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Evaluation of Physical, Chemical, and Microbial Quality of Toned Milk Available in Bangladesh Market

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ABSTRACT

Toned milk has been gaining popularity in Bangladesh day by day, but its qualities are yet to be evaluated. The study was conducted to assess the qualities of toned milk of the available brands (Brand A, Brand B, and Brand C) in the local markets of Bangladesh. The physical quality including color and appearance, odor, flavor, and body was evaluated by expert panel members comparing them to the Bangladesh Institute of Standards (BIS). The chemical parameters including acidity, lactose, fat, solids-not-fat (SNF), total solids (TS), and protein contents were evaluated. The microbiological parameters, we evaluated, were the total viable count (TVC) and coliform count of toned milk from different brands. The organoleptic tests revealed toned milk from Brands A and C as good quality (overall score >80), but that from Brand B as fair quality (overall score = 73). The specific gravity, SNF, and TS varied significantly between different brands of toned milk ($P < 0.05$). The highest specific gravity was in Brand A and Brand C toned milk (both 1.031) and the lowest in Brand B toned milk (1.030). The SNF content was the highest in Brand A toned milk (8.974) and the lowest in Brand B toned milk (8.529). The TS content was the highest in Brand A toned milk (12.174) and the lowest in Brand B toned milk (11.729). However, the specific gravity, SNF and TS were within the BSTI standards range. The fat, acidity percentage, protein, casein and lactose content did not differ significantly ($P > 0.05$), and possessed a good quality based on the BSTI standards. There were highly significant differences among the total viable count of bacteria of different brands of toned milk ($P < 0.01$), but the values were within BSTI standards. No coliforms were detected, indicating that good sanitary measures were adopted during manufacture and storage.

Keywords: Chemical, Coliform, Microbial, Physical, TVC

INTRODUCTION

Milk is widely regarded as a complete food, offering an essential source of nutrients such as proteins, fats, carbohydrates, vitamins, and minerals (Scholz-Ahrens et al., 2020). It plays a crucial role in the daily diet of people of all ages, particularly children, pregnant and lactating women, and the elderly (Marshall et al., 2022). Among various dairy products, toned milk has emerged as a popular choice, especially in urban areas (Rameshkumar et al., 2018). It is produced by diluting whole milk with skim milk and water, resulting in a product that contains lower fat while maintaining an acceptable level of essential nutrients

(Kailasapathy et al., 2015). This makes toned milk a cost-effective alternative to full-cream milk, particularly for middle- and lower-income populations (Silla, 2023). The increasing demand for this form of milk reflects consumer preferences for affordable yet nutritionally adequate dairy options (Bimbo et al., 2017).

Despite its benefits, the quality and safety of toned milk remain a pressing concern (Fusco et al., 2020). Milk is highly perishable and can be easily contaminated if not handled, processed, or stored under hygienic conditions (Singhal et al., 2020). It also provides an excellent medium for the growth of various microorganisms, including harmful pathogens, which can lead to foodborne illnesses (Singhal et al., 2020). Alongside microbial contamination, issues such as adulteration, poor handling, and deviations from standard processing techniques can adversely affect the physical (e.g., color, consistency, and flavor) and chemical (e.g., fat content, solids-not-fat, acidity, and pH) properties of milk (Chandan, 2015). In Bangladesh, the availability of toned milk is increasing in both packaged and unpackaged forms (Nur et al., 2021). However, concerns about quality control persist (Nur et al., 2021). Although national regulatory bodies like the Bangladesh Standards and Testing Institution (BSTI, 2021) have established guidelines for milk quality, their enforcement is often challenged by limited infrastructure, inconsistent monitoring, and inadequate cold chain management (Jensen et al., 2016). Consequently, milk quality can vary significantly across brands and locations, putting consumer health at risk (Karmaker et al., 2019).

Previous studies conducted in other South Asian countries have revealed considerable discrepancies between labelled and actual nutritional content in toned milk, along with microbial counts exceeding permissible limits. However, in the context of Bangladesh, comprehensive studies evaluating the overall quality of toned milk are scarce. Existing research has either focused on a narrow range of parameters or been limited to specific geographic areas. Hossain et al. (2011) found that raw and processed market milk in Bangladesh often failed to meet standard chemical and microbiological quality, highlighting issues of contamination and adulteration. Das et al. (2015) evaluated the microbial load in milk and milk-based dairy products in Bangladesh, revealing high levels of contamination that raise concerns about hygiene practices in milk processing and handling. Senthilkumar et al. (2023) showed that protein nanofibrils can enhance the nutritional value of toned milk in India without affecting its sensory or physicochemical properties. Arif et al. (2020) analyzed raw milk samples from dairy farms and urban areas in Lahore, Pakistan, revealing issues with adulteration, high microbial load, and the presence of heavy metals, indicating serious public health concerns.

However, the physical, chemical, and microbial qualities of toned milk of various brands in Bangladesh are still yet to be known. It is hypothesized that various producers of toned milk in Bangladesh are maintaining the standard of market toned milk. In Bangladesh, toned milk is produced by Bangladesh Milk Producer’s Cooperative Union Limited, Aarong Dairy, Pran Dairy Limited, and Akij Dairy Limited introduced to the country in 2021, toned milk is designed to be cost-effective while maintaining nutritional values similar to whole milk, except for a reduced fat content. This makes it an accessible option for low-income individuals seeking to meet their protein needs.

Monitoring the quality of toned milk is essential for safeguarding consumer health, ensuring product integrity, and building public trust in the dairy sector (Haldar et al., 2022). It is also vital for regulatory agencies and manufacturers to identify lapses in the production or distribution chain and implement corrective measures (Montgomery et al., 2020). With milk being a staple in the diets of children and vulnerable populations, any compromise in its safety or nutritional value can have serious health implications (Handford et al., 2016). A holistic approach that simultaneously examines physical, chemical, and microbial characteristics across various brands and distribution points is critically needed.

This study was therefore designed to evaluate the quality of toned milk currently available in the Bangladeshi market. The specific objectives were to: (i) assess the physical characteristics of toned milk, including visual appearance, odor, and consistency; (ii) analyze chemical properties such as fat content, solids-not-fat (SNF), protein concentration, pH level, and titratable acidity; and (iii) investigate microbial quality by measuring total viable bacterial count and detecting the presence of coliform bacteria.

MATERIALS AND METHODS

Sample collection, sample designing, and location of the study

In Bangladesh, milk is commonly distributed through two methods. In the first scenario, farmers transport milk in open containers and directly sell it in the market without undergoing any processing or packaging. Alternatively, in a different approach, milk companies gather milk from farmers or dairy farms, subject it to pasteurization or UHT treatment, and subsequently package the processed milk. This packaged milk is then made available for purchase in stores under designated brand names. In this study, pasteurized toned milk samples were collected from various shops and transported the samples from shops to the laboratory by a cool box. Samples were chosen randomly based on batch and date of production. A total of 18 samples were collected. Among the samples, there were 6 samples each of three renowned brands of Bangladesh which we named Brand A, Brand B, and Brand C. Six samples of Brand C were tagged as M1, M2, M3, M4, M5, and M6. Six samples of Brand B and Brand A tagged as F1 to F6 and A1 to A6 respectively. Samples were preserved for a short time at 4^0C temperature. All the quality tests were performed at the Dairy Science Lab and Poultry Research and Training Centre (PRTC), CVASU.

Organoleptic Tests

The assessment of milk products involves a sensory examination using sight and smell to evaluate and document overall quality. This initial and fundamental test serves as the primary method for assessing the characteristics of milk and its various products. However, it is essential to supplement this test with additional laboratory analyses. The sight and smell evaluation (color and appearance, odor, flavor, body) is conducted promptly after opening the packets according to (Deka, 2020; FSSAI and ILRI, 2020).

Taste Panel Score

A team of experts assessed the sensory quality of each toned milk sample through organoleptic evaluation using a scoreboard recommended by the Bureau of Indian Standards (BIS). Tested milk was graded according to quality measures as suggested by BIS.

Determination of Specific Gravity

Specific gravity was determined by the conventional method using a lactometer described in (Deka, 2020; FSSAI and ILRI, 2020). Briefly, the samples were mixed thoroughly, poured into a dry cylinder which

enables the lactometer to float without touching the sides. Then, the lactometer was put into the lactometer jar and allowed to remain steady. The lactometer reading was taken as soon as it became stationary around within 20-30 seconds. Later the corrected lactometer readings, followed by the specific gravity of the samples were calculated using this calculation:
Corrected Lactometer Reading (CLR) = Lactometer reading ± (temperature of milk - 60) × 0.1
Specific gravity = (CLR/1000) + 1

Chemical Evaluation
Fat percentage determination

Fat% was determined by the Traditional Gerber centrifuge approach according to (Deka, 2020; FSSAI and ILRI, 2020). Briefly, 10 ml sulfuric acid was taken in a Gerber lactometer using a pipette. Then, 10.75 ml well-mixed milk sample was added to the butyrometer, followed by 1 ml amyl alcohol was added. The cork of the butyrometer was closed, and the contents were mixed properly. Later, the butyrometer was put into the centrifuge machine, and the content was centrifuged at 1100 rpm for 5 minutes. Finally, the reading of fat percentage was taken.

SNF percentage and Total solids (TS) percentage determination

SNF refers to the non-fat solid components in milk, excluding the fat content. It was determined by the conventional method using a lactometer described in (Jagdish and Neeraj, 2008; Deka, 2020; FSSAI and ILRI, 2020). Firstly, collected and marked milk samples were mixed thoroughly by hand. Then, the properly mixed milk was poured into a dried measuring cylinder which enabled the lactometer to float without touching the periphery. Secondly, let the lactometer be flown into the cylinder. The lactometer was allowed to remain steady in the milk. Thirdly, the lactometer reading was taken as soon as it became stationary within 30 seconds. Finally, the corrected lactometer reading (CLR) was noted for further calculation of solid-not-fat (SNF%).

Calculation of SNF%: According to the Indian Standard Institution Formula used by (Jagdish and Neeraj, 2008).
SNF% = (CLR / 4) + 0.2F + 0.6
Here,
CLR = Corrected Lactometer Reading F = Fat percentage in the milk sample.

Calculation of TS%:

According to Troyes formula described in (Jagdish and Neeraj, 2008).
TS% = SNF% + fat%

Determination of acidity percentage

The acidity percentage of milk was determined by titration according to (FSSAI, 2016). Firstly, collected and marked milk samples were mixed thoroughly by hand. Then, 10ml milk sample was taken in a porcelain beaker. Secondly, 2-3 drops of phenolphthalein indicator were added to the sample. Thirdly, a thorough titration was done by using 0.1N NaOH until the faint pink color appeared. The same procedure was done repeatedly for 3 times. Upon completion of each procedure, the alkali used for each titration was recorded.

Calculation:
Acidity % = (ml of alkali used × normality of NaOH × 0.09 ×100)/ml of milk sample

Determination of Protein and Casein percentage

Protein and casein were determined by Aldehyde method/ Formol titration method (Pyne, 1932) as described in the milk and milk product testing manual of the Madras Veterinary College. Firstly, 10ml of milk sample was taken into a conical flask. Then, 0.4ml of potassium oxalate was added and mixed thoroughly. The mixture was kept rest for 2 minutes. After 2 minutes, 2-3 drops of phenolphthalein indicator were added to the mixture. Then, the titration procedure was done using 0.1N NaOH until a faint pink color appeared. Next, 2 ml of formaldehyde solution was added into the titrated solution and kept at rest for 30 minutes. Further titration was done again following the same procedure. Upon completion of each procedure, the alkali used for each titration was recorded.

Calculation:

Protein%= Titrate value×1.7 Casein%= Titrate value× 1.32

Determination of lactose percentage

Lactose was determined by Bock's method (Gänzle, Haase and Jelen, 2008) as described in the milk and milk products testing manual of the Madras Veterinary College. Firstly, 20ml of milk sample was taken in a 100ml volumetric flask. Secondly, 12 ml of 10% sodium tungstate (Na_2WO_4) and 12 ml of 2/3N sulphuric acid (H_2SO_4) were added to the sample. The mixture was made up to the mark using distilled water. Thirdly, the mixture was filtrated, and the filtrate was taken into a burette. Afterward, 25ml of Benedict solution was taken into a separate 250ml conical flask. Further, the lactose content in the filtrate was determined by titrating it with boiled Benedict solution until the white precipitation with straw yellow color appeared.

Calculation:

Calculation of the above titration method is done bearing in mind that 25 ml of Benedict reagent is completely reduced by 0.067 grams of lactose.

Lactose% = (0.067× 100× 100) / (titrate value× 20% of specific gravity)

Microbial Evaluation

Total viable count

Total plate count results indicate the number of colonies capable of developing under specified physical and chemical conditions, encompassing factors like atmosphere, temperature, pH, nutrient availability, and the presence of growth-inhibiting agents. Colonies represent clusters of viable microbial cells, making direct comparisons with direct counts unfeasible. Plate counts tend to underestimate microbial presence as they may exclude dormant, viable but non-culturable, and non-culturable microorganisms. This test was conducted by following the method recommended by (Wehr and Frank, 2004) and (FSSAI, 2016). Firstly, all the Tubes and Petri dishes to be used were marked as batch no., sample no., parameter., and dilution no. Secondly, pipette out either 10ml or 11ml sample from the sample bottle into either 90ml or 99ml of diluent bottle (1:10 dilution). Then, pipette out 1ml of diluted sample from (1:10) dilution bottle into 9ml of dilution tube. Gradually, pipette out 1ml from each dilution into respectively marked dilution plates. Subsequently, go for further dilutions if required by pipetting out from the previous. Now, the PCA medium was poured into the plates and allowed to solidify. After this, the solidified plates were incubated at 35 ± 2^0C for 48-72 hours. Finally, the colony was counted using the colony counter.

Coliform count

Coliform bacteria, which may be present in dairy products processed under unsanitary conditions, were investigated in this study. The coliform count of milk was determined according to (Wehr and Frank, 2004) and (FSSAI, 2016) using MacConkey's agar. The process involved preparing a serial dilution of the sample and inoculating a sterile Petridis with 1 ml of the necessary dilutions in duplicate. Subsequently, each plate received 10-15 milliliters of previously melted MacConkey's agar cooled to 45°C, and thorough mixing ensued. The agar was allowed to solidify, followed by the addition of a second layer of three to four milliliters of medium over the hardened surface. The dishes were inverted and incubated for 24 hours at 37°C in an incubation chamber. After the incubation period, positive test results were identified by the presence of dark red colonies measuring at least 0.5mm.

Statistical analysis

The data were stored in Microsoft Excel 2010, and subsequently, data analysis was performed using R statistical software version 4.3.3. A Shapiro test was employed to assess the distribution of the data. Parameters exhibiting a normal distribution underwent one-way ANOVA testing, while parameters deviating from normal distribution were analyzed using the nonparametric Kruskal-Wallis test. Following ANOVA, Tukey's test was applied as a post hoc test. In contrast, after the Kruskal-Wallis test, the Bonferroni test was conducted as a post hoc test where there was a significant difference. A significance level of $P \leq 0.05$ was considered to determine the significance of the mean differences.

RESULTS AND DISCUSSION

Physical parameters analysis

The score of color and appearance of Brand C was higher than Brand A and Brand B where Brand B had the lowest value (Table 1). There was no significant difference among them (p-value 0.21). In case of odor, Brand A toned milk had a higher score than the other two brands. There is no significant difference among them (p-value 0.51). Brand A toned milk has a high score value for both flavor and body but there is no significant difference among them (p-value 0.08, 0.95). The total score of Brand A toned milk for sensory evaluation by expert panel is 88.67 giving it grade B and good quality whereas scores for Brand B and Brand C are 73.33 and 82.00 giving them grade C and B, respectively. Though there are no significant differences among them in their total scores (P = 0.36) (Table 1). The result shows that the Brand A toned milk had a better score than the other two whereas Brand B had the lowest scores in expert panel. The present study on toned milk showed better overall sensory performance than Arafat et al. (2016), who studied these on UHT milk, where flavor scores ranged from 37.67±2.52 to 43.67±3.21 and color scores from 16.00±1.73 to 18.67±2.31. This variation in physical properties might have occurred due to the differences in the manufacturing process of toned milk of various companies.

Chemical analysis

The specific gravity of Brand B toned milk was significantly lower than the Brand A and Brand C toned milk (P< 0.001) (Table 2). The acidity, casein and protein of Brand A, Brand B and Brand C toned milk were not significant (P >0.31). The fat of Brand A toned milk was significantly higher than Brand B toned milk. The SNF of Brand A and Brand C toned milk were significantly higher than the Brand B toned milk (P <0.001). The TS of Brand A and Brand C toned milk were significantly higher than the Brand B toned milk (p <0.001). The Lactose of Brand A, Brand B and Brand C toned milk were not significant (P = 0.94) (Table 2).

The toned milk samples' specific gravities (1.030–1.031) were in line with those published by Karmaker et al. (2019), reporting a standard density and little adulteration. Additionally, the protein level (3.24%–3.35%) was similar to their findings for pasteurized samples (3.20%–3.58%) and UHT milk. The fat standardization method in toned milk might be the reason why the fat content in this study (1.89%–1.9%) was much lower than the 3.24%–3.56% reported by Karmaker et al. (2019). Similar to pasteurized milk, the SNF and TS levels (8.52%–8.97% and 11.72%–12.17%, respectively) indicated satisfactory solids retention. The results for lactose (4.45%–4.96%) and acidity (0.17%–0.18%) stayed within reasonable bounds and resembled Karmaker's (2019) data, demonstrating appropriate preservation and chemical stability.

Microbial analysis

The Total viable count of bacteria in Brand B toned milk was significantly lower than the Brand C toned milk (P <0.001) (Table 3). The coliform count was nil in all toned milk samples from the available brands.

The present study's microbiological examination of toned milk showed that none of the three commercial brands tested had any coliform contamination, indicating adequate pasteurization and proper treatment. Brand B's Total Viable Count (TVC) was 36,167 ± 2,124.89 CFU/ml, whereas Brand C's was 39,667 ± 1,302.68 CFU/ml. These differences were statistically significant (p < 0.001). With counts of 0–5 CFU/ml and no coliforms present, Kamal et al. (2021) reported much lower TVC levels in pasteurized market milk, indicating higher microbiological quality in their examined goods. The current study's increased TVC could be defined by changes in post-pasteurization handling, longer supply chain time, or storage conditions. However, an absence of coliforms indicates the microbiological quality of the toned milk of evaluation and complies with Kamal et al. (2021) by confirming that there was no fecal contamination.

Comparison with BSTI standards

BSTI has established criteria for toned milk, focusing on selected parameters such as fat content, solids-not-fat (SNF), total viable count (TVC), and coliform count. As per the BSTI 2021 guidelines, the fat percentage in tested toned milk from all three companies (mean <2) fell below the standard (min 2%) (Table 4). Similarly, the SNF content of toned milk of all three companies (mean <8.93) was below the standard (9.0%) set by BSTI (2021). The Acidity of all sampled toned milk (mean <1.77) was also below BSTI (2021) standard point (0.18). On the contrary, the protein content of all three companies' toned milk (mean >3.2) had met the standard value (>3.0). The lactose content of examined toned milk (mean >4.4) was above the set value (4.4%). Conversely, the total viable count exceeded the BSTI standard (mean >36166). However, the coliform count in the toned milk from the three companies met the standard (Table 4).

This research involved analyzing a total of 18 samples of toned milk from three companies (Brand A, Brand C, and Brand B) to assess their physical (color and appearance, odor, flavor, body), chemical (specific gravity, acidity, casein, protein, fat, SNF, TS, lactose), and microbial (TVC, coliform count) qualities. All parameters were compared against BSTI standards. Due to limited scientific research on the quality evaluation of toned milk, there is limited literature available for comparison purposes.

According to Fenton (1968), market milk should be free from any foreign particles, sediment, unpleasant odor and abnormality for consumption. All three toned milk were free from extender materials which indicated the acceptance for consuming. Though, the flavor varied giving a low recognition for Brand B which may be caused by improper processing and handling of milk or preservation of raw milk in inappropriate condition (Zucali *et al.*, 2016).

Specific gravity serves as a crucial indicator of milk quality, reflecting factors such as fat and other solids content and temperature. At 15°C it varies from 1.020 –

1.038 (Sharp and Hart, 1936). The finding of this study indicates that the toned milk was good quality as its value is within the acceptable limit. In low fat pasteurized milk specific gravity was found 1.022 – 1.032 (Sánchez-Macías *et al.*, 2010). This study finely matches with the findings indicating sample toned milk had undergone proper standardization or the original milk was a good quality milk.

The acidity% of all the toned milk was the highest level as set by (BSTI, 2021). Although the acidity level exceeds the threshold of 0.14% suggested by (Popescu and Angel, 2009), this could be attributed to the pasteurization and processing of milk in industries. Measuring the acid content in milk is crucial for assessing its quality, with acidity playing a significant role in taste. Elevated acidity levels in milk can be attributed to factors such as its age and bacterial activity (O'Mahony, 1988). The extent of bacterial presence and the storage temperature are key determinants affecting the formation of acidity (Hossain, Alam and Sikdar, 2011). As the Acidity of the sampled toned milk was under the utmost level it can be said that the quality of the milk was reasonably good.

The protein content of cow milk has been reported to vary from 3.22% to 3.92 % (Ramasamy et al., 1999; Lingathurai et al., 2009). Results of this study showed that the protein content of toned milk was above the threshold level of 3.0% set by BSTI (2021). The protein content of Brand A toned milk is the highest having 3.34 whereas Brand B toned milk had the lowest value of 3.244. Thus, results obtained for all toned milk samples met up the standard protein content as per BSTI (2021). However, the difference of protein content among the tested toned milk was not significant (p-value 0.31). A proper level of protein content indicates the good quality of milk. The original milk must have contained high protein as pasteurization can cause decrease of protein in some extent (Franzoi et al., 2022).

In the current study, the average values of fat content observed for the three brands toned milk were generally below the minimum level of 2% (BSTI, 2021). The fat of Brand A toned milk was significantly higher than Brand B toned milk. Brand B had the lowest level of fat (1.89%) whereas Brand A toned milk had the highest fat content (1.99%) which is very close to standard. The reduction of fat level in the toned milk may be the result of starting milk with a lower-than-normal fat level (Fonseca and Santos, 2001) or may also be caused by the withdrawal of fat from the original milk that were used for pasteurization or any alteration of proper ration. Burgwald (1959) found 1% fat in double toned milk and <2% fat in single toned milk.

Brand A toned milk boasted the highest SNF content among the three brands (8.97%), nearing the BSTI (2021) standard. Brand B exhibited the lowest SNF content (8.529%). The Food and Drug Administration (FDA) mandates a minimum SNF content of 8.25% for toned milk (Graf, 1974). The results of this study align closely with the FDA (2019). FSSAI (2016) established an SNF standard of 8.5%, which is also upheld by this study. Conversely, BSTI (2021) set the SNF standard at 9%, a benchmark not met by the SNF contents of the sampled toned milk of three companies. The slightly lower SNF content might be attributed to standardization or lower SNF content in the original milk, or it could be due to the loss of solids content during pasteurization. The addition of water dilutes milk, reducing its total solids content.

The lactose content in cow's milk varies depending on the breed of the cow (Fox et al., 2015). Cerbulis and Farrell (1975) discovered that milk must contain at least 4.2% lactose for any manufacturing process. According to BSTI (2021), the standard for lactose content in toned milk is set at 4.4%. Additionally, the lactation stage influences lactose levels. During early to mid-lactation, lactose levels typically exceed 4.5%, while herds on a high nutritional plane may reach 4.6-4.9%. Towards late lactation, these levels typically drop below 4.5% (Kittivachra et al., 2007). Having the lactose value above standard indicated the good quality of milk.

According to Reta and Addis (2015), total bacterial count for grade A pasteurized should not exceed 20,000cfu/ml. Food Safety and Standards Authority of India (FSSAI) set the microbial standard at a maximum of 30,000 cfu/ml. Total plate count can vary in a range of 13,000-18,000 cfu/ml based on the pasteurization process and proper temperature maintenance (Anderson et al., 2011). Though BSTI (2021) has set a standard of relatively higher value at a maximum of 30,000cfu/ml, none of the tested toned milk could accomplish the criteria. Since this a first time study on toned milk in Bangladesh, literature is scarce to compare the results. However, high bacteria count in pasteurized milks could be attributed to several factors, including bacteria surviving the pasteurization process, and contamination after pasteurization due to substandard processing and handling practices, or inadequate hygiene maintained by employees involved (Saha and Ara 2012).

This study revealed no presence of coliforms in any of the tested toned milk samples from the three brands, aligning precisely with the BSTI standard. This absence indicates no fecal or post-pasteurization contamination. According to Frazier and Westhoff (1958), the coliform standard for "grade A" milk should not surpass 10 cfu/ml. However, research conducted by Saha and Ara (2012) found coliform counts in pasteurized milk ranging from 10 to 14 cfu/ml. That milk may be subjected to fecal contamination due to improper pasteurization or post-pasteurization contamination (Acharya et al., 2017).

CONCLUSION

All the brands didn't maintain the composition as labelled on the packages, but most of them were within the normal range of chemical parameters including protein, lactose and SNF% as BSTI standard. In case of microbial quality, all three companies' toned milk is of good quality having zero coliforms but slightly alarming in total viable count (TVC) having more than 30,000 cfu/ml. The outcomes are expected to support policymakers, dairy producers, and public health professionals in developing strategies to enhance milk safety and processing standards. Moreover, this study will contribute to raising consumer awareness about milk quality and the importance of safe food handling and consumption.

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Table 1. Sensory evaluation of studied toned milk

Brand	Parameters (Mean±SD)				Total (mean)	Quality	Grade
	Color and appearance	Odor	Flavor	Body			
Brand A	8.33±0.58	17.67±2.52	35.00±0.00	27.67±2.52	88.67	Good	B
Brand B	8.00±1.00	15.00±2.65	27.00±6.81	22.67±11.02	73.33	Fair	C
Brand C	9.00±0.00	14.67±4.16	32.00±2.51	26.00±5.29	82.00	Good	B
P value	0.21	0.51	0.08	0.95	0.36	-	-

Different superscript letters in the same row differ significantly (p <0.05)
BIS score board: color and appearance-10, odor- 20, Flavor-40, body- 30 scores;
For BIS grading: Excellent- >90 score, 'A' grade, Good- '80-90' score, 'B' grade, Fair- '60-79' score, 'C' grade, and '<60' score, 'D' grade.

Table 2. Chemical analysis of studied toned milk

Parameters	Brands (Mean ± SD)			Anova (p-value)	Kruskal Wallis (p-value)
	Brand A	Brand B	Brand C		
Specific gravity	1.031±0.0011[a]	1.030±0.0005[b]	1.031±0.0006[a]	_	<0.001
Acidity%	0.174±0.008	0.7±0.008	0.174±0.011	_	0.46
Casein%	2.601±0.163	2.519±0.088	2.531±0.145	_	0.46
Protein%	3.348±0.194	3.244±0.114	3.320±0.183	_	0.31
Fat%	1.991±0.079[a]	1.892±0.090[b]	1.925±0.062[ab]	_	0.02
SNF%	8.974±0.229[a]	8.529±0.144[b]	8.935±0.129[a]	<0.001	_
TS%	12.174±0.229[a]	11.729±0.144[b]	12.135±0.129a	<0.001	_
Lactose%	4.45±0.067	4.93±0.069	4.96±0.10	_	0.94

Different superscript letters in the same row differ significantly (p <0.05)

Table 3. Microbial analyses studied toned milk

Brands	TVC (Total Viable Count) (Mean ± SD)	Coliform Count
Brand A	37750±2094.36[b]	0
Brand B	36167±2124.89[b]	0
Brand C	39667±1302.68[a]	0
P- value (ANOVA)	<0.001	-

Different superscript letters in the same row differ significantly ($p < 0.05$)

Table 4. Comparison with BSTI standards

Parameters	Standards (BSTI, 2021)	Brands (mean)		
		Brand A	Brand B	Brand C
Specific gravity	1.028 –1.036	1.031	1.030	1.031
Acidity%	0.18	0.174	0.177	0.174
Casein%	-	2.601	2.519	2.531
Protein%	3.0	3.348	3.244	3.320
Fat%	Min 2%	1.991	1.892	1.925
SNF%	9.00%	8.974	8.529	8.935
TS%	-	12.174	11.729	12.135
Lactose%	4.4	4.45	4.93	4.96
TVC (cfu/ml)	<30000	37750	36167	39667
Coliform count/ml	<10	0	0	0