Nutritional and microbiological quality assessment of commercial yogurt sold in different districts of Bangladesh: a food safety issue

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Received: 01 November 2020/Accepted: 26 November 2020/ Published: 30 November 2020

Abstract: The aim of this study was to investigate the nutritional and microbial quality of yoghurt from different districts of Bangladesh. Protein content was higher (4.56g/kg) in SB2 (sample Bogura-2), fat content was also higher (5.67g/kg) in SB3 (sample Bogura-3). The acidity found ranged from 0.77% to 0.98%, pH obtained ranged between 3.6 to 4.98 and total solid retained between 23.08 to 26.95 for all samples. Highest Total Viable count (TVC) value was found in SB2 (68.9×10⁴±0.23 CFU/ml) and lowest value was observed in SJ2 (23.01×10⁴±0.43 CFU/ml). No mold and yeast were found in the collected samples during study period that indicates all are follow hygiene procedure but all of the yogurt samples were contaminated with fewer amount (5.6±0.66 to 12.56±0.44 CFU/ml) of coliform. The mean value of acceptability score of yogurt sample was higher (99.2) in SB2 (sample Bogura-2) during the study period. Organoleptically, the overall quality of all yogurt samples was good. Considering the pH, acidity, total solids, protein, fat, carbohydrate and ash values for all yogurt samples collected from Bogura had better quality as compared to other samples. From the present study, it was found that all of the samples collected from Bogura district were much better quality compared to other samples in terms of nutritional, biochemical and microbial aspect. All of the samples were found in contaminated with lower amount of coliform so necessary actions should be taken in every step of processing, maturing and marketing to overcome this problem.

Keywords: yogurt; nutritional; biochemical; microbiological; coliform; yeast

1. Introduction
Fermented milk products were introduced since the beginning of civilization (Mckinley, 2005). Yogurt is one of the important fermented milk products which is popular and nutritious all over the world (Hayaloglu et al., 2007). Yogurts are considered as ready to eat, products commonly taken for energy production and for good health, throughout the world (Alli et al., 2010). It can also be taken as a drink beverage to fulfillment of the thirsting (Alfa-Lawal, 1984). Yogurt contains good source of protein and beneficial for sound health (Cueva and Aryana, 2008). It is recognized as a balanced food which contains almost all of the nutrients founds in raw milk, it is also a good source of probiotics. Some people cannot digest raw or heated milk they can easily digest yogurt, some bacterial growth occur in this type products that can play vital role in digestive system of human
being. A wide range of flavoring compounds are found in this products to spice it (Anther, 1986; Oyeleke, 2009). For its physiological, nutritional and beneficial effects, it is considered as a popular drink and widely accepted that is in higher demand (De et al., 2014).

As the number of dairy farms in Bangladesh is increasing, so is the production and marketing of dairy products. Yogurt is a fermented milk product prepared from fresh milk that can be easily contaminated. Yeast and mold are regarded as primarily contaminants in Nigeria (Suriyarachchi and Fleet, 1981; Oyeleke, 2009). Acidic environment is suitable for growth and multiplication of fungi (De et al., 2014). Some species of Aspergillus produces secondary metabolites such as aflatoxins which are toxic and carcinogenic (Issazadeh et al., 2012). The yogurt of Bogura, Naogaon, Rajshahi, Jashore, Dinajpur and Dhaka are famous among the different types of yogurt available in Bangladesh. People in our country usually consume yogurt to increase their nutritional value and digestive power. The quality of yogurt differs due to differences in milk and processing. If a conscious citizen knows how nutritious yogurt is in any part of Bangladesh or what kind of microorganisms exist in yogurt, he can easily fulfill his desire. That is why the present study was drawn, to assess the nutritional and microbiological value of commercial yogurt collected from different districts of Bangladesh.

2. Materials and Methods
2.1. Experimental period
The experiment of this study was carried out to evaluate the nutritional and microbiological quality of commercial yogurt collected from different districts of Bangladesh. A total of 18 samples from 6 different district were collected during the experimental period of 15 March, 2020 to 22 September, 2020. Physical parameters were investigated by a skilled panel member, chemical and microbiological parameters were examined in Dairy Science laboratory of the Department of Dairy Science, Faculty of Animal Science and Veterinary Medicine, Sher-e-Bangla Agricultural University, Dhaka.

2.2. Sample collection and storage
Three of each yoghurt samples were collected from 6 districts such as Bogura (SB1, SB2, SB3), Rajshahi (SR1, SR2, SR3), Naogaon (SN1, SN2, SN3), Jashore (SJ1, SJ2, SJ3), Dhaka (SD1, SD2, SD3) and Dinajpur (SDj1, SDj2, SDj3) of Bangladesh. Collected samples were transported to the Dairy Science laboratory and stored under 4°C temperature for further analysis.

2.3. Organoleptic quality assessment
To examine the physiological parameters all the samples were judged by a skilled panel member to evaluate the smell/flavor, color, body and consistency and overall preferences by scoring method.

2.4. Nutritional quality assessment
After completing the organoleptic judgement; all the samples were chemically analyzed in the laboratory in terms of pH value, acidity percentage, total solids (TS) (g/kg) by standard method of determination. Nutritional composition viz., protein, fat, ash and carbohydrate content were determined in the Fishing and Post-Harvest Technology laboratory at Sher-e-Bangla Agricultural University, Dhaka. The proximate composition of the samples was analyzed in triplicate according to standard procedure given in Association of Official Analytical Chemists (AOAC, 2000).

2.5. Microbiological quality assessment
Total Viable Count (TVC), Total Fungal Count (TFC), Total Coliform Count (TCC), yeast and molds of all the yogurts samples were determined by standard method and gram positive, cocci and rod were tested by staining method.

2.6. Statistical analysis
All the data collected from the experiments were carefully stored in a computer excel file for results preparation. The collected data were analyzed and graphically presented with the help of Microsoft Office Excel 2010 software and SPSS version 20.0, data were represented as the mean ± SD (standard deviation).

3. Results and Discussion
Quality of yogurt collected from different district are the composite of all attributes which are tested.
3.1. Physical characters
Physiological parameters such as color and flavor, texture and taste, body and consistency and overall preferences are shown in Figure 1.

3.1.1. Color and flavor
Examination of color and flavor are the most important at the time of quality determination of yogurt. Color and flavor of yogurt samples were measured by scoring method and found that the values varied between 33±0.17 to 39.6 ± 0.67, where the score was 40 (Figure 1). Highest value was observed in SB2 (yogurt collected from Bogura) and lowest value was obtained in SD1 and SJ3 (Yogurt collected from Dhaka and Jashore respectively). Addition of 10% jack fruit juice with dahi, smell and taste score were 41.44 ± 0.05, which was more or less similar with the present study (Ara et al., 2015).

3.1.2. Texture and taste
Texture and taste are another important parameter for the determination of yogurt quality. The value of texture and taste of the yogurt samples was in the range of 22 ± 0.15 to 29.6 ±0.28 out of 30; highest value was observed in SB2 (29.6±0.28) samples collected from Bogura and lowest value was observed in SD1 and SD3 (Figure 1). Drake et al., (2000) was found that the textural quality of yogurt including firmness, viscosity, and creaminess, functional ingredients provide health benefits (Drake et al., 2000). Similar results were showed by Afrin et al., (2016) highest color and texture BAU dairy farm dahi (18.67 ± 0.58) and the lowest value was observed Shes Moor dahi (13.67 ± 0.58).

3.1.3. Body and consistency
The scoring value of body and consistency of the samples examined was in the range of 12 ± 0.56 to 19.5±0.19 out of 20, highest value was observed in SB1 (yogurt collected from Bogura) and lowest value was found in SD3 (Figure 1). Body and consistency score were found in higher in Maharam Ali dahi, Bogra and BAU Dairy Farm dahi, Mymensingh whereas the lowest value was in Shes Moor dahi (Afrin et al., 2016). Mangashetti et al., (2003) showed that, dahi produced from concentrated milk with 7.5% sugar showed smooth textural characteristics.

3.2. Results of nutritional quality
3.2.1. Protein content
Protein content of yogurt samples ranged from 2.7 ±0.65 g/kg and 4.56±0.11g/kg; higher value was observed in SB3 and lowest value was found in SJ1 (Figure 2). Rashid and Miyamoto (2005) was found similar results, protein content of all dahi samples were in the range of 3.99-4.74%.
3.2.2. Fat content
Fat is one of the major constituents of yogurt, highest fat content was observed in SB3 and value was 5.67±0.43 g/kg and lowest value was found in SDj2 and value was 3.65±0.89 g/kg. Average fat content was 4.50 g/kg (Figure 2). This result agreed with the findings of Rashid and Miyamoto (2005) who reported that the samples from Mymensingh had the highest (4.88±0.99%) fat content.

3.2.3. Carbohydrate content
Carbohydrate content of collected samples was in the range of 13.6 ±0.67 g/kg to 18.8±0.44g/kg, highest value was observed in SD2 and lowest value was found in SN2. Similar findings were observed by Khan (2008), the carbohydrate content of dahi samples were in the range of 8.47 ± 0.12.

3.2.4. Ash content
Ash content was higher in SD3 and lower in SR2 which varies with the range of 0.76± 0.65 g/kg to 1.4±0.33 g/kg Similar findings showed in a research conducted by Haj et al., (2007), ash content of all the dahi samples were agreed with the range of 0.73-0.91%) which ranges between 0.78-0.80% (Chandra et al., 2013).

3.3. Chemical assessment
3.3.1. pH value
pH of the yogurts samples varies between 3.65 to 4.98 and highest and lowest value was found in SD3 and SJ2 respectively (Table 1). The pH value (4.53 ± 0.06) was observed in dairy farm dahi of BAU and the lowest value (3.93 ± 0.06) was found in Jamuna dahi Afrin et al., (2016) which is more or less similar with the current study.

3.3.2. Acidity%
The percentage of acidity of the examined samples ranged between 0.77% to 0.98% has shown in (Table 1) supported by the finding of Alam (2014) that the acidity of dahi was 0.7%.

3.3.3. Total solids (TS)
TS content of the yogurt samples were highest in SR1; 26.78 g/kg and lowest in SB1; 23.08g/kg (Table 1). Generally, the total solids content of yoghurt ranges from 17.11 to 21.80% (Muhammad et al., 2005). The TS content of different deviate from the previous research findings due to the used of different concentration of sugar during products preparation.
Table 1. Chemical assessment of yogurt samples collected from different district of Bangladesh.

| Yogurt samples | pH±SD    | Acidity±SD | Total solids±SD |
|----------------|----------|------------|-----------------|
| Jashore        |          |            |                 |
| SJ1            | 4.56±0.14| 0.87±0.1   | 23.76±0.23      |
| SJ2            | 3.65±0.6 | 0.86±0.34  | 25.63±0.24      |
| SJ3            | 4.25±0.46| 0.87±0.35  | 24.7±0.35       |
| Rajshahi       |          |            |                 |
| SR1            | 3.87±0.45| 0.77±0.78  | 26.78±0.34      |
| SR2            | 4.15±0.35| 0.98±0.32  | 23.57±0.24      |
| SR3            | 4.19±0.24| 0.89±0.24  | 24.65±0.24      |
| Dhaka          |          |            |                 |
| SD1            | 4.85±0.17| 0.88±0.24  | 25.78±0.33      |
| SD2            | 4.0±0.8  | 0.78±0.23  | 24.56±0.63      |
| SD3            | 4.98±0.45| 0.93±0.22  | 25.67±0.44      |
| Naogaon        |          |            |                 |
| SN1            | 3.84±0.78| 0.90±0.34  | 24.65±0.46      |
| SN2            | 4.09±0.34| 0.98±0.13  | 26.67±0.35      |
| SN3            | 3.65±0.35| 0.78±0.35  | 24.67±0.11      |
| Bogura         |          |            |                 |
| SB1            | 4.76±0.35| 0.84±0.36  | 23.08±0.09      |
| SB2            | 4.65±0.35| 0.82±0.23  | 23.77±0.4       |
| SB3            | 4.24±0.34| 0.88±0.24  | 25.67±0.08      |
| Dinajpur       |          |            |                 |
| SDj1           | 3.85±0.56| 0.79±0.48  | 24.57±1.08      |
| SDj2           | 3.98±0.34| 0.77±1.34  | 26.75±0.56      |
| SDj3           | 3.86±0.13| 0.81±0.67  | 26.95±0.25      |

3.4. Microbiological quality analysis
The results of microbiological assessment are shown in Table 2, where the value of TVC, TCC and Mold & Yeast are presented.

3.4.1. TVC (Total viable count)
In our study highest TVC value was found in SBj (68.9×10⁴±0.23 CFU/ml) and lowest value was observed in SJj (23.01×10⁴±0.43 CFU/ml) which agreed with the previous findings of Sarker et al., (2012) that Bogura region dahi showed the highest bacterial counts (Table 2).

3.4.2. TCC (Total coliform count)
In our study TCC value was in the range of 5.6±0.66 to 12.56±0.44 CFU/ml where highest value was found in SRj and SDj respectively, on the other hand lowest value was observed in SBj (Table 2). Higher TCC value indicates that the yogurt prepared under unhygienic condition and unsafe for human consumption. Value of TCC was higher (17.67±2.51) in Shes Moor dahi, Mymensingh and the lowest value (9.00±1.0) was found in BAU Dairy Farm dahi (Afrin et al., 2016) which is more or less similar with the present study.
3.4.3. Mold and yeast
Presence of mold and yeast indicates the hygienic situation of that product, there was no mold and yeast in the collected yogurt samples that indicates the quality of yogurt from different districts were maintained hygienically (Table 2).

Table 2. Microbiological quality assessment of different yogurt samples.

| Yogurt samples | TVC ±SD (CFU/ml) | TCC±SD (CFU/ml) | Yeast & mold ±SD (CFU/ml) |
|----------------|------------------|-----------------|---------------------------|
| Jashore        |                  |                 |                           |
| SJ1            | 56.87×10⁴±0.34   | 8.87±0.54       | ***                       |
| SJ2            | 23.01×10⁴±0.23   | 8.43±0.21       | ***                       |
| SJ3            | 53.87×10⁴±0.19   | 9.3±0.33        | ***                       |
| Rajshahi       |                  |                 |                           |
| SR1            | 66.09×10⁴±0.8    | 11.34±0.34      | ***                       |
| SR2            | 58.34×10⁴±0.45   | 12.56±0.44      | ***                       |
| SR3            | 45.87×10⁴±0.34   | 9.56±0.19       | ***                       |
| Dhaka          |                  |                 |                           |
| SD1            | 35.23×10⁴±0.22   | 12.56±0.27      | ***                       |
| SD2            | 28.6×10⁴±0.13    | 8.8±0.62        | ***                       |
| SD3            | 48.56×10⁴±0.54   | 12.08±0.87      | ***                       |
| Naogaon        |                  |                 |                           |
| SN1            | 37.68×10⁴±0.9    | 9.8±0.76        | ***                       |
| SN2            | 25.06×10⁴±0.65   | 11.54±0.36      | ***                       |
| SN3            | 25.6×10⁴±0.23    | 7.9±0.44        | ***                       |
| Bogura         |                  |                 |                           |
| SB1            | 67.01×10⁴±0.43   | 6.5±0.41        | ***                       |
| SB2            | 68.9×10⁴±0.34    | 5.9±0.43        | ***                       |
| SB3            | 59.05×10⁴±0.67   | 5.6±0.66        | ***                       |
| Dinajpur       |                  |                 |                           |
| SDj1           | 66.12×10⁴±0.34   | 11.35±0.98      | ***                       |
| SDj2           | 46.21×10⁴±0.11   | 12.45±0.11      | ***                       |
| SDj3           | 32.76×10⁴±0.25   | 13.6±0.23       | ***                       |

***Not detected

3.4.4. Ratio of cocci and rod
Ratio of cocci and rod in most of the yogurt samples collected from different district of Bangladesh were 2:1 to 4:1 which agreed with the findings of Afrin et al., (2016).

4. Conclusions
The nutritional and microbial quality of yoghurt collected from different regions of Bangladesh was investigated. This study revealed that, yogurt collected from Bogura district had better quality in terms of nutritional, biochemical and microbiological aspects. No mold and yeast found in the collected samples that indicates all products are produced under sanitary conditions hence safe for human consumption. A few coliforms found in each sample which represent sample were contaminated so some necessary action needs to be taken in every step of processing and transportation.

Acknowledgements
The authors would like to thank all the stuff of the Department of Dairy Science and Fishing and Post-Harvest Technology laboratory, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh for their kind cooperation and regular support to carry out the research work.

Conflict of interest
None to declare.
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