Effect Of Different Pretreatments On The Improvement Of Nutritional Quality And Taste Of Amla Preserves (*Phyllanthus Emblica*)

Author

Nilima Yashwantrao Bhoge

Affiliation

Department of food science. Arts science and Commerce College, Chikhaldara, District Amravati, Maharashtra

Abstract

Amla is a seasonal fruit with high vitamin C content. Preserving with sucrose can add up to the taste and increase the shelf life. Fresh, ripe and healthy amla fruits from the local market of Chikhaldara and were subjected to four methods of pretreatments- untreated, blanched, untreated with freeze and blanched with freeze. The blanching was carried out at 95±2°C for 3 minutes and the freezing was done at 4°C for 24 hours. These pretreated amla samples were preserved with the sucrose syrup to increase brix from 50° to 80° Brix for 15 to 17 days. These preserves were evaluated for fungal contamination. The combination pretreatment of blanching with freeze was found to be superior to other pretreatments in retaining the vitamin C (34.8 %). Total sugar and reducing sugar content was 76.8 % and 36.3 % respectively and had a good colour post process. The untreated samples were the most undesired. The one-way ANOVA showed significant difference in the color and taste of untreated amla preserves between 50° and 80° brix. The statistical significance between any of the pretreatments in regards to texture was not significant but slight variation was observed between 50° and 80° brix with softness, chewiness and flavor increased with increased sugar syrup. The microbial analysis found absence of molds in all the samples. This production process was optimal and desirable from commercial perspective.

Keywords: Amla, Blanched, Brix, Microbial analysis, Pretreatment, Sensory evaluation

Introduction

Amla (*Phyllanthus emblica*) is a nutritious plant that is known by the various names- Indian gooseberry, Malacca tree, Amalaki in Sanskrit, and Emblic (Lim, 2012; Naz & Pandey, 2021). It is proven to have numerous medical and cosmetic uses (Naik et al., 2005). However, it is a highly perishable fruit and seasonal fruit, available from October to January (Devi et al., 2020). The high vitamin C in the fruit makes it very tangy and unpalatable. However, additives int the fruits enhances the taste. Making amla preserve can provide a solution to commercial utilization of this fruit (Ghimire, 2022).

Food preservation techniques include those that reduces microbial growth and slow down food degradation. Processes that prevent aesthetic degradation by hydrolytic enzymatic activity are also a part of food preservation (FAO, 2019). Food preservation increases the shelf life of the product by decreasing the spoilage of the food through microorganisms and enzymatic activity (Ananou et al., 2007). Food preservation of fruits in the form of various food products can be helpful in the availability of the foods round the year and improve the export potential (Kalia & Parshad, 2015; Panda, 2010).

The effects of various food preservation techniques on food quality and food systems vary. Compared to current methods, several ancient methods of food preservation like boiling, canning, dehydration like sun drying fermentation and jellying have been demonstrated to use less energy and produce less carbon dioxide (Vermeulen et al., 2012). Due to their high cost, marginal farmers are unable to directly afford storage facilities like cold storage and controlled/modified environment storage (Verma & Gupta, 2004). Hence, use of modern preservation techniques like pasteurization, freezing, blanching, irradiation are gaining importance currently (Board, 2012). These methods increase the shelf life for longer period, make food preserves wholesome packed with nutritional qualities and provide natural color and flavor to the products. Apart from providing all these flavors, taste and shelf-life qualities, the preserved food products should retain and prevent the loss of vitamin C. Numerous researchers have utilized the retention of vitamin C as a marker in processed foods for the retention of other heat-sensitive nutrients (Maeda & Salunkhe, 1981).

Pretreatment of the fruit is necessary to prevent vitamin C and other nutritional component losses during preservation. Ramasastri (1974) found that the sun-drying of fresh amla pulp resulted in a 30% loss of ascorbic acid. Many methods are employed for the Vitamin C retention purpose, like optimum harvest conditions, short processing time, blanching, freezing, best storage conditions, packaging practices, etc. During blanching, certain minerals, water-soluble vitamins, and other water-soluble components are lost. In order to prevent this, setting temperature between 85- 90°C is crucial and adjusting the time just to deactivate the enzymes (Heldman & Hartel, 1999). Sometimes, a single technique or a combination of techniques known as Hurdle technology is employed in order to achieve better results (Alasalvar et al., 2010).

In places where there is not enough temperature, the production of preserves in sucrose syrup provides a viable option to generate revenue from processed amla product. A processed version offers considerable economical returns than raw fruit, in places like Chikaldhara. Therefore, the goal of the current study was to create an appropriate product that contains more vitamin C with colour retention and improved texture. The impact of pretreatments on the quality of amla preservation was studied. The microbial analysis to study the efficacy of the process was also found. The sensory and taste parameters of the fruit were improved, with lower microbial load and higher shelf life.

Material and Methods

Collection of amla

Fresh amla grown in Chikhaldara district were procured from the local market, Chikhaldara. The fruit samples were mature, ripe, healthy and fresh with roughly similar size.

Preparation of amla for pretreatment process

Healthy fruits without any visible infection were selected for the pretreatment. Rotten, damaged and bruised were discarded. The selected healthy fruits were washed with tap water, followed by distilled water to remove any impurities and adherent dust from the fruits. The fruits were then pricked with stainless steel needles.

Pretreatment process

Before moving to actual preservation process of amla, the pretreatment was carried out. Fruits were given small slits until the seeds into equal quadrants such that the fruit pulp remained attached to the seeds. One kilo fruits each were kept as raw or untreated (A), blanched (B), untreated-freeze (C), and blanched-freeze (D). The blanching was carried out at 95±2 °C for 3 minutes and the freezing process was carried out at 4 °C for 24 hours. After blanching, the samples were cooled immediately to prevent the discoloration of the fruits.

Preparation of amla preserve

The steps for preparing preserves were followed as directed by Basnet (2018) for the pretreated amla samples. On first day, 1 kg of fruit of all the respective pretreatments were added with 1kg of sugar. The sugar gradually liquified and covered up the entire strata of layers of amla. This also created a gradual osmotic imbalance and drew out the water from the fruits at a slow pace, but also permeated sucrose inside the fruits (Shephard, 2006). The Brix count was taken using refractometer. The °Brix was found to be 38° Brix at this stage. Dry sugar powder of approximately 148 g was added to the syrup to elevate the ° Brix to 50°. The syrup was then heated for 8 minutes to dissolve the sucrose and allowed to cool for 24 hours. In each sample, °Bx was increased by 10° Brix every day until it reached 80° Brix. Approximately 115 g of sugar was used to raise the sucrose concentration by 10° Brix. Every increment of brix by addition of sugar was followed by 8 minutes of boiling to dissolve the sugar. Additionally, 2.5 grams of citric acid was added to prevent the crystallization of sugar syrup (Priya & Khatkar, 2013). The subsequent addition of sugar to increase the sucrose concentration was done on lower heat, to merely dissolve the sucrose. The fruit preserve was kept for 7 days.

Microbial analysis of the amla preserve

The amla preserves of the four pretreatments of the final cut out brix (80° Brix) was evaluated for the bacterial and fungal occurrence during three different storage time periods. The testing was done by method for yeast and mold count of food stuffs and animal feed- IS 5403 given by gazette notification of revised microbiological standards for fruits and vegetables and their products, given by FSSAI, 2018 on its official website. The yeast count was done using the formula

$$Yeast\ count = \frac{\sum C}{(n1+0.1n2)d}$$

Where $\sum C$ is the sum of yeast colonies counted on the plates, n1 is the number of plates counted in the first dilution, n2 is the number of plates counted in second dilution and d is the dilution from which the first counts were obtained. 5 plates of 10^{-1} and 10^{-2} were sampled to find any mold growth.

Biochemical analysis of amla preserve

After steeping process, the syrup samples were collected every 24 h with sterile spoons The sticking sugar syrup was removed by gently washing under running water, and the surface water was blotted with tissue paper. Samples from all pretreatment process were carefully ground in a mortar and pestle with distilled water. The pH of the pretreated amla preserves was determined using a pH meter. Total sugar and reducing sugar were determined through Lane and Eynon's method from the process mentioned by (Ranganna, 1986). The content of ascorbic acid was determined through 2-6 dichlorophenol indophenol titration method described by (Ranganna, 1986).

Quality evaluation of the preserve through sensory evaluation

A sensory assessment of the preserve was done with the assistance of 10 semi-trained judges from Department of Food science, Arts, Science and Commerce college, Chikhaldara. The judges were familiar with amla preserves evaluation traits (such as colour, taste, texture). Evaluation was done by 9 points Hedonic scale, ranging from dislike extremely (1) to like extremely (9) (Ranganna, 1986). The samples were provided on labelled, spotless, clear petri dishes. Between each test, a score card and water for mouth rinsing were supplied to the judges. The sensory evaluation was carried out every day during the process of preservation.

Statistical analysis

The readings for all the experiments were taken in triplicates. At the 5% level of significance, the data from the sensory analysis were analysed using a one-way ANOVA (no blockings) and the data from the sugar uptake were examined using a one-way ANOVA (no blockings) through IBM SPSS software. The LSD technique (a statistical analysis tool created by Lawes Agricultural Trust, Rothamsted Experimental Station, 1985) was used to compare the mean results.

Results

Chemical composition of fresh amla fruits

The chemical composition of amla was evaluated from the fresh fruit samples. The vitamin C content recorded to be 574.67 mg per 100 grams. The total sugar content found was 6.54 % while the reducing sugar i.e., sucrose was 2.94 % respectively. The overall pH obtained was acidic (3.4). The details of the chemical composition are mentioned in Table 1.

Table 1 Chemical composition of fresh amla fruit samples

Chemical composition of amla	Value
Vitamin C as ascorbic acid (mg/100g)	574.67 ± 2.44
Total sugar %	6.54 ± 0.01
Reducing sugar %	2.94 ± 0.009
pH	3.4 ± 0.06

Values are means of triplicate readings. Figures in parentheses are standard error

Effect of pretreatments on the pH of the amla preserves

The pH of the pretreated amla preserves was determined and the effects of various pretreatments was evaluated. There was no significant difference observed in the pH of the amla preserves. It was found to be in the range of 2 to 3 and was acidic. The pH for the raw or untreated pretreated samples, blanched samples, freeze samples and blanched with freeze samples were 2.7, 2.5, 2.7, and 2.4 respectively (Table 2). The pH was same for the raw and raw with freeze pretreated amla preserves while it was lowest for blanched with freeze amla preserves (Figure 1).

Table 2 Effect of pretreatments on the pH of the amla preserves

Pretreatment	pH
Raw or untreated	2.7^{b}
Blanched	2.5^{b}
Untreated with freeze	2.7^{b}
Freeze + blanched	2.4^{a}

Values are means of triplicate readings. The standard error calculated was 0.06. The mean with similar superscript alphabet (b) are significantly similar means. Rest is significantly different at 0.05 level of significance.

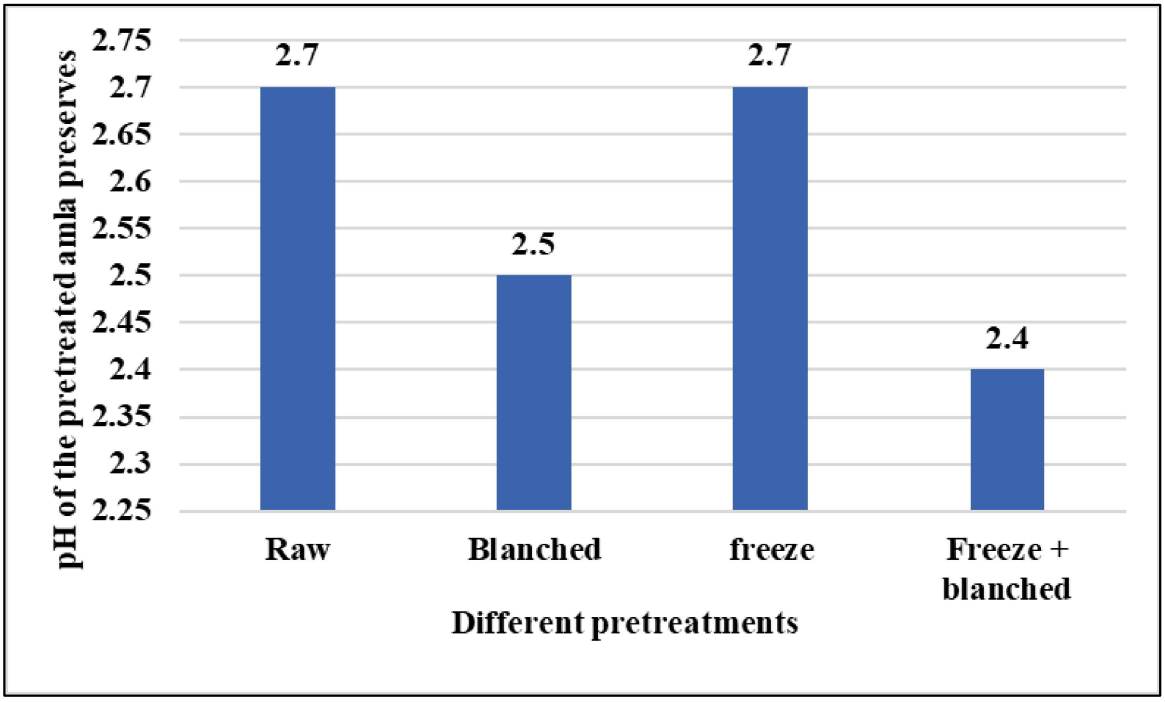

Figure 1 Effect of pretreatments on the pH of the amla preserves

Effect of pretreatments on the reducing sugar and total sugar content of the amla preserves

The percent reducing sugar was evaluated of the amla preserves when pretreated by the four methods. The reducing sugar content of the various pretreated amla preserves were in the range of 31 % to 37 %. The reducing sugar content for the raw pretreated samples, blanched samples, freeze samples and blanched with freeze samples were 31.2 %, 35.6 %, 33.4 % and 36.3 % respectively. The highest reducing sugar content occurred in blanched with freeze samples while the lowest was found in raw pretreated amla preserves (Figure 2).

The percent total sugar was also observed of the pretreated amla preserves. The total sugar was in the range of 69 %- 76 % for all the pretreated amla preserves. The reducing sugar content for the raw pretreated samples, blanched samples, freeze samples and blanched with freeze samples were 69.5 %, 73.6 %, 71.6 % and 76.8 % respectively. The highest total sugar was obtained with blanched with freeze pretreated amla preserve while the lowest was obtained with raw pretreated amla preserve (Figure 3). The details of effect on reducing sugar and total sugar are mentioned in Table 3.

Table 3 Effect of pretreatments on the reducing sugar and total sugar of the amla preserves

Pretreatment	Reducing sugar content (%)	Total sugar content (%)
Raw or untreated	31.24	69.52
Blanched	35.65	73.65
Raw/untreated + freeze	33.47	71.63
Blanched + freeze	36.32	76.89

Values are means of triplicate readings. The standard error calculated was 0.06. All means are significantly different at 0.01 level of significance.

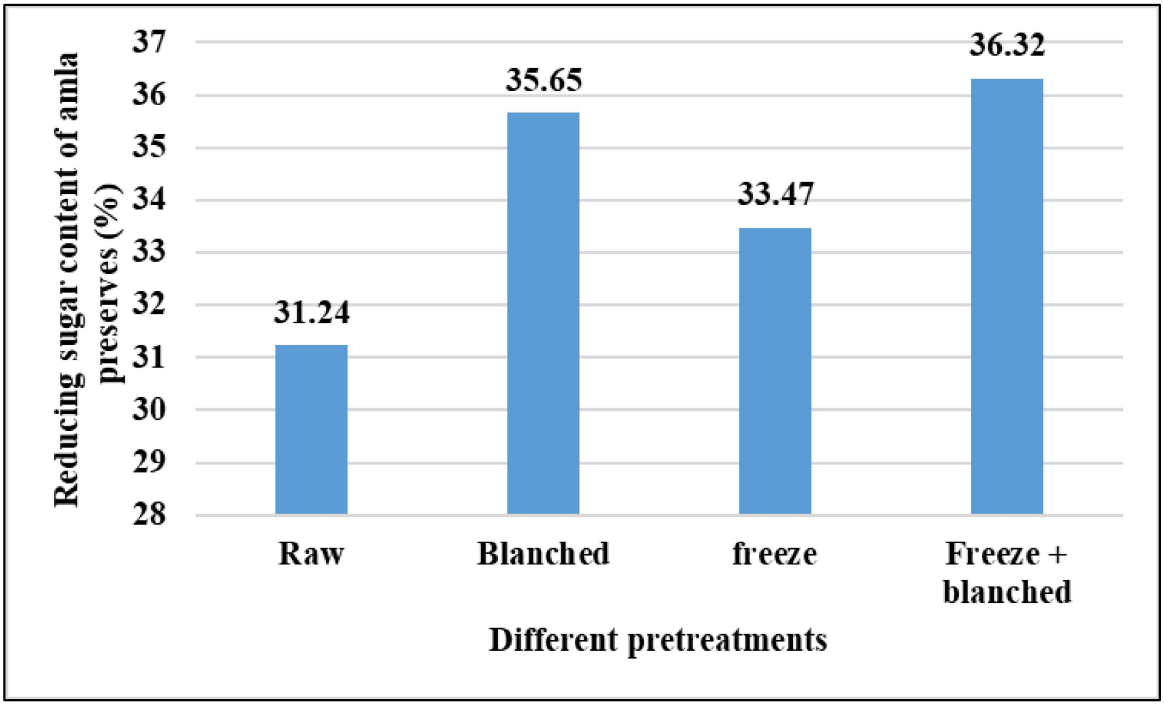

Figure 2 Effect of pretreatments on the reducing sugar of the amla preserves

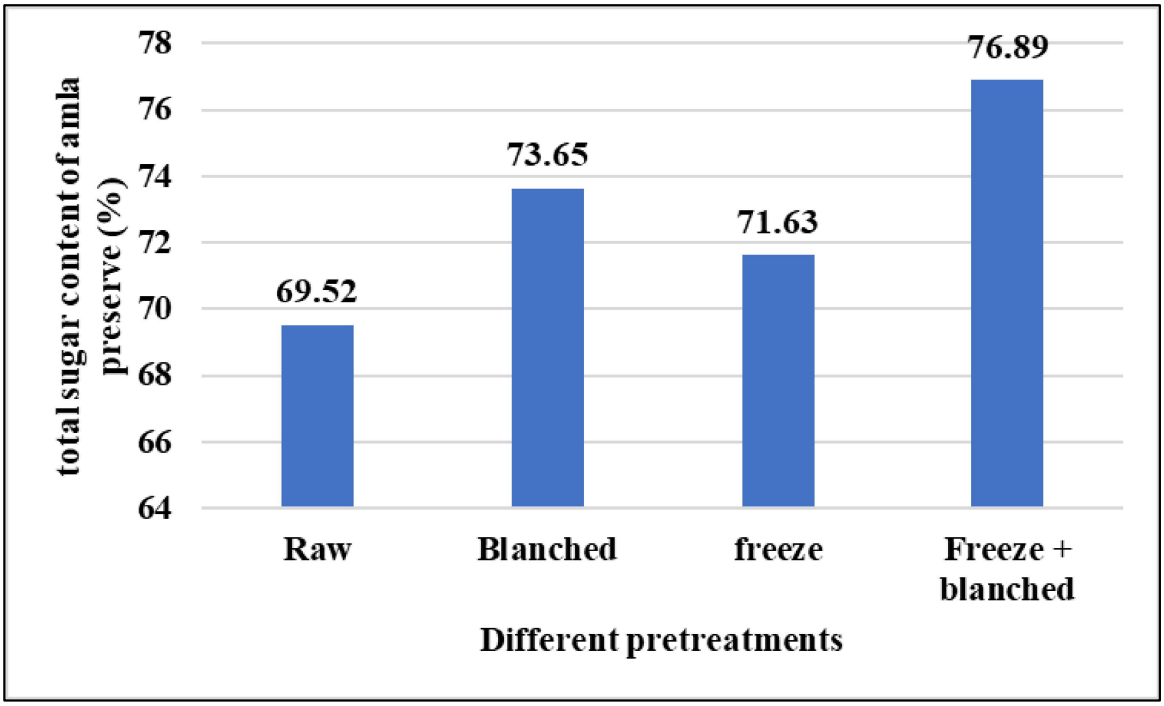

Figure 3 Effect of pretreatments on the total sugar of the amla preserves

Effect of pretreatments on the Vitamin C content of the amla preserves

Effect of various pretreatments on amla preserve were evaluated to study the vitamin C or ascorbic acid content. The vitamin C content had decreased during the pretreatment process compared to the vitamin C content of the fresh amla fruit samples but the percent retention of vitamin C was significant in some of the pretreatments like blanching and freezing. The vitamin C content obtained with raw, blanched, raw with freezing and blanched with

freezing pretreatments were 178.2 mg, 194.5 mg, 185.6 mg and 200.4 mg respectively (Table 4). The maximum vitamin C was obtained with blanched with freezing pretreatment while the lowest was with the raw pretreatment process (Figure 4). The percent retention of ascorbic acid with raw, blanched, raw with freezing and blanched with freezing pretreatments were 31.01 %, 33.79 %, 32.22 % and 34.84 % respectively with minimum loss and maximum retention of the vitamin obtained with blanched with freezing pretreatment for amla preserve.

Table 4 Effect of pretreatments on the vitamin C content of the amla preserves

Pretreatment	Vitamin C content (mg/ 100 grams)	Percent retention of ascorbic acid
Raw or untreated	178.2	31.01
Blanched	194.5	33.79
Raw/untreated + freeze	185.6	32.22
Blanched + freeze	200.4	34.84

Values are means of triplicate readings. The standard error calculated was 0.06. All means are significantly different at 0.01 level of significance.

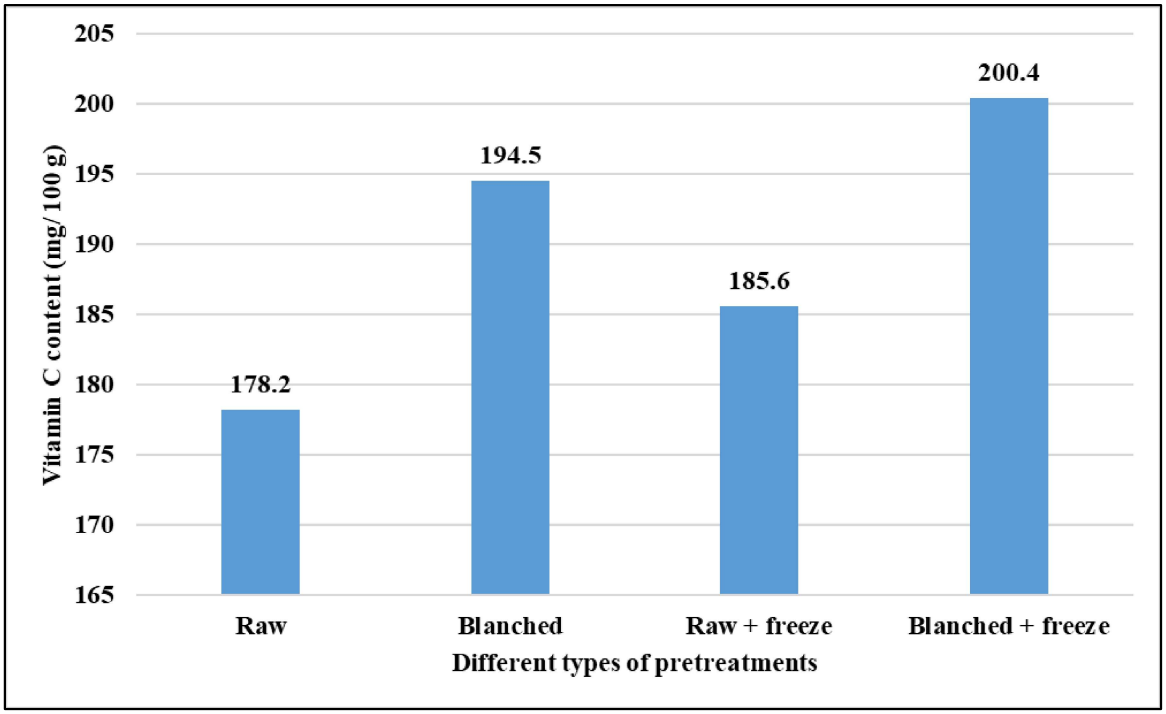

Figure 4 Effect of pretreatments on the vitamin C content of the amla preserves

Sensory evaluation of pretreated amla preserves

Amla pretreated in the four different ways was used for the preserve preparation. This preserved amla was sensory evaluated at three stages during the preservation procedure. The amla preserve made were tested organoleptically for 50° brix, 70° brix and 80° brix syrups. The test was carried out on a 9 point hedonic scale. The details are mentioned in Table 5 and Figure 5.

Color: It was found that the effect of pretreatments on color was not varied and had less impact compared to other parameters. The color was found to decrease with increasing brix concentration and with increasing time period. All the four pretreated fruit samples scored 9 points or had likeable color when treated with 50° brix solution and analyzed after 24 hours. However, the color remained intact and fresh with the score of 9 for the blanching and blanching with freezing pretreatment when subjected to all 50°, 70° and 80° brix solutions. The color for raw fruit samples decreased with increasing brix solution and time period. After 24 hours, when dipped with 50° brix, the color point was 9 while after 96 hours with 70° brix, the color scored 7 points and after the solution attained 80° brix with 144 hours, the score was 6 points i.e., the color was less likeable. The color of the raw fruit samples when pretreated with freezing exhibited the same fresh color of 9 points with 50° brix and 70° brix solution scored 8 points while after 144 hours with 80° brix solution, the color deteriorated and scored 7 points. The blanched and blanched with freezing pretreatment retained the fresh color for both 50° and 70° brix solution with 9 points while the color score decreased to 8 points after 144 hours or 80° brix.

Taste: The taste of the fruit samples was found to be highly enhanced with the pretreatment processes. The taste was found to be increasing with increased brix concentration. The taste scores were low for the raw fruit samples compared to blanched and freezing pretreatment samples. The taste of the raw pretreatment sample scored 6 and was found to be highly sour when dipped in 50° brix solution. When brix was increased to 70°, the taste also improved and turned to be sweeter and scored 7 points. When the sugar was again increased to 80°, the fruit samples turned out to be much more likeable than the former ones and scored 8 points. The raw pretreated fruit samples were however, more firm and less palatable. When the raw fruit samples were freezed during the pretreatment process and then evaluated for the sensory test, the taste was similar to raw samples while they were found to be more flavorful. During the 50° brix preserve, the samples scored 6 for the taste and with 70° and 80° brix the taste improved and turned to be sweeter and flavorful with scores of 7 and 8. The blanched fruit preserve samples when evaluated through taste were found to be sweeter and softer than the other two pretreatments. The taste was superior in all the sugar syrups tested. With 50° brix solution, it scored 7 that was sweet while with 70° and 80° brix solution, the pretreated blanched amla preserve taste was enhanced and scored 8 and 9 respectively. The taste effects of blanched with freeze pretreatment were most superior among all the pretreatments of amla preserve. The taste was quite likeable with sweet and flavorful amla preserve. The first two solutions- 50° and 70° brix had score of 8 while that with 80° brix had a score of 9.

Texture: The texture of the amla preserves of different pretreatment was wide in range. The texture of raw amla preserves were hard in taste and feel and hence scored less compared to other pretreated preserves. With 50° brix solution after 24 hours, the score of raw pretreated amla preserve was 7 and it remained same even after 96 hours with treating 70° brix solution with a score of 7. The texture of blanched amla preserves was very good in feel and tasted soft and sweet but were a little chewy with all the syrup soaked by the fruit samples. With 50° brix solution, the score was 8 while it further increased to 9 when treated with 70° and 80° brix solution respectively. The sweetness and softness of the pretreated blanched amla preserves increased with increasing time and sugar

concentration. The freezing pretreatment of the raw amla samples resulted in the hard, sweet yet flavorful texture of the preserves. After dipping in the 50° brix solution, the score was 8 and it remained same even after dipping in the 70° brix solution while it increased to 9 when dipped in the 80° brix solution. The superior texture was obtained with blanching with freezing pretreatment of the amla preserves. The score for 50°, 70° and 80° were 9. The texture as soft, sweet and flavorful that was smooth in the hands.

Table 5 Effect of pretreatments on the sensory evaluation of the amla preserves

Sensory evaluation	Different sugar syrup concentration								
	50° brix			70° brix			80° brix		
Pretreatment	Color	Taste	Texture	Color	Taste	Texture	Color	Taste	Texture
Raw or untreated	9 ± 0.0	6 ± 0.6	7 ± 0.6	7 ± 0.6	7 ± 0.6	7 ± 0.6	6 ± 0.6	8 ± 0.6	8 ± 0.6
Blanched	9 ± 0.0	7 ± 0.6	8 ± 0.6	9 ± 0.0	8 ± 0.6	9 ± 0.0	8 ± 0.6	9 ± 0	9 ± 0.0
Raw/untreated + freeze	9 ± 0.0	6 ± 0.6	8 ± 0.6	8 ± 0.6	7 ± 0.6	8 ± 0.6	7 ± 0.6	8 ± 0.6	9 ± 0.0
Freeze + blanched	9 ± 0.0	8 ± 0.6	9 ± 0.0	9 ± 0.0	8 ± 0.6	9 ± 0.0	8 ± 0.6	9 ± 0.0	9 ± 0.0

Values are means of triplicate readings. Numbers in parentheses are standard error of the mean.

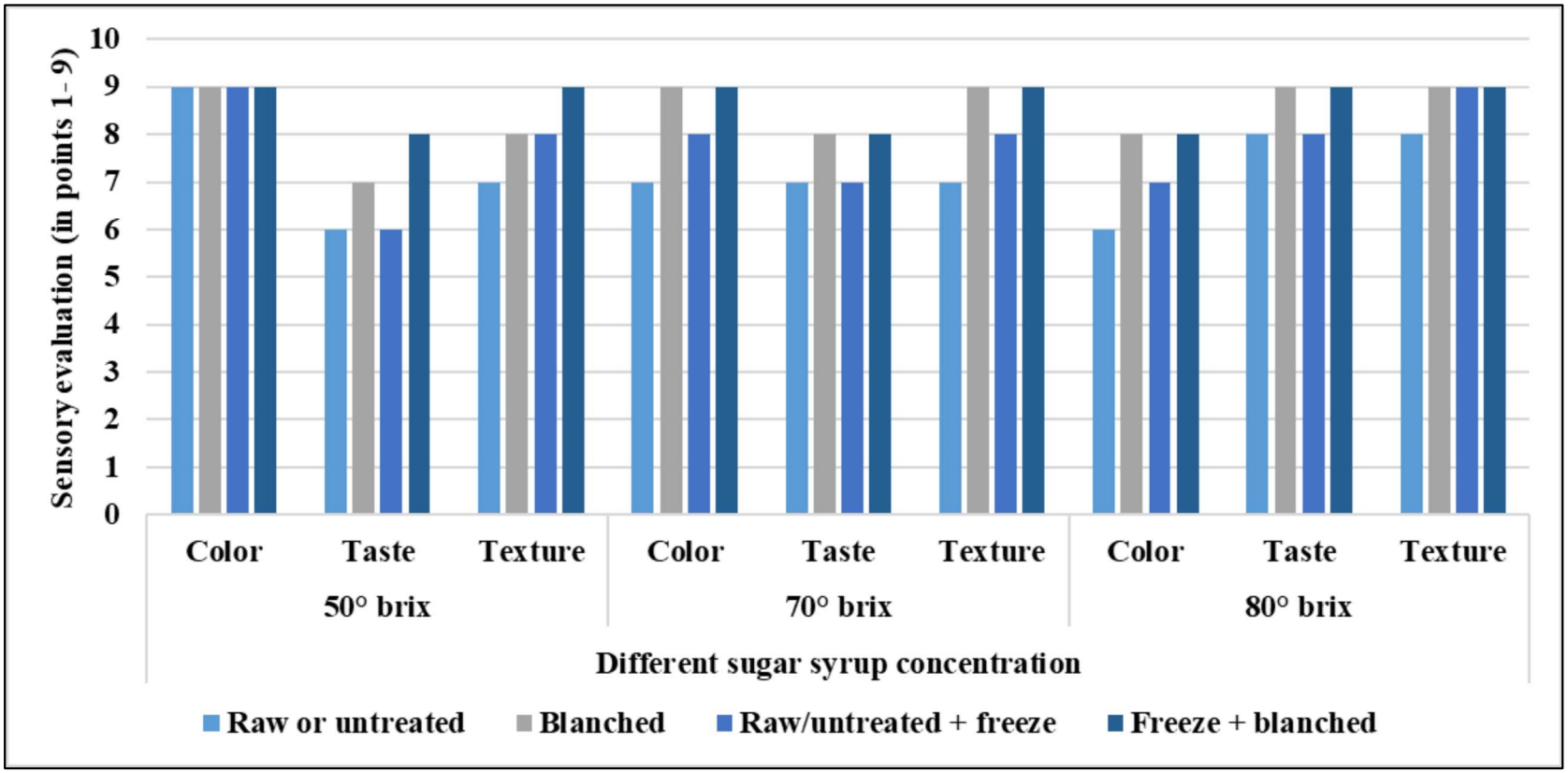

Figure 5 Effect of pretreatments on the sensory evaluation of the amla preserves

Table 6 The one-way ANOVA analysis of color of amla preserve

Different pretreatments		Untreated			Blanched			Raw + freeze			Blanched + freeze		
	Sugar brix	50	70	80	50	70	80	50	70	80	50	70	80
Untreated	50	-	*	*									
	70		-										
	80			-									
Blanched	50				-								
	70					-							
	80						-						
Raw + freeze	50							-		*			
	70								-				
	80									-			
Blanched + freeze	50										-		
	70											-	
	80												-

Table 7 The one-way ANOVA analysis of taste of amla preserve

Different pretreatments		Untreated			Blanched			Raw + freeze			Blanched + freeze		
	Sugar brix	50	70	80	50	70	80	50	70	80	50	70	80
Untreated	50	-		*									
	70		-										
	80			-									
Blanched	50				-		*						
	70					-							
	80						-						
Raw + freeze	50							-		*			
	70								-				
	80									-			
Blanched + freeze	50										-		
	70											-	
	80												-

Table 8 The one-way ANOVA analysis of texture of amla preserve

Different pretreatments		Untreated			Blanch			Raw freeze			Blanch freeze		
	Sugar brix	50	70	80	50	70	80	50	70	80	50	70	80
Untreated	50	-											
	70		-										
	80			-									
Blanch	50				-								
	70					-							
	80						-						
Raw freeze	50							-					
	70								-				
	80									-			
Blanch freeze	50										-		
	70											-	
	80												-

Microbial analysis of amla preserve with different storage time

The microbial analysis found that there was no mold or yeast growth even at the 10^{-1} dilution. The same was true even in the 80 days stored bottles. All the bottles had a higher shelf life and suggested good pretreatment for yeast control.

Discussion

Preserving perishable food products and retaining their nutritional qualities is a commercially competing factor in food industry. It is crucial to retain vitamin C and maintain ideal sugar levels and taste in amla preserve. The chemical composition of fresh amla had vitamin C content 574 mg/ 100 g, with reducing sugar and total sugar to be 2.9 % and 6.5 %. The current findings are in accordance with Basnet (2018) and Suman et al. (2014) suggesting that there wasn't much variation in the raw fruit biochemistry. Albeit, the content might vary with season, harvest and varieties, but was seemingly with a mean value of around 500 mg/100g. This provided considerable acidity but is prone to deterioration by light and needs to be preserved.

The brix of the sucrose syrup for the preparation of amla preserve was increased gradually ever day by 10° because if the fruit is blanched in a thick syrup or high brix, osmosis will cause its juice to be taken out quickly, causing the fruit to shrink and very little sugar is absorbed by the fruit. The gradual sucrose concentration increment gave fruits with good sucrose absorbtion and fruit colour. This was in accordance with Lal et al. (1960). The syrup was prepared using the boiling method to sterilize the syrup and prolong its preservation. The heating of syrup on ever subsequent sucrose concentration increment helped in cooking as well as sugar solubilization. The crystallization was also absent at higher sugar concentrations. This can be due to citric acid present in the srup (Priya & Khatkar, 2013). The process of preserve syrup preparation was quite successful and provided consistent results.

The pH after the pretreatment and preserve process become slightly acidic in the range of 2 to 3. The pH level of the amla preserve was discovered to be 2.67, which is within range according to Gehlot (2006). The total sugar content of the amla preserve was discovered to be 72.89%, which is within the range established by Gehlot (2006). Due to the sample's improved rate of sugar absorption, the total sugar content of the blanched with freeze sample was larger than that of the untreated and untreated with freeze sample. The vitamin C retention was found to be higher in the blanched with freeze pretreated amla preserves compared to untreated samples. This can be caused by the oxidative enzymes that break down ascorbic acid becoming inactive (Fellows, 2009). Gupta et al. (2008) reported that the blanching inactivates the enzyme maximizes the ascorbic acid retention. The results were in accordance with that obtained by (Kumar et al., 2012).

The blanching pretreatment gave soft texture to the amla preserve at 95°C. Cooking and blanching produce texture changes that are mostly caused by the solubilization and degradation of pectin found in the cell walls, as well as the gelification of those pectins. The results are in accordance with the Neri et al. (2011) that gave soft texture to carrot fruits when blanched at higher temperature for a short period of time.

The microbial analysis showed that the pre-treatment and syrup formation process had a considerably good effect on the microbial control. The lower pH and intermittent heating treatment for sugar solubilization provided hostile environment for any microbial growth. It is already proven that the bacterial load in sugar preserves are low and need not be measured (Microbiological Specifications for Foods et al., 2011; PFA, 2004). Hence, FSSAI and Food Adulteration Act and Rule of India, 2004 recommends yeast and mold growth measurement. The maximal permissible limit is mentioned to be 50 CFU per gram of preserve. The current results found that the all the treated products reduced the mold count. There might probably be a lower thermostable fungal strains in the product preparation area, hence no fungal presence was seen in the microbial assay. Once the pretreatment was successful, there was a logical absence of any microbial load in successive storage regime. Also, the sugar syrup is a natural fungal control agent and proves that the optimal syrup diffusion hindered the fungal growth.

Conclusion

The astringent fruits have limited consumption despite their nutritional benefits. The high ascorbic acid content, necessitates its need to improve the taste and texture and preservability without compromising the food quality**.** Among all the observed preservation technique, blanched and freeze pretreated amla preserve exhibited optimum vitamin C retention, high reducing and total sugar content. All the compared preservation techniques were better than the untreated amla. The color, taste and texture were found to be optimum up to 80° brix sugar syrup in the preparation of the amla preserve as compared to untreated and only blanched or freezing methods. Therefore, these combination strategies of pretreatments can be suitable for treatment of amla.

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