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Article

Development of flavored dahi by incorporating soymilk and cocoa powder

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Abstract: The experiment was conducted to develop the chocolate-flavored soy dahi and find the accepted level of soymilk that should be added to milk to produce chocolate-flavored dahi. Therefore, four distinct kinds of dahi designated T_0 (control, 100% cow milk), T_1 (75% cow milk and 25% soy milk) and T_2 (50% cow milk and 50% soy milk) and T_3 (25% cow milk and 75% soy milk) were prepared by partially substituting cow milk to soy milk. Each variety also contained 1.5% cocoa powder. A panel of professional judges assessed the sensory (organoleptic) properties of the produced samples. The physical study's findings revealed that the overall organoleptic (i.e., smell and taste, body and texture, color and appearance) scores of dahi of kinds T_0, T_1, T_2, and T_3 varied significantly ($P<0.01$) from one another. According to the findings of the chemical test, the soy milk addition considerably lowered the amount of fat, acidity, total solids, and minerals while dramatically increasing the amount of moisture and protein ($P<0.05$). The growth of lactic acid bacteria is considerably better, however, it gradually reduces with the higher Addition of soy milk to cow milk. Based on the findings, it was concluded that soy milk could substitute milk by 25%, producing dahi that may be almost as good as that made only with milk and cocoa powder.

Keywords: flavored dahi; milk; soymilk; cocoa powder

1. Introduction

Dahi is one of the common value-added dairy products made from milk by fermentation. It is popularly known as yogurt is the most widely eaten and oldest type of fermented dairy product in the world and is consumed throughout Bangladesh either as a part of the daily diet along with the meal or as a refreshing beverage (Shah, 2017). According to the Prevention of Food Adulteration (1976) rules, dahi shall contain the same percentage of fat and solids-not-fat as the milk from which it is prepared. Fermented foods, such as dahi, are extremely important because they offer and retain huge amounts of healthy foods with a wide variety of flavors, fragrances, and textures, which improve the human diet (Sarkar, 2008). The starter cultures, processing conditions, milk supply, chemicals and additives used to make dahi all contribute to its final flavor. The starter

cultures used in the fermentation process are a particularly important contributor to the development of taste components (Shah, 2017). Dahi of varying flavors relies on thermophilic starter cultures. They are added to dahi for their purported health advantages but also change the flavor. When making stirred dahi, mesophilic microorganisms are utilized (Surono and Hosono, 2011).

Soybeans consist of 30% carbohydrate, 18% fat, 14% moisture, and 38% protein and contain all nine essential amino acids at levels that meet human requirements. Soy milk provides excellent nutrition, they are low in saturated fat and the quality of soy protein is equal to the quality of animal protein (Deshpande, 2004). Soymilk is an excellent milk substitute for health-conscious consumers (Jeske *et al*., 2018) Soy yogurt, made in a similar way to milk fermentation by adding cultures to soy milk, has grown in popularity because of its high protein content and several beneficial effects like reduction of cardiovascular disease, alleviate arthritic symptoms, reduce osteoporosis, prevent breast and prostate cancers, improve brain function and a good food source for dairy milk substitution for those with lactose-intolerant or allergic to milk proteins (Donkor *et al*., 2007; Champagne *et al*., 2009; Wagar *et al*., 2009; Jeske *et al*., 2018; Rizzo and Baroni, 2018). Yet, owing to the presence of hexanal and pentanal compounds, soy yogurt decreases its popularity due to an unpleasant or "beany" flavor and the flatulence it causes (Sethi *et al*., 2016; Krause *et al*., 2022). Traditional methods can cause the oxidation of soy milk during the soaking and grinding of soybeans, whereas modern procedures may minimize the creation of undesired volatile chemicals (Hui and Evranuz, 2012). The fermentation process by using lactic acid bacteria can also reduce the beany flavor of soy milk (Donkor *et al*., 2007). However, adding flavoring agents such as cocoa powder and other flavoring agents to fermented soy milk may be a good option for reducing soy milk's beany flavor. Therefore, the objectives of the current study are the development of flavored dahi by incorporating soymilk and cocoa powder and assessing the physicochemical and microbiological quality of the prepared dahi.

2. Materials and Methods

2.1. Ethical approval

Ethical approval was not required for this study.

2.2. Materials

2.2.1. Collection of milk and soybean

The whole milk used in this experiment was collected from Sher-e-Bangla Agricultural University (SAU) dairy farm and soybean seeds were collected from the local market of Dhaka city.

2.2.2. Preparation soy milk from soybean

The soy milk was prepared by the method used by Islam *et al*., 2015 with slight modifications. For preparing soy milk, whole soybean seeds were ground in a soy flour mill and made soy flour. Before making the soy flour immature, field damage and the black seeds were discarded. For preparing 1000 ml of soy milk, 125 g powder was correctly dissolved by stirring. The soy milk was strained through a filter cloth to separate the residue. Finally, soy milk was boiled for 5 minutes at 100^0C with constant stirring.

2.2.3. Collection of Cocoa powder

CADBURY cocoa powder was collected from the local market.

2.3. Analysis of cow’s milk and soy milk

The initial chemical quality of cow milk and soy milk was analyzed before the preparation of various types of dahi. in terms of specific gravity, acidity (%), pH, total solids (%), moisture (%), fat (%), protein (%), carbohydrate (%) and ash (%) by AOAC, 2016.

2.4. Preparation of different types of dahi

Soya milk was prepared by soaking and grinding methods. After collecting cow milk, it was mixed with soya milk in a different ratio. 1.5% Cocoa powder was combined with the milk to obtain chocolate flavor. Then, the Addition of 10% sugar with the incorporated milk and pasteurization was done. Then, the milk was cooled to 40^0C and starter culture (about 1%) was added. The milk was poured into the cup and incubation at 37^0C for 8 hours. Refrigeration was done after removing from incubation.

2.5. Design of the experiment

Treatment	Preparation of mixed milk		Cocoa powder (% of mixed milk)
	% Cow's milk	% Soy milk	
T_0	100%	0%	1.5%
T_1	75%	25%	1.5%
T_2	50%	50%	1.5%
T_3	25%	75%	1.5%

2.6. Evaluation of different types of dahi

Sensory parameters on the prepared dahi sample measured by expert panel judges were as:

I. Smell and taste score - 50
II. Body and consistency score -30
III. Color and appearance score – 20
IV. Overall score- 100

2.7. Analysis of dahi

After organoleptic evaluations of the dahi sample, all treatments were chemically analyzed in the laboratory in terms of acidity (%), pH, total solids (%), moisture (%), fat (%), protein (%), carbohydrate (%) and ash (%) by AOAC, 2016 method.

2.8. Microbial analysis

Microbial analysis of the dahi samples was analyzed using a specific agar media method. Lactic acid bacteria are one of the important microorganisms present in dahi. Lactic acid bacteria count was enumerated by using De Man Rogosa (MRS) agar (HiMedia Laboratories).

2.9. Statistical analysis

The experimental material in this study was completely homogenous and statistical analysis was done by using a Completely Randomized Design (CRD) having four (4) treatments with three (3) replications for each. A paired T-Test was used to measure the differences in lactic acid bacteria growth compared with the control. $P < 0.05$ was considered statistically significant.

3. Results and Discussion

3.1. The initial quality of cow and soy milk

To know the quality of the dahi, the present study prepared and investigated the chemical quality of different cow milk and soy milk samples. The results revealed that cow milk had a specific gravity of 1.03±0.001, an acidity of 0.17±0.010%, a moisture content of 866.20±3.78g/kg, a total solids content of 133.80±3.78 g/kg, a fat content of 48.91±2.03 g/kg, protein content of 32.92±1.07 g/kg, an ash content of 7.84±0.04 g/kg, and carbohydrate content of 44.13±1.76 g/kg (Table 1). In comparison, soy milk had a lower specific gravity of 1.02±0.001, a lower acidity of 0.13±0.010%, a higher moisture content of 902.50±1.95 g/kg, a lower total solids content of 97.50±1.95 g/kg, a lower fat content of 25.00±1.00 g/kg, the higher protein content of 43.17±0.76 g/kg, a lower ash content of 6.87±0.35 g/kg, and lower carbohydrate content of 22.47±1.69 g/kg (Table 1). For mixed dahi preparation plant-based sources as a suitable economical partial substitute for cow's milk and an ideal nutritional supplement for the people who are suffering from lactose-intolerant syndrome (Dhananjay *et al*., 2006).

Table 1. Chemical composition of cow and soy milk.

Types of milk	Specific gravity	Acidity (%)	Moisture (g/kg)	Total solids (g/kg)	Fat (g/kg)	Protein (g/kg)	Ash (g/kg)	Carbohydrate (g/kg)
Cow Milk	1.03± 0.001	0.17± 0.010	866.20± 3.78	133.80± 3.78	48.91± 2.03	32.92± 1.07	7.84± 0.04	44.13± 1.76
Soy milk	1.02± 0.001	0.13± 0.010	902.50± 1.95	97.50± 1.95	25.00± 1.00	43.17± 0.76	6.87± 0.35	22.47± 1.69

Date expressed as mean ± SD.

These findings are consistent with the studies that have reported differences in the composition of cow milk and plant-based milk alternatives such as soy milk (Wang *et al*., 2018; Mateos-Aparicio *et al*., 2019). The lower fat content and higher protein content in soy milk make it a popular choice among individuals who are lactose intolerant or have a dairy allergy (Wang *et al*., 2018). Therefore, the Addition of different ratios of soy milk to cow milk for the preparation of dahi will not decrease the nutritive value as well as the demand for the mix.

3.2. Organoleptic quality of dahi

The present study evaluated the sensory attributes of the prepared dahi at different time points (T_0, T_1, T_2, and T_3) using a panel of trained evaluators. The parameters assessed included Smell and Test (scored 50), Body and Consistency (scored 30), Colour and Texture (scored 20), and Overall Score (100). The results showed a significant decrease in the sensory scores over time for all parameters (Table 2). The Smell and Test score decreased from 45.74a±0.07 at T_0 to 38.50c±2.18 at T_3, the Body and Consistency score decreased from 26.93a±0.52 at T_0 to 22.86b±1.28 at T_3, and the Color and Texture score decreased from 17.81a±0.17 at T_0 to 14.36b±0.43 at T_3 (Table 2). Similarly, the overall score also showed a significant decrease from 90.47a±0.71 at T_0 to 75.72c±3.88 at T_3. These findings are consistent with the studies that have reported the use of soy milk in the dahi increase the beany flavor and subsequently reduces the organoleptic score (Ma *et al*., 2020; Kim *et al*., 2021). Similarly, these results are in close agreement with the statement of Osman and Razig (2017), who reported that yoghurt samples made by mixing soymilk and cow milk have almost a similar appearance. As soy milk has beany flavor, the sensory attributes of the food product declined significantly over time, might indicating a slight decrease in quality. The worst result from this study derived from the T_3 group, where 75% soy milk was used. The use of soy milk with cow milk produced yellowish in color but it has a beany flavor. However, it was factual that the smell, taste and mouth feel evaluation tests of soy milk mix dahi gained the lowering trend scores as compared with cow milk (Ismail *et al*., 2017). Therefore, an acceptable level of dahi can be made with the minimum Addition of soy milk to cow milk.

Table 2. Sensory evaluation of dahi samples prepared from cow milk and mixed milk (cow milk and soy milk).

Parameter	Sample			
	T_0	T_1	T_2	T_3
Smell and Test (50)	45.74^{a} ±0.07	43.21^{ab}±2.61	41.76^{bc}±2.18	38.50^{c}±2.18
Body and Consistency (30)	26.93^{a}±0.52	26.26^{a}±2.11	24.65^{ab} ±1.22	22.86^{b}±1.28
Color and Texture (20)	17.81^{a}±0.17	16.92^{a}±0.83	15.39^{b}±0.68	14.36^{b}±0.43
Overall Score (100)	90.47^{a}±0.71	86.39^{ab}±5.31	81.80^{c}±3.76b	75.72^{c}±3.88

T_0: 100% milk dahi (control); T_1: 75% milk +25% soy milk dahi; T_2: 50% milk + 50% soy milk dahi; T_3: 25% milk + 75% soy milk dahi. Date expressed as mean ± SD. a,b,c superscripts not similar within the mean of same row differ significantly; *p<0.001

3.3. Chemical analysis of prepared dahi

Table 3 presents the chemical evaluation of dahi samples prepared from cow milk and its partial replacement with soy milk. The acidity of the samples decreased significantly ($p<0.05$) with the increase in the proportion of soy milk in the formulation, from 0.73% in T_0 to 0.67% in T_3. This result is in line with previous studies that reported a decrease in acidity with the Addition of soy milk to milk-based products (Chalamaiah *et al*., 2012; Yilmaz and Dagdemir, 2017). The moisture content increased significantly ($p<0.05$) with the increase in the proportion of soy milk in the samples, from 701.87 g/kg in T_0 to 752.20 g/kg in T_3, while the total solids content decreased significantly ($p<0.05$) from 298.13 g/kg in T_0 to 247.83 g/kg in T_3. This is consistent with the findings of other researchers who reported a decrease in total solids content and an increase in moisture content in milk-based products containing soy milk (Kumar *et al*., 2015; Nadeem *et al*., 2018).

The fat content of the dahi samples decreased significantly ($p<0.05$) with the increase in the proportion of soy milk, from 87.00 g/kg in T_0 to 46.33 g/kg in T_3. This agrees with the results of other studies that reported a decrease in fat content in dairy products with the Addition of soy milk (Chalamaiah *et al*., 2012; Alimohamadi *et al*., 2019). On the other hand, the protein content increased significantly ($p<0.05$) with the increase in the proportion of soy milk, from 43.97 g/kg in T_0 to 71.57 g/kg in T_3. This is consistent with the findings of previous studies that reported an increase in protein content in milk-based products with the Addition of soy milk (Kumar *et al*., 2015; Yilmaz and Dagdemir, 2017).

Table 3. Chemical composition of dahi samples prepared from mixed milk (cow milk and soy milk).

Parameters	Sample			
	T_0	T_1	T_2	T_3
Acidity (%)	0.73^{a} ±0.02	0.72^{ab}±0.01	0.70^{b}±0.01	0.67^{c}±0.01
Moisture (g/kg)	702.87^{a}±4.15	715.00^{c}±9.44	734.50^{b} ±5.24	752.20^{a}±4.11
Total Solids (g/kg)	297.13^{a}±4.15	285.00^{b}±9.44	265.47^{c}±5.28	247.83^{d}±4.11
Fat (g/kg)	85.00^{a}±2.14	72.33^{b}±1.53	57.67^{c}±1.53	46.33^{c}±1.53
Protein (g/kg)	45.97^{d}±1.20	54.60^{c}±2.01	60.54^{b}±1.54	71.57^{a}±2.25
Ash (g/kg)	9.67^{a}±0.48	9.47^{b}±0.06	9.20^{bc}±0.10	8.90^{c}±0.10
Carbohydrate (g/kg)	157.50^{a}±3,80	148.77^{a}±0.17	138.10^{b}±3.25	121.00^{c}±4.84

T_0: 100% milk dahi (control); T_1: 75% milk +25% soy milk dahi; T_2: 50% milk + 50% soy milk dahi; T_3: 25% milk + 75% soy milk dahi. Date expressed as mean ± SD. a,b,c superscripts not similar within the mean of same row differ significantly; *p<0.001

The ash content of the dahi samples showed a decreasing trend with the increase in the proportion of soy milk, from 9.97 g/kg in T_0 to 8.90 g/kg in T_3, although the difference was only significant ($p<0.05$) between T_0 and T_3. This result is in contrast to the findings of Nadeem *et al*. (2018), who reported an increase in ash content in milk-based products with the Addition of soy milk. Finally, the carbohydrate content of the samples decreased significantly ($p<0.05$) with the increase in the proportion of soy milk, from 157.20 g/kg in T_0 to 121.00 g/kg in T_3. This is consistent with the results of the studies that reported a decrease in carbohydrate content in milk-based products with the Addition of soy milk (Kumar *et al*., 2015; Alimohamadi *et al*., 2019).
Overall, the results of this study indicate that partial replacement of cow milk with soy milk in dahi formulation has a significant effect on the chemical composition of the product. However, the quality of the dahi is closer to the control when the Addition of 25% soy milk with cow milk.

3.4. Lactic acid bacteria growth on the dahi

The microbiological quality of the dahi, especially the lactic acid bacteria content, was performed to evaluate the finished product. After the preparation of dahi, the lactic acid bacteria content of T_0 (cow milk) sample was significantly higher than other mixed dahi sample (Figure 1). Addition of a higher amount of soy milk with cow milk gradually reduced the lactic acid bacteria count in treated sample. This kind of difference might be due to the availability of lactose in cow milk dahi was more than in other mixed dahi (Ashraf *et al*., 2011). However, the microbial status of the dahi samples conforms to the accepted standard wwhich is between 8 log CFU/g and 6 log CFU/g. The growth of lactic acid bacteria is very important for the quality of dahi as they can prevent undesirable growth and improve the dahi quality.

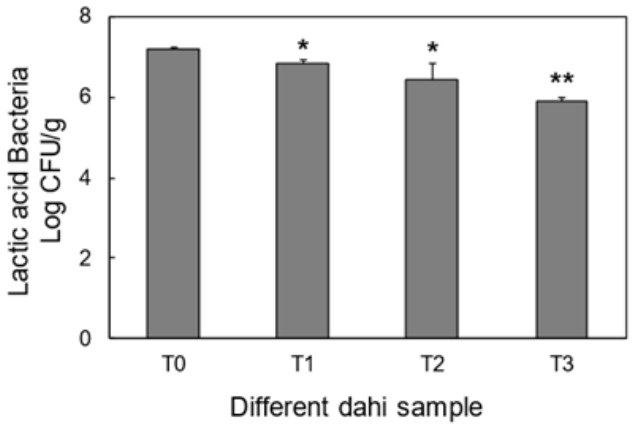

Figure 1. Growth of lactic acid bacteria in different dahi sample. T0: 100% milk dahi (control); T1: 75% milk +25% soy milk dahi; T2: 50% milk + 50% soy milk dahi; T3: 25% milk + 75% soy milk dahi. Data expressed as means ± SD (n = 3). **: Significant difference at *P* < 0.001 vs control. *: Significant difference at *P* < 0.005 vs control.

When cow milk is gradually substituted by soymilk and added cocoa powder then the lactic acid bacteria and cocoa powder masks the beany flavor in soymilk (Hou *et al*., 2000). Additionally, the lactic acid bacteria convert isoflavones into aglycones, which are able to offer more health benefits to human beings (Tsangalis *et al*., 2002; Lee *et al*., 2013) as well as partially remove the beany flavor. The microorganisms consume the carbohydrates from milk and soy milk then some flatulence factors produce acids such as acetic acid and lactic acid and finally improve the quality of dahi. In this experiment T_1 samples (75% milk +25% soy milk) showed higher growth of lactic acid bacteria other than the combined dahi, which can help to select the development of combined dahi with the Addition of the actual ratio of soy milk to cow milk.

4. Conclusions

From the findings of this study, it might be concluded that 25% cow milk could be replaced with soymilk i.e. dahi made by a mixture of 25% soy milk and 75% cow milk, produced better results. It was also found that the Addition of different ratios of soy milk to cow milk and cocoa powder for the preparation of dahi was not decreased the nutritive value of the mix rather, closer observation was observed. Further studies are needed to investigate the effect of these changes on the sensory properties, consumer acceptance, and related prices of the product.

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Data availability

All relevant data are within the manuscript.

Conflict of interest

None to declare.

Authors' contribution

Conceptualization: Md. Asaduzzaman, Methodology: Md. Asaduzzaman, Mofassara Akter and Ashikur Rahman, Laboratory analysis: Md. Asaduzzaman, Ashikur Rahman and Abdur Rahman, Data collection and Statistical analysis: Md. Asaduzzaman, Mofassara Akter, Ashikur Rahman, Md. Moniruzzaman and Abdur Rahman Writing-original draft preparation: Md. Asaduzzaman, Writing-review and editing: Md. Asaduzzaman, Mofassara Akter and Md. Saiful Islam. All authors have read and approved the final manuscript.

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