



Preparation of Whey-Based Banana Beverage and its Quality Evaluation

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Abstract

A value-added functional beverage was formulated utilizing unprocessed whey with excellent nutritional qualities and bland flavors; along with banana juice and the required amount of sugar. Five different formulations were prepared with varying proportions of whey, banana juice, and sugar. Sensory analysis was carried out for all five formulations and based on statistical analysis the one which showed the highest value for body, color, flavor, taste, and overall acceptability was selected for further analysis (85% liquid whey and 15% banana juice). The shelf-life of the final product was observed for 30 days at room temperature ($25\pm 5^{\circ}\text{C}$) and refrigerated temperature ($7\pm 1^{\circ}\text{C}$). A significant variation in body, color, flavor, taste, and overall acceptability were observed by varying the composition of whey and banana juice ($p < 0.05$). The beverage was pasteurized at 82.5°C for 20 min and stored at normal ($25\pm 5^{\circ}\text{C}$) and refrigerated ($7\pm 1^{\circ}\text{C}$) for 30 days. The effects of storage time and temperature on physicochemical (TSS, pH, acidity) and microbial (TPC, yeast & mold count) properties were evaluated. Out of five formulations, the one selected via sensory analysis had TSS of 12.4°Bx , total solids 14.21%, 0.302% acidity, pH 5.72, 5.087 % reducing sugar, 0.53% protein, 0.56% ash, 0.87% crude fiber, 184.43mg potassium (mg/100gm) and 0.912mg vitamin C in 100 ml. The prepared beverage was stored for 30 days under refrigerated and normal conditions, and changes in TSS, pH and acidity were observed: 12.4-13.3%, 5.72-5.214, 0.32-0.43%, and 12.4-13.8%, 5.72-4.64, 0.32-0.68% respectively. Overall analysis showed that the beverage prepared with 85% liquid whey and 15% banana juice could be stored for 30 days under refrigerated conditions without the addition of preservatives.

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1. Introduction

Ready-To-Serve (RTS) is a type of beverage that contains at least 10 % fruit juice and 10% total soluble solids besides about 0.3 % acid (Srivastava and Kumar, 2002). Beverages are refreshing to drink which is easily digestible, thirst-quenching, appetizing, and nutritionally superior to many foods. Banana provides around 90 to 93 calories per 100g. This energy value can be supplied by having 3 to 4 bananas daily, especially with milk, which is often recommended to gain weight. Since it has only 90 calories per 100 g (butter has about 700 calories per 100 g), banana reduces your calorie intake and thus helps in weight loss. Preparation of the banana juice is limited mostly to home scale production (Kumar *et al.*, 2013).

Whey is one of the highly nutritious by-products obtained from the dairy industry producing cheese, whey, and *paneer*. It constitutes almost 45-50% of total milk solids; 70% of milk sugar mainly lactose; 20% of milk proteins; 70-90% of milk minerals and most of the water-soluble vitamins originally present in milk (Horton, 1995; Shukla *et al.*, 2004). Whey extracted from milk is a wholesome protein source known to be "high-quality protein," as it contains all nine of the essential amino acids. There are two different types of whey: sweet whey and acid whey. Sweet whey is a by-product of ripened cheese production (pH 5.8–6.6) whereas acid whey is obtained from cottage cheeses (pH 3.6–5.1) (Park and Haenlein, 2013).

Whey proteins are especially high in essential amino acids such as tryptophan, which helps enhance brain serotonin levels (Delgado-Andrade *et al.*, 2006). Whey is not only a good source of protein but is also significantly rich in minerals and lactose. Whey (a by-product of cheese production) is of relative importance in the dairy industry due to the large volumes produced and the nutritional composition. Worldwide whey production is estimated at around 180 to 190×10⁶ ton/year; of this amount, only 50% is processed (Baldasso *et al.*, 2011). Cheese-whey (CW) produced is treated and transformed into various foods and feed products. About half of this amount is used directly in liquid form, 30% as powdered cheese-whey, 15% as lactose and its by-products, and the rest as cheese whey-protein concentrate (Lacta, 2012).

Whey consists of major proteins and minor proteins. Major whey proteins are β -lactoglobulin-65%, α -lactalbumin-25%, serum albumin-8%, and minor proteins/peptides are Glycomacropeptide (GMP), Bovine serum albumin, lactoferrin, Immunoglobulin, Phospho-lipoproteins. Whey proteins have a Biological Value of 110, which is higher than the value for casein, soy protein, beef, or wheat gluten, and have a high content of sulfur-containing amino acids such as cysteine and methionine (Fox and McSweeney, 1998). Whey proteins are high-quality proteins due to their high cysteine content and significant quantities of B vitamins. They are also rich in calcium, phosphorous, magnesium, and zinc (Hazen, 2005). Whey was also successfully applied for treatments of diarrhea, bile illness, skin problems, scales in the urinary tract, and some intoxication. Due to the high amount of whey proteins with nutritional value, these beverages are the ideal source of energy and nutrients for athletes. Whey proteins are a rich source of branched-chain amino acids (BCAA) like isoleucine, leucine, and valine. BCAAs unlike other essential amino acids are metabolized directly into the muscle tissue and are the first amino acids used during periods of exercise and resistance training (Shukla *et al.*, 2000).

Bananas are popular for aroma, texture, and are easy to peel and eat, besides being rich in potassium and calcium and low in sodium content. Potassium carries proven health benefits. It is an electrolyte that counteracts the effects of sodium, helping to maintain consistent blood pressure. Potassium is also important

for maintaining the balance of acids and bases in the body. Low potassium intake has repeatedly been linked with high blood pressure cardiovascular disease, so, ensuring a good intake of potassium may be just as important. An increase in potassium intake along with a decrease in sodium is crucial to reducing the risk of cardiovascular disease (Ware, 2018). The objective of the study was to utilize dairy by-products (whey) and banana juice to prepare the functional beverage. The best formulation was selected based on sensory evaluation and its nutritional composition was analyzed. And finally, the shelf life of the best formulation was studied.

2. Methodology

2.1 Preparation of whey

Milk was heated at a temperature of 71°C and coagulated at that temperature using a 2% citric acid solution. Complete coagulation was obtained within a minute. The whey thus obtained was strained using a muslin cloth to get a clear liquid.

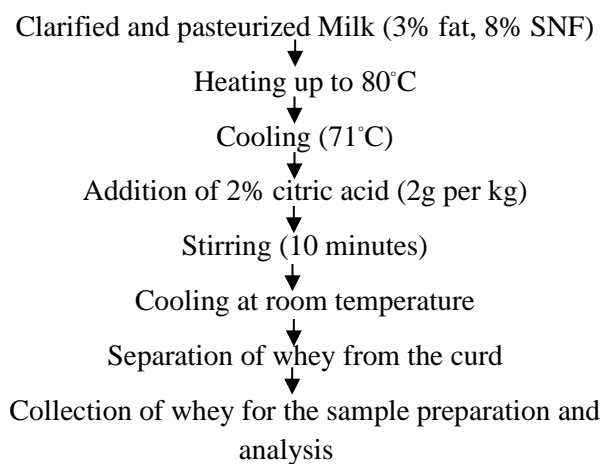


Figure 1: Flowchart for preparation of whey [Source: De S (2001)]

2.2 Preparation of banana juice

Natural banana juice was prepared without imparting any chemical/ enzymatic treatments as per the method suggested by Dhamsaniya (2012). The process flow diagram for the preparation of natural banana juice is shown in Figure 1. Ripe bananas were washed with chlorinated water followed by manual peeling and cutting into slices of 3 – 4 mm. The banana slices along with water in the ratio of 1:2 (banana slices: water, w/w) were heated at 100°C for 45 minutes followed by cooling, pressing, filtration, pasteurization (at 90°C for 10 min) and again cooling at room temperature. The prepared banana juice was

stored at $7\pm 1^\circ\text{C}$ in the refrigerator for further use.

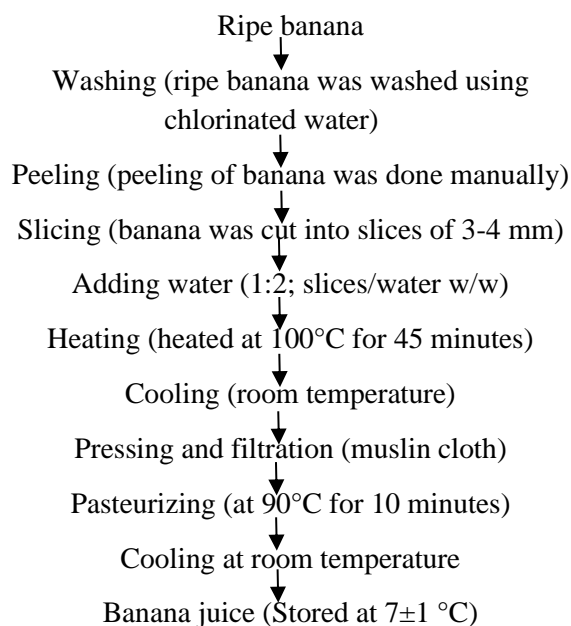


Figure 2: Process flow diagram for preparation of banana juice

2.3 Preparation of whey beverage

The prepared whey was filtered to remove foreign material, then the filtered whey was heated to about 45°C . Banana juice and sugar were added in the calculated amount in hot whey. The prepared compositions were filled hot and crown corked in 200 ml glass bottles. The bottles were pasteurized at 72°C for 30 min and let cool down to room temperature (28°C). Sensory analysis was done for all prepared compositions, and based on sensory score best sample was selected for further chemical and microbiological analysis (Singh, 2014).

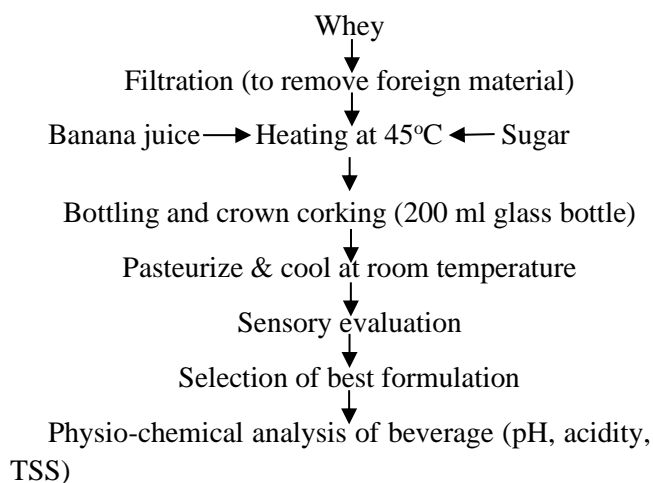


Figure 3: Flow chart for the preparation of a whey-based banana beverage

2.4 Physical and chemical examination of raw whey, banana juice, and RTS

The physicochemical properties such as total soluble solids, fat content, acidity, pH, ascorbic acid, and microbiological analysis were done for raw whey, banana juice, and prepared beverage. The proximate compositions such as protein content, crude fiber, total and reducing sugar, ash content, potassium were determined (Ranganna, 2000).

2.5 Sensory evaluation

The laboratory-prepared samples were evaluated for color and appearance, taste, body flavor, and overall acceptability on a 9-point hedonic rating scale (AOAC, 2005).

2.6 Statistical analysis

The experiment was conducted in triplicates. The data was analyzed by GenStat programming (GenStat Discovery version 12). The means were compared using LSD and the best treatment was selected for further analysis (physio-chemical analysis).

3. Results and Discussion

Banana juice and whey were prepared in the lab of Sunsari Technical College, Dharan. The prepared juice and whey were filtered, and five different compositional variations of whey-based RTS were prepared (95:5, 90:10, 85:15, 80:20 & 75:25).

All five formulations were then pasteurized at 88°C for about 15 min and then analyzed through sensory evaluation. The best-scored sample was then selected and stored for 30 days in a refrigerator ($7\pm 1^\circ\text{C}$) for shelf-life study.

3.1 Analysis of raw material

In the preparation of RTS, whey and banana juice was the major ingredient which was analyzed for their chemical composition presented as in Table 1.

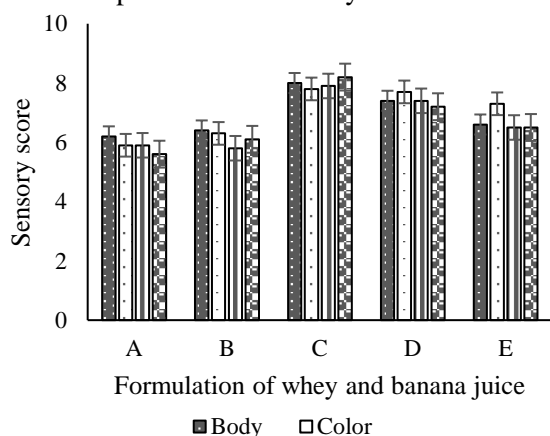
3.2 Effect of formulations on sensory characteristics

Five different compositional variations of whey-based RTS were prepared (95:5, 90:10, 85:15, 80:20 & 75:25) which were coded as A, B, C, D, and E respectively. The TSS of all the samples were kept constant $12\pm 1^\circ\text{Bx}$.

Table 1: Chemical composition of Raw materials (db)

| Parameter | Whey | Banana |
|-------------------------------|-----------------|----------------|
| T.S.S (°Bx) | 6.8 (0.28) | 15.8(0.05) |
| Moisture (%) | 92.94 (0.03) | 83.37 (0.1) |
| pH | 4.2 (0.005) | 4.96 (0.03) |
| Acidity (%) as lactic acid | 0.4 (0.04) | 0.16 (0.041) |
| Total sugar (%) | 5.99 (0.02) | 9.69 (0.02) |
| Reducing sugar (%) as lactose | 4.46 (0.02) | 7.83 (0.02) |
| Proteins (%) | 0.87 (0.005) | Not detectable |
| Ash (%) | 0.57 (0.005) | 2.27 (0.02) |
| Potassium (mg/100 g) | Not detectable | 261(0.05) |
| Ascorbic acid (mg/100 g) | Not detectable | 6.8(0.15) |
| Total solids (%) | 7.06 (0.03) | 16.63 (0.02) |
| Crude Fiber(gm/100 gm) | Not detectable | 1.44 (0.02) |

Then the formulated beverages were analyzed based on their quality attributes (sensory evaluation). The data for the overall acceptability of all the samples were determined and present in figure 4. The mean sensory score from the sensory evaluation of the five different samples A, B, C, D, and E was found to be 7, 6.8, 8.6, 6.9, and 7.1 respectively. The overall mean value for body, color, flavor, and taste was found to be highest for sample C. Thus, sample C was chosen as the best sample and further analysis was carried out.

**Figure 4:** Overall acceptability of prepared products

3.3 Chemical composition of the final product

The sample C with whey 75% (V/V) and banana juice 15% (V/V) was rated superior in the sensory evaluation. Banana flavor and banana taste on the beverage were accepted and rated superior. The chemical composition of the final product is presented in Table 2.

The physiochemical characteristics of the whey-based banana beverage are tabulated in Table 2. Banana is rich in minerals and especially potassium. The results were found to be similar to the results obtained by Dhamsaniya, (2013) and Yadav *et al.*, (2010).

Table 2: Chemical composition of the final product

| Parameter | Final product |
|-------------------------------|---------------|
| T.S.S (°Bx) | 12.4 (0.05) |
| Moisture (%) | 87.6 (0.01) |
| pH | 5.72 (0.02) |
| Acidity (%) as lactic acid | 0.302 (0.005) |
| Reducing sugar (%) as lactose | 5.087 (0.02) |
| Crude fiber | 0.87(0.32) |
| Total sugar (%) | 14.21 (0.02) |
| Proteins (%) | 0.53 (0.02) |
| Ash (%) | 0.56 (0.01) |
| Potassium (mg/100 g) | 184.43(0.002) |
| Ascorbic acid (mg/100 g) | 0.912 (0.32) |
| Total solids (%) | 14.853 (0.02) |

3.4 Shelf-life study

Prepared whey banana beverage was stored for 30 days' time period at refrigerated (R) condition ($7\pm 1^\circ\text{C}$) and ambient (A) temperature ($25\pm 5^\circ\text{C}$) and changes in its properties were observed.

3.5 Microbiological analysis

Analysis for total plate count (TPC), coliform, yeast, and mold count was done. There was no colony observed during the initial storage period. During the preparation of the beverage, pasteurization was done. At this temperature treatment destruction or elimination of all viable organisms along with enzymes, inactivation occurs in a food product. Due to storage conditions in an air-tight product, the growth of microorganisms was found to be slow. The growth of coliforms in both temperatures was found to be nil.

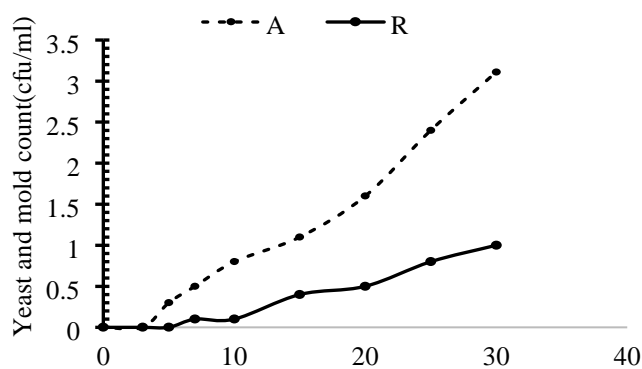


Figure 5: Change in yeast & mold for many days of storage and temperature

As time progressed the microbial load i.e. yeast and bacteria, also increased while the growth of microorganisms varied alongside the temperature in which they were stored that is at ambient and refrigeration temperature. The total plate count, and yeast and mold count were found to be zero on the first day while it kept on increasing as the time progressed at both ambient and refrigerated temperature but there was a significant difference in the growth of microorganisms at ambient temperature and refrigeration temperature.

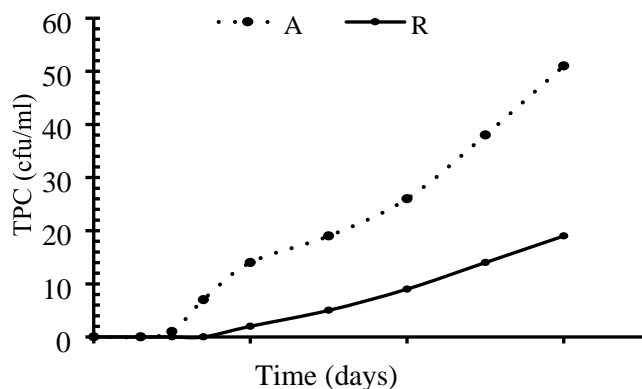


Figure 6: Change in TPC for number of days of storage and temperature

3.6 Effect on TSS

TSS was found to be slightly increased during the storage period. TSS for the beverage increased from 12.4 – 13.8°Bx ($25\pm 3^\circ\text{C}$) and 12.4 – 13.3°Bx ($7\pm 1^\circ\text{C}$) during the 30 days of storage. The rise in TSS was due to the hydrolysis of polysaccharides into monosaccharides and oligosaccharides. Retention or minimum increase in TSS content of juice during storage is desirable for the preservation of good juice quality (Bhardwaj and Pandey, 2011). Similar results were observed in the preparation of mixed fruit RTS (Bull *et al.*, 2004; Deka and Sethi, 2001).

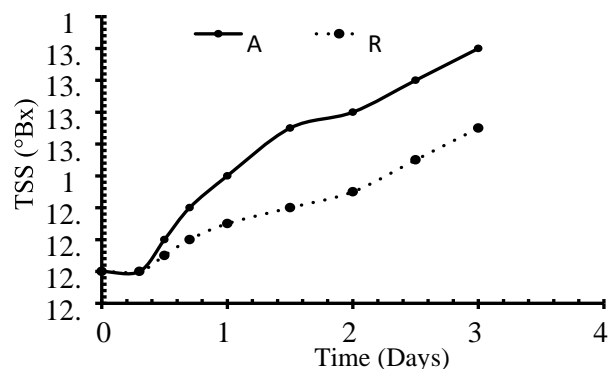


Figure 7: Effect of storage time and temperature on TSS of prepared beverage

3.7 Effect on pH

During storage pH gradually decreased from 5.72 to 4.64 ($25\pm 5^\circ\text{C}$) and 5.72 to 5.21 ($7\pm 1^\circ\text{C}$) affecting the organoleptic quality of juice. This may be due to the production of organic acids due to the action of ascorbic acid on the sugar and protein content of the beverages. Lactose and proteins are converted into lactic acid and amino acids leading to a decrease in the pH of the beverage.

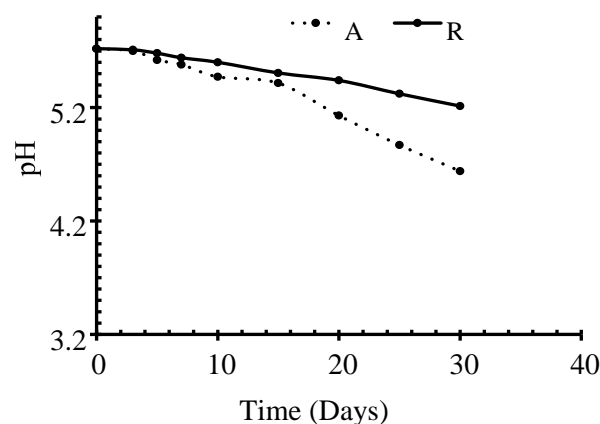


Figure 8: Effect of storage time and temperature on pH of prepared beverage

Similar results were reported for a juice blend of bottle guard and basil leaves juice by Majumdar *et al.* (2011) and for pineapple juice blend with carrot and banana (Awsii and Dorcus, 2012). LSD showed that there was a significant difference in pH at a 5% level of significance.

3.8 Effect on acidity

During 30 days of storage, the acidity elevated from 0.32 to 0.68 (25 ± 5 °C) and 0.32 to 0.43 (7 ± 1 °C). The increase in acidity may be due to the production of organic acids and amino acids by the action of ascorbic acid on the sugar and protein content of the beverages. Also increase in percent acidity might be due to the slight growth of micro-organisms in the beverage. The results obtained confirm with those of earlier results for whey-based papaya pulp blended RTS beverage stored at refrigeration temperature for three months (Saravanakumar, and Manimegalai, 2003).

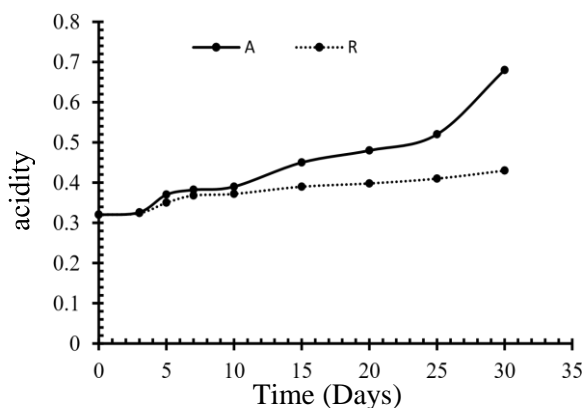


Figure 9: Effect of storage time and temperature on the acidity of prepared beverage

4. Conclusion

Sensory evaluation of the sample showed RTS prepared from 75% whey (V/V), 15% banana juice (V/V), and 12.4°Bx TSS showed the highest acceptability in terms of the body, color, flavor, and taste. The physio-chemical analysis of the best-selected product was found to be corresponding to a standard RTS drink. The changes during storage for 30 days were observed which showed a significant rise in TSS and acidity. From a microbial point of view, the beverage could be stored for 10 days at ambient temperature and 30 days in a refrigerator. The product proved as a nutritionally as well as organoleptically desirable beverage with agreeable taste, flavor.

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Conflicts of Interest

The authors declare that there is no conflict of interest.

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