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Development of non carbonated sugarcane juice beverages blended with fruit juices

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Abstract
The non carbonated sugarcane juice beverages blended with juice of kinnow (10-15 %), aonla (5%), lemon (2-2.5%) and ginger (2.5-3%) and sugarcane juice beverage with lemon and ginger juice (3% each) were found superior. The pasteurization of sugarcane juice beverages at 82 ^{0}C temperature for 5 min along with 120ppm sodium benzoate and processing of bottled juice in boiling water for 30 min was found optimum during processing. The beverages stored at refrigerated temperature (4 ^{0}C) scored slightly high score for all the sensory and chemical parameters than the stored at room temperature (30±4 ^{0}C). There was slight decrease in values of total soluble solids (1.6%), pH (3.63%), ascorbic acid (22.5%), total sugars (2.38%), viscosity (1.71%) for all the beverages after 3 months during storage of 6 months while the values for titratable acidity and reducing sugars were increased 4.91% and 7.9%, respectively. The total polyphenol and total flavonoids were decreased by 20 per cent while the antioxidant activity was decreased by 25 per cent during the storage of six months. The beverages showed stability till 3 months while further storage slightly decreased the values. The products were found acceptable even after six months storage.

Keywords: Aonla juice, non carbonated beverage, sugarcane juice, kinnow juice, lemon juice, ginger juice

Introduction
Sugarcane (*Saccharum officinarum*) is widely cultivated in tropical and subtropical regions of the world as a major crop. India is the second largest producer of sugarcane having 5.06 million ha area under cultivation and annual crop production of 366.8 million tonnes Anonymous (2016) [1]. The share of sugarcane is 80 per cent to meet the world demand of sugar and the rest is from sugar beet. Sugarcane juice is a common drink where sugarcane is grown commercially. In India, sugarcane juice is extracted by crushing the sugarcane by hand or mechanically operated small machines or sometimes wooden charkas operated by manually or bullock in rural and urban areas. The both urban and rural population is acquainted with thirst quenching and delicious drink made up from sugarcane juice with lemon, mint and ice. The sugarcane juice has many medicinal properties as strengthens the stomach, kidneys, heart, eyes, brain and sex organs. It is very useful in scanty urination. It keeps the urinary flow clear and helps kidneys to perform their functions properly (Karthikeyan and Samipillai 2010) [6].
Sugarcane, kinnow, aonla and lemon are valued very much for their refreshing juice with nutritional and medicinal properties. Ginger juice also has anti-bacterial and anti-fungal properties with pleasant flavour. Therefore, blending these fruit juices for the preparation of sugarcane juice beverages is thought to be a convenient and economic alternative for utilization of these fruits. Though sugarcane juice has a great demand in the market but the problem of its safety processes and storage life and is rarely available commercially in packaged form. It is need of development of effective treatments and procedures to keep the sugarcane juice fresh with improved quality also for its safety and wide marketability. Considerable efforts have been aimed to prepare healthy beverage for wide marketability.

Objectives
1. To develop healthy non carbonated sugarcane juice beverages blended with juices of kinnow, aonla, lemon and ginger without addition of external sugar and acids.
2. To study the effect of storage period and temperature on physicochemical and phytochemical constituents of beverages.

Materials and methods
Extraction of juices
Sugarcane The sugarcane var. CoPb-91 from Punjab Agricultural University Research Station Kapurtala, kinnow, aonla, lemon and ginger from local market were procured.

Sugarcane was cleaned, cut into 2.5 feet length, washed by clean by mechanical washer, skin and nodes were scrapped with special curved blade stainless steel (SS) knife and again washed in mechanical washer for 2 min and surface dried in perforated SS trays using fans. The juice of sugarcane was extracted with double extraction using mechanical crusher (SS make). The extracted juice was first filtered through the SS screen and then filtered through the four fold clean muslin cloth. The juices of Kinnow, aonla, lemon and ginger were washed, peeled manually using hand gloves and SS knife. The juice was extracted through juice extractor and filtered through the double folded muslin cloth. Fresh aonla fruits were sorted graded, washed and heat treated in hot water (95 ^{0}C) till the fruit colour changes to pale yellow. The seeds were removed manually and segments were separated. The juice was extracted from segments using juice extractor with addition of equal quantity of clean water for extraction. Juice and pulp was then filtered through the four fold muslin cloth. The lemon fruits were sorted, graded, washed, drained for water removal and then surface dried. The lemons were halved using stainless steel knives and juice was extracted using manually operated machine and then filtered through the four fold muslin cloth. The fresh ginger was washed, peeled manually, cut into small pieces and grinded in mixer with double quantity of water. The slurry was then filtered through the double folded muslin cloth and kept for 2hr in cylindrical transparent plastic container to settle the sediment at bottom. Clear extract is then filtered through 4 fold muslin cloth.

Processing of juices and beverages

The juices and beverages were pasteurized at 82 ^{0}C for 5 min. and sodium benzoate (120ppm) as preservative was added. The juices and beverages were then hot filled and processed in boiling water for 30 min , cooled to room temperature slowly in running tap water, surface dried and labelled.

Experimental design

The juice from fresh sugarcane CoPb-91 was extracted using Stainless Steel made juice extractor (Kalsi make) with double extraction under due care of cleaning and sanitation before and after extraction. The juice of kinnow, aonla, lemon and ginger were extracted, processed and packed for the further blending with sugarcane juice for beverage development. The 23 combination of treatments for blending fruit juices were used for standardization recipe to develop blended sugarcane juice beverages. The combination of treatments were made in such a way that there was no need to add external sugars in the beverages. The optimization of pasteurization temperature and time was undertaken. The beverage was pasteurized at different temperatures viz. 78, 80, 82, 84 and 85 ^{0}C for different periods (2, 3, 4, 5 and 6 min.) with sodium benzoate (120ppm) as preservative were tested for optimization. The beverages were then hot filled and processed in boiling water for 30 min , cooled to room temperature slowly in running tap water, let it for the surface dry and labelled. The bottles were stored at two different temperatures viz. ambient temperature (30±4 ^{0}C) and refrigerated temperature (4 ^{0}C) for the further storage study of 6 months. The effects of storage period and temperature on sensory and physicochemical parameters were studied.

Method for preparation of beverages

Fresh sugarcane juice was extracted using standard method. he proportion of juices of sugarcane, kinnow, aonla, lemon and ginger extract was added according to the type of blend. The blends of the products were then heated to the optimum temperature (82 ^{0}C) for 5 min then required sodium benzoate was added (120ppm) and mixed well. The products were filled in sterile glass bottles, sealed the bottles with sterile caps using corking machine. Bottles were then heat processed in boiling water for 30 min then cooled to room temperature slowly in running tap water, kept for the surface dry and labelled. The bottles of the products were stored at ambient temperature and refrigerated temperature for the further use for sensory evaluation, physicochemical and storage study.

Standardization of recipe for non carbonated sugarcane juice beverages

The samples of non carbonated sugarcane juice beverages were made using different combination treatments viz. T1 to T23 as shown in Table 1 for the standardization of recipe. The combination of treatments were made in such a way that there was no need to add external sugars in the beverages. The sugarcane juice was considered as a natural source for sweetening of the beverages. The required quantity of sugar level was maintained for the better acceptability of the beverages.

Sensory quality evaluation

The samples prepared during product formulation and standardized samples of sugarcane juice beverages were evaluated fresh as well as during storage study for sensory quality by a panel of semi trained judges (15 No.) for appearance, mouth feel, aroma, taste, consistency and overall acceptability using 9-Point Hedonic Scale as described by Larmond (1970) [9].

Physicochemical analysis

The beverages were analyzed for the proximate composition viz. moisture content, total solids, ash, content, titratable acidity and ascorbic acid (Ranganna 2015) [12]; pH using digital pH meter (Elico India) which was calibrated according to method of AOAC (2005) [3]; antioxidant activity by DPPH (Brand-William *et al* 1995); total phenols by Folin-Ciocalteau method (Singleton and Rossi 1965) [13]; total flavonoids (Marinova *et al* 2005) [10], total sugars (Dubois *et al* 1956) [5]; reducing sugars (Nelson 1944 and Somogyi 1952) [11]; viscosity using RV model viscometer, mineral content by Inductively Coupled Plasma- Atomic Emission Spectrophotometer (ICP-AES). The colour of the samples was measured by using Lovibond Tintometer as described in Ranganna (2015) [12].

Storage studies

The best samples of non carbonated sugarcane juice beverages packed in 200 ml glass bottles were stored at room temperature (30±4 ^{0}C) and refrigeration (4 ^{0}C) temperature for six months. The effect of storage on TSS, titratable acidity, pH, ascorbic acid, total sugars, reducing sugars and viscosity was studied at fixed interval of one month.

Microbial examination

The total plate count for bacteria was counted by using method of AOAC (1995) [2] and The yeast and mould count was counted by using dilution plate method using potato dextrose agar (Krishnakumar and Devadas, 2006a).

Statistical analysis

The data related to sensory and physic chemical attributes of fresh and stored samples of sugarcane juice beverages were

statistically analyzed to find out the effect of storage period and temperature on the sensory and physicochemical characteristics of the products with the help of Analysis of Variance (ANOVA) as described by Gomez and Gomez (2010).

Results and Discussion

Development of non carbonated sugarcane juice beverages

The development of non carbonated sugarcane juice beverages were carried out by blending the different proportions of juices of sugarcane, kinnow, aonla, lemon and ginger as stated in Table 1.

Standardization of recipe for non carbonated sugarcane juice beverages

The samples of non carbonated sugarcane juice beverages were made using different combination treatments viz. T1 to T23 as shown in Table 1 for the standardization of recipe. The combination of treatments were made in such a way that there was no need to add external sugars in the beverages. The sugarcane juice was considered as a natural source for sweetening of the beverages. The required quantity of sugar level was maintained for the better acceptability of the beverages. The juice mixes of different treatments were pasteurized at 82 ^{0}C for 5 min and the preservative was adjusted to 120ppm level in each non carbonated beverage samples which was kept within the permissible limit of FSSAI. The beverages were hot filled in the sterile bottles of 200 ml capacity, sealed and heat processed for 30 min in boiling water. The bottled samples were cooled and stored in refrigerated storage. The recipes were standardized for non carbonated sugarcane juice beverages on the basis of sensory evaluation of products using 9 point hedonic scale by the semi trained panel.

Table 1: Combination of treatments used for recipe standardization of non carbonated sugarcane juice beverages

Treatment	Juices/ extract (per cent)				
	Sugarcane	Kinnow	Aonla	Lemon	Ginger
T0	96	-	-	2.0	2.0
T1	65	20	11	2.0	2.0
T2	65	15	16	2.0	2.0
T3	70	10	16	2.0	2.0
T4	70	15	11	2.0	2.0
T5	70	20	6.0	2.0	2.0
T6	75	10	10	2.5	2.5
T7	75	15	5.0	2.5	2.5
T8	80	5.0	10	2.5	2.5
T9	80	10	6.0	2.0	2.0
T10	80	9.0	6.0	2.5	2.5
T11	80	10	5.0	2.0	3.0
T12	80	10	5.0	2.5	2.5
T13	75	15	5.0	2.5	2.5
T14	75	15	5.0	2.0	3.0
T15	85	5.0	5.0	2.5	2.5
T16	85	5.0	5.0	2.0	3.0
T17	85	8.0	3.0	2.0	2.0
T18	85	7.0	4.0	2.0	2.0
T19	90	2.5	2.5	2.5	2.5
T20	92	2.0	2.0	2.0	2.0
T21	95	-	-	2.5	2.5
T22	95	-	-	2.0	3.0
T23	95	-	-	3.0	2.0

Sensory evaluation of non carbonated sugarcane juice beverages

The chilled samples were tested for sensory quality parameters viz. appearance, mouth feel, aroma, taste, consistency and overall acceptability by the semi trained panel using 9 point hedonic scale. The non carbonated sugarcane juice beverage prepared by using treatment T23 (sugarcane juice 95%, lemon juice 3%, ginger juice 2 %) was found superior on sensory evaluation and scored 8 for overall acceptability and was further used as a control sample, while the non carbonated sugarcane juice beverage samples blended with juices of kinnow, aonla, lemon and ginger by using treatments of T11 (80% sugarcane juice, 10 % kinnow juice, 5 % aonla juice, 2 % lemon juice and 3 % ginger juice), T12 (80% sugarcane juice, 10 % kinnow juice, 5 % aonla juice, 2.5 % lemon juice and 2.5 % ginger juice) and T14 (75% sugarcane juice, 15 % kinnow juice, 5 % aonla juice, 2 % lemon juice and 3 % ginger juice) were scored high over the other treatments for all the parameters of sensory quality viz. appearance, mouth feel, aroma, taste, consistency and overall acceptability on sensory evaluation by judges of semi trained panel using 9 point hedonic scale. It was observed from Table 2 that the non carbonated sugarcane juice beverages were found highly acceptable due to the use of natural juices of sugarcane, kinnow, aonla, lemon and ginger with limited preservative. The sample of treatment T14 was found superior for all parameters of sensory quality on sensory evaluation by the semi trained panel using 9-point hedonic scale followed by the T11, T12 and T23 treatments. The treatment T23 is used as control for the further study of non carbonated sugarcane juice beverages as it contains only lemon and ginger juices with sugarcane juice. The other blends of T11, T12 and T14 contained sugarcane juice along with the kinnow, aonla, lemon and ginger juices. The best samples of non carbonated sugarcane juice beverages of treatments T23 (control), T11, T12 and T14 were chosen for further study. The samples of these treatments were prepared in bulk and stored for its further study of physicochemical characteristics, storage stability and microbial quality.

Table 2: Sensory evaluation of non carbonated sugarcane juice beverages

Treatment	Appearance	Mouth feel	Aroma	Taste	Consistency	Overall acceptability
T0	7.66	7.00	7.16	7.16	7.33	7.16
T1	7.66	6.33	7.50	7.00	8.00	6.33
T2	7.83	7.16	7.30	7.16	7.66	7.00
T3	7.16	7.73	7.50	6.83	7.50	7.50
T4	7.56	6.66	6.33	6.83	7.33	6.66
T5	7.50	6.33	7.50	6.66	7.33	6.66
T6	7.46	7.50	7.33	7.50	7.00	7.33
T7	7.63	7.50	7.33	7.50	7.33	7.33
T8	7.16	6.83	7.33	7.33	7.33	6.83
T9	7.50	6.83	7.16	6.50	7.53	7.16
T10	6.50	7.00	7.00	7.00	7.50	7.00
T11	8.16	8.00	8.00	8.33	8.00	8.16
T12	8.00	8.16	8.16	8.00	8.16	8.00
T13	7.83	7.83	7.33	7.33	8.16	7.83
T14	8.50	8.16	8.33	8.33	8.00	8.50
T15	7.83	7.33	8.00	7.83	7.66	7.66
T16	7.83	6.66	7.66	7.16	7.33	7.33
T17	6.83	6.50	7.50	6.66	6.83	7.33
T18	6.83	6.66	6.50	6.66	6.50	6.66
T19	7.33	6.50	6.66	6.83	6.66	6.66
T20	6.83	7.16	6.66	6.33	7.33	6.66
T21	7.83	7.00	6.83	7.66	7.60	7.33
T22	7.66	6.66	7.00	7.33	7.00	7.33
T23	8.00	8.00	7.83	8.00	7.33	8.00
CD at 5%	0.63	0.62	0.58	0.68	0.47	0.61

Physicochemical and phytochemical constituents of non carbonated sugarcane juice beverages

The non carbonated sugarcane juice beverages T23, T11, T12 and T14 were analyzed for physicochemical characteristics as depicted in Table 3 showed that total soluble solids were found higher (18.7 ^{0}B) in control sample than T11, T12 and T14. The per cent values for ash content, acidity, total sugars and reducing sugars of non carbonated sugarcane juice beverages T23, T11, T12 and T14 were 0.16, 0.52, 17.73, 0.44; 0.12, 0.47, 16.25, 0.54; 0.16, 0.65, 16.35, 0.56 and 0.17, 0.61, 15.78, 0.63, respectively. Also the values for the ascorbic acid (mg/100ml), antioxidant activity (mg/100ml), total polyphenols (mg GAE/100ml) and total flavonoids (mg QE/100ml) for respective beverages were observed as 4.3, 16.53, 16.62, 17.3; 53.2, 80.21, 80.7, 81.9; 496.6, 621.3, 624.2, 660.3; 5.22, 15.42, 15.3, 16.2, respectively. The viscosities (cp) were ranged between 3.55 to 3.84 and found significantly no differences. The mineral content values (mg/100ml) for the non carbonated sugarcane juice beverage samples viz. T23, T11, T12 and T14 were found at par and showed good amount of minerals in the beverages shown in Table 4. The mineral content values (mg/100ml) for all beverages were found in good amount as calcium (13.18 – 13.73), iron (1.45-1.52), potassium (43.23 – 51.77), sodium (4.37 – 4.97), phosphorus (24.01 – 24.17), sulphur (37.52 – 38.65), zinc (0.36- 0.39), magnesium (6.58 – 7.73), copper (0.09 – 0.11) and nickel (0.01).

Table 3: Physicochemical and phytochemical constituents of non carbonated sugarcane juice beverages

Parameters	Control (T23)	T11	T12	T13	CD at 5%
Moisture content (%)	80.96	81.64	81.69	81.68	0.14
Total solids (%)	19.03	18.36	18.30	18.31	0.14
TSS (^{o}Brix)	18.70	17.30	17.30	16.76	0.42
Ash (%)	0.16	0.12	0.16	0.17	0.01
Titratable acidity (%)	0.52	0.47	0.65	0.61	0.30
pH	2.42	2.56	2.37	2.39	0.09
Ascorbic acid (mg/100ml)	4.30	16.53	16.62	17.30	0.86
Antioxidant activity (% inhibition)	53.20	80.21	80.70	81.90	0.53
Total phenol (mg GAE/100ml)	496.6	621.3	624.2	660.30	0.16
Total flavonoids (mg QE/100ml)	5.22	15.42	15.30	16.20	0.14
Total sugars (%)	17.73	16.25	16.35	15.78	0.07
Reducing sugars (%))	0.44	0.54	0.56	0.63	0.02
Viscosity (cp)	3.60	3.62	3.84	3.55	NS

Table 4: Mineral content of the of non carbonated sugarcane juice beverages (mg/100ml)

Mineral	Non carbonated beverage				CD at 5%
	Control (T23)	T11	T12	T14	
Calcium	13.72	13.18	13.59	13.73	0.02
Iron	1.52	1.45	1.49	1.51	0.01
Potassium	43.23	45.14	49.5	51.77	0.47
Sodium	4.97	4.85	4.37	4.91	0.01
Magnesium	7.73	6.58	7.72	7.15	0.05
Copper	0.11	0.09	0.11	0.10	0.01
Phosphorous	24.17	24.01	24.11	24.14	0.02
Manganese	0.33	0.34	0.35	0.33	0.01
Zinc	0.36	0.39	0.37	0.38	0.01
Sulphur	38.65	37.64	38.53	37.52	0.05
Nickel	0.01	0.01	0.01	0.01	NS

The high quality and quantity nutrients in the non carbonated sugarcane juice beverages viz. T23, T11, T12 and T14, which made from juices only without addition of sugar and acids as sugarcane juice had sufficient sweetness and lemon juice was used as a source for acids, limited preservative (120ppm of sodium benzoate) used within permissible limit along with ginger as a natural preservative with use of natural source of ascorbic acid (kinnow, lemon, aonla) which made it highly acceptable. The taste was found highly acceptable during sensory evaluation.

Effect of storage period and storage temperature on sensory qualities of non carbonated sugarcane juice beverages

The effect of storage period on sensory qualities of non carbonated sugarcane juice beverages (T23, T11, T12 and T14) were studied for the 6 months at room (30±4 ^{0}C) and refrigeration (4 ^{0}C) temperature and the periodic observations were noted after each month. The data presented in Fig.1 showed that all the samples of non carbonated sugarcane juice beverages were found acceptable with slight decreased sensory score by semi trained panel during the storage of 6 months for all parameters viz. appearance, mouth feel, aroma, taste, consistency and overall acceptability though the beverages were found stable during the storage period.

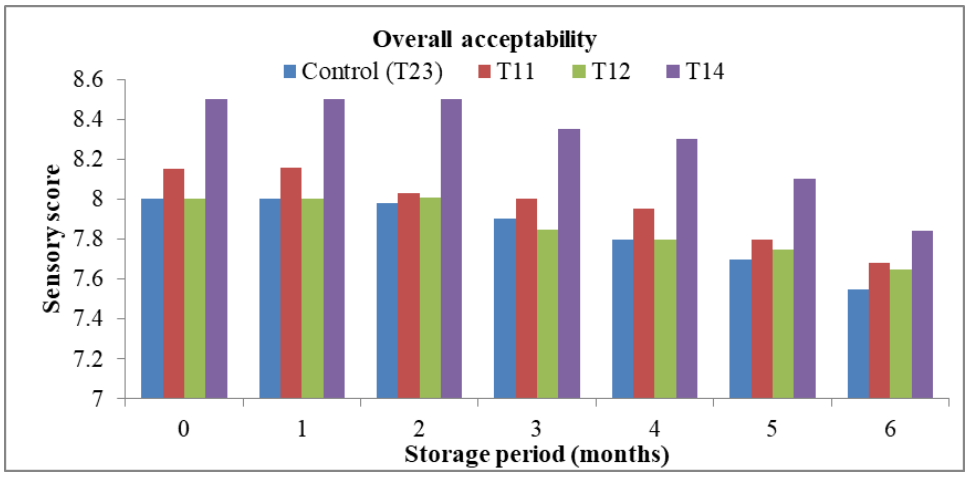

Fig 1: Effect of storage period on sensory qualities of non carbonated sugarcane juice Beverages

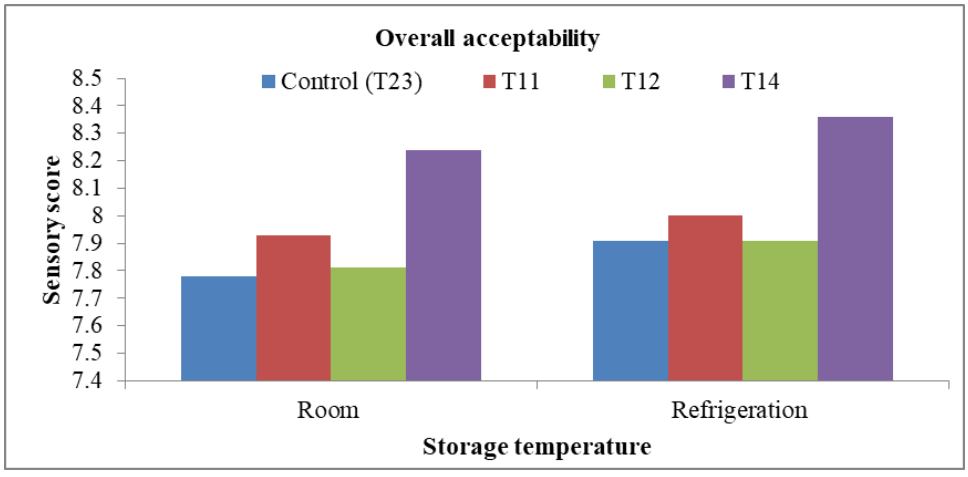

Fig 2: Effect of storage temperature on sensory qualities of non carbonated sugarcane juice beverages (6 months storage)

The effect of storage temperature both at room (30±4 ^{0}C) and refrigeration (4 ^{0}C) on sensory qualities of non carbonated sugarcane juice beverages depicted in Fig.2 showed that the beverages stored at refrigerated temperature scored slightly high for all the sensory parameters than the stored at room temperature. The non carbonated sugarcane juice beverages were found slightly superior in quality at refrigerated storage for 6 months over the storage at room temperature but both beverages were scored well on sensory evaluation.

Effect of storage period on physicochemical and phytochemical constituents of non carbonated sugarcane juice beverages

The effect of storage period and storage temperature on physicochemical characteristics of non carbonated sugarcane juice beverages (T23, T11, T12 and T14) during 6 months storage at room (30±4 ^{0}C) and refrigeration (4 ^{0}C) temperature is noted in Table 5. The observations showed that there was slight decrease in values of total soluble solids (1.6%), pH (3.63%), ascorbic acid (1.35%), total sugars (2.38%) and viscosity (1.71%) for all the beverages after 3 months during storage of 6 months. The values for titratable acidity and reducing sugars were increased 4.91% and 7.9%, respectively during the storage of 6 months. The values for the phytochemical viz. total polyphenol and total flavonoids were decreased by 20 per cent while the antioxidant activity was decreased by 25 per cent during the storage of six months. The same trend has been reported by Karpagavalli and Amutha (2015) [7]. The values for titratable acidity and reducing sugars were increased 4.91% and 7.9%, respectively during the storage of 6 months; however the beverages showed stability till 3 months while further storage slightly decreased the values. The products were found acceptable after six months storage.

Table 5: Effect of storage period on physicochemical and phytochemical constituents of non carbonated sugarcane juice beverages

Treatment	Storage period (months)						
	0	**1**	**2**	**3**	**4**	**5**	6
	Total soluble solids (^{0}B)						
Control (T23)	18.70	18.70	18.70	18.70	18.69	18.65	18.61
T11	17.30	17.30	17.30	17.25	17.20	17.15	17.00
T12	17.30	17.30	17.30	17.28	17.25	17.23	17.00
T14	16.76	16.76	16.72	16.62	16.40	16.37	16.35
CD at 5%	0.13						
	Titratable acidity (%)						
Control (T23)	0.52	0.52	0.52	0.52	0.53	0.55	0.56
T11	0.47	0.47	0.47	0.47	0.48	0.49	0.51
T12	0.65	0.65	0.65	0.65	0.66	0.67	0.68
T14	0.61	0.61	0.61	0.61	0.62	0.63	0.64
CD at 5%	NS						
	pH						
Control (T23)	2.42	2.42	2.42	2.41	2.40	2.39	2.37
T11	2.56	2.56	2.56	2.55	2.54	2.52	2.51
T12	2.37	2.37	2.37	2.36	2.35	2.22	2.00
T14	2.39	2.39	2.38	2.37	2.37	2.36	2.36
CD at 5%	NS						
	Ascorbic acid (mg/100ml)						
Control (T23)	4.30	4.22	4.00	3.38	3.36	3.34	3.32
T11	16.53	16.00	14.72	13.500	13.00.	12.60	12.35
T12	16.62	16.20	15.60	14.80	14.01	13.20	12.44
T14	17.30	16.60	16.00	15.20	14.50	13.90	12.78
CD at 5%	0.02						
	Total polyphenols (mg GAE/100ml)						
Control (T23)	496.6	473.22	458.31	442.00	426.22	413.20	396.21
T11	621.3	604.23	585.52	569.32	548.00	526.30	492.00
T12	624.2	605.23	585.52	564.22	543.33	519.65	498.32
T14	660.30	640.00	618.34	595.11	574.42	552.10	531.21
CD at 5%	0.08						
	Total flavonoids (mg QE/100ml						
Control (T23)	5.22	5.02	4.82	4.63	4.55	4.36	4.20
T11	15.42	14.90	14.41	13.95	13.82	12.63	12.41
T12	15.30	14.81	14.31	13.82	13.32	12.81	12.38
T14	16.20	15.50	14.20	14.13	13.40	13.24	12.98
CD at 5%	0.03						
	Antioxidant activity (% inhibition of DPPH)						
Control (T23)	53.20	50.10	47.32	45.25	43.20	41.10	38.99
T11	80.21	77.20	74.21	71.65	69.54	64.35	60.88
T12	80.70	77.80	74.56	71.00	68.24	64.50	61.20
T14	81.90	78.52	75.31	71.50	68.75	64.37	61.50
CD at 5%	0.01						
	Total sugars (%)						
Control (T23)	17.73	17.73	17.73	17.72	17.71	17.67	17.63
T11	16.25	16.25	16.25	16.20	16.10	15.85	15.80
T12	16.35	16.35	16.35	16.25	16.20	15.93	15.80

Treatment	Storage period (months)						
	0	1	2	3	4	5	6
T14	15.78	15.78	15.78	15.65	15.50	15.40	15.30
CD at 5%	0.04						
	Reducing sugars (%)						
Control (T23)	0.44	0.44	0.44	0.44	0.45	0.47	0.49
T11	0.54	0.54	0.54	0.55	0.56	0.57	0.58
T12	0.56	0.56	0.56	0.57	0.58	0.59	0.61
T14	0.63	0.63	0.63	0.64	0.65	0.66	0.68
CD at 5%	NS						
	Viscosity(cp)						
Control (T23)	3.60	3.60	3.60	3.59	3.58	3.54	3.52
T11	3.62	3.62	3.62	3.61	3.60	3.59	3.57
T12	3.84	3.84	3.84	3.83	3.82	3.81	3.80
T14	3.55	3.55	3.55	3.53	3.52	3.50	3.47
CD at 5%	0.02						

Effect of storage temperature on physicochemical and phytochemical constituents of non carbonated sugarcane juice beverages

It was observed from table 6 that, the all treatments (T23, T11, T12 and T14) beverages stored at refrigerated temperature depicted slightly high values for all physicochemical parameters than the samples stored at room temperature. The non carbonated sugarcane juice beverages were found slightly superior in quality those stored at refrigerated storage for 6 months over the storage at room temperature but both beverages showed statistically non significant changes in the values of all parameters. The values for physicochemical parameters of T23, T11, T12 and T14 beverages stored at room and refrigerated temperature were found as total soluble solids (18.99, 17.2, 17.23, 16.5 and 19.05, 17.27, 17.28, 16.63), titratable acidity (0.53, 0.49, 0.66, 0.63 and 0.52, 0.48, 0.65, 0.62), pH (3.4, 3.53, 3.27, 3.37 and 3.41, 3.55, 3.32, 3.38), total sugars (17.69, 16.02, 16.12, 15.51 and 17.71, 16.13, 16.21, 15.69), reducing sugars (0.46, 0.56, 0.57, 0.65 and 0.45, 0.54, 0.56, 0.54) and viscosity (3.57, 3.6, 3.82, 3.52 and 3.58, 3.61, 3.83, 3.53), respectively. The values for the phytochemical viz. total polyphenol showed 20 % loss of polyphenols at room temperature while 18 per cent loss was observed at refrigeration storage for six months. The total flavonoids were decreased by 20 per cent both at room and refrigerated storage while, while the antioxidant activity was decreased by 25 per cen at room temperature and 20 per cent at refrigerated storage of six months. The same trend has been reported by Karpagavalli and Amutha (2015) [7].

Table 6: Effect of storage temperature on physicochemical and phytochemical constituents of non carbonated sugarcane juice beverages (6 months storage)

Storage temperature	Carbonated beverage			
	Control (T23)	T11	T12	T14
	Total soluble solids (^{0}B)			
Room	18.99	17.20	17.23	16.50
Refrigeration	19.05	17.27	17.28	16.63
CD at 5%	0.06			
	Titratable acidity (%)			
Room	0.53	0.49	0.66	0.63
Refrigeration	0.52	0.48	0.65	0.62
CD at 5%	NS			
	pH			
Room	3.40	3.53	3.27	3.37
Refrigeration	3.41	3.55	3.32	3.38
CD at 5%	NS			
	Ascorbic acid (mg/100ml)			
Room	3.32	12.35	12.44	12.78
Refrigeration	3.53	12.54	12.63	12.81
CD at 5%	NS			
	Total polyphenols (mg GAE/100ml)			
Room	396.21	492.00	498.32	531.21
Refrigeration	404.10	502.40	509.52	540.35
CD at 5%	0.02			
	Total flavonoids (mg QE/100ml)			
Room	4.20	12.41	12.38	12.98
Refrigeration	4.21	12.43	12.40	12.99
CD at 5%	NS			
	Antioxidant activity (% inhibition of DPPH)			
Room	38.99	60.88	61.20	61.50
Refrigeration	40.88	64.32	64.55	64.67
CD at 5%	0.01			
	Total sugars (%)			
Room	17.69	16.02	16.12	15.51

Storage temperature	Carbonated beverage			
	Control (T23)	T11	T12	T14
Refrigeration	17.71	16.13	16.21	15.69
CD at 5%	NS			
	Reducing sugars (%)			
Room	0.46	0.56	0.57	0.65
Refrigeration	0.45	0.54	0.56	0.54
CD at 5%	NS			
	Viscosity (cp)			
Room	3.57	3.60	3.82	3.52
Refrigeration	3.58	3.61	3.83	3.53
CD at 5%	0.01			

Effect of storage period and storage temperature on microbiological quality of non carbonated sugarcane juice beverages.

It was observed from table 7 that the total plate count was absent in the non carbonated sugarcane juice beverages up to 5 months storage both at room and refrigerated temperatures, while the treatment T23 and T11 showed the value for total plate count (cfu/ml) of 5 and 3 after the storage of five month, while 12 and 7 after six months storage at room temperature. The treatment T12 showed 3 cfu/ml after six months storage at room temperature. The total plate count was found absent in all the treatments stored at refrigerated temperature. The total plate count in the samples of all treatments was found far below the prescribed limit of FSSAI law. The yeast and mould count was found absent in all the treatments at both the temperatures of storage. It is observed that all the treatments were found storage stable during the storage of 6 months as the ascorbic acid content and acidity due to lemon and citrus fruit juices, also the presence of ginger juice in the beverages. The beverage also possessed stability due to the presence of prescribed limit of preservative (sodium benzoate 120ppm). The samples stored at low temperature had better stability than stored at room temperature.

Table 7: Effect of storage period and storage temperature on microbiological quality of non carbonated sugarcane juice beverages

Treatment	Storage period (months)													
	0		1		2		3		4		5		6	
	RT	RF	RT	RF	RT	RF	RT	RF	RT	RF	RT	RF	RT	RF
	Total plate count (cfu/ml)													
T23(Control)	-	-	-	-	-	-	-	-	-	-	5	-	12	-
T11	-	-	-	-	-	-	-	-	-	-	3	-	7	-
T12	-	-	-	-	-	-		-	-	-	-	-	3	-
T14	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Yeast and Mould count (cfu/ml)													
T23(Control)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T11	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T12	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T14	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Conclusion

The healthy non carbonated sugarcane juice beverages were made by blending nutritious juices of kinnow, aonla, lemon and ginger without external addition of sugar and acids. Sugarcane juice had sufficient sweetness and lemon juice was used as a source for acids, with use of limited preservative (120ppm of sodium benzoate) within permissible limit along with ginger as a natural preservative, also use of natural sources of ascorbic acid (kinnow, lemon, aonla) helped to stabilize the beverage and which made it highly acceptable. The blending with fruit juices enriched the phytochemical compounds and mineral content in the beverages. The beverages were found slightly superior in quality at refrigerated storage for 6 months over the storage at room temperature but both beverages were found acceptable on sensory evaluation. Hence the nutritious beverages from sugarcane juice blended with natural juices would be the boon for the healthy nation and sector of soft drink industry.

References

1. Anonymous India stats- socio-economic statistical information about India, agricultural production. 2016. https:www.indiastat.com/agriculture/2/agricutural production/225/stats.aspx.
2. AOAC. Official Methods of Analysis. Association of Official Analytical Chemists International, 16th ed. Edited by Patricia Cuniff, Virginia, USA. Test. 1995, 17.2.01:3-4.
3. AOAC. Official Methods of Analysis. Association of Official Analytical Chemists, 18th ed. Washington, D.C. USA., 2005.
4. Brand-Williams W, Cuvelier ME, Berset C. Use of free radicals method to evaluate antioxidant activity. Lebensm Wiss Technol - Food Sci Technol., 1995, 28, 25-30.
5. Dubois M, Gilles KA, Hamilton JK, Rebers PA, Smith F. Colorimetric method for determination of sugars and related substances. Anal Chem. 1956; 28:350-56.
6. Karthikeyan J, Samipillai SS. Sugarcane in therapeutics. J Herb Medicin Toxicology. 2010; 4:9-14.
7. Karpagavalli B, Amutha, S. Influence of storage condition on the antioxidant activity of pomegranate squash. Plant Archives. 2015; 15:405-10.
8. Khurdiya DS. Preparation of lime juice for carbonated drink. J Food Sci Technol. 1988; 25:315-16.
9. Larmond E. Methods of sensory evaluation of food. Can Deptt Agri Pubs., 1970, 1284.
10. Marinova D, Ribarova F Atanassova M. Total phenolics and total flavonoids in Bulgarian fruits and vegetables. J Univ Chem Technol Metallurgy. 2005; 40:255-60.

11. Nelson NA. photometric adaptation of the Somogyi method for the determination of glucose. J Biol Chem. 1944; 153:375-80.
12. Ranganna S. Handbook of Analysis & Quality Control for Fruit and Vegetable Products, Tata McGraw Hill Publishing Co. Ltd., New Delhi, India., 2015.
13. Singleton VL, Rossi JA. Colorimetry of total phenolics with phosphomolybdic- phoshotungustic acid reagents. Amer J Enol Viticult. 1965; 16:144-58.
14. Somogyi M. Notes on sugar determination. J Biol Chem. 1952; 195:19-23.
15. William WB, Cuvelier E, Berset CM. Use of free radicals method to evaluate antioxidant activity. LWT- Food Sci Technol. 1995; 28:25-30.