Acta Scientific NUTRITIONAL HEALTH (ISSN:2582-1423)

Volume 5 Issue 9 September 2021

Research Article

Seasonal Variations in Fatty Acid Profile of Milk Among Different Milch Species (Cow, Buffalo, Camel, Sheep and Goat)

Syeda Aima Bokhari*, Sanaullah Iqbal and Hasiba Munir

University of Animal Sciences, Lahore, Pakistan

***Corresponding Author:** Syeda Aima Bokhari, University of Animal Sciences, Lahore, Pakistan.

Received: June 02, 2021

Published: August 28, 2021

Abstract

This study was conducted in University of Veterinary and Animal Sciences, Lahore regarding seasonal variations in fatty acid profile of milk among different milch species. Milk from 5 different species was taken including cow, buffalo, camel, sheep and goat from Pattoki campus, UVAS. Nature of study was experimental. Fatty acid profile was assessed in 2 different seasons including 3 months of summer i.e. May, July and August and 3 months of winter i.e. November, December, January. Data was analyzed statistically on Co-Stat using two-way completely randomized ANOVA and was presented in tabular and graphical form. Significance value was kept less than 5% ($p < 0.05$). Results of Fatty Acid profile of milk in all species showed abundance of palmitic acid in all species. C16:0 was high in summer in cow milk and was recorded to be high in buffalo milk during winter season. C18:1 was high in all species during winter than in summer. All medium chain fatty acids i.e. C6, C8, C10, C12 and C14 were high in sheep milk during winter season. C14 was high in all species during summer season.

Keywords: Cow; Buffalo; Fatty Acid; Milk; Sheep

Introduction

One of the most important foods for infant's growth is milk. Different species have different milk composition solely because of different requirements of the young ones of particular specie. The reason behind differences in nutrient needs among newborns of different species includes a variety of reasons such as variations in growth rate after birth, baby's maturity and body composition at the time of birth and specific environmental conditions of the natural setting [16].

Milk is designated as a complete food containing all essential nutrients required by a neonate of a specific mammal [6]. It is considered as nature's most complete biological fluid required for growth and nourishment of children as well as adults [14]. Milk is described as a characteristic secretion of mammary glands of all mammals required for the nourishment of their young ones [9]. Milk is the most important food during first years of life of a young one [10].

In terms of human nutrition, milk is considered as one of the best food both for the infant and adults due to variety of nutrients in it [2]. Milk is a blend of different nutrients and bioactive compounds including best quality protein such as amino acids, whey and casein, high quality fat and an unusual fatty acid composition posing an immense impact on human health. Along with these nutrients, milk also contains a well-balanced ratio of vitamins and minerals necessary to carry out important body functions on daily basis. These includes calcium, phosphorous and magnesium and

vitamins like vitamin A, D and B complex [12]. This unique composition of milk renders its importance to be consumed according to ones need. That's why, if milk and milk products are not taken in the right amount during adult years, this will lead to serious health consequences such as osteoporosis and rickets, a serious bone deformation disease [17].

Importance of milk from nutritional point of view can be assessed by the fact that 1.14 liters of milk provides fats, calcium, phosphorous, riboflavin, half protein, one third of vitamin A, vitamin C, thiamine and one fourth of energy according to one's daily requirement [8].

Milk composition, in general, is 85% water and remaining are milk solids. Milk solids comprises of around 4% fat and around 9% SNF. SNF contains 3.4% protein, 4.8-5% lactose and less than 1% minerals [3].

Of all natural fats available, milk fat is the most complex one with a great variety of fatty acids. Milk fat contributes 69% of saturated fatty acids, 27% of monounsaturated fatty acids and 4% of poly unsaturated fatty acids. Linolenic acid is one the major fatty acid in mammalian milk that imposes a great variety of health benefits including prevention against cardiovascular diseases, cancers, increased blood pressure etc. [19].

Fat in milk give it its unique flavor and nutritive value. Milk fat is also rich in fat soluble vitamins such as vitamin A and D as well as in linoleic acid. Milk fats also have its effect on processing of dairy products. Fat content differs in different species such as in cow it is around 4.5% and in goat milk it constitutes about 3.2-4.2%. Factors effecting milk fat includes stage of lactation, season, bread and seasonal variations [11]. Different researches have shown that short chain fatty acids in milk are found in high amount during summer than in winter [18].

History of milk dates back to the Neolithic time period which helped in acquiring food from various sources. This era began domestication of animals. The earlier effort of animal domestication began in Middle East 11,000 years ago [4].

In developing countries, milk plays a wonderful role in improving health status of individuals in terms of good nutrition and improvement in food security situations. Poverty and malnutrition, the biggest health alarm in developing countries can be reduced with improvement in livestock, dairy technology and better milk quality [16]. In dairy production, cattle are considered the most important ones. A large number of animals are being bred for this reason. Globally, every region has chosen specific specie to be domesticated according to their requirements. Throughout the world, buffalo milk is the most consumed milk. In countries like Kenya, Saudi Arabia and Pakistan, camel milk is consumed in these regions as well as camels are raised here. Around the world, the major milk production relies on cow, buffalo, sheep, goat and camel [4].

According to Food and Agriculture Organization Corporate Statistical Database 2010, Pakistan is ranked among top ten milk producing country in the world with a yearly production of 35.5 billion liters. After India & Bangladesh, Pakistan is considered 2nd largest milk producer of buffalo and goat with 22.3 and 0.7 billion liters respectively. In milk production, buffalo has the highest share of 62.8%, after which comes cow with 34.9%, goat is 2%, camel is 0.2% and sheep is 0.1%. Pakistan is blessed with a fairly large population of buffaloes, cows, sheep, camels and goats (30.8, 34.3, 27.8, 1.0 and 59.9 million, respectively) [1]. Different mammalian species have different milk composition [16]. A wide range of factors are involved that result in these variations. A few of them are seasonal and environmental differences, feed given, age and health status of the animal and lactation stage. These factors in turn affect the quality of milk products such as butter and different types of cheeses [13].

To our knowledge, in Pakistan, there is limited data available in order to determine variations regarding nutritional profile among milk producing species with respect to seasonal changes. Therefore, nutritional profile of five milk producing species (cow, buffalo, sheep, goat, camel) was investigated in this study in order to generate the data to compare variations in nutritional profile among above mentioned species in winter and summer season.

Materials and Methods

Research design

This study was conducted in Department of Food Science and Human Nutrition, University of Veterinary and Animal Sciences Lahore for a period of 6 months. In this study, fresh milk was obtained from five different species (Cow, Buffalo, Sheep, Goat and Camel)

by direct milking on monthly basis. The samples were collected in sterilized labelled bottles and were kept in the refrigerator at $4^{\theta}C$ for further analysis.

Sample collection

Milk samples were collected in labelled sterilized bottles with specific codes from five different species including camel, cow, buffalo, sheep and goat from University of Veterinary and Animal Sciences, Ravi Campus, Pattoki.

Fatty acid profile

This was performed in two phases. First phase was performed in Food Science and Human Nutrition department, UVAS, Lahore. Milk from each specie was defatted with the help of centrifuge (Uni 320R, v2.02) for 15 minutes. After centrifugation, 2nd phase was done in PCSIR laboratories. 2g of fat portion was analyzed for its fatty acid profile using facilities in PCSIR laboratories with the help of gas chromatography.

Statistical analysis

Data was analyzed statistically using Microsoft Excel and CO-Stat. Two-way ANOVA was used. Differences were considered significant at $p < 0.05$. Data was presented in both tabular and graphical forms.

Results

Source	Species				
F.A (%)	Cow	Buffalo	Came	Goat	Sheep
$C_{6:0}$	2.03a	1.5b	0.75c	1.7b	2.08a
$C_{8:0}$	1.68a	0.98b	0.55b	2.1a	1.93a
$C_{10:0}$	2.13c	2c	1.38d	8.88b	9.83a
$C_{12:0}$	3.05b	2.98b	2.53c	5.25a	5.45a
$C_{14:0}$	6.25c	11.18a	7.7b	10.75a	10.48a
$C_{14:1}$	1.3b	1.35b	1.3b	1.05b	1.8a
$C_{15:0}$	0.53b	1.1a	0.38b	0.65b	0.6b
$C_{16:0}$	32.78a	32.48a	31.43a	28.13b	26.375c
$C_{16:1}$	1.55b	1.25b	6.35a	0.675b	1.35b
$C_{18:0}$	11.03a	11.25a	8.7a	11.15a	9.58a
$C_{18:1}$	33.68a	30.63b	33.03a	25.85c	27.43c
$C_{18:2}$	3.33a	2.65a	3.35a	3.4a	2.63a
$C_{18:3}$	1.58a	1.23a	1.05a	0.98a	1.08a

Table a: Mean of Fatty acid profile of milk in different milch species.

This table shows the mean of each fatty acid in different species in both seasons i.e. summer and winter. This table signifies that there is evident difference in each fatty acid among different species. Alphabetical representations (i.e. p value) indicate statistically significant results among different species. Same alphabetical order shows non-significant results.

Mean values of different fatty acids with regard to seasonal variation are graphically represented below.

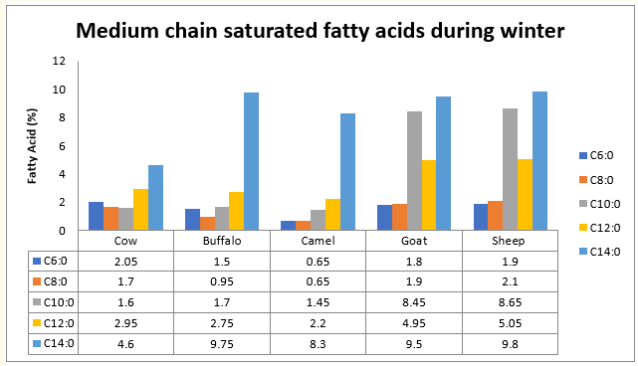
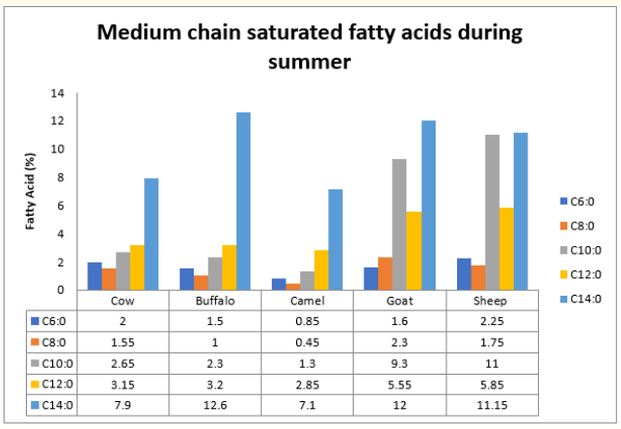


Figure 1: Mean values of Medium chain fatty acids among cow, buffalo, camel, goat and sheep during winter.

This figure shows graphical representation of medium chain fatty acids among different species during winter season. Medium chain fatty acids includes C6, C8, C10, C12 and C14. C6 was found to be highest in cow milk, C8 was highest in sheep milk, C10 was highest in sheep milk followed by goat milk with slight difference, C12 was again high in sheep milk followed by goat milk with slight variation and C14 was high in sheep milk then in buffalo milk and last in camel milk. Overall, all medium chain fatty acids were high in sheep milk during winter season.

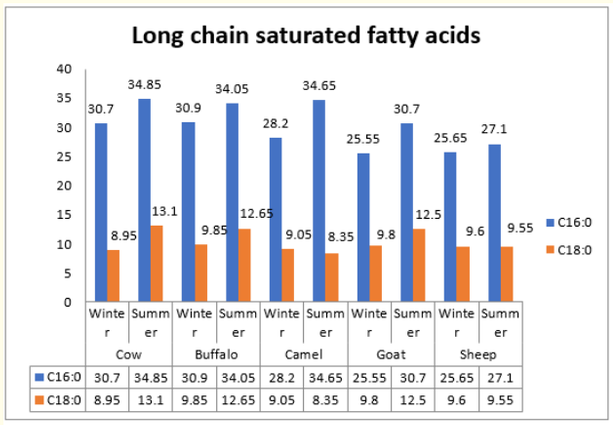
From figure 2 it is quite evident among all medium chain fatty acids, C14 is high in all species during summer season. C14 is high in buffalo followed by goat, sheep, cow and camel. C12 and C10 are both high in sheep and goat followed by buffalo. C8 is high in goat followed by sheep and cow. C6 is high in sheep and cow.

This figure provides clear comparison of seasonal variations in long chain fatty acids among 5 different species. C16 is high during summer in cow milk whereas in winter its high in buffalo milk. C18 is high in cow and buffalo milk during summer season and in winter it is high in buffalo and goat milk.



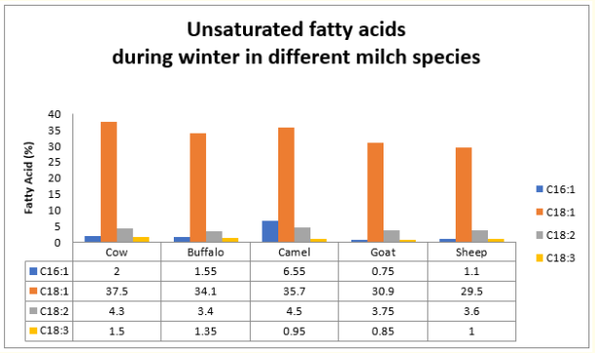
	Cow	Buffalo	Camel	Goat	Sheep
C6:0	2	1.5	0.85	1.6	2.25
C8:0	1.55	1	0.45	2.3	1.75
C10:0	2.65	2.3	1.3	9.3	11
C12:0	3.15	3.2	2.85	5.55	5.85
C14:0	7.9	12.6	7.1	12	11.15

Figure 2: Mean values of Medium chain fatty acids among cow, buffalo, camel, goat and sheep during summer.



	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
	Cow		Buffalo		Camel		Goat		Sheep	
C16:0	30.7	34.85	30.9	34.05	28.2	34.65	25.55	30.7	25.65	27.1
C18:0	8.95	13.1	9.85	12.65	9.05	8.35	9.8	12.5	9.6	9.55

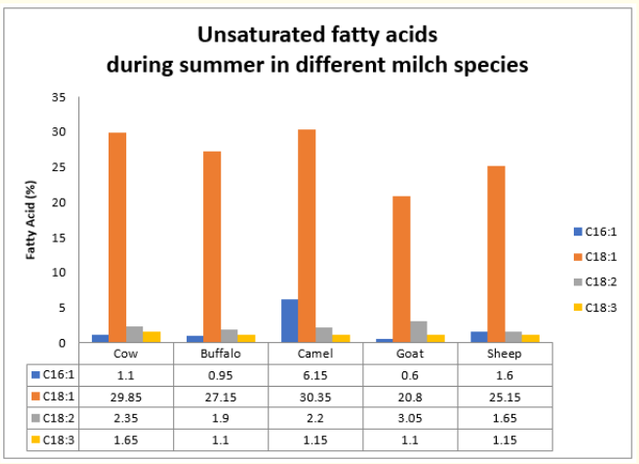
Figure 3: Mean values of Long chain saturated fatty acids among cow, buffalo, camel, goat and sheep during summer and winter seasons.



	Cow	Buffalo	Camel	Goat	Sheep
C16:1	2	1.55	6.55	0.75	1.1
C18:1	37.5	34.1	35.7	30.9	29.5
C18:2	4.3	3.4	4.5	3.75	3.6
C18:3	1.5	1.35	0.95	0.85	1

Figure 4: Mean values of unsaturated fatty acids among cow, buffalo, camel, goat and sheep during winter season.

It is quite evident from figure 4 that C18:1 is highest in almost all species during winter season with slight variations. C16:1 is highest in camel milk, C18:2 is high in camel and cow milk with little difference and C18:3 is highest in cow among all species.



	Cow	Buffalo	Camel	Goat	Sheep
C16:1	1.1	0.95	6.15	0.6	1.6
C18:1	29.85	27.15	30.35	20.8	25.15
C18:2	2.35	1.9	2.2	3.05	1.65
C18:3	1.65	1.1	1.15	1.1	1.15

Figure 5: Mean values of unsaturated fatty acids among cow, buffalo, camel, goat and sheep during summer season.

Figure 5 shows that C18:1 is highest in camel milk followed by cow, buffalo, sheep and goat milk. C16:1 is highest in camel milk whereas in remaining species it is present in negligible amounts. C18:2 is high in goat milk and C18:3 is high in cow milk followed by camel and sheep milk with same amounts and then by buffalo and goat milk having same quantities present in them

Table anova tables of different fatty acids among cow, buffalo, camel, goat and sheep.

Source	df	SS	MS	F	p
Species	4	4.59	1.14825	12.758333	.0006 ***
Seasons	1	0.01	0.018	0.2	.6643 ns
Interaction Species * Seasons	4	0.18	0.04675	0.5194444	.7238 ns
Error	10	0.9	0.09		
Total	19	5.69			

Table 1: C6:0 (Caproic Acid).

*** Highly significant; ns = non-significant

Source	df	SS	MS	F	p
Species	4	6.85	1.71325	14.217842	.0004 ***
Seasons	1	0.012	0.0125	0.1037344	.7540 ns
Interaction Species * Seasons	4	0.33	0.08375	0.6950207	.6123 ns
Error	10	1.20	0.1205		
Total	19	8.40			

Table 2: C8:0 (Caprylic Acid).

*** Highly significant; ns = non-significant

Source	df	SS	MS	F	p
Species	4	274.29	68.5745	398.68895	.0000 ***
Seasons	1	4.41	4.418	25.686047	.0005 ***
Interaction Species * Seasons	4	3.31	0.828	4.8139535	.0200 *
Error	10	1.72	0.172		
Total	19	283.7			

Table 3: C10:0 (Capric Acid).

*** Highly significant; ns = non-significant.

Source	df	SS	MS	F	p
Species	4	30.72	7.68125	96.015625	.0000 ***
Seasons	1	1.46	1.458	18.225	.0016 **
Interaction Species * Seasons	4	0.20	0.05175	0.646875	.6417 ns
Error	10	0.8	0.08		
Total	19	33.19			

Table 4: C12:0 (Lauric Acid).

*** Highly significant; ns = non-significant.

Source	df	SS	MS	F	p
Species	4	75.48	18.85675	29.883914	.0000 ***
Seasons	1	15.48	15.488	24.545166	.0006 ***
Interaction Species * Seasons	4	13.04	3.25925	5.1652139	.0161 *
Error	10	6.31	0.631		
Total	19	110.26			

Table 5: C14:0 (Myristic Acid).

*** Highly significant; ns = non-significant.

Source	df	SS	MS	F	p
Species	4	128.95	32.237	28.873265	.0000 ***
Seasons	1	82.82	82.8245	74.182266	.0000 ***
Interaction Species * Seasons	4	14.55	3.637	3.2575011	.0591 ns
Error	10	11.16	1.1165		
Total	19	237.48			

Table 6: C 16:0 (Palmitic Acid).

*** Highly significant; ns = non-significant.

Source	df	SS	MS	F	p
Species	4	86.35	21.5895	51.587814	.0000 ***
Seasons	1	0.48	0.4805	1.1481481	.3091 ns
Interaction Species * Seasons	4	1.12	0.2805	0.6702509	.6273 ns
Error	10	4.18	0.4185		
Total	19	92.14			

Table 7: C16:1.

*** Highly significant; ns = non-significant.

Source	df	SS	MS	F	p
Species	4	20.913	5.22825	1.2601229	.3476 ns
Seasons	1	15.84	15.842	3.8182695	.0792 ns
Interaction Species * Seasons	4	17.0	4.25075	1.024524	.4405 ns
Error	10	41.49	4.149		
Total	19	95.248			

Table 8: C18:0 (Stearic Acid).

*** Highly significant; ns = non-significant.

Source	df	SS	MS	F	p
Species	4	187.31	46.828	22.299048	.0001 ***
Seasons	1	239.43	239.432	114.01524	.0000 ***
Interaction Species * Seasons	4	18.73	4.682	2.2295238	.1385 ns
Error	10	21	2.1		
Total	19	466.47			

Table 9: C18:1(Oleic acid).

*** Highly significant; ns = non-significant.

Source	df	SS	MS	F	p
Species	4	2.50	0.62675	1.5747487	.2549 ns
Seasons	1	14.11	14.112	35.457286	.0001 ***
Interaction Species * Seasons	4	1.52	0.38075	0.9566583	.4717 ns
Error	10	3.98	0.398		
Total	19	22.12			

Table 10: C18:2 (Linoleic Acid).

*** Highly significant; ns = non-significant.

Source	df	SS	MS	F	p
Species	4	0.912	0.228	1.398773	.3029 ns
Seasons	1	0.05	0.05	0.3067485	.5919 ns
Interaction Species * Seasons	4	0.16	0.04	0.2453988	.9060 ns
Error	10	1.63	0.163		
Total	19	2.752			

Table 11: C18:3 (Linolenic acid).

*** Highly significant; ns = non-significant.

These Anova tables shows highly significant results of C6, C8, C10, C12, C14, C16, C16:1 and C18:1 among species whereas C10, C12, C14, C16, C18:1 and C18:2 shows high significant results in different seasons.

Discussion and Conclusion

Of all natural fats available, milk fat is the most complex one with a great variety of fatty acids. Milk fat contributes 69% of saturated fatty acids, 27% of monounsaturated fatty acids and 4% of poly unsaturated fatty acids. Linolenic acid is one the major fatty acid in mammalian milk that imposes a great variety of health benefits including prevention against cardiovascular diseases, cancers, increased blood pressure etc. [19].

In human diet, milk and its products are the most nutritious ones. Exclusive nutritional quality of milk and milk products is due to its fat portion. Milk fat comprises of more than 400 fatty acids. A number of factors are responsible for variations in fat concentration including breed, diet and health of animal, season and lactation stage. Heart diseases, cancer, obesity and diabetes account for more than 80% of death rate all around world. One of the most important factor in controlling all these diseases is the fat, its type and amount to be consumed in prevention of all these health related issues. Fatty acid profile of milk is highly related to beneficiary of human health. Milk fat is one of the most complex natural fats that consist of approximately 400-500 fatty acids MUFA's are beneficial as they increase HDL cholesterol and decrease LDL cholesterol. One of the highest MUFA found in milk of all mammals is oleic acid (C18:1). Other MUFA's found in small amount includes 14:1 and 16:1 Saturated fatty acids are the most stable components and primary fat component of human diet. But these FA's are responsible for major health hazards including heart diseases, obesity etc. One of the most important SFA is C16:0. SFA's are responsible for increased LDL blood concentration [11].

According to a study conducted by Saroj., *et al*. [19] variations in fatty acid composition of different species occur as a results of different seasons. Results of present study for C6:0, C8:0, C10:0, C12:0 and C14:0 for all species are similar to Saroj., *et al*. [19]. Total SFA's in the present study ranged between 55-65g/100g during summer and <60g/100g during winter in all species. These results are also in accordance to Saroj., *et al*. [19]. Medium and long chain saturated fatty acids i.e myristic, palmatic and stearic and long chain unsaturated fatty acids i.e. oleic acid all together resulted in TFA more than 65%. Present study results are similar to results reported by Rodríguez-Alcalá., *et al*. [16] and Talpur., *et al*. [20]. C16:0 and C18:1 was highest among all fatty acids in all species with the highest C16 recorded in summer than winter and high C18:1 in winter than summer. These results are favoured by Saroj., *et al*. [19].

3-5% of TFA comprises of PUFA in milk in almost all species. Present study results are similar to results reported by Rodríguez-Alcalá., *et al*. [16] and Talpur., *et al*. [20]. MUFA in present study are higher in winter in all species and these results are similar to Haenlein and Wendorff [7]. Diet [14] and seasons positively affect fatty acid composition of milk in all species as a result of grazing during summer and spring season [5].

Bibliography

1. Ahmad S., *et al*. "Composition and physico-chemical characteristics of buffalo milk with particular emphasis on lipids, proteins, minerals, enzymes and vitamins". *Journal of Animal and Plant Sciences* 23 (2013): 62-74.

2. Alabdulkarim B. "Effect of camel milk on blood glucose, cholesterol, triglyceride and liver enzymes activities in female Albino rats". *World Applied Sciences Journal* 17.11 (2012): 1394-1397.

3. Ayub M., *et al*. "Composition and adulteration analysis of milk samples". *Sarhad Journal of Agriculture* 23.4 (2007): 1127.

4. Barłowska J., *et al*. "Nutritional value and technological suitability of milk from various animal species used for dairy production". *Comprehensive Reviews in Food Science and Food Safety* 10.6 (2011): 291-302.

5. Chilliard Y., *et al*. "A review of nutritional and physiological factors affecting goat milk lipid synthesis and lipolysis". *Journal of Dairy Science* 86.5 (2003): 1751-1770.

6. El-Agamy E. "The challenge of cow milk protein allergy". *Small Ruminant Research* 68.1 (2007): 64-72.s

7. Haenlein G. "Goat milk in human nutrition". *Small Ruminant Research* 51.2 (2004): 155-163.

8. Hamad M and Baiomy A. "Physical properties and chemical composition of cow's and buffalo's milk in Qena governorate". *Journal of Food and Dairy Sciences, Mansoura University* 1.7 (2010): 397-403.

9. Kanwal R., *et al*. "Comparative analysis of quality of milk collected from buffalo, cow, goat and sheep of Rawalpindi/Islamabad region in Pakistan". *Asian Journal of Plant Sciences* 3.3 (2004): 300-305.

10. Mahmood A and Usman S. "A comparative study on the physicochemical parameters of milk samples collected from buffalo, cow, goat and sheep of Gujrat, Pakistan". *Pakistan Journal of Nutrition* 9.12 (2010): 1192-1197.

11. Markiewicz-Kęszycka M., *et al*. "Fatty acid profile of milk-a review". *Bulletin of the Veterinary Institute in Pulawy* 57.2 (2013): 135-139.

12. Nateghi L., *et al*. "The effect of different seasons on the milk quality". *European Journal of Experimental Biology* 4.1 (2014): 550-552.

13. Ozrenk E and Inci SS. "The effect of seasonal variation on the composition of cow milk in Van Province". *Pakistan Journal of Nutrition* 7.1 (2008): 161-164.

14. Palmquist D and Jenkins T. "Challenges with fats and fatty acid methods". *Journal of Animal Science* 81.12 (2003): 3250-3254.

15. Park YW. "Overview of bioactive components in milk and dairy products". *Bioactive Components in Milk and Dairy Products* (2009): 3-5.

16. Rodríguez-Alcalá LM., *et al*. "Fatty acid profile and CLA isomers content of cow, ewe and goat milks processed by high pressure homogenization". *Innovative Food Science and Emerging Technologies* 10.1 (2009): 32-36.

17. Sabahelkheir M and Hassan A. "Amino acid composition of human and animal's milk (camel, cow, sheep and goat)" (2012).

18. Sabahelkhier M., *et al*. "Comparative determination of biochemical constituents between animals (goat, sheep, cow and camel) milk with human milk". *Research Journal of Recent Sciences* (2012).

19. SAROJ B., *et al*. "Seasonal variation in fatty acid profile in the milk of different species under popularly followed feeding system in India". *Indian Journal of Animal Sciences* 87.4 (2017): 484-489.

20. Talpur FN., *et al*. "Milk fatty acid composition of indigenous goat and ewe breeds from Sindh, Pakistan". *Journal of Food Composition and Analysis* 22.1 (2009): 59-64.

Volume 5 Issue 9 September 2021