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COMPARATIVE STUDY OF MILKS OF DIFFERENT TYPES OF MILKS AND THEIR NUTRITIONAL COMPOSITION IN DISTRICT SARGODHA

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ABSTRACT

Around the world, milk is an essential part of human diet. Although cow's milk is the most often consumed, blended and alternative milk products are becoming more and more well-liked. This change calls for a thorough comprehension of their relative nutritional worth. In the dairy-rich district of Sargodha, Pakistan, this study sought to compare the nutritional makeup and physicochemical characteristics of commercially available mixed milk (MMS, probably cow plus buffalo) and cow's milk (CMS). Using sterile procedures, twelve samples—six CMS and six MMS—were randomly selected from different parts of Sargodha. With the help of advanced analytical techniques, a qualified laboratory studied significant features of density, pH, freezing point, protein, lactose, fat, solids-not-fat (SNF), and salts. Statistically analysed using SPSS. The analysis revealed significant compositional differences. Mixed milk samples (MMS) contained a higher (4.37%-5.50) average fat content than cow milk (3.51%-5.13%). However, in case of SNF (8.84-10.27% vs. 8.10-9.16%), protein (3.86-4.39% vs. 2.90-3.64%), lactose (5.79-6.58% vs. 4.40-5.43%), and mineral salts (0.87-0.98% vs. 0.60-0.81%), the cow milk was always better than the mixed milk. Furthermore, cow milk was lower in freezing point and higher in density implying that the suture concentration was richer, and thus less was diluted. The researchers conclude that pure cow milk in the Sargodha region is nutritionally better, and there were significantly higher levels of protein, lactose and even minerals, despite the mixed milk being higher in fat. The reduced values of blended milk provide a potential source of processing or adulteration. These findings underline the importance of informed nutritional choices, especially in relation to the populations that are vulnerable and may require ideal nutrition, and the requirement of strict quality control in commercial milk products.

Introduction

Cow's milk is a food of universal significance as it is a well-balanced source of essential macro and micronutrients. It is an unending source of vital nutrition which is very advisable in immunological, muscular and bone functions. It also represents a healthy and safe base of newborn formula. Despite most milk which is produced in the world is based on cows, the replacements that are plant based are increasingly gaining popularity due to ethical and environmental factors. But the quality protein, easily digested calcium, and necessary lipids to grow that are present in cow milk are missing in many other options. It also contains a lot of lactose that enhances good gut flora and also greatly increases vitamin D and calcium absorption. (1).

Over six billion people drink cow milk and its derivatives on a regular basis. Dairy products produced by the cow milk are thus an extension of the daily life of every person in the world. It is also the most popular food in the world and has massive sociocultural worth. The world consumption statistics indicate that the average individual consumes an average of 116.50 kg of cow milk per person per year. This figure is shocking since it explains the extent to which milk is consumed as an essential source of essential minerals.

Other factors that have contributed to this high consumption level, other than its relevance to society are the nutritional demands of dairy products in general and its protein and calcium content specifically. (2). Milk fat is the essential and high-energy compound that provides milk with its characteristic flavor and texture along with the number of calories it has and the quality of dairy products such as cheese and butter. Biologically, it is a source of essential fat-soluble vitamins and important fatty acids that are needed to grow, develop and have immunity. The content of the milk is the primary determinant of the price and the value of milk in the world dairy industry. To ensure quality of products, correct labeling, and regular nutritional needs to protect consumers, several countries have legislative measures concerning minimum whole milk fat content. Consequently, a lot has been researched in order to understand the processes at the molecular level that regulate the synthesis of milk fat. Such studies are important to ensure animal nutrition and feed is maximized to maximum output. The ultimate objectives of this research are to enhance profitability of the farms, fulfilling the regulatory demands, and providing the consumers with better healthier dairy products. (3). Milk composition differs significantly across species, breeds and individual animals. This depends on the genetic composition of the animal, its age, health, lactation period, food and the rate at which it is milked. To develop a differentiated product, one has to understand these differences in nutrition and bioactive contents. This fact enables the production of alternatives to those who have an allergy to or cannot tolerate cow milk. Also, it allows improving the quality of milk by means of cross-breeding programs and targeted selection.(4). Even though the milk of the other animal species such as buffaloes, sheep, goats, and camels is essential in the human diet in most regions of the world, cow milk has been the focus of various studies. Buffalo milk is second in the world behind cow milk (approximately 84) in terms of volume produced annually (82 billion liters per year). Buffalo milk is also one of the richestmilks in terms of content. Fat, especially buffalo milk, is the main ingredient that makes it so highly valuable in terms of nutrition and energy. Thus, nutritionally, buffalo milk has some importance in those countries where buffaloes are reared. Unlike cow milk, there is a lack of data on physical and chemical composition of buffalo milk fat.(5). Due to the common health benefits attributed to it, milk is a necessity among every age group. Raw bovine milk is susceptible to various factors, among which are as breed, nutrition, season, lactation stage, and others. In addition, this could potentially have a high national disparities in the breeds of dairy cows and livestock practices which can influence the technological properties and milk composition.(6). Milk and milk products contain a number of important nutrients, such as oleic acid, conjugated linoleic acid, omega-3 fatty acids, vitamins, minerals, and bioactive substances, including antioxidants. Fresh buffalo milk has a higher antioxidant capacity compared to fresh cow's milk due to a higher concentration of antioxidant compounds, including vitamin E (5.5 mg/100 mL in buffalo milk and 2.1mg/100 mL in cow milk), vitamin C (3.66mg/100 mL in buffalo milk and 0.94mg/100 mL in cow milk), and other antioxidants such as selenium (Se), zinc (Zn), ty Also, buffalo milk is two to four times more catalases active compared to cow milk.(7). Punjab is one of the leading states in the country as far as milk production is concerned. Punjab contributes approximately 6.70 percent of the national milk production with an estimated production of 12.60 MT of milk in 2019-20. has its origin in buffaloes, and constitutes about 72.0 per cent of all the milk produced in the state, and the buffalo share of the federal producer is only about 49.0 per cent.(8).

The milk production and milk composition (Na, K, C1, lactose) of the different glands in healthy goats (and cows) varied randomly between days, but were always parallel to each other. As such, the differences in the gland composition can be used as an indicator of subclinical mastitis.(9).

The elements of blood change during pregnancy and when a mother nurses.

Plants and animals are directly connected because most of the macro and micro minerals are higher in the winter than in the summer of both animal blood and the forage. To determine the seasonal effect of the use of three estrus synchronization protocols and the effects of these protocols on the plasma biochemical profile of buffaloes, the current study was undertaken.(10). The composition of cow milk is the most important aspect of the dairy industry. It is vital to the value of milk and affects the ability to process it as well as its nutritional value. Internal (e.g., the breed of cow) and external (e.g., feeding practices, changes in season, frequency of milking and milking equipment) influences influence the composition of milk. New dairy plants and production will provide milk with new methods and demands on its composition and new dairy products will come.(11). Buffalo milk provides energy to body functions such as regulation of hormones and brain as it is rich in lactose compared to cow, goat, sheep and camel milk. (12). The number of microbial populations is also small at the beginning of lactation, but it may increase to the highest part of the teat when the milking process proceeds throughout the season. The time that the cow milk can be stored is the time that the microbial load of cow milk is known and avoided, thereby ensuring that the milk does not go bad.(13). Milk is one of the most significant postnatal determinants of the immunological, metabolic and nutritional programming of the newborn health of mammals. Besides the nutritional benefits, bioactive constituents of milk, including bacteria, growth factors, immune globulins, antimicrobial peptides (AMPs), cytokines and chemo kinesis, are significant in terms of health. Probiotics of animal milk are useful in the health and immunity of newborns and young animals.(14).

Materials and Methods

FIELD SURVEY

This comparative and nutritional compositional study was conducted in the Sargodha region of known as Punjab province in Pakistan. It is a city that is famous due to its tremendous dairy production and agricultural production. This study focuses on comparing and deciding on the nutritional make up of various milk types. This study has employed sample collection, processing and analyses procedures to ensure that the obtained results are valid.

SAMPLE COLLECTION

The samples of milk were collected randomly in twelve locations in Sargodha. Sterilized glass vials were used in order to prevent contamination and ensure accurate results. After taking six samples of cow milk samples, buffalo milk samples were collected and labeled to identify them. Additional samples of cow and mixed (cow + buffalo) milk were also collected by us. All samples were stored in sterile bottles then quickly frozen to preserve quality and prevent bacterial growth prior to being put through a lab.

LABORATORY ANALYSIS:

A certified biotechnology lab received the collected milk samples for a thorough nutritional analysis. To assess essential elements including proteins, lipids, carbs, vitamins, and minerals, cutting-edge scientific techniques were employed. A comparative table detailing the nutritional composition of each sample was created using the results. With variances in protein, fat, and carbohydrate levels among samples, the data showed variability in nutritional content. Buffalo milk has higher quantities of fat and protein, while cow milk often had a higher lactose level. Samples of mixed milk showed intermediate values, combining the traits of the two types. Animal species, diet, place of origin, and handling techniques are some of the variables that might be blamed for these variances. The results emphasize the necessity of quality assessment while highlighting the nutritional variation among milk sources.

This type of analysis guarantees that consumers are given correct information regarding the health benefits of milk. Better nutritional decisions are supported by the study's assistance in determining the best milk sources for dietary requirements. All things considered, the laboratory findings offer insightful information about the compositional variations across samples of cow, buffalo, and mixed milk.

	CMS1	CMS2	CMS3	CMS4	CMS5	CMS6	MMS1	MMS2	MMS3	MMS4	MMS5	MMS6
Fat	4.71%	3.51%	4.15%	4.51%	4.02%	5.13%	5.26%	4.59%	4.37%	5.50%	4.40%	5.40%
SNF	10.27%	9.85%	8.84%	10.22%	9.37%	9.50%	9.16%	8.49%	8.34%	9.00%	8.10%	9.00%
Density	37.26	37.96	32.65	37.46	35.04	33.37	32.01	30.19	29.55	3020.00%	27.7	30.4
Lactose	6.58%	6.35%	5.79%	6.55%	6.09%	6.16%	5.43%	5.06%	4.98%	4.90%	4.40%	4.40%
Salts	0.98%	0.95%	0.87%	0.98%	0.91%	0.92%	0.81%	0.75%	0.74%	0.70%	0.60%	0.60%
Prote	4.39	4.20	3.86	4.36	4.05	4.13	3.64	3.40	3.34	3.30%	2.90	2.90

in	%	%	%	%	%	%	%	%	%		%	%
water	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00%	0.00 %	0.00 %
Temp	36.6	41	39	36	32	37	32	40	34	32	40	40
F.P	-0.79	- 0.75	- 0.68	-0.78	0.72	- 0.74	-0.65	-0.59	-0.58	-0.62	-0.52	-0.59
PH	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11

Statistical analysis

Statistical analysis was done with the use of SPSS software. Descriptive statistics (mean, median, and standard deviation) were used to add the data. A comparison of the nutritional values of cow and buffalo milk was conducted by using independent samples t-test. ANOVA was applied to compare differences in more than two groups. Correlation analysis helped in making easier the examination of the relationship between different nutritional components. These methods demonstrated the importance of proper methods of analysis in nutrition studies that confirmed significant compositional differences between milk types. ANOVA demonstrated broader variances in all the data and allowed making significant conclusions on the differences between species, the t-test was able to compare two groups.

Results

Dairy products which are products of cow milk are a staple of global diets and are valued in terms of their nutritional value. In areas with low access to dairy, other milks, including buffalo milk, that is richer in fat, protein and minerals can be used to prevent malnutrition and enhance health. Moreover, buffalo milk is very useful as an ice cream, yogurt, cheese and butter ingredient.

In 12 milk samples (6 cow's milk (CMS1-CMS6) and 6 mixed milk (MMS1-MMS6)), the fat, protein, lactose, and pH and other significant features were measured in this study. Precision was tested by using the standard deviation. The results make comparing nutritional value and quality easier. Table no.1:CMS2 contained the lowest fat content and CMS6 contained the highest with the percentage of cow milk samples varying between 3.51 and 5.13. The fat content of Mix milk samples was between 4.37 percent and 5.50 percent with the highest proportion of 5.50 percent of MMS4 and the lowest proportion of 4.37 percent of MMS3. This may imply that commercial **milk products are fortified or are standardized fat.**

Fig no: 1 The bar graph illustrates the difference in fat content of mix milk samples (MMS) and cow milk samples (CMS). The percentage of fat in MMS is always bigger than the equivalent CMS. MMS4 contained the highest amount of fat (5.5%), and CMS2 contained the lowest (3.5%). The average content of mixing milk appears to contain more fat as compared to cow milk obtained at farms.

In table no.2: Percentage of solids-not-fat (SNF) in the cow milk samples ranged between 8.84 percent (CMS3) to 10.27 percent (CMS1). In contrast, the SNF values of the samples of the mix milk were between 9.16% (MMS1) and 8.10% (MMS5). This implies that the cow milk usually contains more non-fat solids as compared to mix milk.

Fig no.2 The graph compares the Solids-Not-Fat (SNF) content of mix milk samples (MMS) and cow milk samples (CMS). The value of CMS samples is higher in comparison with the equal MMS. CMS1 included the highest number of SNF (10.3%), and MMS5 included the lowest number of SNF (8.1%).

In table no.3: Density of cow milk samples was 32.65 (CMS3) to 37.96 (CMS2). The samples of mix milk were densely varying 27.70 to 32.01 (MMS5 and MMS1). As opposed to the mix milk, which can be processed or added with water, this consistent trend suggests that the cow milk can be more compositional and less diluted.

Fig no. 3: This is a bar graph of the comparison of the density of mix milk samples (MMS) and cow milk samples (CMS). CMS is always more dense than MMS. The highest density measured was CMS2 (38.0) and MMS5 (27.7) had the lowest.

In table no.4: It was found that the level of lactose in the samples of cow milk was between 5.79 percent (CMS3) and between 6.58 percent (CMS1). The lactose content of mix milk was compared with 4.40% (MMS5 and MMS6) to 5.43% (MMS1), which was lesser to some degree. This implies that market milk samples usually have reduced levels of lactose, as compared to fresh cow milk.

Fig no: 4 The graph shows the content of lactose (in percent) of six different samples of cow milk (CMS1-CMS6) and the corresponding mix milk samples (MMS1-MMS6). CMS has a consistent lactose level as compared to MMS. CMS contains lactose (5.8 to 6.6-percent) in CMS3, CMS1 and CMS4 respectively. In comparison, MMS ranges between 5.4 percent (MMS1) to 4.4 percent (MMS5 and MMS6) instead.

Table no.5 Cow milk samples showed a salt content ranging between 0.87-0.98%, highest salt content (0.98) was observed in CMS1 and CMS4. The salt concentration in samples of mix milk was a little lower, with the range of 0.81% (MMS1) to 0.60% (MMS5 and MMS6). This implies that the CMS samples always contain more salt.

Fig no.5: In this bar graph the salt content (percent) of CMS and MMS milk samples of six groups (CMS1-CMS6 and MMS1-MMS6) is compared. In all cases CMS samples are more salty than MMS samples. MMS values decrease to between 0.8 to 0.6% whereas the CMS values range between 0.9 to 1.0. CMS5 and CMS6 have the largest difference with CMS having 0.9% salt and MMS having 0.6%.

In table no.6: Cow milk had the protein content of between 3.86 and 4.39% protein content. The proteins content of mix milk ranged between 2.90% and 3.64% (MMS1). In both classes, CMS4 is the richest in protein (4.4% in CMS and 3.3% in MMS). CMS5 and CMS6 give the lowest levels of protein in the case of CMS and MMS.

Fig no.6: This graph compares the protein composition of six different samples (CMS1-CMS6) of CMS and MMS categories. The protein content of CMS is always higher than that of MMS. CMS contains protein content of 3.6 to 4.4 whereas MMS contains protein percentage of 2.9 to 3.9.

The temperature readings, however, were more realistic in table no.7 With cow milk samples at temperatures between 32degC to 41degC, where CMS2 (41degC) and CMS5 (32degC) had the highest and lowest temperature respectively. The CMS are constantly higher in all categories than the rest.

Fig no.7: This bar graph compares the temperature of six different categories (CMS1 to CMS6) when comparing CMS and MMS. Both CMS (41) and MMS (40) show the highest temperature of CMS2. The values of MMS are between 32 and 40 whereas CMS are between 37 and 41.

Discussion

Dairy products, in particular cow milk, are fundamental to the global nutrition due to their high concentrations of both macronutrients (proteins, lipids, and carbs) and micronutrients (calcium, vitamins and minerals).

The macronutrients

Proteins: Cow milk is a complete protein containing all the nine essential amino acids that the human body cannot produce, by itself. The principal proteins are whey and caseins, which are critical in rebuilding tissues, muscle development as well as overall body performance.

Lipids (Fats): Milk fat does have fat-soluble vitamins(A, D, E, and K) and makes an excellent source of energy. It also contains essential fatty acids.

Carbohydrates: Lactose is the main carbohydrate in the form of disaccharide which assists in the absorption of calcium and phosphorous and provides a stable supply of energy.

Micronutrients:

Milk is one of the most bioavailable food sources of calcium. Calcium plays a critical role in healthy bones, teeth, transmission of nerves, and contraction of the muscles.

Vitamins: It is a significant source of riboflavin (B2) and vitamin B12, which is needed to form nerve and produce red blood cells. It is also often supplemented with vitamin D.

Minerals: Milk has zinc (which helps the body in immunological functions), potassium (which helps in blood pressure) and phosphorus (which collaborates with calcium in building bones).

Lactose intolerance is a non-allergic disorder that arises when a person lacks sufficient amounts of an enzyme called lactase that is required in the breakdown of lactose. Undigested lactose in the intestine is fermented causing gas, bloating, diarrhea, and abdominal cramping. It is extremely common, and found in large numbers among adults all over the world, particularly of East Asian, West African, Arab, Jewish, Greek, and Italian origin.

Cow's milk protein allergy (CMPA) is a true immune-mediated allergic response to a single or a combination of milk proteins--usually casein or whey. Symptoms may range as mild as hives or eczematous conditions, up to severe and possibly fatal conditions, such as anaphylaxis. Whilst it is mostly outgrown in adults, it is mostly common in infants and young children.

The aim of the study was to determine whether cow milk (CMS) and mixed milk (MMS) produced in the Pakistani area of Sargodha could be used by humans based on their nutritional profiles and the assessment of the significant physicochemical properties.

This is the hypothesis and objective of the study. It addresses a very important and overlooked issue especially in the regional context.

"Mixed Milk" (MMS), what is it? This is a very essential point. Mixed milk can refer to the act of adding water, or cheaper alternatives such as buffalo milk, or even plant-based fluids to high-cost cow’s milk in various poor countries with a view to increasing volume and profit. This is one form of economic adulteration.

Key findings:

Fat Content: Mixed milk (MMS) contained higher percentages of fats than cow milk (3.51-5.13%), which could have been due to fortification or natural changes that occur when cow milk is mixed with buffalo milk, which is higher in fat content.

Solids-Not-Fat (SNF): The nutritional superiority of cow milk was further explained by the fact that cow milk consistently contained more lactose (5.79-6.58%) and protein (3.86-4.39%) than mixed milk (4.40-5.43% lactose).

Salts and Density: Cow milk show high density values (32.65-37.96) compared to mixed milk (27.70-32.01), which means that it is not as diluteable and has more compositional integrity. Similarly, the salt concentration of cow's milk (0.87-0.98%) was higher as compared to mixed milk (0.60-0.81%).

PH: The pH of all samples were similar (0.11) and this indicates that there were no significant changes in acidity.

Implications:

The research proves that milk of cows is more nutritionally valuable in general, particularly protein, lactose, and mineral content, which is more appropriate to the growth and development.

Mixed Milk Reflections: Despite the fact that the mixed milk contained a greater amount of fat, its reduced amounts of protein, lactose, and SNF suggest that there might be some effects of dilution and processing that might dilute the nutritional potential of the product.

Industry and Public Health Perspectives: To prevent adulteration and to ensure optimum preservation of nutrients, our findings bolster the importance of close control of quality in commercial milk products. The research also highlights the importance of carrying out further research on alternative milk sources to be able to cater to the dietary restrictions without undermining the nutritional adequacy.

Conclusion

Cow milk is still healthier than mixed milk varieties when it comes to critical macronutrients and micronutrients. But to ensure that plant-based and blended milk products meet nutritional requirements, increasing demand of substitute requires improved fortification methods and legal standards. The health consequences of these substitutes in the long-term needs to be explored in future studies especially among the vulnerable populations such as newborns and individuals with special nutritional needs.

Acknowledgements

None.

Author Contributions

KH and FS planned the experiments, AA and FZ interpreted the results, NA, KA and AB made the write up and IA statistically analyzed the data and made illustrations.

Conflict of Interest

All authors declare no conflict of interest

Data Availability

Data presented in this study will be available on a fair request to the corresponding author

Ethics Approval

Not applicable to this paper

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Table no.1 fat content of CMS and MMS

	CMS 1	CMS 2	CMS 3	CMS 4	CMS 5	CMS 6	MMS 1	MMS 2	MMS 3	MMS 4	MMS 5	MMS 6
Fat	4.71 %	3.51 %	4.15 %	4.51 %	4.02 %	5.13 %	5.26 %	4.59 %	4.37 %	5.50 %	4.40 %	5.40 %

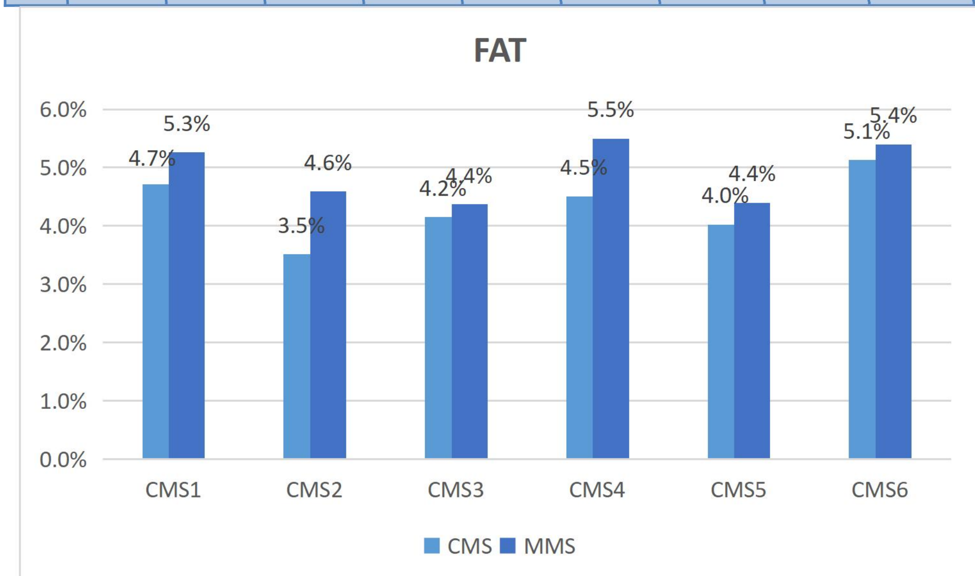
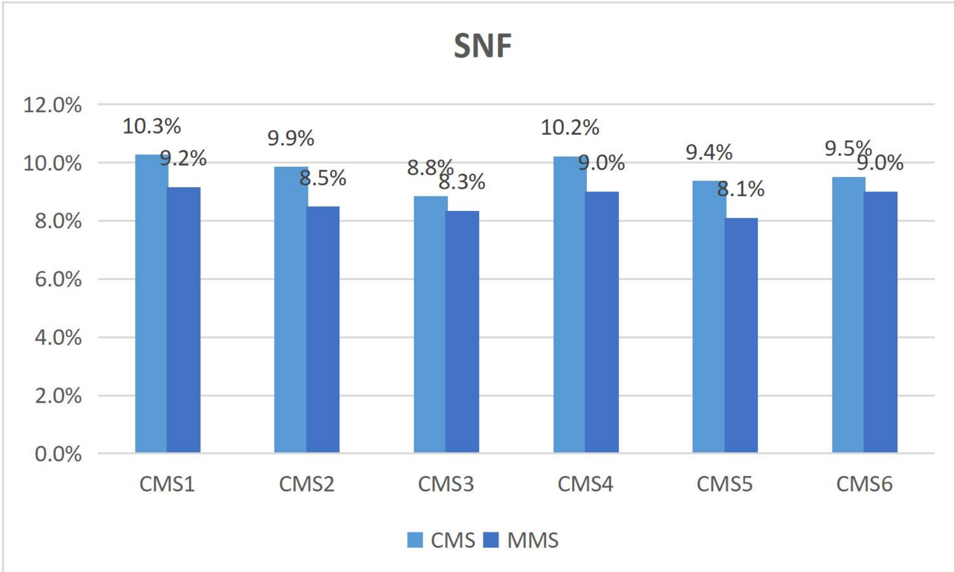


Table no.2 SNF content of CMS and MMS

	CMS 1	CMS 2	CMS 3	CMS 4	CMS 5	CMS 6	MMS1	MMS2	MMS3	MMS4	MMS5	MMS6
SNF	10.27 %	9.85 %	8.84 %	10.22 %	9.37 %	9.50 %	9.16 %	8.49 %	8.34 %	9.00 %	8.10 %	9.00 %



	CM S1	CM S2	CM S3	CM S4	CM S5	CM S6	MM S1	MM S2	MM S3	MM S4	MM S5	MM S6
Density	37.26	37.96	32.65	37.46	35.04	33.37	32.01	30.19	29.55	30.20	27.7	30.4

Table no.3 density content of CMS and MMS

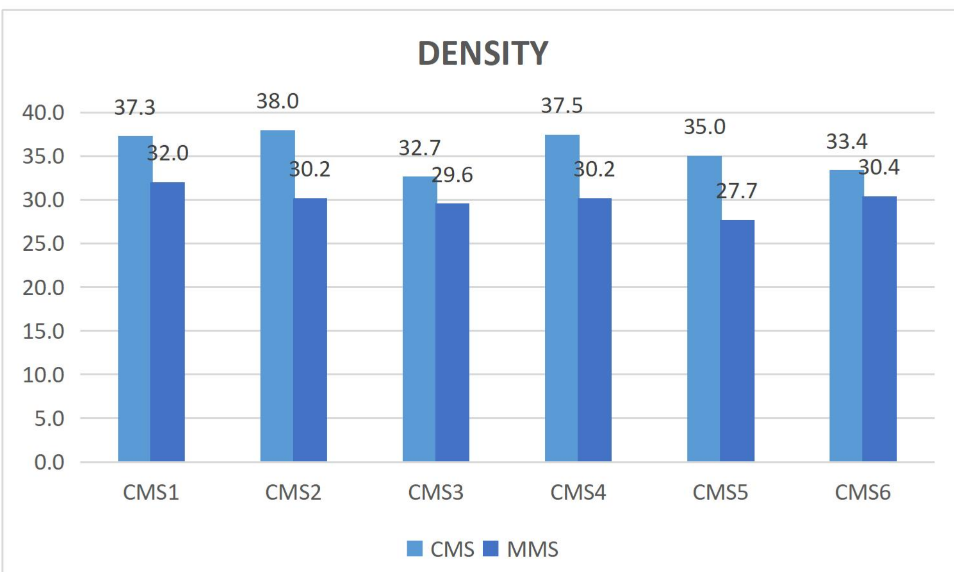


Table no.4 Lactose content of CMS and MMS

	CM S1	CM S2	CM S3	CM S4	CM S5	CM S6	MM S1	MM S2	MM S3	MM S4	MM S5	MM S6

Lactose	6.58 %	6.35 %	5.79 %	6.55 %	6.09 %	6.16 %	5.43 %	5.06 %	4.98 %	4.90 %	4.40 %	4.40 %

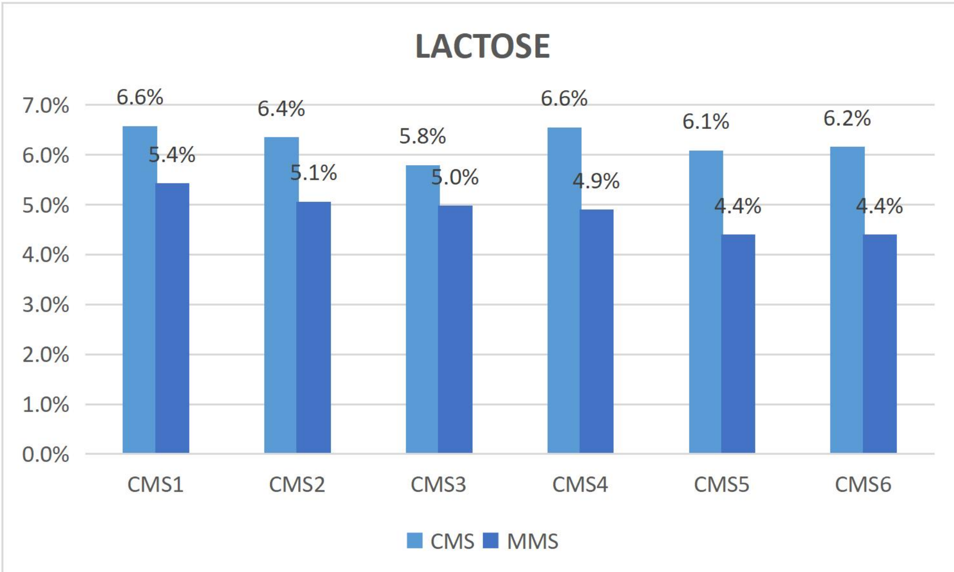


Table no.5 Salt content of CMS and MMS

	CMS 1	CMS 2	CMS 3	CMS 4	CMS 5	CMS 6	MMS 1	MMS 2	MMS 3	MMS 4	MMS 5	MMS 6
Salts	0.98 %	0.95 %	0.87 %	0.98 %	0.91 %	0.92 %	0.81 %	0.75 %	0.74 %	0.70 %	0.60 %	0.60 %

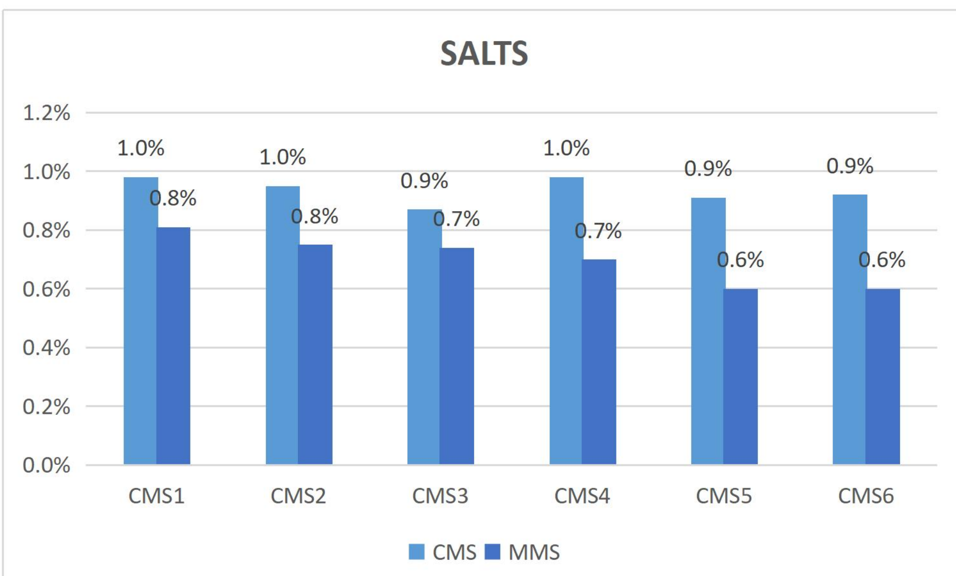


Table no.6 Protein content of CMS and MMS

	CMS 1	CMS 2	CMS 3	CMS 4	CMS 5	CMS 6	MMS1	MMS2	MMS3	MMS4	MMS5	MMS6

Protein	4.39 %	4.20 %	3.86 %	4.36 %	4.05 %	4.13 %	3.64 %	3.40 %	3.34 %	3.30 %	2.90 %	2.90 %

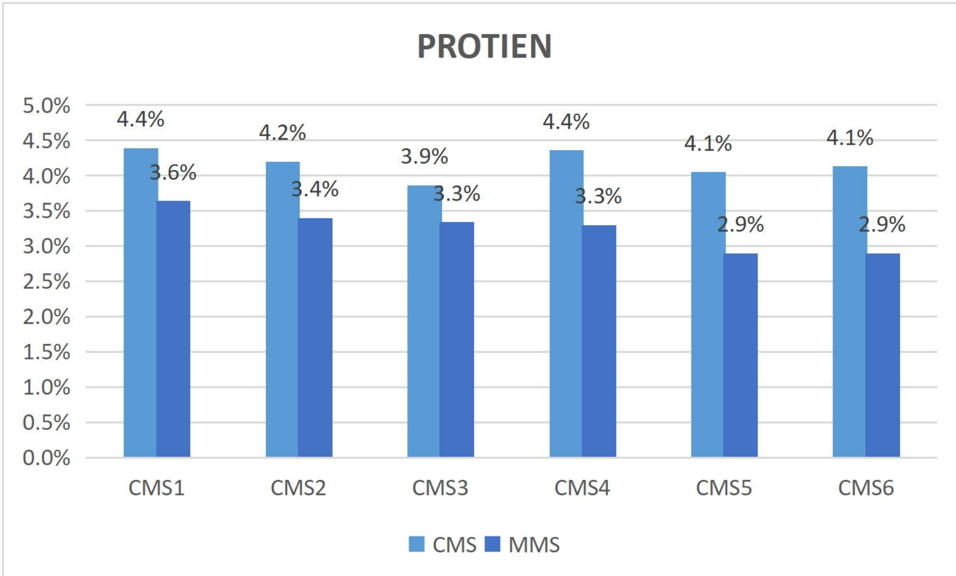


Table no.7 temperature content of CMS and MMS

	CMS 1	CMS 2	CMS 3	CMS 4	CMS 5	CMS 6	MMS 1	MMS 2	MMS 3	MMS 4	MMS 5	MMS 6
Temp	36.6	41	39	36	32	37	32	40	34	32	40	40