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Effect of thermal treatment on multifruit smoothie

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Abstract
The research is aimed to standardize the thermal treatment and nutrient profiling of multifruit smoothie. The smoothie was produced by blending 29% custard apple pulp, 31% mango pulp, 40% pineapple juice and 0.3% xanthan gum. The Complete Random Design was used for thermal treatment with a temperature of 75, 85 and 95 ° for 5, 10 and 15 minutes. Dependent variables for the standardization of thermal treatment were TSS, pH, ascorbic acid, β-carotene, and sensory and microbial quality attributes. The thermal standardized smoothie had TSS of 25.40 °Brix, pH of 3.78, titrable acidity of 0.510%, ascorbic acid of 37.98 mg/100 g, β-carotene content of 489.72 µg/100 g, total plate count of 1.09 log CFU/ml, yeast and mold count of 1.17 log CFU/ml, no coliform count and sensory attributes with colour and appearance score of 8.68, taste of 8.54, aroma of 8.64, consistency of 8.69 and overall acceptability of 8.63. Further, the smoothie had a viscosity of 3749.57 cP, 12.77% reducing sugar, and 20.46% total sugar and iron content of 2.16 mg/100 g). This study gives an insight into the impact of thermal processing on the nutrient, microbial and sensory quality of multifruit smoothie.

Keywords: Thermal treatment, custard apple, mango, pineapple, smoothie

1. Introduction

Consumption of fruits provides most of the essential vitamins, minerals and various phytochemicals that help in strengthening the immune system of the body. India is the second largest producer of fruits after China, but the per capita production is only about 100 g per person per day as given in a report by the Ministry of Food Processing Industries (MOFPI, 2018) [5]. Moreover, about 25 to 30 percent of the total production is lost due to spoilage at various post-harvest stages. Hence to avoid losses and to bring value addition to fruits, a smoothie has been developed.

Smoothies are known for their thick, rich mouthfeel and often employ cream, fruit, juice, dairy, soy, vegetable, vitamin and fiber components (Mutilangi and Pereyra, 2008) [6]. The manufacture of smoothies is primarily based on the use of a mixture of fruits and vegetables, after removing seeds and peel, which are processed into pulp or puree (Titus, 2008) [13]. It is a creamy cold beverage, which is conventionally made of blended fruit or berries together with fruit juice and optionally with yoghurt or other dairy products or/and crushed ice cubes, that is, using only natural ingredients. The texture is thicker than slush drinks but may resemble that of milkshakes (Smith *et al*., 2013) [12].

Smoothies made from fruits are rich in phytochemicals depending on the fruit used. Mango contains β-carotene ranging from 661.27 to 2,220 µg per 100 g, ascorbic acid from 9.79 - 77.71 mg per 100 g, total carotenoid from 1.91 to 2.63 mg per 100 g and total phenolic compounds from m 48.40 to 208.70 mg per 100 g (Ribeiro *et al*. 2007) [10]. Custard apple contains significant quantities of vitamin C, iron, calcium, thiamine, amino acid, potassium, carotene, riboflavin, niacin and ascorbic acid, magnesium and dietary fibres (Patel and Kumar, 2008) [8]. Despite its high sugar content, the glycemic index of custard apples is low. Similarly, pineapple is rich in ascorbic acid and several other micronutrients.

Generally, fruits are prone to non-enzymatic browning and spoiled by microorganisms due to the availability of free moisture in them. Thermal treatment is most commonly practised in industries to reduce them to safe level. The aim of the present investigation is to standardize the thermal treatment and to minimize the nutrient loss and reduce microorganism to safety level to have extended shelf life.

2. Materials and Methods

2.1 Materials

Canned mango pulp (*Mangifera indica* var. Kesar) was procured from Austin Foods & Beverages Private Ltd., Anand, Gujarat. Fresh pineapples (*Ananas comosus*) were brought from the local fruit market, in Anand, Gujarat and frozen custard apple pulp (*Annona squamosa*) was purchased from Shroff Foundation Trust, Chhota-Udepur, Gujarat. Xanthan gum was procured from Chiti Chem Corporation, Vadodara, Gujarat. All chemicals used for chemical evaluation were of analytical grade with known purity and were procured from Molychem, Mumbai, Maharashtra.

2.2 Methodology

Graded and sorted fruits were washed and peeled. Bracts of the pineapple were removed and rind was sliced away in large strips and juice was extracted using food processor. The juice was strained using double-layered muslin cloth. Custard apple pulp was thawed before usage. The smoothie was prepared by blending 29% custard apple pulp, 31% mango pulp and 40% pineapple juice based on preliminary trials. To have a desired consistency 0.3% xanthan gum was added. Then, all ingredients were blended properly and heat treatment was given at a temperature ranging from 75 to 95 ℃ for 5-15 minutes. After the treatment immediately smoothie were hot filled into glass bottles and capped by twisting lug cap. After cooling, smoothies were stored under refrigerated (5±2 ℃) conditions till further evaluation.

2.3 Sensory Evaluation

All thermally treated multi-fruit smoothies were subjected to sensory evaluation using a 9-point Hedonic scale where a score of 1 is for 'dislike extremely' and 9 for 'like extremely' (Meilgaard *et al*., 1999) [4]. Sensory evaluation was carried out in the College of Food Processing Technology and Bioenergy, Anand Agricultural University, Gujarat, India by a panel of 10 trained members. The samples were served at refrigeration temperature and evaluated for their color and appearance, taste, aroma, consistency, and overall acceptability.

2.4 Biochemical analysis of sample

Moisture content, protein, crude fat, ash, crude fibre, titrable acidity, pH, total soluble solids, reducing sugar and total sugars, ascorbic acid, and iron were analysed as per the method given by Ranganna (1986) [9]. β-carotene content was estimated according to Nagata & Yamashita (1992) [7]. All chemical analyses were conducted in triplicates.

2.5 Microbiological analysis

Microbiological analysis of multifruit smoothie was enumerated for total plate count (TPC), coliform count and yeast and mold count according to the standard procedure given by Ranganna (1986) [9].

2.6 Non enzymatic browning

The absorbance of the supernatant was obtained at 440 nm using a UV–Vis spectrophotometer. To 10 ml of sample, 10 ml of water and 30 ml of ethyl alcohol were added. The blend was mixed thoroughly and filtered. The colour developed was measured at 440 nm with 60 percent aqueous alcohol as blank (Ranganna, 1986) [9].

2.7 Viscosity of the multi-fruit smoothie

Viscosity measurements of each sample were determined using the Brookfield viscometer DV-II + Pro model (make: Tek Instruments, Vadodara). The Brookfield viscometer was levelled on the platform and the spindle used for smoothie-type products was an LV spindle set with spindle number S64 was attached to the viscometer by screwing them onto the lower shaft, which was operated at different RPMs of 3, 12, 30, 60 RPM (Smith *et al*., 2013) [12]. The viscosity of all the products was determined at 19±0.5 °C and expressed as cP. The temperature of the sample during the experiment was measured by dipping the temperature probe in the sample which was coupled to the viscometer.

2.8 Color value

Visual colour was measured using Lovibond RT850i CREISS (Cyber Chrome, Inc. Stone Ridge, NY) in terms of L* (lightness), a* (redness and greenness) and b* (yellowness and blueness). The instrument was calibrated with a white standard. The smoothie sample was placed in a glass cuvette against the light source and post-process colour L*, a*, and b* values were recorded.

2.9 Statistical analysis

All chemical analyses were conducted in triplicate and mean values±standard deviation were computed and reported. The thermally processed smoothie was analysed for responses like TSS, pH, ascorbic acid, β-carotene content, microbial quality of the product i.e., total plate count, yeast and mold count, coliform count and organoleptic attributes (Color and appearance, Taste, Aroma, Consistency and Overall acceptability). The experiments were carried out with three replications and observations were statistically analysed using Completely Randomized Design (CRD). The statistical analysis of the experiment was performed using General Factorial Design in Design Expert Version 10.0.3.

3. Results and Discussion

The efficacy of the different thermal treatments of multifruit smoothie on the responses microbial parameters i.e., total plate count (TPC), yeast and mold count and coliform count, sensory parameters namely, colour and appearance, taste, aroma, consistency and overall acceptability, TSS and pH, titrable acidity, ascorbic acid, β-carotene were recorded.

3.1 Microbial quality

Table 1 shows the effect of thermal treatments given on the microbial quality of the multifruit smoothie**.** The initial mean value for control (unheated) was 4.97 log CFU/ml which reduced to ND (not detectable) for higher treatments. The time, and temperature combination of (5 min, 75 °C) reduced the count to 4.01 log CFU/ml. As the duration of treatment increases along with temperature, there is an increased trend in the reduction of microbial count. The mean values presented revealed that TPC was significantly affected by the thermal treatments given. Due to the treatments, a significant decrease in the TPC was observed ranging up to four log reductions. The maximum decrease in the count was at 95 °C for 15 min, up to four log reductions, and microbial colonies were ND (not detectable). Treatments with higher temperatures and longer duration of exposure to such high temperatures were found to be more efficient in decreasing the microbial load of the product. Microorganism inactivation was due to denaturation of protein material and changes in cell membrane. Similar trends were observed by Zacconi *et al*. (2015) [14] in the log reduction of microbial load.

Table 1: Effect of thermal treatments on microbial quality

Temperature (°C) (A)	Time (min) (B)	Total Plate Count (log CFU/ml)	Yeast and Mold Count (log CFU/ml)	Coliform Count (log CFU/ml)
Control		4.97±0.002	4.74±0.007	3.16±0.008
75	5	4.01±0.007	4.07±0.007	2.42±0.005
85	5	3.23±0.001	3.47±0.006	2.07±0.002
95	5	2.38±0.007	2.62±0.004	1.72±0.009
75	10	3.46±0.002	3.04±0.001	2.001±0.004
85	10	2.004±0.005	2.15±0.001	1.47±0.001
95	10	1.41±0.008	Not Detectable	Not Detectable
75	15	2.62±0.003	2.01±0.003	Not Detectable
85	15	1.09±0.11	1.17±0.08	Not Detectable
95	15	Not Detectable	Not Detectable	Not Detectable

Each observation is mean ± standard deviation of three replicates (n=3)

The mean value for control (unheated) was 4.74 log CFU/ml which reduced to ND (not detectable) for higher treatments. The time, and temperature combination of (5 min, 75 °C) reduced the count to 4.07 log CFU/ml. As the duration of treatment increases along with temperature, there was an increased trend in the reduction of microbial count. The maximum decrease in the count was observed at 95 °C for 10 min and 15 min up to four log reduction, microbial colonies were not detectable. Yeast and mold count was significantly ($p \leq 0.05$) affected by the applied thermal treatments. Due to the treatments, significant decrease ($p \leq 0.05$) in the yeast and mold count was observed ranging up to four log reductions. Markowski *et al.*, (2017) [3] reported a decrease in microbial load with thermal treatment to apple based smoothie.

The mean values for was 3.16 log CFU/ml which reduced to ND (not detectable) for higher thermal treatments. The time, and temperature combination of (5 min, 75 °C) reduced the count to 2.42 log CFU/ml. As the duration of treatment increases along with temperature, there was an increased trend in the reduction of microbial count. The maximum decrease in the count was for (10 min, 95 °C), (15 min, 75 °C), (15 min, 85 °C) and (15 min, 95 °C) up to three log reductions, microbial colonies were not detectable. Due to the treatments, a significant decrease ($p \leq 0.05$) in the coliform count was observed ranging up to three log reductions. Treatments with higher temperatures and longer duration of exposure to such high temperatures were found to be more efficient in decreasing the microbial load of the product. Similar trends were observed by Zacconi *et al.* (2015) [14] in the log reduction of microbial load.

3.2 Physico-chemical quality

The influence of thermal treatments on the physico-chemical parameters of the smoothie is given in Table 2. The mean values presented revealed that total soluble solids was significantly affected ($p \leq 0.05$) by the thermal treatments. The TSS of control was 21.37 °Brix which elevated to 28.40 °Brix for (15 min, 95 °C) treatment. The time, and temperature combination of (5 min, 75 °C) increased the TSS to 22.43 °Brix. As the duration of treatment increases along with temperature, there is an aggravation of TSS. It was due evaporation of a portion of water during thermal treatment. As temperature and time increased, TSS increased significantly ($p<0.05$). The pH of control was 3.88 which reduced to 3.77 for (15 min, 95 °C) treatment. The time, and temperature combination of (5 min, 75 °C) decreased the pH to 3.87. As the duration of treatment increases along with temperature, there is a decline in pH values. There was no significant decline in the pH of thermally treated juices was observed. The acidity of the untreated smoothie was 0.462 percent citric acid which aggravated to 0.516 percent citric acid for (15 min, 95 °C) treatment. The time, and temperature combination of (5 min, 75 °C) increased the titrable acidity to 0.471 percent citric acid. As the duration of treatment increases along with temperature, there was an aggravation of titrable acidity. Arjmandi *et al* (2016) [1] observed an increase in TSS in thermally treated smoothies.

Table 2: Effect of thermal treatments on physico-chemical (TSS, pH, Titrable acidity) and nutritional content (ascorbic acid and carotene content)

Temperature (°C)	Time (min)	TSS (° Brix)	pH	Titrable acidity (percent citric acid)	Ascorbic acid (mg/100 g)	β-Carotene content (µg/100 g)
Control		21.37±0.15	3.88±0.01	0.462±0.005	85.40±0.77	928.2±9.71
75	5	22.43±0.11	3.87±0.005	0.471±0.006	69.85±0.63	756.84±4.89
85	5	23.20±0.18	3.87±0.01	0.473±0.002	54.87±0.09	687.26±7.24
95	5	24.83±0.10	3.79±0.02	0.506±0.003	33.24±0.47	127.5±1.50
75	10	23.80±0.19	3.86±0.01	0.488±0.005	62.82±0.22	697.4±5.60
85	10	24.34±0.13	3.85±0.02	0.497±0.004	44.71±0.08	572.1±2.40
95	10	27.39±0.12	3.78±0.01	0.510±0.002	19.78±0.02	18.77±3.61
75	15	24.53±0.11	3.81±0.005	0.502±0.003	54.73±0.11	586.73±4.24
85	15	25.40±0.17	3.78±0.011	0.510±0.004	37.98±0.35	489.72±2.25
95	15	28.40±0.19	3.77±0.01	0.516±0.004	9.81±0.01	12.85±2.96

Each observation is mean ± standard deviation of three replicates (n=3)

The mean values presented in Table 2 revealed that ascorbic acid was significantly affected ($p \leq 0.05$) by the thermal treatments. Due to the treatments, a significant decrease ($p \leq 0.05$) in the ascorbic acid was observed. The untreated smoothie had an ascorbic acid content of 85.40 mg/100 g which was reduced drastically to 9.81 mg/100 g for (15 min, 95 °C) treatment, which was 88.51 percent reduction compared to control. The time, and temperature combination of (5 min, 75 °C) decreased the ascorbic acid to 69.85 mg/100 g. As the duration of treatment increases along with temperature, there was a decline in the ascorbic acid of the product. Barba *et al*. (2010) [2] demonstrated a similar result of the effect of thermal treatment on ascorbic acid in a vegetable beverage. The β-carotene content of control was 928.2 µg/100 g which was reduced to 12.85 µg/100 g for (15 min, 95 °C) treatment, which was a 98.6 percent reduction from the initial value. The time, and temperature combination of (5 min, 75 °C) decreased the β-carotene content to 756.84 µg/100 g. As the duration of treatment increases along with temperature, there was a decline in the βcarotene content of the product. Due to the treatments, a significant decrease ($p \leq 0.05$) in the β-carotene content was observed.

3.3 Sensory Quality

Thermal treatments have affected various sensory attributes namely, colour and appearance, taste, aroma, consistency and overall acceptability (Table 3). Colour and appearance of the product is the visual perception which in turn, defines the product quality. The score for colour and appearance varied from 6.66 to 8.90 was represented in Table 3. The mean values presented revealed that colour and appearance was significantly affected ($p \leq 0.05$) by the thermal treatments given. Due to the treatments, a significant decrease ($p \leq 0.05$) in the colour and appearance was observed. The initial mean value for control (unheated) was 8.90 which was reduced to 6.66 for (15 min, 95 °C) treatment. The time, and temperature combination of (5 min, 75 °C) decreased the score to 8.85. As the duration of treatment increases along with temperature, there was decline in colour and appearance of the product. Colour degradation due to heat processing was observed by Sadilova *et al*. (2009) [11].

Table 3: Effect of thermal treatments on sensory attributes

Temperature (°C)	Time (min)	Colour and Appearance	Taste	Aroma	Consistency	Overall Acceptability
Control		8.90±0.10	8.92±0.07	8.95±0.04	8.98±0.01	8.93±0.02
75	5	8.85±0.14	8.86±0.02	8.90±0.03	8.87±0.01	8.84 ±0.03
85	5	8.83±0.02	8.78±0.09	8.84±0.08	8.45±0.05	8.80±0.12
95	5	7.17±0.21	7.13±0.05	6.66±0.14	7.83±0.15	7.20±0.15
75	10	8.82±0.01	8.79±0.06	8.82±0.03	8.66±0.23	8.77±0.09
85	10	8.79±0.02	8.67±0.03	8.78±0.01	8.36±0.17	8.75±0.04
95	10	7.03±0.08	6.27±0.10	6.56±0.02	7.66±0.12	6.88±0.23
75	15	8.75±0.03	8.62±0.09	8.73±0.12	8.37±0.09	8.69±0.16
85	15	8.68±0.03	8.54±0.06	8.64±0.07	8.69±0.04	8.63±0.05
95	15	6.66±0.09	5.87±0.24	6.46±0.19	7.15±0.05	6.53±0.17

Each observation is mean ± standard deviation of three replicates (n=3)

The taste of the product is the important parameter for its acceptance which in turn, defines the product quality. The score for taste varied from 5.87 to 8.92 as represented in Table 3. The mean values presented revealed that taste was significantly affected ($p \leq 0.05$) by the thermal treatments. Due to the treatments, a significant decrease ($p \leq 0.05$) in the taste was observed. The initial mean value for control (unheated) was 8.92 which reduced to 5.87 for (15 min, 95 °C) treatment. The time, and temperature combination of (5 min, 75 °C) decreased the score to 8.86. As the duration of treatment increased along with temperature, there was a decline in the taste of the product. Aroma of the product is the primary attribute of the sensory which effects the acceptance which in turn, defines the product quality. The score for aroma varied from 6.46 to 8.95 (Table 3). The mean values presented revealed that aroma was significantly affected ($p \leq 0.05$) by the thermal treatments given. Due to the treatments, a significant decrease ($p \leq 0.05$) in the aroma was observed. The initial mean value for control (unheated) was 8.95 which reduced to 6.46 for (15 min, 95 °C) treatment. The time, and temperature combination of (5 min, 75 °C) decreased the score to 8.90. As the duration of treatment increases along with temperature, there was decline in aroma of the product.

Consistency of the product defines the body and texture of the product and is very crucial factor for the mouth feel of the product on its consumption. The score for consistency varied from 7.15 to 8.98 (Table 3). The mean values presented revealed that consistency was significantly affected ($p \leq 0.05$) by the thermal treatments given. Due to the treatments, a significant decrease ($p \leq 0.05$) in the consistency was observed. The initial mean value for control (unheated) was 8.98 which was reduced to 7.15 for (15 min, 95 °C) treatment. The time, and temperature combination of (5 min, 75 °C) decreased the score to 8.87. As the duration of treatment increases along with temperature, there was decline in consistency of the product.

The score for overall acceptability varied from 6.53 to 8.93 (Table 3). The mean values presented revealed that overall acceptability was significantly affected ($p \leq 0.05$) by the thermal treatments given. Due to the treatments, a significant decrease ($p \leq 0.05$) in the overall acceptability was observed. The initial mean value for control (unheated) was 8.93 which was reduced to 6.53 for (15 min, 95 °C) treatment. The time, and temperature combination of (5 min, 75 °C) decreased the score to 8.84. As the duration of treatment increases along with temperature, there is a decline in the overall acceptability of the product.

3.4 Optimization of the Thermal Treatments

Numerical optimization technique of the software Design Expert 10.0.3 was used for simultaneous optimization of the multiple responses. Equal weightage was given to each dependent variable for the optimization. Two optimum solutions were found by software showing the optimum condition of independent variables with the predicted values of responses. The first and second solutions found were heating at 85 °C for 15 min and 75 °C for 15 min which had the desirability of 0.927 and 0.711 out of 1 respectively. Due to the maximum desirability of 85 °C and 15 min of 0.927 out of 1, this combination was selected. The predicted values of total plate count of 1.01 log CFU/ml, yeast and mold count of 1.41 log CFU/ml, coliform counts 0 log CFU/ml, total soluble solids of 25.4 °Brix and pH of 3.78, the acidity of 0.526 percent, ascorbic acid of 37.98 mg/100 g, β-carotene content of 489.72 µg/100 g, colour and appearance score of 8.68, taste score of 8.54, aroma score of 8.64, consistency score of 8.69, overall acceptability score of 8.63.

3.5 Profiling of the Multi Fruit Smoothie
The final multi-fruit smoothie was prepared using optimized parameters. The product, so prepared was tested for physico-chemical properties, nutritional profiling and microbiological studies and the results are presented as shown in Table 4. The proximate composition of the standardized product has been analysed. The moisture content, protein, fat, crude fibre, ash and carbohydrate were 74.52±0.53, 0.69±0.011, 0.31±0.018, 0.64±0.02, 0.57±0.02 and 23.60±0.46 percent respectively. The physicochemical characterization of the final product was done with a determination of TSS (25.26±0.15 °Brix), pH (3.78±0.02), titrable acidity (0.510±0.005 percent citric acid), reducing sugar (12.77±0.02 percent), and total sugar (20.46±0.41 percent). Non-enzymatic browning was found to be 0.0909±0.002. The viscosity of the final product was found to be 3749.57±4.06 cP. The colour value of the product was assessed with the Lovibond tintometer and ΔE was reported to be 0.89±0.01. The nutritional quality of the product is determined by the appreciable quantity of ascorbic acid (38.21±0.17 mg/100 g), β-carotene content (490.73±3.51 µg/100 g) and iron content (2.16±0.03 mg/100 g). The microbiological quality in terms of the total plate count, yeast and mold count and coliform count of optimized multi-fruit smoothie was tested and the results are presented in Table 4. The total plate count (1.01±0.03), yeast and mold count (1.41±0.05) and coliform count observed in multi fruit smoothie were not detectable, as the product was heat treated to 85 °C for 15 minutes. The sensory quality of the product was determined by analyzing the attributes like colour and appearance (8.78±0.13), taste (8.54±0.25), aroma (8.73±0.17), consistency (8.69±0.21) and overall acceptability (8.48±0.33).

3.6 Nutritional Information
The prepared multi-fruit smoothie provides ample nutrition and nutritional information per serving. It can be said as an instant energy provider as energy provided by 200 ml of product is 254.86 Kcal. Being a fruit-based product, fat provided by the smoothie is very scare i.e., 0.791 g per 200 ml. Protein (1.759 g per 200 ml) provided is fairly more as compared to other fruit-based beverages due to the presence of custard apple. The carbohydrate (60.18 g) provided by the drink is more due to presence of added sugar. Multifruit smoothie can be stated as a good source of vitamin C (providing 49 percent of daily value), and vitamin A (38 percent of daily value) and provides an appreciable amount of iron (providing 28 percent of daily value)

Table 4: Average proximate composition, physicochemical, nutritional properties, and microbiological qualities of the standardized product

Attributes	Value	Attributes	Value
Proximate composition		**Nutritional profiling**	
Moisture (percent)	74.52±0.53	Ascorbic acid (mg /100 g)	38.21±0.17
Fat (percent)	0.31±0.01	β-Carotene content (µg /100 g)	490.73±3.51
Protein (percent)	0.69±0.01	Iron Content (mg/100 g)	2.16±0.03
Crude fibre (percent)	0.64±0.02		
Ash (percent)	0.57±0.02	**Microbiological quality**	
Carbohydrate (percent)	23.60±0.46	Total Plate Count (log CFU/ml)	1.01±0.09
Physico-chemical composition		Yeast and Mold Count (log CFU/ml)	1.14±0.08
TSS (°Brix)	25.26±0.15	Coliform Count (log CFU/ml)	ND
pH	3.78±0.02		
Titrable acidity (% citric acid)	0.510±0.005	Sensory quality	
Reducing sugar (percent)	12.77±0.02	Colour and Appearance	8.78±0.13
Total sugar (percent)	20.46±0.41	Taste	8.54±0.25
Non enzymatic browning (OD at 440 nm)	0.09±0.002	Aroma	8.73±0.17
Viscosity (cP) at 19.2±0.5 °C	3749.57±4.06	Consistency	8.69±0.21
Colour value (ΔE)	0.89±0.01	Overall Acceptability	8.48±0.33

Each observation is mean ± standard deviation of three replicates (n=3)

4. Conclusion
The developed multifruit smoothie can be one of the functional fruit beverages. This experiment standardized the thermal processing parameter (85 °C for 15 minutes) based on the responses of thermal treatment. The final product had moisture content, protein, fat, crude fibre, ash and carbohydrate were 74.52, 0.69, 0.31, 0.64, 0.57 and 23.60 percent respectively. The physicochemical characterization of the final product was done with the determination of 25.26 °Brix TSS, 3.78 pH, titrable acidity 153 of 0.510 percent citric acid, 12.77 percent reducing sugar, and 20.46 percent total sugar. From the results, we conclude that thermal processing leads to destruction of vitamin C and β-Carotene. Even though maximum microbial load reduction occurs at high temperatures, at the same time nutrient quality is getting degraded. To preserve the nutritional quality low temperature is recommended.

5. Conflicts of Interest
The authors declare that there is no conflict of interest regarding the publication of this paper.

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