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RESEARCH PAPER

Chemical qualities of raw milk of goat, cow and buffalo : A comparative study

U.K. Shukla* **and** Akash Kumar Pandey
Department of N.R.M., Faculty of Agriculture, Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot, Satna, (M.P.) India

Abstract : The present investigation entitled "Chemical qualities of raw milk of Goat, cow and buffalo : A comparative study" was carried out during January to April 2022 at the Mini Dairy Farm Rajola Livestock Production and Management (Unit), Department of Natural resource management (NRM), Faculty of Agriculture, Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot – Satna (Madhya Pradesh), to the study chemical qualities of raw milk of goat, cow and buffalo It can be concluded from the study that the goat milk has lower TS, fat, lactose and protein content and it has higher ash content compared to cow milk and buffalo milk. It has higher SNF compared to cow milk but it has lower SNF compared to buffalo milk.

Key Words : Cow, Buffalo, Goat, Raw milk

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INTRODUCTION

Milk is a whitish food generally produced by the mammary secretory cells of females in a process called lactation; it is one of the defining characteristics of mammals. The milk produced by the glands is contained in the udder. Milk secreted in the first days after parturition is called colostrum (Kebchaoui, 2012).

Milk is used throughout the world as a human food in at least one or more form. Because of its high nutritional value, milk is considered as one of the most important diet items of many people (Mehari, 1988).

Now-a-days consumption patterns of milk products that were built up over centuries are under attack. The quality of milk is controversially discussed in relation to potential negative health impacts or dangers facing the claims on health promotion of milk intake in general, milk fats and raw milk chiefly. (Lichtenstein *et al.*, 2006).

Milk provides a complete source of proteins, lipids and carbohydrates to support the growth of the neonate until they are able to digest foods from other sources. Breast feeding of infants is highly recommended for at least the first six months of life. Amongst mammals, humans are unique using milk from other species to feed their infants and young children. Thus, due to a myriad of reasons, many are fed milk formula manufactured from cow milk. (Hodgkinson *et al*.,2017).

Chemically, milk is a complex mixture of fat, protein, carbohydrates, minerals, vitamins and other miscellaneous constituents dispersed in water, make it a complete diet (Haug *et al*., 2007).

Carbohydrates in milk are almost exclusively

***Author for correspondence:**

represented by lactose, a disaccharide, which must be cleaved into glucose and galactose by the intestinal enzyme lactase (or @dkar CD. Lactose. In: Caballero *et al.,* 2016).

Eighty per cent of the protein fraction of cow's milk is caseins, which predominantly contain glutamic acid, proline, arginine, and branched amino acids (leucine, isoleucine, valine). Beta-casein, representing about 35% of total caseins, exists in two different forms (A1 and A2), with possibly different physiological effects. (He *et al.,* 2017).

When determining raw milk composition it is also important to realize the interaction between the feeding systems, management practices and breed (Heck *et al.,* 2009).

Raw milk is milk produced by the secretion of the mammary gland of farmed animals, which has not been heated to more than 40^0C or has not undergone any treatment with an equivalent effect (European Parliament and the Council of the European Union, 2004).

Goat (*Capra hiricus*) milk is wanted or even needed by people of all income groups. Despite the much larger volume available of cow milk, it's usually cheaper production and therefore, lower market price, the production and marketing of goat milk and its products is therefore, an essential niche in the total dairy industry sector. Goat milk differs from cow or human milk in having better digestibility, alkalinity, buffering capacity and certain therapeutic values in medicine and human nutrition (Coni *et al.,* 1999 and Kumar *et al.,* 2012).

Cow's milk naturally contains the large amount of protein needed for her calf. That amount of protein is not only unnecessary but unhealthy for humans. Excess protein in our diets causes calcium to leach out of our bones. This can be a cause of osteoporosis. Studies have also shown that there are certain proteins in cow's milk which acts as allergen particularly to breast fed infants. These allergens cause hypersensitivity reactions, lymphadenopathy and hepato-splenomegaly. Studies have revealed that more than 100 distinct antigens are released by digestion of cows' milk which stimulates humoral responses and formation of different antibodies. The common problems in children are GIT disorders, acute gastrointestinal blood loss, milk borne infections, lack of minerals, abdominal pain, bedwetting, asthma, intestinal bleeding, colic and diabetes (Ziegler *et al.,* 1990).

Milk of buffaloes constituting an important source of market milk has some unusual qualities. It meets certain specific food requirements of human population in India and elsewhere. The fat content can exceptionally be as high as 15 per cent and the overall average may be 7 %. Milk is also an excellent medium for the growth of a large variety of bacteria. Bacteria need considerable amounts of nutrient such as water, carbohydrate, fat and other substances for their growth and milk contains all of these nutrients (Harrigan *et al.,* 1976).

MATERIAL AND METHODS

This chapter has been divided in to three parts. The first part deals with sampling, measurement of physico-chemical characteristics of goat milk, cow milk, and buffalo milk. The second part deals with the estimation of processing related properties of goat, cow and buffalo milk. The third part deals with the determination of selected enzyme activity in goat, cow, and buffalo milk.

Milk samples :

All goat milk samples were collected in a clean and dry container from a herd, maintained at Goat farm, Rajula, Chitrakoot ,Satna.Cow milk samples were collected as pooled sample from Cattle farm LPM Unit Rajula. Buffalo milk samples were collected as pooled sample from the Milk samples were collected in clean and dry sample bottles and kept at refrigeration temperature. The analysis of milk samples were done at the LPM Unit Department of NRM, faculty of agriculture MGCGV Chitrakoot, Satna, M.P.

The objective was to find out the comparative chemical qualities of raw milk of goat, cow and buffalo for ten days as replication different parameter were subject to statistical analysis applying the technique of analysis of variance (f-test) the most widely used method for determining protein content by kjeldahi method for nitrogen determination since nitrogen is a characteristic can be finding.

Preparation of samples for analysis:

The goat, cow and buffalo milk samples for chemical analysis were prepared as per the method described in BIS Handbook (SP 18: 1981).

Determination of protein :

Add to the clean and dry Kjeldahl flask, 5-10 boiling aids, 15g K_2SO_4, 1.0ml of the copper sulphate solution, approximately 5±0.1 g of prepared milk sample (or milk product sample containing equipment amount of protein),

weighed to the nearest 0.1mg and add 25ml of concentrated sulphuric acid. Use the 25ml acid also to wash down any copper sulphate solution, K_2SO_4 or milk left on the neck of the flask. Gently mix the contents of the Kjeldahl flask. Titrate the boric acid receiving solution with standard hydrochloric acid solution (0.1 N) to the first trace of pink colour. Take the burette reading to at least the nearest 0.05ml. A lighted stir plate plate may aid visualization of the end point.

Calculate the nitrogen content, expressed as a percentage by mass, by following formula :

$$Wn = \frac{1.4007 \times (Vs - Vb) \times N}{W}$$

Specific gravity :

The specific gravity of milk were determined by lactometer.

Determination of fat :

The milk is mixed with sulphuric acid and iso-amyl alcohol in a special gerber tube, permitting dissolution of the protein and release of fat. The tubes are centrifuged and the fat rising into the calibrated part of the tube is measured as a percentage of the fat content of the milk sample. The method is suitable as a routine or screening test. It is an empirical method and reproducible results can be obtained if procedure is followed correctly.

Read the percentage of fat after adjusting the height in the tube as necessary by movements of the lock stopper with the key. Note the scale reading corresponding to the lowest point of the fat meniscus and the surface of separation of the fat and acid. When readings are being taken hold the butyrometer with the graduated portion vertical, keep the point being read in level with the eye, and then read the butyrometer to the nearest half of the smallest scale division.

Determination of lactose :

Pipette 5 ml each of working standard lactose and unknown solution into 25 ml test tubes. Add 5 ml of glycine NaOH buffer, 0.5 ml of methylamine solution and 0.5 ml of sodium sulphite solution in each tube, mix thoroughly. Heat tubes in a thermostatically controlled water bath at 65 ^{0}C for 25 min. and cool immediately in an ice water bath for 2 min. to stop the reaction. Read absorbance against blank at 540 nm in a spectrophotometer or a suitable spectrophotometer. Draw a standard curve by plotting absorbance against concentration of lactose and determine the concentration of lactose from it.

Determination of ash :

$$\text{Total ash} = \frac{(M2 - M)}{(100 - Mo) \times (M1 - M)}$$

Determination of total solid :

$$\text{Total solids \% by mass} = \frac{(M2 - M)}{(M1 - M)} \times 100$$

Determination of water :

Water per cent

Water per cent = 100-T.S.

Determination solid not fat :

Determine solid not fat in the sample by deducting moisture and milk fat and calculate acidity in terms of ml of 0.1N NaOH/ 10g Milk solids not Fat as per requirement ofFSSAI Rule as shown below:

$$\frac{\text{Volume of 0.1 NaOH} \times 100 \times 100 \times 10}{\text{Weight of MSNF} \times \text{Weight of sample}}$$

Statistical analysis of data :

The data recorded during the course of investigation was subjected to statistical analysis by "Analysis of variance technique". The significant and non-significant treatment effects were judged with the help of 'F' (variance ratio) table. The significant differences between the means were tested against the critical difference at 5% probability level. For testing the hypothesis, the following ANOVA table was used.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Protein :

protein content in goat milk was 3.84 to 4.04% with a mean value of 3.90%. Similarly, in cow milk range of protein was 3.54 to 3.64% with a mean value of 3.58%. On the other hand, protein content ranged between 4.54 to 4.59% with a mean value of 4.56% in buffalo milk. Thus, buffalo milk had the highest protein content, which was followed by cow milk and lowest protein per cent was found in goat milk. The protein content of goat milk

Table 1 : Protein (%) in goat, cow and buffalo milk

Replication		Goat	Cow	Buffalo	Mean
R1		3.95	3.54	4.54	4.01
R2		4.04	3.58	4.59	4.07
R3		3.86	3.61	4.59	4.02
R4		3.77	3.58	4.54	3.96
R5		3.83	3.55	4.54	3.97
R6		3.84	3.59	4.55	3.96
R7		3.91	3.56	4.54	4.00
R8		3.92	3.64	4.58	4.05
R9		4.00	3.61	4.59	4.07
R10		4.02	3.59	4.59	4.07
Range	Max	4.04	3.64	4.59	4.07
	Min	3.84	3.54	4.54	3.96
	Mean	3.904	3.585	4.565	4.018
		Result	S.E. ±	C.D. (P=0.05)	
	Replication	NS	0.026	0.054	
	Due to animal	S	0.047	0.098	

NS= Non-significant

was statistically significant ($p < 0.05$) with cow milk. The protein content of buffalo milk was significantly higher ($p > 0.05$) than that of the goat milk as well as cow milk.

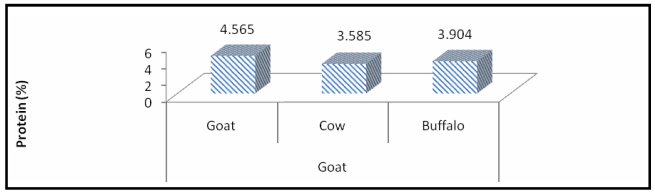

Fig. 1 : Protein (%) in goat, cow and buffalo milk

Specific gravity :

Specific gravity in goat milk was 1.093 to 1.072% with a mean value of 1.081%. Similarly, in cow milk range of specific gravity was 1.340 to 1.300% with a mean value of 1.311%. On the other hand, specific gravity ranged between 1.060 to 1.030% with a mean value of 1.048% in buffalo milk. Thus, goat milk had the highest Specific gravity, which was followed by buffalo milk and lowest specific gravity per cent was found in cow milk.

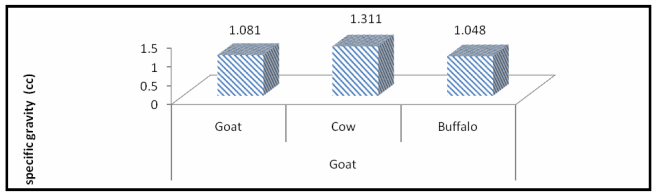

Fig. 2 : Specific gravity (cc) in goat, cow and buffalo milk

Fat :

Fat content in goat milk was 3.91 to 3.84% with a mean value of 3.88%. Similarly, in cow milk range of fat was 4.02to 3.13% with a mean value of 3.50%. On the other hand, fat content ranged between 7.73.6.93 to 6.93% with a mean value of 7.4% in buffalo milk. Thus, buffalo milk had the highest fat content, which was followed by cow milk and lowest fat per cent found in goat milk. The fat content of goat milk was significantly lower ($p > 0.05$) than that of the cow milk as well as buffalo milk. The fat content of cow milk was also significantly lower ($p > 0.05$) than that of the buffalo milk.

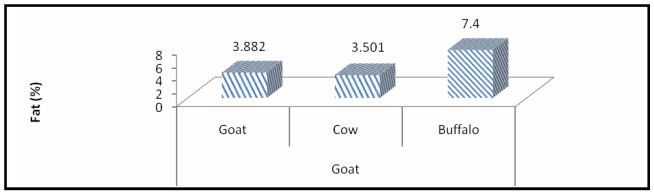

Fig. 3 : Fat (%) in goat, cow and buffalo milk

Lactose :

Lactose content determined in ten replications was 4.69 to 4.46% with a mean value of 4.573% in goat milk. Similarly, in cow milk range of lactose was 4.08 to 3.88% with a mean value of 4.00%. On the other hand, lactose content ranged between 4.97 to 4.80% with a mean value of 4.87% in buffalo milk. The buffalo milk had the highest

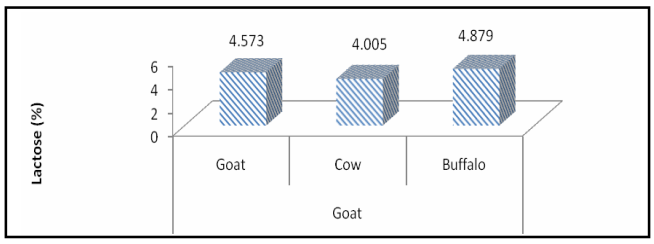

Fig. 4 : Lactose (%) in goat, cow and buffalo milk

lactose content, which was followed by cow milk and lowest lactose content was found in goat milk. The lactose content of buffalo milk was statistically significant ($p < 0.05$) with cow milk.

Ash :

Ash content determined in ten replications was 1.01

Table 2 : Specific gravity (cc) in goat, cow and buffalo milk

Replication		Goat	Cow	Buffalo	Mean
R1		1.09	1.32	1.03	1.15
R2		1.07	1.30	1.06	1.14
R3		1.09	1.32	1.06	1.15
R4		1.08	1.31	1.06	1.15
R5		1.08	1.31	1.06	1.15
R6		1.07	1.30	1.06	1.14
R7		1.09	1.34	1.04	1.16
R8		1.08	1.30	1.05	1.14
R9		1.08	1.31	1.05	1.15
R10		1.08	1.30	1.04	1.14
Range	Max	1.093	1.340	1.060	1.16
	Min	1.072	1.300	1.030	1.14
	Mean	1.081	1.311	1.048	1.146733
		Result	S.E. ±	C.D. (P=0.05)	
Replication		NS	0.005	0.009	
Due to animal		S	0.008	0.017	

NS= Non-significant

Table 3 : Fat (%)in Goat, cow and buffalo milk

Replication		Goat	Cow	Buffalo	Mean
R1		3.87	3.63	7.53	5.01
R2		3.90	3.13	7.43	4.82
R3		3.89	3.17	7.53	4.86
R4		3.89	3.41	6.93	4.74
R5		3.84	3.30	7.73	4.96
R6		3.90	3.23	7.33	4.82
R7		3.91	3.28	7.43	4.87
R8		3.87	3.88	7.23	4.99
R9		3.89	4.02	7.73	5.21
R10		3.86	3.96	7.13	4.98
Range	Max	3.91	4.02	7.73	5.21
	Min	3.84	3.13	6.93	4.74
	Mean	3.882	3.501	7.4	4.927667
		Result	S.E.±	C.D. (P=0.05)	
Replication		NS	0.114	0.239	
Due to animal		S	0.207	0.436	

NS = Non-significant

Table 4 : Lactose (%) in goat, cow and buffalo milk

Replication		Goat	Cow	Buffalo	Mean
R1		4.46	3.97	4.90	4.44
R2		4.59	4.05	4.96	4.53
R3		4.52	4.03	4.82	4.46
R4		4.67	4.03	4.92	4.54
R5		4.56	4.08	4.83	4.49
R6		4.62	4.03	4.82	4.49
R7		4.69	4.08	4.85	4.54
R8		4.47	3.88	4.80	4.38
R9		4.59	4.02	4.92	4.51
R10		4.56	3.88	4.97	4.47
Range	Max	4.69	4.08	4.97	4.54
	Min	4.46	3.88	4.80	4.38
	Mean	4.573	4.005	4.879	4.485
		Result	S.E.±	C.D. (P=0.05)	
Replication		NS	0.028	0.058	
Due to animal		S	0.051	0.106	

NS= Non-significant

Table 5 : Ash (%) in goat, cow and buffalo milk

Replication		Goat	Cow	Buffalo	Mean
R1		0.80	0.79	0.77	0.787
R2		1.01	0.65	0.98	0.880
R3		0.85	0.66	0.82	0.777
R4		0.83	0.69	0.8	0.773
R5		0.93	0.76	0.9	0.863
R6		0.89	0.77	0.86	0.840
R7		0.87	0.73	0.84	0.813
R8		0.85	0.67	0.82	0.780
R9		0.88	0.71	0.85	0.813
R10		0.86	0.67	0.83	0.787
Range	Max	1.01	0.79	0.98	0.88
	Min	0.80	0.65	0.77	0.77
	Mean	0.88	0.71	0.85	0.81
		Result	S.E. ±	C.D. (P=0.05)	
Replication		NS	0.114	0.239	
Due to animal		S	0.207	0.436	

NS=Non-significant

to 0.80% with a mean value of 0.88% in goat milk. Similarly, in cow milk range of ash was 0.79 to 0.65% with a mean value of 0.71%. On the other hand, ash content ranged between 0.98 to 0.77% with mean value of 0.85% in buffalo milk. The goat milk had the highest ash content, which was followed by buffalo milk and cow milk had the lowest ash content. However, the

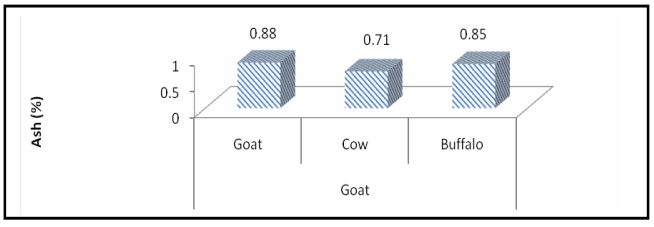

Fig. 5 : Ash (%) in goat, cow and buffalo milk

differences in ash content of three types of milk studied *viz.,* goat milk, cow milk and buffalo milk were found statistically significant ($p < 0.05$).

Total solid :

Total solid (TS) content TS content in goat milk was 12.82 to 12.72% with a mean value of 12.766%. Similarly, in cow milk range of TS was 13.32 to 12.22 % with a

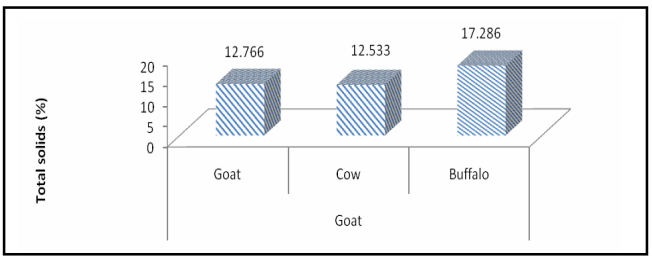

Fig. 6 : Total solids (%) in goat, cow and buffalo milk

Table 6 : Total solids (%) in goat, cow and buffalo milk

Replication		Goat	Cow	Buffalo	Mean
R1		12.74	12.33	17.44	14.17
R2		12.77	12.42	17.70	14.30
R3		12.82	12.64	17.09	14.18
R4		12.79	12.95	17.31	14.35
R5		12.74	12.49	17.19	14.14
R6		12.80	12.41	17.17	14.13
R7		12.76	13.32	17.17	14.42
R8		12.78	12.31	17.25	14.11
R9		12.74	12.22	17.40	14.12
R10		12.72	12.24	17.14	14.03
Range	Max	12.82	13.32	17.70	14.42
	Min	12.72	12.22	17.09	14.03
	Mean	12.766	12.533	17.286	14.195
		Result	S.E.±	C.D. (P=0.05)	
Replication		NS	0.107	0.225	
Due to animal		S	0.196	0.411	

NS=Non-significant

Table 7 : Viscosity in goat, cow and buffalo milk

Replication		Goat	Cow	Buffalo	Mean
R1		1.56	1.54	2.04	1.713
R2		1.52	1.69	1.94	1.717
R3		1.47	1.72	2.28	1.823
R4		1.5	1.60	2.25	1.783
R5		1.56	1.80	2.38	1.913
R6		1.49	1.54	2.24	1.757
R7		1.54	1.69	2.11	1.780
R8		1.5	1.88	2.29	1.890
R9		1.55	1.91	2.28	1.913
R10		1.57	1.83	2.17	1.857
Range	Max	1.57	1.91	2.38	1.91
	Min	1.47	1.54	1.94	1.71
	Mean	1.53	1.72	2.20	1.81
		Result	S. E.±	C.D. (P=0.05)	
Replication		NS	0.092	0.193	
Due to animal		NS	0.168	0.353	

NS=Non-significant

mean value of 12.53%. On the other hand, TS content ranged between 17.70 to 17.09 % with a mean value of 17.28% in buffalo milk. Thus, goat milk had the lowest TS content amongst all three types of milk studied in the present investigation. On the other hand the highest TS content was found in buffalo milk. Thus, TS content of goat milk was significantly lower ($p > 0.05$) than that of the cow milk as well as buffalo milk. Similarly TS content of cow milk was significantly lower ($p > 0.05$) than that of the buffalo milk.

Viscosity :

Viscosity content in goat milk was 1.57 to 1.47% with a mean value of 1.53%. Similarly, in cow milk range of viscosity was 1.91 to 1.54 % with a mean value of 1.72%. On the other hand, viscosity content ranged between 2.38 to 1.94 % with a mean value of 2.20% in buffalo milk. Thus, goat milk had the lowest viscosity content amongst all three types of milk studied in the present investigation. On the other hand the highest viscosity content was found in buffalo milk. Thus, viscosity content of goat milk was significantly lower ($p > 0.05$) than that of the cow milk as well as buffalo milk. Similarly viscosity content of cow milk was significantly lower ($p > 0.05$) than that of the buffalo milk.

SNF :

SNF content determined in ten replications for goat milk was 8.92 to 9.00% with a mean value of 8.956%. Similarly, in cow milk range of SNF was measured to be 8.59 to 7.85% with a mean value of 8.33%. On the other hand, SNF content ranged between 9.89 to 9.38% with a mean value of 9.61% in buffalo milk. Thus, buffalo milk had the highest SNF content, which was followed by goat milk and lowest SNF was found in cow milk. The SNF content of goat milk was statistically non significant ($p < 0.05$) with cow milk. The SNF content of buffalo milk was significantly higher ($p > 0.05$) than

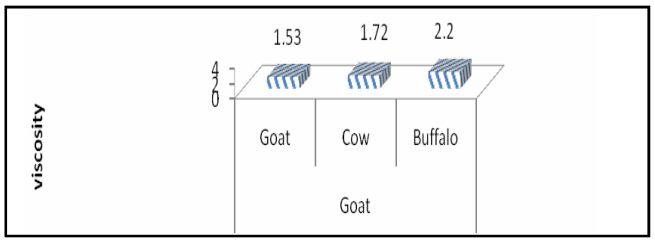

Fig. 7 : Viscosity in goat, cow and buffalo milk

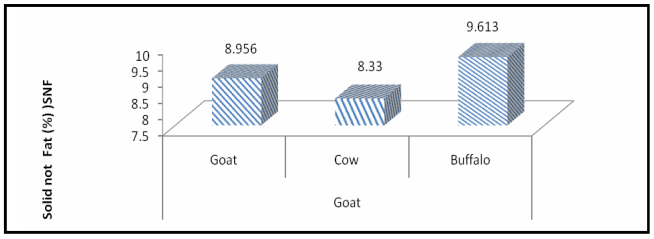

Fig. 8 : Solid not fat (%) SNF in goat, cow and buffalo milk

Table 8 : Solid not fat (%) SNF in goat, cow and buffalo milk

Replication		Goat	Cow	Buffalo	Mean
R1		8.94	8.49	9.58	9.00
R2		8.94	7.85	9.89	8.89
R3		9.00	8.45	9.50	8.98
R4		8.97	8.47	9.71	9.05
R5		8.97	8.21	9.53	8.90
R6		8.97	8.38	9.38	8.91
R7		8.93	8.59	9.65	9.06
R8		8.98	8.45	9.51	8.98
R9		8.92	8.21	9.81	8.98
R10		8.94	8.20	9.57	8.90
Range	Max	9.00	8.59	9.89	9.06
	Min	8.92	7.85	9.38	8.89
	Mean	8.956	8.33	9.613	8.966333
		Result	S.E.±	C.D. (P=0.05)	
Replication		NS	0.077	0.163	
Due to animal		S	0.141	0.297	

NS= Non-significant

that of the cow milk and goat milk.

Conclusion :

It can be concluded from the study that the goat milk has lower TS, fat, lactose and protein content and it has higher ash content compared to cow milk and buffalo milk. It has higher SNF compared to cow milk but it has lower SNF compared to buffalo milk.

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