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Variation in Milk Fatty Acid Composition with Body Condition in Dairy Buffaloes (*Bubalus bubalis*)

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ABSTRACT : Buffaloes usually maintain higher body condition and do not produce milk at the cost of their own body reserves under tropical conditions. The mobilization of body reserves for fulfilling the demands of lactation has been extensively studied in dairy cows while limited work is available on this aspect in dairy buffaloes. Therefore, the present study was conducted to examine variations in milk fatty acid profiles with body condition in Nili-Ravi buffaloes. A total of 24 Nili-Ravi buffaloes within 60 days after parturition, were selected from a private dairy farm in the district of Peshawar. All animals consumed the same diet during the experimental period. A total of 576 raw milk samples were collected for laboratory analysis. The study continued up to 6 months during 2008. Body condition score (BCS), milk yield and composition were recorded once a week. Means for milk fatty acid profile were compared for various levels of BCS. The mean milk yield and fat content were 9.28 kg/d and 5.36%, respectively. The total saturated fatty acids (SFA) were 64.22 g/100 g and the unsaturated fatty acids (UFA) were 35.79 g/100 g. Of the SFA the highest amount was recorded for $C_{16:0}$, followed by $C_{18:0,}$ and $C_{14:0}$. The total sum of hypercholesterolemic fatty acids (HCFA, $C_{12:0}$, $C_{14:0}$ and $C_{16:0}$) was 43.33 g/100 g. The concentrations of UFA were greater for moderate BCS followed by poor and highest BCS while SFA showed the opposite trend. The correlation analysis showed that milk yield was negatively affected by BCS and milk fat positively affected, though non-significantly. The present study suggests that Nili-Ravi dairy buffaloes produce similar milk to dairy cows regarding availability of cardioprotective fatty acids, with the highest concentration of $C_{18:1\ cis\text{-}9}$. Two HCFA ($C_{12:0}$ and $C_{14:0}$) were associated with higher body condition. Buffaloes with moderate body condition yielded milk containing healthier fatty acids. (**Key Words :** Body Condition, Saturated Fatty Acids, Unsaturated Fatty Acids, Hypercholestrolemic Fatty Acids, Dairy Buffaloes)

INTRODUCTION

Bovine milk fat is an essential part of human diet. The milk of all ruminants contains lipids but the concentrations usually differ among species from 2 to 8% (Belitz and Grosch, 1999). Milk primarily consists of saturated (SFA), monounsaturated (MUFA) and polyunsaturated fatty acids (PUFA). Typical milk fat from dairy cows contains 70% SFA, 25% MUFA and 5% PUFA (Grummer, 1991; Lock and Shingfield, 2004). The milk fat with potential positive effects on human health should contain 60% of MUFA (Pascal, 1996), 30% of SFA and 10% of PUFA (Hayes and Khosla, 1992).

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Not all of the SFAs increase blood cholesterol in humans. Only three (lauric, $C_{12:0;}$ myristic, $C_{14:0}$ and palmitic, $C_{16:0}$) are considered to be hypercholesterolemic fatty acids (HCFA, Williams, 2000) leading to cardiovascular disease. These three fatty acids constitute about 44% of the total milk fatty acids. However, Clandinin et al. (2000) suggests that palmitic acid ($C_{16:0}$) may not have negative effects if the availability of $C_{18:2}$ n-6 is sufficient; stearic acid ($C_{18:0}$) is neutral, while linoleic, α-linolenic and oleic acids are considered cardioprotective (Djoussé et al., 2001; Bemelmans et al., 2002). The vaccinic acid ($C_{18:1}$ trans-11), linolenic acid ($C_{18:3}$) and conjugated linoleic acid (CLA), particularly rumenic acid ($C_{18:2\ cis\text{-}9,\ trans11}$) have shown positive health effect such as prevention of mammary gland and skin tumors in experimental animals (Ha et al., 1990; Ip et al., 1994). Vaccinic acid has been associated with anti-carcinogenic properties due to *in vivo* conversion into rumenic acid (Turpeinen et al., 2002; Corl et al., 2003).

Various sources of milk fatty acids may be categorized

into dietary intake, adipose tissues mobilization and de novo synthesis in the mammary tissues. The mobilization of adipose tissues reserves is triggered when the energy balance is negative in order to meet the demands of lactation. During fat metabolism, desaturation of stearic acid occurs in the intestinal epithelium and mammary tissues by the desaturase enzymes (Enoch et al., 1976). Hence, the fatty acids from dietary and adipose tissue mobilization results in greater quantities of long chain SFA and UFA. Cows that have a low BCS rely more on exogenously derived fatty acids than adipose tissue reserves, for milk fat synthesis (Pedron et al., 1993).

To provide healthy food to the consumers, the beneficial fatty acids must be increased and the critical fatty acids decreased keeping in view the forthcoming challenge to the dairy industry. Buffaloes maintain higher body condition and do not produce milk at the cost of its own body reserves (Qureshi et al., 2007). In order to provide precursors for milk synthesis, the process of lipolysis has been identified as a good dairy characteristic in cattle while buffaloes do not qualify this criterion by maintaining higher BCS during lactation. Therefore, the present study was conducted to examine the milk fatty acid contents in response to variation in body condition under tropical conditions.

MATERIALS AND METHODS

The present study was conducted at district Peshawar located in the northwest frontier province of Pakistan. A total of 24 Nili-Ravi buffaloes within 60 days after parturition were selected out of 50 animals at the private dairy farm situated at village Palosi close to the university campus. The buffaloes were reared under intensive farming system with higher input cost but little support in farm development, scientific management and marketing. The experimental animals were offered green fodders (Egyptian clover and whole crop maize) *ad libitum* and concentrate (wheat bran, cotton seed cake and maize oil cake, molasses and macrominerals) mixture at the rate of 1 kg per 2 liters of milk produced. All the animals consumed the same diet during the experimental period. The animals were milked twice a day at 12 hours interval. A total of 576 raw milk samples were collected from buffaloes, for laboratory analysis. The animals were stall-fed and chopped fodders were provided at 1,000 and 1,400 h. Water shower was made available to all animals during the hot season twice a day at the farm.

During the experimental period, all the animals were confined in the shed with access to drinking water availability throughout the day from an adjacent tank. The study continued up to 6 months during the year 2008.

Body condition score (BCS)

The BCS of all the cows was recorded weekly, using the method described by Peters and Ball (1987). According to this method the thickness of fat over the lumber and tail head area was estimated and was assigned a score from 0 (very weak) to 5 (very fat). The BCS was categorized as: 0, spine very prominent and transverse vertebral processes feel sharp with no fat cover; 1, spine prominent and transverse processes feel sharp with little fat cover; 2, transverse processes can be felt but are rounded with a thin covering of fat; 3, individual transverse vertebral processes can only be felt by firm pressure; 4, the transverse processes cannot be felt; and 5, the transverse processes covered with a thick layer of fat. The experimental animals fell within the range of 1.5, 2.5 and 3.5 and were categorized as poor, moderate and high, respectively.

Milk yield (MY), sampling and analysis

The milk yield (kg/d) and milk composition were recorded once a week for up to 24 weeks period. Milk samples (200 ml each) in bottles were transported in an icebox to dairy production laboratory and were stored in refrigerator at -20°C until analyzed. The fat, protein and lactose contents were determined using ultrasonic milk analyzer (model Ekomilk Total Ultrasonic Milk Analyzer, Bullteh 2000, Stara Zarqora, Bulgharia) according to manufacturer's instructions.

Determination of fatty acids

Fat extraction : The milk fat separation was carried out by the method of Feng et al. (2004). A 20 ml of fresh milk in a 50 ml conical plastic tube was centrifuged at 12,000 rpm for 30 min at 4°C. A portion (1.0 g) of the fat cake layer was transferred to 1.5 ml micro-tube and left at room temperature for approximately 20 min until the fat cake melted. This was again centrifuged at 13,000 rpm for 20 min at room temperature by microcentrifuge. After centrifugation, the fat had separated into 3 layers: the top layer of lipid; the middle layer of protein, fat and the water insoluble solids and the bottom layer of water.

Preparation of methyl esters : The lipids were transesterified with sodium methoxide prepared in the laboratory by the method of Christie (1982) with modification by Chouinard et al. (1999). Hexane (2 ml) was added to 40 mg of butter oil followed by 40 μl of methyl acetate. After the mixture was vortexed, 40 μl of methylation reagent (1.75 ml methanol: 0.4 ml of 5.4 mol/L sodium methylate) was added. The mixture was vortexed and allowed to react for 10 min, and then 60 μl of termination reagent (1 g oxalic acid/30 ml diethyl ether) was added. The sample was centrifuged for 5 min at 2,400×g at 5°C leaving a clear layer of hexane; an aliquout

of the hexane was taken in sealed gas chromatography vials and kept at -20°C until analysis.

Gas chromatography : The fatty acid methyl esters (FAME) were quantified using Perkin-Elmer chromatograph (model Clarus 500, Beaconsfield, UK) with flame ionization detector. The separation of FAME was performed with 100-m fused silica capillary column (i.d., 0.25 mm) coated with 0.2 μm film of cyanopropylo-polysiloxane (CP-SIL 88; Varain Middelburg, The Netherlands). Hydrogen was used as the carrier gas. The FAME of 1 μl was identified as the appropriate quantity and hence injected manually. The column temperature was held at 70°C for 4 min post-injection, increased to 110°C (8°C/min), increased to 170°C (5°C/min), held at 170°C for 10 min and ramped to 240°C (8°C/min) and held for 7 minutes. The injector and detector temperatures were maintained at 225 and 250°C respectively. Peaks were identified by pure methyl ester standards (GLC-10 and GLC-30 FAME mixtures; Materya Inc. Pleasant Gap, PA. USA). A butter oil reference standard (CRM 164; Commission of the European Community Bureau of References, Brussels, Belgium) was used to determine recoveries and correction factors for individual fatty acids.

Data analysis

Statistics were performed by SPSS 10.0 (1999) for Windows XP. The data obtained were subjected to analysis of variance for means comparison using the general linear model (GLM) procedures. Means for fatty acid profiles of milk were compared for various levels of BCS (poor, moderate and high). Means were subsequently ranked using Duncan's Multiple Range Test (DMRT) as described by Steel and Torrie (1980). Number of observations, means and standard deviations were recorded for the groups. A bivariate analysis with Pearson correlations ($p<0.05$ level, 2-tailed) was conducted with the data to determine the relationship between BCS, individual fatty acids, fat content and milk yield.

RESULTS

The mean milk yield in Nili-Ravi buffaloes recorded during the study was 9.28 kg/d ranging from 4.77 to 16.00 kg/d (Table 1). The average fat percentage was 5.36, ranging from 3.00 to 8.23. The total amount of saturated fatty acids (SFA) was on the average 64.22 g/100 g varying from 59.01 to 67.65 g/100 g and the unsaturated fatty acids (UFA) were 35.79 g/100 g ranging from 32.35 to 40.99 g/100 g. Out of the SFA the highest amount was of palmitic acid ($C_{16:0}$, 30.06 g/100 g), followed by stearic acid ($C_{18:0,}$ 14.70 g/100 g) and myristic acid ($C_{14:0}$, 10.84 g/100 g). The highest monounsaturated fatty acids (MUFA) level was of oleic acid ($C_{18:1\ cis-9}$, 29.47 g/100 g). The concentration of polyunsaturated fatty acids (PUFA) was 4.91 g/100 g. The medium chain fatty acids $C_{12:0}$, $C_{14:0}$ and $C_{16:0}$ are the critical fatty acids, considered as hypercholestrolemic (HCFA) associated with cardiovascular disease in human population. The total sum of these three fatty acids was 43.33 g/100 g.

Effect of BCS on milk fatty acids profile

The fatty acid composition of buffalo milk as influenced by BCS is presented in Table 2. The fatty acids were significantly ($p<0.05$) influenced by the body condition. The concentrations of unsaturated fatty acids (UFA) were greater with the moderate BCS followed by poor and highest one (38.16±1.92, 37.39±2.09 and 35.15±1.77 g/100 g

Table 1. Descriptive statistics for milk yield (kg/d), fat contents (%) and fatty acids profiles (g/100 g)

Parameter	N	Mean	Std. Deviation	Min	Max
BCS[1]	576	3.20	0.58	1.50	3.50
Fat %	576	5.35	1.18	3.00	8.23
MY[2]	576	9.27	3.26	4.77	16.00
C8	576	1.37	0.30	1.15	2.00
C10	576	2.23	0.44	1.20	2.82
C12	576	2.43	0.52	1.74	3.50
C14:0	576	10.84	0.91	8.40	11.65
C16:0	576	30.06	1.68	28.00	32.88
C18:0	576	14.75	1.62	11.50	16.91
C18:1 $_{cis-9}$	576	29.47	1.43	28.00	32.32
C18:2 $_{cis-9, 12}$	576	2.45	0.53	1.60	3.24
C18:3 $_{cis-9, 12, 15}$	576	2.46	0.80	1.65	3.45
SFA% [3]	576	64.20	2.16	59.01	67.65
UFA% [4]	576	35.79	2.16	32.35	40.99

[1] Body condition score. [2] Milk yield. [3] SFA = Saturated fatty acids. [4] UFA = Unsaturated fatty acid.

Table 2. Mean and standard deviation for milk fatty acids (g/100 g) as influenced by body condition score in dairy buffaloes (n = 576)

BCS[1]	Fatty acid concentrations (g/100 g)					
	C8	C10	C12	C14	C16	C18
1.5	1.16^{b}±0.16	1.69^{b}±0.39	1.85^{b}±0.53	10.28^{b}±1.08	31.32^{a}±0.29	12.93^{b}±0.67
2.5	1.17^{b}±0.17	1.75^{b}±0.37	1.87^{b}±0.22	10.04^{b}±1.16	31.49^{a}±1.71	12.80^{b}±0.63
3.5	1.44^{a}±0.33	2.38^{a}±0.35	2.56^{a}±0.48	11.04 ^{a}±0.73	29.64 ^{b}±0.34	15.30^{a}±1.40
p	p<0.05	p<0.05	p<0.05	p<0.05	p<0.05	p<0.05
	C 18:1 $_{cis-9}$	C 18:2 $_{cis-9, 12}$	C 18:3 $_{cis-9, 12, 15}$	SFA[2]	UFA[3]	-
1.5	29.44^{b}±1.77	2.62^{b}±0.53	3.33^{a}±0.11	62.61^{b}±1.93	37.39^{b}±2.09	-
2.5	30.36^{a}±1.46	2.80^{a}±0.52	3.32^{a}±0.12	61.84^{b}±1.96	38.16^{a}±1.92	-
3.5	29.28^{b}±1.13	2.37^{c}±0.50	2.20^{b}±0.75	64.05^{a}±2.90	35.15^{c}±1.77	-
p	p<0.05	p<0.05	p<0.05	p<0.05	p<0.05	-

[1] BCS = Body condition score (scale 1 to 5). [2] SFA = Saturated fatty acids; [3] UFA = Unsaturated fatty acid.
[a, b, c] Mean in the same column within a group having different superscripts are significantly different.

respectively, p<0.05) while the saturated fatty acids (SFA) showed an opposite trend (Figure 1).

The concentrations of short and medium chain as well as $C_{18:0}$ were greater with the increase in BCS, while $C_{18:1\ cis-9}$, $C_{18:2\ cis\ 9,\ 12}$ and $C_{18:3\ cis\ 9,\ 12,\ 15}$ were greater with moderate BCS and lowest with higher BCS (Figure 2). The two hypercholestolemic fatty acids (HCFA $C_{12:0}$ and $C_{14:0}$) increased with BCS while the $C_{16:0}$ was higher with the moderate BCS (Figure 3).

Correlation of fatty acids

The correlation analysis showed that milk yield was negatively effected by BCS and milk fat positively though non-significantly (Table 3). The short and medium chain fatty acids as well as $C_{18:0}$ correlated positively while the monounsaturated (MUFAs), polyunsaturated fatty acids (PUFAs) and $C_{16:0}$ negatively with body condition. All the SFA (short, medium and long chain fatty acids except $C_{16:0}$, correlated positively with each other and negatively with UFA. Similarly, the UFA showed a mutual positive correlationship. Also $C_{18:0}$ correlated negatively but with increasing intensity with $C_{18:1\ cis-9}$, $C_{18:2\ cis,\ cis-9,12}$ and $C_{18:3\ cis-9,12,15}$ (r = -0.168, -0.519 and -0.899, respectively, p<0.05).

The Figure 1 shows that moderate BCS was associated with the highest concentration of UFAs and lowest SFAs.

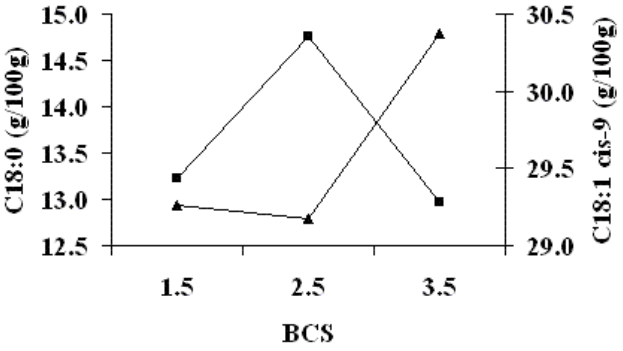

Figure 2. Changes in oleic acid ($C_{18:1cis-9}$), the major mono-unsaturated fatty acids (MUFA) and stearic acid ($C_{18:0}$, %) with body condition score (BCS) in Nili-Ravi buffaloes. The two fatty acids showed a negative correlation (r = -0.168, p<0.01).

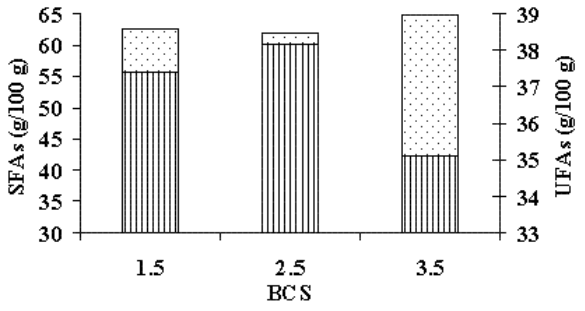

Figure 1. Changes in concentration of saturated (SFAs, dotted area) and un-saturated fatty acids (UFAs, vertical lines) with body condition score (BCS) in dairy buffaloes. Both types of the fatty acids were significantly different across various levels of BCS (p<0.05). The SFA and UFA correlated negatively and significantly (r = -0.614, p<0.01).

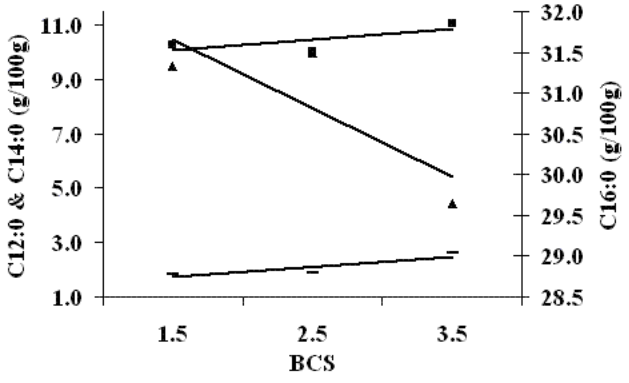

Figure 3. Changes in hypercholestrolemic $C_{12:0}$, $C_{14:\ 0,}$ and $C_{16:0}$,) fatty acids with body condition score (BCS) in Nili-Ravi Buffaloes. The three types of fatty acids showed a significant correlation with the BCS (r = 0.557, 0.388, -0.411, p<0.01).

Table 3. Correlation of milk fatty acids (g/100 g) with BCS, fat and milk yield in dairy buffaloes

Para-meters	Correlating parameters						
	BCS	Fat	MY[1]	C8	C10	C12	C14
Fat	0.074[ns]						
MY[1]	-0.239**	-0.035[ns]					
C-8:0	0.349**	0.036[ns]	-0.406**				
C-10:0	0.588**	0.072[ns]	-0.404**	0.610**			
C-12:0	0.557**	0.017[ns]	-0.312**	0.831**	0.820**		
C-14:0	0.388**	-0.021[ns]	-0.251**	0.515**	0.519**	0.547**	
C-16:0	-0.411**	0.051[ns]	-0.156**	-0.124*	-0.495**	-0.533**	-0.232**
C-18:0	0.597**	0.004[ns]	-0.293**	0.747**	0.847**	0.946**	0.708**
C-18:1	-0.168**	-0.100*	0.181**	0.017[ns]	-0.242**	-0.119**	-0.411**
C-18:2	-0.254**	0.072[ns]	0.160**	-0.554**	-0.296**	-0.439**	-0.582**
C-18:3	-0.548**	-0.012[ns]	0.172**	-0.614**	-0.776**	-0.909**	-0.401**
SFA[2]	0.435**	0.043[ns]	-0.487**	0.843**	0.701**	0.773**	0.789[ns]
UFA[3]	-0.414**	-0.058[ns]	0.245**	-0.388**	-0.572**	-0.576**	-0.620**
	C16:0	C18:0	C18:1	C18:2	C18:3	SFA[2]	
C-18:0	-0.022[ns]						
C-18:1	0.081[ns]	-0.168**					
C-18:2	0.081[ns]	-0.519**	0.296**				
C-18:3	0.740**	-0.899**	0.077**	0.322**			
SFA[2]	-0.014[ns]	0.796**	-0.324**	-0.592**	-0.537**		
UFA[3]	0.307**	-0.679**	0.838**	0.616**	0.551**	-0.614**	

** p<0.01; * p<0.05; ns = Non-Significant difference.
[1] Milk yield. [2] SFA = Saturated fatty acids. [3] UFA = Unsaturated fatty acid.

DISCUSSION

The HCFA ($C_{12:0,}$ $C_{14:0}$ and $C_{16:0}$) found in this study on Nili-Ravi buffaloes were considerably lower and cardioprotective fatty acids ($C_{18:1}$ and $C_{18:2}$ and $C_{18:3}$) level were higher than the Bulgharian Murrah buffaloes as reported by Mihaylova and Peeva (2007). They found that total amount of SFAs were 72.15% (varying from 64.92 to 77.60%), PUFA 3.15% and the HCFA were 43.62%. Our values are in close agreement with Fernandes et al. (2007) who reported that the total SFAs, MUFA and PUFA in Murrah buffaloes in Brazil were 65.04%, 31.68% and 3.28% respectively and the HCFA varied from 32.48 to 42.90%. Our values for dairy buffaloes are not much different from dairy cows where the SFAs varied from 60 to 65% and UFAs 35 to 40% of the total fatty acids (Lock and Garnsworthy, 2003). Talpur et al. (2008) compared fatty acid composition of Nili-Ravi and Kundi buffaloes in Sindh province. The average SFAs were; 66.96 g/100 g and 69.09 g/100 g; MUFA 27.62 and 25.20 g/100 g; PUFA 2.77 and 2.76 g/100 g and HCFA 42.8 and 46.54 g/100 g, of total fatty acids for Kundi and Nili-Ravi breed respectively. It appears that the cardioprotective quality of milk from Nili-Ravi buffaloes is almost similar to dairy cows and Brazilian and better than Bulgharian Murrah buffaloes.

Effect of BCS on milk fatty acids profiles

The concentrations of unsaturated fatty acids (UFAs) were highest with the moderate BCS followed by poor and highest one. Our findings confirm a previous report on lactating Angus×Gelbvieh beef cows (Lake et al., 2006) suggesting that moderate BCS will provide greater percentage of $C_{18:0}$ and $C_{18:1\ trans-10}$ in milk which was attributed to the dietary source. In the present study increasing body condition were reflected by an increase in $C_{18:1\ cis-9}$ and decreased in $C_{18:0}$ concentration, showing an improvement in the milk quality. Further increase in BCS up to higher level was associated with a reverse pattern of the two fatty acids.

The opposite pattern of BCS and UFAs concentration was probably due to lipolysis. In adipose tissue, $C_{18:1\ cis-9}$, $C_{16:0}$, and $C_{18:0}$ account for nearly 90% of fatty acids in molar proportions (Christie, 1981) and body fat mobilization would probably increase direct accumulation of these fatty acids into milk fat. In addition, desaturation of stearic acid occurs in the intestinal epithelium and mammary tissues (Enoch et al., 1976). Some 40-50% of $C_{18:1\ cis-9}$ in milk fat is formed from $C_{18:0}$ in the mammary gland via desaturase (Chillard et al., 2000). The net outcome of all these processes is the higher level of UFA and more specifically the $C_{18:1}$ concentration, which has

been confirmed through this study.

In Mediterranean dairy buffaloes activity of Δ^9-desaturase enzyme was studied (Fernandes et al., 2007). The farm maintained on pasture and corn silage showed higher ratios of UFAs/SFAs indicating greater Δ^9-desaturase activity. The stearoyl-coenzyme A (CoA) desaturase catalyzes the start of a double bond in the Δ^9 position, between carbons 9 and 10 of a variety of fatty acyl CoA substrates. The desired substrate is stearic acid, which is converted to oleic acid. Thus oleic acid in milk fat is in part a consequence of stearoyl CoA desaturase (Banks, 1987). As a result, milk fatty acids tend to be higher in UFAs.

The higher BCS was associated with higher concentrations of SFAs in this study. Similarly, higher percentages of $C_{12:0}$ and $C_{14:0}$ in milk from higher BCS beef cows was reported by Lake et al. (2006) advocating greater de novo synthesis of fatty acids by the mammary glands. Our findings of higher $C_{12:0}$ and $C_{14:0}$ associated with higher BCS confirms their results. The fatty acids synthesized de novo resulted in 4 to 16 carbons from the mammary gland utilization of acetate and β-hydroxybutyrate (Bath et al., 1985). Fatty acid synthase catalyses the conversion of acetyl-Co A and malonyl-Co A into various fatty acids (up to $C_{16:0}$) (Yin et al., 2001). According to Palmquist et al. (1993) the fatty acids synthesized de novo in the mammary gland are $C_{6:0}$ to $C_{14:0}$ and partly $C_{16:0}$.

Lower BCS in this study was associated with milk quality better than higher and lower than moderate BCS in respect of concentration of HCFA, UFA and SFA. In previous studies, cows that have a low BCS relied more on exogenously derived fatty acids than adipose tissue reserves for milk lipid synthesis (Pedron et al., 1993). Short-chain fatty acids are produced from acetate in the rumen while long-chain fatty acids are generated either from body fat or ingested lipids (Payne et al., 1979).

In buffaloes the milk yield was negatively correlated with BCS probably due to mobilization of body reserves, revealing their better genetic potential to be used as dairy breed under tropical conditions. Dairy cows with higher genetic merit have a higher predisposition for mobilization of body fat reserves to cover milk production demands (Veerkamp, 1998; Pryce et al., 2002). These findings were supported by a study of Veerkamp and Brotherstone (1997) that BCS and milk yield are in a negative correlation. Animals of higher genetic merit for milk production have consistently higher rates of lipolysis and hormone sensitive lipase activity (McNamara et al., 1987; Smith and McNamara, 1990).

It has been reported that dairy animals maintained a physiological target for BCS during lactation (Garnworthy and Topps, 1982). These physiological targets may get reduced with the genetic improvement directed towards increased milk yield. As the dairy buffalo is not an improved breed, it may have set a higher physiological target for BCS as compared with Holstein Friesian. This phenomenon may be confirmed in buffaloes and Holstein Friesian cows maintained under the same management in the field conditions; where the lactating buffaloes may be seen with the higher BCS under tropical environment.

CONCLUSION

The present study suggests that Nili-Ravi dairy buffaloes produce milk almost similar to dairy cows regarding availability of cardioprotective fatty acids, with the highest concentration of oleic acid ($C_{18:1cis-9}$, 29.47 g/100 g). Buffaloes with moderate body condition yielded greater concentrations of these fatty acids followed by poor and highest ones. Two hypercholestolemic fatty acids ($C_{12:0}$ and $C_{14:0}$) were associated with higher body condition.

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