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FORTIFICATION OF CURD THROUGH NATURAL COLORS

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ABSTRACT

The main purpose of the study was to measure the feasibility of incorporation of beetroot juice in the manufacture of Dahi (curd). Six different types of Dahi were manufactured incorporating 0, 5-, 10-, 20,30- and 40-ml beetroot juice with 400ml milk. The prepared Dahi samples were tested physiochemical composition, protein and organoleptic score of the finished product. It was found that the physical qualities of the Dahi improved by the addition of beetroot juice with milk.When addition of more amount of beetroot juice were found increase the physiochemical composition, protein and organoleptic score but decrease the acidity level. The addition Treatment T_4(30ml of beetroot) juice shown better organoleptic score. It also revealed that treatment T_5(40ml beetroot juice) addition shown superior results for physiochemical and protein. The study suggested that Dahi could be successfully manufactured incorporating Treatment T_4 (30ml beet root juice) and T_5 (40ml beetroot juice). Production of greater volume of Dahi from reduced volume of whole milk incorporating a cheap additive like beetroot juice might make Dahi product business more profitable and popular.
***Keywords*:** Curd, Beetroot, juice, Colouring pigment, Betalains, Organoleptic score.

Introduction

In recent years natural fortification of colours in food have attracted the attention of food researchers throughout the world. Thus, fortification of natural colours in fermented food can be hopefully be enacted to produce functional food, exhibit higher nutritional activity. Curd (Dahi) is a fermented milk product which is widely consumed all over India, plain, sugared or salted. There is an increasing trend in the development of functional dahi by fortification of natural colours and flavours; as well as to provide health benefits. Beetroot (*Beta vulgaris* L.) had been selected for color because it is more attractive and also because it may be well linked to genes for flavour too.

Dahi have live cultures that nurture therapeutic and health promoting properties along with nutritional benefits. The lactose in the milk is converted to lactic acid by the action of starter cultures and the lactic acid act as preservative for the milk and the low pH (4.5-5.0) also inhibit the growth of harmful micro-organism, thus increasing the shelf life of the product.

In recent years, dahi has become a popular vehicle of incorporating the probiotic species, *L. acidophilus* (Hull *et al*., 1984) and *B.bifidium* (Holcom *et al*., 1991). Presence of alpha α- D- galactosidase activity in probiotic dahi indicates its suitability for lactose-intolerant infants (Sarkar and Mishra, 1998). Dahi is becoming more popular among fermented milk products since it has nutritional and therapeutic properties. In the recent times many physicians are prescribing to consume more of these type of fermented milk products for those suffering from intestinal disorder; mostly the aged and children groups (Rao *et al*., 1982). Dahi is valued for controlling the growth of bacteria and incurring intestinal diseases like constipation, diarrohea and dysentery. Yoghurt are effective in curing the blood cholesterol level, recently

there has been increasing trends to fortify the product with vegetables (Desai *et al*., 1994).

Dahi is an increasingly popular cultured dairy product in most countries. This is partially because of an increased awareness of consumers regarding possible health benefits of yoghurt. Dahi is easily digested, possess high nutritional value and is a rich source of carbohydrates, protein, fat, vitamins, calcium and phosphorus. As milk protein, fat and lactose components undergo partial hydrolysis during fermentation wherein yoghurt is an easily digested product of milk (Rasic and Kurman, 1978).

Physical properties of dahi are influenced by milk composition and manufacturing condition. Variables affecting physical properties include heat treatment applied to milk, protein content, acidity, culture, additives, homogenization, mechanical handling of coagulum and presence of stabilizers.

Beetroot (*Beta vulgaris)* is botanically classified as an herbaceous biennial from Chenopodiaceae family. It has numerous cultivated varieties. The most well-known root vegetable is also known by beetroot, garden beet, red beet, table beet or as a beet. Beet root has its origin from Russia and Ukraine. The red beet root has been cultivated for many years in all temperate climates even in India. The bulb colours of beetroots are range from yellow to red. Deep red coloured beetroots are the most popular for human consumption. Beetroot is used as a vegetable, juice and extracts. Red beet contains 12 -20% dry matter, including 4 - 12% sugar, 1.5% protein, 0.1% fat, 0.8% fibre ,minerals such as sodium, potassium, Phosphorus, calcium and iron as well as small amounts of vitamins. Besides it contains 50-60 mmol/g of phenolic compound which possess properties of promoting human health and natural food additives. Beetroot is also used for traditional medicine as a food colorant and additives to cosmetics. (Henry,1996; Stuppner and Egger, 1996).

Colour is one of the important attributes of food and most sensitive part of any commodity not only for its appeal but also it enhances consumer acceptability. It indicates freshness, quality indicator and safety that are also indices of good aesthetic and sensorial value of the food commodity (Chattopadhyay *et al*., 2008). For this purpose synthetic dyes are used. Recently, dyes derived from natural sources for these applications have emerged as an important alternative to potentially harmful synthetic dyes. The natural colorants are termed as bio colourants.

The colouring pigments present in beetroots is collectively known as betalain or betanine. In most varieties of beetroot, the red pigment batanine is the predominant colouring compound representing 75-90% of the total colour present (Nielsen and Holst, 2005). Betalain are nitrogen containing water soluble plant pigments whose colour range from red to violet. The red to violet betacyanins and the yellow to orange betaxanthins are more purple and brighter and the colour hue does not change with pH in the 4-7 than anthocyanin. Yellow betaxanthin has maximum absorptivity at 535 and 480 nm respectively. The use of betalains as food colourant is approved by European union and betalains are labeled as E-162. Betalains are more stable in pH and temperature (15°C). It has been reported that betalains has antioxidant radical scavenging properties, antimicrobial and antiviral activity (Pedreno and Escribano, 2001). Betalain not only for their usefulness in preservation but also because of their beneficial effect on human health as antioxidant. Sometimes betacyanin is better than the commercially available antioxidants.

Betalains being bio colorants may also play an important role in human health because it contains biologically active compounds which posses a number of pharmacological properties like anti-mutagenic, anti inflammatory and anti-artheritic effect, antineoplastic, radiation protective, vasotonic, chemo and hepato-protective activities.

The objective of our research was to fortify curd with Beetroot (*Beta vulgaris* L.*)* juice of different concentrations and to determine the physiochemical composition, protein and organoleptic score of the finished product. The main aim was to fortify the curd or Indian Dahi with nutrients, enhance its antioxidant potential, make it more lucrative at market front with attractive colour and palatability thus overall enhancing its functional properties. Shelf life in question was also taken care of. Regarding flavor we thought of retaining the traditional dahi flavour so that people could feel that they are having dahi and not a new product thus making its acceptability easy among the masses. Further, an enhancement on its commercial value was also kept in mind

Materials and Methods

This chapter deals with the materials used and methodologies adopted during present investigation relating to the technological, analytical, microbiological and sensory aspects of production of beetroot juice extract and its use as a fortifying agent in dahi. Details of specialized equipment used in this study are also given. The trials were conducted in the laboratory of Department of Horticulture, Institute of Agricultural Science in asepetic environment under a room temperature of 25 $\pm 1^0$C having six treatments

with two replicates. The experimental period was from November, 2019 to March, 2020.

Raw materials and ingredients

Milk

Amul brand homogenized toned milk (Brand name: Amul Taaza) having 3% minimum fat and 8.5% minimum SNF was procured from local market of Kolkata for dahi preparation. The nutritional information as laid out in the packet per 100g (Approx values)were : Energy(kcal)- 58.2, Total fat-3g, Saturated fat-2g, Total carbohydrate- 4.8g, Protein- 3g, Calcium-140mg.

Beetroot

Round, disease free fresh beetroot cv. Detroit Dark Red was procured from farmer's field from the outskirts of Kolkata.

Starter Culture

Lactic culture like *Lactobacillus acidophilus* and *Bifidobacterium bifidum* culture were procured from home.

Packaging Material

Ceramic as well as polythene coated paper cups of 200ml were used for this study.

Water

Distilled water was used for preparation and analytical purpose

Equipments and instruments

Utensils and Glass ware

Stainless steel vessels of varying capacities and stainless steel stirrers were used at various stages of investigation. Conical flask, beakers, volumetric flasks, plastic trays, measuring jars of Borosil were used for preparation of fortified dahi. Corning glass test tubes of 20ml, 50ml, 100ml and conical flask of 200 ml, 500 ml was used for mixing the beet root juice in milk, propagation of starter culture, chemical and microbiological analysis. Glass wares were cleaned by detergents and sterilized using hot air oven at 160-180 °C for 2h and used for microbiological analysis of the product.

Chemicals

High purity commercially available analytical grade chemicals were used in this investigation.

Equipments

UV-Vis spectrophotometer (Make up : Jasco, Model: VL-630)

Laminar air flow chamber,

Precision balance (Makeup: Kern)

Autoclave, Hot air oven, Incubator, Refrigerator, Microwave oven, Knife, Blender, Induction Cooktop etc. were used in the investigation.

Method

Experimental procedure for development of fortified dahi by using beetroot juice

The beetroots were washed in running tap water and cleaned to remove any dirt in it. Thereafter it was peeled, chopped and grinded using a mixer. Then the beet root juice was extracted by passing the mashed portion through a threefold muslin cloth to get fibre free juice which was collected in a conical flask. Next the beetroot juice was heated in a microwave oven for 10 minutes. Milk was boiled on the induction cooktop for 15-20 minutes. After that the boiled milk was cooled down at 60°C followed by mixing of the starter culture in milk. Thereafter the beetroot juice was mixed in different proportions as mentioned below, making a total of six treatments in total.

Treatment Details

Notations	Treatments
T_1	395ml milk + 5ml beetroot juice
T_2	390ml milk + 10ml beetroot juice
T_3	380ml milk + 20ml beetroot juice
T_4	370ml milk + 30ml beetroot juice
T_5	360ml milk + 40ml beetroot juice
T_6	400ml milk without beetroot juice (Control)

The milk was next poured into Ceramic as well as polythene coated paper cups of 200ml and incubated at 37± 1°C for 12 – 13 hours. After incubation period the set dahi was refrigerated at 4 ± 1°C.

Analytical Method

pH Determination

pH was determined using a pH meter (model EAL 920). 5ml of the sample was measured out and homogenized in 50 mL of distilled water. pH meter was first standardized using buffer solution of pH 4.0-9.0, sufficient time was allowed for stabilization before taking the reading.

Determination of Antioxidant

Materials required

2,2,diphenyl -1 – picrylhydrazyl (DPPH),sample extract and methanol or ethanol.

Preparation of DPPH

2mg of DPPH was dissolved in 100ml of methanol or ethanol (This is very photosensitive

reaction, therefore care has to be taken accordingly like the beaker, used for dissolving the chemicals and the volumetric flask used for storing should be wrapped with Alluminium foil or brown paper).

Methodology

2g of the sample (dahi) was thoroughly mixed in 20ml of methanol. The sample was centrifuged and stored overnight in refrigerated condition in a test tube. The following day, 100ml (0.1µl) of the sample was transferred to another test tube (for the reaction) wrapped in aluminum foil . 3.9ml of prepared DPPH reagent was added to the test tube and left undisturbed for 30 minutes and absorbance was measured in a spectrophotometer at 517nm.

Preparation of standard solution:

Take 0.1 ml of distilled water with 3.9 ml of DPPH and keep it undisturbed for 30 minutes.

Calculation

$$\frac{Abs0 - Abs1}{Abs0} \times 100$$

Where;

Abs_0 = Blank- methanol, standard (sample)

Abs_1 = Blank – methanolsample (extract)

Estimation of Protein by Lowry's Method

Materials

- 2% Sodium Carbonate in 0.1N Sodium Hydroxide (Reagent A)
- 0.5% Copper sulphate ($CuSO_4.5H_2O$) in 1% potassium sodium tartrate (Reagent B)
- Alkaline copper solution: Mix 50ml of A and 1ml of B prior to use (Reagent C)
- Folin-Ciocalteau Reagent (Reagent D)
- Protein Solution (Stock standard)

Weigh accurately 50mg of bovine serum albumin (Fraction V) and dissolve in distilled water and make up to 50ml in a standard flask.

- Working standard

Dilute 10ml of the stock solution to 50ml with distilled water in a standard flask.1ml of this solution contains 200µg protein.

Procedure

Extraction is usually carried out with buffers used for the enzymatic assay. Weigh 500mg of the sample and grind it well with a pestle and mortar in 5-10 ml of the buffer. Centrifuge and use the supernatant for protein estimation.

Estimation of Protein

1. Pippet out 0.2, 0.4, 0.6, 0.8 and 1ml of the working standard into a series of test tubes.
2. Pippet out 0.1ml and 0.2 ml of sample extract in two other test tubes.
3. Make up the volume to 1ml in all the test tubes. A tube with 1ml of water serves as the blank.
4. Add 5ml of reagent C to each tube including blank. Mix well and allow it to stand for 10 min.
5. Then add 0.5ml of reagent D, mix well and incubate at room temperature in the dark for 30 min. Blue colour is developed.
6. Take the readings at 660nm.
7. Draw a standard graph and calculate the amount of protein in the sample.

Estimation of Ascorbic Acid (Rangana)

Procedure

10g of curd sample was taken and strained. The sample is filtered or centrifuged. Titrate of known volume is taken in a 100ml of volumetric flask. The volume is made up to the mark with 3% metaphosphoric acid. It is then ready for titration.

Titration

1. A burette is filled with a blue coloured indophenol dye solution (2,6-dichlorophenol indophenol) after washing with distilled water and cleansing, taking care that no air bubble is left inside.
2. An aliquot part of the sample made in metaphosphoric acid is taken in conical flask.
3. Titration is done till the end point comes which is known by the appearance of pink colour which should persist for at least 15sec on shaking.

Standardization of Dye solution

1. 5ml of standard ascorbic solution is taken in a conical flask.
2. To this 5ml of 3% metaphosphoric acid is added and shaken well.
3. It is titrated against the dye solution taken in the burette.
4. End point is determined by appearance of pink colour which persists for 15 sec. on shaking.

Calculation

Determination of dye factor =

$$\frac{0.5}{\text{Avg burette reading for standardisation of dye solution}}$$

Mg of Vit.C(Ascorbic acid) in 100ml of filter juice =

$$\frac{\text{Burette reading} \times \text{dye factor} \times \text{Total volume for sample}}{\text{wt.of sample} \times \text{vol.of allicot}} \times 100$$

Estimation of Acidity

Materials required

0.1N NaoH, Phenolpthalin indicator, Sample extract.

Preparation of Reagents

0.1N NaoH: In order to prepare it, dissolve 4gm of NaoH pellets in 1000ml of distilled water.

Phenolpthalin indicator: Weigh 0.5gm of phenolpthalin and add or dissolve the powder in 100ml of 50% ethyl alcohol.

Procedure

Take 10g of curd, dilute the curd and make up its volume up to 100ml.Fill the burette with 0.1 NaoH solution. Take 10ml of juice from the diluted curd prepared into a separate beaker and add 1-2 drops of phenolpthalin indicator. Titrate the juice against 0.1N NaoH solution placed in burette. Titration should be stopped when a pink colour end point is observed. Note the burette reading at that point.

Calculation

Acidity =

$$\frac{\text{Titre} \times \text{Normality of alkali} \times \text{m.eq.wt.of acid} \times \text{vol.made upto}}{\text{Weight}/_{\text{volume}} \text{ of sample} \times \text{vol.of aliquot}} \times 100$$

Sensory evaluation

The best product was determined through sensory evaluation. This was done using 10-men semi-trained panelist from the Department of Horticulture, Institute of Agricultural Science, University of Calcutta. The panelists were instructed to indicate their preferences for each of the samples. A nine-point hedonic scale where nine was the highest score and one was the lowest score for each attribute such as color, flavor, texture and overall acceptability was used to evaluate the product and also the interpretation of the consumer responses with respect to acceptance of the product. Hedonic rating scale i.e. like extremely to dislike extremely. The former carried a score of 9 while latter was scored as 1. In this scale scores were categorized as 9-Like Extremely, 8-Like Very Much, 7-Like Moderately, 6-Like Slightly, 5-Neither Like nor Dislike, 4-Dislike Slightly, 3-Dislike Moderately, 2-Dislike Very Much, 1-Extremely Dislike.

Statistical Analysis

Plot Means were used for statistical analysis. The statistical analysis for various parameters was done at Department of Horticulture, Institute of Agricultural Science, University of Calcutta, Kolkata 700019 using statistical package. CRD was worked out by one way ANOVA (Analysis of variance) using online statistical package (www.ccari.res.in/wasp). Comparison of treatment means were further tested using Duncan's Multiple Range Test (DMRT) to identify significant difference ($p<0.05$) between means.

Result and Discussion

pH- Among the treatments T6 was having the lowest pH (4.825) followed by T1(4.980). The highest pH was observed in T5(5.295). Significant differences was observed among treatments T1, T5, T6 and T2 while T3 and T4 were at par. The data recorded after seven days exhibited the same trend but having a lower ph value. Treatments T5, T3 and T6 were significantly different among themselves. T1 and T2 were at par and did not show any sharp difference. The results of present findings are in conformity with those of Mustafa (1997), who found that pH of plain dahi was 4.45 as well as of Kosikowski (1966) who too reported that the pH of normal dahi samples should be approximately 4.5.

Table 1: pH values of beetroot juice fortified curd treatments.

Treatments	Treatment means	
S. No.	Average (0 Days)	Average (After 7 days)
T_1	4.980 ^{c}	4.090 ^{c}
T_2	5.175 ^{b}	4.135 ^{c}
T_3	5.205 ^{ab}	4.280 ^{b}
T_4	5.225 ^{ab}	4.320 ^{ab}
T_5	5.295 ^{a}	4.385 ^{a}
T_6	4.825 ^{d}	3.960 ^{d}
Coff. Of Var.	0.767	0.918
CD (0.05)	0.096	0.094

Note: Treatment means having common letter(s) are not significantly different from each other at 5% level of significance by DMRT

Acidity- With respect to acidity at the initial evaluation, it was observed that treatment T6 (5.608) was having the highest acidity followed by T1(5.504). The least acidic was T5(4.799).Treatments T3,T4,T5 and T6 showed significant differences among themselves while T1 and T2 were at par. The same trend was observable after 7 days. Treatments T1 and T2 as well as T3 and T4 were at par while significant difference was observed between T6 and T5. Our findings do agree with that of Panda *et al*., 2006 who reported pH and titratable acidity are inversely related, with decrease in pH during storage there was corresponding increase in titratable acidity. Our results do not agree with the findings of Desai *et al*. 1994 and Mustafa,1997who found that the titratable acidity of fruit Dahi was significantly increased due to the addition of fruit juice/pulp. It may be due to alkaline nature of beet root juice.

Table 2 : Titratable Acidity values of beetroot fortified curd treatments

Treatments	**Treatment means**	
S.No.	**Average (0 Days)**	**Average (7 Days)**
T_1	5.504^{ab}	6.019^{ab}
T_2	5.489^{ab}	5.725^{bc}
T_3	5.352^{b}	5.548^{cd}
T_4	5.115^{c}	5.488^{cd}
T_5	4.799^{d}	5.226^{d}
T_6	5.608^{a}	6.249^{a}
Coff. Of Var.	1.406	2.482
CD (0.05)	0.183	0.347

Note: Treatment means having common letter(s) are not significantly different from each other at 5% level of significance by DMRT

Ascorbic acid(mg/100g) {Rangana}- High ascorbic acid content was noted in T5(8.955) followed closely by T4(8.460) at the initial estimation. Ascorbic acid was low in T6 and T1. Treatments T1 and T6 were at par while significant difference was observable among T5,T4 and T2. T3 was having ascorbic acid in between T4 and T2. On the 7^{th} day the overall ascorbic acid of all the treatments reduced substantially, the highest being in T5(6.146) and least in T6(4.055). The following treatments were at par viz. T5 &T3, T4 & T2, T1 & T6. Ghosh and Guha, 1935 in their experimental findings found that the formation of curd stabilizes the vitamin in the milk completely which would otherwise be lost if it is stored in the form of milk at 0^0C.No increase in Vit C was observed during the curdling process. In the present investigation, we have observed a reduction of Vit C in all the treatments including control (plain dahi) after storability of seven days. Ascorbic acid is an important nutrient quality factor, which is very sensitive to degradation due to its oxidation compared to other nutrients during storage.

Table 3 : Ascorbic acid content in various treatments of beetroot fortified curd

Treatments	**Treatment means**	
S.No	**Average (0 Days)**	**Average (7 Days)**
T_1	7.290^{d}	4.328^{c}
T_2	7.985^{c}	5.061^{b}
T_3	8.270^{bc}	5.748^{a}
T_4	8.460^{b}	5.294^{b}
T_5	8.955^{a}	6.146^{a}
T_6	7.210^{d}	4.055^{c}
Coff. Of Var.	1.979	3.399
CD (0.05)	0.389	0.425

Note: Treatment means having common letter(s) are not significantly different from each other at 5% level of significance by DMRT

Protein content (Lowry's method)- Among the treatments protein content was high in T5 (14.180) and least in T6(9.210). Treatments T5 &T4 and T1 &T6 were at par. Treatment T2 and T3 were having partial

resemblance. Protein content after 7 days of storage showed substantial decline. Highest was observed in T5(13.590) and least in T6(8.884).T3 & T4 as well as T1&T6 were at par. T5 & T2 exhibited significant difference between themselves. The results exhibit that with increasing amount of beet root juice added to the curd, higher amount of protein was observed. This type of finding was also reported by Mustafa (1997), who found that plain dahi contains less amount of protein than fruit dahi. Similar type of result was also obtained by Desai *et al.* (1994).

Table 4 : Protein content in various treatments of beetroot fortified curd

Treatments	Treatment means	
S.No	Average (0 Days)	Average (7 Days)
T_1	9.465^{c}	9.114^{d}
T_2	11.955^{b}	11.290^{c}
T_3	13.035^{ab}	12.398^{b}
T_4	13.770^{a}	12.096^{b}
T_5	14.180^{a}	13.590^{a}
T_6	9.210^{c}	8.884^{d}
Coff. Of Var.	4.740	2.372
CD (0.05)	1.385	0.652

Note: Treatment means having common letter(s) are not significantly different from each other at 5% level of significance by DMRT

Total Antioxidant (DPPH method)- The highest antioxidant estimate was observed in T5followed by T4,T3 and T2. The least was observed in T1. Treatments T1 and T2 were at par. Significant difference between T5 and T6 was noted.T4 and T3 exhibited partial resemblance.On the 7th day highest antioxidant value was observed in T5 followed by T4, however significant difference was observed among all the treatments except T3 which was in partial agreement to T4 and T2. The antioxidant power of beetroot juice fortified dahi decreased significantly during storage period. Similar result of decreasing antioxidant activity was reported for soya bean camel milk curd with highest antioxidant activity in initial days and subsequent reduction added during storage (Shori *et al*., 2013). According to Gad *et al*., 2010 the antioxidant power of curd containing 10% date palm syrup reduced significantly after 12 days of storage.

Table 5: Antioxidant values in various treatments of beetroot fortified curd

Treatments	Treatment means	
S.No	Average (0 Days)	Average (7 Days)
T_1	55.002^{c}	42.288^{d}
T_2	55.782^{c}	43.131^{c}
T_3	56.233^{bc}	43.608^{bc}
T_4	58.146^{ab}	44.023^{b}
T_5	59.199^{a}	44.746^{a}
T_6	51.752^{d}	41.006^{e}
Coff. Of Var.	1.571	0.547
CD (0.05)	2.154	0.578

Note: Treatment means having common letter(s) are not significantly different from each other at 5% level of significance by DMRT

Organoleptic Observations (Based on scoring technique of standardized procedure)

Texture- It was the best in T_5 (7.230) followed by T_4 (6.710) and T_3 (6.140) at the initial stage.The least was observed in T_6 (5.265). There was significance difference between T_5 (7.230) and T_1 (5.200). T_4 (6.710) and T_2 (5.360) exhibited partial resemblance. After 7 days the texture consistency was almost same for T_5 (6.235) & T_4 (5.820) thus making them at par. Parity was also observed between T_1 (4.610) & T_6 (4.525) and T_3 (5.360) & T_2 (4.845) exhibiting partial resemblance. The texture score of beetroot juice fortified dahi decreased significantly during storage period. Veena *et al*.,2017 reported similar results of reduction in body and texture scores of dahi fortified with different functional ingredients during storage.

Table 6: Measure of Texture among different fortified curd treatments

Treatments	Treatment means	
S.No	Average (0 Days)	Average (7 Days)
T_1	5.200 [d]	4.610[c]
T_2	5.360 [d]	4.845 [c]
T_3	6.140 [c]	5.360 [b]
T_4	6.710 [b]	5.820 [a]
T_5	7.230 [a]	6.235 [a]
T_6	5.265 [d]	4.525 [c]
Coff. Of Var.	2.643	3.443
CD (0.05)	0.387	0.441

Note: Treatment means having common letter(s) are not significantly different from each other at 5% level of significance by DMRT

Flavour- Changes in the flavour score of the treatments during storage is shown in Table 7 and Figure: 7. In the beginning flavor was the best in T_5 (7.535) followed by T_4 (7.495) and T_3 (6.625). T_1 (5.025) &T_6 (4.910) as well as T_3 (6.625) & T_2 (6.160) were at par .Critical difference was observed between T_5 (7.535) & T_6 (4.910). After 7 days, the flavor constituent was highest in T_4 (6.585) followed by T_3 (5.545), T_5 (5.425) & T_2 (5.150), almost same for T_3 (5.545) & T_5 (5.425), thus making them at par means there was no significant difference between them. Similar results were also observed between T_4 (6.585) & T_3 (5.545) and T_6 (4.110) & T_1 (4.095). The flavour score of fortified dahi was significantly reduced during storage period.

Off flavour development during storage of curd was the main reason marked by panelists for product deterioration, which could be attributed to the production of undesired aldehydes and fatty acids by lipid oxidation (Cheng *et al*., 2010 and Bhattarai *et al*., 2013).

Table 7 : Measure of Flavour among different fortified curd treatments.

Treatments	Treatment means	
S.No	Average (0 Days)	Average (7 Days)
T_1	5.025 [d]	4.095[d]
T_2	6.160 [c]	5.150 [c]
T_3	6.625 [b]	5.545 [b]
T_4	7.495 [a]	6.585 [a]
T_5	7.535 [a]	5.425[bc]
T_6	4.910 [d]	4.110 [d]
Coff. Of Var.	2.801	2.815
CD (0.05)	0.431	0.355

Note: Treatment means having common letter(s) are not significantly different from each other at 5% level of significance by DMRT

Colour- Changes in colour appearance score of beet root juice extract incorporated in dahi during storage and various treatments is shown in Table 8 and Figure: 8 . Colour acceptability was high in T_5 (8.885) followed by T_4 (7.985) and T_3 (6.725). Significant difference was observed between T_5 (8.885) & T_6 (5.050) and T_4 (7.985) &T_1 (5.140). The least was observed in T_6 (5.050). After seven days, colour exhibited the same trend but there was decrease in colour intensity in a marginal manner. Treatments T_5 (8.025) & T_6 (4.440) were significantly different between them. T_1 (4.575) and T_6 (4.440) were at par and did not show any sharp difference. There was less decrease in colour score with progress in storage days. Highest colour and texture score was recorded in case of dahi having 40% beetroot juice and lowest score was recorded in case of control (plain dahi). The result of this experiment supports the findings of Desai *et al*. (1994) who observed that addition of fruit juice improves the colour and texture score of dahi.

Table 8 : Scoring of Colour among different fortified curd treatments

Treatments	Treatment means	
S.No	Average (0 Days)	Average (7 Days)
T_1	5.140 ^{e}	4.575 ^{e}
T_2	5.760 ^{d}	5.110 ^{d}
T_3	6.725 ^{c}	6.390 ^{c}
T_4	7.985 ^{b}	7.340 ^{b}
T_5	8.885 ^{a}	8.025 ^{a}
T_6	5.050 ^{e}	4.440 ^{e}
Coff. Of Var.	1.610	2.205
CD (0.05)	0.260	0.323

Note: Treatment means having common letter(s) are not significantly different from each other at 5% level of significance by DMRT

Total Organoleptic score: Changes in the total organoleptic score of beet root juice incorporated in dahi during initial phase and on 7th day of storage among various treatments is shown in Table: 9 and Figure: 9. Overall organoleptic score was high in T_5 (23.625) followed by T_4 (21.650) and T_3 (19.350). Significant difference was observed between T_5 (23.625) & T_6 (15.200) and T_4 (21.650) & T_1 (15.480). The least score was observed in T_6 (15.200). After seven days the same trend was exhibited, however overall organoleptic score fell marginally thus deciphering high chances of acceptability. On the 7th day, treatments T_5 (19.725) & T_6 (12.925) were significantly different between them. T_1 (12.935) and T_6 (12.925) were at par and did not show any sharp difference. Our observations validate the findings of Ismail *et al*., 2014 who reported overall organoleptic score decreased with storage period. Similar observations were recorded by Turksoy *et al*., 2011. The result of our experiment also supports the findings of Desai *et al*.,1994 who observed that addition of fruit juice improved the total organoleptic score in Dahi.

Table 9: Total organoleptic score among different fortified curd treatments.

Treatments	Treatment means	
S.No	Average (0 Days)	Average (7 Days)
T_1	15.480^{e}	12.935^{d}
T_2	17.225^{d}	14.450^{c}
T_3	19.350^{c}	16.700^{b}
T_4	21.650^{b}	19.425^{a}
T_5	23.625 ^{a}	19.725^{a}
T_6	15.200^{e}	12.925^{d}
Coff. Of Var.	2.154	1.274
CD (0.05)	0.989	0.500

Note: Treatment means having common letter(s) are not significantly different from each other at 5% level of significance by DMRT

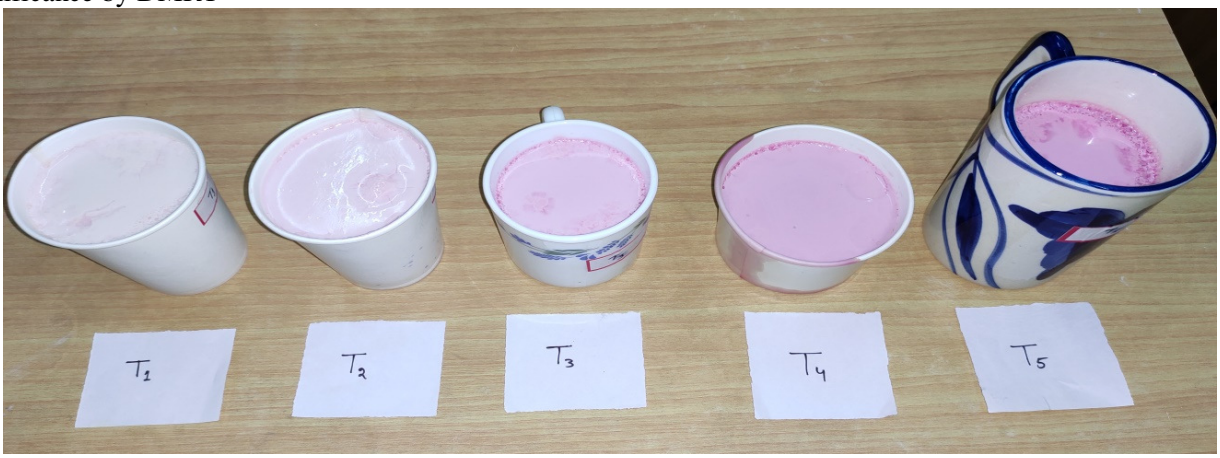

Plate 1: Different types of Dahi prepared in the laboratory.

Conclusion

The result of this study showed that addition of beetroot juice to curd as colouring agent improved the physic-chemical attributes under study, colour and sensory properties of curd, especially when added in optimal quantities. The utilization of beetroot as a natural colourant improved the nutritional and sensory properties of the product. It was overall observed that treatments T_5 (360ml milk + 40ml beetroot juice) and T4 (370ml milk + 30ml beetroot juice) were very much acceptable as such. However, more studies in the field of sensory qualities, storability and microbial growth needs to be evaluated before making the final call.

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