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Effect of TSS and CO_2 Pressure on Bio-Chemical and Sensory Qualities of Enzymatic Clarified Carbonated Jamun and Pomegranate Beverages

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A B S T R A C T

Jamun and Pomegranate fruits were crushed and treated with pectinase enzyme at 0.5 % concentration (w/v) incubated for 2-3 h at ambient temperature (AT). The clarified juices were used to prepare carbonated beverages by adjusting the total soluble solids (9, 12 and 15° B) keeping the acidity constant at 0.25 % and varying the carbonating pressure as 0 (non-carbonated), 80, 100 and 120 psi The carbonated jamun and pomegranate beverage could be stored for 6 months at ambient and low temperatures (LT) and was found acceptable with respect to colour, flavour, taste and overall acceptability. Heat processing and carbonation improved the colour, flavour and taste of the carbonated jamun and pomegranate beverages.

Introduction

Beverages are consumed by all age groups to quench the thirst, as social drinks and for health conscious and medicinal values. Non-alcoholic beverages are various types such as fruit based drinks, synthetic drinks, sweetened aerated water or carbonated drinks and some times non-alcoholic beer, wine *etc*. In India cold drinks are in demand for the greater part of the year. Carbonated drinks like cola type, lemon, lime, orange flavour etc. have become popular. The production centres of these products are located mostly in cities catering largely to the urban as well as rural populations. Carbonated beverages are popular among people of all age groups and are consumed for varied reasons including taste, refreshment, relaxation, pressure, sociability and more commonly to quench the

thirst (Phillips 1992). Most of the carbonated drinks contain synthetic colouring and flavouring components, which are suspected to be allergenic (Taylor 1982). Inclusion of concentrated fruit juices in the soft drinks not only imparts characteristic colour and flavour but also provides some nutrients (El-Wakeli *et al.,* 1974). Since the demand for soft drinks is increasing every year, we can exploit this trend by developing nutrient enriched carbonated fruit juice beverages, as the consumers are becoming increasing conscious of the ways in which diet is linked to a healthy life style (Euromonitor Market Direction 1999). The production of fruit based syrups, nectars and squashes have indicated a declining trend. Aseptically processed and packaged retail packs of ready-to-serve fruit beverages are emerging in the market. If the fruit juices are added to sweetened aerated waters, they provide nutrients, and also some more diversification to the soft drinks. Coupled with increasing demand for soft drinks, there is considerable scope for developing naturally existing nutrient rich carbonated fruit juice beverage. Total soluble solids (TSS) and CO_2 gas pressure for carbonation are key parameters that affect the sensory quality of the carbonated beverages. Based on these facts, the present investigation was conducted to study the effect of total soluble solids and CO_2 pressure on physico-chemical and sensory quality of carbonated Jamun and Pomegranate beverages.

Materials and Methods

Fully ripened jamun and pomegranate were procured from the fruit mandi, Madurai. The fruits were washed thoroughly with clean water and fruits were crushed in a fruit mill with addition of 20 % water. The juice was heated to 65° C for 10 min. The juice was treated with 0.5 % pectinase enzyme at AT (32-37° C) for 2-3 h with intermittent stirring. Juices was strained and filtered through three fold muslin cloth. The enzyme clarified juice was filled in clean pre-sterilized bottles (650 ml cap.) upto the brim and sealed with crown cork. The carbonated beverages were prepared by pre-mix method using clarified jamun and pomegranate juices by adjusting total soluble solids (TSS) at 9, 12, 15° B (with fixed acidity of 0.25 %). The desired amount of sugar and citric acid was dissolved in water by gentle heating, strained through muslin cloth and mixed thoroughly with concentrated fruit juices. The beverages were carbonated with carbonating machine at different CO_2 pressure (0, 80, 100 and 120 psi). The fruit beverage filled in pre-sterilized bottles (300 ml cap.) sealed with crown cork heated at 60° C for 20 min in water bath. For storage study, the carbonated beverages were stored at two different temperatures (ambient temperature – AT (32-37° C) and low temperature – LT (3-5° C).

Total soluble solids (TSS) as ° Brix were measured with a hand refractometer of 0-32° B (UNICO make). The pH of the Jamun and Pomegranate beverages was measured using Analog model, 301 (Corian Research, USA). The titrable acidity was determined by titration against 0.01 N NaOH (Ranganna 1986). The total and reducing sugar contents were determined using dinitrosalicylic acid (Miller 1959). The relative viscosity was measured using Ostwald viscometer by comparing the time (in seconds) taken to flow out a definite volume of the sample to that taken by equal volume of distilled water. Ascorbic acid and tannin were determined as per the procedure given by Ranganna (1986). Carbonated Jamun and Pomegranate beverages were subjected to sensory evaluation by a panel of 10 panelists using composite scoring test for colour, flaovur, mouth feel, taste and overall acceptability (Amerine *et al.,* 1965). The data were subjected to statistical analysis by Factorial Completely Randomised Design (FCRD) as suggested by Rangaswamy (1995).

Results and Discussion

Total soluble solids and titrable acidity were recorded as 9.30° B and 0.36 %, 10.70° B and 0.40 % in jamun and pomegranate juice, respectively (Table 1).

The pH of the jamun and pomegranate juices was recorded as 1.80 and 1.40, respectively. The viscosities were recorded as 1.40 in clarified jamun juice and clarified pomegranate juice. Jamun and Pomegranate juice contain 25.83 and 26.75 of Brix-acid ratio. Jamun juice recorded 6.90 and 8.90 % of reducing and total sugar while Pomegranate juice recorded 7.80 and 9.60 % respectively. The tannin content of jamun juice recorded 0.80 while pomegranate juice recorded as 0.90 mg %.

Physico-chemical characteristics of carbonated Jamun beverages

A gradual increase in TSS during storage at both temperatures lead to a final TSS of 15.0° B in AT and 14.6° B in LT respectively (Fig. 1). Khurdiya and Lotha (1994) reported that TSS mainly consists of sugars and acids. Reports showed that TSS increased on storage of fruit juices due to hydrolysis of polysaccharide and concentration due to dehydration. The TSS of Jamun based beverages ranges from 17 to 25° B which was reported by Jasim (1996). In carbonated jamun juice, titrable acidity was 0.33 % which increase to 0.43 and 0.41 % at 6 months of storage under AT and LT (Fig. 1). The pH of carbonated jamun beverage was 3.1 which decreased to 2.2 under AT and 2.7 under LT after 6 months of storage. The reducing and total sugar contents of carbonated jamun beverages was 10.3 and 10.1 %, 13.3 and 13.6 % at 6 months of storage in AT and LT respectively. A gradual decrease in Brix acid ratio (BAR) content of carbonated Jamun beverage was observed during storage. The BAR reduced from 41.2 to 34.1 and 35.6 under both AT and LT, respectively. Khurdiya and Srivastava (1994) observed that brix-acid ratio (BAR) of the guava juice was in the range of 15.7 to 22.1. Hence, the clarified guava juice as such could not be consumed. However, it can be ameliorated by increasing the BAR to 37.5 i.e. 13.5° B with 0.36 % acidity at the initial level and by carbonation. Similar conditions were noted in the present study. The storage temperature greatly influences the anthocyanin content. It decreased at faster rate at AT than at LT. After 6 months of storage, the loss of anthocyanin was 36.8 and 39.3 mg % at AT and LT, respectively. Thus, LT storage caused higher retention of anthocyanin than in AT.

Physico-chemical characteristics of carbonated Pomegranate beverages

A slight increase in TSS was noticed incase of juices after a storage period of 6 months (Fig. 2). The increase of TSS ranged from 14.6 ° B to 15.9 in AT and 15.3 ° B in LT. A gradual increase in acidity was recorded throughout the storage period of 6 months. Similar observation had been reported by Islam *et al.*, (1996) for mango based beverages. The initial acidity of carbonated Pomegranate beverage stored at AT and LT were 0.30 % which had increased to 0.38 and 0.33 %, respectively. An increasing trend in the acidity of the carbonated Pomegranate beverages had directly influenced by the change in pH. The pH of carbonated pomegranate beverage was 3.60 which decreased to 3.24 under AT and 3.32 under LT after 6 months of storage. Gradual increase in reducing sugar from 7.3 to 8.4 and 7.8 %, during storage at both temperatures (AT and LT) respectively. This might be due to the hydrolysis of non reducing sugars which continued to increase while non reducing sugar showed a decreasing trend in fruit beverage during storage, rise in level of reducing might be

assigned to the conversion on non reducing sugar, owing to the process of hydrolysis. Similar findings were also reported by Khurdiya *et al.*, (1996) in carbonated guava beverage. Total sugar of the carbonated beverage showed a gradual decrease during storage and the corresponding decrease for beverage from 14.1 to 13.6 and 13.8 % under AT and LT storage, respectively. The storage temperature gradually influenced the ascorbic acid content. It decreased at faster rate at AT than at LT. After 6 months of storage, the ascorbic acid was ranged from 16.41 to 8.80 and 12.75 mg % at AT and LT respectively. Thus, LT storage caused higher retention of ascorbic acid than beverage stored at AT.

Table.1 Physico-chemical composition of jamun and pomegranate juice

	Jamun juice	Pomegranate juice
TSS, ° Brix	9.30	**10.70**
Acidity, %	0.36	**0.40**
pH	1.80	**1.40**
Brix acid ratio, BAR	25.83	**26.75**
Viscosity, min	1.40	**1.40**
Reducing sugar, %	6.90	**7.10**
Total sugar, %	8.90	**9.60**
Tannin, %	**0.80**	**0.90**

Table.2 Sensory quality of carbonated Jamun beverage

CO_2 pressure, psi	Colour				Flavour				Mouth feel			
	9^0 B	12^0 B	15^0 B	Mean	9^0 B	12^0 B	15^0 B	Mean	9^0 B	12^0 B	15^0 B	Mean
0	12.1	12.3	13.6	**12.7**	12.4	13.0	13.6	**13.0**	0.0	0.0	0.0	**0.0**
80	12.7	13.6	15.4	**13.9**	12.5	13.4	14.0	**13.3**	11.8	15.9	16.2	**14.6**
100	13.5	14.0	15.6	**14.4**	13.2	14.0	14.2	**13.8**	13.5	14.8	15.9	**14.7**
120	12.6	13.7	15.1	**13.8**	12.6	13.4	14.1	**13.4**	13.1	14.6	15.6	**14.4**
Mean	**12.7**	**13.4**	**14.9**		**12.7**	**13.5**	**14.0**		**9.6**	**11.3**	**11.9**	
CD at 0.05												
TSS (T)				0.467				0.250				**2.628**
CO_2 Pressure (C)				0.404				0.217				**2.276**
T X C				0.805				0.434				**4.552**
	Taste				Overall acceptability							
0	10.0	10.7	11.2	**10.6**	11.1	11.9	12.2	**11.7**				
80	10.8	12.8	13.0	**12.2**	11.3	12.3	13.4	**12.3**				
100	12.3	13.7	14.4	**13.5**	12.5	13.6	14.2	**13.4**				
120	11.2	12.6	13.5	**12.5**	12.0	13.2	14.0	**13.0**				
Mean	**11.1**	**12.5**	**13.0**		**11.7**	**12.8**	**13.4**					
CD at 0.05												
TSS (T)				0.547				0.401				
CO_2 Pressure				0.474				0.347				
T X C				0.948				0.694				
Values are the average of 10 taste panelists and maximum score for each attribute is 20												

Table.3 Sensory quality of carbonated pomegranate beverage

CO_2 pressure, psi	Colour				Flavour				Mouth feel			
	9^0 B	12^0 B	15^0 B	Mean	9^0 B	12^0 B	15^0 B	Mean	9^0 B	12^0 B	15^0 B	Mean
0	10.2	11.2	11.5	**11.0**	10.3	12.1	12.5	**11.6**	0.0	0.0	0.0	**0.0**
80	13.3	14.0	15.4	**14.2**	13.5	14.4	16.4	**14.8**	11.5	14.3	14.3	**13.4**
100	12.6	12.9	14.3	**13.3**	13.2	14.2	16.1	**14.5**	12.7	12.6	15.0	**13.4**
120	12.8	13.0	14.6	**13.5**	12.9	13.6	14.9	**13.8**	12.1	12.2	14.9	**13.0**
Mean	**12.2**	**12.8**	**14.0**		**12.5**	**13.6**	**15.0**		**9.7**	**9.8**	**11.0**	
CD at 0.05												
TSS (T)				0.589				0.663				**2.391**
CO_2 Pressure				0.510				0.578				**2.071**
T X C				1.020				1.149				**2.142**
	Taste				**Overall acceptability**							
0	10.6	9.2	11.7	**10.5**	10.3	11.1	12.0	**11.1**				
80	13.6	14.0	15.3	**14.3**	13.6	14.6	15.9	**14.7**				
100	13.1	14.2	14.4	**13.8**	12.1	13.2	15.0	**13.4**				
120	11.6	13.3	14.0	**12.9**	12.7	12.9	14.2	**13.2**				
Mean	**12.2**	**12.7**	**13.8**		**12.2**	**13.0**	**14.3**					
CD at 0.05												
TSS (T)				0.692				0.639				
CO_2 Pressure				0.600				0.553				
T X C				1.199				1.107				
Values are the average of 10 taste panelists and maximum score for each attribute is 20												

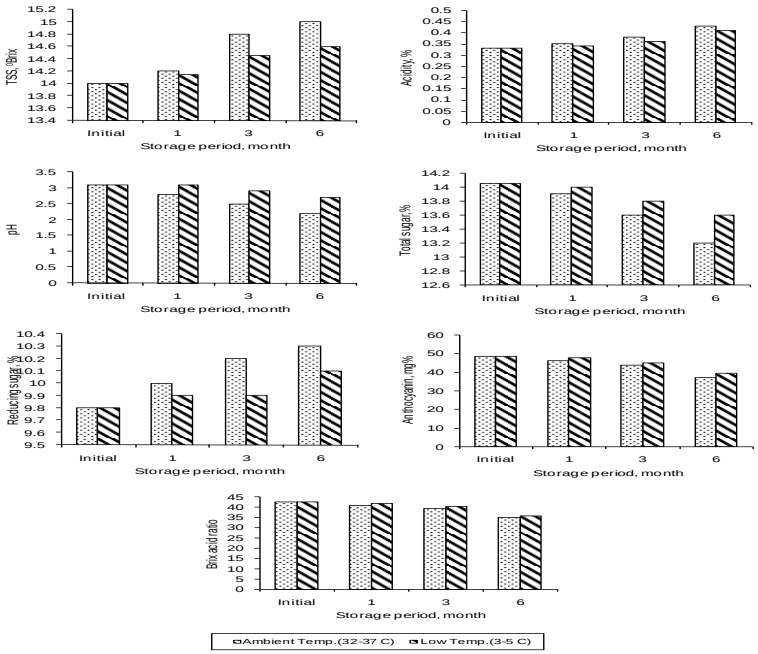

Fig. 1. Changes in physico-chemical characteristics of carbonated jamun beverages

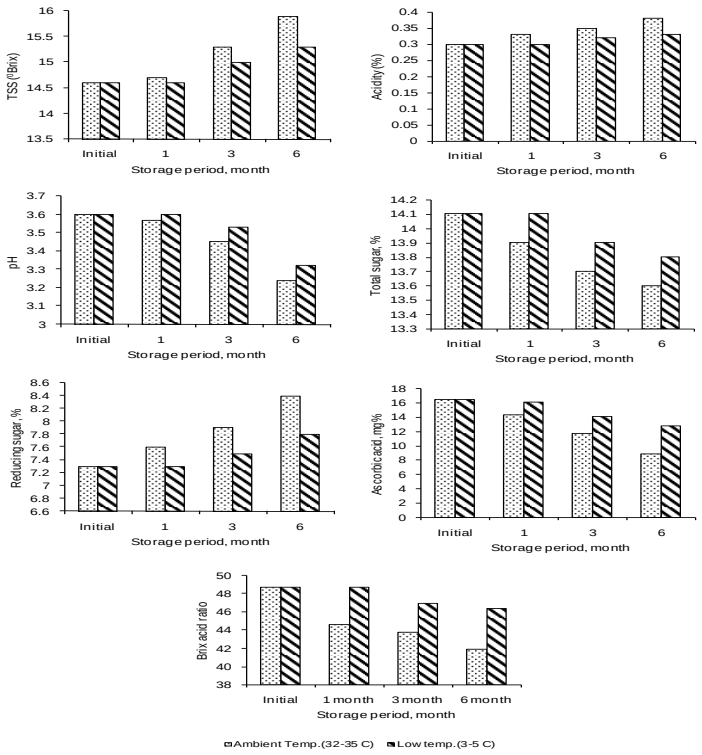

Fig. 2. Changes in physico-chemical characteristics of carbonated pomegranate beverages

Sensory qualities of carbonated jamun beverage

The score for colour of different variables ranged from 12.1 to 15.6 (Table 2).

Jamun beverage with TSS of 12 at 100 psi CO_2 gas pressure scored the maximum closely followed by 120 psi (13.6) and 80 psi (13.2). The TSS of 15° B recorded significantly higher scores of 15.6 than 12° B (14.0) and 9°B (13.5). Sensory score for flavour of carbonated jamun beverage ranged from 12.4 to 14.2. Beverage with 15° B TSS carbonated at 100 psi scored maximum (14.2) closely followed by 120 psi (14.1) and 80 psi (14.0) while that with 9° B at 0 psi (non carbonated) score the minimum scored for flavour. TSS of 15° B recorded significantly maximum score (14.2) compared to 12° B (14.0) and 9° B (13.2) at 100 psi CO_2 pressure.

The data reveals that scores for mouth feel ranged from 0 to 16.2. The non carbonated (0 psi) beverage with 9, 12 and 15° B TSS scored the minimum while 15° B beverage carbonated at 80 psi scored the maximum followed by 100 psi (15.0) and 120 psi (15.6). The sensory score for the taste ranged from 10.0 to 14.4. Beverage with 15° B TSS carbonated at 100 psi gas pressure scored the maximum (14.4) followed by 120 psi (13.4) and 80 psi (13.0). All the carbonated beverage scored significantly higher than non-carboanted beverages for overall acceptability. TSS of 15° B and carbonated pressure of 100 psi and 120 psi scored maximum for overall acceptability of the carbonated jamun beverage. In this study a beverage prepared from jamun contain 15° B TSS at 100 psi which is found to be the best. Carbonation has been reported to enhance the sensory characters (colour, flavour, taste and over all acceptability) of the jamun beverage

due to increased acidity, sparkle and taste of CO_2 itself. Kaushal and Kaushal (2003) reported about the effect of TSS and CO_2 gas pressure on the sensory scores of carbonated beverages made from reconstituted apple juice. Similar findings were also found the same study.

Sensory qualities of carbonated pomegranate beverage

The effect of TSS and CO_2 gas pressure on the sensory quality of carbonated beverage prepared from pomegranate was showed in Table 3.

The scores for colour ranged from 10.2 to 15.40 for different treatments. Pomegranate beverages with 15° B TSS carbonated at 80 psi CO_2 gas pressure scored the maximum followed by 120 psi (14.6) and 100 psi (14.3) while that with 12° B at 0 psi (non carbonated) scored the minimum followed by 100 psi (12.9). TSS of 15° B scored significantly higher (14.0) than 12° B (12.8) and 9°B (12.2). Carbonation pressure of 80 psi scored the highest (14.2) which was statistically on par with 100 psi (13.3) but significantly higher than 120 psi (13.5) and 80 psi (11.0). Data presented in Table 3 for scores for flavour ranged from 10.3 to 16.4. Khurdiya *et al.,* (1996) revealed that juice content and carbonation pressure had no significant effect on the flavour score of the carbonated guava beverage. Pomegranate beverage with 15° B TSS recorded the maximum at 80 psi (14.8) and 100 psi (14.5) while that with 12° B at 0 psi (non carbonated) recorded the minimum score followed by 120 psi (13.6). TSS of 15° B scored significantly higher (15.0) than 12 ° B (13.6) and 10° B (12.5).

Scores for mouth feel ranged from 0 to 15.0 for different treatments. Pomegranate beverage with 9, 12 and 15° B without carbonation obviously, scored the minimum while 15° B beverage carbonated at 100 psi (15.0) scored the maximum followed by 120 psi (14.9) and 80 psi (14.3). TSS of 15° B scored the maximum of 15.0, which was significantly higher than 120 psi (14.9) and 60 psi (14.3). Scores for taste ranged from 9.2 to 15.3 for different treatments. Beverage with TSS of 15° B carbonated at 80 psi scored the highest followed by 100 psi (14.4) and 120 psi (14.0) while 12° B beverage at 0 psi (non carbonated) scored the lowest followed by 80 psi (14.0). TSS of 15° B scored significantly higher (13.8) than 12° B (12.7) and 9° B (12.2). Thus TSS of 15° B scored the highest for all the sensory attributes and carbonation pressure of 80 psi CO_2 gas scored the highest for all the attributes. Therefore, Jamun as well as pomegranate juice beverage with 15° B TSS carbonated at 80 psi and 100 psi CO_2 gas pressure was adjudged to be the best from overall sensory quality. Saxena and Arora (1996) reported that carbonated RTS blends resulted in sparkling drinks of excellent sensory quality. Khurdiya (1989, 1990) also reported similar results on different fruit juice beverages.

The clarified jamun and pomegranate juice produced by enzymatic clarification can production of carbonated beverages. The CO_2 beverages prepared from jamun and pomegranate can be stored at both AT (32-37° C) and LT (3-5° C) retaining colour, flavour, taste and over all acceptability.

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