

MICROBIOLOGICAL ANALYSIS OF BOVINE COLOSTRUM AND ORGANOLEPTIC EVALUATION OF BOVINE COLOSTRUM RECIPES

Prajakta Jayant Nande¹

¹Assistant Professor (Sr. Gr.) in Food Science and Nutrition (Faculty of Science and Technology)

Department of Home Science, Rashtrasant Tukadoji Maharaj Nagpur University, Mahatma Jyotiba Phule
Educational Campus, Amravati Road-440033, Nagpur, Maharashtra, India

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ABSTRACT:

Bovine colostrum secreted by the cow's udder is sterile but due to its high nutrient content, it can be good growth substrate for contaminating bacteria. The aim of this study was to conduct microbiological analysis of fresh colostrum of cow, to use steamed colostrum of cow instead of paneer in Indian recipes like *burfi* and *pakoda*, to evaluate sensory quality of recipes and to calculate nutritive value of recipes. Microbial contamination can commonly originate from inside the udder, external sources, and the surfaces of equipment used in the handling and storage of colostrum. Potential risks associated with microbial contamination of bovine colostrum include foodborne diseases, reduced immune system functions, transmission of infectious diseases and decreased milk quality. For microbiological examination of cow colostrum, 15 samples of first day's colostrum from the breed of Sahiwal were taken and stored in sterile bags. These mixed colostrum samples were analyzed for *Streptococcus* spp, *Bacillus cereus*, *Staphylococcus aureus*, *Lactobacillus* spp, and *Salmonella* spp using standard procedures. Also, total plate count, spore count, coliforms and yeast was analyzed. Bacteriology for colony-forming units per gram (cfu/g) of raw bovine colostrum samples showed the presence of *Lactobacillus* spp (2.3×10^3), Moulds *Aspergillus* (<10), Total plate count (3.2×10^4), aerobic spore count (2.5×10^1), anaerobic spore count (<10), thermophillic spore count (<10), mesophillic spore count (2.5×10^1), coliform (5.2×10^3) and yeast (<10). But *Salmonella* and *Bacillus aureus* were not detected in the samples. For development of recipes like *burfi* and *pakoda*, bovine colostrum was steamed and then it was incorporated. Control recipes were prepared using paneer which was replaced by steamed bovine colostrum in experimental recipes. Products were standardized for their evenness and palatability examination was carried by six trained jurors in three trails. Nutritive value of recipes was determined. Food products designed using cow colostrum were approved for appearance, colour, doneness, texture, flavor and taste in comparison with control recipes at both 5% & 1% levels ($p > 0.05$). Bovine colostrum *burfi* received the mean scores of 9.88 for appearance, 10 for colour, 9.55 for texture, 9.77 for mouthfeel, 9.88 for flavour, 10 for taste and 9.88 for acceptability. The mean scores obtained for bovine colostrum *pakoda* included 10 each for appearance, color, texture, mouthfeel, flavor and acceptability whereas the score was 9.77 for taste. Bovine colostrum *burfi* and *pakoda* were found energy dense (309 and 404 kcal/100 g, respectively). These two products were found to be high in protein (*burfi*-13.72 and *pakoda*-7.50 g/100 g) and fat (*burfi*-22.39 and *pakoda*-37.14 g/100 g). To prevent microbial contamination of bovine colostrum, it's essential to maintain proper hygiene, careful handling, using sterile containers, washing hands thoroughly, and applying appropriate heat treatment.

INTRODUCTION:

Bovine colostrum has been valued for its nutritional and medicinal properties throughout history and across various cultures. Colostrum is the first food for mammalian newborns. Bovine colostrum is a fluid that comes from the breast of the cow the first few days after giving birth to the calf before first milk appears. Extensive research and documentation have been conducted on the nutritional advantages offered by cow's foremilk. Bovine colostrum comprises bioactive proteins such as growth factors, immunoglobulin G, lactoperoxidase, lysozyme, lactoferrin, and cytokines, believed to be advantageous for human health.^{1,2,3} In contrast to mature milk, colostrum has a much higher protein and moderately higher fat content, with substantially less lactose^{4,5}.

Historical records indicate that the use of colostrum dates back to ancient civilizations such as Egypt and India, where it was used for both nutritional purposes and as a traditional remedy for various ailments⁶.

In traditional Ayurvedic medicine, colostrum, known as “kshira”, has been used to promote general health, boost immunity, and treat conditions such as diarrhea and dysentery⁷

In European folklore, colostrum was believed to have magical properties and was used in rituals and folk medicine practices to promote fertility, protect against evil spirits, and promote healing. The potential benefits for human well-being include the inhibition of viral and bacterial pathogens, enhanced gastrointestinal health, and improved body composition.^{1,8,9} The rising popularity of colostrum products is attributed to a growing demand for functional foods and dietary supplements as an alternative to conventional drug therapies.³ In some cultures, colostrum is consumed as a culinary delicacy or ingredient in traditional dishes. In some parts of India, colostrum is used to make sweets and savory dishes. In certain cultural traditions, colostrum plays a role in rituals and ceremonies associated with childbirth, fertility, and initiation rites. It may be given to newborns as a symbol of nourishment and protection.

Being a very good origin of bioactive proteins, now a day's bovine colostrum is used in various products for human consumption.¹⁰ Immune factors, immune regulator substances and growth factors are biologically active components of colostrum.¹¹ In India, where cows are sacred, colostrum is distributed to the homes with milk and it has been used as a therapeutic remedy to treat many diseases. This custom began thousands of years ago with the activity of Ayurvedic physicians and with the so-called “holy healers”. In India colostrum sweet cake is prepared as a sweet dish in home as well in restaurants. At the end of 18th century, researches proved the benefits of colostrum on the cattle life; this was the first step for its therapeutic use in humans.¹⁰ The side effects of bovine colostrum and lactose intolerance are very less in comparison with milk.¹²

Colostrum can be contaminated by microorganisms.^{13,14} High-quality colostrum plays a crucial role in safeguarding calves from numerous diseases during the initial 4-6 weeks of their lives through the supply of antibodies. Studies indicate that promptly providing a sufficient volume of clean, high-quality foremilk after birth yields long-term advantages. Nevertheless, contamination risks increase during the collection, handling, and storage phases.¹⁵ These harmful microorganisms have the ability to attach to unbound immunoglobulins in the intestinal tract, impeding their absorption.¹⁶ Hence, it is crucial for the raw cow's foremilk employed in the production of food products for human eating to exhibit minimal bacterial presence impacting protein quality. Moreover, during preprocessing phases, it must be devoid of any pathogenic organisms. The production of top-notch colostrum relies fundamentally on the high-quality raw colostrum.

The denaturation of bioactive proteins present in cow's foremilk leads to the loss of their physiological function and the advantageous outcomes they offer. Conventional pasteurization methods have demonstrated the denaturation of numerous bioactive proteins. Consequently, alternative processing methods are often necessary when preparing colostrum for human use. Studies have indicated that heat treatment of colostrum can effectively reduce bacterial concentrations while preserving the concentration of colostrum immunoglobulins.^{17,18,19,20}

Steamed colostrum resembles paneer which is soft cheese crafted through the coagulation of milk using acid/starter and heat is widely enjoyed across South Asia. This cheese is commonly utilized in the creation of various culinary dishes and snacks. It serves as a substantial source of high-quality protein, fat, minerals, and vitamins.²¹

The objective of the current investigation was to perform a microbiological assessment of freshly obtained raw bovine colostrum and to develop recipes by using steamed bovine colostrum cake and to examine adoption indicators of these products.

MATERIALS AND METHODS:

A. Collection of Sample:

The 15 colostrum samples were taken from purposively chosen farms of Sahiwal cows). Available cows were chosen and samples were collected within 24 hours of delivery under hygienic condition. Cows were milked manually after suckling the calf. Colostrum samples were mixed thoroughly and poured in sterile bags and kept on cold pack in insulated portable ice box and carried to the testing ground. Samples were chilled and stored at -20°C for further use.

B. Microbiological Analysis of Bovine Colostrum:

A raw bovine colostrum mixed sample was taken to the ANACON laboratory for bacterial analysis. *Streptococcus* spp (SS), *Lactobacillus* spp (LS), *Staphylococcus aureus* (SA), *Bacillus cereus* (BC), *Salmonella*, *Aspergillus* spp, Total Plate Count (TPC), Spore count (Aerobic spore count, anaerobic spore count, thermophillic spore count, and mesophillic spore count), coliform and yeast were analyzed. The investigation was conducted at ANACONLABS (Anacon Laboratory Pvt. Ltd, Nagpur, India- **ISO 9001:2008 Certified** Organization, recognized by **Ministry of Environment & Forests (MoEF)**, New Delhi, India, accredited by **National Accreditation Board for Testing & Calibration Laboratories (NABL)** for complying with International Standard IS-17025 in various categories including the categories of '**Water, Food, Coal/coke, Ores**' & accredited by **Quality Council of India (QCI)** for conducting environmental studies, **Bureau of Indian standards (BIS) & Food safety (FSSAI, Govt. of India)**). *Streptococcus* spp. and *Staphylococcus aureus* were performed with the IS 5887 (Part II):1976 guidelines. For *Lactobacillus* spp. ISO 20128:2012 method was used. *Bacillus cereus* and Spore counts were analysed by using Bacteriological Analytical Manual (BAM) method. To determine *Salmonella* IS 5887 (Part III):1999 protocol was used.²² A mould *aspergillus* was enumerated with IS 5403:1999 method.²³ IS 5402:2012 standards was used to isolate total plate count.²⁴ Coliform and Yeast were determined by IS 5401 (Part I):2012²⁵ and IS 5403:1999²³ respectively.

For microbiological analysis, dilution, plating, and microbial count methods were utilized. Briefly, *Streptococcus* spp was obtained on the ethyl violet azide dextrose agar, the *Lactobacillus* spp was obtained on MRS/Clindamycin/Ciprofloxacin agar, *Staphylococcus aureus* on Biard-Parker agar, which were incubated at 37°C for 48 hours, 72 hours and 30 hours respectively. Bovine colostrum sample was incubated for 18-24 hours at 30°C in Mannitol- Egg Yolk Polymyxin agar to enumerate *Bacillus cereus*. For detection of *Salmonella*, the sample inoculates in a phenol red/brilliant green agar and incubates at 35°C or 37°C. The dish is subsequently examined either after a full day or following a 48-hour incubation period, as deemed necessary. This examination is essential to ascertain the potential presence of colonies that, based on their distinctive characteristics, are identified as presumptive *Salmonella*. *Aspergillus* spp and yeast were introduced onto 15 ml of yeast extract-dextrose chloramphenicol agar medium (previously liquefied) and allowed to cultivate at a temperature of 25°C for duration of 5 days. Then to measured total plate count and spore count in bovine colostrum plate count agar was used and kept in the incubator at 30°C ± 1°C for 72 h ± 3 h. For analysis of coliform violet red bile agar medium was used at incubated at 30°C, 35°C and 37°C for 24 h ± 2 hours.

C. Preparation, Standardization and Sensory Evaluation of Recipes:

1. Preparation of Paneer and Steamed Bovine Colostrum

For this study, control recipes namely paneer *burfi* and paneer *pakoda* were standardized. Experimental recipes were prepared by replacing paneer with fresh bovine colostrum steamed cake and comparisons were done for sensory attributes. Perishable items were purchased fresh whereas non perishable ingredients were purchased in greater quantity. Similar to cottage cheese, an indigenous coagulated milk product is created by introducing organic acid or a starter to milk at elevated temperatures. Paneer is widely added into a variety of culinary dishes and snacks. For control recipes paneer was prepared from raw cow's milk. The processes of preparation of paneer and steamed bovine colostrum cake are given in Figure 1 and 2, respectively.

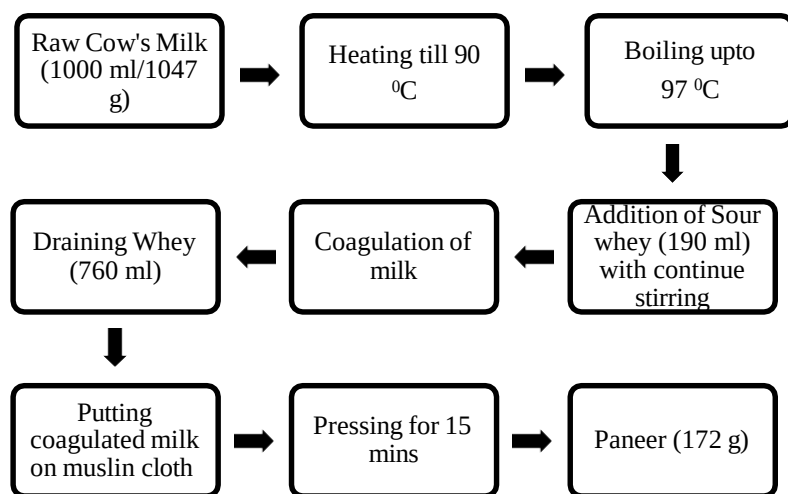


Figure 1: Flow Chart for Paneer Preparation

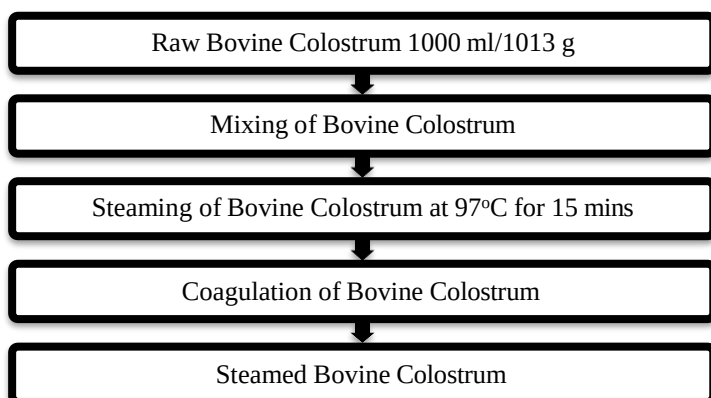


Figure 2: Flow Chart for Preparation of Steamed Bovine Colostrum

2. Composition of *Burfi* and *Pakoda*

In India, bovine colostrum is consumed in the form of smooth junket called as “Kharvas/Junnu/Ginnu”, which is prepared by steam cooking of the mixture of colostrum, sugar, cardamom powder and saffron.²⁶ Many people avoid this sweet due to its typical taste and flavour. Therefore, an attempt was made to prepare steamed colostrum *burfi* by using different methods. *Burfi* is dense milk based sweet from the Indian subcontinent which is typically flavoured with cardamom and nuts. For the present study, standard methods of preparation for paneer *burfi* and paneer *pakoda* were followed. Table 1 shows the composition of control and experimental *burfi*.

Table 1: Ingredient Composition for *Burfi*

Sr. No.	Ingredients	Quantity (g)	
		Paneer <i>Burfi</i>	Colostrum <i>Burfi</i>
1	Paneer	35	-
2	Steamed Colostrum	-	35
3	Coconut (fresh)	15	15
4	Milk Powder	15	15
5	Powdered Sugar	10	10
6	Ghee	10	10
7	Cardamom Powder	0.5	0.5

Pakoda, also called pakora, pakodi, or ponako, is a fried snack and is found across South Asia especially in India. *Pakoda* is a generic term used for deep fried fritters. Mostly, flours like gram flour, rice flour or corn flour are used for coating the veggies, paneer, cheese, egg etc and then they are deep fried in oil. *Pakoda* gets its name from the substance which is used to make it like potato *pakoda*, onion *pakoda*, spinach *pakoda*, paneer *pakoda*, egg *pakoda* etc. Table 2 shows the composition of control and experimental *pakoda*.

Table 2: Ingredient Composition for Pakoda

Sr. No.	Ingredients	Quantity (g)	
		PaneerPakoda	ColostrumPakoda
1	Paneer	35	-
2	Steamed Colostrum	-	35
3	Bengal Gram Flour	20	20
4	Onion	20	20
5	Coriander Leaves	5	5
7	Green Chillies	5	5
8	Omum	1	1
9	Turmeric Powder	1	1
10	Baking Soda	0.5	0.5
11	Oil	42.5	47.5
12	Salt	3	3

3. Sensory Evaluation of Recipes

Palatability judgment of colostrum *burfi* and colostrum *pakoda* was carried out in comparison with paneer burfi and paneer pakoda. The delectability of the products was ranked three times by six examiners for looks, tinge, palate, mouth feel, taste and adequacy.

Trained panelists (females, age 40-50 yrs) were chosen from Food Science and Nutrition Department of Rashtrasant Tukadoji Maharaj Nagpur University, Maharashtra, India. The panel was involved in the tasting procedures from last ten years. They were free from any disease condition like cough and cold, or allergies and they did not have any food preferences or dislikes.

Recipes were coded and presented to the panelists one by one in a confidential manner to avoid biased judging. Recipes were graded using four stages ranking from highest score of 10 to lowest score of 4 for all sensory traits (very good for score 10, good for score 8, fair for score 6 and poor for score 4).²⁷

D. Calculation of Nutritive Value of Control and Experimental Recipes:

The nutritional value of both control and experimental recipes was determined utilizing Indian Food Composition Tables.^{28,29} Nutritive value of bovine colostrum was referred.³⁰

E. Statistical Analysis:

Differentiation of colostrum *burfi* and *pakoda* was done with paneer burfi and pakoda for palatability factors using student's 't' test. The level of significance was kept at the levels of 1% and 5%.

RESULTS AND DISCUSSION:

1. Microbiological Analysis of Fresh Bovine Colostrum:

Table 3 demonstrates bacteriological quality of fresh bovine colostrum.

Table 3: Bacteriological Quality of Fresh Bovine Colostrum

Sr. No.	Microorganisms	Microbial Load(CFU/g)
1	<i>Streptococcus</i> spp	Present in very minor amount (very low read number)
2	<i>Lactobacillus</i> spp	2.3×10^3

3	<i>Staphylococcus aureus</i>	Present in very minor amount (very low read number)
4	<i>Bacillus cereus</i>	ND
5	<i>Salmonella</i>	ND
6	<i>Aspergillus</i> spp	<10
7	Total plate count (TPC)	3.2×10^4
8	Spore count	
	Aerobic spore count	2.5×10^1
	Anaerobic spore count	<10
	Thermophillic spore count	<10
	Mesophillic spore count	2.5×10^1
9	Coliform	5.2×10^3
10	Yeast	<10

ND- Not Detected

Colostrum could be a vehicle for some pathogens for animal and/or human health.³¹ In this study, the result reveals that raw bovine colostrum sample was found to be containing *Streptococcus* spp but in very minor amount (very low read number). Lima, *et al.* (2017)³² also found *Streptococcus* spp in bovine colostrum in their study; whereas Conte (2012)¹¹ collected 234 samples for his study and found that 48 (20.5%) samples were contaminated by *Streptococcus* spp. Elizondo-Salzaaret *al.* (2009)²⁰ investigated the impact of heat treatment on bacterial counts in samples of bovine colostrum. For that bovine colostrum samples were heated for 0, 30, 60 and 90 minutes at 57° C, 60° C and 63° C in preheated water bath and stated that all this treatment reduced the activity of *Streptococcus* spp. Therefore, proper heat treatment is necessary before using bovine colostrum. The present study analyzed only raw bovine colostrum samples for microorganisms.

The initial secreted milk is rich source of nutrients, growth factors as well as it has antimicrobial substances.³³ Bovine colostrum contains valuable probiotics like *Lactobacillus* and *Bifido bacterium* strains.³⁴ For the present study, *Lactobacillus* spp which is useful for fermentation was found to be present in fresh bovine colostrum and the reported value was 2.3×10^3 cfu/g.

Lactobacillus spp has the potential to be effective in treating or preventing diarrheal diseases, acting as an adjuvant for vaccines, averting rotavirus-induced diarrhea, mitigating milk-related allergic reactions, and offering protection against alcohol-induced liver disease and colon cancer.³⁵ which mean that the presence of *Lactobacillus* in bovine colostrum can be good for health.

The bacteria namely *Staphylococcus aureus* is often rooted in the upper airway and on the cuticle which is a gram-positive, round-shaped bacterium and is a member of the firmicutes.³⁶ Here, in raw bovine colostrum sample, *Staphylococcus* spp was found to be present but in very minor amount (very low read number). The presence of *Staphylococcus aureus* in bovine colostrum was 306 CFU/ml as reported by Houseret *al.* (2008).⁹ Conteet *al.* (2013)¹¹ also studied on quality of bovine colostrum and found low levels ($2.82 \log_{10}$ CFU/ml) of *Staphylococcus aureus*. A low *Staphylococci* count could be related to the colostrum defense activity.¹⁰ It is affirmed that employing the conventional pasteurization times and temperatures of milk on bovine colostrum can effectively diminish or eliminate *Staphylococcus aureus*¹⁴ but McMartinet *al.* (2006)³⁶ stated that this practice has some drawbacks like denaturation of IgG and changes in viscosity and suggested that colostrum could undergo a process of heating to 60°C for up to 120 minutes maintaining both viscosity and IgG concentration unchanged. Elizondo-Salzaaret *al.* (2009)²⁰ stated that thermal processing of bovine colostrum at 60°C for 30 and 60 minutes reduced the *Staphylococcus aureus* activity without any changes in protein and viscosity.

Salmonella spp has been extracted from fresh milk and researchers analyzed colostrum samples for pathogenic organisms and *Salmonella* spp and they found 15% colostrum samples showed *Salmonella*

spp (out of 55 samples).³⁰ The results are concerning and indicate that inadequately pasteurized colostrum products might pose a risk of *Salmonella* exposure, potentially representing a public health concern. For the present study, *Salmonella* was not detected during analysis. Conte and Scarantino (2013)¹¹ also reported the absence of *Salmonella* spp. In the finding of the present research, *Salmonella* spp was not found, which was a positive result and it may be due to proper care taken during collection of colostrum samples, handling and storage of bovine colostrum samples.

Bacillus cereus is a rod-shaped, gram-positive bacterium that can thrive in aerobic or facultatively anaerobic conditions. With motility and the ability to form spores, it is ubiquitously distributed in the environment. While *Bacillus cereus* is commonly linked to foodborne illnesses, there is a growing trend in reporting its involvement in severe and potentially lethal infections beyond the gastrointestinal tract.³³ *Bacillus* spp was not detected in the raw colostrum sample under present research (Table 5). Fecteau, *et al.* (2002)³⁸ collected 234 samples for bacterial contamination study and reported that *Bacillus* species was isolated in 36 (15.4%) samples out of 234 from 6 herds.

Aspergillus genus of moulds is crucial, being highly prevalent, and its species play a role in causing food spoilage and mycotoxin production. Because of a strong correlation between the presence of mould *aspergillus* spp and the occurrence of mycotoxin³⁹, it is important to search for the presence of mould *Aspergillus* before it is used for calf feed as well as for human consumption. For the present research, *Aspergillus* was found to be less than 10 CFU/g.

Total plate count (TPC) stands as one of the pivotal criteria for determining the quality of bovine colostrum. TPC should not exceed 100000 CFU mL⁻¹ (>5 log CFU mL⁻¹) (European Commission, 2006). Prior research has indicated varying counts of microorganisms in colostrum, spanning from 1.4 to 7.0 log CFU mL⁻¹⁴⁰, from 3.0 to 6.8 log CFU mL⁻¹⁴¹, from 5.4 to 7.2 log CFU mL⁻¹⁴², from 1.86 to 11.02 log CFU mL⁻¹⁴³ and from 3.97 to 5.90 log CFU mL⁻¹⁴⁴. For the present research, the TPC was found to be 3.2 x 10⁴CFU/g (32000)CFU/ml, which was well below the recommended industry standard of < 1.0 × 10⁵CFU/ml (100,000 CFU/ml). The study by Stewart *et al.* (2005)¹⁵ established control measures to minimize bacterial contamination in bovine colostrum. It identified that the most efficient treatment involved employing potassium sorbate preservative in refrigerated samples. This approach led to a significant reduction in both total plate count (TPC) and total coliform counts, maintaining a consistent level over the 96-hour storage period. Use of potassium sorbate in bovine colostrum may prevent TPC and coliform activity and can improve the quality of bovine colostrum.

Spore forming bacteria pose a significant challenge to the dairy industry as they predominantly infiltrate the dairy product chain at the farm level, withstand processing obstacles, and subsequently proliferate in the finished products.⁴⁵

For this present study, aerobic spore count was 2.5 x 10¹cfu/g and anaerobic spore count was less than 10 cfu/g. Conte and Scarantino (2013)¹³ reported that the psychrophillic aerobic count was very high (6.51 log 10/ml) but anaerobic bacteria was absent in their samples which suggests that lack of hygiene in farm environment. Very high psychrophillic aerobic count cannot be neglected, moreover, deep freezing of bovine colostrum gives significant results to reduced aerobic spore count in bovine colostrum, and care should be taken during thawing.

Studies are not done exclusively on mesophillic and thermophillic spore count. For the present research, mesophillic spore count from bovine colostrum was found to be 2.5 x 10¹ cfu/g and thermophillic spore count isolated from bovine colostrum was very low (<10 cfu/g).

Kent *et al.* (2016)⁴⁶ studied mesophillic and thermophillic spore count in raw milk and found that mesophillic and thermophillic spore counts were present in raw milk as well as in dairy powders. Fecteau *et al.* (2002)³⁸ studied bacterial contamination of bovine colostrum and reported that coliforms were found in 103 samples out of 234 samples. As per the statement of Elizondo-Salazar (2009)²⁰, coliforms are important calf pathogens and should be present as low as possible in colostrum. In the present study, coliform count was found to be high (5.2 x 10³CFU/g). Houser *et al.* (2008)⁹ also reported high values

323,372 CFU/ml of coliform counts in bovine colostrum. The presence of coliforms poses health risk to the animal as well as the newborn calf and may contaminate the milk samples also, thereby bringing down the quality of the milk (Pavithra *et al.*, 2018)⁴⁷.

In milk and dairy products, growth of yeast is undesirable (Buchi and Seiler, 2011)⁴⁸. The presence of these microorganisms can lead to spoilage of bovine colostrum. In the present study, it is observed (Table 3) that the yeast count was <10 cfu/g which was within maximum recommended industry standard. Santos *et al.* (2017)⁴³ reported lesser yeast count (1.3 CFU/ml, 1.7 CFU/ml and 1.7 CFU/ml for <200 L, 201-700 L and >700 L of daily milk yielding cow's colostrum) in bovine colostrum. Fecteau *et al.* (2002)³⁸ also studied 234 samples of bovine colostrum for bacteriological analysis and found that only 2 samples (0.8%) were contaminated by yeast.

Elizondo-Salazar *et al.* (2009)²⁰ documented that subjecting bovine colostrum to heat treatment at 60 °C for either 30 or 60 minutes resulted in a decrease in bacterial count, a marginal reduction in IgG concentration, and had no impact on viscosity. If colostrum is processed properly, and it can be making microbes free and can used safely for human consumption. In this study, bovine colostrum was steamed first and then it was incorporated into different food preparation.

2. Sensory Evaluation of Control and Experimental Recipes:

Bovine colostrum is a versatile ingredient used in various food products due to its high protein, fat, and antibody content. Sensory properties such as taste, texture, and aroma are critical in determining consumer acceptability of colostrum-based recipes.⁴⁹

The incorporation of flavors, sweeteners, and other ingredients can enhance the organoleptic properties of colostrum products. For instance, blending colostrum with fruit flavors has shown to improve its taste and acceptability among consumers.⁵⁰ For the present research, control *burfi* and *pakoda* were produced using paneer. Colostrum *burfi* and *pakoda* were prepared using steamed bovine colostrum cake. Control *burfi* and *pakoda* were compared with experimental *burfi* and *pakoda* for their sensorial quality and the results are shown in Tables 4 and 5, respectively.

Table 4: Sensory Evaluation of Control and Experimental Burfi

Sr.No.	Perceptual Attributes	Burfi		“t” Values
		Control (Paneer)	Experimental (Colostrum)	
1	Appearance	9.66	9.88	0.95
2	Colour	9.77	10	1.43
3	Texture	9.22	9.55	0.56
4	Mouthfeel	9.77	9.77	0
5	Flavour	10	9.88	1.09
6	Taste	9.88	10	1.09
7	Acceptability	9.33	9.88	2.11

The t-values suggest a lack of significant difference at both the 5% and 1% significance levels ($p > 0.05$).

Table 5: Sensory Evaluation of Control and Experimental Pakoda

Sr.No.	Perceptual Attributes	Pakoda		“t” Values
		Control (Paneer)	Experimental (Colostrum)	
1	Appearance	10	10	0
2	Colour	10	10	0
3	Texture	9.88	10	1.09
4	Mouthfeel	10	10	0
5	Flavour	10	10	0
6	Taste	10	9.77	1.43
7	Acceptability	9.88	10	1.09

The t-values suggest a lack of significant difference at both the 5% and 1% significance levels ($p > 0.05$).

In India, *burfi* is the most popular milk based sweet. *Burfi* made of milk, khoa, paneer, legumes flour & many other ingredients are highly relished by a large segment of people and are an integral part of all the festive occasions.^{51,52} *Burfi* is a dense milk solid based sweet Indian confectionary. For this research, control *burfi* was prepared using paneer. There were insignificant differences noted between paneer *burfi* and bovine colostrum *burfi* for appearance, colour, texture, mouthfeel, flavour, taste, acceptability ($t = 0.95, 1.43, 0.56, 0, 1.09, 1.09$ and 2.11 respectively, $p > 0.05$). Colostrum *burfi* was rated higher than paneer *burfi* for appearance (mean scores: 9.88 and 9.66, respectively), colour (mean scores: 10 and 9.77, respectively), texture (mean scores: 9.55 and 9.22, respectively) and taste (mean scores: 10 and 9.88, respectively) which yielded higher acceptability for it (mean scores: 9.88 and 9.33, respectively). The acceptability of the *burfi* can further be enhanced by adding dry fruits and nuts. It can be made even more attractive by adding colour or pulps of fruits or by making layers of different colours and flavours.

Pakoda is a popular snack across the Indian subcontinent. It is noted that there were no notable distinctions between the control and experimental *pakoda* concerning attributes such as appearance, color, doneness, texture, flavor, taste, and overall acceptability ($t = 0, 0, 1.09, 0, 0, 1.43$ and 1.09 , respectively, $p > 0.05$). From Table 5, it can be observed that aside from the taste (mean score: 9.77), all other studied sensory attributes of colostrum *pakoda* received perfect mean scores of '10' which is definitely encouraging to use this miracle food in popular recipes for human consumption. Paneer *pakoda* was found to be slightly crumblier whereas the texture of colostrum *pakoda* was moist and its mouthfeel was smooth.

Research on development and sensory evaluation of bovine colostrum recipes are very meager. Barthkeine *et al.* (2017)⁵³ prepared antimicrobial gummy candies with the use of bovine colostrum and reported that it was highly acceptable with desired antimicrobes. Another study was done on khees prepared from cow and buffalo colostrum by Poonia and Dabur (2012)⁵⁴ and they reported that cow khees scored higher for all sensory attributes than buffalo khees. This may be due to the fact that cow khees had soft and silky texture and nutty flavour while buffalo khees had rough and coarse, chewy body and texture.

3. Nutritive Value of Control and Experimental *Burfi* and *Pakoda*:

Nutritional values for both the control and experimental variations of *burfi* and *pakoda* were computed and are displayed in Tables 6 and 7, respectively. The fundamental variance in the nutritional content of the control and experimental *burfi* stemmed from the differing nutritional profiles of paneer and bovine colostrum.

Table 6: Nutritive Value of Control and Experimental *Burfi*

Sr. No.	Nutrients	BURFI			
		Control (Paneer)		Experimental (Colostrum)	
		Total (85.5 g)	Per 100 g	Total (85.5 g)	Per 100 g
1	Energy (kcal)	309	361	264	309
2	Carbohydrate (g)	14.7	17.19	11.26	13.17
3	Protein (g)	13.3	15.56	11.73	13.72
4	Total fat (g)	21.9	25.61	19.14	22.39

From the Table 6, it is observed that energy value of bovine colostrum *burfi* did not differ widely however, all three energy yielding nutrients in bovine colostrum *burfi* was found to be less than that of paneer *burfi*.

Table 7: Nutritive Value of Control and Experimental Pakoda

Sr. No.	Nutrients	PAKODA			
		Control (Paneer)		Experimental (Colostrum)	
		Total (133 g)	Per 100 g	Total (138 g)	Per 100 g
1	Energy (kcal)	556	418	557	404
2	Carbohydrate (g)	16.71	12.56	13.24	9.59
3	Protein (g)	11.75	8.83	10.35	7.50
4	Total fat (g)	49.12	36.93	51.25	37.14

It was noted that oil absorption was higher in *pakoda* made out of colostrum. Very minor differences were noted for energy and energy giving nutrient content of paneer and colostrum *pakoda*.

Conclusion

In general, bovine colostrum is safe and well tolerated. The bacterial quality of raw colostrum cow alone can significantly impact the bioactive protein quality in bovine colostrum. It is concluded that gathering, picking up, storage and heating of bovine foremilk reduce the bacterial contamination of bovine colostrum. Two paneer recipes namely, *burfi* and *pakoda* were replaced by steamed bovine colostrum and analyzed for their sensory attributes which were highly acceptable. It is concluded that steamed bovine colostrum can be successfully incorporated in common Indian recipes like *burfi* and *pakoda* without affecting their palatability. Use of other ingredients in making these recipes is helpful in adding and enhancing the flavor and taste. Future research can be carried out to see the practical implications of use of bovine colostrum on large scale. Also, effect of bovine colostrum on health status of population can be studied. Potential impact of bovine colostrum can be studied on different groups like children, elderly, malnourished people, and athletes. However, the evidences that bovine colostrum is safe and well tolerated are required. A thorough safety assessment is needed for potential allergenic reactions, long-term side effects and contraindications.

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