



## Preservation and Shelf life Extension of Cashew Apple Juice

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### Abstract

*The fleshy cashew apples are highly nutritious and consist of complex mixture of vitamins, polyphenols, sugars, minerals, organic acids and amino acids. These are regarded as an excellent source of vitamin C, which is six times more than an orange and twelve times that of the pineapple. Although cashew fruits are available in abundance, their utilization is limited due to astringency and rapid microbial deterioration. In the present paper an attempt was made to investigate a combined method for preservation of cashew apple juice with an intention to reduce the astringency and microbial count, thereby prolonging shelf life of the juice. The devised method combines the effects of clarification, sterile filtration and chemical preservation. The juice quality was analyzed for sensory attributes, physico-chemical parameters and microbial count at an interval of 15 days. The experimental data was statistically analyzed using STATISTICA 6.0. The results revealed that the juice can be preserved safely under refrigeration upto three months.*

**Key words:** Cashew apple juice, Clarification, Sterile filtration, Chemical preservatives, Shelf life.

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### Introduction

Cashew, *Anacardium occidentale* L. (Anacardiaceae), is a hard, drought-resistant, tropical tree, widely grown primarily for its nuts. Cashew apple, the pseudo-fruit, is fibrous, juicy and weighs approximately 6-8 times of the nut. For every ton of raw-nut produced, 10 tons of apples are obtained, which are not commercially exploited (Bhat et al. 2010). Cashew apples are quite nutritious, rich in polyphenols, minerals, organic acids, carbohydrates, pigments and vitamins mainly vitamin C (170-350 mg/100 g) (Chempakam 1983). These are found to possess anti-microbial and anti-mutagenic activities (Kubo et al. 1993; Melo-Cavalcante et al. 2003). The juice can be utilized as substrate for the production of dextransucrase, ethanol, biosurfactant, hyaluronic acid, mannitol and many other value added products (Chagas et al. 2007; Pinheiro et al. 2008; Rocha et al. 2006; Oliveira et al. 2005; Fontes et al. 2009).

Besides its nutritional importance, therapeutic properties and value-added applications, around 90 % of the harvest

gets wasted (Azevedo and Rodrigues 2000) and the remaining 10 % of harvested cashew apple is either consumed as fresh or processed industrially into a variety of products such as juices, syrups, canned fruits, pickles, jams, chutneys, candies, toffees, ice creams, vinegar, marmalade and distilled products (Maciel et al. 1986; Nanjundaswamy et al. 1985; Ogunsina and Lucas 2008). The wastage of cashew apples is mainly attributed to short shelf life and rapid microbial action. Unlike other fruit juices, the juice extracted from cashew apple cannot be consumed due to its characteristic astringent taste, which causes biting sensation of the tongue and throat. In order to decrease astringency and to prevent spoilage, it is essential to investigate a suitable method for the preservation of cashew apple juice. Various methods of cashew apple juice preservation and shelf life evaluation have been reported by many scientists. Hot fill and aseptic methods were efficient in maintaining physico-chemical characteristics of the juice upto twelve months (Costa et al. 2003). Clarified cashew apple juice along with tannase treatment stored at 4°C was stable for two months (Campos et al. 2002). Jatto and Adegoke (2010) preserved cashew apple juice using aqueous extract (hot and cold) of *Aframomum danielli* and observed

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reduction in the vitamin C content and sugars after two weeks. Azoubel et al. (2009) used a combined method of preservation i.e., drying of cashew apples with osmotic dehydration and observed that osmotic pretreatment was efficient in reducing water activity but was not effective in protecting the juice from oxidation. Another study focused on the microbial inactivation by high hydrostatic pressure of 400 MPa for 3 min at 25°C and the juice quality was stable for 8 weeks under refrigeration (Lavinias et al. 2008). It was found that no single method of juice clarification or preservation were efficient in increasing shelf life while decreasing astringency and microbial count. The present study was carried out to investigate the effect of clarification, sterile filtration and chemical preservation of cashew apple juice stored at 4°C.

### Material and Methods

**Procurement and processing of cashew apples.** Cashew apples were collected from the local agricultural farm at Yendada village, Visakhapatnam. Fresh, juicy, good quality cashew apples were sorted for processing. The fruits were weighed, washed thoroughly under tap water followed by distilled water to remove foreign materials and then soaked in preservative solution (1 ppm potassium metabisulphite) until juice extraction. The juice was extracted, filtered through sterilized muslin cloth and a yield of 780 ml/kg was obtained.

**Processing of cashew apple juice.** Clarifying agent, 2 g/L sago (optimum concentration) was added and allowed for precipitation of tannins for 12 hrs at 4 °C. The juice was then filtered using a series of filters, Whatman and Millipore membrane filters of pore size 0.44 µm and 0.22 µm under sterile environment. To the clarified juice, chemical preservatives, citric acid and benzoic acid at a concentration of 0.1 g/L each were added and transferred to sterilized glass bottles. Replicate samples were refrigerated and analyzed for juice quality at an interval of 15 days. Fresh cashew apple juice was used as the control sample.

**Shelf life study.** The shelf life of the juice is studied in terms of sensory, physico-chemical and microbiological quality.

**Sensory analysis.** Sensory evaluation of the preserved juices was judged for colour, flavor, taste, sedimentation and overall acceptability on a nine-point hedonic scale, varying from “dislike extremely” (score 1) to “like extremely” (score 9) was used, according to Stone and Sidel (1992). An informal panel of 10 untrained testers carried out the acceptance tests in the morning shift (9:30–11:30 am) under white light. Samples, one per tester, were served in transparent glass cups.

**Physico-chemical analysis.** pH of the juice was measured using digital pH meter (ELICO L1 614 pH analyser) and expressed as pH units. Total soluble solids (TSS) as % Brix was determined using digital ATAGO refractometer (ATAGO, PAL-Maple Pocket type). Colour was

determined by measuring absorbance at 420 nm and clarity as percent transmission at 660 nm using dual beam UV-VIS spectrophotometer (ELICO BL-198). Total titratable acidity as % malic acid was determined by titration using 0.1N sodium hydroxide and phenolphthalein indicator solution and tannins as % tannic acid were estimated by Folin-Denis method, as recommended by Ranganna (1986). Viscosity in centipoise was determined using Ostwald’s viscometer. Vitamin C content as mg/100 ml, total and reducing sugars as % were determined using Dichlorophenol Indo Phenol (DCPIP), phenol sulphuric acid and Di Nitro Salicylic acid (DNS) methods respectively as described in Sadasivam and Manickam (2008). Phenols were determined using Folin-Ciocalteu colorimetric methodology as described by Waterhouse (2002) and expressed as mg gallic acid equivalents/100 ml. Polyphenol oxidase activity was measured according to Sigma quality control test procedure and represented as Units/mg enzyme.

**Microbiological analysis.** Nutrient agar and Rose Bengal Agar media were used for the enumeration of bacteria and yeasts, molds respectively. The juice containing media plates were incubated at 35±2°C for 24 hours for Nutrient agar and Rose bengal agar plates at 28±2°C for 7 days according to the methods of APHA (2001).

**Statistical analysis.** Analysis of variance (ANOVA) was carried out using the software STATISTICA 6.0 (Stat-Ease Inc., Tulsa, OK, USA). Significant differences ( $p \leq 0.05$ ) among preserved juices were detected using Tukey post hoc test.

### Results and Discussion

**Sensory analysis.** Fresh cashew apple juice was light yellow in color whereas the juice after filtration was colorless throughout the storage period. The hedonic scale rating of color of both the fresh juice as well as preserved juice was 9.0, indicating the acceptability of both the samples. The mean sensory scores of the juice presented significant difference in taste and color upto three months (Table 1). This could be due to decrease in tannins (causing astringency) and elimination of colored pigments (carotenoids, mainly  $\beta$ -cryptoxanthin) from the fresh juice. After three months, though there is no change in color, taste of the juice was not acceptable. There was no significant difference in sedimentation, flavor and overall acceptability throughout the storage period, indicating the effectiveness of the preservation method in retaining sensory attributes.

**Physico-chemical analyses.** The results of physico-chemical evaluations are as shown in Table 2. The pH of the preserved juice decreased from 3.4 to 2.93 upto 90 days and later increased. This decrease in pH could be attributed to the action of citric acid and benzoic acid. Most of the bacteria will not grow at low pH and hence good keeping quality of the juice is maintained (Ranganna 1986). Evaluation of pH in foods is important as it influences palatability.

Table 1. Mean scores of sensory acceptance of fresh and preserved cashew apple juice

Attribute	Fresh juice	Preserved sample					
		Storage time (in days)					
		15	30	45	60	75	90
<b>Color</b>	9.0	9.0	8.5	9.0	8.5	8.0	8.0
<b>Flavor</b>	8.5	8.0	8.0	8.5	8.0	8.0	8.0
<b>Taste</b>	3.5	8.0*	9.0	8.5	9.0	8.0	8.5
<b>Sedimentation</b>	7.5	7.5	8.0	7.0	8.0	7.5	8.0
<b>Overall acceptance</b>	8.5	9.0	8.5	9.0	8.5	8.5	8.0

Value is significantly different at  $p \leq 0.05$ .

Table 2. Significant changes in important physico-chemical characteristics of preserved cashew apple juice

Storage time (in days)	pH	TSS (%)	Vitamin C (mg/100 ml)	Total sugars (%)	Tannin content (%)	PPO (U/min/mg protein)
<b>0 (fresh juice)</b>	3.4*	13.8	164.00	9.64	0.56*	4.28*
<b>15</b>	3.33*	13.7	164.40	9.63	0.41*	4.45*
<b>30</b>	3.2*	13.9	164.20	9.58	0.37*	4.68*
<b>45</b>	3.15*	14.1	164.67	9.57	0.22*	4.83*
<b>60</b>	3.13*	14.0	164.50	9.53	0.19*	4.95*
<b>75</b>	3.11*	13.8	164.32	9.51	0.17*	5.08*
<b>90</b>	2.93*	14.2	164.60	9.52	0.15*	5.20*

Values in the same column are significantly different ( $p \leq 0.05$ ).

Table 3. Microbiological quality of the preserved cashew apple juice

No. of days	Bacteria(in CFU/ml)	Yeasts(in CFU/ml)	Molds (in CFU/ml)
0	-Nil-	-Nil-	-Nil-
15	-Nil-	-Nil-	-Nil-
30	-Nil-	-Nil-	-Nil-
45	-Nil-	-Nil-	-Nil-
60	-Nil-	-Nil-	-Nil-
75	-Nil-	-Nil-	-Nil-
90	-Nil-	-Nil-	-Nil-
105	<5	-Nil-	-Nil-
120	<5	<1	<1

In addition to sensory analysis, color and clarity of the juice were analysed with spectrophotometer. The juice was colorless and clear upto three months, without cloudiness, haze or precipitation. Clarity of the juice indicates good appearance and acceptability in the market.

Total soluble solids content (TSS) of fruit juices indicates maturity of fruits procured for juice extraction. Total soluble solids of the juice were in the range of 13.8-14.2 % Brix upto 90 days and later decreased. The stability of Brix value of the juice indicates that the fruits were collected at mature stage. This might be the reason for good palatability and acceptability of the juice, as can be deduced from the fact that reducing sugars are the main constituents of soluble solids. The decrease in TSS might be due to the utilization of sugars by fermenting organisms leading to degradation of sugars. Moreover, decrease could also be attributed to the precipitation of tannins and colloidal

particles in the juice by sago. The result was in conformity with Costa et al. (2003), who stored the juice by hot fill and aseptic methods.

Total titratable acidity of fresh cashew apple juice was in the range of 0.328 to 0.432 % as malic acid and was stable upto a period of 90 days and decreased later. The stability of titratable acidity indicates the concentration of organic acids mainly malic acid present in the juice is stable. The decrease in titratable acidity might be due to release of acids by decomposition, hydrolysis, oxidation or fermentation, which modifies the hydrogen ion concentration and consequently, food acidity.

Fresh juice was viscous whereas juice after filtration was found to be clear without any turbidity, as evident from the decrease in viscosity (1.398 to 1.258 cps). The decrease in viscosity implies better physical stability of the juice and was found to be stable upto three months. The results of cashew apple juice clarified using combination of sterile

filtration and filter aids also reveal the reduction in viscosity of the juice. It was also observed that viscosity of the juice treated with other clarifying agents: gelatin, starch and polyvinylpyrrolidone (PVP) did not vary significantly ( $p \leq 0.05$ ) (authors' unpublished work).

Vitamin C content of the juice was found to be  $164 \pm 1.0$  mg/100 ml and was stable upto 90 days and 12.18 % decrease was observed at the end of six months (Figure 1). The decrease in vitamin C could be probably attributed to oxidation, which occurs in fruit juices during storage and is highly dependent on the presence of oxygen in the head space or dissolved in the juice (Costa et al. 2003). Many authors reported the decrease in vitamin C during the storage of cashew apple juice. A decrease of 25.65 % for hot fill and 26.74 % for aseptic method was reported by Costa et al. (2003) for a shelf life of 350 days. Filho and De (1987) study shows vitamin C loss of 10-11 % at the end of 120 days stored at room temperature.

Total and reducing sugars in the preserved juice were stable upto a period of 90 days. After 90 days, the sugar content started decreasing (Figure 2). The loss of sugars with storage time might be attributed to non-enzymatic browning reactions, either caramelization or Maillard reactions occurring between amino acids or reducing sugars.

Significant difference ( $p \leq 0.05$ ) in tannins and phenols was observed with storage time. However, the decrease in tannins was significant ( $p \leq 0.05$ ) from 0.56 to 0.15 % and from 345 to 115 mg gallic acid equivalents/100 ml upto 90 days and later increased. Treating the juice with sago, helped to reduce tannins and phenols in the juice, which tend to impart astringency. This result was in conformity with the work of Jayalekshmy and John (2004). The decrease in tannin content was in accordance with decrease in absorbance value, which indicates clarity of the juice (Figure 3). The decrease in tannins and phenols indicates the juice is clear, colourless and non-astringent. Andrade (1988) reported that tannins present in the cashew apple favors darkening of the juice, and addition of metabisulphite reduces the browning of the juice.

Significant increase ( $p \leq 0.05$ ) in polyphenol oxidase (PPO) activity was observed towards the end of 90 days and was in accordance with decrease in tannin content (Figure 4) and phenols. The increase in PPO might be explained due to its action on degradation of tannins and phenols by the action of sago.

**Microbiological analysis.** The microbiological count of fresh cashew apple juice was found to be higher ( $< 15$ ). The initial presence of microorganisms in fresh cashew apple juice could be due to the presence of sugars. When the juice was subjected to sterile filtration, complete removal of microorganisms was observed and the juice quality was stable upto 90 days. It was observed that  $< 5$  CFU/ml bacteria and 1 CFU/ml, for yeasts and molds increased after three months (Table 3), which might be due to the

germination of spores as the effect of preservatives decreased gradually.

Figure 1. Variation of vitamin C content with storage time

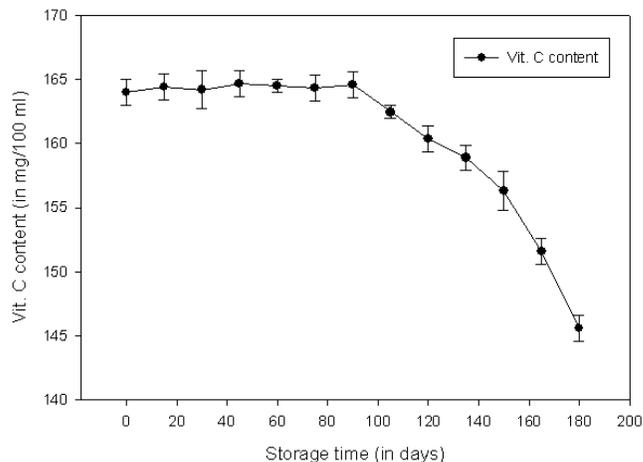


Figure 2. Variation of total sugars and reducing sugars with storage time

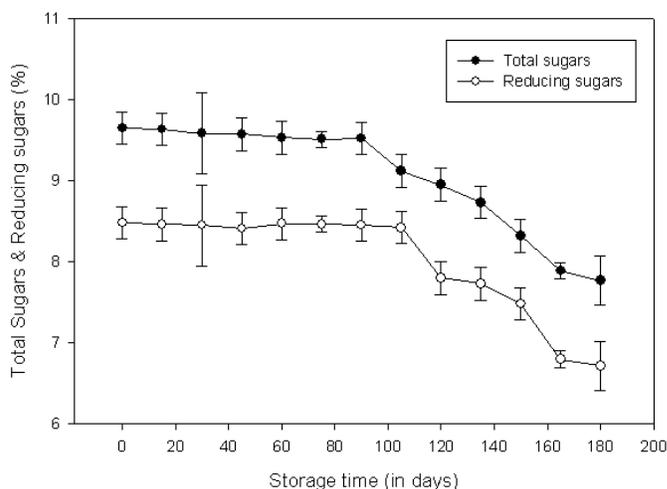


Figure 3. Decrease in tannin content with absorbance during the storage period of 90 days

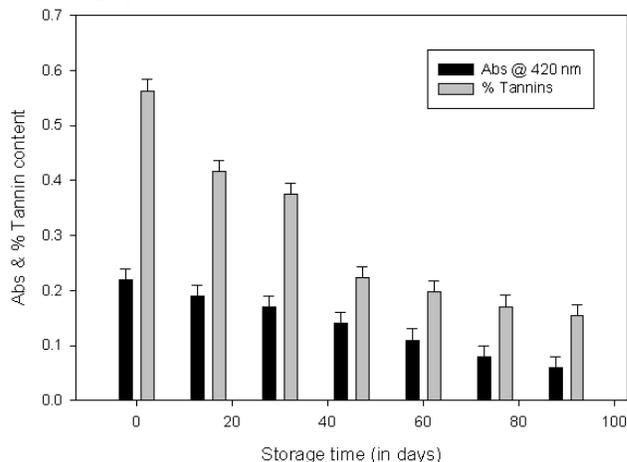
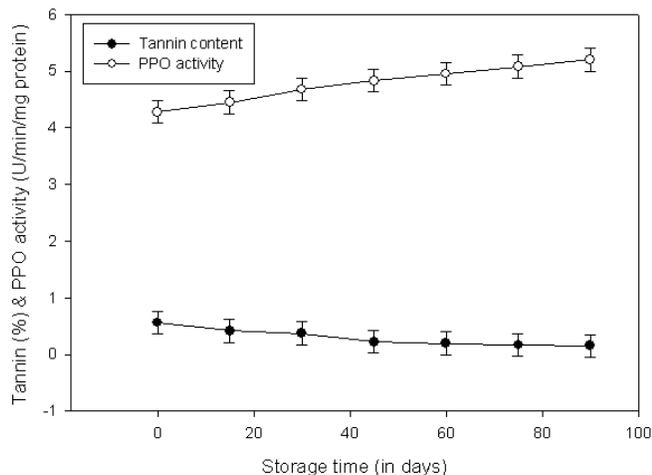


Figure 4. Variation of tannin content and PPO activity with storage time



### Conclusion

Results confirmed that combination of clarification, sterile filtration and chemical preservation is suitable for preservation of cashew apple juice upto three months under refrigeration. This method was efficient in decreasing astringency, microbial count and in retaining nutrient quality of the juice, since soluble solids, total sugar content and vitamin C were not affected significantly. The juice was also acceptable in terms of sensory attributes. Further, the method described is simple, rapid, inexpensive and convenient for industrial use in the processing and preservation of cashew apple juice. The utilization of the preserved juice should be encouraged as health drink and could be recommended to people with vitamin C deficiency because of its high vitamin C content. Above all, preservation of cashew apple juice is important because of the seasonality of its production which makes it abundantly available during its season and scarce during off season.

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