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COMPARATIVE STUDIES ON NUTRITIVE QUALITY OF BUFFALO AND COW MILK

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ABSTRACT

The present study was conducted to evaluate the nutritive quality of buffalo and cow milk at Department of Animal Products Technology, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University Tandojam, during the year 2012-13. A total of 40 milk samples of buffalo and cow (n = 20, each) were examined for macro nutrients such as total solids (TS), fat, protein, lactose and ash contents as well as the calorific values. A remarkable ($P<0.05$) higher concentration of Total solids, fat, protein, lactose and ash contents was observed in buffalo milk contrast to that of cow milk. Calorific value in buffalo milk was considerably ($P<0.05$) higher compared to that of cow milk. Buffalo milk was concluded to be a rich source of macro-nutrients as well as calorific values and suggested to be utilized as nutritional soft drink and/or as better base for dairy products. While cow milk with low fat content concluded to be utilized as low fat soft drink and/or as base material for low fat dairy products.

KEYWORDS: Calorific Value, Macro Nutrients, Total Solids

INTRODUCTION

Milk is an almost ideal food having high nutritive value. It supplies body building proteins, bone forming minerals and furnishes energy giving lactose and milk fat. Besides supplying certain essential fatty acids, it contains the above nutrients in an easily digestible and assimilable form (Vishweshwar and Krishnaiah, 2005). Milk is the most versatile of all the animals desired food commodities and is a basic source for many of its physical forms like cheese, yoghurt, ice cream, ghee, powder milk and many other forms of fluid milk (Khan *et al*, 2007). Milk of different species contains the same kind of constituents but in varying in amount. Within a given species, genetic factors, environmental conditions and stage of lactation influence the composition of milk (Kanwal *et al*, 2004).

Pakistan is the second top producer and consumer of buffalo milk after India. The buffalo milk has many advantages regarding nutritional qualities and chemical composition and characterized by higher fat, total solids, proteins, caseins, lactose and ash contents than that of cow milk. In fact several factors like species, breed, feeding system, stage of lactation and season of the year are influenced on chemical composition and nutritional qualities (Ahmed *et al*, 2013). While, cow milk has also long been considered a highly nutritious and valuable human food and is consumed in millions of varieties of dairy products (Mahmood and Sumaira, 2010). Comparative studies regarding the compositional and nutritional qualities among different breeds of cattle, goat and sheep, cow and goat, cow and sheep have been carried out throughout the world. As Pakistan is endowed with superior buffalo breeds, the major milk producing animals in the country, it is necessary to see the major differences in composition and nutritional qualities of milk in comparison with

cow milk. The present study was, therefore be conducted on comparison of the nutritive and calorific values of buffalo and cow milk.

MATERIALS AND METHODS

Buffalo and cow milk samples obtained from Livestock Experiment Station, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University Tandojam, were used during present investigation.

Equipments/Apparatus

- **Hot Air Oven**

Hot air oven (Memmert 854, Schawabch W. Germany) was used to evaporate the moisture content of milk samples.

- **Analytical Balance**

Analytical balance (Adam, Model No. AAA 2502) was used to weigh the milk samples and reagents.

- **Gerber Centrifuge Machine**

Centrifuge machine (Funk Gerber, Model No. 12105 Germany) was used to centrifuge the milk samples during determination of fat content of milk samples.

- **Micro Kjeldhal Digestion and Distillation Unit**

Micro Kjeldhal digestion unit (LABCONCO Mod 60300-01) was used to digest the samples during determination of protein content of milk.

- **Titration Kit**

Titration kit was used to titrate the samples after distillation during determination of protein content of milk.

- **Muffle Furnace**

Muffle furnace (Newer Herm Mod; L9/11/8KM, Germany) was used to ignite the milk samples during the determination of ash content of milk.

Experimental Procedure

A total of forty (40) fresh milk samples of buffalo and cow (n=20, each) were collected in clean and sterile sample bottles from Livestock Experiment Station, Department of Livestock Management and was brought to the Laboratory of Animal Products Technology, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University Tandojam, for the analysis of macro nutrient.

ANALYSIS OF BUFFALO AND COW MILK

- **Total Solids Content**

Total solids content (TS) was observed according to the method of Association of Official Analytical Chemists (AOAC, 2000). The milk sample (5g) was taken in a pre-weighed flat bottom dish. The dish was placed in hot air oven at 101±1^{o}C for 3 hrs and transferred to desiccator having a silica gel as desiccant. After 1 hr, the dish was weighed. The drying and desiccating were repeated till achieving the constant weight and calculation was made as per following

formula.

$$\text{Total solids content (\%)} = \frac{\text{Wt of dried sample (c– a)}}{\text{Wt of sample taken (b – a)}} \times 100$$

Where,

a = weight of empty dish

b = weight of sample + dish

c = weight of dried sample + dish

- **Fat Content**

Fat content was determined by Gerber method as described by James (1995). Milk sample (11 ml) was mixed with 90 % sulfuric acid (10 ml) and amyl alcohol (1 ml) in butyrometer and closed with rubber cork. The butyrometer was placed in a Gerber centrifuge machine and centrifuge for 5 min at 1100 round per minute (r.p.m). The fat percentage was noted on the butyrometer scale.

- **Protein Content**

Protein content was determined according to the method of British Standards Institution (BSI, 1990). The sample (5g) was digested using Micro Kjeldhal digester in the presence of catalyst (0.2 g of copper sulfate and 2 g of sodium sulfate) where sulfuric acid (30 ml) was used as an oxidizing agent. The digested sample was diluted with distilled water (250 ml). Then 5 ml portion from the diluted sample was distilled with NaOH (40 %) using Micro-Kjeldhal distillation unit, where steam was distilled over 2 % boric acid (5 ml) containing an indicator for 3 minutes. The ammonia trapped in boric acid was determined by titrating with 0.1N HCl. The nitrogen percentage was calculated using following formula:

$$N\,\% = \frac{1.4\,(V_1 - V_2) \times \text{normality of HCl}}{\text{Weight of sample taken} \times \text{volume of diluted sample}} \times 250$$

Where,

V_1 = Titrated value of milk sample

V_2 = Titrated value of Blank sample

While protein content was calculate from the N % by multiplying with conversion factor i.e. 6.38 as reported by James (1995).

- **Lactose Content**

Lactose content was determined by subtracting the sum of total percent of fat, protein and ash contents from that of total solids content of milk.

- **Ash Content**

Ash percentage was determined by Gravimetric method as described by AOAC (2000) using muffle furnace. The milk sample (5g) was taken in pre-weighed crucible, and transferred to muffle furnace (550^{o}C) for 4±1 h. Ignited

sample was transferred to desiccator having silica gel as desiccant. After 1 hr the crucible was weighed and the content was calculated by following formula:

$$\text{Ash (\%)} = \frac{\text{Weight of ignited sample}}{\text{Weight of sample taken}} \times 100$$

- **Calorific Values of Buffalo and Cow Milk**

Calorific/energy values were calculated from the proximate analysis results using the following generalized equation.

Kcal 100g^{-1} = (% protein × 4) + (% fat × 9) + (% lactose × 4)

- **Statistical Analysis**

A computerized statistical package of Student Edition of Statistix (SXW), version 8.1 (Copyright 2005, Analytical software, USA) was used to analyze the data. The data so obtained was tabulated and analyzed with statistical procedure of summary statistics, under which descriptive statistics and frequency distribution test, were applied to observe the variability within same character of milk among different samples and their frequencies. The data were further analyzed through statistical procedure of analysis of variance (ANOVA) to observe the significant differences among the variables and in case of significant difference exist, the mean were further computed using least significant difference (LSD) at 5 % level of probability.

RESULTS

- **Comparison of Macro Nutrients of Buffalo and Cow Milk**
  - **Total Solids Content**

The total solids content (TS) of buffalo and cow milk was analyzed, and results are presented in Table (1 & 2). The results of present study revealed that coefficient of variance (CV) percent in TS content of cow milk was slightly higher than that of buffalo milk. Moreover, frequency distribution test showed that in buffalo milk 10 (50%) samples were below, and 10 (50%) samples above from the concentration of mean total solids content. While in case of cow milk samples, the similar pattern of frequencies to that of buffalo milk samples were observed. The statistical analysis showed that TS content in buffalo milk was remarkably ($P<0.05$) higher than that of cow milk. The least significant difference (LSD; 0.05) of mean test also confirmed the significant variation in TS content of buffalo and cow milk.

  - **Fat Content**

The fat content of buffalo and cow milk was determined, and results are depicted in Table (1 & 2). Findings of the present study showed that there were not great variation in a fat content of buffalo milk but in case of cow milk it varied greatly. Statistical observations revealed that fat content in buffalo milk was comparatively ($P<0.05$) higher than that of cow milk. The LSD (0.05) also revealed the significant variation in fat content of buffalo and cow milk.

  - **Protein Content**

The protein content of buffalo and cow milk was determined, and results are depicted in Table (1 & 2). Moreover, frequency distribution test (Table 4.6) Appendix-IV**,** illustrates that 9 (45%) samples of buffalo milk were less than and 11 (55%) samples were greater than that of the concentration of mean protein content. In case of cow milk samples, 9(45%)

samples were below, 6(30%) above and 5 (25%) samples equal to that of mean concentration of protein content of cow milk. The statistical analysis further showed that protein content in buffalo milk was remarkably ($P<0.05$) higher than that of cow milk. The LSD (0.05) of mean test also confirmed the significant variation in protein content of buffalo and cow milk.

- **Lactose Content**

Results of lactose content revealed a wide variation in buffalo milk. The lactose content of each milk (buffalo or cow) was distributed with frequency of 10 (50%) less than and 10 (50%) greater than that of mean concentration of lactose content of milk. The statistical analysis (ANOVA) further showed that the average lactose content in buffalo milk was significantly ($P<0.05$) higher than that of cow milk. The significant variation in lactose content of buffalo and cow milk was also confirmed by LSD (0.05) mean test (Table 1 & 2).

- **Ash Content**

Results illustrated in Table 1 & 2 showed that the variability in ash content of buffalo and cow milk was relatively similar. It was found that in buffalo milk samples ash contents are distribute with frequency of 12 (60%) less than and 8 (40%) greater than that of the level of mean ash content, while in case of cow milk, 15 (75%) samples of milk were less than and 5 (25%) greater than that of mean concentration of ash content. The statistical analysis illustrated that ash content in buffalo milk was comparatively ($P<0.05$) higher than that of cow milk, (Appendix-I). The LSD (0.05) of mean test also showed the significant variation in ash content of buffalo and cow milk.

- **Comparison of Calorific Values of Buffalo and Cow Milk**

The calorific values of buffalo and cow milk were calculated, and results are presented in Table 1 & 2. The variability in calorific values of cow milk was higher than that of buffalo milk. The calorific values in buffalo milk was distributed with frequency of 10 (50%) less than and 10 (50%) greater than that of mean concentration of calorific values of milk. The statistical analysis (ANOVA) showed that calorific value in buffalo milk was remarkably ($P<0.05$) higher than that of cow milk. The significant variation in calorific values of buffalo and cow milk was also confirmed by computing the LSD (0.05) of mean test.

DISCUSSIONS

Cow milk is the most universal raw material for processing, which results in broadest spectrum of manufactured products. The buffalo milk, regarding the high content of protein, including casein and also fat make a very good raw material for processing. Therefore knowledge about cow and buffalo milk is the most comprehensive as this milk has a crucial significance in human nutrition. In study an approach was made to compare the nutritive status and calorific value of the buffalo and cow milk.

In present study, the buffalo milk showed higher Total solid (TS) content and it was remarkably ($P<0.05$) higher than that of cow milk. The results are in line with the finding of Enb *et al*. (2009) and their results showed that the TS content of buffalo milk was higher than that of cow milk. While, Soliman (2005) reported that the buffalo milk contained comparatively higher Ts contents than that of cow milk. TS content of buffalo milk higher than that of cow milk was also reported by Mahmood and Sumaira (2010). These findings are not in agreement with the results of present study for TS content of buffalo milk, but similar in some extent with TS content of cow milk. However, the results of Enb *et al*. (2009)

for TS contents of buffalo milk and cow milk was lower than that of findings of the present study. It is real fact that generally buffalo milk contained higher TS content than that of cow milk (Barlowska *et al*, 2011). However, Ahmed *et al*. (2013) reported that the buffalo milk appeared the richest products from a compositional point of view and characterized by higher total solids than cow milk.

The fat content in buffalo milk was comparatively higher than that of cow milk. The findings are not in consistent with that observed by Soliman (2005), who found higher fat content in buffalo milk, but the fat content observed for cow milk was relatively similar to that of present study. The findings of Kanwal *et al*. (2004) for the fat content of buffalo milk supported the present study and they found relatively similar fat content in buffalo milk. The present results for fat content in buffalo and cow are not in line with results of Mahmood and Sumaira, 2010; Barlowska *et al*. (2011), who reported high fat percent in buffalo and low fat percent in cow milk.

In present study protein content in buffalo milk was significantly ($P<0.05$) higher than that of cow milk. The protein content in buffalo and cow milk observed in the present study was in agreement with the findings of Soliman (2005); Mahmood and Sumaira (2010), who reported higher protein content in buffalo milk compared to cow milk. While, the results reported by Enb *et al*. (2009) did not supported the present findings and observed lower protein in buffalo and cow milk. The higher protein content in buffalo milk than that of cow milk might be due to the concentration of both, the casein and whey proteins which are reported higher in buffalo milk than that of cow milk (Sindhu, 1998). In general, the interspecies variability in protein content of milk could be of due to variation in genetic makeup of the animal (Walstra *et al*, 2006). It might be predicted that those animals which grow most rapidly (in proportion to their size) might need milk quite rich in protein and vice versa, since it furnishes the material for the development of muscle tissue (Herringten, 2000).

The average lactose content was comparatively ($P<0.05$) higher in buffalo milk than that of cow milk. Apparently similar findings are reported by Soliman (2005) who observed higher percentage of lactose in buffalo milk than that of cow milk. Present observations are in agreement with findings of Mahmood and Sumaira (2010) who found the similar trend for lactose content in buffalo and cow milk. While, findings of Barlowska *et al*. (2011) did not support the present study who did not find comparable concentration of lactose in buffalo and cow milk. Moreover, the findings of Myburgh *et al*. (2012) for lactose in cattle milk, was not in line with the lactose content in cow milk observed in the present study. The change in milk components might occur even while in the udder and this has been partly attributed with the formation of different component at various sites in the mammary secretory cell that probably come into contact with one another. They also reported that several changes might occur due to the milking, subsequent lowering of temperature and even soon (Walstra *et al*. 2006). The results of present study showed that the ash content in buffalo milk was comparatively ($P<0.05$) higher than that of ash content in cow milk. These results are in line with the findings of Mahmood and Sumaira (2010), who recorded high ash content in buffalo milk compared to cow milk. The findings of Enb *et al*. (2009) supported the present findings, who also observed higher levels of ash than that of cow milk. However, Present findings of ash content are also disagreed with findings of Kanwal *et al*. (2004) who reported the lower values of ash in buffalo and cow milk, than that of observed in the present study. It is obvious to noteworthy that though lactose content has negative relationship with the dissolve salts, the level of one of these components might alter the level of the other in the equilibra. This might be happened in the variability of ash content under present study. The calorific values calculated in buffalo milk was remarkably ($P<0.05$) higher than that of cow milk. These results are not in line with the findings of Soliman (2005),

who reported the higher calorific values for both buffalo and cow milk. Moreover, Kanwal *et al*. (2004) confirmed the present findings, who reported the remarkably higher calories in buffalo milk than that of cow milk (Barlowska *et al.* 2011). Furthermore, it has been reported, that the buffalo milk was found superior in chemical composition than that of cow milk resulting more calories per unit weight (Sahai, 1996). Nevertheless the difference in calorific value might be attributed with variation in lactose, fat and protein percentages in milk (Rao and Mishra, 2010).

CONCLUSIONS

On the basis of present finding it was concluded that:

- Buffalo milk was rich source of macro nutrients (fat, protein, lactose and ash) than that of cow milk.
- The buffalo milk was more energetic, than that of cow milk.

REFERENCES

1. Ahmed, S, F. M. Anjum, N. Huma, A. Sameen and T. Zahoor. 2013. Composition and physico-chemical characteristics of buffalo milk with particular emphasis on lipids, proteins, minerals, enzymes and vitamins. The J. Ani and Plant Sci. 23:62-74.
2. AOAC, 2000. Milk and milk products. In: Official Methods of Analysis. AOAC International, Gaithersburg, Maryland, USA.
3. Barlowska, J, M. Szwajkowska, Z.L. Nczuk and J. Krol. 2011. Nutritional value and technological suitability of milk from various animal species used for dairy production. Comprehensive reviews in Food Sci. and Food Safety.10:291-302.
4. BSI, 1990. Determination of nitrogen content of liquid milk. In: Methods of chemical analysis of liquid milk and cream. BSI: 1741, British Standards Institution, London, UK.
5. Enb, A, M.A.A. Donia, N.S. Abd-Rabou, A.A.K. Arab and M.H. El-Senaity. 2009. Chemical composition of raw milk and heavy metals behavior during processing of milk products. Global Veterinaria. 3(3):268-275.
6. Herringten, B.L. 2000. Milk and milk processing. Greenwood Publishers, Lucknow, India. Pp. 25-26.
7. James, C.S. 1995. Determination of fat content of dairy products by the Gerber method. Analytical chemistry of food. Blacki Academic and Professionals, an imprint of Champan and Hall, Glasgow, UK. Pp: 93-95.
8. Kanwal, R, T. Ahmad and B. Mirza. 2004. Comparative analysis of quality of milk collected from buffalo, cow, goat and sheep of Rawalpindi/Islamabad region in Pakistan. Asian J. Plant Sci. 3(3):300-305.
9. Khan, M.A.S, M.N. Islam and M.S.R. Siddiki. 2007. Physical and chemical composition of swamp and water buffalo milk: a comparative study. Ital. J. Ani. Sci. 6(2):1067-1070.
10. Mahmood, A and U. Sumaira. 2010. A comparative study on the physico-chemical parameters of milk samples collected from buffalo, cow, goat and sheep of Gujrat, Pakistan. Pak. J. Nut. 9(12):1192-1197.
11. Myburgh, J, G. Osthoff, A. Hugo, M.D. Wit, K. Nel and D. Fourie. 2012. Comparison of the milk composition of free-ranging indigenous African cattle breeds. S. Afr. J. Ani. Sci. 42(1):1-14.

12. Rao, A and S. Mishra. 2010. An assessment of the nutritional profile of milk in different seasons and locations in varanasi through modern laboratory techniques. Ind. J.Prev. Soc. Med. 41(3 and 4):237-239.

13. Sahai, D. 1996. Buffalo milk: chemistry and processing technology. International Publication, Karnal. p. 20-57.

14. Sindhu, J.S. 1998. Chemical aspects of cow and buffalo milk in relation to quality of traditional dairy products. In Compendium: Advances in traditional dairy products. Centre for Advanced Studies in Dairy Technol. NDRI Karnal, p. 12-16.

15. Soliman, G.Z.A. 2005. Comparison of chemical and mineral content of milk from human, cow, buffalo, camel and goat in Egypt, J. Hosp. Med. 21:116–130.

16. Vishweshwar, S.K and N. Krishnaiah. 2005. Food and nutritive value of milk. Quality control of milk and processing, State Institute of Vocational Education Director of Intermediate Education Govt. of Andhra pradesh, India, p. 10.

17. Walstra, P, J.T.M. Wouters and T.J. Geurts. 2006. Dairy science and technology (Ed.2nd). Taylor and Francis group, LLC, USA. Pp. 26-33.

APPENDICES

Table 1: Comparative Analysis of Total Solids (Fat, Protein, Lactose, Ash) and Calorific Values of Buffalo and Cow Milk

	Descriptive Measures	Buffalo Milk	Cow Milk	Significance	
TOTAL SOLIDS CONTENTS (%)	**Minimum**	**14.24**	**11.84**	**P-Values**	**LSD±SE (0.05)**
	Maximum	15.83	13.58	<0.001	0.30±0.15
	Mean	15.03	12.84		
	SE±	0.10	0.10		
	CV	3.18	3.57		
FAT CONTENTS (%)	Minimum	5.10	3.60	<0.001	0.10±0.05
	Maximum	5.45	4.50		
	Mean	5.25	4.04		
	SE±	0.02	0.04		
	CV	1.97	4.92		
PROTEIN CONTENTS (%)	Minimum	3.12	3.12	<0.017	0.27±0.13
	Maximum	4.90	4.90		
	Mean	4.13	3.80		
	SE±	0.10	0.09		
	CV	10.55	10.81		
LACTOSE CONTENTS (%)	Minimum	3.60	3.03	<0.011	0.41±0.20
	Maximum	5.93	5.18		
	Mean	4.82	4.28		
	SE±	0.15	0.14		
	CV	13.60	14.62		
ASH CONTENTS (%)	Minimum	0.70	0.60	<0.001	0.05±0.03
	Maximum	1.00	0.90		
	Mean	0.82	0.72		
	SE±	0.02	0.01		
	CV	11.72	9.66		
CALORIFIC VALUES	Minimum	79.26	59.16	<0.001	2.22±1.10
	Maximum	86.65	77.45		

(Kcal/100g of milk)	Mean	83.11	66.77		
	SE±	0.49	0.98		
	CV	2.68	6.55		

Table 2: Frequency Distribution of Total Solids Content (%) and Calorific Values of Buffalo and Cow Milk

	Frequency Distribution		Buffalo Milk	Cow Milk
TOTAL SOLIDS CONTENTS (%)	Less than mean	No. of samples	10	10
		Percent	50	50
	Equal to mean	No. of samples	00	00
		Percent	00	00
	Greater than mean	No. of samples	10	10
		Percent	50	50
FAT CONTENTS (%)	Less than mean	No. of samples	08	07
		Percent	40	35
	Equal to mean	No. of samples	05	00
		Percent	25	00
	Greater than mean	No. of samples	07	13
		Percent	35	65
PROTEIN CONTENTS (%)	Less than mean	No. of samples	09	09
		Percent	45	45
	Equal to mean	No. of samples	00	05
		Percent	00	25
	Greater than mean	No. of samples	11	06
		Percent	55	30
LACTOSE CONTENTS (%)	Less than mean	No. of samples	10	10
		Percent	50	50
	Equal to mean	No. of samples	00	00
		Percent	00	00
	Greater than mean	No. of samples	10	10
		Percent	50	50
ASH CONTENTS (%)	Less than mean	No. of samples	12	15
		Percent	60	75
	Equal to mean	No. of samples	00	00
		Percent	00	00
	Greater than mean	No. of samples	08	05
		Percent	40	25
CALORIFIC VALUES (Kcal/100g of milk)	Less than mean	No. of samples	10	11
		Percent	50	55
	Equal to mean	No. of samples	00	00
		Percent	00	00
	Greater than mean	No. of samples	10	09
		Percent	50	45