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Storage studies of enzyme clarified astringency free cashew apple juice and its value-added products

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Abstract
The main objective of the study is to evaluate the enzyme activity on removal astringency in cashew apple juice. The VRI 3 cashew apple variety was selected for the study. The cashew apples were washed, blanched and pressed using Hydraulic press juice was extracted. Attempts were made to remove tannin by the addition of enzyme tannase & pectinase at 1% level to the extracted juice. After the addition of enzyme, the juices were left undisturbed for 24h. The clarified juice was collected from top of the bottles and deactivation of enzyme was done by pasteurizing it till it reached a temperature of 80ºC, cooled and stored in fresh, sterilized PET bottles. From the juice the value-added products like RTS, Squash, jam and nutria bar were prepared and kept for storage studies. The current study revealed that the 1% pectinase enzyme clarification yield juice (95%) 0.5% tannase enzyme was best to reduce the tannin content (88.5 mg/100 g to 42 mg/100 g) after one day of storage compared to traditional method. The products had shelf life of six months and nine months for juice, RTS, squash, and bar without any changes in sensory characteristics.

Keywords: Cashew apple – VRI 3 – juce extraction – enzymes – value added products – storage studies

Introduction
Cashew cultivation in India during 2009-2010 was 923 hectare and production was 613 metric tonnes. India's foreign exchange by way of export of cashew kernels was 4390 crore in 2011-2012 according to report of Cashew Export and Promotion Council of India (CEPCI). India is the world's largest producer, processor and exporter of cashew kernels (CEPCI).
Cashew cultivation in India is confined to mainly peninsular areas. It is grown in Kerala, Karnataka, Maharashtra, Tamil Nadu, Andhra Pradesh, West Bengal and Orissa. Its cultivation is very limited in North Eastern states. It is estimated that about 30 million tonnes of cashew apples are produced yearly in the world (Michodjehoun-Mestres *et al.*, 2009) [8]. About 10-15 tonnes of cashew apples are produced for every tonne of cashew nut. This gets wasted due to improper packaging and handling techniques and lack of awareness about nutrient content.
Cashew apples are highly perishable fruits and cannot be stored for more than one day at ambient conditions. This is due to relatively high metabolic activity (62-72 mL kg^{-1} hr^{-1}) in ambient conditions (Biale and Barcus, 1970) [3]. Further its delicate skin and high water content (84.5-90.4% on w.b) make them more prone for microbial growth (Filgueiras *et al.*, 1999) [5]. The fragile skin of cashew apple makes it sensible to mechanical damages. They tend to lose quality right after harvest. Thus they need special care to increase their shelf-life.
Cashew apples are good source of Vitamin C. Besides Vitamin C, it contains sufficient quantity of minerals, water soluble vitamins and tannins. Tannins impart astringency and could be precipitated by the addition of enzymes. Alternatively steeping in salt solution also removes tannin. Juice, syrup, candies, pickles, chutney, jams and jelly, could be prepared from cashew apples. Cashew apples are fermented in Goa to produce an alcoholic beverage called 'Feni' (DCR).
The cashew apple will only keep for 24 hours after it has been picked. Transporting large quantities of cashew apples is difficult for this reason. When stacked in layers, cashew apples may burst and lose their juice because of the weight on top of them.

Materials and Methods
Cashew apple variety namely VRI 3, was procured from the Regional research Station, Vriddhachalam. The cashew apples were washed, blanched and pressed using Hydraulic press juice was extracted. Attempts were made to remove tannin by the addition of enzyme tannase & pectinase at 0.5 and 1%-4h.

The clarified juice was collected from top of the bottles and deactivation of enzyme was done by pasteurizing it till it reached a temperature of 80ºC, cooled and stored in fresh, sterilized PET bottles.

Various valueadded products were prepared from the extracted juice of cashew apple. The products prepared are:

- Squash,
- Ready – to – serve (RTS) beverage,
- Jam and
- Fruit bar

Procedure for preparation of Squash

Ingredients

Clarified Cashew apple juice	:	1l
Water	:	1.4 l
Sugar	:	1.6 kg
Citric acid	:	10 g
color	:	1.25 mg
Preservative	:	350 ppm

Procedure

The squash was prepared as per the FSSAI specifications. The clarified cashew apple juice was taken. Sugar syrup was prepared by using water, sugar and citric acid, cooled and filtered. The juice was mixed with sugar syrup and artificial colour and preservative were added and bottled.

Procedure for preparation of RTS (Ready to Serve beverage) Ingredients

Clarified Cashew apple juice	:	150 g
Water	:	730 g
Sugar	:	120 g
Citric acid	:	5 g
color	:	0.5 mg
Preservative	:	70 ppm

Procedure

The RTS was prepared as per the FSSAI specifications. The clarified cashew apple juice was taken. Sugar syrup was prepared by using water, sugar and citric acid, cooled and filtered. The juice was mixed with sugar syrup and artificial colour and preservative were added and bottled. Then the RTS were treated for (in bottle) sterilization, cooled and kept for storage.

Procedure for preparation of Jam

Ingredients

Clarified Cashew apple juice	:	500 g
Muskmelon pulp	:	500g
Sugar	:	750 g
Citric acid	:	10 g
Pectin	:	20 g
Lemon yellow color	:	1 mg
Preservative	:	40 ppm

Procedure

Cashew apple juice was taken along with muskmelon pulp. Sugar, citric acid, pectin was added and boiled till the consistency reached. Artificial colour was added and preservative was added and poured in to bottles. Capping was done after the jam was set.

Procedure for preparation of Nutribar

Ingredients

Clarified Cashew apple juice	:	500 g
Muskmelon pulp	:	500 g
Sugar	:	250 g
Citric acid	:	2.5 g
Corn flour	:	20 g
Preservative	:	500 ppm

Procedure

Measure a known volume of clarified cashew apple juice. Proportionately measure other ingredients. Blend the muskmelon pulp and clarified cashew apple juice well. Add the blended pulp, corn flour, sugar and citric acid. Boil the mixture till it reaches a TSS of 50º brix. Add KMS and mix well. Smear oil in a tray. Pour the contents and spread as a thin sheet. Dry it at 50ºC for 6 h, continuously in a drier. After drying, the sheet is cut into bars and removed from the tray. Individual bars were stuck to form layers and were coated with sugar powder and corn flour mixture. The fruit bar thus prepared were wrapped in a butter-paper and packed in PE covers and sealed air tight and stored in a cool dry place.

Analysis of stored products

Analysis for chemical characteristics, sensory qualities was done along with enumeration of microbes at 30 days interval up to 6 months. The Total Soluble Solids (TSS), acidity, ascorbic acid, total sugars, reducing sugars, and tannin were estimated by the method prescribed by Ranganna (2005) [9]. Sensory qualities such as colour, flavour, texture, taste and overall acceptability were carried out by a panel of judges using nine point hedonic scales (Amerine et al., 1965) [1].

Results and Discussion

Cashew apple juice was extracted by hydraulic press and treated with pectinase and tannase enzymes (1 and 0.5% concentration) and value-added products like Ready To Serve Juice, Squash, Jam and nutri bars were prepared from the clarified juice. The products had shelf life of six months and nine months for juice, RTS, squash, and bar. The results and discussion were given below.

Table 1: Chemical characteristics of stored cashew apple products

Chemical characteristics	Storage period	Juice	RTS	Squash	Jam	Nutri bar
Acidity (g/100 g)	1 day	0.280±0.03	0.064±0.02	0.200±0.04	0.204±0.50	0.206±0.04
	180th /270th day	0.043±0.02	0.12±0.03	0.028±0.03	0.078±0.41	0.065±0.02
Ascorbic acid (mg/ 100 g)	1 day	794.12±0.05	300.05±0.06	429.25±0.03	432.72±0.02	389.56±0.06
	180th /270th day	187.50±0.03	125.00±0.05	187.50±0.02	201.52±0.04	198.50±0.05
Tannin	1 day	42.25±0.01	33.50±0.02	35.00±0.03	32.75±0.05	33.00±0.04

(mg/100g)	180th /270th day	29.00±0.02	23.50±0.03	29.25±0.02	28.75±0.04	27.50±0.04
TSS	1 day	12.20±0.03	12.10±0.02	40.00±0.04	65.00±0.50	50.00±0.04
(° brix)	180th /270th day	10.70±0.02	13.90±0.03	38.70±0.03	45.65±0.41	39.28±0.02
Total Sugar	1 day	5.40±0.03	2.33±0.02	42.80±0.01	62.80±0.02	51.50±0.03
(g/ 100 g)	180th /270th day	8.75±0.01	1.80±0.03	40.52±0.02	42.12±0.03	42.35±0.02
Reducing sugar	1 day	0.54±0.05	0.14±0.06	7.88±0.03	8.50±0.02	6.25±0.06
(g/100 g)	180th /270th day	1.08±0.03	3.50±0.05	8.02±0.02	10.23±0.04	8.25±0.05

All means are based on triplicate value. Means with different letters in each column differ highly significantly $P< 0.01$*: wet weight basis.

1% pectinase enzyme clarification yield juice (95%). 0.5% tannase enzyme was best to reduce the tannin content (88.5 mg/100 g to 42 mg/100g) after one day of storage compared to traditional method. The products had shelf life of six months and nine months for juice, RTS, squash, and bar without any changes in sensory characteristics. The chemical characteristics gradually changed during storage.

There was a slight decrease in the TSS of in squash, jam and bar, which did not affect the quality of the products. Since per cent soluble solids act as a rough index of the amount of sugars in fruits and vegetables, it would be expected that these values would increase rapidly during ripening and then decrease due to respiration. The acidity levels in the products could affect their flavour and acceptability. Ghanta (1999) [6] reported that the ascorbic acid content of the prepared products was reduced during storage period and it was low at the end. The similar results were observed in this study. Low temperature was found to have pronounced effect in reducing respiration rate because of which the ascorbic acid was retained to a greater extent. The tannin content was reduced in the juice itself because of enzyme treatment and products also during storage there was reduction trend was observed.

The reducing sugar increased and total sugar decreased during storage. The decrease in sugar content is due to their subsequent utilization via glycolysis for maintenance of respiration over longer period of storage. Sugars, acids and their interactions are important to sweetness, sourness and overall flavour intensity. Changes in reducing sugars, total sugars and sucrose were parallel and the general trend was a decrease with time at each storage conditions. Reduction in the loss of sugars was probably the result of decreased respiration rate. In this study chemical changes were altered slightly due to vacuum packing fruits than control which was deteriorated easily.

The rate of increase in acidity was found to be higher in ambient temperature. This might be due to chemical interactions between the organic constituents of the induced by temperature and action of enzymes. These results are in confirmation with Bawa and Saini (1987) [2] in carrot juice. The slight increase and decrease in pH in grape and pineapple squashes due to changes in acidity and it is directly proportional to acid. Similar findings were reported by Chobe (1999) [4] in pomegranate squash. There was slight decrease in total sugars was observed both the squashes irrespective of storage conditions, packaging material and treatments. This might be due to conversion of starch and carbohydrates in to sugars. There was minimum change because the loss of moisture, the total sugar content may be maintained. The results were on par with the study conducted by Madan and Dhawan (2005) [7] in carrot incorporated pineapple squash. The slight increase in reducing sugars was recorded in both the squashes packed in both packaging material and storage conditions. This is because of more exposure of stored materials to storage atmospheres which enhances the process of conversion of reducing sugars in squash. Also, continuous hydrolysis of non – reducing to reducing sugars might have increased the sugar percentage. These results are in confirmation with Waskar and Deshmukh (1995) [9] in pomegranate juice.

Conclusion

The current study revealed that the 1% pectinase enzyme clarification yield juice (95%) 0.5% tannase enzyme was best to reduce the tannin content (88.5 mg/100 g to 42 mg/100g) after one day of storage compared to traditional method. The products had shelf life of six months and nine months for juice, RTS, squash, and bar without any changes in sensory characteristics. The chemical characteristics gradually changed during storage. The value-added products may be taken up as a industrial production.

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