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Development and quality evaluation of dahi (Traditional sweet curd) fortified with wood apple juice (*Aegle marmelos*)

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Abstract

Dahi has been consumed by people for its nutrient value and eating it regularly may boost several aspects of health like reduce the risk of heart disease, osteoporosis as well as aid in weight management. The research was conducted to prepare fruit flavored yogurt with different levels of wood apple juice (0%, 5%, 10% and 15%) with whole milk in four different traits bearing samples identity A, B, C and D respectively. Samples were analyzed for composition, as well as organoleptic and microbial qualities. It was found that total score was significantly ($p<0.001$) increased by addition of 5% (w/w) juice, but decreased when the levels of juice were increased to 10% and 15% (w/w). Dahi fortified with 5% wood apple juice was also the best in terms of smell and taste ($p<0.01$), body and consistency ($p<0.05$) and color and appearance ($p<0.01$). Addition of wood apple juice also significantly increased the total solids content ($p<0.01$), fat content ($p<0.05$) and pH ($p<0.05$), while no changes were observed for protein and ash contents. Total bacterial count in all the samples was found to be acceptable through there was no significant difference observed. The coliform count significantly ($p<0.01$) increased as the levels of fruit juice increased, though it was in acceptable range. Acceptability by consumer was also studied. Therefore, it can be recommended that the fortification of whole milk with 5% wood apple juice results in a fruit flavored dahi that is highly acceptable to the consumer.

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Introduction

Fermented dairy foods are very important because they provide great quantities of nutritious foods in a diversity of flavor, aroma and texture to enrich the human diet (Sarkar and Misra, 2002). Dahi is a well known fermented milk product consumed throughout Bangladesh, either as a part of the daily diet along with the meal or as a refreshing beverage. Wood apple is known to have anticancer activity, pyretic and analgesic activities and also provides relief in constipation (Sharma *et al.*, 2006). According to Gopalan (1971), it contains 61.5 g water, 1.89 g protein, 0.39 mg fat, 1.79 mg minerals, 31.8 g carbohydrate, 55 g carotenes, 0.13 mg thiamine, 1.19 mg riboflavin, 1.1 mg niacin and 8 mg vitamin C/100 g of edible portion. It has high religious, cultural, nutritional and medicinal values. The pulp of the fruit is a natural source of natural antioxidants and bioactive compounds. Preparation of fruit dahi has been investigated by a number of researchers in different parts of the world (Desai *et al.,* 1994 and Shukla *et al.,* 1987). For this reasons, the present study was designed to manufacture fruit dahi from whole milk fortified with different levels of wood apple juice, and to compare their qualities on the basis of physical, chemical and microbiological parameters.

Materials and methods

Experimental site and milk collection

The experiment was conducted at the Dairy Technology and Microbiology Laboratory of the department of Dairy Science under the faculty of Animal Husbandry, Bangladesh Agricultural University, Mymensingh, Bangladesh. Cow's milk was collected from Bangladesh Agricultural University Dairy Farm by taking all necessary sanitary precaution.

Sources and preparation of wood apple juice

The wood apple was purchased from Natun Bazar fruit market of Mymensingh town and cut into small parts with the help of knife, and then pieces of wood apple were blended. During blending 50% water was added with fruit pulp for proper blending. After blending the juice was filtered by sterilized cheese cloth.

Preparation of different types of dahi

From each trial, 2 L of fresh milk was boiled until its volumes were reduced by 20 percent of original volume. Sugar was added to the milk at the rate of 12 percent during boiling. During heating milk was stirred continuously with the help of a stirrer. The milk was then removed from the heater and allowed to cool down at room temperature. When the temperature was reduced to about 45°C.Four different types of dahi were manufactured incorporating 0, 5, 10, and 15 percent wood apple juice with whole milk of cow bearing samples identity A, B, C, & D respectively. In here treatment was four and replication was three. The wood apple juice was incorporated in the milk after the milk was poured in small cups (100ml) except control. Then starter was added @ 2% (w/w). Starter culture was collected from Dairy farm, BAU. The plastic cups were pre-washed with boiled water before use. The samples were incubated at 42°C until the complete coagulation of dahi samples. After complete coagulation (4-5 hrs) the dahi samples were stored at refrigerator at 4°C until analysis.

Evaluation of prepared dahi samples

The experiment was replicated three times and each time, quality of prepared dahi samples were evaluated by Organoleptic, Chemical and Microbiological test. Organoleptic evaluation was done with the help of an expert panel of judges and mark distribution for organolaptic test were smell and test, body and consistency, color and appearance were 50, 30 and 20 respectively. Chemical test Total solids and ash contents of the different types of dahi were determined by oven drying method according Association of Official Agricultural Chemists (AOAC, 2003). Fat content was determined by Babcock method using the procedure described by (Aggarwala and Sharma, 1961) Crude protein was determined by Kjeldahal procedure and pH was measured with the help of a pH meter (Ciba corning Diagnostics Ltd. Sudbury, Suffolk, England Co. 106xD). Standard Plate Count, Coliform Count were also performed as microbial test.

Statistical analysis

Analysis of variance test (ANOVA) was done to find out the difference between the treatments. 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) (Steal and Torrie,1960) using the SPSS (11.5) statistical program (SPSS Inc.233 South Wacker Drive, 11th Floor, Chicago, IL 60606-6412). All results were further tested using Duncan's Multiple Range Test (DMRT) to identify significant difference ($p<0.05$) between means. The trials were replicated in triplicate.

Results and discussion

Organoleptic Parameters

The plain Dahi and wood apple Dahi were stored at refrigeration temperature and their qualities were measured with the help of organoleptic test (smell and taste, body and consistency and color and appearance) by a panel of judges.

Smell and Taste

Smell and taste score of A, B, C and D samples are shown in Table 1. Statistical analysis showed that there was ($p<0.01$) significant difference within the smell and taste scores of different types of dahi. Higher smell and taste score was recorded in case of B and D types dahi. On the other hand, lowest score was seen in case of A and C types. The results of this study agrees with that reported by Mustafa, (1997) who found that addition of fruit juice improved smell and taste of dahi. Similar results were also found by Desai *et al.* (1994) and White (1991).

Table 1. Scores obtained by wood apple juice fortified dahi samples for different organoleptic parameters.

Physical Parameters	Different types of dahi sample				Level of Significance
	A	B	C	D	
Smell and Taste (50)	$41.25^{b}\pm0.75$	$45.25^{a}\pm0.47$	$41.50^{b}\pm0.64$	$45.25^{a}\pm0.85$	**
Body and Consistency (30)	$24.25^{ab}\pm0.85$	$26.75^{a}\pm0.85$	$23.5^{b}\pm0.64$	$23.00^{b}\pm0.91$	*
Color and Appearance (20)	$17.75^{ab}\pm0.25$	$19.25^{a}\pm0.25$	$16.25^{b}\pm0.62$	$15.75^{b}\pm1.03$	**
Total Score (100)	$83.25^{b}\pm1.10$	$91.25^{a}\pm1.10$	$81.25^{b}\pm1.25$	$81.00^{b}\pm1.58$	***

Superscripts with different letters on the means in the same row differ significantly

(* = Significant at $p<0.05$, ** = Significant at $p<0.01$, *** = Significant at $p<0.001$).

Body and Consistency

Body and consistency score are presented in Table 1. Statistical analysis showed that there was a significant ($p<0.05$) difference within the body and consistency scores of different types of dahi. Highest body and consistency score was found in case of B sample. On the other hand, lowest scores were seen in case of C and D types. Desai *et al.,* (1994) and Mustafa, (1997) reported that body and consistency of dahi or yoghurt improved due to the addition of fruit juice. The findings of this research indicate that the amount of fruit juice should be limited to the 5% level. In this connection, Manus (1973) reported that course texture in yoghurt was probably due to imbalance of the *S. thermophilus* and *Lb. bulgaricus,* resulting in over production of acetaldehyde which was the characteristic aroma compound in yoghurt.

Color and Appearance

The color and appearance of A, B, C and D type dahi samples are presented in Table 1. Statistical analysis showed that there was significant ($p<0.01$) difference between scores of different dahi samples. The highest score for color and appearance was recorded in case of B type dahi and the lowest scores were recorded for C and D types respectively. The result of the experiment supports the findings of Desai *et al.* (1994) who observed the addition of fruit juice improved the color and appearance score of dahi. From the result of the study we can say that incorporation of wood apple juice improved the color and appearance qualities of dahi, though the percentage should be limited to 5%. Addition of a higher percentage changed the appearance of the dahi, which was considered unpleasant by the judges.

Total score

The total score of A, B, C and D types of dahi are presented in Table 1. Statistical analysis showed that there was significant difference ($p<0.001$) between the total scores of different dahi samples.

The highest total score was recorded in case of B type dahi and the lowest scores were recorded for C and D type dahi. The result of this experiment supports the findings of Desai *et al.* (1994) who observed the addition of fruit juice improved the total score of dahi.

Table 2. Composition (mean±SD) of different types of dahi fortified with wood apple juice.

Parameters	Different types of dahi sample				Level of Significance
	A	B	C	D	
Total Solid (TS) (g/kg)	263.70^{b}±6.80	271.90^{b}±6.66	278.88^{b}±3.50	325.00^{a}±14.0	**
Fat (g/kg)	41.60^{a}±1.6	38.60^{ab}±1.2	37.00^{b}±1.5	34.60^{b}±0.30	*
Protein (g/kg)	37.90±0.20	38.30±0.30	38.90±0.30	40.30±1.10	NS
Ash (g/kg)	8.70±0.40	9.00±0.40	9.10±0.40	9.50±0.40	NS
pH	4.56^{c}±0.03	4.45^{bc}±0.07	4.33^{ab}±0.04	4.26^{a}±0.03	*

Superscripts with different letters on the means in the same row differ significantly

(* = Significant at $p<0.05$, ** = Significant at $p<0.01$, NS = Not significant).

Chemical Parameters

The results of chemical tests are discussed in the following subsections.

Total solids content

The total solids content of A, B, C and D types of dahi are given in Table 2. The highest total solids content was found in D and the lowest in A. Statistical analysis showed that there was a significant difference ($p<0.01$) among the total solids contents of A, B, C and D type dahi.

This could be attributed to the higher total solids content of wood apple juice (30-34%) as compared to that of milk (13%). The result agrees with the work of Desai et al. (1994), who found that total solids content increased significantly due to addition of fruits in yoghurt. Mustafa (1997) 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.

Fat content

The fat content of A, B, C and D types of dahi are presented in the Table 2.

The highest fat content was found in A and the lowest in D type dahi. Statistical analysis showed that there was a significant difference ($p<0.05$) within the fat content of A, C, B and D types dahi.

The result does not agree with the work of Desai *et al.,* (1994), who found that fruit yoghurt contained lower amounts of fat than the plain yoghurt. Similar type of results was also obtained by Mustafa (1997).

This difference in finding could be due to the different types of fruit juice used in different studies.

The fat content of wood apple juice (0.3%) is negligible as compared to that of whole milk (3.5-4.0%). Therefore, replacement of a portion of milk with wood apple juice would certainly reduce the fat percentage in the fortified dahi. Fat percentage of plain sweet dahi was also studied by Ghosh and Rojorhia (1987) and their reports were nearly similar with the findings of this research.

Protein content

The protein content of A, B, C and D type dahi are given in Table 2. Statistical analysis showed that there was no significant difference within the protein content of A, C, B and D dahi samples. The result disagrees with the work of Mustafa (1997), who found that plain dahi contained higher amount of protein than fruit dahi. This difference in protein contents between milk and wood apple juice is not so large; hence little effect was observed for fortification with wood apple juice.

Table 3. Microbiological parameters (mean±SD) of different types of dahi fortified with wood apple juice.

Parameter	Different types of dahi sample				Level of Significance
	A	B	C	D	
Standard Plate Count (cfu/ml×10^5)	106.66±11.66	108.33±9.38	108.33±6.17	113.00±8.02	NS
Coliform Count (cfu/ml)	4.00^b±0.57	4.66^b±0.57	6.33^a±0.33	7.66^a±0.33	**

Superscripts with different letters on the means in the same row differ significantly
(** = Significant at p<0.01, NS = Not significant).

Ash content

The ash content of A, B, C and D types of dahi is shown in Table 2. Statistical analysis showed that there was no significant difference within the ash contents of A, B, C and D dahi samples. The findings of this study agree with the work of Desai *et al.* (1994) and Mustafa, (1997). Both researchers found that addition of fruit juice did not increase the ash percentage in dahi.

pH value

The pH values for the A, B, C and D types are given in Table 2.Statistical analysis showed that there was a significant difference (p<0.05) within the pH values of A, B, C and D dahi samples. Addition of fruit juice decreased the pH value of dahi. The lowest pH value was found in the D type followed by the type C, whereas plain dahi should the highest value. This could be attributed to the low pH of wood apple juice (pH 5.31) as compared to that of whole milk (pH 6.70). Therefore, as the proportion of juice increased, acidity is also increased.

Microbiological parameters

Standard Plate Count (SPC)

The SPC (cfu/ml) of A, B C, and D types of dahi are shown in Table 3. Statistical analysis showed that there was no significant difference among the different samples. This finding indicates that addition of wood apple juice does not alter the microbial growth environment. All the results are typical for normal dahi. The present investigation showed higher SPC values than those of Rahman (1998) who found that average total viable count was 2.80xl0^4 per g in the jackfruit flavored dahi.

Coliform count

The coliform count (cfu/ml) of A, B C, and D types of dahi are presented in Table 3. Statistical analysis showed that there was significant difference (p<0.01) among the different samples. The number of coliform bacteria increased with higher levels of juice which may indicates the presence of coliform bacteria in the wood apple juice, because the juice was not boiled. Nonetheless, the coliform counts of all of the samples were within the acceptable range, which was an indication of hygienic production.

Conclusion

Considering all the findings it might be deduced that wood apple could be added to increase the organoleptic and nutritional qualities of dahi. Although the study shows that the 'B' (5% wood apple juice) type dahi had the highest score, higher wood apple juice levels were fairly acceptable. Addition of wood apple juice developed an acceptable caramelized color and sweet aroma which was appreciated by panel of judges. Therefore, it could be recommended that 5% wood apple juice with whole milk should be used to prepare high quality fruit flavored dahi. Wood apple is available in markets all over Bangladesh throughout the year at moderate price. So, the manufacturers and the consumers might welcome the idea of incorporation of wood apple juice in the manufacture of fruit flavored dahi which have a better consumer appeal.

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