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Milk fatty acid profile of Bhadawari buffaloes

B P KUSHWAHA[1], SULTAN SINGH[2], S B MAITY[3], K K SINGH[4], A K MISRA[5] and INDERJEET SINGH[6]

ICAR-Indian Grassland and Fodder Research Institute, Jhansi, Uttar Pradesh 284 003 India

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Buffalo milk has an important role in human nutrition in India, where buffaloes are the major dairy animals with a population of about 109 million (19th Livestock Census 2012). In national total milk production of 155.5 million tonnes (year 2015–16), buffaloes contribute more than 55%. There are thirteen recognised buffaloes breeds in the country and Bhadawari is one of them famous for high milk fat content. Average standard lactation milk yield of Bhadawari buffaloes is around 1500 kg. Average fat, SNF, protein and lactose in Bhadawari buffaloes milk recorded were 8.26, 9.57, 4.05 and 5.23%, respectively (ICAR-IGFRI Annual Report 2015–16). Milk composition and quality are important characteristics that determine the nutritive value and consumer preference. Normally milk fat contains about 65% saturated, 30% monosaturated and 5% polyunsaturated fatty acids. Saturated fatty acids are associated with cholesterol and heart disease. Poly unsaturated fatty acids such as omega 3 and omega 6 and mono unsaturated fatty acids are considered to be good for human health. Whether saturated fatty acid is a risk factor for heart diseases is a question with numerous controversial views. World Health Organization advises that saturated fat is a risk factor for heart diseases and recommend dietary limits on saturated fats as one means of reducing that risk (WHO 2003). However, Mente *et al*. (2009) reported that despite the contribution of dairy product to the saturated fatty acids intake of the diet, there was no clear evidence that dairy food consumption is consistently associated with higher risk of cardiovascular disease. Several other studies (Chowdhury 2014, Siri-Tarino 2010) have opined that saturated fat was not associated with risk of cardiovascular diseases. The milk fatty acids composition depends on several factors such as species, breed and genetic variation, stage of lactation, health and nutrition etc. To our knowledge probably no information is available on the fatty acid profile of Bhadawari buffalo's milk. Hence the present work was undertaken to study the milk fatty acid composition of the Bhadawarti buffaloes known for their high milk fat content.

The study was carried out at Indian Grassland and Fodder Research Institute, Jhansi, Uttar Pradesh, where a herd of Bhadawari buffaloes is being maintained under Network Project on Buffalo Improvement. The milk samples were collected from lactating buffaloes of nearly same body weight (around 400 kg). Animals were maintained under uniform management conditions. All the buffaloes were stall fed and had access to green fodder *ad lib.* while concentrate mixture was provided at the rate of 1 kg/2 kg of milk production as recommended by Ranjhan (1994) for lactating buffaloes under tropical conditions. The ration was offered twice daily in equally divided doses, while clean drinking water was made available *ad lib*. During the month when milk samples were collected for fatty acid analysis, buffaloes were offered wheat straw, berseem/oat and concentrate mixture (barely, mustard cake and wheat bran in equal proportion along with common salt and mineral mixture at the rate of 1 kg each for 100 kg of concentrate). Milk samples for fatty acid profile estimation were collected from 10 multiparous lactating buffaloes during the month of January. At sampling time, average days of lactation were 81 days ranging from 20 to 126 days. Fat was separated from each of the milk samples collected. Milk fat samples were analysed for milk fatty acid profile at CSIR-Central Food Technological Research Institute, Mysore, India, using AOCS Official Method 1998, Ce1–62 and Ce2–66.

Twenty–two fatty acids of different saturation levels were detected in Bhadawari milk (Table 1), where 13 were saturated (SFA) and 9 were unsaturated fatty acids (USFA). The milk contained 77.3% saturated fatty acids (SFA), 21.54% monounsaturated fatty acids (MUFA), 1.1% poly unsaturated fatty acids (PUFA) and 1.4% unidentified (Table 2). The quantity of saturated fatty acids in Bhadawari buffaloes was comparatively higher than those reported by Qureshi *et al*. (2015) in Nili ravi buffaloes (70.41%), Varricchio *et al.* (2007) in Mediterranean buffaloes (64.78 to 66.34%), Fernandes *et al*. (2007) in Brazillian Murrah buffaloes (55.6 to 62.6%) and Mihaylova and Peeva (2007) in Bulgarian Murrah buffaloes (64.92 to 77.60%). These differences could be due to difference in breed, feeding and

Present address: [1]Principal Scientist (bpkush64@gmail.com), Network Project on Bhadawari Buffaloes; [6]Director (inderjeetdr@gmail.com), Central Institute for Research on Buffaloes, Hisar, Haryana, India. [2-4]Principal Scientist (singh.sultan@rediffmail.com, sb_maity@yahoo.co.in, krisksingh@gmail.com), [5]Principal Scientist and Head (asimkmisra@gmail.com).

Table 1. Fatty acid profile (%) of Bhadawari buffaloes milk

Fatty acid	Isomer	Type	Min	Max	Average	SE
Butyric acid	4:0	Saturated	0.9	3.3	1.94	0.28
Caproic acid	6:0	Saturated	1.0	3.1	1.90	0.24
Caprylic acid	8:0	Saturated	0.7	1.9	1.27	0.14
Capric acid	10:0	Saturated	1.5	4.1	2.71	0.30
Lauric acid	12:0	Saturated	2.1	6.0	3.78	0.43
Myristic acid	14:0	Saturated	10.5	24.7	18.06	1.75
Myristoleic acid	14:1	Monounsaturated	0.9	2.0	1.43	0.10
Pentadecanoic acid	15:0	Saturated	1.1	1.8	1.49	0.08
Pentadecenoic acid	15:1	Monounsaturated	0.3	0.4	0.36	0.18
Palmictic acid	16:0	Saturated	28.3	39.5	32.94	1.11
Palmitoleic acid	16.:1	Monounsaturated	0.9	1.4	1.07	0.06
Heptadecanoic acid	17:0	Saturated	0.3	0.7	0.43	0.03
Heptadecenoic acid	17:1	Monounsaturated	0.3	0.7	0.54	0.05
Stearic acid	18:0	Saturated	6.8	19.4	10.96	1.31
Trans isomer (18:1)	18:1t	Monounsaturated	1.1	4.2	2.32	0.34
Oleic acid	18:1	Monounsaturated	9.5	21.5	15.01	1.45
Linoleic acid	18:2	Polyunsaturated	0.6	1.2	0.80	0.06
Linolenic acid	18:3	Polyunsaturated	0.2	0.4	0.30	0.04
Arachidic acid	20:0	Saturated	0.3	0.8	0.58	0.10
Eicosanoic acid	20:0	Saturated	0.2	1.1	0.60	0.11
Behenic acid	22:0	Saturated	0.4	0.8	0.64	0.08
Erucic acid	22:1	Monounsaturated	0.4	1.2	0.78	0.15
Unidentified			0.9	1.7	1.40	0.08
Saturated fatty acid		SFAs'	68.10	83.20	77.3	1.85
Unsaturated fatty acids		UFAs'	15.30	30.70	22.61	1.88

Table 2. Concentration of fatty acids groups (% by weight) in Bhadawari milk

Fatty acid group	Average %
Saturated fatty acids (SFA)	77.30
Unsaturated fatty acids (USFA)	22.61
MUFA	21.51
PUFA	1.1
USFA/SFA	0.29
N-6 (Omega 6)	0.8
N-3 (Omega 3)	0.3
N-3/N-6	0.37

management, lactation stage, geographical locality and environment etc.

The five most important saturated fatty acids (SFA) in quantitative terms were palmictic acid (32.94), myristic acid (18.06), oleic acid (15.01), stearic acid (10.96) and lauric acid 3.78), which accounted for more than 80% of SFA's. Saturated fatty acids (SFAs) had the highest concentration (mean 77.3 g/100g) of the total milk fatty acids and ranged from 68.10 g/100 g to 83.20 g/100 g. Within SFAs the highest level was of C16:0- palmictic acid (32.94 g/100 g) followed by C14:0-myristic acid (18.06 g/100 g) and C18:0-stearic acid (10.96 g/100 g). The sum of three hypercholestremic FAs (HCFAs-C12:0, C14:0 and C16:0) was 54.78 g/100 g. The myristic acid (C14:0) has critical role in human health as it involve in increase HDL and LDL (German 1999). It has beneficial effects through increased reverse cholesterol transport. The HDL act as antioxidant and prevents oxidation of LDL which protect against certain microbe infection (German and Dillard 2004). The average concentration of unsaturated fatty acids (UFAs) was 22.61 varying from 15.30 to 30.70 g/100 g. In UFAs the highest concentration was of C18:1-oleic acid (15.01 g/100 g) which varied between 9.5 to 21.5 g/100g. In total milk fatty acids, average concentrations of mono-unsaturated and poly-unsaturated fatty acids were 21.51 and 1.1 g /100 g, respectively. Average concentration of short chain fatty acids (SCFAs: C4:0, C:6:0), medium chain fatty acids (MCFAs: C8:0, C10:0, C12:0), and long chain fatty acids (LCFAs: C16:0, C18:0, C16:1, C18:2) were 3.84, 7.76 and 45.77 g/100 g respectively. The short chain fatty acids have a neutral or cholesterol decreasing effect (Mihaylova and Peeva 2007). The high content of medium chain fatty acids are usually considered as beneficial for human health as they are more easily absorbed and metabolized (Elagba and Ayman 2016).

The concentration of SFAs and UFAs in the present study were closely related with the findings of Mihaylova and Peeva (2007) in Bulgarian Murrah Buffaloes where the SFAs varied from 64.92 to 77.60%, UFAs varied from 19.56 to 31.42%; and Qureshi *et al*. (2015) in Pakistan dairy buffaloes where the SFAs varied from 64.96 to 78.83, UFAs varied from 21.17 to 21.59 g/100g. Comparatively lower saturated fatty acids (64.78–66.34%) and higher unsaturated fatty acids (MUFA 25.63–27.86%, PUFA 3.45–5.11%) were reported by Varricchio *et al*. (2007) in Mediterranean buffaloes than the Bhadawari. The ratio of USFA/SFA is a good indicator of the nutritional quality of milk

(Konuspayeva *et al*. 2008). In the present study, the ratio of 0.29 was comparable with 0.30 and 0.32 recorded for cow's and goat's milk, respectively (Cardak *et al*. 2003). Comparatively higher USFA/SFA ratio (0.48 to 0.57) was reported in camel's milk by Elagba and Ayman (2016). Omega-6 and Omega-3 are called as essential fatty acid, which are essential for good health. These fatty acids are not synthesized in the body hence they must come from the food we eat. Average concentration of omega-6 (Linoleic acid) and omega-3 (Linolenic acid) were 0.80 and 0.30%, respectively. Varricchio *et al.* (2007) reported comparatively higher omega-6 (1.97 to 2.91%) and omega-3 (0.96 to 1.38%) in Mediterranean buffaloes than those observed in the present study.

The results demonstrate that the milk fatty acid profile of Bhadawari buffaloes is comparable with other buffalo breeds. However, a detailed study is required to understand the feeding management and lactation stage effect on milk fatty acid composition.

SUMMARY

In present study, milk fat samples from ten multiparous lactating Bhadawari buffalo's of average 81 days lactation (between 20–126 days) were evaluated for fatty acid profile. The buffaloes were offered wheat straw-sorghum-concentrate mixture diet to meet their production requirement. In milk fat, twenty two fatty acids were detected which consisted of 13 saturated (SFA) and 9 unsaturated fatty acids (USFA). The milk fat contained 77.3% SFA, 21.54% monounsaturated fatty acids (MUFA), 1.1% poly unsaturated fatty acids (PUFA) and 1.4% unidentified. Palmictic acid (32.94), myristic acid (18.06), oleic acid (15.01), stearic acid (10.96) and lauric acid (3.78%) were the main acids and constituted more than 80% of SFA. Among SFAs, the highest concentration was of C16:0- palmictic acid (32.94) followed by C14:0-myristic acid (18.06) and C18:0-stearic acid (10.96 g/100 g). The sum of three hypercholestremic FAs (HCFAs - C12:0, C14:0 and C16:0) was 54.78 g/100 g. Among UFAs the highest concentration was of C18:1- oleic acid (15.01 g/100 g) which varied between 9.5 to 21.5 g/100g. Average concentration of short chain fatty acids (SCFAs: C4:0, C:6:0), medium chain fatty acids (MCFAs: C8:0, C10:0, C12:0), and long chain fatty acids (LCFAs: C16:0, C18:0, C16:1, C18:2) were 3.84, 7.76 and 45.77 g/100 g, respectively. Average concentration of omega-6 (Linoleic acid) and omega-3 (Linolenic acid) were 0.80 and 0.30%, respectively. Results indicated that milk fatty acid composition of Bhadawari buffaloes is comparable to other buffalo breeds.

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REFERENCES

AOCS. 1998. Method Ce 1-62. Preparation of fatty acid methyl ester. *Official Methods and Recommended Practices of the American Oil Chemist's Society*, Champaign, IL, USA.

AOCS. 1998. Method Ce 2-66. Fatty acid analysis by gas chromatograph. *Official Methods and Recommended Practices of the American Oil Chemist's Society*, Champaign, IL, USA.

Chowdhary R, Warnakula S, Kunustor S, Crowe F, Ward H A, Johnson L, Franco O H, Butetrworth A S, Forouhi N G, Thompson S G, Khaw K T, Mozaffarian D, Danesh J and Di Angelantonio E. 2014. Association of dietary, circulating, and supplement fatty acids with coronary risk: A systematic review and meta-analysis. *Annals of Internal Medicine* **160**(6): 398–406.

Cardak A D, Yetismeyen A and Briickner H. 2003. Quantitative comparison of free fatty acids in camel, goat and cow milk. *Milch* **58**: 127–30.

Elagba M and Ayman M. 2016. Fatty acids content in milk of Dromedary camel (*Camelus dromedaries*) from farming and pastoral systems in Sudan. *International Journal of Science and Research* **5**(6): 570–73.

Fernandes S A A, Mattos W R S, Matarazzo S V, Tonhati H, Gama M A S and Lanna D P D. 2007. Total fatty acids in Murrah buffaloes milk on commercial farms in Brazil. *Italian Journal of Animal Science* **6**(2): 1063–66.

German J B. 1999. Butyric acid: a role in cancer prevention. *Nutrition Bulletin* **24**: 293–99.

German J B and Dillard C J. 2004. Saturated fats: what dietary intake? *American Journal of Clinical Nutrition* **80**: 550–59.

ICAR- Indian Grassland and Fodder Research Institute, Jhansi *Annual Report* 2015–16.

Konuspayeva G, Lemarie E, Faye B, Loiseau G and Montet D. 2008. Fatty acid and cholesterol composition of camel's milk (*Camelus bavtrianus*, *Camelus dromedaries* and hybrids) in Kazakhstan. *Dairy Science Technology* **88**: 327–40.

Mente A, de Koning L, Shannon H S and Anand S S. 2009. A systematic review of the evidence supporting a causal link between dietary factors and coronary heart disease. *Archives of Internal Medicine* **169**(7): 659–69.

Parodi P W. 1999. Congucated linoleic acid and other anticarcinogenic of milk fat. *Journal of Dairy Science* **19**: 1339–49.

Mihaylova G and Peeva T. 2007. Trans fatty acids and conjugated linoleic acid in the buffalo milk. *Italian Journal of Animal Sciences* **6**(2): 1056–59.

Qureshi M S, Mushtaq A, Jan S and Inyat-ur-Rahman. 2015. Effect of age and lactation on milk fatty acid profile in dairy buffaloes. *Buffalo Bulletin* **34**(3): 275–83.

Ranjhan S K. 1994. Consultants reports on the availability and requirement of feed and fodder for livestock and poultry. Department of India, New Delhi.

Siri-Tarino P W, Sun Q, Hu F B and Krauss R M. 2010. Meta-analysis of prospective cohort studies evaluating the association of saturated fat with cardiovascular disease. *American Journal of Clinical Nutrition* **91**(3): 535–46.

Varricchio M L, Di Francia A, Masucci F, Romano R and Proto V. 2007. Fatty acid composition of Mediterranean buffalo milk fat. *Italian Journal of Animal Sciences* **6**(Suppl.1): 509–11.

WHO/FAO Expert Consultation. 2003. Diet, Nutrition and the Prevention of Chronic Diseases (WHO Technical Report Series 916). World Health Organization. pp. 81–94.

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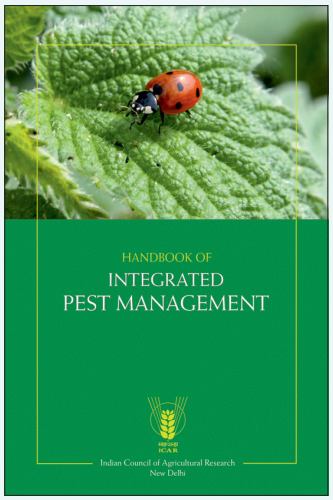

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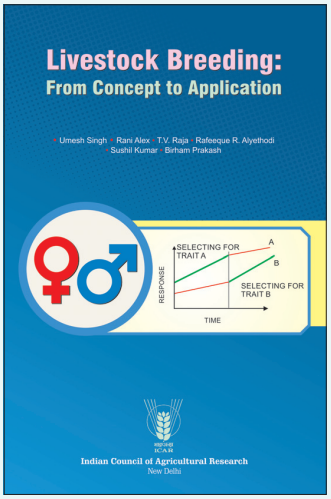

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