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Dahi (Curd) preparation from milk with different levels of carrot (*Dacus carota*) juice

Abstract

The main purpose of the study was to measure the feasibility of incorporation of carrot juice in the manufacture of Dahi (curd). Four different types of Dahi were manufactured incorporating 0, 5, 10, and 15 percent carrot juice with whole milk. The prepared Dahi samples were tested through physical, chemical and microbiological analysis to evaluate their qualities. Data on different parameters were recorded and analyzed. It was found that the physical qualities of the Dahi improved by the addition of carrot juice with milk. The addition 5% of carrot juice shown better smell and taste. It also revealed that 15% carrot juice addition shown superior results for consistency as well as color and texture. Addition of carrot juice decreased the Fat content and pH Value but increased the protein content, total solids content, ash content and acidity ($p<0.05$). Dahi containing 5% carrot juice showed little better performance with respect to chemical qualities than the control ($p<0.05$). It further revealed that carrot juice increased the number of bacteria than the control Dahi. The study suggested that Dahi could be successfully manufactured incorporating 15% carrot juice. Production of greater volume of Dahi from reduced volume of whole milk incorporating a cheap additive like carrot juice might make Dahi product business more profitable and popular.

Keywords: curd, yogurt, carrot, juice, marketing, value chain, microbiological effect

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Abbreviation: TS, total solids; CRD, completely randomized design; ANOVA, analysis of variance test; LSD, least significant difference

Introduction

Dahi is one of the oldest fermented milk products and is the most popular one in the Indian subcontinent. This product is known by different names in different countries of the world. In European countries, it is known as yogurt in the Middle Eastern countries the product has different names such as 'leben' in Egypt, 'Albany' in Syria and 'Dahi' in the Indian subcontinent. About 7% of the total milk production in India and 4% of the total production of Pakistan and Bangladesh is converted to Dahi for consumption.[1] Many people of Bangladesh lead their livelihood by rearing cattle.[2] Milking cow is an important asset for farmers for earning money by selling milk and milk products which helps to reduce their poverty.[3–5] The dairy farmers of riverine island (char) areas are dependent on their milking cows.[6,7] In the developing countries of Asia and Africa, yogurt is more likely to be produced as naturally soured milk and to be consumed by the adult more than fresh whole milk. It is generally considered as a safer product and its unique flavor carrot to so many that considerations are being given by nutritionists to incorporate inexpensive sources of nutrients. Different types of Dahi such as sweet Dahi, sour Dahi and flavored Dahi are found in the market. Sweet Dahi is generally prepared from a mixed culture of S. lactis, S. thermaphilus and S. citrophilus and sugar is usually added@8-12% volume of milk. The fermented products have therapeutic properties and high nutritive value. Flavoured Dahi is made by the addition of synthetic flavor or natural fruit juice (Table 1).

Table 1 Composition of natural yogurt

Components	Natural yogurt	
	Full fat	Low fat
Protein (%)	3.9	5
Fat (%)	3.4	1
Carbohydrate (%)	3.9	6.5

Mechanism of curd formation during dahi making

Fermentation in milk consist essentially the gradual conversion of lactose into lactic acids by lactose fermenting organisms. The lactose molecule is broken down by the enzyme lactase to glucose and galactose on its path way (glycolytic pathway) towards lactic acid. Each of the simpler sugars is further acted upon by several routes of lactic acid, and there can be several forms of acid end products.[8] However, a portion of the acid combines with the calcium of casein to form calcium lactate, thus setting free the casein and coagulating it when its iso-electric point (pH 4.6) is reached. The calcium combine as $CaHPO_4$ in milk goes completely into solution more rapidly than calcium combined as caseinate during souring.

$$\underset{\text{Lactose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow[\text{Lactase}]{\text{Lacticacidbacteria}} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Galactose}}{C_6H_{12}O_6}$$

$$\underset{\text{Glucose}}{C_6H_{12}O_6} \xrightarrow{\text{Glycolyticpathway}} \underset{\text{Lacticacid}}{4C_3H_6O_3}$$

$$Ca - caseinate + Lactic\ acid \rightarrow Ca - lactate = casein\left(curd\ form\right)$$

Nutritive and therapeutic value of the carrot juice incorporated Dahi

Lactose intolerance: Numerous studies have shown that yogurt with live, active cultures is a well-tolerated alternative to milk for lactose malidigesters, even though it does not contain significantly less lactose than milk. Although 20 to 30% of the lactose in milk is hydrolyzed to glucose and galactose during yogurt fermentation, the total lactose content is often not lower than that of milk because of the non-fat milk solids added to many yogurts. The most likely explanation for this tolerance of yogurt which is supported by various studies is the presence of microbial beta-galactosidase the enzyme which breaks lactose down to its constituent's glucose and galactose. Being intracellular, this bacterial enzyme survives gastric digestion and comes into play once in the intestine. As it is sensitive to freezing, though the enzymes offer or no activity in frozen yogurts.[9]

Protection against cancer: Studies relating yogurt intake to cancer form a melting pot of contradictory results. Whilst an inverse association was found between yogurt consumption and breast cancer, yogurt intake was positively linked ovarian cancer in another study. Findings from animal studies indicate do yogurt and its constituent microflora, lactobacilli, and bifido bacteria inhibit the growth or cause regression of transplantable or chemically induced tumors, but unfortunately, there is no concrete evidence of a similar benefit to humans.[9]

Protection against gastrointestinal infections: Consumption of yogurt containing live lactic bacteria may well interfere with the colonization and proliferation of food-borne pathogens, preventing gastrointestinal disturbance such as diarrhea, Scientists currently investigated the protective effect of Streptococcus thertwphilus.[10] Lactobacillus bulgaricus and Lactobacillus acidophilus against these upsets and cite the following central characteristic abilities:

i. Lowering intestinal pH, flavoring lactic acid bacteria.
ii. Competing with pathogens for essential nutrients
iii. producing antibacterial substances (bacteriocins)
iv. Neutralizing toxins.

Bifidobacterium spp has been pushed into the spotlight recently for its potential benefits in intestinal disorders. Although relatively little is known about it, the predominant organism in the intestine of breastfed infants has been shown to fight off a number of pathogens. It may also correct large bowel flora imbalance caused by antibiotics or conditions such as cancer, liver or kidney disease and impaired gastrointestinal function in the elderly.[11]

Protection against coronary heart disease and improves Immunity: The yogurt may reduce blood cholesterol and save from disease. Specific and non-specific immune mechanisms can be enhanced by in taking of live active bacteria which protect from pathogens, and viruses. The fermented milk products is increasing gradually so that farmers can easily find alternate uses of milk and maintain their livelihood, food and nutritional security.[6,12] Dahi is one of the popular fermented milk products and a much-demanded item of diet for a human.[10] The preparation of Dahi has been investigated by a number of research workers in different parts of the world.[12–14] However, in Bangladesh limited number of works has been done in the preparation of fruit Dahi and no works has yet been done for prepared of Dahi incorporating of carrot juice with milk.

Carrot and its nutritive value: Carrots are grown around the year and popularly known as the vegetable. It is easy to grow, tasty and highly nutritious for children and adults. There are more than 100species of carrots ranging from not only in colors but also its size from as small as two inches to three feet. Carrots are the second most popular type of vegetable after potatoes which provide much nutrition for body. It bears vitamin B1, vitamin B2, vitamin B6, vitamin K, biotin, fiber, potassium, and thiamine (Table 2).

Table 2 Nutritional value of carrot

Components	In 100g
Water	87-88
Total Solid (TS)	13-Dec
Fat	0.19
Carbohydrate (CHO)	14-Oct
Protein	1
Calcium (Ca) mg	27
Phosphorus (P) mg	44
Energy (Kcal)	43
Vit C (mg)	9.3
Vit A (I.U)	2800
Folic acid	14

Source: UNAID research institute.

Dahi is one of the most important pleasant and charming foods in every country. It is extensively used chiefly along with other foods due to its good flavor and high food value. The preparation of Dahi has been investigated by a number of researchers in different parts of the world. But very few works have been done in Bangladesh in the preparation of fruit Dahi. The specific objectives of the study were (a) to study the feasibility of making Dahi by incorporating different levels of carrot juice with whole milk and (b) to recommend an appropriate technology and the level of carrot juice to be used for the preparation of a kind of fruit-flavored Dahi from whole milk.

Materials and methods

The present study was conducted at Dairy Science Laboratory of Bangladesh Agricultural University (BAU) during the period from March 1 to June 25, 2012. Chemical analysis was also done at Dairy Science Laboratory of Bangladesh Agricultural University, Mymensingh, Bangladesh.

Preparation of carrot juice

The carrot was purchased from KR market of BAU campus Mymensingh, Bangladesh and brought to the laboratory for collecting juice. It was washed with distilled water. Then the carrot was cut into small parts with the help of knife then pieces of carrot were blended. After blending the juice was filtered by a clean cloth (hot water washed).

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Preparation of plain Dahi (control) and carrot Juice dahi

Whole milk was collected from the vendors and local market of Mymensingh Town. Milk was boiled for sometimes to reduce about 20percent of original volume. Sugar was added to the milk at the rate of 8 percent during boiling. During heating, milk was stirred thoroughly with the help of a stirrer. After desired heating milk pan was taken out from the heater and allowed to reduce Temperature. When the temperature became about 40°C, then the milk was divided into four equal portions and different types of Dahi were prepared from each portion by using the different proportions of carrot juice (Table 3) discussed below:

Table 3 Indicators and percentage of carrot

Indicator	Percentage of carrot
1. Carrot juice	0% (Plain)
2. Carrot juice	5
3. Carrot juice	10
4. Carrot juice	15

The carrot juice was incorporated into yogurt at 5, 10 and 15% level in a different cup except for control. Juice was added before incubation with culture as suggested by Gandhi et al.[14] and Singh.[15] Heated milk was cooled to 40°C and inoculated with the desirable proportion of culture (2%) which was collected from Dairy farm, BAU. The plastic cups were pre-washed with boiled water before use. The samples were incubated at 37°C until the complete coagulation of Dahi samples. After complete coagulation (8-12hrs) the Dahi samples were stored at about 5°C under refrigeration until use.

Evaluation of prepared Dahi samples

Organoleptic test: The experiment was conducted three times and each time quality of prepared Dahi samples was evaluated with the help of physical, chemical and microbial tests. The parameter used to monitor the physical quality of Dahi samples were smell and taste, body and consistency and color and texture.

Chemical tests: After the organoleptic evaluations all Dahi samples were chemically analyzed in the laboratory for composition. The parameters were Total solids (TS) content (g/kg), Fat content (g/kg), Protein content (g/kg), Ash content (g/kg), Acidity content (%) and pH.[11,17] Total solids and ash content of the different type of Dahi samples were determined by Oven drying method according to Association of Official Agricultural Chemists.[16] Fat percent was determined by Babcock method using the procedure described by Aggarwala et al.[16] Acidity was determined by titrating with N/10 sodium hydroxide solution using the procedure of Aggarwala et al.[16] Crude protein was determined by Kjeldahl procedure and pH was measured with the help of a pH meter-215.[17]

Microbiological test: Standard Plate Count (cfu/g) and Coliform count (cfu/g) microbiological tests were done to determine the microbiological quality of different types of Dahi sample. Analysis of variance test (ANOVA) was done to find out the statistical difference between the means. In this experiment, all experimental materials were completely homogenous and for this reason, data were analyzed by using one-way analysis of variance test in Completely Randomized Design (CRD)[18] using the MSTAT statistical program. Least significant difference (LSD) was determined for ranking the products.[17,19]

Results and discussion

The findings of the present study are presented in Tables 4-6. For ease of description, the results have been discussed under following four headings.

Organoleptic parameters

Smell and taste: Smell and taste score of Dahi sample containing and A, B, C and D carrot juice was 47.67±1.15, 44.67±0.58, 43.67±0.58 and 47.33±0.58 respectively. The values are presented in Table 4. Statistical analysis showed that there was (P>0.01) significant difference within the smell and taste score of different types of Dahi. Higher smell and taste score was recorded in case of A and D level of carrot juice Dahi. On the other hand, the lowest score was seen in case of C type Dahi. The result of this experiment agrees with the work of Zaman et al.[19] who found that addition of fruit juice improved the smell and taste score of Dahi. Similar results were also reported by Najgebauer-Lejko et al.[10] Islam et al.[17] also found that smell and taste of Dahi or yogurt were improved due to the addition of fruit juice.

Body and consistency: Body and consistency score of Dahi samples containing A, B, C and D were 27.33±0.58, 23.33±0.58, 26.33±0.58 and 23.67±1.15 respectively. The values are presented in Table 4. Statistical analysis showed that there was a significant difference in the body and consistency scores of different types of Dahi. Highest body and consistency score was found in case of C. On the other hand, lowest score was seen in case of B and D type Dahi. The result of this experiment agreed with the findings of Najgebauer-Lejko et al.,[20] and Islam et al.[17] Both of them found that body and consistency of Dahi or yogurt improved due to the addition of fruit juice.

Color and texture: The color and texture of A, B, C and D type's levels of Dahi were 17.67±0.58, 16.67±0.58, 18.00±0.00 and 16.33±0.58 respectively. The values are presented in Table 4. Statistical analysis showed that there was a significant difference between the color and texture scores of different Dahi samples. The highest score of color and texture was recorded in case of C type Dahi and the lowest score was recorded for D type. The result of our experiment supports the findings of Desai et al.,[13] who observed the addition of fruit juice improved the color and texture score of Dahi. In this connection, Manus LJ[21] reported that course texture in yogurt was probably due to an imbalance of the Streptococcus thermophilus and Lactobacillus bulgaricus, resulting in overproduction of acetaldehyde which was the characteristic aroma compound in yogurt. The incorporation of carrot juice improved the organoleptic qualities of Dahi.

Total Score: The Total score of A, B, C and D type's levels of Dahi were 89b±0.68, 83c±0.58, 87b±0.58, and 90a±0.65respectively. The values are presented in Table 4. Statistical analysis showed that there was a significant difference between the total scores of different Dahi samples. The highest total score was recorded in case of D type Dahi and the lowest score were recorded for B type. The result of our experiment supports the findings of Desai et al.,[13] who observed the addition of fruit juice improved the total score of Dahi.

Different letters in the same row indicate a significant difference

Table 4 Comparison of organoleptic parameters of plain Dahi carrot juice fortified Dahi

Physical parameters	Different types of Dahi samples				LSD value	Level of significance
	A	B	C	D		
Smell and Taste (50)	47.67c ±1.15	44.67c±0.58	43.67b ±0.58	47.33a ±0.58	0.65	**
Body and Consistency (30)	27.33a ±0.58	23.33c±0.58	26.33a ±0.58	23.67c ±1.15	0.65	**
Colour and Texture (20)	17.67ab ±0.58	16.67b±0.58	18.00a ±0.00	16.33b ±0.58	0.058	**
Total Score (100)	89b±0.68	83c±0.58	87b±0.58	90a±0.65	0.58	**

Different letters in the same row indicate a significant difference

**=Significant at p<0.05.

A=whole milk+0% carrot juice Dahi, B= whole milk+5% carrot juice Dahi, C= whole milk+10% carrot juice Dahi.

Table 5 Chemical composition of different type of Dahi

Parameters	Different types of Dahi				LSD value	Level of significant
	A	B	C	D		
Fat (g/kg)	37.7±0.42	36.9±0.58	35.2±0.35	33.8±0.33	0.38	NS
Protein (g/kg)	35.7a±0.10	31.4c±0.10	32.9b±0.10	34.7ab±0.10	0.1	**
Carbohydrate (g/kg)	141.8d±0.12	153.5c±0.12	162.5b±0.10	172.3a±0.10	0.11	**
Ash (g/kg)	06.3c±0.01	06.9b±0.010	07.5ab±0.010	08.1a±0.006	0.03	**
TS(Total Solid) (g/kg)	222.8c±0.30	225.6c±0.49	238.1b±0.50	255.0a±0.53	0.42	**
PH	4.40a±0.10	4.23b±0.06	4.03c±0.06	3.90d±0.10	0.04	**
Acidity (%)	0.70d±0.02	0.83c±0.03	0.88b±0.03	0.93a±0.03	0.03	**

D= whole milk +15% carrot juice Dahi, Different letters in the same row indicate a significant difference

**=Significant at p<0.05.

Note: NS=Not significant; A=whole milk +0% carrot juice Dahi; B= whole milk +5% carrot juice Dahi; C= whole milk +10% carrot juice Dahi; D= whole milk +15% carrot juice Dahi.

Table 6 Microbiological parameters of different type of Dahi Samples

Parameter	Types of Dahi				LSD value	Level of significant
	A	B	C	D		
Standard plate Count (cfu/g)	53.67c±5.69	63.67bc±5.13	73.33b±15.28	95.00a±22.91	15.13	**
Coliform count (cfu/g)	10.00±0.00	13.33±5.77	13.33±5.77	20.00±6.00	3.88	NS

Different letters in the same row indicate a significant difference

**=Significant at p<0.05; NS, not significant.

Note: A=whole milk+0% carrot juice Dahi, B= whole milk+5% carrot juice Dahi, C= whole milk+10% carrot juice Dahi, D=whole milk+15% carrot juice Dahi.

Chemical parameters

Total solids: The average Total solids content of A, B, C and D types of Dahi were 222.8±0.30, 225.6±0.49, 238.1±0.50 and 255.0±0.53g/kg respectively Table 5. The highest Total solids content was found in D and the lowest in A type Dahi. Statistical analysis showed that there was a significant difference among the Total solids content of A, B, C and D type Dahi. The result agrees with the work of Cliff et al.,[22] who found that total solids contents increased significantly due to the addition of fruits in yogurt. Islam et al.[17] also conducted an experiment with different types of fruit juice and found that addition of fruit juice significantly increased the total solids content of Dahi.[23]

Fat: The average values for the fat content of A, B, C and D types of Dahi were 37.7±0.42, 36.9±0.58, 35.2±0.35, 33.8±0.33g/kg respectively Table 5. Statistical analysis showed that there was no significant difference between the fat contents of A, C, B, and D type Dahi. The result does not agree with the work of Desai et al.[13] who found that fruit yogurt contained lower amounts of fat than the plain yogurt. A similar type of results was also obtained by Mustafa.[24]

Fat percent of plain sweet Dahi was studied by Cliff et al.[22] and the fat percent of plain Dahi of this experiment is nearly similar to the findings of them.[17,25]

Protein: The average values of the protein content of A, B, C, and D type Dahi were 35.7±0.10, 31.4±0.10, 32.9±0.10 and 34.7±0.10, respectively Table 5. The protein content was higher in plain Dahi and lower in B. Statistical analysis showed that there was a significant difference in the protein content of A, C, B and D Dahi samples. The result agreed with the work of Islam et al.[17] who found that plain Dahi contained a higher amount of protein than fruit Dahi. A similar type of result was also obtained by Islam et al.[17]

Carbohydrate: The average values of Carbohydrate content of A, B, C, and D type Dahi were 141.8±0.12, 153.5±0.12, 162.5±0.10 and 172.3±0.10g/kg respectively Table 5. The carbohydrate content was higher in D Dahi and lower in A type. Statistical analysis showed that there was a significant difference between the Carbohydrate contents of A, C, B and D Dahi samples. This result agrees with Desai et al.,[13] who found that carbohydrate contents increased significantly due to the addition of fruits in yogurt.[26]

Ash: The average ash content of A, B, C and D types of Dahi was 06.3±0.01, 06.9±0.010, 07.5±0.010 and 08.1±0.006g/kg respectively Table 5. The highest ash content was found in D and the lowest ash content was found in A sample. Statistical analysis showed that there was a significant difference ($p<0.05$) within the ash contents of A, B, C and D Dahi samples. The findings of this study agree with the work of Mustafa[24] and Desai et al.[13] Both researchers found that addition of fruit juice increased the ash percentage in Dahi.

pH: The average pH values were 4.40±0.10, 4.23±0.06, 4.03±0.06 and 3.90±0.10, for the A, B, C and D types respectively Table 5. Addition of fruit slightly decreased the pH value of Dahi. It is well known that when pH value decreases then acidity increases.[23] In this experiment acidity of carrot juice fortified Dahi increased which might be due to decreased pH values. The result of present findings agreed with the work of Islam et al.[17] who found that pH of plain Dahi was 4.25. Kosikowski[27] also reported that the pH of normal Dahi samples should be approximately 4.4.

Acidity: The average values of acidity percentage were 0.70d±0.02, 0.83c±0.03, 0.88b±0.03 and 0.93a±0.03 for A, B, C and D carrot juice made Dahi respectively (Table 5). Statistical analysis showed that the differences of acidity percentage among different treatments were significant. Acidity increased due to the addition of carrot juice.[23] The results of acidity of Dahi samples agree with the findings of Desai et al.[13] who found that the titratable acidity of fruit Dahi was significantly increased due to the addition of fruit juice/pulp. Mustafa[24] prepared Dahi by using different types of seasonal juice and observed that acidity content of Dahi increased due to the addition of fruit juice in Dahi.

Microbiological

Total viable bacteria count (cfu/g): The total viable count per g of A, B C, and D types of Dahi were $53.67±5.69×10^4$, $63.67b±5.13×10^4$, $73.33±15.28×10^4$ and $95.00±22.91×10^4$per g respectively Table 6. Statistical analysis showed that there was significant difference $p<0.05$ among the different samples. This finding indicates that total viable count increase with the addition of carrot juice. The present investigation showed lower SPC values than those of Rahman[28] who found that average total viable count was $2.80xl0^4$/g in the jackfruit flavored Dahi.

Coliform count (cfu/g): The total coliform count per g of A, B C, and D types of Dahi were10.00±0.00, 13.33±5.77, 13.33±5.77 and 20.00±10.00cfu/g respectively Table 6. Statistical analysis showed that there was no significant difference among the different samples. This finding indicates that total coliform count almost similar to different sample which was an indication of hygienic production[17,29,30] (Figure 1) .

Figure 1 Different types of Dahi prepared in the laboratory.

Conclusion

In this experiment, an attempt was made to prepare Dahi by adding different levels of carrot juice with whole milk. It was found that Dahi samples prepared by using 15% evaluation carrot juice scored highest for the total score ($p<0.05$) on organoleptic. Chemical analyses showed that the differences in fat percentage between plain and carrot juice made Dahi and among the different types of Dahi samples were insignificant. Differences of protein content in different Dahi samples was significant ($p<0.05$). It was reveal that by adding 15% carrot juice was shown better quality of the product better than other samples. Addition of carrot juice developed deep color in flavored of Dahi which was more attractive and nutritious, thus appreciated by a panel of judges. This study suggested to using 15% carrot juice with whole milk for preparing high quality fruit flavored Dahi. So, the manufacturers and the consumers might welcome to the incorporation of carrot juice in the manufacture of Dahi from whole milk.

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Conflicts of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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