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Quality evaluation of processed star fruit (*Averrhoa Carambola*)

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Abstract
Fruits are highly perishable items which needs processing to make it durable. In the present investigation there were various types of processing techniques were used to determine the best processing method with the minimum loss of naturally present antioxidant in Star Fruits that can be uses in the development of food products. The findings revealed that, regarding organoleptic evaluation of processed star fruit, in context of high temperature treatment sensory attributes were higher in water boiling temperature (100ºC). Regarding the low temperature treatment, scores of deep freezer temperature were higher in comparison to others and for drying treatment; it was found that sun drying scores the highest. Anti-nutrient content which includes tannin and oxalic acid was found lowest in water boiling temperature (100ºC) i.e. 0.78±0.06 and 0.65±0.02 mg/100 g respectively in context of high temperature treatment. While in low temperature treatment anti-nutrient was 0.83±0.01 mg tannin and 0.73±0.02 mg oxalic acid per 100 g in deep freezer temperature, which was lowest among others. Regarding drying treatment lowest tannin and oxalic acid was recorded 1.10±0.55 mg and 0.72±0.05 mg per 100 g respectively for sun drying. Highest antioxidant activity of processed star fruit, was found with (100ºC) i.e. 77.64±1.50 % in context of high temperature treatment. While in low temperature treatment it was found 75.49±1.77 % for deep freezer treatment which was highest among others, and in drying treatment it was found highest in sun drying which was 92.14±1.02 %. The present investigation concluded that minimum loss of antioxidant activity in Star Fruit was found in water boiling temperature, Deep freezer temperature and sun drying comparison to other processing methods. These processing techniques can implement in the new food product development which will highly rich in antioxidants.

Keywords: Star fruit, perishable, processing, antioxidant, high temperature treatment, low temperature treatment, drying

Introduction
India is known for its diverse tropical and sub-tropical agro-climatic conditions, which are conducive to grow various types of fruits and vegetables. India stands second (27.8 million metric tones) in fruit production after China. *Star Fruit* is an important minor fruits and have been attributed to possess several medicinal properties. Star fruit (*Averrhoa carambola*) belongs to the family Oxalidaceae and is often called as "Carambola" or "Five finger fruit". The star fruit is a good source of reducing sugars, ascorbic acid, minerals (K, Ca, Mg and P) and amino acids (serine, glutamic acid and alanine) (Adiyaman *et al*., 2013) [1]. Star fruit just like any fruit do not last forever; they can be kept under room temperature for two to five days until ripe, one to two weeks once it is ripe in the refrigerator and ten to twelve months in the freezer. The present investigation has been planned with the objectives to process the Star Fruits by using different processing methods like High Temperature Treatment, Low Temperature Treatment and Drying and to identify the best processing method with minimum losses of antioxidants.

Methodology
- **Locale of Study:** The present study was conducted in the Department of Food Science & Nutrition, College of Community and Applied Sciences, Maharana Pratap University of

Agriculture & Technology Udaipur, (Rajasthan).

- **Procurement of Sample:** Fresh Star fruit samples were collected from the local fruit markets in Udaipur, Rajasthan during the months between October to December. The purchase was made in single lot from the market.

- **Processing and Evaluation for Acceptability:** In the present investigation different processing including High Temperature Treatment (water boiling temperature on 100^{o}c, high pasteurization temperature on 90^{o}c and Low pasteurization temperature on 70^{o}C), Low Temperature Treatment (refrigerator temperature on 3^{o}C to 5^{o}C, freezer temperature on -15^{o}C to -17^{o}C and deep freezer temperature on -25^{o}C to -40^{o}C) and Drying (sun drying, solar drying and oven drying) of Star Fruit were done to identify the best processing method with minimum losses of antioxidants which can be used in future for product development. For this purpose organoleptic evaluation, anti-nutritional properties and antioxidant evaluation were conducted using standard procedures.

The acceptability of processed fruits was assessed on the basis of judgment given by panel members, anti-nutritional properties and antioxidant evaluation were done by standard methods. Out of the different processing, one best method was selected on the basis of sensory acceptability scores, anti-nutrient properties and antioxidant evaluation.

Plate 1: Different Types of Processing Techniques Applied on Star Fruits

Result and discussions

- **Organoleptic Evaluation:** For organoleptic evaluation of processed Star Fruit, samples were prepared and sensory was done with the help of semi-trained panel members. The results of the organoleptic evaluation of processed Star Fruit are presented in Table 1. In context of High Temperature Treatment, the overall acceptability was higher in water boiling temperature which was 6.12±0.14 in comparison to high pasteurization temperature and low pasteurization temperature which were 5.9±0.19 and 5.8±0.21 respectively. The scores of other parameters includes color, taste, texture, flavour and appearance were also higher in water boiling temperature which were 6.4±0.41, 6.1±0.41, 5.9±0.4 and 6.3±0.27 respectively. Regarding the Low Temperature Treatment, scores of deep freezer temperature were in the range from "like slightly" to "like moderately". The scores includes color, taste, texture, flavour, appearance and overall acceptability were 7.0±0.35, 6.5±0.35, 6.9±0.41, 6.5±0.35, 6.9±0.41 and 6.74±0.15 respectively. The overall acceptability of other two temperatures which includes refrigerator temperature and freezer temperature were 6.34±0.11 and 6.08±0.31. It was slightly lower than the deep freezer temperature. The other two temperatures' acceptability score were in the range from "Neither liked nor disliked" to "liked slightly".
  Regarding Drying Technique, scores of sun drying process were highest among others. The overall acceptability score was 7.26±0.20 which was in the range of "like moderately". Color, texture, flavour and appearance were in the range of "like moderately" and the taste was under the range of "liked slightly". The acceptability scores of solar and oven drying for color were 6.8±0.44 and 6.9±0.4, for taste were 6.2±0.44 and 6.2±0.27, for texture were 6.2±0.27 and 6.5±0.35 for flavour were 6.0±0.5 and 6.5±0.35 and for appearance were 6.4±0.41 and 6.8±0.27 respectively. These scores were slightly lower than the scores of sun drying which were for color 7.6±0.41, taste 6.7±0.27, texture 7.5±0.35, flavour 7.1±0.41 and appearance 7.4±0.41.
  The above results indicate that water boiling temperature, deep freezer temperature and sun drying process were the methods which could be used for the products formulation of Star Fruits.

Table 1: Mean ± SD scores of sensory evaluation of processed star fruit

Processing methods		Parameters					
		Color	Taste	Texture	Flavour	Appearance	Overall acceptability
High temperature treatment	Water boiling temperature	6.4±0.41	6.1±0.41	5.9±0.41	5.9±0.41	6.3±0.27	6.12±0.14
	High pasteurization temperature	6.3±0.27	5.9±0.41	6.0±0.35	5.5±0.35	6.0±0.35	5.9±0.19
	Low pasteurization temperature	6.4±0.41	5.4±0.41	5.7±0.44	5.4±0.41	6.1±0.22	5.8±0.21
Low temperature treatment	Refrigerator temperature	6.4±0.41	6.3±0.27	6.3±0.27	6.2±0.27	6.5±0.35	6.34±0.11
	Freezer temperature	6.6±0.41	5.6±0.41	5.9±0.41	5.6±0.41	6.7±0.27	6.08±0.31
	Deep freezer temperature	7.0±0.35	6.5±0.35	6.9±0.41	6.5±0.35	6.9±0.41	6.74±0.15
Drying	Sun drying	7.6±0.41	6.7±0.27	7.5±0.35	7.1±0.41	7.4±0.41	7.26±0.20
	Solar drying	6.8±0.44	6.2±0.44	6.2±0.27	6.0±0.5	6.4±0.41	6.32±0.29
	Oven drying	6.9±0.41	6.2±0.27	6.5±0.35	6.5±0.35	6.8±0.27	6.58±0.24

- **Anti-Nutrient Content of Processed Star Fruit:** Anti-nutrient content which includes tannin and oxalic acid was presented in Table 2. It results revealed that tannin content in the High Temperature Treatment for water boiling temperature was found lowest (0.78±0.06) in comparison to other two. Likewise it was reported in Low

Temperature Treatment that the tannin content was low in deep freezer temperature (0.83±0.01). The results of Drying Process express that sun drying process have the lowest tannin content i.e., 1.29±0.63.

Regarding oxalic acid content in processed Star Fruit the values for high temperature treatment revealed that lowest oxalic content was found in water boiling temperature (0.65±0.02). In the Low Temperature Treatment method the lowest values recorded for the deep freezer temperature (0.73±0.02) in comparison to other two. In the Drying Process the oxalic content was recorded lowest in sun drying (0.72±0.05).

Edem *et al.* (2011) [2] reported that *C. africanum* fruit has a high level of oxalates (4.99mg/100g) and tannins (0.029 mg/100g). The oxalate value is higher than (1.06 mg/100g) reported for *B. coricea* seeds and (0.159 mg/100g) reported for Pennsetum purpureum. In a similar study, Wilson *et al*. (1982) [3] reported that the range of oxalaic acid content for ripe fruit was 0.8 to 7.3 mg/g. Also Joseph and Mendonca in 1991 reported that the oxalic acid levels detected ranged from 0.2 to 5.1 mg/g for ripe fruit.

Table 2: Anti-nutrient content of processed Star Fruit (mean ±SD) per 100g on dry and fresh weight basis

Processing method	Anti-nutrients	
	Tannin	Oxalic acid
Water boiling temperature	0.78±0.06	0.65±0.02
High pasteurization temperature	0.85±0.03	0.74±0.02
Low pasteurization temperature	0.87±0.02	0.72±0.02
Refrigerator temperature	0.87±0.03	0.76±0.01
Freezer temperature	0.84±0.03	0.74±0.01
Deep freezer temperature	0.83±0.01	0.73±0.02
Sun drying	1.10±0.55	0.72±0.05
Solar drying	1.29±0.63	0.89±0.02
Oven drying	1.87±0.20	0.97±0.02

- **Antioxidant Properties of Processed Star Fruit:** The antioxidant activity of processed Star Fruit was presented in Table 3 which denotes that the antioxidant activity of High Temperature Treatment which includes water boiling temperature, high pasteurization temperature and Low pasteurization temperature which were found 77.64±1.50, 72.85±1.72 and 73.84±1.35 respectively. The Low Temperature Treatment antioxidant activity which includes refrigerator temperature, freezer temperature and deep freezer temperature were found 69.00±1.75, 72.67±1.21 and 75.49±1.77 respectively. The last processing was Drying which includes sun drying, solar drying and oven drying and their antioxidant activity were found 92.14±1.02, 88.78±1.49 and 80.22±1.13 respectively.

  The respective results showed that in these different processing methods the highest antioxidant activity was found in water boiling temperature, Deep freezer temperature and sun drying comparison to other processing methods.

Table 3: Antioxidant properties of processed star fruit

Processing method	Total antioxidant activity (%)
Water boiling temperature	77.64±1.50
High pasteurization temperature	72.85±1.72
Low pasteurization temperature	73.84±1.35
Refrigerator temperature	69.00±1.75
Freezer temperature	72.67±1.21
Deep freezer temperature	75.49±1.77
Sun drying	92.14±1.02
Solar drying	88.78±1.49
Oven drying	80.22±1.13

Summary and Conclusion

The present investigation concluded that different types of processing techniques could make direct effects on characteristics of antioxidant rich Star Fruit. Minimum loss of antioxidant activity in Star Fruit was found in water boiling temperature, Deep freezer temperature and sun drying comparison to other processing methods. These processing techniques can implement in the new food product development which will highly rich in antioxidants**.**

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