.38	3.71±0.42	4.30±0.35	0.162
USFA	29.04±1.08	30.77±2.96	29.74±2.43	31.75±2.19	32.7±1.50	0.903

Table 3. Effect of Protected Palm fats intake level on Milk fatty acids profile (g/100g) in Crossbred dairy cows (Mean± SE)

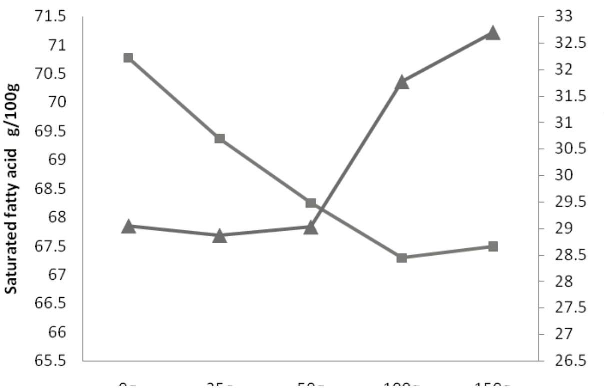

Figure 1. Effect of protected-palm-fats feeding (g/day) on unsaturated (▲) and saturated fatty acids (g/100g, ■) in the milk of dairy cows.

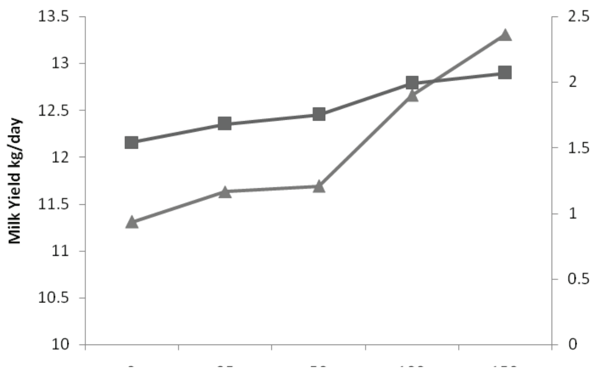

Figure 2. Effect of different levels of protected palm fats (g/day) on milk yield (kg/day, ▲) and progesterone concentrations (ng/ml, ■).

significantly (P<0.002) decreased SFA of milk from 70.78 to 67.49 (g/100g). Within the SFA the caproic (C6:0) capylic (C8:0) and capric (C10:0), lauric (C12:0), myristic (C14:0) acids decreased while palmitic (C16:0) was significantly (P<0.001) increased. In polyunsaturated fatty acids linolenic acid (C18:3) was significantly (P<0.05) enhanced by increasing supplement fats up to 150 g/day. Similar finding was observed by Purushothaman et al. [7] who fed 200 g palm protected fats to crossbred cows, and observed that with the supplementation the proportion of caproic (C6:0), capylic (C8:0) and capric (C10:0) acid decreased significantly (p<0.01) while the palmitic (C16:0), polyunsaturated fatty acid: oleic (C18:1), linoeic (C18:2) and linolenic (18:3) acids concentration in increased in milk fats of crossbred cow.

Lauric acid (12:0), myristic acid (C14:0), and palmitic acid (C16:0) are to be the serum total and LDL-cholesterol raising SFA [8]. Myristic acid C14:0 is more hypercholesterolemic than palmitic acid C16:0 [9]. The increased concentration of palmitic acid in milk fat was due to palm oil, rich in palmitic acid. The decrease in C14:0 and C12:0 by 27.94% and 38% respectively can be related to the inhibition of these fatty acid with the supplementation, rich in PUFA. The present study is supported by West and Hill [10] reporting that supplementation of protected fats decreased the percentage of short-chain fatty acids and increased the long-chain fatty acids in milk fat. Similarly, Pantoja et al. [11] in Holstein dairy cows, found an increase in C16:0 and C18:0 fatty acids and decrease in C8 to C14 fatty acids. McDonald and Scott [12] reported that cows fed protected fat containing polyunsaturated oil had marked increased linoleic acid of milk fat.

Effect of Protected fats on Milk yield: In our study milk yield is increased by the supplemented levels of protected palm fats in both crossbred and Holstein dairy cows. Similar findings were reported by Sajith Purushothaman et al. [7] about increased milk yield (by 1.9 kg/day) when fed 200 g protected palm fats. An increase in the production of milk has been also reported by Sarwar et al [13] and Palmquist and Jenkins. [14] in cows supplemented up to 300 g of rumen-protected. Supplementation of calcium salt of long chain fatty acids increased the milk production significantly (P<0.05) as reported by Maeng et al. [15]. Staples et al., [16] reviewed the effects of feeding fats on reproduction in dairy cows and also summarized their effects on milk yield, addition of calcium salt of palm oil increased milk yield by 2.4 kg/day.

Effect of protected fats on milk progesterone: Milk progesterone was affected by intake of protected palm fats (P<0.033) changing favourably with increasing level of fats supplementation. Lowest progesterone concentration (1.54 ng/ml) was found in controlled group while highest 2.07 ng/ml of progesterone in 150g fat supplemented group. A similar study carried by Lopes [17], observed 1.81 ng/ml of progesterone on supplemented fed of 200 g of polyunsaturated fatty acid to *Bos indicus* beef cows. Espinoza et al., [18] supplemented 125g of protected palm oil to Herford and Angus and found greater than >1ng/ml of progesterone in cyclic cows. The increase in milk progesterone may be due to combating negative energy balance as already reported [19].

5. Summary and Conclusion

This paper investigated the effect of feeding protected palm fats on milk fatty acids profiles. The results suggest that hypercholestermic properties of the milk were reduced and cardio-protective properties were enhanced by feeding protected palm fats. It was also associated with increased milk yield and progesterone level reflecting better fertility and productivity. In early lactation 150 g/day palm protected fat may be supplemented for maximum yield, better reproductive performance and healthier milk.

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