Current Journal of Applied Science and Technology

Volume 42, Issue 46, Page 197-204, 2023; Article no.CJAST.110489
ISSN: 2457-1024
(Past name: British Journal of Applied Science & Technology, Past ISSN: 2231-0843, NLM ID: 101664541)

Development and Quality Evaluation of Ready to Serve (RTS) Beverage from Dragon Fruit

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CJAST/2023/v42i464307

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/110489

Original Research Article

Received: 04/10/2023
Accepted: 08/12/2023
Published: 11/12/2023

ABSTRACT

Aim: The aim of the present investigation was to standardize dragon fruit (*H. polyrhizus)* RTS beverage based on sensory evaluation and changes in TSS, ascorbic acid, color value, titratable acidity and antioxidant activity and overall acceptability.
Study Design: RSM (Response Surface Methodology) with face centered design.
College of Food Processing Technology & Bioenergy, Anand Agricultural University, Anand, between August 2022 to July 2023.
The dragon fruit RTS beverage was prepared with dragon fruit juice, sugar and citric acid at three different levels of combinations ranged from 10-14 %, 10-15% and 0.3-0.9% respectively.
The efforts were made to study biochemical composition and sensory properties of the RTS beverage. The optimized value for standardized dragon fruit RTS beverage were observed for 14% fruit juice, 12.75% sugar and 0.38% citric acid based on results obtained. It was optimized based all sensorial quality attributes such as color, flavor, taste, overall acceptability and TSS (15.70^{o}Bx) antioxidant activity (26.44% DPPH inhibition) and color value (a*) 1.49 were found enhanced as concentration of juice was increased.

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The dragon fruit RTS beverage prepared by using dragon fruit juice, sugar and citric acid was nutritious and also safe for consumption since there is no addition of artificial color and flavor.

Keywords: Dragon fruit; TSS; antioxidant activity; RTS; citric acid; RSM.

1. INTRODUCTION

Dragon fruit is part of the Cactaceae family and order of Caryophyllales [1]. In early 19th century, the French brought it to Southeast Asia. More than 93% of the world's dragon fruit production is produced by three major countries: Vietnam, China, and Indonesia [2]. *Hylocereus polyrhizus* (red flesh with red peel dragon fruit), *Selenicereus megalathus* (white flesh with yellow peel dragon fruit) and *Hylocereus undatus* (white flesh with red peel dragon fruit) are the three different species of dragon fruit. Pulp (47.40-73.76%), peel (36.70-37.60%), and seed (2.70-14.67%) make up the three main components of dragon fruit. The fruits of the red dragon (*Hylocereus polyrhizus*) have a huge rectangular form, a dark red peel with enormous scales and a crimson pulp with small black seeds inside [3].

The color of *H. polyrhizus* is contributed by betacyanin a compound from a set of water-soluble nitrogen containing pigments known as betalains [1]. Betalains play a vital role as the major antioxidant contributor in *H. polyrhizus* whereas non-betalainic phenolic compounds play a minor role [4]. Betacyanin was found to boost the formation of beneficial gut flora in dragon fruit [5]. It is low in calories, cholesterol-free and high in antioxidants. It helps to prevent cardiovascular disease and keeps blood pressure in check [6]. The production of fruits and vegetable juices is important for human health and commercial sector [7]. Fruit juices are a good source of sugars, vitamins and minerals, valuable components to human health. The current food trend toward healthier diets makes juice consumption an important natural food alternative and improves the availability of its nutritive compounds [8].

Dragon fruit can be used to make a variety of processed products, including RTS (ready to serve) beverage, jam, jelly, juice, nectar, squash, cordial smoothies and more, all of which have delicious flavors and essences. Its luscious pulp can also be used to make soft drinks. It encourages the formation of probiotics which aids digestion. It aids in the reduction of blood glucose levels in people with type 2 diabetes [6]. 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 [9].

Fruit juice based beverages are accepted by consumers because of its appealing color and pleasant taste with nutritional attributes. 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]. Hence keeping these points in mind present investigation was done to standardize process parameters for preparation of red dragon fruit RTS beverage.

2. MATERIALS AND METHODS

The dragon fruits (*Hylocereus polyrhizus*) with uniform and ripened quality were procured from R K farm and Nursery, Nakhatrana, Dist. Kutch-Bhuj Gujarat. The dragon fruit RTS beverage was prepared as per treatment given in Table 1. The selected and sorted dragon fruits were washed with tap water to remove soil and dust particles. The fruits were cut into half, peel was removed manually and small pieces were made by using stainless steel Knife. After cutting operation thick mass of pulp was passed through stainless steel sieve to extract the juice and seeds were removed. Extracted juice was filtered through muslin cloth. The standardization of dragon fruit RTS beverage was carried out by using three different levels of fruit juice concentrations (10-14%), sugar (10-15%) and citric acid (0.3-0.9%) respectively. The digital refractometer was used for measurement of TSS (Total Soluble Solids) and stored in 200 ml PET (Polyethylene Terepthalate Terephthalate) bottles for further use.

2.1 TSS (Total Soluble Solids)

TSS of dragon fruit pulp, extracted juice and beverage was measured by using Atago RX - 7000x refractometer.

2.2 Titratable Acidity

Five to ten ml of sample was taken, mixed with 200 ml of distilled water and transferred to a 250 ml volumetric flask. Hundred milliliters of that aliquot were taken in conical flask and titrated with 0.1 N NaOH using phenolphthalein as indicator. The percentage titratable acidity was calculated by formula given [12].

$$\text{Titratable acidity (\%)} = \frac{\text{T} \times \text{N} \times \text{V} \times \text{E}}{Aliquote\ volume} \times 1000$$

Where,

T = Titre value (ml)
N = Normality of NaOH
V = Volume made up (ml)
E = Equivalent weight of citric acid

2.3 Color Value

The color value of dragon fruit juice was measured by Lovibond colorimeter (Model RT85i) in terms of L*(Lightness), a*(redness and greenness) and b* values (yellowness and blueness). The instrument was calibrated with white and black standard. Sample is placed in a cuvette against the light source and post sources color L*, a*, b* values were recorded.

2.4 Antioxidant Activity

Antioxidant activity of dragon fruit juice, beverage was determined using the DPPH scavenging effect method as described [13]. Hundred milligrams of sample were prepared by adding 1 g of sample in 10 ml of methanol. Hundred milligrams of the aliquot of extract was withdrawn in test tube and then 2.9 ml of DPPH (0.1 mM) solution was added. After vortexing the mixture incubated in dark for 30 min. Absorbance was measured against blank at 517 nm in UV visible Spectrophotometer. DDPH solution was used as blank (control). The antioxidant activity of dragon fruit pulp was calculated by the following formula:

$$\text{Antioxidant activity (\%)} = \frac{\text{AB} - \text{AA}}{\text{AA}} \times 100$$

Where,

AB = Absorbance of blank
AA= Absorbance of sample

2.5 Ascorbic Acid

Ascorbic acid of the samples was estimated using 2, 6-dichlorophenol-indophenol by titration method [12].

$$\text{Ascorbic acid (mg/ 100 g)} = \frac{\text{T} \times \text{D} \times \text{V} \times 100}{\text{A} \times \text{V}}$$

Where,

T = Titre value
D = Dye factor
V = Volume made up
A = Aliquot of extract taken for estimation
W= Weight or volume of sample taken for estimation

2.6 Statistical Analysis

The data collected on different characteristics were analyzed by optimal Randomized Design in Response Surface category in software Design Expert (version 13).

3. RESULTS AND DISCUSSION

The perusal of data containing the standardization of dragon fruit juice beverage and its effect on TSS, titratable acidity, color, ascorbic acid, overall acceptability and antioxidant activity are presented in Table 1.

3.1 Effect of Different Levels of Fruit Juice, Sugar and Citric Acid on TSS of Dragon Fruit RTS Beverage

Total soluble solids (TSS) generally denote the amount of per cent of dissolved solids in a solution and refractometer is the commonly used instrument for its measurement. The data depicted in Table 1. revealed that TSS dragon fruit RTS beverage prepared using fruit juice, sugar and citric acid treated was ranged from 14.25 to 16.75ºBx. The maximum 16.75ºBx of TSS was obtained when 14% dragon fruit juice, 15% sugar and 0.9% citric acid were used; whereas lowest 14.25ºBx of TSS was observed when 10% dragon fruit juice, 10% sugar and 0.3% citric acid was used. dragon fruit juice, sugar and citric acid have significant effect ($p<0.05$) on TSS of dragon fruit RTS beverage. It was observed that TSS increased significantly with increase in dragon fruit juice and sugar syrup percent in the formulation.

Table 1. Standardization of process for preparation of RTS beverage from dragon fruit juice

Run No	Variables					Responses			
	Fruit juice (%)	Sugar (%)	Citric acid (%)	TSS (ºBx)	Titratable acidity (%)	Color (a*)	Ascorbic acid (mg/100 ml)	Antioxidant activity (%DPPH inhibition)	Overall acceptability
1	14	15.00	0.6	16.10	0.28	1.28	3.64	24.31	8.25
2	14	15.00	0.3	16.25	0.27	1.51	3.71	26.60	8.26
3	12	15.00	0.9	16.75	0.33	1.43	3.75	26.80	7.50
4	12	12.50	0.6	15.52	0.24	1.21	3.48	24.58	8.25
5	12	12.50	0.6	15.42	0.25	1.11	3.45	24.26	8.10
6	12	12.50	0.6	15.60	0.24	1.25	3.50	24.20	7.95
7	10	12.50	0.6	15.55	0.25	1.22	3.52	23.70	7.90
8	10	15.00	0.3	15.30	0.22	1.02	3.41	20.95	8.05
9	14	10.00	0.9	14.65	0.30	1.06	3.15	21.53	7.30
10	12	10.00	0.3	15.05	0.21	1.44	3.65	26.42	8.17
11	12	12.50	0.3	15.40	0.21	1.31	3.45	23.88	8.13
12	12	12.50	0.6	15.50	0.26	1.19	3.55	24.32	8.40
13	14	12.50	0.6	15.48	0.27	1.07	3.42	23.90	8.35
14	10	10.00	0.9	15.60	0.31	1.43	3.68	26.70	7.45
15	12	10.00	0.3	14.25	0.20	0.95	3.17	20.42	8.10
16	10	12.50	0.9	15.70	0.29	1.08	3.38	24.70	7.25
17	12	12.50	0.6	14.85	0.26	1.10	3.10	21.35	8.18
18	10	10.00	0.6	14.70	0.25	1.15	3.24	24.35	8.22
19	14	15.00	0.9	15.85	0.32	0.98	3.45	21.60	7.35
20	14	12.50	0.6	16.10	0.27	1.42	3.65	26.81	8.28

Table 2. The optimum solution for standardized dragon fruit RTS beverage

Parameter	Optimum value
Dragon fruit juice (%)	14
Sugar (%)	12.75
Citric acid (%)	0.38

Table 3. Responses for optimized dragon fruit RTS beverage

Parameters	Mean ± SD
TSS (ºBx)	15.70 ± 0.03
Titratable acidity (%)	0.233 ± 0.003
Color value(a*)	1.49 ± 0.01
Antioxidant activity (% DPPH inhibition)	26.44 ± 0.23

Each value is replication of the three observations

3.2 Effect of Different Levels of Fruit Juice, Citric Acid and Sugar on Titratable Acidity of Dragon Fruit RTS Beverage

The total acid concentration in food is generally measure of titratable acidity of that food. It is also deciding factor in consumer acceptability of product. Generally organic acids are found in foods i.e. citric acid, lactic acid, tartaric acid and acetic acid. These organic acids are responsible for the flavor, color, microbial stability and shelf life of food. Titratable acidity for different combinations of fruit juice, sugar and citric acid varied from 0.20% to 0.33% in dragon fruit RTS beverage (Table 1). Higher acidity was observed when formulation of fruit juice, sugar and citric acid were used at 14%, 15% and 0.9% respectively, whereas lower acidity was observed in the formulation of fruit juice, sugar and citric acid with 10%, 10% and 0.3% level respectively. Fruit juice, sugar and citric acid have significant effect ($p<0.05$) on titratable acidity of dragon fruit RTS beverage. The titratable acidity increased with increase in citric acid level in the formulation (Fig. 2).

3.3 Effect of Different Levels of Fruit Juice, Citric Acid and Sugar on Color of Dragon Fruit RTS Beverage

Color is the first attribute perceived by the human senses and play an important role in the consumers' perception of final selection of food.

It is depicted from Table 1 represents the effect of fruit juice, sugar and citric acid on the color of dragon fruit RTS beverage. The color value (a*) of beverage for different combinations ranges from 0.95 to 1.51. Highest color value was observed when 14% of fruit juice, 15% of sugar and 0.3% citric acid were used; while, minimum color value (a*) was observed when 10% of fruit juice, 10% of sugar and 0.3% of citric acid were used in formulation. Only fruit juice had significant effect ($p< 0.05$) on color value (a*) of dragon fruit RTS beverage. The color value (a*) decreased with decrease in fruit juice level in the formulation (Fig. 3), sugar and citric acid had less contribution to color value.

3.4 Effect of Different Levels of Fruit Juice, Sugar and Citric Acid on Ascorbic Acid of Dragon Fruit RTS Beverage

Ascorbic acid is one the important factor that decides antioxidant activity of foods which prevents or avoids free radicals' formation. The ascorbic acid content for different combinations of fruit juice, sugar and citric acid varied from 3.10 to 3.75 mg/100 ml. The maximum 3.75 mg/100 ml of ascorbic acid was obtained when 14% fruit juice, 15% sugar, 0.9% citric acid were used whereas the minimum 3.10 mg/ 100 ml of ascorbic acid was obtained when 10% fruit juice, 12.50%, sugar, 0.6% citric acid were used. fruit juice and sugar have significant effect ($p< 0.05$) on ascorbic acid of dragon fruit RTS beverage; whereas citric and combined effect all three process parameters found to have non-significant effect ($p>0.05$) on ascorbic acid content of dragon fruit RTS beverage. The ascorbic acid of dragon fruit RTS beverage was increased with increase in fruit juice levels in formulation (Fig. 4).

3.5 Effect of Different Levels of Fruit Juice, Sugar and Citric Acid on Antioxidant Activity (% DPPH inhibition) of Dragon Fruit RTS Beverage

The score for antioxidant activity for different combinations varied from 20.42% to 26.81% (Table 1). The maximum antioxidant activity of 26.81% was obtained when 14% fruit juice, 12.50% sugar syrup, 0.6% citric acid were used; whereas, the lowest antioxidant activity of 20.42% was obtained when 10% fruit juice, 10% sugar, 0.3% citric acid were used for the dragon fruit RTS preparation. Fruit juice and citric acid have significant effect ($p<0.05$) on antioxidant activity of dragon fruit RTS beverage whereas sugar level and combined effect of fruit juice, sugar and citric have non-significant effect ($p>0.05$) on dragon fruit RTS beverage. The antioxidant activity was increased with increase in fruit juice level in formulation (Fig. 5).

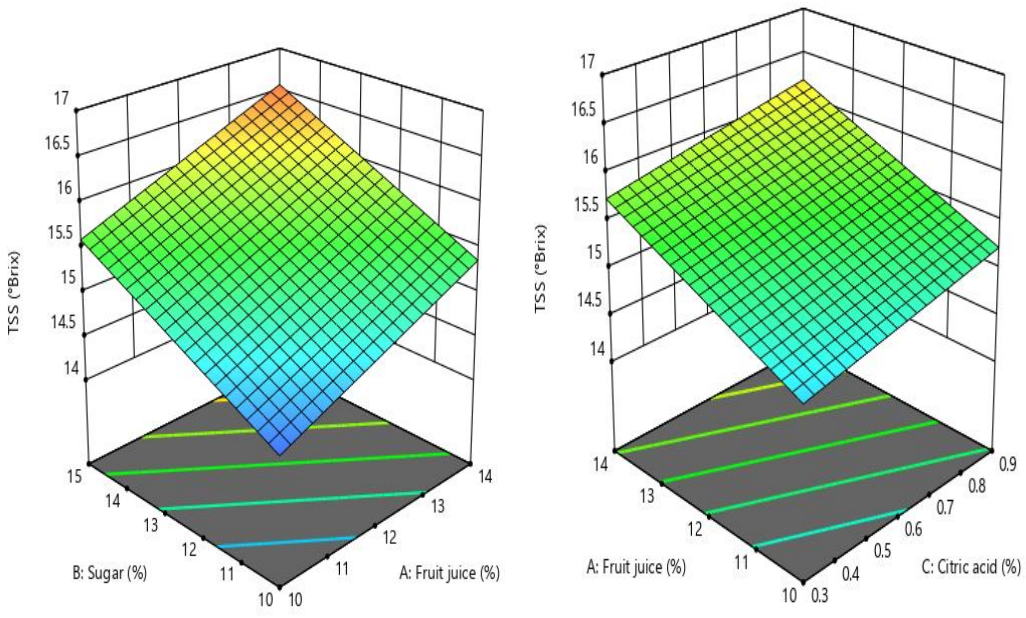

Fig. 1. Effect of fruit juice, sugar and citric acid on TSS of dragon fruit RTS beverage

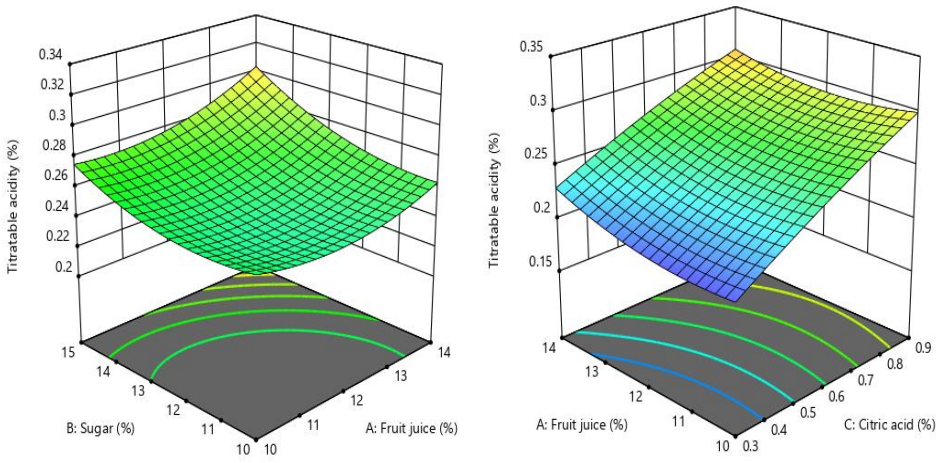

Fig. 2. Effect of fruit juice, sugar and citric acid on titratable acidity of dragon fruit RTS beverage

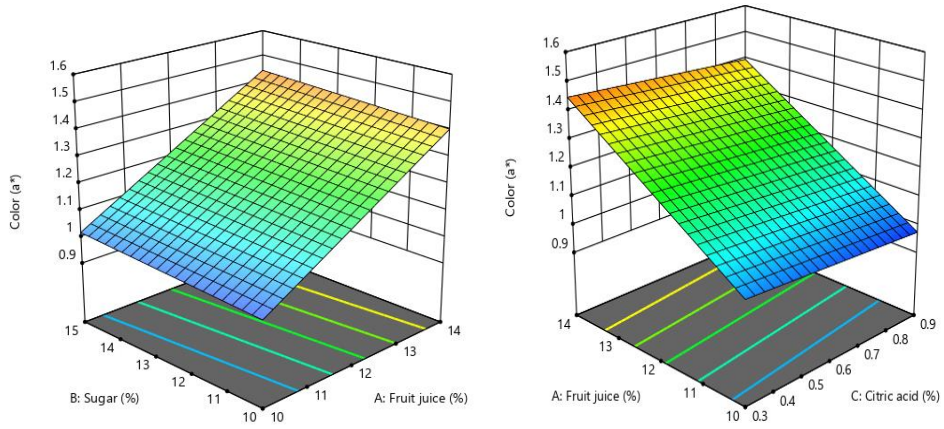

Fig. 3. Effect of fruit juice, sugar and citric acid on color of dragon fruit RTS beverage

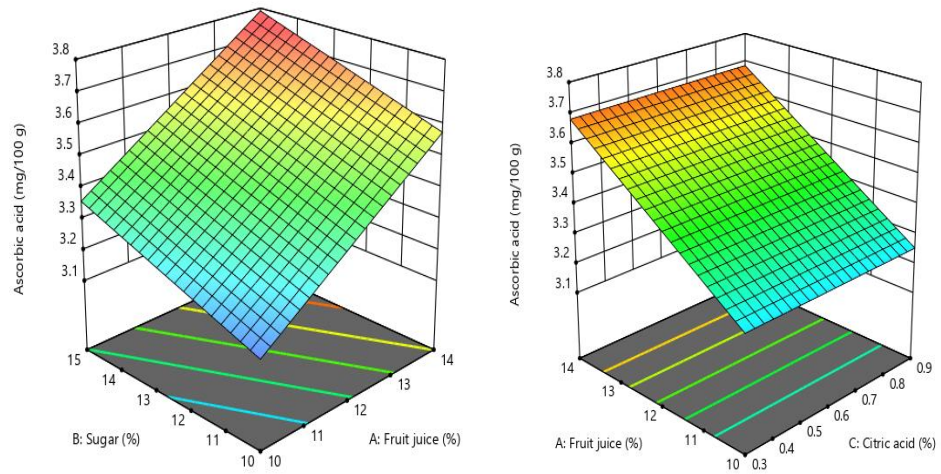

Fig. 4. Effect of variables on ascorbic acid of dragon fruit RTS beverage

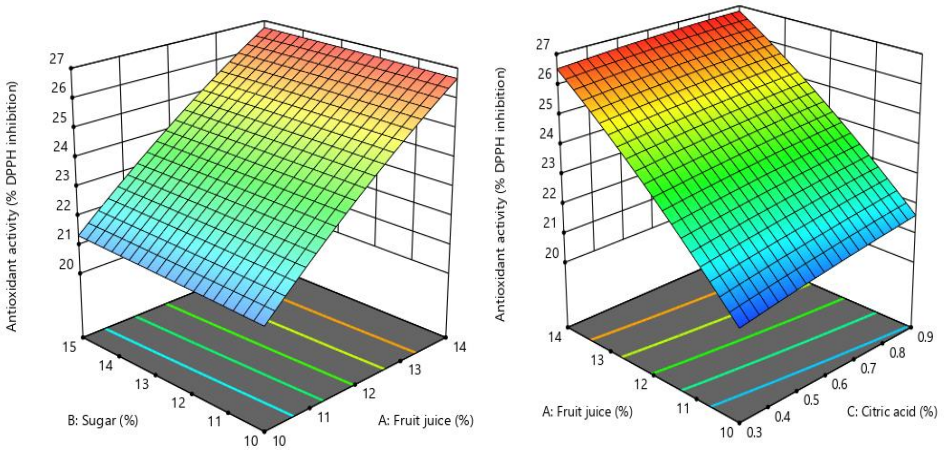

Fig. 5. Effect of fruit juice, sugar and citric acid on antioxidant activity of dragon fruit RTS beverage

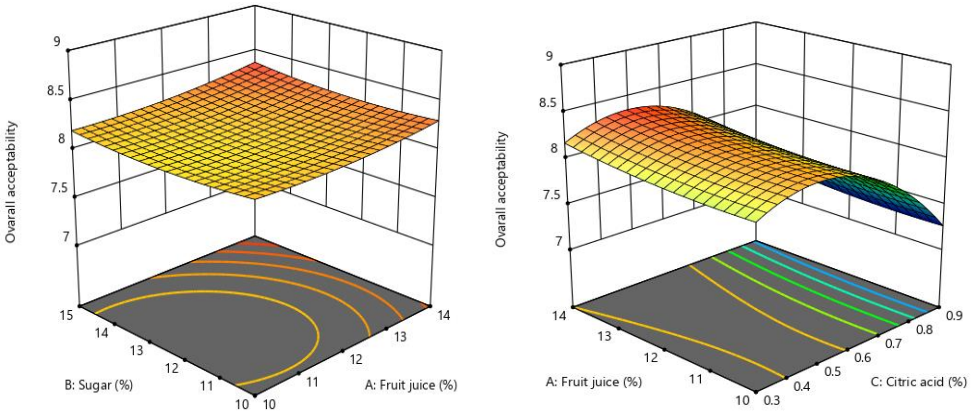

Fig. 6. Effect of fruit juice, sugar and citric acid on overall acceptability dragon fruit RTS beverage

3.6 Effect of Different Levels of Fruit Juice, Sugar and Citric Acid on Overall Acceptability Score of Dragon Fruit RTS Beverage

The score for overall acceptability for different combinations varied from 7.25 to 8.35 (Table 1) The maximum overall acceptability score of 8.35 was obtained when 12% dragon fruit juice, 12.50% sugar and 0.6% citric acid were used; whereas minimum overall acceptability score obtained was 7.25, when 12% dragon fruit juice, 12.50% sugar and 0.9% citric acid were used. Only citric acid has significant effect ($p<0.05$) on overall acceptability of dragon fruit RTS beverage whereas fruit juice, sugar levels and combined effect of fruit juice, sugar and citric acid have non-significant effect ($p>0.05$). The overall acceptability score decreased with increase in citric acid per cent in formulation (Fig. 6).

3.7 Physicochemical and Nutritional of Optimized Dragon Fruit RTS Beverage

The data obtained for the physicochemical and nutritional properties of optimized dragon fruit RTS beverage are presented in Table 3 The optimized dragon beverage has 15.70°Bx TSS, 0.23% titratable acidity, 3.65 mg per 100 ml ascorbic acid and 8.26 overall acceptability. The color in terms of (a*) value was observed 1.49 and antioxidant activity was 26.44%. The optimized dragon fruit RTS beverage was found accepted more on the basis of sensory evaluation with optimum level of ascorbic acid, TSS and titratable acidity.

4. CONCLUSION

The dragon fruit RTS beverage prepared by using dragon fruit juice, sugar and citric acid was nutritious and also safe for consumption since

there is no addition of artificial color and flavor. The findings above indicate that dragon fruit RTS beverage was prepared by using 14% fruit juice, sugar 12.75% and citric acid 0.38%. Thus, beverage was optimized based on sensory evaluation and quality attributes. Increased concentration of fruit juice resulted in increase in color, ascorbic acid and antioxidant activity of dragon fruit RTS beverage.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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https://www.sdiarticle5.com/review-history/110489