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## Development and storage study of antioxidants rich cashew apple lemon blend ready serve beverage

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**Abstract**

The cashew apple despite its high nutrient profile is still in sorry status of its utilization in value added products due to processing unawareness, tannin content and appealing smell. For each unit of raw cashew nut six to eight fold heavy cashew apple is produced. To get rid of astringency due to tannins the concentration of cashew apple juice in the final product was so adjusted that it will naturally bring down the concentration of tannins below threshold value through optimum dilution with water. For the development of ready to serve nectar (RTS Nectar) extracted cashew apple juice (20%) was blended with different concentrations of lemon juice and found 3% lemon juice blend to be more acceptable through sensory analysis and nutrient compositions. Lemon juice was found to be able to mask the objectionable smell of cashew apple positively. Cashew apple RTS without lemon juice and one commercial lemon RTS were used for comparison with cashew apple lemon blended RTS Nectar. The antioxidant activity (DPPH Scavenging Activity) of organoleptically accepted combination of CAJ-lemon blend RTS was significantly higher (281.6 μmoles/15min/100 μl juice) than the non-blended cashew apple RTS (203.8 μmoles/15min/100 μl juice) and commercial lemon juice RTS (117.0 μmoles/15min/100 μl juice). Similar trend was observed in case of vit-C content, where in CAJ-lemon blend RTS contained 75mg/100ml of vit-C where as non-blended RTS and commercial lemon juice RTS contained 68.0 and 13.2 mg/100ml of vit-C respectively. Total phenolic content of CAJ-lemon blend RTS was found almost two fold higher (0.06%) than non-blend (0.04%) and commercial lemon juice RTS (0.02%). The significant improvement in the shelf life of the beverage was recorded (150 DAS) due to synergistic effect of 70 ppm KMS and refrigeration temperature during storage over the one stored at refrigeration temperature without KMS (90 DAS).

**Keywords:** Cashew apple processing, RTS, nectar, antioxidant activity, microbial stability

**Introduction**

India being one of the leading producer of raw cashew nut with current annual harvest of 7.28 lakh tonnes and cashew apple as a major by-product of cashew industry is produced simultaneously about 60 lakh tonnes per annum [1]. For each unit of raw cashew nut six to eight time's heavy cashew apple is produced. Cashew nut is naturally endowed with delicious taste and equally high market potential but at other hand the cashew apple is in sorry status of its utilization despite high nutritional value. Cashew apple is a tropical fruit with 85% juice and also rich in vitamins and minerals with 8-11 % of fermentable sugars and 260 to 340 mg/100 g of Vitamin C, which is almost six times that of citrus fruits (40 mg/100g) [2, 3] and almost ten times more than that of pineapple, an important customary tropical fruit. Cashew apple juice is sweet and nutritious, but has astringency owing to its tannins content (0.2-0.3%), which makes it less palatable and limits processing and marketability. Defatted soybean meal at the rate of 2% at 4°C for 4 hrs found to be effective (34.3%) in tannin reduction with 89.5% juice recovery [4]. Furthermore the tannin removal can be achieved by soaking cashew apples in 2% sodium chloride containing 500 mg potassium metabisulphite in a litre of water [5], by using polyvinyl pyrrolidone (PVP) [6] and sago [7].

Considering the fact that cashew apples are highly nutritious and harvested over a period of 4 - 5 months during a year, its use as a raw material for a variety of fruit-based products can prompt revolution in cashew industry and more importantly will improve the livelihood of cashew farming community by generating the extra revenue through its sale [8]. Cashew apple can be processed as wine, gin, brandy, RTS, syrup, vinegar and jam some of which are being produced in commercial scale in Brazil, India and Mozambique [9].

In the present study the efforts are made to develop a highly nutritious and palatable ready to serve beverage from cashew apple juice by blending lemon juice to mask the little offensive smell of cashew apple [10]. Ten released varieties and one accession were screened for their suitability in beverage preparation and selected those with maximum TSS and Vitamin C, less tannin content and maximum juice recovery.

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Five varieties namely Vengurla-3, Accession-301, Dhana, Bhaskara and Ullal-3 were found to be more suitable for the preparation of RTS beverage in terms of overall acceptability through organoleptic evaluation and nutritive value with major focus on antioxidant value of final product to call it as a functional food beverage.

The threshold value for the sensation of astringency of tannins is 0.1% [11]. Below this concentration astringency cannot be sensed. The concentration of cashew apple juice in the final product was so adjusted that it will contribute maximum to the nutritional value of the product and naturally bring down the concentration of tannins below threshold value through optimum dilution with water. Blending with lemon juice resulted in to a delightful and delicious beverages with improved organoleptic quality and nutritive value as well. Keeping in view the nutritive and health benefits of cashew apple and lemon, the present product is developed where lemon possess bland taste and cashew apple can serve as the best functional food. Since portion of the pure fruit juice content of the beverage is more than 20%, the product falls in the category of "Ready to Serve Nectar" (RTS Nectar) beverage in food technological terms. Organoleptic evaluation of cashew-lemon blended RTS nectar was carried out using nine-point scale by semi-trained panel [12]; most acceptable beverage was selected for storage study. Selected beverage was stored under refrigerated conditions for a period of three months and the beverage was analysed for chemical, sensory and microbial qualities.

#### Material and methods

**Reagents and standards:** All chemicals used in this experiment were of analytical grade. Standards used Gallic acid (G7384, 98% purity), BHT (B1378, 99% purity) and Sesamol (S8518, 99% purity) all were from Himedia (Mumbai, India).

**Variety Screening:** Ten released varieties and one accession were screened for their suitability in beverage preparation and selected those with maximum TSS and Vitamin C, less tannin content and maximum juice recovery. Five varieties namely Vengurla-3, Accession-301, Dhana, Bhaskara and Ullal-3 were found to be more suitable for the preparation of RTS beverage.

#### Extraction of juice

Fully ripe cashew apples of selected screened varieties collected from the plantations at National Research Centre for Cashew, Puttur. The cashew apples were washed, followed by cutting in to 2-4 halves (stem end and nut end were discarded). The halves were fed to pulper and obtained pulp is strained in through four fold muslin cloth. Depending upon the extent of suspended particles the juice was allowed to settle for 2-4 hours at refrigeration temperature (4°C). Leaving the sediments at the bottom the juice was decanted and used for product preparation. Similarly the lemon juice was obtained from fresh and firm yellow lemons.

#### RTS Preparation

The cashew lemon blended RTS was formulated using following combinations of cashew apple juice (%): lemon juice (%) as A (20:0), B (20:6), C (20:5), D (20:4), E (20:3) F (20:2). To make out the difference in the palatability and overall acceptance, a control sample (A) product was prepared from the cashew apple juice only and compared with the RTS prepared by blending lemon juice with different levels of concentration keeping cashew apple juice content same in all the preparations. To overcome the little flat

aftertaste all the formulations were added with 0.250g citric acid per litre of the cashew apple juice. The concentration of citric acid was determined by conducting a small trial of experiments. The final quantity of the RTS was made by adding sugar (10<sup>0</sup>Bx) and water as per the recipe and the mixture was pasteurized and filled in PET bottles with food grade colour and 70 ppm KMS as a preservative.

#### Biochemical Chemical Analysis

The prepared cashew apple- lemon blended RTS were analyzed initially for the various parameters of TSS, titrable acidity, pH and Total sugar using AOAC methods [13]. Antioxidant activity of fresh cashew apple juice, cashew apple lemon blend RTS, RTS from cashew apple juice only and one commercial same category beverage for comparison was determined by DPPH scavenging assay [14]. The concentration of phenolics and tannins in the juice was determined using spectrophotometric (Folin-Ciocalteu's) method [15]. TSS of the juices was determined by hand refractometer (ERMA). Vitamin C content was measured by 2, 6- Dichlorophenol – Indophenol visual titration method [16].

**Antioxidant activity:** Fresh cashew apple juice, cashew apple RTS without lemon juice, commercial lemon RTS and cashew apple lemon blended RTS Nectar were allowed to stand for at 12 h at 4°C after addition of 5 mg of gelatine /10 ml juice. The free radical scavenging potential of the sample was checked by DPPH method. The sample was tested against a methanolic solution of 1,1 diphenyl 2-picryl hydrazyl (DPPH) [17]. Concentration of the samples was in the range 0.5 – 5 µg/ml, which was incubated with 100 µM free radical for 20 min at 25°C in dark. The degree of discoloration indicates the scavenging potential of the antioxidants. The change in absorbance at 517 nm was used as a measure of antioxidant activity. Methanol was used for blank.

#### Sensory Analysis

In sensory evaluation, different sensory characteristics such as colour, taste, aroma, appearance and overall acceptability attributes, was conducted by semi-trained panellists [18] using 9 point hedonic scale, where score 1 is for "dislike extremely" and 9 for "like extremely".

#### Microbial Analysis

The prepared beverage formulation was studied for microbial load. The total microbial load was calculated by standard plate count method. The standard plate count was done according to the method described in "Recommended method for the microbiological examination of food" [19]. The microbial analysis of the cashew apple lemon blend RTS Nectar was performed at the interval of 30, 60, 90, 120, 150 and 180 days after storage (DAS) at room temperature and refrigerated storage (10°C) with and without addition of permitted chemical preservative.

#### Storage Study

The RTS was stored at refrigerated temperature conditions (4°C) to study the storage behaviour of the cashew lemon blended RTS with respect to the changes in chemical and sensory qualities [20] during storage. The blended RTS was evaluated immediately after preparation and at an interval of 30 days up to 150 days after storage.

#### Statistical Analysis

To test the significance of results Completely Randomized Design (CRD) was used. The data obtained in the experiments

were recorded and analyzed statistically using analysis of variance technique (ANOVA) to determine statistical significance of treatments [21].

## Result and Discussion

### Screening of Cashew Apple Varieties for biochemical Composition

Eleven released varieties were analyzed for their biochemical

parameters and presented in table 1. Out of eleven varieties selected for study, five varieties viz., Vengurla-3, NRCC-301, Dhana, Bhaskara and Ullal-3 found to be suitable for the preparation of RTS beverage in terms of overall acceptability through organoleptic evaluation and biochemical composition. It was also concluded that the varieties having TSS more than 9<sup>0</sup>Bx and tannin content less than 0.6% are suitable for making such beverage.

**Table 1:** Screening of Cashew Apple Varieties based on biochemical composition

Variety	Colour	Mean apple Weight (g)	Mean Juice Content (%)	Mean TSS (°B)	Mean Tannin (mg/g)	Mean Vitamin C (mg/100g)	Mean Acidity (g/100ml)
Bhaskara	Red	68.5	61.5	8.5	0.60	73.24	0.43
Madakkathara - 2	Red	79.0	63.5	10.0	0.51	68.90	0.59
Ullal-3	Red	70.0	60.0	10.5	0.39	73.54	0.29
Vengurla -4	Red	73.5	58.0	9.5	0.48	71.09	0.37
NRCC-301	Red	132.0	69.5	9.0	0.50	68.08	0.27
NRCC Selection-2	Red	71.0	65.0	11.0	0.68	63.80	0.48
Dhana	Yellow	73.0	61.0	9.0	0.63	59.72	0.40
Priyanka	Yellow	113.0	69.0	10.5	0.39	87.37	0.41
VTH-174	Yellow	79.0	48.0	11.5	0.66	65.87	0.52
Kanaka	Yellow	63.0	50.0	12.0	0.58	63.28	0.39
Vengurla-3	Yellow	72.0	56.0	10.5	0.41	76.35	0.40

n= 3

### Organoleptic Evaluation of Cashew Lemon Blend RTS

The organoleptic analysis of Cashew blended RTS is depicted in table 2. From the table is clearly viewed that among the blended RTS, sample E (20:3) has obtained max score for

color and flavour 7.6, astringency 7.8, taste 8.2 and overall acceptability 7.9 while control sample A (20:0) has received minimum score for color (3.9), flavour (4.5), Astringency (5.4), taste (4.9) and overall acceptability (4.5).

**Table 2:** Organoleptic evaluation of Cashew apple- Lemon blend RTS

Sample Code	Colour	Flavour	Astringency	Taste	Overall Acceptability
A (Only CA Juice)	3.9	4.5	5.4	4.9	4.5
B	4.9	5.1	5.7	5.0	5.0
C	4.7	4.4	5.4	5.7	5.2
D	6.2	6.4	6.7	7.0	6.4
E	7.6	7.6	7.8	8.2	7.9
F	6.1	6.2	6.4	6.6	6.4
SEd	0.5538	0.4480	0.5544	0.4753	0.3839
CD (.05)	1.1103	0.8983	1.1116	0.9530	0.7697
CD(.01)	1.4796	1.1971	1.4814	1.2700	1.0258
CV%	22.24	17.58	19.89	17.05	14.55

(Nine point hedonic scale where, score 1: Disliked Extremely; 9: Liked Extremely)

### Nutritional value and functional properties of the product compared with fresh juice, RTS without lemon juice and a commercial lemon RTS

Comparative nutritional value and functional properties of the CA-Lemon blended RTS and commercial lemon RTS is presented in Table 3. It is clearly understood that the RTS prepared from the selected combination of juices found to be superior to RTS prepared using cashew apple juice only. Moreover, the product could retain maximum ascorbic acid (75.9 mg/100ml) and total phenolics (0.06%) over RTS without lemon juice (68.0 mg/100ml and 0.04 %) and commercial lemon RTS (13.2 mg/100ml and 0.02 %). Tannin content (86.62mg/100ml) of the product was found below

threshold level of sensation of astringency ( $\leq 0.1\%$ ) which confirms that at this concentration the product do not give an astringent taste. Presence of sufficient amount of ascorbic acid, tannins and phenolics made the product more functional than the traditional one, DPPH Scavenging activity of the selected combination was greater (281.6  $\mu\text{moles}/15\text{min}/100 \mu\text{l}$  juice) than the product prepared only from cashew apple juice (203.8  $\mu\text{moles}/15\text{min}/100 \mu\text{l}$  juice) and commercial lemon RTS (117.0  $\mu\text{moles}/15\text{min}/100 \mu\text{l}$  juice) (Table 3). This is attributed to additional antioxidants in the product due to the presence of 3% lemon juice unlike the control. The trend of the nutritional value was same that of Chauhan *et al.* [22]

**Table 3:** Nutritional value and functional properties of the product compared with fresh juice and RTS without lemon juice

S. No.	Parameter	Raw Juice	RTS Without Lemon Juice	Cashew Apple- Lemon Blend RTS	Commercial Lemon RTS
1.	TSS ( <sup>o</sup> Bx)	11.5	10.0	10.0	10.0
2.	Ascorbic acid (mg/100ml)	330.0	68.0	75.9	13.2
3.	Tannin (mg/100ml)	289.0	90.86	86.62	3.7
4.	Total phenol (%)	0.28.0	0.04	0.06	0.02
5.	DPPH Scavenging Activity ( $\mu$ moles/15min/100 $\mu$ l juice)	1184.2	203.8	281.6	117.0
6.	Acidity (%)	0.48	0.33	0.38	0.46
7.	Carbohydrates (%)	14.05	13.02	13.06	13.0
8.	Sugars (%)	12.04	11.04	12.06	12.02
9.	Protein (%)	0.18	----	----	----
10.	Fat (%)	0.09	----	----	----
11.	Energy (Kcal/100ml)	51	47	51	50

**Microbial evaluation of cashew apple lemon blend RTS:**

The preparation with 70 ppm potassium metabisulphite (KMS) at room temperature remained safe for 60 days over the one without added KMS (30 DAS). The significant improvement in the shelf life of the beverage was recorded

(150 DAS) due to synergistic effect of 70 ppm KMS and refrigeration temperature during storage over the one stored at refrigeration temperature without KMS (90 DAS) (Table: 4). The results are in accordance with the findings of Ramachandran and Nagarajan [23].

**Table 4:** Microbial evaluation of cashew apple lemon blend RTS

Duration of Storage	Standard Plate Count (CFU/ml) at Different Storage Temperatures			
	Room Temperature (without KMS)	Room Temperature (70 ppm KMS)	Refrigeration (10 <sup>o</sup> C without KMS)	Refrigeration (10 <sup>o</sup> C with 70 ppm KMS)
0 DAS	ND	ND	ND	ND
30 DAS	ND	ND	ND	ND
60 DAS	2 x 10 <sup>2</sup>	ND	ND	ND
90 DAS	40 x 10 <sup>3</sup>	4 x 10 <sup>2</sup>	ND	ND
120 DAS	-----	16 x 10 <sup>3</sup>	3 x 10 <sup>3</sup>	ND
150 DAS	-----	-----	26 x 10 <sup>4</sup>	ND
180 DAS	-----	-----	-----	6 x 10 <sup>2</sup>

**Storage study of Cashew lemon RTS under refrigerated conditions**

Table 4 depicts the synergistic effect of low temperature (4<sup>o</sup>C) storage and use of permitted preservative (70 ppm KMS). It was clearly seen that there is no significant loss in the nutrients under check except Vitamin C reduced down to

282 mg/100ml from 338 mg/100ml. The results obtained also justified the findings of microbial studies with respect products shelf life. The findings were quite similar to Ullah *et. al.* [24] where they worked on preservation of ready to serve blended carrot and kinnow (Mandarin) drink.

**Table 5:** Storage study of Cashew lemon RTS under refrigerated conditions

Storage Time (Months After Storage) at 4 <sup>o</sup> C	Color	TSS ( <sup>o</sup> Bx)	Vitamin C (mg/100ml)	Tannins (mg/100ml)	Phenols (%)
0 MAS	Lemon Yellow	11.5	338	394	0.36
1 MAS	No Change	11.6	330	393	0.34
2 MAS	No Change	11.3	316	391	0.34
3 MAS	No Change	11.4	310	390	0.33
4 MAS	No Change	11.5	290	388	0.33
5 MAS	No Change	11.5	282	388	0.32

**Conclusion**

Use of 3% lemon juice could successfully masked the objectionable cashew apple smell and improved the product overall acceptance. A RTS beverage with high antioxidant value stood microbiologically and biochemically stable due to synergistic activity of low temperature (4<sup>o</sup>C) during storage and with added preservative (70ppm KMS) and product has a market potential towards commercialization as functional food beverage.

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