Development of fruit enriched whey beverage

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Abstract

The investigation was aimed at developing nutritious health beverage by utilising whey with incorporation of fruit juices such as pineapple and orange juice. Paneer whey was blended with pineapple juice and orange juice at a proportion of 0 to 30 per cent the physico chemical sensory attribute studies revealed that pineapple juice blended to whey at a level of 30 per cent and orange juice at a proportion of 25 per cent to prepare a most acceptable beverage. Out of that whey blended with 30 per cent of pineapple juice level was optimised. The most acceptable beverage was stored in glass bottles at 4 ± 1 ºC and it was observed that the beverage prepared as above stored for period of 12 to 16 days as revealed by physico chemical and microbiological attribute studies during period of storage.

Keywords: whey, pineapple and orange juice

1. Introduction

Whey is a valuable by-product from dairy industries obtained during manufacture of cheese, chhana, paneer, casein and shrikhand and is not being utilized to its full extent on the other hand whey presents interesting nutritional value as food supplement and its discard is increasingly frowned upon by environmentalists (Jindal et al., 2004). It is a major output of the total global production (Shukla et al., 2004; Raju et al., 2005; Mishra, 2008)117, 12, 9. About 40% of the total global production of whey is disposed as raw whey (Reddy et al., 1987)14 causing serious problems of environmental pollution due to high organic matter content. It has been estimated by the Water Pollution Research Laboratory that whey has a Biological Oxygen Demand (BOD) of 38,000 to 46,000 ppm, even in some cases it reaches up to 76000 ppm as compared to 200 ppm permissible limit for domestic sewage (Mishra, 2008)9. Whey disposal is a serious problem for dairy industry. In order to reduce pollution load, whey should be treated to obtain commercial products (Gupta and Nair, 2010)5. The Government of India has promulgated the Environmental Protection Act-1986 that makes it obligatory to pre treat whey before discharge in inland water or rivers.

Consumption of the whey can supplement much of the lost organic and inorganic nutrients to the extra cellular fluid and utilization of these fluids can be targeted to the people work with strenuous occupation like sportsman, body builders, competitive athletes, exercising for pleasure and other people with similar kind of activity (Prendergast et al., 1985; Mathur et al., 1988)8]. Currently, total world production of whey is approximately 85 million tonnes in which India contributes approximately 2, 80, 000 tonnes of the total global production (Shukla et al., 2004; Raju et al., 2005; Mishra, 2008)117, 12, 9. Presence of electrolytes in whey is an important criteria before going for healthy whey drink because it can be used as a source of replenishment for the loss minerals (Reddy et al., 1987)14. Presence of electrolytes in whey is an important criteria before going for healthy whey drink because it can be used as a source of replenishment for the loss minerals (Reddy et al., 1987)14. Most of the work regarding utilization of whey has been carried out worldwide in the production of whey.

Fruit juices are well recognized for their nutritive value, mineral and vitamin content. They are beverages that are consumed for their nutritional value, thirst-quenching properties and stimulating effect or for their medicinal values (Fawole and Osho, 2002)2. The low pH of fruit juices greatly limits the number and the type of bacteria that can survive. (Ryu and Beuchat, 1998)15. At present bulk of the beverages are generally synthetic flavoured, that are made available in market. If this could be substituted with fruit juice and dairy by product, results in beneficial contribution to the consumer, dairy industries and beverage manufacturers as well as fruit growers.
With the above considerations the present investigation has been taken up, keeping in view of the following objectives: To optimize blending of whey with fruit juice on the quality of whey based health beverage.

2. Materials and methods
The following materials and ingredients were used in this investigation for the preparation of dairy by product-based beverage. Milk: Fresh cow milk was procured from the Student’s Experimental Dairy Plant (SEDP) for the preparation of paneer and the resultant whey was used for the research work. Whey - Panner whey procured obtained from Students Experimental Dairy Plant (SEDP), Dairy Science College, Hebbal, Bengaluru, was used in this investigation.

Fruit juice - The fruits (Pineapple and Orange) were procured from local market and juice was extracted in an hygienic condition. Sugar - Good quality cane sugar was procured from the local market.

Chemicals
All the chemicals used for chemical analysis were of analytical grade

Media used for microbiological study
Standard Plate Count Agar (SPCA) was used for enumeration of total count. Whereas Violet Red Bile Agar (VRBA) and Malt Extract Agar (MEA) for enumeration of coli forms and yeast and mold respectively.

Methods
2.1 Preparation of whey beverage
Whey has procured from Student Experimental Dairy Plant, and whey beverage has prepared by following procedure

2.2 Preparation of fruit juices
Fresh ripened and matured pineapple of medium size was selected for extraction of juice. The outer skin was removed with the help of a stainless steel knife and the fruit was washed with, clean water and cut into small pieces. The pieces were then grinded in a blender and the juice was extracted. The extracted juice was filtered through a muslin cloth to remove musts and to get clear juice. Similarly well ripened oranges of good quality were procured from the market for the extraction of juice. The outer skin was peeled off and only inner juicy portion of the fruit was utilized for juice extraction. The juicy portion was placed into blender and the juice was extracted. The extracted juice was filtered through a muslin cloth to remove musts and to get clear juice.

2.3 Process optimization for preparation of beverage with its admixture of whey and fruit juices based beverage.
Whey based beverage is prepared by blending fruit (Orange, Pineapple) juices at 15, 20, 25 and 30 per cent level to whey. The resultant blends were added with 10 per cent sugar, pasteurized, cooled. The beverage thus prepared was subjected to various physico-chemicals and sensory attributes studies to adjudge the optimum level of blending.

3. Result and discussion
3.1 Effect of blending fruit juices to whey on Physico-chemical and sensory properties of formulated whey beverage
In this study, various blends of whey and pineapple and orange juice were tried. The effect of blending pineapple juice/orange juice on various physico-chemicals and sensory properties of beverage was evaluated and the results are delineated in the following sections
3.1 Effect of blending fruit juices to whey on physical properties of formulated whey beverage

Pineapple and orange juice was blended with whey at various proportions. The effect of blending pineapple and orange juice on pH, acidity, specific gravity and viscosity of the blend is presented in Table 1.

With increasing in the level of blending from 0 to 30 per cent, there was study decrease in pH of pineapple and orange juice blended whey beverage. The pH of control was 5.32, whereas pineapple juice whey beverage was 5.10, 5.0, 4.99 and 4.92 at 15, 20, 25 and 30 per cent blending of pineapple juice to whey respectively and for orange juice whey beverage it was recorded to be 5.25, 5.23, 5.21 and 5.19 respectively at 15, 20, 25, and 30 per cent blending. The pH of Pineapple juice (4.0) and Orange juice (4.9) blended beverage was lower as compared to plain whey beverage (5.32).

With increase in the incorporation of pineapple/orange juice in whey, there was significant increase in acidity. The acidity of control was 0.22 per cent whereas pineapple juice blended whey was 0.32, 0.34, 0.35 and 0.36 at 15, 20, 25 and 30 per cent blending of pineapple juice to whey respectively and for orange juice blended whey beverage it was 0.25, 0.26, 0.27, and 0.28 per cent acidity at 15, 20, 25 and 30 per cent blending respectively. The acidity of fruit juice (Pineapple and Orange) beverage was found to be higher as compared to control. It is evident from the results that with increasing level of blending of pineapple and orange juice to whey there was significant increase in specific gravity of blends. The specific gravity of control was 1.024 whereas for pineapple juice blended with whey it was 1.024, 1.039, 1.042, 1.045 and 1.046 at 15, 20, 25 and 30 per cent, respectively. As against 1.038, 1.041, 1.042 and 1.043 for orange juice whey beverage respectively, at the same respective level of blending.

With increase in the incorporation of pineapple and orange juice to whey, there was significant increase in viscosity. The viscosity of control was 1.068 cP whereas pineapple juice blended whey it was 1.12, 1.15, 1.21 and 1.28 cP at 15, 20, 25 and 30 per cent blending respectively. In case of orange juice whey beverage the viscosity was observed to be 1.10, 1.12, 1.19 and 1.20 cP at 15, 20, 25 and 30 per cent blending respectively.

3.2 Effect of blending fruit juices to whey on chemical composition of formulated whey beverage

The chemical composition of pineapple and orange juice blended formulated whey beverage are presented in Table 2.

In the formulated whey beverage the level fat significantly decreased with an increase in the level of pineapple juice from 0.15 per cent to 0.127, 0.12, 0.11 and 0.105 per cent respectively at 15, 20, 25 and 30 per cent blending.

Table 1: Effect of blending fruit juices to whey on physical characteristics of formulated whey beverage

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Control (100:0)</th>
<th>Whey: Pineapple juice (85:15)</th>
<th>Whey: Orange juice (85:15)</th>
<th>CD (P≤0.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acidity (%LA)</td>
<td>0.22</td>
<td>0.32</td>
<td>0.34</td>
<td>0.36</td>
</tr>
<tr>
<td>pH</td>
<td>5.32</td>
<td>5.10</td>
<td>5.00</td>
<td>4.99</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>1.024</td>
<td>1.039</td>
<td>1.042</td>
<td>1.045</td>
</tr>
<tr>
<td>Viscosity (cP)</td>
<td>1.068</td>
<td>1.12</td>
<td>1.15</td>
<td>1.19</td>
</tr>
</tbody>
</table>

Table 2: Effect of blending fruit juices to whey on chemical composition of formulated whey beverage

As the level of incorporation of fruit juices increased in whey there was corresponding increase in the ash content both in case of orange and pineapple blended beverage.

Total solids content in pineapple juice blended whey beverage significantly increased with an increase in the level of pineapple juice the total solids content was it was 17.43, 17.89, 18.34 and 18.79 per cent in pineapple juice based beverage, where as it was 16.93, 17.21, 17.48 and 17.75 per cent in orange juice blended beverage, respectively at 15, 20, 25 and 30 per cent blending as against the control which had 15.64 per cent total solids.

**Table 1:** Effect of blending fruit juices to whey on Physical characteristics of formulated whey beverage

**Table 2:** Effect of blending fruit juices to whey on chemical composition of formulated whey beverage

*10% sugar level is maintained for all the samples

**Average of three trials
3.1.3 Effect of blending fruit juices to whey on sensory characteristics of formulated whey beverage

Pineapple and orange juices were blended with whey at various proportions. The effect of blending these juices to whey on the sensory characteristics of the beverage is presented in Table 3 and Fig1.

With increase in the level of incorporation of pineapple juice from 15 to 30 per cent, there was significant increase in the sensory scores of the beverages. There was being 8.0 for control and 8.45 at 30 per cent blend, whereas with the increase in the level of incorporation of orange juice from 15 to 25 per cent, there was significant increase in the sensory scores of the beverages. Whereas at 30 per cent level there was significant decrease in scores for overall acceptability attributes. At 30 per cent secured highest sensory score with respect to overall acceptability score (8.45) as compared to other level of blending of fruit juices. Whereas for orange juice blend the maximum score attained for small acceptable attribute was at 25 per cent level (8.30).

Table 3: Effect of blending fruit juices to whey on sensory characteristics of formulated whey beverage

<table>
<thead>
<tr>
<th>(Whey: Juice)</th>
<th>Colour and appearance</th>
<th>Body and texture</th>
<th>Flavour</th>
<th>Overall acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>100:0</td>
<td>7.90&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.80&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.70&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Whey: Pineapple juice</td>
<td>85:15</td>
<td>8.10&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.95&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.90&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>80:20</td>
<td>8.25&lt;sup&gt;c&lt;/sup&gt;</td>
<td>8.09&lt;sup&gt;c&lt;/sup&gt;</td>
<td>8.10&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>75:25</td>
<td>8.30&lt;sup&gt;c&lt;/sup&gt;</td>
<td>8.10&lt;sup&gt;c&lt;/sup&gt;</td>
<td>8.25&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>70:30</td>
<td>8.40&lt;sup&gt;c&lt;/sup&gt;</td>
<td>8.20&lt;sup&gt;c&lt;/sup&gt;</td>
<td>8.30&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Whey: Orange juice</td>
<td>85:15</td>
<td>8.00&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8.07&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8.12&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>80:20</td>
<td>8.10&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8.10&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8.12&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>75:25</td>
<td>8.15&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8.12&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8.20&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>70:30</td>
<td>7.75&lt;sup&gt;c&lt;/sup&gt;</td>
<td>7.69&lt;sup&gt;c&lt;/sup&gt;</td>
<td>7.50&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>CD(P≤0.05)</td>
<td>0.14</td>
<td>0.10</td>
<td>0.15</td>
<td>0.14</td>
</tr>
</tbody>
</table>

*10% sugar level is maintained for all the samples
**Average of three trials

Fig 1: Effect of blending fruit juices to whey on sensory characteristics of formulated whey beverage
3.2 Shelf life assessment of optimised whey enriched with pineapple juice

3.2.1 Effect of storage on Acidity and pH of optimised whey enriched with pineapple juice (4±1 ºC)

The physical quality pH of optimized dairy by product based health beverage has evaluated in terms of acidity are presented in table 4. As could be seen from the Table 4, the acidity and corresponding pH values of sample at 0th day for was observed to be 0.36 with a corresponding pH of 4.92 respectively. These sample after 4 days of storage as shown acidity of 0.38 with a corresponding pH of 4.85. Similarly after 8th day of storage corresponding acidity and pH for the above samples were found to be 0.40 and pH 4.75 respectively. With increase in the duration from 0th day to 12th day there was significant increase in the acidity (per cent lactic acid) and corresponding decrease in pH in sample as could be seen from table 4 there was progressive increase in acidity and decrease in pH of all the samples during storage.

<table>
<thead>
<tr>
<th>Optimised Beverage</th>
<th>Acidity (% LA)</th>
<th>pH 0</th>
<th>pH 4</th>
<th>pH 8</th>
<th>pH 12</th>
<th>pH 16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whey Enriched With Pineapple Juice</td>
<td>0.36</td>
<td>0.38</td>
<td>0.40</td>
<td>0.44</td>
<td>0.51</td>
<td>Not accepted</td>
</tr>
</tbody>
</table>

Table 4: Effect of storage on Acidity and pH of optimised whey enriched with pineapple juice (4±1º C)

3.2.2 Effect of storage on microbiological quality of optimised whey enriched with pineapple juice (4±1º C)

The microbiological quality of optimized dairy by product beverage during storage as the evaluated in terms of total bacterial count, coliform and yeast and mold count are presented in table 5.

<table>
<thead>
<tr>
<th>Beverages</th>
<th>Storage (log 10 cfu/ml)</th>
<th>0th day</th>
<th>4th day</th>
<th>8th day</th>
<th>12th day</th>
<th>16th day</th>
<th>17th day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whey Enriched With Pineapple Juice</td>
<td>TBC</td>
<td>Coli</td>
<td>Y&amp;M</td>
<td>TBC</td>
<td>Coli</td>
<td>Y&amp;M</td>
<td>TBC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.58</td>
<td>NIL</td>
<td>1.09</td>
<td>0.30</td>
<td>1.22</td>
<td>0.11</td>
</tr>
</tbody>
</table>

Table 5: Effect of storage on microbiological quality of optimised whey enriched with pineapple juice (4±1º C)

4. Discussion

This investigation was undertaken to develop health beverage blending with fruit juices (pineapple, orange). The results obtained during the process of product development have been discussed here under along with suitable justification and support of literature.

4.1 Physico – chemical and sensory characteristics of formulated whey beverage with fruit juices

During the course of experiment whey was blended with pineapple and orange juice at 15, 20, 25 or 30 per cent levels. The results pertaining to the effect of blending juices on physico- chemical and sensory properties of blend are presented in Tables 1, 2 and 3. The decrease in pH and increase in acidity in increasing in the level of blend is due to initial lower pH and higher acidity of pineapple juice (pH-4) and orange juice (pH -4.9) which have been used to blend with paneer whey. With the increase in the level of pineapple and orange juices from 0 to 30 per cent was proportionate decrease in pH and increase in acidity. The pH of fruit juice (Pineapple – 4.0 and Orange – 4.9) was found to be lower as compare to control. The pH of pineapple blended beverage at 30 per cent blend was 4.92 and corresponding acidity was 0.36, whereas the respective pH and acidity of orange blended beverage at 25 per cent blend was 5.21 and 0.27 per cent as against the control which has depicted pH of 5.32 and acidity of 0.22 per cent. There was increase in specific gravity and viscosity of both pineapple blended and orange blended beverage. With increasing the level of juices from 0 to 30 per cent there was proportionate decrease in fat level. The decrease in fat content of beverages with the increasing in the level of incorporation of fruit juices (Pineapple and Orange) as compared to control which had a fat content of 0.15. With increasing in the level of blending fruit juices to whey beverage, there was increase in the protein content, if fruit juices blended whey beverage, which could be attributed to the higher protein content of both pineapple and orange juice. The protein content of whey (control) beverage was 0.39 per cent. Whereas the protein content of pineapple and orange juice was found to be 0.4 and 1 per cent respectively.

Similarly with increasing in incorporation of fruit juices to whey, there was corresponding increasing in ash content of beverage. This is due to higher ash content of pineapple juice (0.8%) and orange juice (0.7%) as compared to whey which had shown ash content of (0.6%). As the level of incorporation fruit juices is increased there was corresponding increase in the carbohydrate content of the beverage, which could be attributed to the initial higher carbohydrate content of pineapple juice and orange juice (pineapple-13.5% & orange – 10%) as compare to plain whey (4.5). Similarly was the trend in respect of total solid content of pineapple and orange based beverage as the initial total solid content of pineapple juice and orange juice was found to be 13 and 12 per cent respectively, as compare to whey (6.32%). The changes in physical and chemical properties as a result of incorporation of fruit juices have been reported by several workers and our results are in agreement with the earlier.
workers. Bhavsagar et al., (2010) observed that with increasing in the level of incorporation fruit juices to whey results in decreasing in pH and corresponding increase in acidity besides resulting in increased specific gravity and viscosity. They also reported that increasing in the level of incorporation of fruit juices to whey results in decreased fat content and increased protein, carbohydrate, ash and total solid content of the blend. Similar observation have been made by Nairu et al., (2011) when orange pulp was incorporated to whey during the preparation of orange pulp blended whey beverage.

From among various proportions of pineapple and orange juice (15, 20, 25 or 30 per cent) blended to whey, the beverage prepared with pineapple juice of 30 per cent incorporation and orange juice at 25 per cent incorporation as compared to all other combinations. The variation in the scores awarded for various fruit juice blends on overall acceptability could be attributed to the personnel preference of consumers to the particular flavour. Some of the earlier workers reported that sensory evaluation panel preferred pineapple based whey beverage followed by mosambi and orange based whey beverage. Shashidhar, (2007) reported that beverage prepared with pineapple flavour at 30 per cent secured highest sensory score as compare to all the other combinations. Shukla et al., (2013), tried various levels of pineapple juice with whey (80:20, 75:25, 70:30 and 65:35) and reported that 65:35 blend secured highest score. The present experimental results are similar to the results reported by Suresha (2002), wherein he observed that pineapple flavoured whey permeate beverage is highly acceptable followed by mango and orange permeate beverage.

4.2 Shelf life assessment of optimised whey enriched with pineapple juice

4.2.1 Effect of storage on Acidity and pH of optimised whey enriched with pineapple juice (4±1°C)

Acidity and pH of formulated dairy by-products based health beverage during storage are presented in table 4. The pH of the beverage decreased with the corresponding increase in acidity with the progress and storage. The decrease in pH and corresponding increase in acidity of optimised whey enriched with pineapple juice could be attributed to the production of organic acids and amino acids due to action of ascorbic acid on sugar and protein content of beverages. Lactose and proteins are converted into lactic acid and amino acids leading to increase in acidity and decrease in the pH of the beverages. Similar results have also been reported by Skidler et al., (2001), Sirohi et al., (2005) and Yadav et al. (2010) for mango RTS and banana whey beverage. Garg and Goyal (2006) reported that the increase in acidity of aonla cider was due to the accelerated degradation of pecic substances or due to formation of organic acids by ascorbic acid degradation. Similar observation also recorded by Rashmi, (2011) who reported that acidity increases with corresponding decrease in pH during storage in development of amla whey drink.

4.2.2 Effect of storage on microbiological quality of optimised whey enriched with pineapple juice (4±1°C)

The results pertaining to the microbiological quality with respect to total bacterial count, coli forms and yeast and mold count of various formulated dairy by-products based health beverages during storage at 4 ± 1°C are presented in table 5. The initial bacterial count for optimised whey enriched with pineapple juice beverages was found to be 0.58 log _10_ cfu/ml, and there was no presence of coliform and yeast and mold with the progress of storage period there was increase in total bacterial count, coli forms and yeast and mold count. On 16th day of storage optimised whey enriched with pineapple juice was having bacterial count of 2.65 log _10_ cfu/ml, coliform count of 0.24 log _10_ cfu/ml and yeast and molds was found to be 0.87 log _10_ cfu/ml respectively. The increase in total bacterial count increase may be with regard to acidophilic bacteria. Yeast and mold may be the major contributor due to acidic nature of them in fruit and vegetable formulated dairy by product based health beverage. The results are in agreement with Mandal et al., (1997) who reported that the increase in standard plate count of channa whey beverages on storage. Krishnaiah et al., (1989) reported standard plate count of channa whey beverage stored under refrigeration condition increased from 2 to 7.9 SPC/ml for 30 days. Kumari and Rajorhia, (1998) reported that beverage acidification preserves the product from microbial growth and hence the product had shelf life as high as 16 days.

References


