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Physical, chemical and microbiological qualities of dahi collected from Bogra and Mymensingh district of Bangladesh

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Abstract: The research work was carried out to evaluate the physical, chemical and microbiological qualities of dahi collected from different sources. In another step, cocci and rod ratio were investigated and microbial activities were also investigated by reactions in litmus milk. For this reason, dahi samples were collected from Bogra (Maharam Ali dahi-A, Rofat dahi-B, Jamuna Dahi-C) and Mymensingh district (Dayamoy-D, Misti Kanan-E, Krishna Kebin-F, BAU Dairy Farm Dahi-G, KR Market-H, Shes Moor-I). Physical tests were performed by a panel of expert judges. Chemical and microbiological parameters were tested in the Dairy Microbiology, Dairy Chemistry and Dairy Technology Laboratory of the Department of Dairy Science, Bangladesh Agricultural University, Mymensingh. In case of overall physical score, the highest value was (95.33 ± 1.53) found in BAU Dairy Farm dahi. Considering chemical parameters, pH value and fat content of BAU Dairy Farm dahi were higher than that of other dahi samples. So, BAU Dairy Farm dahi was of the best quality on the basis of physical and chemical analysis. In microbiological analysis, (total viable count and coliform count) significant differences were found among all samples. All samples contained lower number of coliforms. No yeast and mold was found in any dahi sample may be followed the hygienic practices. Litmus milk characteristics of the isolated cultures showed desirable changes such as acid, smooth and firm coagulation obtained from Maharam Ali dahi and BAU Dairy Farm Dahi types of dahi sample which contained possible organisms of *Streptococcus thermophilus* and *Lactobacillus bulgaricus*. Considering all parameters, it can be concluded that BAU Dairy Farm dahi and Maharam Ali dahi were found as superior. In addition, this study gives information regarding the microbial status; e.g. cocci and rod ratio in the traditional fermented dahi of collected samples.

Keywords: dahi; physical; chemical; microbiological qualities; litmus milk; rod and cocci ratio

1. Introduction

Dahi is a fermented dairy product by lactic acid fermentation of milk by the action of yoghurt starter bacteria and is one of the most popular products throughout the world (Hayaloglu *et al.*, 2007). In all major developing countries of the world, the productions of fermented milk products are increasing rapidly. In India, 9% of the total milk produced is used for the preparation of dahi (Singh, 2007). In Bangladesh, its amount is less for converting dahi. Dahi prepared locally by the fermentation of wild strains of lactic acid bacteria (LAB) (Dewan and Tamang, 2007). Lactic acid bacteria (LAB) are the prime agents in producing fermented milk and milk products. Dahi is prepared almost all districts of Bangladesh. In Bogra and Mymensingh town, there is a number of sweetmeat shops produce dahi. There are some renowned sweetmeat makers also who produce tasteful dahi but the quality, based on microbial standard is not maintained.

Indigenous dahi contains mixture of lactic acid bacteria starter culture and thus the quality of dahi may vary with the type of starter culture used for inoculation. The essential bacteria in a dahi cultures are *Streptococcus*

thermophilus and *Lactobacillus bulgaricus*. For the best results these organisms should be in approximately equal numbers in the culture, otherwise the dahi will lack the most desirable characteristics. The ratio between various types of bacteria such as rod and cocci were not clearly conducted on Bangladeshi dahi. For this reason the present study was designed to monitor the physical, chemical and microbiological qualities of dahi and to know the cocci and rod ratio in dahi as well as microbial activity investigated in experimental site.

2. Materials and Methods

2.1. Site and period of experiment

The experiment was conducted at the Dairy Microbiology, Dairy Chemistry and Dairy Technology Laboratory of the Department of Dairy Science, Bangladesh Agricultural University, Mymensingh during the period of July 2 to October 28, 2015.

2.2. Collection of dahi samples

Nine dahi samples were collected from two areas such as Bogra (Maharam Ali dahi-A, Rofat dahi-B, Jamuna dahi-C) and Mymensingh district (Dayamoy dahi-D, Misti Kanan-E, Krishna Kebin-F, BAU Dairy Farm dahi-G, Kamal Ranjit market dahi-H, Shes Moor dahi-I).

2.3. Physical tests (Sensory and organoleptic evaluation)

All dahi samples were judged to evaluate the smell and taste, body and consistency, color and texture and there by the overall of physical score of the samples by a panel of expert judges.

2.4. Chemical tests

For certifying the nutritional status the samples were evaluated in various ways. After organoleptic evaluation; all dahi samples were chemically analyzed in the laboratory in terms of pH value, acidity percentage, total solids (TS) (g/kg), ash (g/kg), fat (g/kg), protein (g/kg) and carbohydrate content (g/kg).

2.5. Microbiological tests

Dahi samples were tested by gram staining method for counting the gram positive cocci and rod. Total viable count, coliform count, yeast and mold count was performed in microbiological test.

2.6. Reactions in litmus milk

Then colony peaked up the milk and kept in litmus tube. One loop of culture was inoculated in 10 mL of sterilized litmus milk, incubating at 37°C for a period of 48 hours.

2.7. Statistical analysis

Data were represented as the mean \pm SD (standard deviation). Data were subjected to one-way ANOVA and mean difference was determined using Tukey's HSD test. All analysis was conducted in "SAS / STAT" (version 9.13" for Windows Service Pack 4, 2004 SAS Institute, Cary NC USA) for Windows. Differences at $p < 0.01$ were considered statistically significant.

3. Results and Discussion

3.1. Qualities of dahi

Dahi samples were collected from Bogra and Mymensingh area and a total of were collected and monitored by physical, chemical and microbiological tests.

3.2. Physical tests

Physical tests (smell and taste, body and consistency, color and texture and overall physical score) of dahi were done as per recommended protocol and results were compiled in Table 1.

3.2.1. Smell and taste

There was significant difference ($p < 0.01$) among the smell and taste score of dahi samples. Highest smell and taste score (48.33 ± 0.58) was found in Maharam Ali dahi, Bogra and BAU Dairy Farm dahi, Mymensingh whereas the lowest value (39.66 ± 1.53) was observed in Shes Moor dahi sample. Ara *et al.* (2015) found that addition of 10% jack fruit juice with dahi, smell and taste score was 41.44 ± 0.05 , which was agreed with the present findings.

3.2.2. Body and consistency

There was significant difference ($p < 0.01$) among the body and consistency score of all dahi samples. Highest body and consistency score was also found in Maharam Ali dahi, Bogra and BAU Dairy Farm dahi, Mymensingh whereas the lowest value was in Shes Moor dahi. Mangashetti *et al.* (2003) found that, dahi produced from concentrated milk with 7.5% added sugar has smooth body and textural characteristics. The variation in body and consistency score of dahi culture among different sources could be attributed to different starter cultures, total solids content and manufacturing process employed.

3.2.3. Color and texture

There was significant difference ($p < 0.01$) present among the color and texture score of all samples. Highest color and texture was found in BAU Dairy Farm dahi (18.67 ± 0.58) and the lowest value was observed Shes Moor dahi (13.67 ± 0.58). Improving the textural quality of yogurt including firmness, viscosity, and creaminess, functional ingredients provide health benefits (Drake *et al.*, 2000). These additional properties may affect consumer acceptability and preference (Fox, 2001).

3.2.4. Overall physical score

Statistical analysis showed that there was significant difference ($p < 0.01$) present on the overall physical score among all samples. Highest overall physical score was recorded in BAU Dairy Farm dahi (95.33 ± 1.53). On the other hand, lowest score was seen in case of Shes Moor dahi (74.33 ± 1.53). The result of physical taste score agrees with the findings of Islam *et al.* (2010) who found that overall physical taste score were 86.45 ± 7.65 which was the similar of Bogra dahi sample especially Rofat dahi sample. Many parameters affect flavor, body, and texture of yogurt such as the starter culture, incubation temperature, processing conditions (e.g., heat treatment, homogenization) and compositional properties of the milk base (Shaker *et al.*, 2001).

3.3. Chemical tests

The results of chemical analyses (pH value, acidity, total solids, fat, protein, carbohydrate, ash) of dahi samples collected from study areas are shown in Table 2.

3.3.1. pH value

There was significant difference ($p < 0.01$) present among the pH value for collected dahi of different sources. Highest pH value (4.53 ± 0.06) was found in BAU Dairy Farm dahi and the lowest value (3.93 ± 0.06) was observed of Jamuna dahi. The result of present findings were agreed with the work of Kamruzzaman *et al.* (2002) who reported that pH value of dahi samples at room temperature varied from 4.01 to 4.16.

3.3.2. Acidity content

There was significant difference ($p < 0.01$) among the acidity content of dahi samples. Acidity content and pH value were oppositely correlated. Highest value (0.80 ± 0.02) was observed in case of Jamuna dahi, Bogra whereas the lowest value (0.7 ± 0.2) was observed in Dayamoy dahi, Mymensingh. Alam (2014) found that acidity of dahi was 0.7% which agrees with the present findings. The result of present findings (average acidity 0.7%) nearly similar with the work of Rashid and Miyamoto (2005) who found that acidity of dahi was 0.6%.

3.3.3. Total solids (TS) content

There was significant difference ($p < 0.01$) present among the total solids content of dahi samples. Total solids content of Krishna Kebin dahi sample was found higher than that of the other samples. Three types of samples were found to similar in sample and that was the lowest value. The differences for the total solids content in different dahi samples may be due to different level of sugar content. Normally total solids content of yoghurt ranges from 17.11 to 21.80% (Muhammad *et al.*, 2005) which was the lowest value from the present findings.

3.3.4. Fat content

There was significant difference ($p < 0.01$) among the fat content for collected dahi of different sources. Highest fat content was found to BAU Dairy Farm dahi compared to the Maharam Ali dahi which containing lowest score. The reasons for lower fat content may be due to use of skimmed milk or low fat content milk. The fat content of dahi samples were agreed with the results observed by Rashid and Miyamoto (2005) who reported that the samples from Mymensingh had the highest ($4.88 \pm 0.99\%$) fat content.

3.3.5. Protein content

There was significant difference ($p < 0.01$) present among the protein content of different dahi samples. Protein content of Misti Kanan dahi was found higher and Rofat dahi was found lower among the samples. The protein content of all dahi samples were slightly lower than the protein content range of 3.99-4.74% as reported by Rashid and Miyamoto (2005). Yogurt can also be an excellent source of high-quality protein, which promotes satiety, helps in maintaining a healthy body weight (Webb, 2014).

3.3.6. Carbohydrate content

There was significant difference ($p < 0.01$) present among the carbohydrate content of dahi samples. Result reveals that Dayamoy dahi contained highest carbohydrate and the lowest value was observed in Misti Kanan. The carbohydrate content of dahi samples were not in agreement with the carbohydrate content of 8.47 ± 0.12 as reported by Khan (2008).

3.3.7. Ash content

There was significant difference ($p < 0.01$) present among the ash content of dahi samples. Samples of Jamuna dahi and Shes Moor dahi showed significantly highest value (0.9 ± 0.02) in ash content compared to BAU Dairy Farm dahi and Kamal Ranjit market dahi (0.7 ± 0.04) which was the lowest value. The ash content of all the dahi samples were agreed with the range of 0.73-0.91% as found by Haj *et al.* (2007) and the range of 0.78-0.80% as reported by Chandra *et al.*, 2013.

3.4. Microbiological status

The results of gram positive cocci and rod content of dahi samples are compiled in Table 3.

3.4.1. Cocci (%)

Statistical analysis showed that there was significant difference present among gram positive cocci content of dahi samples. The highest value (77.33 ± 2.35) was observed in Misti Kanan dahi, Mymensingh and the lowest value (31.67 ± 7.09) was observed in Shes Moor dahi, Mymensingh. Mikulec (2009) observed from his experiment that lactic acid were found in yoghurt samples as the form of *lactococci* (44.28%) which was agreed the present findings. Variability in the bacterial culture could be attributed due to the type of dahi, quality of dahi, heat treatment of dahi, incubation period and types of starter culture.

3.4.2. Rod (%)

Statistical analysis showed that there was also significant difference ($p < 0.01$) present among the rod content for collected dahi of different sources. The highest value (68.33 ± 7.09) was observed in Shes Moor dahi, Mymensingh whereas the lowest value (22.67 ± 3.06) was observed in Misti Kanan dahi, Mymensingh. Result indicates that the highest and lowest value of rod was in oppositely correlated with the value of cocci percentage. Ali (2011) found 22% Lactobacilli to their experiment, which was agreed in Misti Kanan dahi, Mymensingh to the present study.

3.4.3. Ratio of cocci and rod

The ratio of cocci and rod in most of the dahi samples were 1:1 to 3:1 which was also agreed with the findings of Mikulec (2009). Proper ratio of rods and cocci (*Lactobacillus bulgaricus* : *Streptococcus thermophilus*; 1:1) are generally important for preparing cultured dairy products (Jelena, 2002).

3.5. Microbiological examination test

The results of microbiological test (Total viable count and coliform count) are shown in Table 4. No yeast and mold was detected which indicates that the quality of dahi from different sources were maintained hygienically.

3.5.1. Total viable count

Statistical analysis showed that there was significant difference ($p < 0.01$) found among the dahi samples. Highest value (67.33×10^4) was observed in Maharam Ali dahi and the lowest value (28.67×10^4) was observed in Misti Kanan, Mymensingh. The samples of Bogra region dahi showed the highest bacterial counts which agreed with the result of Sarker *et al.* (2012).

Table 1. Organoleptic score of dahi samples collected from different sources.

Physical parameters	Types of dahi sample									'p' value
	A	B	C	D	E	F	G	H	I	
Smell and taste (50)	48.33 ^a ±0.58	41.66 ^c ±1.52	45.66 ^{ab} ±0.58	47.00 ^{ab} ±1.00	41.67 ^c ±1.15	45.00 ^b ±1.00	48.33 ^a ±0.58	40.66 ^c ±1.15	39.66 ^c ±1.53	0.0001
Body and consistency (30)	28.00 ^a ±0.00	26.66 ^{ab} ±0.58	25.66 ^{bc} ±0.58	27.33 ^{ab} ±0.58	24.33 ^{cd} ±0.58	23.67 ^{cd} ±0.58	28.33 ^a ±0.58	22.00 ^{ef} ±1.00	21.00 ^f ±1.00	0.0001
Color and texture (20)	18.33 ^a ±0.58	17.66 ^{ab} ±0.58	17.33 ^{ab} ±0.58	16.00 ^{bc} ±1.00	16.33 ^{bc} ±0.58	16.00 ^{bc} ±1.00	18.67 ^a ±0.58	15.33 ^{cd} ±0.58	13.67 ^d ±0.58	0.0001
Overall physical score (100)	94.66 ^a ±0.58	86.00 ^{cd} ±2.00	88.67 ^{bc} ±1.15	90.33 ^b ±0.58	82.33 ^d ±1.15	84.67 ^d ±1.52	95.33 ^a ±1.53	78.00 ^e ±1.73	74.33 ^e ±1.53	0.0001

Table 2. Chemical analysis of dahi samples collected from different sources.

Parameters	Types of dahi sample									'p' value
	A	B	C	D	E	F	G	H	I	
pH	4.21 ^{bc} ±0.03	3.97 ^{dc} ±0.60	3.93 ^e ±0.06	4.46 ^a ±0.08	4.26 ^{bc} ±0.03	4.36 ^{ab} ±0.06	4.53 ^a ±0.06	4.27 ^{bc} ±0.03	4.15 ^{cd} ±1.3	0.0001
Acidity (%)	0.80 ^b ±0.02	0.89 ^a ±0.01	0.90 ^a ±0.02	0.72 ^d ±0.02	0.79 ^{bc} ±0.01	0.74 ^c ±0.02	0.70 ^d ±0.01	0.78 ^{bc} ±0.02	0.80 ^b ±0.01	0.0001
Total solids (g/kg)	24.99 ^{cd} ±0.68	24.35 ^d ±0.77	25.14 ^{bcd} ±0.46	26.80 ^{ab} ±0.40	25.87 ^{abcd} ±0.41	26.85 ^a ±0.65	26.25 ^{abc} ±0.84	24.80 ^{cd} ±0.44	25.61 ^{abcd} ±0.40	0.0004
Fat (g/kg)	3.10 ^d ±0.36	3.73 ^{bcd} ±0.83	3.20 ^{cd} ±0.10	4.50 ^{ab} ±0.43	4.80 ^{ab} ±0.20	4.83 ^{ab} ±0.21	5.10 ^a ±0.52	4.00 ^{abcd} ±0.20	4.33 ^{abc} ±0.15	0.0001
Protein (g/kg)	3.50 ^{ab} ±0.20	3.11 ^b ±0.10	3.63 ^{ab} ±0.20	3.67 ^{ab} ±0.21	3.97 ^a ±0.25	3.47 ^{ab} ±0.21	3.63 ^{ab} ±0.23	3.60 ^{ab} ±0.20	3.40 ^b ±0.10	0.0061
Carbohydrate (g/kg)	17.50 ^a ±0.49	16.61 ^{bcd} ±0.28	17.39 ^{abc} ±0.38	17.80 ^a ±0.26	16.27 ^d ±0.25	17.67 ^a ±0.42	16.64 ^{bcd} ±0.35	16.46 ^{cd} ±0.42	16.97 ^{abcd} ±0.20	0.0002
Ash (g/kg)	0.88 ^{ab} ±0.02	0.88 ^{ab} ±0.02	0.91 ^a ±0.02	0.83 ^b ±0.01	0.83 ^{bc} ±0.02	0.88 ^{ab} ±0.02	0.77 ^{cd} ±0.04	0.73 ^d ±0.02	0.90 ^a ±0.02	0.0001

Table 3. Gram staining from dahi samples collected from different sources.

Gram staining	Types of dahi sample									'p' value
	A	B	C	D	E	F	G	H	I	
Cocci (%)	50.0 ^{ab} ±3.61	32.67 ^b ±7.09	56.0 ^{ab} ±2.0	51.0 ^{ab} ±1.0	77.33 ^{ab} ±2.35	46.33 ^{ab} ±7.77	51.33 ^{ab} ±3.06	69.67 ^a ±1.53	31.67 ^b ±7.09	0.0023
Rod (%)	50.0 ^c ±3.61	67.33 ^{ab} ±7.09	44.0 ^{cd} ±2.0	49.0 ^c ±1.0	22.67 ^e ±3.06	53.33 ^{bc} ±7.64	48.67 ^c ±3.06	33.67 ^{de} ±4.73	68.33 ^{ab} ±7.09	0.0001
Ratio of cocci and rod	1:1	0.48:1	1.27:1	1.04:1	3.41:1	0.81:1	1.05:1	2.06:1	0.46:1	

Table 4. Microbiological quality of dahi collected from different sources.

Parameter	Types of dahi sample									'p' value
	A	B	C	D	E	F	G	H	I	
Total viable count (cfu/mL)	67.33 ^a ×10 ⁴ ±6.33	36.0 ^{cd} ×10 ⁴ ±6.56	55.33 ^{ab} ×10 ⁴ ±4.72	35.0 ^{cd} ×10 ⁴ ±5.29	28.67 ^d ×10 ⁴ ±4.73	40.0 ^{cd} ×10 ⁴ ±5.57	46.33 ^{bc} ×10 ⁴ ±4.73	58.67 ^{ab} ×10 ⁴ ±4.16	38.67 ^{cd} ×10 ⁴ ±1.53	0.0001
Coliform count (cfu/mL)	9.0 ^{bc} ±1.0	12.0 ^{abc} ±2.0	17.67 ^a ±2.52	7.0 ^c ±1.0	9.0 ^{bc} ±3.6	10.33 ^{bc} ±1.53	9.0 ^{bc} ±1.0	14.0 ^{ab} ±2.0	17.67 ^a ±2.51	0.0001
Yeast and mold count (cfu/mL)	ND	ND	ND	ND	ND	ND	ND	ND	ND	

Where, ^{abcdef} mean with different superscripts in a row differed significantly.

A=Maharam Ali dahi ghar, B=Rofat dahi ghar, C=Jamuna dahi ghar, D=Dayamoy, E=Misti Kanan F=Krishna Kebin, G=BAU Dairy Farm, H=Kamal-Ranjit market, I=Shes moor

Table 5. Litmus milk reactions from the agar plate.

Sample No.	Reactions of isolated colony in Litmus milk	Possible organism
A	Smooth, firm coagulation and acid coagulation (pink)	<i>Streptococcus thermophilus</i> , <i>Lactobacillus bulgaricus</i>
B	Alkaline reaction (blue)	<i>Alcaligenes faecalis</i>
C	Acid reduction, sweet curdling	<i>Streptococcus lactis</i> , <i>Streptococcus liquifaciens</i>
D	Acid and reduction coagulation	<i>Aerobic and anaerobic spore forming pseudomonous</i>
E	Acidified, curdled and alkaline reaction	<i>Streptococcus thermophilus</i> , <i>Streptococcus lactis</i>
F	Acid coagulation and reduction coagulation	<i>Streptococcus thermophilus</i> , <i>Streptococcus lactis</i>
G	Smooth and firm coagulation	<i>Streptococcus thermophilus</i> , <i>Lactobacillus bulgaricus</i>
H	Acid coagulation	<i>Streptococcus lactis</i> , <i>Lactobacillus bulgaricus</i>
I	Acid coagulation and acid formation	<i>Streptococcus lactis</i> , <i>Streptococcus cremoris</i> , <i>Lactobacillus bulgaricus</i> , <i>Lactobacillus acidophilus</i>

Where, A=Maharam Ali dahi ghar, B=Rofat dahi ghar, C=Jamuna dahi ghar, D =Dayamoy, E =Misti Kanan, F =Krishna Kebin, G=BAU Dairy Farm, H=Kamal-Ranjit market, I=Shes moor, Mymensingh.

3.5.2. Coliform count

Statistical analysis showed that there was significant difference ($p < 0.01$) present among all the dahi samples. Highest value (17.67 ± 2.51) was observed in Shes Moor dahi, Mymensingh and the lowest value (9.00 ± 1.0) was observed in Maharam Ali dahi, Misti Kanan dahi and BAU Dairy Farm dahi. The presence of coliform organisms in dahi samples indicated contamination during its production, handling etc.

3.5.3. Litmus milk reactions from the agar plate

The result of the litmus milk characteristics has been reported in Table 5. After 48 hours of incubation, it was observed that most of the cultures were produced acid, gas, reduction coagulation. These reactions were performed in this experiment but selected organisms were not studied in this experiment. The present investigation showed that Maharam Ali dahi and BAU Dairy Farm dahi contained desirable reactions which contain possible organisms (*Streptococcus thermophilus*, *Lactobacillus bulgaricus*).

3.6. Conclusions

From the findings of this study, it can be concluded that Maharam Ali dahi and BAU Dairy Farm dahi were found as superior on the basis of physical, chemical and microbiological qualities. Proper ratio of gram positive cocci and rod were found in Maharam Ali dahi, BAU Dairy Farm dahi and Dayamoy dahi which were collected from Bogra and Mymensingh district. Litmus milk characteristics of the isolated colony showed desirable changes such as acid, smooth and firm coagulation obtained from Maharam Ali dahi and BAU Dairy Farm dahi. However, more researches should be needed to know the complete microbial profile in Bangladeshi traditional dahi.

Conflict of interest

None to declare.

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