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Quality assessment of ready-to-serve (RTS) beverage from blends of carrot, orange and ginger juices

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Abstract
An experiment was conducted to prepare a Ready-To-Serve (RTS) drink by combining carrot juice with orange and ginger juice. Sugar, citric acid, water, and sodium benzoate were used to make ready-to-serve beverage in a variety of combinations according to treatment ratios. Six distinct combinations of carrot juice with orange and ginger juice in the ratios of 100:0:0, 80:15:5, 60:35:5, 40:55:5, and 20:75:5 respectively were created and analyzed for a 90-day period under ambient storage conditions for a variety of quality characteristics. The investigation of nutritional characteristics revealed that as storage days rose, TSS, titrable acidity, and total sugar increased while pH, ascorbic acid, and β-carotene declined. It was determined that the RTS beverage was safe to consume after 90 days of storage.

Keywords: Blended ready-to-serve, nutritional quality evaluation, microbial analysis

Introduction

Carrot (*Daucus carota* L) is the most significant source of dietary carotenoids in Western nations, including the United States of America. It is one of the most consumed root vegetables. In addition to having a significant number of vitamins and minerals, carrots are also a great source of β-carotene and are frequently used to make juice (Demir *et al*., 2004) [4]. A healthy amount of dietary fibre, which has a laxative effect and helps with digestion and nutritional absorption while preventing constipation, is present in carrots. Carrot juice is popular with consumers because of its high nutritional value, fibre, carbs, vitamin A derived from its high β-carotene concentration, colour, fragrant ingredients, and refreshing qualities (Desobry *et al*., 1998) [5]. Due to their abundance in nutrients like carotenes, which promote health, carrots are an important part of human nutrition. Carrots provide a variety of health benefits, including the ability to cleanse the intestines, as well as being diuretic, energising, antidiarrheal, and rich in alkaline elements that purify and energise the blood. Additionally, it has a reputation as a vegetable that promotes health (Olalude *et al*., 2015) [11]. Despite being rich in multi nutritional factors and a crop of economic importance the processing of carrot into beverages is not so popular. The beverages prepared from carrot are nutritionally rich, highly palatable, easily digestible, and refreshing.

Ginger (*Zingiber officinale* Rosc.), a member of the Zingiberaceae family, is prized for its flavour, scent, and several medical benefits. An ancient herbaceous crop called ginger has long been employed in Chinese, American, and European medicine in addition to the Ayurvedic system of medicine in India. Dry ginger has roughly 8.6% protein, 6.4% fat, 9% fibre, 66.5% carbs, 0.1% calcium, 0.15% phosphorus, 0.03% sodium, 1.8% potassium, 175 IU of vitamin A per 100g, 1.9 mg of niacin, and 12 mg of vitamin C, among other nutrients. Strong antibacterial and, to some extent, antifungal activities can be found in ginger. Studies *in vitro* have demonstrated that ginger's active ingredients prevent intestinal bacteria from multiplying. *Escherichia coli*, *Proteus* sp., *Staphylococci*, *Streptococci*, and *Salmonella* have their growth inhibited by it (Ody 2000) [10].

Due to its appealing colour, peculiar flavour, and abundance in vitamins C, B, β-carotene, calcium, and phosphorous orange is extremely significant in the beverage, industrial, and pharmaceutical industries (Sogi and Singh 2001) [19]. Presence of limonate-a-ring-lactone, a non-bitter ingredient, transforms into limonin, a bitter chemical, after storage (Premi *et al*., 1994) [12], orange juice becomes bitter after extraction, restricting the amount of this fruit that may be processed.

Orange juice was combined with certain other highly nutritious fruit juices and spice extracts to enhance the flavour, aroma, palatability, nutritional value, and lessen bitterness. Oranges are traditionally used to cure obesity, as a cooling agent for respiratory disorders including coughs and colds, to increase appetite, and to avoid constipation, menstrual irregularities, hypertension, angina, and palpitations. One orange provides 12.5% of the daily requirement for fibre. Overall, citrus fruits have the potential to be the best superfood that can be combined with veggies to increase their nutritious value.

Thus, combining these juices will increase their nutritional worth as well as their antibacterial properties. In 2004, Sethi *et al*., 2004 [4] proposed that fruit drinks based on Ayurvedic formulations have significant therapeutic and medical benefits for an individual and assessed that there are many fruit drinks or herbal beverages depending on the seasonal requirements for an individual. Numerous fruit drinks or RTS beverages from Ayurveda have been produced or used for people's health (De Carvalho *et al*., 2007) [1]. Additionally, one can consider creating a new product through blending juices of carrot, orange and ginger in the form of a natural health drink that could also be offered as an appetizer. There were six combinations of blended juices of carrot, orange and ginger in different ratios.

Materials and Method

Carrot, orange and ginger was purchased from nearby local market. Other raw materials used in preparation of the RTS was water, sugar, citric acid, sodium benzoate, juice glass bottles, knives, a peeler, trays, a power mixer-grinder, an electronic balance.

Preparation of Blended RTS

The RTS beverage was prepared with freshly made carrot, orange, and ginger juices as well as water and sugar. Juices were combined in six various ratios, including 100:0:0, 80:15:5, 60:35:5, 40:55:5, and 20:75:5. To make sugar syrup, the necessary amount of sugar to achieve the needed TSS of 10º Brix and citric acid were dissolved in water, brought to a boil, filtered through a muslin cloth. To create the RTS beverage, the combined juices of carrot, orange, and ginger were then blended with the appropriate amount of sugar syrup. Through homogenization, all the components were dissolved, and the mixture was then heated at 85 °C for 20 minutes. After being taken out of the flames, it was given ten minutes to cool. After that, 0.6g of sodium benzoate per liter of RTS was added and thoroughly combined with the solution. The pre-sterilized 200 ml glass bottles were filled with the prepared RTS beverage, which was then promptly corked with a machine, leaving a 1" headspace on top, and tightly sealed with caps. The sealed bottles were sterilized for 30 minutes in a hot water bath at 80 °C. After being taken out of the water bath, the bottles were let to cool and stored at room temperature.

Nutritional Analysis

The prepared RTS beverage formulations blended Carrot juice with orange and ginger juice were analyzed initially for the parameters of TSS, titrable acidity, pH, Total sugar and ascorbic acid using AOAC methods.

Total Soluble Solids

Total soluble solids were analyzed by using an ERMA hand refractometer. A single drop of sample was deposited over the prism while being seen through the eyepiece with the projection inlet pointed towards light. Direct readings from the refractometer are used to determine the scale point where the boundary line of the shaded area intersects the un-shaded area.

pH and Titrable Acidity

pH was taken by using a digital pH meter. In a beaker, 50 ml of distilled water was used to dissolve a 5ml sample of each blended product. To titrate this solution against 0.1N NaOH, a 20 ml aliquot of it was taken. As an indication, a few drops of phenolphthalein were utilised. The appearance of the pink coloration served as the endpoint's cue. The result was calculated once the titer value was recorded (Ranganna 2001) [14].

Ascorbic Acid

Take a 10 ml sample, dilute with 3% metaphosphoric acid containing 0.2 mg ascorbic acid mL-1 and volume makeup to 100 ml, and filter the mixture. Pipet 10 ml of filtrate into a conical flask and titrate with standard dye 2,6-dichlorophenol-indophenol to a pink endpoint. The result was calculated once the titer value was recorded

Total Sugar

Total Sugar was determined by using Lane and Eynon method as described by Ranganna (1997) [13]. The total sugar was estimated by taking 50 ml aliquot of clarified and deleaded solution in the 250 ml of volumetric flask. 5ml of HCL was added in it and it was allowed to stand at room temperature for 24 hours. This was neutralized with concentrated NaOH solution and made up the volume up to 250 ml. An aliquot was taken and total sugars were determined as invert sugars.

β-carotene (mg/100 ml)

Add a few crystals of anhydrous sodium sulphate to 5g of fresh sample in 10-15 ml of acetone. Decant the supernatant into a beaker. Repeat the process twice, then transfer it into a separatory funnel and add 10-15 ml of petroleum ether and mix thoroughly. On standing, two layers will separate. Discard the lower layer and collect upper layer in a 100 ml volumetric flask, make up the volume to 100 ml with petroleum ether and record optical density at 452 nm using petroleum ether as blank (Srivastava and Sanjeev, 1998) [20].

Results and Discussion

Total soluble solids

The hydrolysis of polysaccharides into monosaccharides and oligosaccharides may be the cause of the TSS's steady increase over the course of storage. The minimum change in TSS was observed in T_1 among all the treatments during storage. Jan and Masih (2012) [6], Deka and Sethi (2001) [3], and Deka (2000) [2] all obtained results that were comparable. Deka (2000) [2] discovered an increase in total soluble solids during storage at ambient and low temperature in lime-aonla and mango pineapple spiced RTS beverages (Table 1).

Table 1: Changes in TSS of Blended RTS during storage

Treatments	TSS (%)			
	Storage Periods (in days)			
	0	30	60	90
T_0	10.05	10.22	10.41	10.70
T_1	10.00	10.12	10.34	10.47
T_2	10.00	10.29	10.43	10.62
T_3	10.05	10.36	10.52	10.85
T_4	10.02	10.40	10.59	11.08
T_5	10.00	10.47	10.62	11.08
CD at 5%	0.076	0.085	0.086	0.208

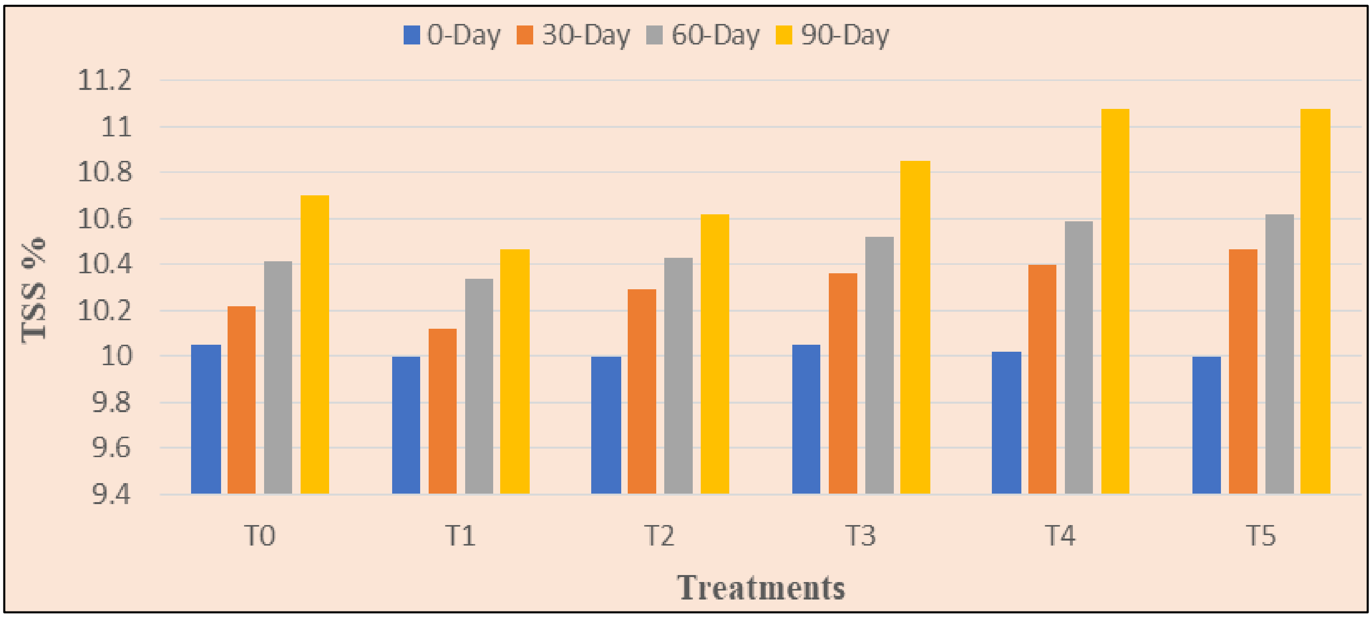

Fig 1: Changes in TSS of Blended RTS during storage

pH

There was a significant decrease in pH during storage period (Table 2). T_0 showed minimum changes in pH level. This might be due to increase in titrable acidity, as acidity and pH are inversely proportional to each other. Majumdar *et al*., 2011 [7] also reported similar results for a juice blend of bottle guard and basil leaves juice.

Titrable Acidity (%)

The data (Table 3) clearly indicated that, the titrable acidity significantly increased during the storage period of 90 days but not significantly affected by storage. It was minimally changed in T_0, T_1 and T_2 while, maximum change was seen in T_5. This increase in acidity of RTS beverage during storage may be due to the formation of organic acids and the contribution of inherent acids, naturally present in the beverage and partially due to the citric acid purposely added at the time of preparation. The results were in conformity with Rashid *et al*., (2018) [15] who reported similar results in guava RTS and Mishra *et al*., (2017) [9] in blended RTS of aloe vera, sweet lime, amla and ginger.

Table 2: Changes in pH of Blended RTS during storage

Treatments	pH			
	Storage Periods (in days)			
	0	30	60	90
T_0	3.70	3.53	2.88	2.80
T_1	3.70	3.53	2.86	2.70
T_2	3.63	3.39	2.82	2.61
T_3	3.60	3.38	2.81	2.57
T_4	3.60	3.33	2.75	2.55
T_5	3.45	3.23	2.73	2.37
CD at 5%	0.044	0.087	0.110	0.201

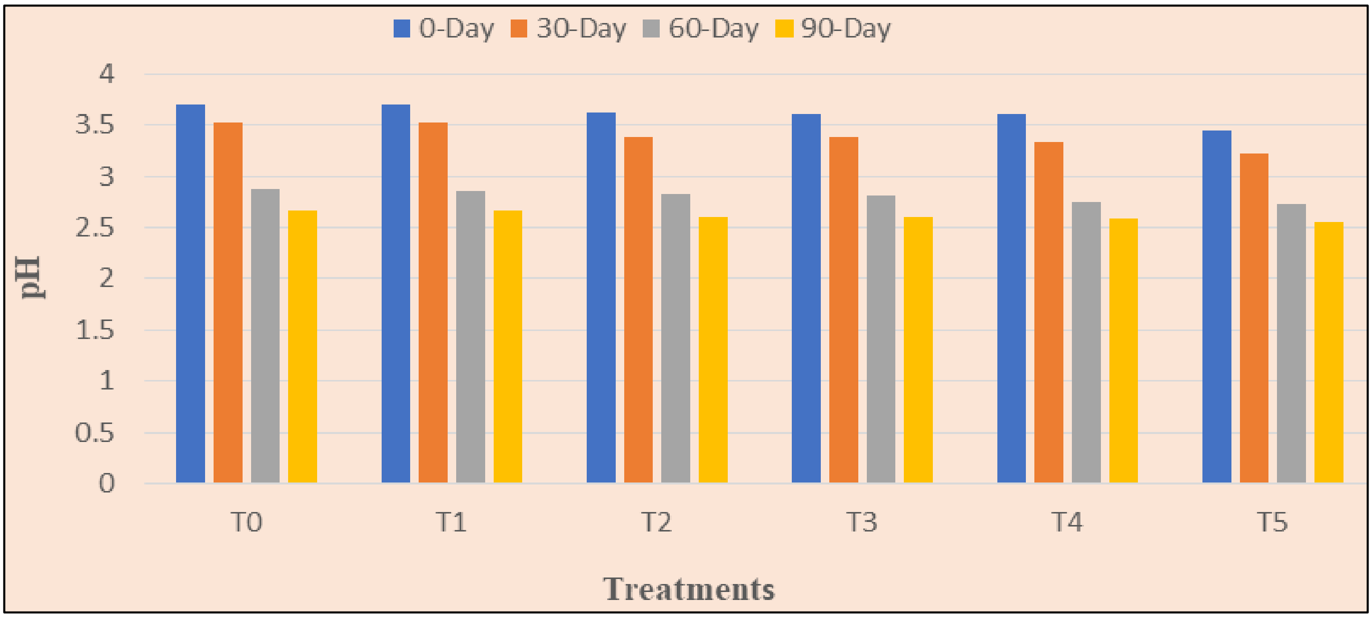

Fig 2: Changes in pH of Blended RTS during storage

Table 3: Changes in Titrable Acidity % of Blended RTS during storage

Treatments	Titrable Acidity %			
	Storage Periods (in days)			
	0	30	60	90
T_0	0.22	0.22	0.25	0.28
T_1	0.23	0.24	0.27	0.29
T_2	0.24	0.28	0.29	0.30
T_3	0.25	0.26	0.29	0.32
T_4	0.25	0.27	0.30	0.32
T_5	0.26	0.27	0.30	0.34
CD at 5%	0.010	0.042	0.015	0.024

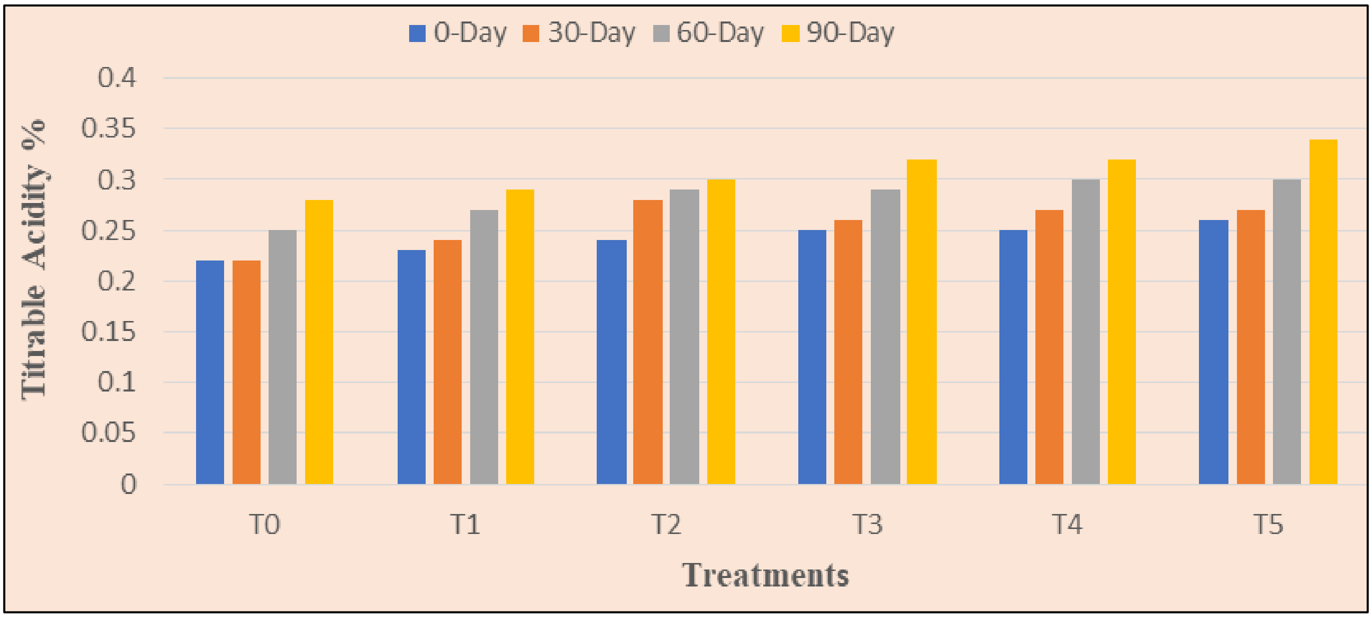

Fig 3: Changes in Titrable Acidity % of Blended RTS during storage

Ascorbic Acid (mg/100 ml)

With increasing storage time, the ascorbic acid (vitamin "C") content of the blended RTS beverage decreased (Table 4). This was likely because ascorbic acid, which is sensitive to oxygen, light, and heat, was easily oxidized in the presence of oxygen by both enzymatic and non-enzymatic catalyst. After reviewing the results presented in the concerned table it can be concluded that T_0 was the most stable treatment combination in terms of ascorbic acid content as it showed the minimum changes during the whole period of storage at room temperature. The reason for minimum changes could be due to pure carrot juice concentration which naturally has lower ascorbic acid when compare to orange juice and less antioxidant activities. The ascorbic acid content increased with increase in concentration of orange in each treatment. A similar trend of decrease in ascorbic acid content was observed by Remyamol (2006) [16] in blended cashew-apple RTS beverage.

Table 4: Changes in Ascorbic Acid (mg/100 ml) of Blended RTS during storage

Treatments	Ascorbic Acid (mg/100 ml) Storage Periods (in days)			
	0	**30**	**60**	**90**
T_0	5.48	5.30	4.30	4.00
T_1	6.75	6.47	5.82	4.72
T_2	7.97	7.43	6.72	5.97
T_3	8.65	8.17	7.42	6.73
T_4	9.82	9.18	8.65	7.42
T_5	11.17	10.98	9.90	8.67
CD at 5%	0.084	0.059	0.081	0.059

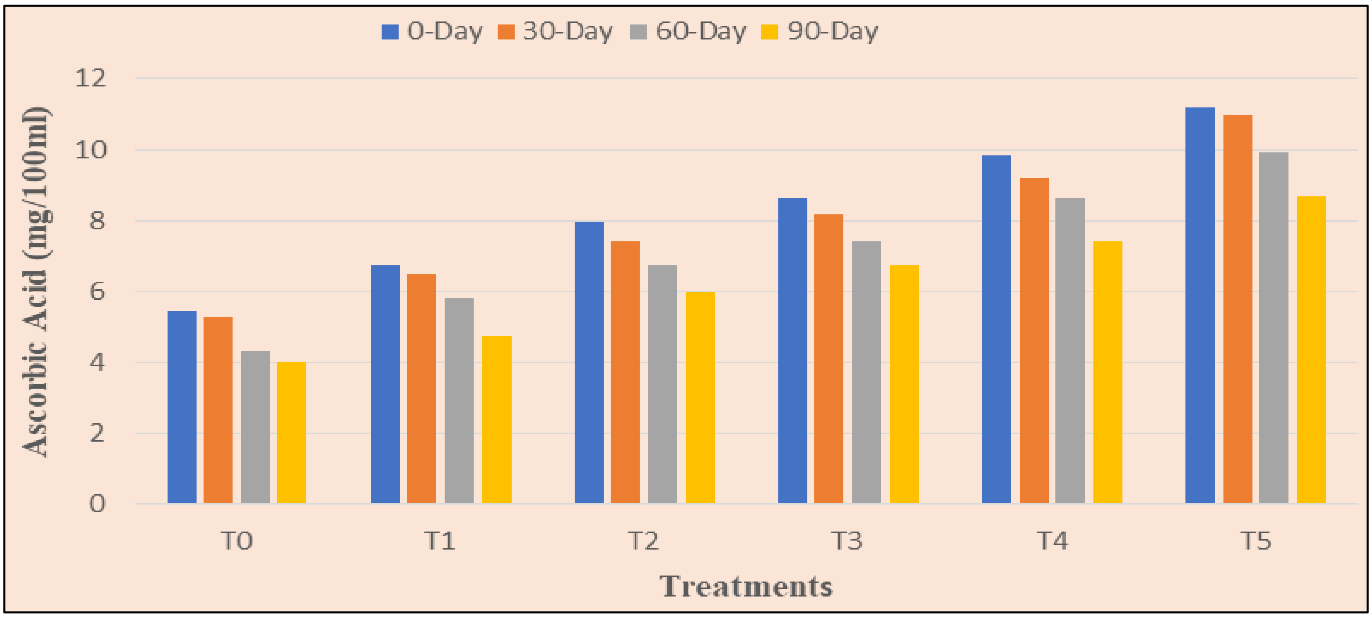

Fig 4: Changes in Ascorbic Acid (mg/100 ml) of Blended RTS during storage

Total Sugars (%)

The total sugar content decreased significantly between the treatments during whole period of storage and reduced continuously till 90th day of storage but T_2 remained most stable. The decrease in total sugar was probably due to the fact that these complex sugars are broken down to simpler ones by microorganisms and utilized for their metabolic activities. Byanna and Gowda (2012) discovered that, after 180 days of storage at room temperature the total sugar content of blended RTS of sweet orange and pomegranate (90:10) decreased from 13.70 to 12.43 per cent.

Table 5: Changes in Total Sugars (%) of Blended RTS during storage

Treatments	Total Sugars (%) Storage Periods (in days)			
	0	**30**	**60**	**90**
T_0	10.88	11.03	10.78	10.34
T_1	11.74	11.59	11.26	11.03
T_2	12.45	12.26	12.11	12.00
T_3	13.02	12.83	12.53	12.19
T_4	13.83	13.63	13.19	12.85
T_5	14.90	14.46	13.82	13.72
CD at 5%	0.641	0.929	0.801	0.965

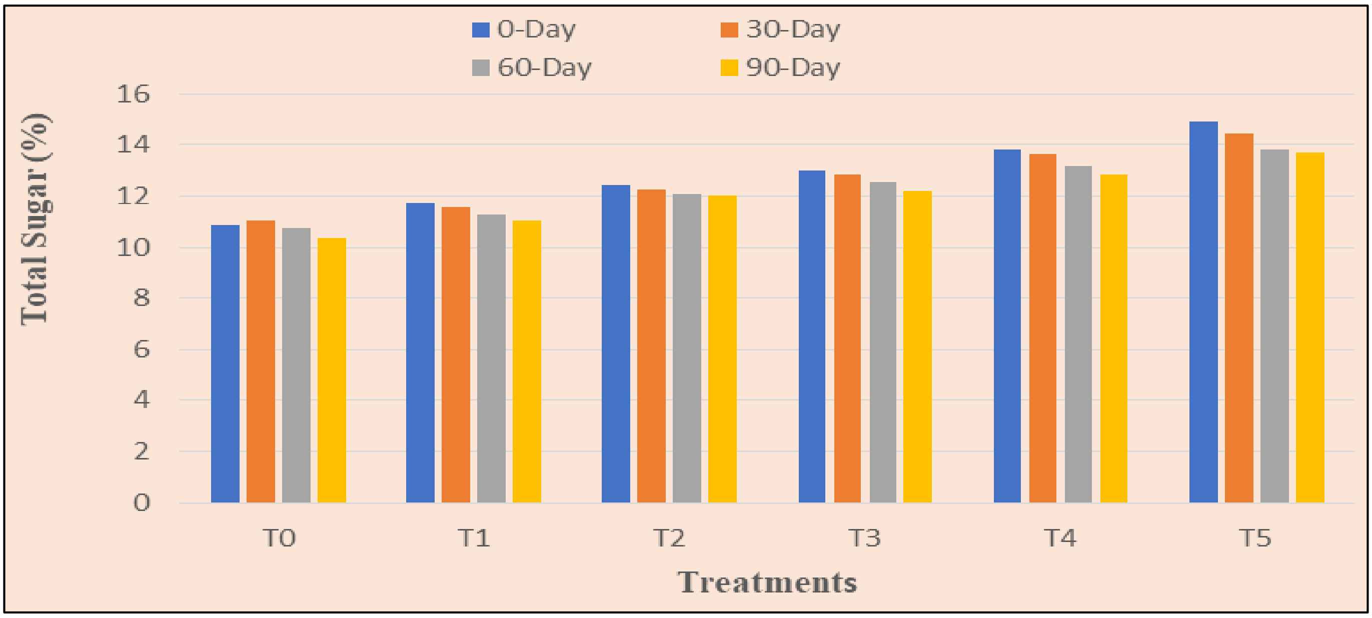

Fig 5: Changes in Total Sugars (%) of Blended RTS during storage

β-carotene (mg/100 ml)

Data pertaining to changes in β-carotene content of different treatments of the blended ready-to-serve is described in Table 6 and illustrated in Fig 6. The data showed continuous decrease in β-carotene content among all the treatments during whole storage period. the minimum change in the β-carotene content has been observed in T_0, T_1 and T_2. The decrease could be due to its unstable and photosensitive nature of β-carotene. The present finding relates with the findings of Senarathna *et al.*, (2019) [17]. They reported a decrease in the β-carotene content of carrot-orange juice based drinking yogurt. Marx *et al.*, (2000) [8] also reported similar finding in carrot juice.

Table 6: Changes in β-carotene (mg/100 ml) of Blended RTS during storage

Treatments	**β-carotene (mg/100 ml)**			
	Storage Periods (in days)			
	0	**30**	**60**	**90**
T_0	0.89	0.86	0.82	0.81
T_1	0.85	0.84	0.79	0.77
T_2	0.81	0.80	0.76	0.73
T_3	0.78	0.76	0.71	0.68
T_4	0.74	0.71	0.67	0.63
T_5	0.42	0.41	0.36	0.32
CD at 5%	0.044	0.036	0.045	0.040

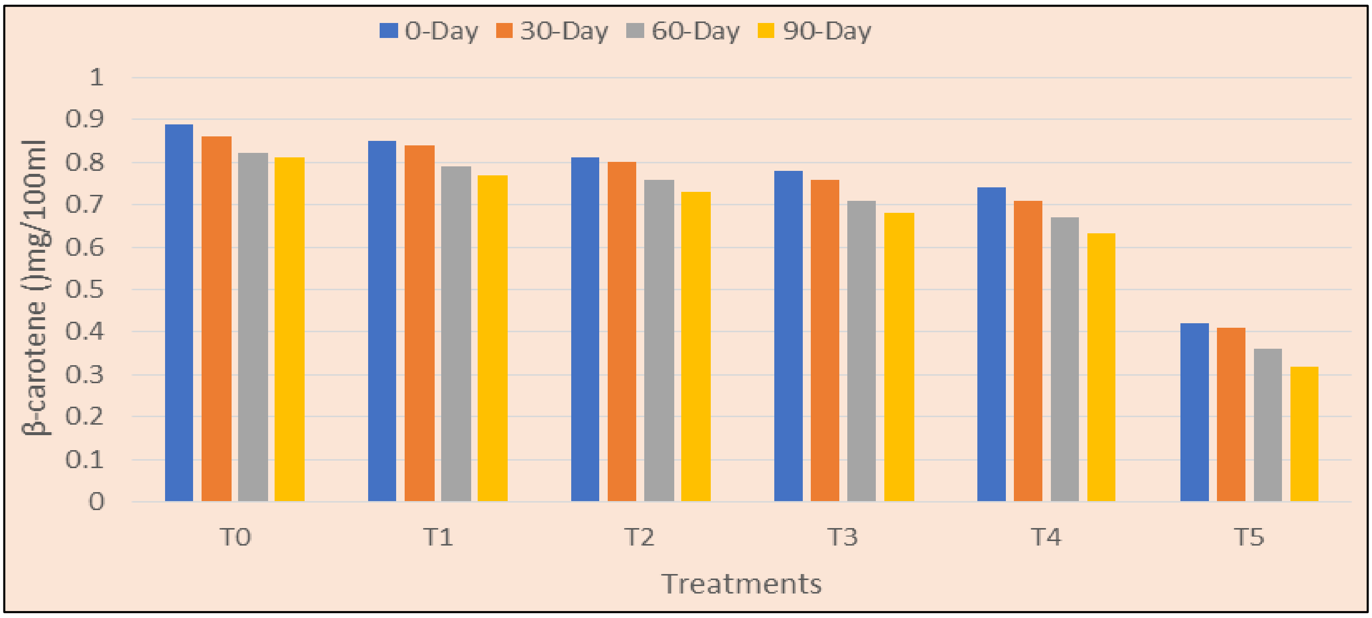

Fig 6: Changes in β-carotene (mg/100 ml) of Blended RTS during storage

Conclusion

The blended RTS beverage prepared by using carrot, orange and ginger juice was nutritious and also safe for consumption since there is no addition of artificial colour and flavour. Physicochemical metrics did not significantly change over the course of the 90-day storage period, however the inclusion of orange and ginger boosted the antioxidant and nutraceutical potential. The composition of a mixed blend juice beverage can potentially meet customer taste and preferences based on the aforementioned findings from the current investigation. Utilizing medicinal plants in the diet or incorporating and maximizing their use in fruit beverages would provide all the health benefits and lower the chance of developing serious health conditions and illness.

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