The Bioscan 12(2): 873-880, 2017
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

# SELECTING THE FLAVOURING AMONGST MANGO PULP AND SUGAR TREATED CARROT SHREDS FOR DEVELOPING VALUE-ADDED *BHAPA DAHI*

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**KEYWORDS**
*Bhapa dahi*
Mango pulp
Carrot shreds
Composition

**Received on :**
02.04.2017

**Accepted on :**
17.05.2017

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**ABSTRACT**
The investigation was carried out to select the flavouring from amongst mango pulp and sugar-treated carrot shreds for preparing *Bhapa dahi*. *Bhapa dahi* was prepared adopting the process standardized by Patel *et al.* (2016) employing thermophilic starter culture. A blend of *chakka* and sweetened condensed milk (SCM) [1:1 w/w] served as the base mix; optimum steaming period was 15 min. The moisture, fat on dry matter (FDM), protein and pH of mango *Bhapa dahi* were 52.48-53.19%, 15.60-15.77%, 7.60-7.73% and 5.14-5.25 respectively. Similar values for carrot *Bhapa dahi* were 47.06-47.48%, 16.19-16.35%, 9.34-9.44% and 5.35-5.36 respectively. *Bhapa dahi* samples had compositional values that were similar to values laid down by FSSA for fruit *shrikhand*. The recommended rate of addition of mango pulp and carrot shreds was 18.0 and 8.0 % by weight of base mix respectively. Mango and carrot flavoured *Bhapa dahi* had 35 and 13 times higher β–carotene content respectively compared to control. *Bhapa dahi* made using recommended flavour addition had sensory score of 92.07 (mango) and 90.98 (carrot) (out of 100) respectively. It is recommended to prepare value added β–carotene enriched *Bhapa dahi* through incorporation of either 18.0% of mango pulp or 8.0% of sugar treated carrot shreds.

## INTRODUCTION

*Bhapa dahi*' (steamed concentrated yoghurt, usually sweetened) is a popular Bengali delicacy prepared at domestic level in West Bengal, India. It is basically a steamed sweetened *dahi* and is often called the 'Indian cheese cake'.

The idea of conducting the research work was to add value to the fermented dairy product (*Bhapa dahi*) through flavour enhancement of the product, increasing its consumer appeal as well as enriching the product with β–carotene (a precursor of vitamin A – important for healthy vision and an antioxidant). Incorporation of herbs like ginger and mint at levels of 1.5% by weight in the preparation of frozen yogurt helped in better survival of Lactic Acid Bacteria in the product; the maximum count of *S. thermophilus* and *L. bulgaricus* noted in such product was 70.5 x $10^7$ and 27.0 x $10^7$ cfu/g respectively (Singh *et al.*, 2013).

The scientific research on *Bhapa dahi* is very scanty. Papers related to *Bhapa dahi* can be found in literature authored by only two researchers (Bhattacharya *et al.,* 1979, 1980; Patel *et al.,* 2016), one of them carried out by us. Bhattacharya *et al.* (1979) had standardized the technology for production of *Bhapa dahi* from a blend of concentrated milk (Volume concentration ratio of 2:1 of milk standardized to 4% milk fat) and *chakka* (partially drained whey from curd/*dahi*) in 70:30 ratio; sugar was used at 15% by weight. The mixture filled in glass bottles were steamed for 10-12 min. to obtain *Bhapa dahi*. A modified method involving use of spray dried skim milk powder (SMP) and starter culture to replace concentrated milk and *chakka* in earlier procedure was standardized by Bhattacharya *et al.* (1980). The optimized conditions arrived at were milk (4% fat) :SMP of 7:2 for 'low-fat' product and 5:1 for 'high-fat' product and a sugar level of 12% by weight. Such cultured mix (acidity of 0.55 % LA) was filled in bottles and subjected to steaming for 10 min to obtain set product. Patel *et al.* (2016) had standardized the formulation and technology for preparation of *Bhapa dahi* utilizing a blend of *chakka* and sweetened condensed milk (SCM) (*chakka*: SCM, 1:1 w/w – served as base mix) as the base mix to which mango pulp (@ 18% by weight) was incorporated for flavouring and value addition. The base mix was subjected to steaming for 15 min. to obtain the set product after which the product was cooled and kept under refrigeration.

Fruits are perceived as part of healthy diet by the consumers. The association of fruit with *dahi* would further endorse its health image. As consumers connect both these foods with health and wellness, the two categories of fruits and cultured milk products are typical example of hybrid dairy products offering health, flavour and convenience. Such products can be prepared by resorting to addition of fresh or deep frozen fruits, fruits concentrates, fruit pulps or even fruit powders. Value addition to fermented milk foods can be accomplished through use of natural fruit or vegetable juices/particulates incorporated into milk solids. Such practice will not only enhance the palatability of product, but also enrich them with phytochemical *i.e.* β-carotene (a precursor of Vitamin A) and

mineral content too. Mango (pulp form) as well as carrot (cooked and sweetened) are well established natural flavourings for a variety of food products *viz*., stirred yogurt, frozen yogurt, *etc*. (Stuti and Prasad 2013, Mbaeyi-Nwaoha *et al.,* 2017). Hence, there is a need to validate the value-addition to *Bhapa dahi* through incorporation of fruit/vegetable component into the milk solids for nutritional security as well as to enhance the sales appeal.

Alphonso is the most popular mango cultivar owing to its highly attractive flavour. The flavouring components of Alphonso mango are mono and sesquiterpenes and the presence of lactones and furanones as affected by the stage of ripening (Pandit *et al.,* 2009). The Alphonso mango pulp is reported to contain 19.6 % TSS, 14.57 % non-reducing sugar, 2.43 % reducing sugar and 0.4 % ash; it had 14.01 mg/100 g of ascorbic acid (Anila and Radha 2003). Such mango pulp had sugar/acid ratio of 42.5 and 0.41 % acidity. Mango is an excellent source of vitamin A and flavonoids like β-carotene, α-carotene, and β-cryptoxanthin. Fresh fruit (100 g) provides about 765.0 IU of vitamin A which translates to 25.0 % of recommended daily levels. Mango (100 g) is also a very good source of vitamin C (~27.7 mg) and vitamin E (~1.12 mg) (Pandey and Dinesh 2010). Besides strong aroma, Alphonso mango is known for its intense peel colouration and delicious taste. Preparation of fruit yoghurt has been investigated by a number of researcher's worldover (Shukla *et al.,* 1987, Desai *et al*., 1994). Alphonso sweetened mango pulp (M/s. Vadilal Co.) contained 26.0 % carbohydarate (inclusive of added sugar), 1.0 % protein and 4 mg of Na/100 g of pulp. The pulp is generally standardized to 14-18ºBrix and 0.65-0.75 % acidity (as citric acid) by adding sugar syrup and citric acid, respectively.

Carrot (*Daucus carota* subsp. *sativus*) is one of the more commonly used vegetable for human nutrition, especially in salads and as carrot *halwa*. Carrot contains on an average 86.0 % moisture, 0.2 % fat, 0.9 % protein, 10.6 % carbohydrate, 1.2 % crude fibre and 1.1 % ash (Gopalan *et al.*,1991). The calcium, iron and phosphorus content of carrot (per 100 g) were 34-80 mg, 0.4-2.2 mg and 25-53 mg respectively (Gopalan *et al.,* 1991, Holland *et al.,* 1991). Carrots are rich source of carotenes and vitamin A. Fresh carrot contains about 11,000 IU of vitamin A/100 g edible portion. Carrot (per 100 g) is also rich in vitamin $B_1$ (~0.06 mg), vitamin $B_3$ (~0.6 mg), vitamin $B_5$ (~0.25 mg) and vitamin $B_9$ (~15 $\mu$g) (Hadley and Fordham 2003). The free sugars identified in carrot juice were sucrose, glucose, xylose and fructose. The taste of carrot is mainly due to the presence of glutamic acid and the buffering action of free amino acids (Kalra *et al.,* 1987). The crude fiber in carrot roots consist of 71.7 % cellulose, 13.0 % hemicellulose and 15.2% lignin (Kochar and Sharma 1992). Caffeic acid is the predominant phenolic acid in carrot. The anthocyanins content in roots may vary from trace amounts in pink cultivars to 1750 mg/kg in black carrots (Mazza and Minizte 1993). The ²-carotene (mg/100 g) of carrot juice based yoghurt made from red carrot juice mix (3: 1, v/v) and yellow carrot juice mix (2:1,v/v) were 3.68 and 16.55 respectively; the anthocyanin content (mg/100 g) of such yoghurts were 22.05 and 0. 0 respectively. (Amany *et al.,* 2012).

Thus, the study was planned to develop a value-added fermented product (*Bhapa dahi*) by incorporating mango pulp and/or sugar treated carrot shreds as flavouring matter to enhance the palatability of the product as well as to enrich the product with valued nutrients and phytochemicals.

## MATERIALS AND METHODS

Hand refractometer (0-32% scale; ERMA, Tokyo, Japan) was used to determine the total soluble solids (TSS) of mango pulp while hand refractometer (58-92 % scale; ERMA, Tokyo, Japan) was used to determine the TSS of sugar syrup used to prepare treated carrot shreds.

Hobart mixer (M/s. Hobart, Corporation, Ontario, Canada, Model No. N 50) operating at three speed was used to prepare the base mix (a blend of *chakka* and SCM) as well as to blend the mango pulp/carrot shreds to the base mix.

**Raw materials**

Milk, *chakka* prepared from such milk and Sweetened condensed milk (SCM) were the dairy ingredients used in preparation of *Bhapa dahi*.

**Dairy ingredients**

**Milk**

Tea special milk of Amul brand (homogenized milk having 4.5 % fat, 8.5 % SNF) was procured from local market of Anand, Gujarat to prepare curd.

**Sweetened condensed milk**

Partly skimmed SCM (M/s. Nestle Co., brand Milkmaid) packed in tin can was procured from Granary, Anand, Gujarat. The composition of SCM is provided in Appendix-I.

**Non-dairy ingredients**

The non-dairy ingredients used were starter culture, sugar, Alphonso mango pulp (sweetened) and sugar treated carrot shreds.

**Starter culture**

Lyofast Y170F Sacco yoghurt cultures (freeze dried lactic cultures; Cadorago Co., Italy) were used for the preparation of curd. For the preparation of curd, 1UC was sufficient to convert 100 lit. of milk into *dahi*.

**Sugar**

Granulated sugar was obtained from local market of Anand, Gujarat.

**Mango pulp**

Alphonso tinned mango pulp (M/s. Vadilal Co., Ahmedabad) was obtained from local Anand market. The particulars of mango pulp are provided in Appendix-II.

**Carrot**

Fresh carrots were bought from the local market of Anand to prepare sugar treated carrot shreds.

**Preparation of sugar treated carrot shreds**

Since carrot in its raw form was not palatable, carrot shreds were treated with sugar syrup to make it tasty. The surface of washed carrot was trimmed and the carrot shredded through a manual stainless steel shredder (pore size ~4 mm). The carrot shreds (~8 mm length and ~3 mm diameter) were subjected to blanching (95ºC for 5 min in hot water). The

blanched carrot shreds were cooked (simmering) in 60.0 % sugar syrup (checked with hand refractometer – ERMA, Tokyo, Japan) for adequate period of time (10-15 min) and then cooled to refrigeration temperature. Such sugar treated carrot shreds were used as flavouring, added to the base mix in the preparation of value-added *Bhapa dahi*.

**Preparation of *Bhapa dahi***

The process standardized for preparation of *Bhapa dahi* by Patel *et al.* (2016) was followed.

All the selected ingredients (*i.e. chakka,* SCM and flavourings) were weighed accurately as per the calculations based on the formulation. Hobart mixer (M/s. Hobart, Corporation, Ontario, Canada, Model No. N 50) was used to prepare the base mix. The 'Tea special milk' was heated to 90ºC and held for 10 min. The milk was then cooled to 42ºC and made into curd by inoculating it with 0.015 % of Lyofast culture. The curd was ready in 5.5 h incubated at 42ºC temperature. '*Chakka*' was obtained from such curd. The composition of *chakka* is furnished in Appendix-III. The SCM was mixed with *chakka* (1:1 proportion w/w) in a Hobart mixer. Subsequently mango pulp or sugar treated carrot shreds (both in cold condition) was added to the base mixture (*i.e. chakka* and SCM) and blended. The final mixture was filled in stainless steel tray with lid (1 lit. capacity) and subjected to steaming in a pressure cooker (Make - Marlex) without applying any pressure (avoiding weight on cooker) for 15 min. The curd set into a firm gel *i.e. Bhapa dahi*. The product was allowed to cool to room temperature and subsequently shifted to a refrigerator ($7 \pm 1$ºC) for storage.

**Use of mango pulp and sugar treated carrot shreds as flavouring agent**

The experiment involved preparing two batches of *Bhapa dahi* using Alphonso mango pulp as a flavouring agent at the rate of 18.0 and 21.0 % by weight of the base mix (*i.e. chakka* and SCM; 1:1 w/w). Each treatment was replicated seven times. Another set of experiment involved preparing three batches of *Bhapa dahi* made using sugar treated carrot shreds at the rate of 6.0, 8.0 and 10.0 % by weight of base mix. Such treatment was replicated five times.

In order to evaluate the sensory aspect, all the five *Bhapa dahi* samples (two with mango pulp and three with carrot shreds) were prepared together simultaneously. Such treatment was replicated four times.

**Analyses of ingredients and final sweetened concentrated yogurt**

The analyses carried out for different ingredients and resultant *Bhapa dahi* is as given below.

**Milk**

The fat content of milk was estimated by Gerber method (BIS, 1977). Solids Not Fat of milk was determined by the standard procedure (Eckles *et al.,* 1951).

**Chakka**

The fat content of *chakka* was determined by Gerber method (BIS ,1980). The total solid (TS) of *chakka* was determined by the standard procedure using Mojonnier Milk Tester, Model-D (Milk Industry Foundation, 1959). The titratable acidity of *chakka* was estimated by standard method (BIS 1973).

**Sweetened condensed milk**

The fat content of SCM was determined by modified Gerber fat test as recommended for *shrikhand* (Puntambekar 1968). The TS of SCM was determined by the standard procedure using Mojonnier Milk Tester, Model-D (Milk Industry Foundation 1959).

**Mango pulp**

The TS of mango pulp was determined by the standard procedure using Mojonnier Milk Tester, Model-D (Milk Industry Foundation 1959).The total soluble solids (TSS) of mango pulp was measured using refractometer (ERMA hand refractometer, Tokyo, Japan; 0 – 32 % scale) at 20ºC. pH determination of mango pulp was carried out following the standard procedure using digital pH meter (M/s. Mettler Toledo AG, Schwerzenbach, Model No. CH-8603) (Anon. 2000). The acidity of mango pulp was determined by titration method and expressed in terms of citric acid (Mann *et al.,* 2010).

**Bhapa dahi**

The fat content of product was determined by modified Gerber fat test as recommended for *shrikhand* (Puntambekar 1968). The total nitrogen content of *Bhapa dahi* was determined using semi-micro Kjeldahl method (Jayaraman 1981). Kjel-plus digestion system (Model-KPS 006L) and Kjel-Plus semi-automatic distillation system (Model-Distil M) both from M/s. Pelican Instruments, Chennai was used for the purpose. The nitrogen content was multiplied with a factor of 6.38 to obtain protein content. The TS of product was determined by the standard procedure using Mojonnier Milk Tester, Model-D (Milk Industry Foundation, 1959). The ash content of product was determined using the standard method (BIS, 1989). The total carbohydrate content of *Bhapa dahi* was obtained by difference. The titratable acidity of product was estimated by the standard method (BIS, 1973). pH determination of *Bhapa dahi* was carried out following the standard procedure using the digital pH meter mentioned earlier for mango pulp (Anon., 2000). The samples of *Bhapa dahi* were analysed for their β-carotene content at the Centre for Analysis and Learning in Livestock Food (CALF) laboratory, National Dairy Development Board, Anand, Gujarat.

**Sensory evaluation of *Bhapa dahi***

On the basis of desirable attributes of *dahi*, the 100 point score card suggested by Ranganadham and Gupta (1987) was used for scoring *Bhapa dahi* samples. The sensory evaluation of product was carried out by ten judges, selected on the basis of triangle and Duo-trio tests. All the judges were well aware about the desirable characteristics of the product. *Bhapa dahi* samples, initially kept in the refrigerator, were presented to the judges, after tempering the product (about 1 h) at $23 \pm 1$ºC. Sensory evaluation of *Bhapa dahi* was conducted in an isolated booth, illuminated with incandescent light and the room temperature was maintained at $23 \pm 1$ºC. The *Bhapa dahi* samples were served in 100 ml polystyrene cups. All the samples were coded and the order of serving the samples was completely randomized.

**Statistical analysis**

The mean value of each attribute under study obtained from duplicate samples of five replications (three treatments) or four

replications (five treatments) were subjected to statistical analysis using 'Completely Randomized Design' with equal number of observations (Steel and Torrie, 1980).

## RESULTS AND DISCUSSION

### Effect of flavouring ingredients on the composition of *Bhapa dahi*

The average values presented in Table 1 shows that the rate of addition of mango pulp in the preparation of *Bhapa dahi* had a significant influence on nearly all of the chemical constituents, except for protein at constant moisture (PCM). As the level of mango pulp was increased from 18.0 to 21.0 %, the moisture content of *Bhapa dahi* increased. Such difference in the moisture content of *Bhapa dahi* led to changes in the other constituents; such constituents were significantly ($P < 0.05$) affected. The fat, fat on dry matter (FDM), protein, carbohydrate and ash content of *Bhapa dahi* containing 21.0 % mango pulp were significantly ($P < 0.05$) lower than the one made utilizing 18.0 % mango pulp. The effect was due to high moisture content (*i.e.* 73.85%) of mango pulp (Appendix-II). *Bhapa dahi* made using 21.0 % mango pulp had significantly ($P < 0.05$) higher titratable acidity than that made using 18.0 % level.

The citric acid content of mango pulp (0.65 %) probably contributed to the total acidity (lactic + citric acid) of *Bhapa dahi*. Since there is an inverse relation between acidity and pH, the pH value of *Bhapa dahi* containing 18.0 % mango pulp was higher than its counterpart containing 21.0 % pulp; the effect was found to be significant ($P < 0.05$) (Table 1).

The total sugar content of Mango yogurt made utilizing 10.0 % of mango pulp was 14.58%. The total sugar comprised of 9.11% sucrose, 3.71% lactose and 1.76% blend of fructose, glucose and galactose (Pereira *et al.,* 2013).

The fat, protein and ash content of fruit yoghurt tended to significantly decrease, while the TS, carbohydrate content and titratable acidity increased upon addition of mango pulp in the product (Desai *et al.,* 1994, Rakhi *et al.,* 2013, Mbaeyi-Nwaoha *et al.,* 2017). The acidity of fruit yoghurt tended to increase while its pH tended to decrease as the rate of addition of strawberry pulp (9.74 % TS, 0.51 % acidity) was raised from 7.0 to 10.0 % by weight in the product (Yousef *et al.,* 2013). Similar results in terms of acidity and pH has been

**Table 1 : Physico-chemical properties of *Bhapa dahi* as affected by the level of mango pulp**

| Constituents# | *Bhapa dahi** made using mango pulp at levels (%,w/w) | | C.D.(0.05) |
|---|---|---|---|
| | 18 | 21 | |
| Moisture | $52.48 \pm 0.08^{a}$ | $53.19 \pm 0.07^{b}$ | 0.09 |
| Fat | $7.49 \pm 0.04^{a}$ | $7.30 \pm 0.05^{b}$ | 0.05 |
| Fat on dry matter | $15.77 \pm 0.09^{a}$ | $15.60 \pm 0.10^{b}$ | 0.11 |
| Protein | $7.73 \pm 0.05^{a}$ | $7.60 \pm 0.05^{b}$ | 0.06 |
| Protein (52% moisture) | $7.81 \pm 0.04^{a}$ | $7.79 \pm 0.05^{a}$ | NS |
| Carbohydrate[2] | $31.27 \pm 0.06^{a}$ | $30.90 \pm 0.04^{b}$ | 0.06 |
| Ash | $1.03 \pm 0.01^{a}$ | $1.01 \pm 0.02^{b}$ | 0.02 |
| Acidity (% lactic acid) | $1.04 \pm 0.02^{a}$ | $1.17 \pm 0.05^{b}$ | 0.04 |
| pH | $5.25 \pm 0.01^{a}$ | $5.14 \pm 0.02^{b}$ | 0.02 |

Figures placed after ± indicates standard deviation, 1-Total carbohydrate obtained by difference, # - all the values are in per cent, except for pH

**Table 2 : Physico-chemical properties of *Bhapa dahi* as affected by the level of carrot shreds**

| Constituents# | *Bhapa dahi* made* using carrot shreds at levels (%, w/w) | | | C.D.(0.05) |
|---|---|---|---|---|
| | 6 | 8 | 10 | |
| Moisture | $47.48 \pm 0.03^{a}$ | $47.26 \pm 0.02^{b}$ | $47.06 \pm 0.04^{c}$ | 0.05 |
| Fat | $8.59 \pm 0.01^{a}$ | $8.58 \pm 0.01^{a}$ | $8.57 \pm 0.01^{a}$ | NS |
| Fat on dry matter | $16.35 \pm 0.02^{a}$ | $16.28 \pm 0.02^{b}$ | $16.19 \pm 0.01^{c}$ | 0.02 |
| Protein | $9.36 \pm 0.01^{a}$ | $9.34 \pm 0.01^{a}$ | $9.33 \pm 0.02^{a}$ | NS |
| Protein (47% moisture) | $9.44 \pm 0.01^{a}$ | $9.39 \pm 0.01^{b}$ | $9.34 \pm 0.02^{c}$ | 0.02 |
| Carbohydrate[1] | $33.31 \pm 0.03^{a}$ | $33.56 \pm 0.03^{b}$ | $33.79 \pm 0.05^{c}$ | 0.05 |
| Ash | $1.26 \pm 0.02^{a}$ | $1.26 \pm 0.01^{a}$ | $1.25 \pm 0.0.1^{a}$ | NS |
| Acidity (% lactic acid) | $0.98 \pm 0.01^{a}$ | $0.98 \pm 0.01^{a}$ | $0.99 \pm 0.01^{a}$ | NS |
| pH | $5.36 \pm 0.02^{a}$ | $5.36 \pm 0.01^{a}$ | $5.35 \pm 0.01^{a}$ | NS |

Figures placed after ± indicates standard deviation, 1- Total carbohydrate obtained by difference, # - all the values are in per cent, except for pH

**Table 3 : Comparison of the sensory scores of *Bhapa dahi* flavoured using sugar treated carrot shreds and mango pulp**

| Sensory attributes | *Bhapa dahi* made using carrot shreds at levels (%,w/w) | | | *Bhapa dahi* made using mango pulp at levels (%,w/w) | | C.D.(0.05) |
|---|---|---|---|---|---|---|
| | 6 | 8 | 10 | 18 | 21 | |
| Flavour (45) | $39.81 \pm 0.64^{c}$ | $42.00 \pm 0.31^{a}$ | $40.52 \pm 0.34^{b}$ | $42.33 \pm 0.51^{a}$ | $41.43 \pm 0.42^{b}$ | 0.71 |
| Body & Texture(30) | $25.95 \pm 0.27^{c}$ | $27.14 \pm 0.20^{a}$ | $26.19 \pm 0.36^{bc}$ | $27.67 \pm 0.67^{a}$ | $26.71 \pm 0.31^{b}$ | 0.61 |
| Colour & Appearance (10) | $8.19 \pm 0.29^{b}$ | $8.74 \pm 0.12^{ab}$ | $8.39 \pm 0.33^{b}$ | $8.81 \pm 0.13^{a}$ | $8.55 \pm 0.19^{a}$ | 0.35 |
| Acidity (10) | $7.76 \pm 0.07^{c}$ | $8.10 \pm 0.24^{ab}$ | $7.52 \pm 0.07^{c}$ | $8.26 \pm 0.22^{a}$ | $8.02 \pm 0.19^{a}$ | 0.27 |
| Package# (05) | $5.00^{a}$ | $5.00^{a}$ | $5.00^{a}$ | $5.00^{a}$ | $5.00^{a}$ | - |
| Total score (100) | $86.71 \pm 1.09^{c}$ | $90.98 \pm 0.62^{ab}$ | $87.62 \pm 0.90^{c}$ | $92.07 \pm 1.33^{a}$ | $89.71 \pm 0.59^{b}$ | 1.46 |

Figures placed after ± indicates standard deviation, Figures in parentheses indicates maximum score,#- Full score was given to package

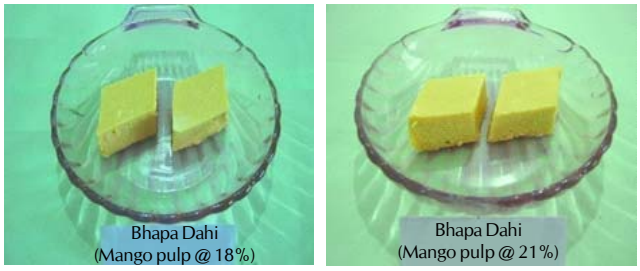


**Figure 1: *Bhapa dahi* using 18%(A) and 21%(B) of mango pulp**

**Appendix 1: Proximate composition of sweetened condensed milk**

| Constituents | Value (%) |
|---|---|
| Fat | 3.90 |
| Protein | 8.20 |
| Total carbohydrates* | 56.50 |
| Ash | 1.95 |
| Total solids | 70.55 |

*- obtained by difference

**Appendix II: Particulars of canned sweetened Alphonso mango pulp**

| Parameters | Value |
|---|---|
| Colour | Orange |
| Total soluble solids (°Brix) | 24.0 |
| Total solids (%) | 26.15 |
| pH | 3.80 |
| Acidity (% citric acid) | 0.65 |

**Appendix III: Proximate composition of *chakka***

| Constituents | Values (%) |
|---|---|
| Fat | 12.5 |
| Protein | 6.50 |
| Lactose* | 6.40 |
| Ash | 0.90 |
| Total solids | 26.30 |
| Acidity (% LA) | 1.75 |

*- obtained by difference

observed when using apple pulp (16.40 % TSS) at levels of 5.0 to 15.0 % in fruit yoghurt (Ghadge *et al.*, 2008). The average values presented in Table 2 shows that *Bhapa dahi* made using sugar treated carrot shreds at levels of 6.0, 8.0 and 10.0 % had a significant ($P < 0.05$) influence only on the moisture, FDM, PCM and carbohydrate content; other constituents remained unaffected.

The moisture content of all the three samples of *Bhapa dahi* containing carrot shreds were significantly ($P < 0.05$) different from each other. As the level of carrot shreds increased from 6.0 to 10.0 %, the moisture content of the resultant *Bhapa dahi* tended to decrease linearly (Table 2). Since sugar treated carrot shreds had on an average 64.2 % TS, it contributed to the total solids of *Bhapa dahi*. The difference in the moisture content of the three products must have brought about a significant ($P < 0.05$) change in the FDM and PCM of resultant products. However, it is important to note that neither the fat nor the protein content of *Bhapa dahi* was significantly affected by varying the rate of addition of carrot shreds. The increase in the carbohydrate content of *Bhapa dahi* with an increase in the level of carrot shreds is understood, since the sugar present in treated carrot shreds (64.2 % TS, majority of this TS being sugar content) contributed to the total carbohydrate content of the product.

Salwa *et al.* (2004) and Sulieman *et al.* (2011) noted a decrease in the fat, total nitrogen and TS content of yoghurt upon addition of incremental levels (5.0 to 20.0 %) of carrot juice (6.45 % TSS). The spreadable Yogurt prepared utilizing 5.0 % of black carrot juice had 66.3% moisture and a pH of 4.91 (Ayar and Gurlin, 2014). The acidity and pH of plain yogurt as well as carrot yogurt made using 15.0% carrot juice was 0.52% LA and 4.15 respectively (Salwa *et al.*, 2004). In the current experiment, the TS content of *Bhapa dahi* increased, while FDM and PCM tended to decrease with an increase in the level of carrot shreds in the final product. The difference in the TS of our finding with other two workers was due to the different forms of carrot used (*i.e.* shreds vs. juice).

Comparing the composition of *Bhapa dahi* made incorporating mango pulp as against carrot shreds, it is evident that those made using mango pulp had higher moisture content (Table 1 and 2).This led to higher values of fat, protein, total carbohydrate and ash in product made utilizing carrot shreds, when compared to those of mango flavoured *Bhapa dahi*. However, the acidity of mango flavoured *Bhapa dahi* was greater than that associated with carrot containing *Bhapa dahi*. The higher content of moisture associated with mango pulp (73.85 % moisture, Appendix-II) compared to treated carrot shreds (35.8% moisture) must have led to such variation in the moisture content of resultant *Bhapa dahi*.

Since there are no standards laid down by FSSA for *Bhapa dahi*, an attempt was made to compare their chemical composition with the FSSA requirements laid down for *shrikhand* (FSSA 2011); since both *Bhapa dahi* and *shrikhand*


**Figure 2 : *Bhapa dahi* using 6%, 8% and 10% of carrot shreds**

utilizes the *chakka* as base material and both of them are sweetened products. Comparison showed that except for ash content, all the *Bhapa dahi* samples (flavoured with mango pulp and carrot shreds) conformed to all of the compositional requirements for *Shrikhand* laid down by FSSA.

**Sensory quality of *Bhapa dahi* made utilizing mango pulp and sugar treated carrot shreds as flavouring ingredient**

The average values of the sensory score of *Bhapa dahi* made using sugar treated carrot shreds and canned mango pulp at varying levels is shown in Table 3. Each sensory parameter of *Bhapa dahi* has been dealt separately hereunder.

**Colour and appearance score**

Both the samples of mango flavoured *Bhapa dahi* had uniform orange yellow colour throughout the mass, however the colour of the product containing higher level of mango pulp (*i.e.* 21.0 %) tended to be of darker shade (Fig. 1A,B). There was some whey separation upon cutting, especially in case of *Bhapa dahi* made using 21.0 % mango pulp. *Bhapa dahi* containing 18.0 and 21.0 % mango pulp had colour and appearance score that was at par with each other (Table 3). Though the natural colour of sugar treated carrot shreds was reddish pink, they appeared pinkish orange in appearance in the white background of *Bhapa dahi* (Fig. 2A,B,C). This improved the 'eye appeal' of carrot flavoured *Bhapa dahi*. The colour and appearance score of *Bhapa dahi* made using 8.0 % carrot shreds was maximum which differed significantly ($P < 0.05$) only from the score of product with 6.0% carrot shreds; those made using 8.0 and 10.0% levels had similar color and appearance score (Table 3). The number of carrot particulates in *Bhapa dahi* containing 6.0 % carrot shreds appeared fewer in number leading to least score for colour and appearance associated with such sample. However, the number of carrot shreds seemed somewhat in excess in *Bhapa dahi* containing highest level (*i.e.* 10.0 %) of carrot shreds. Yousef *et al.* (2013) reported that fruit yoghurt prepared using strawberry pulp added at 7.0 % level had higher colour and appearance score when compared to that made using 10.0 % pulp (*i.e.* score of 4.81 vs. 4.72 out of 5.0). Spreadable Yogurt prepared utilizing 5.0 % black carrot juice had red colour contributed by the anthocyanin pigment in carrot (Ayar and Gurlin, 2014). In our case also the treated carrot shreds conferred pink colour to the resultant *Bhapa dahi*. Ranganadhan and Gupta (1987) reported that whey separation in yoghurt arises from syneresis of gel due to high acid formation. An increase in the level of apple pulp in the preparation of fruit yoghurt led to a product having increased tendency to syneresis (Ghadge *et al.,* 2008). Addition of kokum (*Garcinia indica*) juice in yoghurt matrix led to considerable whey separation and led to lack of uniformity in the body (Desai *et al.,* 1994).

**Flavour score**

The *Bhapa dahi* made using 18.0 % of mango pulp had significantly ($P < 0.05$) greater score for flavour when compared to the one containing 21.0 % level. This indicated that use of excess mango pulp had some adverse effect on the sensory acceptability of the product. This may be due to the intense mango taste as well as the higher tartness; the latter aspect is evident from the slightly lower score for acidity allotted to *Bhapa dahi* samples containing 21.0 % mango pulp (Table 3). Yousef *et al.* (2013) also observed that yoghurt prepared using strawberry pulp at the rate of 7.0 % by weight had higher flavour score (*i.e.* 4.91 out of 5.0) compared to that made using 10.0 % level (*i.e.* 4.51 out of 5.0). Hossain *et al.* (2012) reported that with an increase in the level of strawberry pulp in fruit yoghurt from 5.0 to 15.0 %, there was a gradual decrease in the flavour score (39.8 to 28.4, out of 50.0) of product. The sensory score for flavour of *Bhapa dahi* tended to increase while raising the level of carrot shreds from 6.0 to 8.0 %. However, further increase in the level of carrot shreds (*i.e.* 10.0 %) resulted in significant ($P < 0.05$) decline in the flavour score (Table 3). Hence *Bhapa dahi* containing carrot shreds at 8.0 % level had the maximum flavour score, which differed ($P < 0.05$) significantly from the scores of other two products. Moreover, *Bhapa dahi* made using 10.0 % of carrot shreds had significantly ($P < 0.05$) higher flavour score than the product having 6.0 % of carrot shreds. The reason for the least flavour score associated with *Bhapa dahi* prepared using 6.0 % carrot shreds was low flavour (carrot) impact when such product was consumed. The reason for the decline in the flavour score of *Bhapa dahi* at carrot shred level exceeding 8.0 % was due to perception of intense carrot flavour. Mild carrot flavour was preferred by the judges compared to intense one. Yoghurt made using 10.0% of carrot pomace led to product having yoghurt odour dominating over the aroma of the vegetable (Najgebauer-Lejko *et al.,* 2015).

**Body and texture score**

The body and texture score of *Bhapa dahi* made using 18.0 % mango pulp was significantly ($P < 0.05$) superior to the score associated with product containing 21.0 % pulp (Table 3). *Bhapa dahi* made using 18.0 % mango pulp had a uniform, firm body, smooth texture with good slicing properties. On the other hand, *Bhapa dahi* made using 21.0 % mango pulp was associated with slight pasty and loose body and a granular texture. This led to lower body and texture score associated with *Bhapa dahi* containing higher level of mango pulp. The body and texture score of *Bhapa dahi* made using 8.0 % carrot shreds was the highest, which differed significantly ($P < 0.05$) from the scores of other two samples (Table 3). The *Bhapa dahi* made by using 6.0 % carrot shreds had firm body but was curdy. *Bhapa dahi* made using 8.0 % carrot shreds had a firm body and smooth texture. At maximum level of carrot shreds addition (*i.e.* 10.0 %), the product tended to be somewhat pasty bodied. Possibly the highest carbohydrate content in *Bhapa dahi* containing 10.0 % carrot shreds (Table 2) led to the development of pastiness, owing to the diffusion of greater content of sugar from the sugar treated carrot shreds into the fermented product. Superior body and texture scores were associated with *Bhapa dahi* made utilizing 18.0% mango pulp and 8.0 % carrot shreds. Such body and texture scores were found to be significantly ($P < 0.05$) greater than the scores associated with other *Bhapa dahi* samples. However, the body and texture score of former two *Bhapa dahi* samples (*i.e.* with 18.0 % mango pulp and 8.0 % carrot shreds) were at par with each other (Table 3).

Yousef *et al.* (2013) reported that fruit yoghurt prepared using strawberry pulp added at the rate of 7.0 % by weight, had higher body-texture score (*i.e.* 4.31) compared to the one made using 10.0 % level (*i.e.* 4.20); scoring was out of 5.0. Hossain

*et al*. (2012) reported that with an increase in the level of strawberry pulp in fruit yoghurt from 5.0 to 15.0 %, there was a gradual decrease in the body-texture score of the resultant product. Carrot yoghurt made using 10% of carrot pomace had highest apparent viscosity and adhesiveness compared to yogurt made using pumpkin or red sweet pepper pomace incorporated at same rate of addition. Carrot vegetable as a food additive had great potential to improve the yoghurt structure and contribute to dietary fiber (Najgebauer-Lejko *et al.,* 2015).

**Acidity score**

Being a fermented dairy product, the balance between acidity and sweetness of product has a bearing on the organoleptic quality of product and thereby affected its acceptability by the consumers. The acidity score of *Bhapa dahi* made utilizing 18.0 and 21.0 % mango pulp was at par with each other (Table 3). Nevertheless, the judges perceived *Bhapa dahi* containing 21.0 % mango pulp to be slightly more acidic.

The acidity score of *Bhapa dahi* sample made utilizing 8.0 % carrot shreds was significantly ($P < 0.05$) higher than the scores allotted to products made using 6.0 or 10.0% carrot shreds (Table 3). Use of highest level of sugar treated carrot shreds (*i.e*. 10.0 % level) had some masking effect on the perception of acidic taste of *chakka* leading to significantly ($P < 0.05$) lower acidity score.

**Total sensory score**

When comparing product made using same flavouring, the total sensory score of *Bhapa dahi* made using 8.0 % carrot shreds was significantly ($P < 0.05$) greater than the scores associated with product made utilizing 6.0 or 10.0 % carrot shreds; the latter two product had identical scores (Table 3). *Bhapa dahi* prepared using 18.0 % mango pulp had total sensory score that was significantly ($P < 0.05$) greater than the product containing 21.0 % mango pulp (Table 3). Since *Bhapa dahi* made using 18.0 % mango pulp and 8.0 % carrot shreds had significantly ($P < 0.05$) superior individual scores for flavour, body and texture and colour and appearance, it obviously culminated in products having superior total sensory score over other *Bhapa dahi* samples. The total sensory scores associated with mango flavoured (@ 18.0 %) and carrot flavoured (@ 8.0%) *Bhapa dahi* samples was superior when compared with the scores associated with other *Bhapa dahi* samples;The difference in the total sensory score of the former two *Bhapa dahi* samples was found to be non-significant (Table 3).The least total sensory score (when compared amongst products having same flavoring) was associated with product made using 6.0% of carrot shreds and 21.0% of mango pulp respectively (Table 3). Desai *et al*. (1994) recommended use of 15.0 % mango pulp in the preparation of fruit yoghurt; higher level (*i.e*. 20.0 %) led to lower sensory score. Rakhi *et al*. (2013) advocated use of 10.0 % (vs. 15.0 % level) of mango pulp in preparing fruit yoghurt. The difference in the recommended level of mango pulp for fruit yoghurt might have been due to the difference in the variety of mango used and its stage of ripening. On the basis of sensory evaluation, Yogurt prepared with different levels of carrot juice was rated in decreasing order as follows: Yogurt with 24.0 % juice > Control (without carrot juice) > Yogurt with 8.0 % juice > Yogurt with 16.0 % juice. The yogurt supplementation with 24.0 % carrot juice significantly improved the stability of the lactic acid bacteria; the product had more than $10^7$ probiotic bacteria/g on 21st day of storage, kept under refrigeration (Carmen *et al.,* 2015). The overall acceptability score of plain yoghurt and fruit yoghurt containing 10.0 % mango juice did not differ from each other, whereas product containing 10% mango pulp had significantly lower overall acceptability score compared to plain yogurt. It was recommended to use up to 20.0 % and 30.0 % of mango pulp and mango juice respectively, to produce acceptable quality mango flavoured yogurt (Mbaeyi-Nwaoha *et al.,* 2017). The sensory overall acceptability score reported for yogurt made utilizing 5.0 % of black carrot juice was 5.74 as against a score of 7.14 for cherry flavoured yogurt (Ayar and Gurlin 2014).

**Phytonutrient content of *Bhapa dahi***

The β-carotene (precursor of vitamin A) content of plain, mango flavoured and carrot flavoured *Bhapa dahi* was 0.199, 6.98 and 2.60 mg/100 g respectively. This shows the superiority of mango and carrot flavoured *Bhapa dahi* over plain *Bhapa dahi* in terms of the valued nutrient; β-carotene content was higher in mango and carrot containing products by 35 and 13 times respectively when compared with plain *Bhapa dahi*. The energy value that can be gained through consumption of 100 g of plain, mango flavoured and carrot flavoured *Bhapa dahi* was 246.16, 223.88 and 248.86 kcal respectively.

Since mango (Pandey and Dinesh 2010) as well as carrot (Hadley and Fordham 2003) is a good source of β-carotene, they contributed to enrichment of such phytonutrient in *Bhapa dahi*.

The results revealed similarity in the sensory score of *Bhapa dahi* containing 18.0 % mango pulp and 8.0% of sugar treated carrot shreds. The total sensory scores associated with such *Bhapa dahi* samples were higher than the rest of the *Bhapa dahi* samples. Hence, either of sweetened mango pulp (@ 18 % by weight of base mix) or sugar treated carrot shreds (@ 8.0% by weight of base mix) could be selected as an ingredient as flavouring as well as for value-addition to *Bhapa dahi*. There is enrichment in the β-carotene content of *Bhapa dahi* as a result of such fruit/vegetable incorporation.

## ACKNOWLEDGEMENT

The authors acknowledge the support rendered by Shri Ashish Acharya, Area Manager (Application and Sales, SE-Asia), Sacco srl in supplying us the starter culture for our research work.

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