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EFFECT OF LOW CALORIE SWEETENERS ON BIOCHEMICAL COMPOSITION AND SENSORY QUALITY OF GAUAVA NECTAR DURING STORAGE

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ABSTRACT

A study was undertaken for preparation of nectar using different natural and artificial sweeteners as the treatments and the processed nectar was analyzed in Completely Randomized Design. Biochemical parameters viz., TSS, acidity, ascorbic acid, non-reducing sugars, and total sugars as well as organoleptic attributes (colour, and overall acceptability) of nectar were evaluated at an interval of 0 days upto 90 days in 30 days interval during the storage. An overall result of fruit nectar prepared from guava was found better in the treatment T₃ (50% Equal + 50% Sugar) which was statistically at par with T₇ (50% Stevia + 50% Sugar). Results indicated that the minimum physico-chemical changes viz., TSS (9-9.47°Brix), acidity (0.31- 0.49%), reducing sugars (7.23 - 7.97 %), total sugars (17.28 - 17.74%) showed increasing trend while ascorbic acid (32.42 – 28.78 mg/100 g), non-reducing sugars (10.05-9.81%) and sensory attributes showed decreasing values with duration of storage. The overall acceptability was recorded maximum in T₃ treatment and ranges between (8.09-7.54). Considering above chemical constituents as well as sensory attributes of processed nectar, both the treatments T₃ (50% Equal + 50% Sugar) and T₇ (50 % Stevia + 50% Sugar) were found better for nectar preparation.

INTRODUCTION

India is second largest producer of fruits and vegetables in the world after china, the present quantity of fruit and vegetable processing is very meager (around 2.2%) as compared to 80% in USA, 70% France, 80% Malaysia and 30% Thailand. The fruit and vegetable processing in India is highly decentralized, small-scale industries accounting for 33%, organized 25%, unorganized 42% and large number of units in cottage/household and small scale sector, having capacities of up to 250 tonnes/ annum. (Singh *et al.*, 2014).

Guava (*Psidium guajava* L.), a member of the botanical family Myrtaceae, is one of the major fruit crops grown in tropical and subtropical regions of the world. Owing to its nutritional superiority, cheaper prices and characteristic flavor, it has gained wide popularity amongst rich as well as poor strata of the society. It has good potential for marketing both in raw and processed forms because of its taste, texture, colour, and potentiality for processing into products (Karanjekar *et al.*, 2013).

Being a climacteric fruit, guava is very perishable in nature and very short shelf life therefore, may have enormous potential if converted into nutritious beverages with exotic taste. The finished beverages contain about 8 to 14 per cent sugar. Today's consumers expect more and more pleasure from food. They want to drink that type of beverage which should be lower in fat and sugar.

Nectar is one of the refreshing beverages having zero carbonation, relatively few preservatives and excellent source of several important vitamins and minerals and is used as health drink. Therefore, it is necessary to utilize guava for making nutritious processed health food like nectar and RTS to increase availability over an extended period and to stabilize the price during the glut season. To utilize the produce at the time of glut and to save it from spoilage, the processing technology for preparation guava nectar is highly required. It will also generate opportunity for self-employment by starting small scale processing unit that could be remunerative to the growers and could make significant contribution to food industry.

Sweetness is a strong stimulant of food/drink intake. Sugar provides sweetness and also contributes towards energy intake. The development of products containing low calorie sweeteners could therefore allow consumers to enjoy sweet foods and drinks with fewer calories. Artificial sweeteners are used in place of normal table sugar and can be made from chemicals or some natural herbs. Artificial sweeteners are used in food products to lower the calorie content as part of weight reduction and to assist patients with diabetes in controlling blood sugar more effectively and to lower the risk of tooth decay.

These facts resulted in development of sugar free as low calorie sweeteners. Therefore, fruit beverages can be made with lower calorie sugar like stevia, equal and splenda. The artificial sweeteners used in this study are Sucralose and Aspartame which are marketed by trade name Splenda and Equal, respectively. The chemicals Splenda and Equal are 600 and 200 times sweeter than sugar, respectively. Whereas, stevia is marketed by different names viz. truvia, purevia and stevia powder and it is 200 times sweeter than sugar. Presently, low calorie sweeteners are being used in a wide variety of foods and other items such as jams, pickles, sauces, fruit preserves, soft drinks, ice creams, pharmaceutical products, tooth paste and mouth

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wash. So, the aim of research was to investigate the influence of processing on the biochemical and nutritional composition of guava nectar.

MATERIALS AND METHODS

This experiment was conducted in the Horticulture Processing Laboratory Department of Horticulture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during the year 2014-15.

Raw material and sample preparation

Fully matured and ripe guava fruits of uniform size, free from mechanical damage, bruises and fungal attack were procured from horticulture orchard, IGKV, Raipur. The fruits were washed with tap water in the laboratory. Fruits were used for preparation of nectar with different artificial and natural sweeteners. The pulp was extracted by using pulper machine and strained through 1 mm stainless steel sieve. The prepared nectar was heated at 85°C for 30 minutes with acidity was maintained 0.3%. The prepared nectar product was filled into the clean and sterilized plain glass bottle of 200 ml and sealed with crown cork. The filled bottle was pasteurized in boiling water for 30 minutes and cooled and stored in room temperature. The processed products for biochemical evaluation as well as organoleptic evaluation were periodically observed upto 90 days at 30 days interval. The experiment consists of 12 treatment of alternative sweetener and one treatment of 100% sugar combination each for nectar. The treatment were replicated three times in Completely Randomized block design (CRD).

The following treatments were evaluated in the investigation:

T ₀ 100% sugar	T ₇ 50 per cent Stevia+ 50 per cent Sugar
T ₁ 100 per cent Equal(Aspartame)	T ₈ 25 per cent Stevia+ 75 per cent Sugar
T ₂ 75 per cent Equal+ 25 per cent Sugar	T ₉ 100 per cent Splenda (Sucralose)
T ₃ 50 per cent Equal+ 50 per cent Sugar	T ₁₀ 75 per cent Splenda+ 25 per cent Sugar
T ₄ 25 per cent Equal+ 75 per cent Sugar	T ₁₁ 50 per cent Splenda+ 25 per cent Sugar
T ₅ 100 per cent Stevia	T ₁₂ 25 per cent Splenda+ 75 per cent Sugar
T ₆ 75 per cent Stevia+ 25 per cent Sugar	

Biochemical analysis

Chemical analysis of guava nectar was done initially just after preparation upto 90 days at 30 days interval during storage under ambient condition. TSS of nectar was determined by Hand Refractometer at 20°C and expressed in per cent. The acidity and ascorbic acid of nectar was determined by the procedure given by Ranganna (1986). Sugars (Reducing, non-reducing and total sugars) were determined by the method of Lane and Eynon as described by Ranganna (1986).

Sensory evaluation

The sensory parameters of colour and appearances, aroma, taste and overall acceptability were evaluated with 10 trained panelist based on 9 point Hedonic rating scale as described by Ranganna (1986).

Statistical analysis

The data recorded on different parameters were statistically analyzed using Completely Randomized Design and critical differences (CD) were calculated at 5 % level of significance to compare the treatments as per the method given by Gomez

and Gomez (1984).

RESULTS AND DISCUSSION

The various biochemical changes in guava nectar due to varying recipe (treatment) and storage period are presented in Table 1.

Total soluble solids (TSS)

Maximum total soluble solids were found in (T₀) that was formulated with sugar (100%). Whereas, minimum TSS was recorded in T₉ that was formulated with 100 per cent Splenda (Sucralose). During storage a slight increase in TSS was observed in all samples. The increase in TSS might be due to the formation of pectic substances from protopectin and mono saccharides from disaccharides *i.e.*, degradation of sucrose into glucose and fructose. Similar results have been reported by Sarolia and Mukherjee (2002) in their studies on lime juice.

Acidity

Acidity is also an important attribute because tartness is a major factor in the acceptability of guava drink. Acid gives the characteristic sourness to the product. Highest acidity was recorded in T₉ (Splenda 100%) while, lowest was observed in T₃ (50% Equal + 50% Sugar). There was gradual increase in acidity were observed in all treatments during storage upto 90 days. However, non significant variation in acidity was observed at storage interval of 0 and 30 days. This increase in acidity was attributed to the degradation of sugars into carboxylic acids.

Ascorbic acid

Marginal differences in ascorbic acid contents were observed in various treatments. Ascorbic acid contents decreased significantly at all storage intervals. These losses of ascorbic acid were attributed to the effect of processing, storage time and exposure to light. Highest ascorbic acid was recorded in T₃ (50% Equal + 50% Sugar) while lowest was observed in T₉ (100% Splenda). The decrease in ascorbic acid content may be due to the degradation of ascorbic acid in juice or drink may follow aerobic and an-aerobic pathways (Moshonas and Shaw, 1989). Similar decreasing trend for ascorbic acid contents in different fruit beverages were also reported by the Ranote and Bains (1982).

Reducing sugar

Reducing sugars increased significantly during storage. It is very important component for a processed product with respect to quality, shelf life, taste and discoloration during storage. Highest reducing sugar was observed in T₉ (100% Splenda) while lowest reducing sugar was recorded in T₃ (50% Equal + 50% Sugar). Increase in reducing sugars might be assigned to the partial acid hydrolysis of starch and disaccharide of nectar converted into invert sugar and also inversion of part of non-reducing sugars into glucose and fructose and gradual degradation of polysaccharides in pulp through acid hydrolysis. These results were agreed with the investigation reported earlier for canned mango nectar, guava nectar, and guava-aonla blended beverages.

Non-reducing sugar

Non-reducing sugars in guava nectar showed lowest in

Table 1: Effect of low calorie sweeteners on biochemical composition of guava nectar during storage

Treatment	Storage periods (days)			
	0 days	30 days	60 days	90 days
	Total Soluble Solids (TSS) (%)			
T ₀	18.00	18.22	18.33	18.37
T ₁	2.00	2.14	2.20	2.27
T ₂	5.07	5.16	5.26	5.33
T ₃	9.00	9.25	9.32	9.47
T ₄	13.5	13.53	13.63	13.78
T ₅	1.60	1.69	1.83	1.93
T ₆	5.18	5.26	5.37	5.52
T ₇	9.00	9.27	9.37	9.50
T ₈	13.00	13.32	13.5	13.58
T ₉	1.00	1.34	1.46	1.67
T ₁₀	5.00	5.41	5.57	5.64
T ₁₁	9.12	9.63	9.75	10.00
T ₁₂	13.20	13.43	13.52	13.62
SEm ±	0.025	0.01	0.010	0.010
CD at 5 %	0.070	0.03	0.030	0.030
	Acidity (%)			
T ₀	0.37	0.37	0.48	0.56
T ₁	0.36	0.36	0.46	0.47
T ₂	0.37	0.37	0.47	0.52
T ₃	0.32	0.32	0.37	0.49
T ₄	0.35	0.35	0.49	0.55
T ₅	0.36	0.36	0.39	0.53
T ₆	0.35	0.35	0.41	0.53
T ₇	0.33	0.33	0.43	0.51
T ₈	0.35	0.35	0.46	0.54
T ₉	0.38	0.38	0.54	0.66
T ₁₀	0.36	0.36	0.52	0.62
T ₁₁	0.37	0.37	0.51	0.58
T ₁₂	0.38	0.38	0.53	0.65
SEm ±	0.011	0.010	0.011	0.008
CD at 5 %	NS	NS	0.02	0.02
	Reducing sugar (%)			
T ₀	7.48	7.58	7.83	8.12
T ₁	7.52	7.64	7.88	8.18
T ₂	7.57	7.68	7.96	8.29
T ₃	7.23	7.32	7.68	7.97
T ₄	7.62	7.74	8.04	8.40
T ₅	7.67	7.82	8.08	8.52
T ₆	7.7	7.85	8.11	8.56
T ₇	7.32	7.42	7.73	8.05
T ₈	7.42	7.56	7.78	8.10
T ₉	7.94	8.09	8.34	8.89
T ₁₀	7.87	7.97	8.23	8.64
T ₁₁	7.76	7.87	8.22	8.58
T ₁₂	7.92	8.07	8.29	8.78
SEm ±	0.009	0.010	0.011	0.009
CD at 5 %	0.027	0.030	0.033	0.027
	Total sugar (%)			
T ₀	17.42	17.47	17.72	17.85
T ₁	17.45	17.53	17.75	17.92
T ₂	17.48	17.55	17.79	17.95
T ₃	17.28	17.34	17.61	17.74
T ₄	17.51	17.59	17.83	18.02
T ₅	17.54	17.63	17.84	18.08
T ₆	17.56	17.65	17.85	18.12
T ₇	17.32	17.38	17.65	17.81
T ₈	17.38	17.45	17.69	17.83
T ₉	17.68	17.72	17.92	18.25
T ₁₀	17.62	17.67	17.89	18.2
T ₁₁	17.59	17.65	17.86	18.16
T ₁₂	17.64	17.69	17.9	18.23
SEm ±	0.010	0.009	0.009	0.014
CD at 5 %	0.030	0.027	0.027	0.042

Table 1: Cont....

Treatment	Storage periods (days)			
	0 days	30 days	60 days	90 days
Total Soluble Solids (TSS) (%)				
Non-reducing sugar (%)				
T ₀	9.94	9.91	9.89	9.71
T ₁	9.93	9.89	9.87	9.68
T ₂	9.91	9.87	9.83	9.66
T ₃	10.05	10.02	9.93	9.81
T ₄	9.89	9.85	9.78	9.62
T ₅	9.87	9.81	9.76	9.56
T ₆	9.86	9.8	9.74	9.55
T ₇	10	9.96	9.92	9.78
T ₈	9.96	9.94	9.91	9.76
T ₉	9.74	9.67	9.61	9.34
T ₁₀	9.75	9.7	9.64	9.38
T ₁₁	9.83	9.78	9.68	9.67
T ₁₂	9.72	9.58	9.63	9.56
SEm ±	0.009	0.010	0.012	0.010
CD at 5 %	0.027	0.030	0.03	0.03
Ascorbic acid (mg/100ml)				
T ₀	32.26	31.68	30.88	26.93
T ₁	32.23	31.52	30.72	26.66
T ₂	32.17	30.56	30.68	26.31
T ₃	32.42	32.32	31.17	28.78
T ₄	32.12	31.07	30.62	26.15
T ₅	32.24	29.95	30.57	26.05
T ₆	32.23	30.34	30.54	26.02
T ₇	32.38	31.76	30.98	27.37
T ₈	32.33	31.72	30.92	27.25
T ₉	31.92	29.66	27.02	25.65
T ₁₀	32.05	29.83	27.48	25.89
T ₁₁	32.10	29.91	27.51	25.94
T ₁₂	31.95	29.78	27.13	25.84
SEm ±	0.705	1.93	0.009	0.010
CD at 5 %	NS	NS	0.027	0.02

treatment T₉ (100% Splenda) and highest in T₃ (50% Equal + 50% Sugar) during storage. This gradually decreased during storage which might be due to significant increase in reducing sugar by acid hydrolysis of reducing sugar and there by inversion of non-reducing sugar to reducing sugar, However, the pattern of decrease of non-reducing sugar percent varied according to treatments. Similar type of observation were also reported by Choudhary *et al.* (2008) in guava nectar.

Total sugar

Total sugar of guava nectar showed significantly increasing trend during three months of storage. The lowest total sugar was observed in treatment T₃ (50% Equal + 50% Sugar) and highest total sugar was observed in T₉ (100% Splenda). Total sugar was increased during storage period is due to solubilization of pulp constituents and hydrolysis of polysaccharides including pectin and starch materials. Similar type of observation for total sugar of various products have been reported by Choudhary *et al.* (2008) in guava nectar, Pandey (2004) stability of guava beverages.

Organoleptic evaluation

The effect of artificial and natural sweeteners on organoleptic qualities of guava nectar during storage are presented in the Table 2.

Colour and appearances

The maximum organoleptic score for colour and appearance of guava nectar was recorded in treatment T₃ (50% Equal + 50% Sugar) is statistically at par with T₇ (50% Stevia + 50% Sugar) during storage. The organoleptic score for colour and appearance showed decreasing trend during storage which might be due to the action of acidity which enhances the hydrolytic reaction causes browning and acid also enhances the millard reaction and caramelization which causes more browning in product. Polyphenolic compound present in fruit pulp also reacts with enzymes to get discoloration. These findings were accordance with Kalra&Tandon (1991) in guava nectar.

Aroma

The maximum score for taste of guava nectar was recorded in treatment T₃ (50% Equal + 50% Sugar) which is statistically at par with T₇ (50% Stevia + 50% Sugar) during storage.

Taste

The maximum score for taste of guava nectar was recorded in treatment T₃ (50% Equal + 50% Sugar) which is statistically at par with T₇ (50% Stevia + 50% Sugar) during storage. These findings were accordance with Kalra&Tandon (1991) and Choudhary *et al.* (2008) for guava nectar, Chakraborty *et al.* (1991) for canned mango nectar, Pandey (2004) for guava beverages, Mall and Tandon (2007) for guava-aonla blended

Table 2: Effect of low calorie sweeteners on organoleptic score of guava nectar during storage

Treatment	Storage periods (days)			
	0 days	30 days	60 days	90 days
	Colour and appearance			
T ₀	7.73	7.78	7.63	7.43
T ₁	7.71	7.66	7.53	7.32
T ₂	7.69	7.57	7.47	7.23
T ₃	8.13	8.08	7.93	7.73
T ₄	7.64	7.49	7.37	7.16
T ₅	7.47	7.41	7.35	7.14
T ₆	7.37	7.39	7.29	7.12
T ₇	8.02	7.93	7.83	7.63
T ₈	7.93	7.88	7.74	7.60
T ₉	7.16	6.96	6.79	6.63
T ₁₀	7.23	7.08	6.90	6.78
T ₁₁	7.34	7.18	6.92	6.85
T ₁₂	7.18	6.98	6.85	6.74
SEm ±	0.011	0.011	0.009	0.009
CD at 5 %	0.03	0.03	0.02	0.02
	Aroma			
T ₀	7.71	7.59	7.52	7.24
T ₁	7.63	7.57	7.46	7.16
T ₂	7.68	7.58	7.51	7.20
T ₃	8.02	7.92	7.78	7.41
T ₄	7.49	7.39	7.24	6.98
T ₅	7.46	7.37	7.19	6.91
T ₆	7.32	7.28	7.09	6.83
T ₇	7.98	7.83	7.73	7.37
T ₈	7.78	7.69	7.68	7.28
T ₉	7.08	6.98	6.82	6.58
T ₁₀	7.18	7.02	6.86	6.62
T ₁₁	7.31	7.16	6.94	6.71
T ₁₂	7.29	7.12	6.92	6.67
SEm ±	0.011	0.011	0.010	0.009
CD at 5 %	0.033	0.033	0.030	0.027
	Taste			
T ₀	7.79	7.57	7.45	7.23
T ₁	7.22	7.13	6.98	6.83
T ₂	7.76	7.55	7.43	6.98
T ₃	8.13	7.98	7.69	7.49
T ₄	7.73	7.48	7.27	7.08
T ₅	7.51	7.32	7.18	6.92
T ₆	7.53	7.37	7.21	7.02
T ₇	7.93	7.89	7.53	7.33
T ₈	7.87	7.83	7.49	7.28
T ₉	6.47	6.35	6.21	6.12
T ₁₀	6.94	6.80	6.62	6.47
T ₁₁	7.06	6.82	6.77	6.51
T ₁₂	6.50	6.78	6.59	6.43
SEm ±	0.010	0.010	0.01	0.010
CD at 5 %	0.030	0.03	0.02	0.03
	Overall acceptability			
T ₀	7.74	7.64	7.53	7.3
T ₁	7.49	7.45	7.29	7.03
T ₂	7.71	7.57	7.43	7.17
T ₃	8.09	7.99	7.8	7.54
T ₄	7.58	7.47	7.34	7.08
T ₅	7.48	7.36	7.28	6.82
T ₆	7.40	7.34	7.19	6.96
T ₇	7.97	7.88	7.69	7.43
T ₈	7.86	7.8	7.63	7.39
T ₉	6.87	6.90	6.61	6.42
T ₁₀	7.1	7.01	6.81	6.68
T ₁₁	7.19	7.04	6.87	6.72
T ₁₂	7.05	6.92	6.77	6.64
SEm ±	0.010	0.010	0.01	0.010
CD at 5 %	0.03	0.03	0.02	0.03

beverage, Kumar *et al.* (2008) for musambi RTS Beverage.

Overall acceptability

The maximum score for overall acceptability of guava nectar was found in treatment T₃ (50% Equal + 50% Sugar) during storage. It may be due to non-enzymatic reactions like caramelization and millard. The score for overall acceptability of nectar was declined significantly during storage owing to oxidative reaction to deteriorate the scores of colour, flavour as well taste. These findings were accordance with Kalra and Tandon (1991) and Choudhary *et al.* (2008) for guava nectar.

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