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Development and Evaluation of Whey Based RTS Beverage from Ripe Banana Juice

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Abstract

The investigation was aimed to develop a delicious and nutritious RTS beverage from the ripe banana juice and milk whey. The *M. arvensis* extract was used as a natural flavoring agent. The proportion of banana juice, *M. arvensis* extract and milk whey was varied from 5-15 ml, 1-5 ml and 72-86 ml per 100 ml of the prepared beverage, respectively. The screening of beverage samples was done on the basis of their physicochemical and sensory characteristics. As a result of various studies conducted for optimizing the proportions; an acceptable whey banana RTS beverage was prepared having 15 ml banana juice, 3 ml *M. arvensis* extract, 8 g sugar powder and 77 ml milk whey per 100 ml of the prepared beverage, respectively. The developed RTS beverage could be recommended for the large scale production at industrial level.

Keywords: Banana juice; Whey; Beverage; RTS; Sensory characteristics

Abbreviation: RTS: Ready to Serve

Introduction

Banana (*Musa paradisiaca* L.) is one of the most widely grown fruit, cultivated over 170 countries along the tropic and sub-tropics of the Capricorn. After ripening, banana fruit is highly susceptible to deterioration. Its considerable amount is wasted due to lack of efficient processing techniques that are unique to ripe banana. Very few processed products are available in the market, primarily due to difficulty in retaining the characteristics color, flavor and texture during the processing of ripe banana [1]. Hence, it is utmost important to process the large amount of surplus ripe banana fruits available in the entire banana growing regions for preventing their loss after ripening.

Milk whey is one of the highly nutritious by-products obtained from the dairy industry producing cheese, *chhanna* and *paneer*. It constitutes almost 45-50 percent of total milk solids, 70 percent of milk sugar mainly lactose, 20 percent of milk proteins, 70-90 percent of milk minerals and almost all the water soluble vitamins originally present in milk [2,3]. It resulted into unraveling the secrets of whey proteins and other components and established a sound basis for their nutritional and functional value [4]. Several authors have investigated the possibility of utilizing the milk whey in the fruit beverage preparation [5-9].

Increased awareness in health issues leads to increase the consumption of fruit juices and other natural products as an alternate to the traditional caffeine containing beverages such as tea, coffee or other soft drinks. Accompanying the increase in quantity of consumption, there has been a parallel increase in the variety of fruit juices and beverages offered for sale in the market [5]. Soft beverage industry has made significant progress during the last two decades in terms of rise in production and consumption; however, there is a limited range of fruit juice based RTS beverages available in the Indian market. Many types of syrups and soft drinks containing artificial fruit flavors are well known throughout the world. The basic factor considered is the nutritive and therapeutic values, which make them popular and acceptable [10,11]. At present fruit beverages are generally synthetic flavored, bottled and sold in the market. If this could be substituted with fruit juice and dairy whey, it will be more beneficial to the consumer, dairy industries and beverage manufacturers as well as fruit growers [12].

Therefore, it was found very interesting to utilize the milk whey as a water replacer for the development of a new delicious and nutritious RTS beverage from the ripe banana juice. The use of milk whey produces off-flavor in the beverages. The *Mentha arvensis* extract is commonly used as a natural flavoring agent in most of whey based fruit beverages to compensate the off-flavor of whey. It also acts as a good appetizer; acceptable to consumers and at the same time makes the product more palatable [13]. Looking to the fast growing market segment of functional beverages, it was felt appropriate to use the *M. arvensis* extract as natural flavoring agents in the development of whey based RTS beverage from ripe banana juice to fetch the higher market demand.

Materials and Methods

'Grand Naine' is a popular cultivar of banana grown mostly in all export oriented countries of Asia, South America and Africa [1]. The banana fruit having best quality, well matured and ready for ripening of 'Grand Naine' cultivar were procured from a local fruit market of Junagadh (Gujarat, India). The fruits were allowed to ripe under the natural conditions at room temperature. The banana fruits at ripening stage VII, as described by Robinson [14], were used for the juice preparation.

Preparation of banana juice

Natural banana juice was prepared without imparting any chemical/enzymatic treatments as per the method suggested by Dhamsaniya [15]. The process flow diagram for the preparation of natural banana juice is shown in figure 1. The ripe banana fruits were washed with the chlorinated water followed by manual peeling and cutting into the

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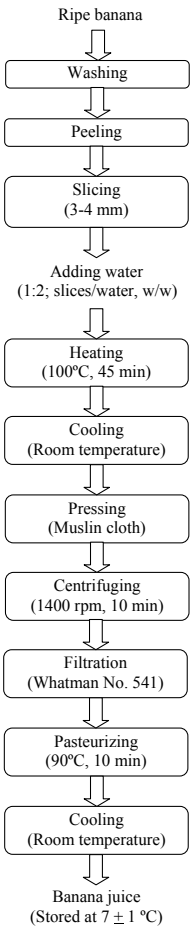

Figure 1: Process flow diagram for the preparation of natural banana juice.

slices of 3-4 mm. The banana slices along with RO purified water in the ratio of 1:2 (banana slice : water, w/w) were heated at 100°C for 45 minutes followed by the cooling, pressing, centrifuging (at 1400 rpm for 10 min), filtration, pasteurization (at 90°C for 10 min) and again cooling at room temperature. The prepared banana juice was stored at 7 ± 1°C temperature in the refrigerator for further use in the RTS beverage preparation.

Preparation of milk whey

The milk whey was prepared following the procedure suggested by De [16] with slight modification (Figure 2). The "*Taaza*" brand standardized milk (3.1% fat, 7.9% SNF) was obtained from the Mother Dairy stall (Junagadh, Gujarat). The milk was boiled in a stainless steel vessel at 80°C for 10 minutes. The boiled milk after cooling to 72°C was acidified by adding 0.2 percent (2g per kg of milk) citric acid (Eagle brand) followed by continuous stirring until the coagulation of milk proteins (casein) taken place. The mixture of milk whey and casein was allowed to cool at room temperature and then the whey was filtered using the muslin cloth. The milk whey thus obtained was filled in a glass bottle and stored in the refrigerator (7 ± 1°C) for further use.

Preparation of *M. arvensis* extract

The *Mentha arvensis* plant material was obtained from the main vegetable market of Junagadh (Gujarat, India). The fresh *M. arvensis* leaves were thoroughly washed in RO purified water and sanitized by using 20 ppm chlorinated water as suggested by Tsen and King [17]. The leaves were cut into small pieces and ground in the domestic mixer-grinder followed by filtering through muslin cloth. The extract thus obtained was also stored in the refrigerator for further use.

Preparation of RTS beverage

The method described by Sirohi et al. [13] was followed in the preparation of whey banana RTS beverages. The proportion of banana juice, *M. arvensis* extract and milk whey was varied as presented in table 1. The ground sugar powder was added at the rate of 8 gram per 100 ml. In each lot about 3.6 liters of beverage was prepared and the experiment was replicated thrice. The prepared beverages were filtered and filled into glass bottles (200 ml) and sealed by crown corking. Then, the bottles were sterilized at 121°C for 10 min followed by cooling at room temperature.

Physicochemical analysis

The *ELICO* make digital pH meter (Model: LI 127) with an

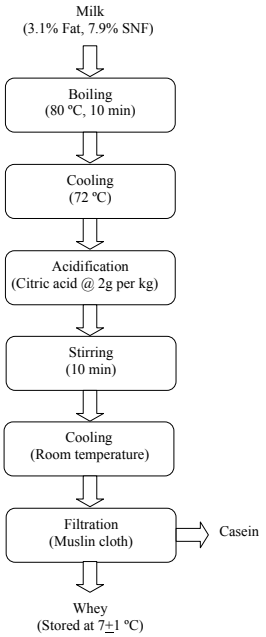

Figure 2: Process flow diagram for the milk whey preparation.

Treatment	Banana juice (ml)	*M. arvensis* extract (ml)	Milk whey (ml)	Sugar powder* (g)
B_1	5	1	86	8
B_2	5	3	84	8
B_3	5	5	82	8
B_4	10	1	81	8
B_5	10	3	79	8
B_6	10	5	77	8
B_7	15	1	76	8
B_8	15	3	74	8
B_9	15	5	72	8

*since the sugar powder was weighed in grams, the total volume of beverage was adjusted by the volume of whey (if required).

Table 1: Selected proportions of banana juice, *M. arvensis* extract and milk whey in the preparation of 100 ml beverage.

accuracy of 0.01 was used for pH measurement of the prepared beverages. The Total Soluble Solids (TSS) was determined by using the hand refractometer (Erma Inc., Tokyo: 0–32%) following the method suggested by Dadzie and Orchard [18]. The observations were corrected using the temperature correction factor given by Askar and Treptow [19] and recorded in Brix. The reducing sugar and total sugar content in the beverage samples were determined by the methods suggested by Ranganna [20]. The titratable acidity in terms of percent citric acid equivalent was determined by the titration method against the standard 0.1N NaOH solution using phenolphthalein as an indicator as described by Ranganna [20]. The ascorbic acid content was determined by using 2-6 Dichlorophenol-indophenol (dye) visual titration method suggested by Askar and Treptow [21].

The browning index of beverage samples was determined as per the method given by Ranganna [20]. A sample of 0.5 g was taken in a test tube. Then, 10 ml of 40% methanol was added in the sample. The sample was shaken thoroughly and kept for 12 h at room temperature. The solution was then filtered. The absorbance of filtrate was read at 420 nm in the UV-Visible Spectrophotometer (Model: Genesys 10, Thermo Scientific) and expressed as optical density (OD). The respective OD value represents the browning index of the sample concerned as suggested by Ranganna [20].

Sensory analysis

The prepared RTS beverage samples with varying levels of banana juice, *M. arvensis* extract and milk whey were presented to a panel of twelve experts comprising of faculty members and postgraduate students. The panelists were associated with the research and development of new food products at the department of processing and food engineering of College of Agricultural Engineering and Technology, Junagadh Agricultural University, Junagadh (Gujarat, India). A nine-point Hedonic scale score card was provided to the panelists to adjudge the quality of the product with respect to appearance, odor, taste and overall acceptability [22].

Statistical analysis

The data obtained during the physicochemical evaluation of the prepared RTS beverage samples were analyzed by SAS statistical software (version 9.1.3, SP4) using 2-factors 3-levels CRD with three replications. The Duncan's New Multiple Range Test (DNMRT) was used to compare the difference among the samples during the sensory evaluation.

Results and Discussion

The mean analyzed data showing effect of varying proportions of banana juice and *M. arvensis* extract on physicochemical properties of prepared RTS beverages are presented in table 2. The values obtained are almost in agreement with the data reported by earlier researchers for whey based fruit beverages.

Effect on pH

The pH of prepared beverage was decreased remarkably from 4.74 to 4.37 with the increase in banana juice concentration (J) from 5 to 15 ml per 100 ml of the prepared RTS beverage (Table 2). This indicated that the increase in the juice concentration decreased the active acidity in the prepared beverages. The effect of the juice concentration was found significant at even 1 percent level of significance. Also, the effect of varying the proportions of *M. arvensis* extract (M) and also their interaction (J x M) was found non-significant. The similar trend of pH was reported by Naik et al. [23] in case of whey based watermelon beverage.

Effect on Total Soluble Solids (TSS)

The increase in proportion of banana juice and *M. arvensis* extract significantly increased the TSS in the prepared RTS beverage. However, their interaction was found non-significant. The similar results were obtained by Theerachatpat [24], Sirohi et al. [13] and Naik et al. [23] in case of preparing the whey based banana powder, mango-*pudina* beverage and watermelon beverage, respectively.

Effect on reducing sugar

From table 2, it can be observed that the reducing sugar content was increased remarkably from 2.415 to 4.087 percent as the banana juice concentration increased from 5 to 15ml in the prepared RTS beverage. This indicated the highly significant effect of banana juice concentration on the reducing sugar content of the whey banana RTS beverage ($P < 0.01$). The reverse trend was noticed in case of *M. arvensis* extract. The reducing sugar content was decreased from 3.278 to 2.965 percent with the increase in proportion of *M. arvensis* extract from 1 to 5 ml in the prepared beverage. This indicated that the increase in amount

Proportion per 100 ml	pH	TSS ºBrix	Reducing sugar %	Total sugar %	Titratable acidity %	Ascorbic acid (mg/100 g)	Browning index OD
Banana juice (J)							
J_1 (5 ml)	4.740	8.421	2.415	8.838	0.157	0.363	0.063
J_2 (10 ml)	4.638	9.634	2.863	10.468	0.222	0.660	0.071
J_3 (15 ml)	4.367	10.836	4.087	14.953	0.403	0.912	0.082
SEm ±	0.064	0.091	0.041	0.148	0.004	0.007	0.001
CD at 5%	0.189	0.270	0.120	0.441	0.011	0.021	0.002
M. arvensis extract (M)							
M_1 (1 ml)	4.667	9.418	3.278	11.989	0.240	0.632	0.067
M_2 (3 ml)	4.598	9.673	3.122	11.422	0.266	0.639	0.072
M_3 (5 ml)	4.480	9.800	2.965	10.848	0.276	0.664	0.076
SEm ±	0.064	0.091	0.041	0.148	0.004	0.007	0.001
CD at 5%	NS	0.270	0.120	0.441	0.011	0.021	0.002
Interaction (J * M)							
SEm ±	0.110	0.158	0.070	0.257	0.007	0.012	0.001
CD at 5%	NS	NS	NS	NS	0.019	NS	NS
CV, %	4.16	2.83	3.89	3.90	4.30	3.23	2.47

Table 2: Mean analyzed data showing effect of varying banana juice and *M. arvensis* extract proportion on physicochemical properties of prepared beverage.

of *M. arvensis* extract reduced the rate of hydrolysis polysaccharides into sugars in the prepared beverage. However, the interaction of both the parameters (J x M) was found non-significant indicated the compensating effect of increasing in the proportion of banana juice and *M. arvensis* extract simultaneously.

Effect on total sugar

The total sugar content was also increased significantly with the increase in concentration of banana juice. This may be due to increase in banana juice quantity proportionately reduced the proportion of milk whey in the prepared RTS beverage. The results were found highly significant even at 1 percent level of significance. Similarly, the total sugar content was decreased with the increase in proportion of *M. arvensis* extract while their interaction was non-significant. The present findings are in agreement with the results reported by Sirohi et al. [13] in case of whey based mango-*pudina* beverage preparation.

Effect on titratable acidity

The titratable acidity was increased exponentially with the increase in proportion of either the banana juice or *M. arvensis* extract in the prepared RTS beverage. The analysis of data reported the highly significant effect of both the ingredients and their interaction (J x M) at 1 percent level of probability (Table 2). The increase in titratable acidity may be due to the acidic nature of both ingredients. Naik et al. [23] reported the similar findings in case of whey based watermelon beverage preparation.

Effect on ascorbic acid content and browning index

The increase in proportion of either the banana juice or *M. arvensis* extract in the prepared RTS beverage proportionally increased the ascorbic acid content and thereby browning in the beverages. The effect of both the ingredients were found highly significant (P<0.01). However, their interaction of data indicated the non-significant results as presented in table 2. The increase in browning may be due to the increase in polyphenoloxidase enzyme activity at higher proportion of either the banana juice or *M. arvensis* extract. The similar results were reported by Ingale et al. [6] in case of whey based custard apple beverage.

Effect on sensory characteristics

The mean sensory score assigned to the beverage samples prepared at different treatment is given in table 3. The maximum mean sensory score was obtained by the beverage sample of treatment B_8 combination for the appearance, taste and overall acceptability attributes of sensory evaluation. Also, the mean sensory score of beverage sample B_6 combination was found maximum in case of odor attribute. But, the sample B_6 was found statistically at *par* with the sample B_8. Hence, the sample B_8 having 15 ml banana juice, 3 ml *M. arvensis* extract, 8 g sugar powder and 77 ml milk whey per 100 ml of RTS beverage was found superior. The present findings are in conformity with the results reported by Naik et al. [23] for the sensory characteristics of whey based watermelon beverage.

Treatment	Mean sensory score*			
	Appearance	Odor	Taste	Overall acceptability
B_1	6.00^{bc}	3.58^{g}	3.08^{f}	3.50^{h}
B_2	5.75^{de}	4.75^{e}	4.67^{e}	4.75^{f}
B_3	5.58^{e}	5.67^{c}	6.00^{b}	5.92^{bc}
B_4	6.08^{b}	4.08^{f}	4.67^{e}	4.42^{g}
B_5	5.83^{cd}	6.00^{b}	5.75^{cd}	5.75^{cd}
B_6	5.67^{de}	6.83^{a}	5.92^{bc}	6.00^{b}
B_7	6.17^{b}	5.08^{d}	5.92^{bc}	5.42^{e}
B_8	6.58^{a}	6.75^{a}	7.83^{a}	7.33^{a}
B_9	5.50^{e}	6.08^{b}	5.67^{d}	5.67^{d}
SEm ±	0.061	0.073	0.073	0.062
CV, %	12.48	16.21	15.92	13.82

*mean values of the samples having same superscript letter are not significantly different (P<0.01)

Table 3: Effect of different treatment on sensory characteristics of the prepared beverage.

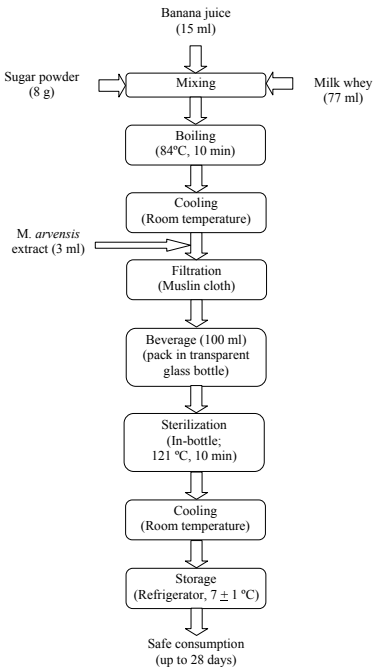

Figure 3: Suggested process flow diagram for the preparation of whey based RTS beverage from ripe banana juice.

As a result of various studies conducted for optimizing the proportion of ingredients; it was found that an acceptable whey based RTS beverage from ripe banana juice could be prepared using the suggested process flow diagram as depicted in figure 3. As shown, the mixture of 15 ml banana juice, 8 g sugar powder and 77 ml milk whey per 100 ml of beverage should be boiled at 84°C temperature for 10 minutes followed by cooling at the room temperature. After cooling, 3 ml *M. arvensis* extract should be added to the mixture for making the product more palatable and acceptable to the consumers. The prepared beverage should be filtered by muslin cloth and packed in airtight transparent glass bottle. After packing, the bottle should be sterilized at 121°C for 10 minutes followed by cooling at room temperature and then store in the refrigerator at 7 ± 1°C temperature for the safe consumption.

Conclusions

It can be concluded that the RTS beverage could be prepared from the ripe banana juice and milk whey using *M. arvensis* extract as natural flavoring agent. The proportion of banana juice and *M. arvensis* extract may be taken as 15 ml and 3 ml per 100 ml of the RTS beverage preparation for getting the optimum physicochemical characteristics and organoleptic quality, respectively. Also, looking to the higher nutritious virtues, the developed whey based RTS beverage from ripe

banana juice could be recommended for the large scale production at industrial level.

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