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EVALUATION OF QUALITY CHARACTERISTICS OF SUGARCANE SYRUP

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ABSTRACT

The sugarcane syrup prepared from fresh sugarcane juice as well as the sugarcane syrup (70^{o} Brix) was processed, packed in three different packaging materials viz., polyethylene (400 gauge) bag (P_1), polyethylene terephthalate (PET) jars (P_2) and glass bottles (P_3) and stored at ambient conditions to study the storage quality. The changes in physical, chemical characteristics, microbial load and sensory scores were evaluated at periodic intervals of 30 days during the period of storage study (180 days). The moisture, pH and total sugar content of sugarcane syrup decreased during storage. An increase in acidity and reducing sugar content of sugarcane syrup were observed at the end of storage. The mineral composition was observed to be high in sugarcane syrup (ash 1.67g/100g, calcium 43.2 mg/100g, phosphorus 42.5 mg/100g and iron 2.22 mg/100g) than sugar syrup. However, there was slight changes were observed in mineral content of the samples during storage. Initially there was no bacterial, fungal and yeast count in control and treated samples. A slight increase in bacterial, fungal and yeast population noticed at the end storage period was found to be within acceptable limits.

KEYWORDS

Sugarcane syrup, Physico-chemical properties and Sensory evaluation.

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INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is cultivated in both tropical and subtropical regions of the world. India is the largest producer of sugarcane in the world running neck to neck with Brazil. Sugarcane is the cheapest energy giving food containing glucose and fructose. (Singh *et al*., 2006)[1]. Sugarcane contains phenolic acids, flavonoids and various other phenolic compounds, which are accounted to be partially responsible for the observed antioxidant activity in sugarcane juice and syrup (Payer *et al*., 2005)[2]. Sugarcane juice is used as a delicious drink and the juice of 100 ml provides 40 kcal of energy, 10 mg of calcium, 1.1 mg of iron and 6 μg of carotene. It has been attributed to possess cooling effects with several medicinal values (Parvathy, 1983)[3]. Sugarcane juice contains moisture (75-85%), non-reducing sugar (10-21%), reducing sugars (0.3-3%), organic substances (0.5-1%), inorganic substances (0.2-0.6%) and nitrogenous bodies (0.5 - 1%) (Swaminathan, 1995)[4].

Sugarcane juice is enjoyed as an inexpensive and pleasing beverage in India. Sugarcane, being one of the cash crops of India, its juice is available almost throughout the country. Fresh sugarcane juice cannot be stored normally for more than six hours and commercially it has short shelf life. In order to improve shelf life, there is an imperative need to develop processing techniques based on sugarcane juice with an aim of evaporating the water in the juice to yield concentrated syrup which is considered to be healthy and also extends its shelf life. Sugarcane syrup can be stored on the shelf for about two years after opening.

Sugarcane syrup has many advantages over sugar and jaggery. Commercial sugar has been implicated as a causative factor in heart diseases and dental problems. White crystalline sugar takes away calcium and potassium from the body during digestion (Asokan, 2007)[5]. At present for obtaining better colour most of the jaggery is produced by using harmful chemical clarificants. Most of the jaggery is prepared by the use of chemicals which contains more than 80-120 ppm of sulphur dioxide in the jaggery. This high amount of sulphur dioxide is detrimental to the beneficial intestinal micro flora leading to gastro intestinal problems and can also cause breathing problems in asthmatic patients. It is also implicated in the etiology of colon cancer and also affects the formation of vitamin A and vitamin B_{12}.

Sugarcane syrup prepared from sugarcane juice is a unique natural product which meets the need of a target public in search of a healthier nutrition. Sugarcane syrup is cheap in cost, loaded with high-energy carbohydrates and rich in iron, calcium and phosphorous. Consumption of sugarcane syrup is reported to build up resistance to disease and colds. Sugarcane syrup is high in policosanol, which has been proven effective at reducing cholesterol levels.

Therefore the nutritional potential of sugarcane syrup as an alternative sweetening agent to sugar and jaggery is of considerable value for majority of the population in rural and urban India. Sugarcane syrup would become increasingly important as sources of nourishment. The focus on sugarcane syrup would encourage food technologists and manufacturers to develop their products accordingly.

MATERIAL AND METHODS

Sugarcane juice was purchased from the local market of Madurai and used for the present study. Packaging materials *viz.*, polyethylene bags (400 gauge) thickness, Poly Ethylene Terephthalate (PET) jars and glass bottles were purchased from the local shop.

Processing of sugarcane syrup

The mechanically crushed sugarcane juice was collected in a clean vessel after straining through a fine sieve to remove suspended impurities from the juice. The steps involved in the processing of sugarcane syrup are given Figure No.1 and Plate No.1. The freshly extracted juice was boiled vigorously till most of the water evaporated and juice gets concentrated as syrup and the temperature starts raising steadily to around 105^{o}C. Sugarcane juice was concentrated to syrup corresponding to TSS of syrup having an end point of 70^{o} Brix. The syrup was filtered using muslin cloth, cooled and packed in thermally sealed polyethylene (400 guage) bags (P_1), PET (polyethylene terephthalate) jars (P_2) and glass bottles (P_3) for six month at room temperature ranging 32-37^{o}C. The changes in physical, chemical, microbial and organoleptic characteristics of sugarcane syrup and the control (syrup prepared from refined sugar) were analyzed at regular intervals of 30 days during a storage period of 180 days.

NUTRIENT ANALYSIS

The various physiochemical tests were carried out for yield of sugarcane syrup. The viscosity of the sugarcane syrup was measured by Deep Vision Viscometer (Model red wood IP 7), moisture

(AOAC, 1995)[6], acidity, pH were determined by the method described, Saini *et al*. (2000)[7], reducing sugar and total sugar were determined by the method described by McDonald and Foley, (1960)[8], ash (Govindaraju *et al.*, 2001)[9], calcium (titration), iron (colorimetric) were determined by the AOAC (1995)[6] and phosphorous (Fiske and Subbarao, 1995)[10], sensory evaluation for colour and appearance, flavor, texture, taste, overall acceptability (Amerine *et al.*, 1965)[11] and microbiological parameters were enumerated by the method described by Istawankiss (1984)[12].

STATISTICAL ANALYSIS

The nutritive values of sugarcane syrup were subjected to statistical analysis to find out the impact of treatments, storage periods and packaging materials on the quality of the samples during storage. Completely Randomized Design (CRD) was applied for the analysis. The levels of significant differences are reported as $p \leq 0.05$.

RESULTS AND DISCUSSION

Physical properties and nutrient composition of the sugarcane syrup

The nutrient composition of sugarcane syrup is presented in Table No.1. The changes in chemical constituents during storage of the sugarcane syrup were assessed for moisture, acidity, pH, protein, reducing and total sugars, ash, calcium, phosphorous and iron at periodic intervals of 30 days during the entire storage period of 180 days. Highly significant difference was noted for moisture, acidity, pH, total sugar and reducing sugars at 5% level ($p \leq 0.05$) in treatment, packaging and storage. The viscosity of freshly prepared sugarcane syrup (T_2) was 236 sec/10ml and the control (T_1) recorded 233 sec/10ml and the corresponding values at the end of storage period were increased. Chauhan *et al.*, (1997)[13] noticed that the viscosity of sugarcane juice increased during storage. The freshly prepared sugarcane syrup had comparatively higher moisture content (24.06 %) than control (24.00 %), which had reduced at the end of the storage period (180 days). Similarly to this result Singh *et al.*, (2002)[14] studied the moisture content of sugarcane juice concentrate gradually decreased from 31.6 to 31.1 per cent during 180 days of storage. The freshly prepared syrup contained 0.56 g/100g acidity in T_1 and 0.64 g/100g acidity in T_2, which had increased during storage. The increase in acidity during storage of T_1 samples packed in P_1, P_2 and P_3 were 0.11, 0.10 and 0.12 g/100g respectively compared to 0.12, 0.11 and 0.13 g/100g respectively obtained in T_2 samples. Kaushik *et al.* (1993)[15] reported that the changes in acidity of honey gradually increased from 2.47 to 3.05 m.e. (malic acid equivalent) /100g during 180 days of storage. The freshly prepared samples recorded a pH of 4.60 in T_1 and 4.65 in T_2. Kaushik *et al.*, (1993)[15] reported that the changes in pH of honey gradually decreased from 4.1 to 3.7 after six months of storage. Among the treatments, the freshly prepared sugarcane syrup (T_2) recorded higher total sugar content compared to control (T_1). The initial total sugar content was found to be 63.95 g/100g in T_2 and 62.20 g/100g in T_1 respectively which had reduced at the end of the storage. The reduction in total sugar content may be due to the utilization of sugars in non-enzymatic browning reaction occurring during storage. Bolbol (2005)[16] observed the total sugar content of date syrup as 71.20 - 91.09 per cent. Initially the sugarcane syrup (T_2) recorded a reducing sugar content of 27.50 g/100g and the control (T_1) had 27.20 g/100g. At the end of 180 days of storage, the values for reducing sugar were increased. The conversion of total sugar to simple sugars during storage might have increased the reducing sugar level in the sugarcane syrup during storage. Singh *et al.*, (2002)[14] observed that the reducing sugar content of sugarcane juice concentrate gradually increased from 29.5 to 32.8 per cent during 180 days of storage. The freshly prepared sugarcane syrup (T_2) and control (T_1) recorded 1.67 and 1.52 g/100g of ash respectively. The calcium, phosphorus and iron content of the syrup were 1.25, 0.26 and 0.04 mg/100g for T_1 and 43.2, 42.5 and 2.22 mg/100g for T_2 respectively. There was slight reduction was observed in ash and mineral content of the samples during the storage period. Singh *et al.*, (2002)[14] reported an ash content of 2.1 ± 0.7 per cent in sugarcane juice concentrate compared to 1.67 g/100g observed in the present study. The mineral components of sugarcane juice concentrate showed an increased level of calcium (79 ± 2.1 mg/100g), phosphorous (86.0 ± 14.7 mg/100g) and iron (4.7 ± 1.6 mg/100g) during storage.

SENSORY EVALUATION

The quality attributes of sugarcane syrup were depicted in Table No.2. The sensory quality of sugarcane syrup for the various sensory attributes such as colour, appearance, flavour, consistency, taste and overall acceptability (8.5 to 8.6 out of 9.0) of the samples were slightly reduced during the storage period. A slight decrease in sensory scores was noticed at the end of storage period.

MICROBIAL POPULATION

The bacterial, fungal and yeast count in sugarcane syrup samples is presented in Table No.3. The microbial load of the sugarcane syrup was found to increase during the storage period in different packaging materials. Initially there was no bacterial, fungal and yeast count in control and treated samples. At the end of 180 days of storage, slight change in microbial load was noticed in the different syrup samples.

Among the packaging materials showed low microbial population and was found to be within the safer limits. The bacteria, fungi and yeast population were more in polypropylene bags, PET jars than glass bottles. Therefore the present study was concluded that the glass bottle is possibility to store the sugarcane syrup. Singh *et al*., (2002)[14] conducted studies on the bacterial population of sugarcane juice concentrate, which showed 3.6×10^{3} cfu/g. The fungal and yeast count of sugarcane juice concentrate which showed a increasing trend was observed during storage. Yusof *et al.*, (1999)[17] observed the changes in quality of sugarcane juice upon delayed extraction and storage. The study revealed that microbial count, especially lactic acid bacteria count, increased during storage of cane juice.

Table No.1: Nutrient changes in the sugarcane syrup during storage (per 100g)

S.No	Nutrients		T_1			T_2			CD (0.05)
			P_1	P_2	P_3	P_1	P_2	P_3	
1	Viscosity (sec/10ml)	Initial	233	233	233	236	236	236	0.47165 NS
		Final	242	242	243	247	246	247	
2	Moisture (%)	Initial	24.00	24.00	24.00	24.06	24.06	24.06	0.02268 **
		Final	23.10	23.12	23.07	23.20	23.22	23.19	
3	Acidity (g)	Initial	0.56	0.56	0.56	0.64	0.64	0.64	0.02152 **
		Final	0.67	0.66	0.68	0.76	0.75	0.77	
4	pH	Initial	4.60	4.60	4.60	4.65	4.65	4.65	0.02657 **
		Final	4.46	4.48	4.47	4.53	4.52	4.51	
5	Total sugar (g)	Initial	62.20	62.20	62.20	63.95	63.95	63.95	0.20589 **
		Final	61.03	61.05	61.01	62.63	62.67	62.65	
6	Reducing sugar (g)	Initial	27.20	27.20	27.20	27.50	27.50	27.50	0.57844 **
		Final	28.66	28.65	28.68	29.06	29.04	29.07	
7	Ash (g)	Initial	1.52	1.52	1.52	1.67	1.67	1.67	0.02965 NS
		Final	1.50	1.49	1.51	1.65	1.64	1.63	
8	Calcium (mg)	Initial	1.25	1.25	1.25	43.20	43.20	43.20	0.05005 NS
		Final	1.22	1.23	1.20	43.17	43.15	43.16	
9	Phosphorous (mg)	Initial	0.26	0.26	0.26	42.50	42.50	42.50	0.05892 NS
		Final	0.23	0.21	0.22	42.45	42.47	42.44	
10	Iron (mg)	Initial	0.04	0.04	0.04	2.22	2.22	2.22	0.02296 NS
		Final	0.02	0.03	0.01	2.20	2.21	2.20	

** - Significant at 5% level, NS - Non-significant**,** T_1 - Sugar syrup, T_2 - Sugarcane syrup P_1- Polyethylene bags (400 guage), P_2- PET jars, P_3- Glass bottles.

Table No.2: Changes in organoleptic characteristics of sugarcane syrup during storage

S.No	Organoleptic characteristics		T_1			T_2		
			P_1	P_2	P_3	P_1	P_2	P_3
1	Colour	Initial	9.0	9.0	9.0	9.0	9.0	9.0
		Final	8.5	8.5	8.6	8.6	8.5	8.6
2	Flavor	Initial	9.0	9.0	9.0	9.0	9.0	9.0
		Final	8.6	8.5	8.5	8.6	8.5	8.6
3	Consistency	Initial	9.0	9.0	9.0	9.0	9.0	9.0
		Final	8.6	8.5	8.5	8.6	8.5	8.6
4	Taste	Initial	9.0	9.0	9.0	9.0	9.0	9.0
		Final	8.7	8.5	8.7	8.7	8.6	8.7
5	Overall acceptability	Initial	9.0	9.0	9.0	9.0	9.0	9.0
		Final	8.4	8.4	8.5	8.5	8.5	8.6

Table No.3: Microbiological changes in sugarcane syrup during storage

S.No	Microbial population		T_1			T_2		
			P_1	P_2	P_3	P_1	P_2	P_3
1	Bacteria x 10^6 cfu /g	Initial	NG	NG	NG	NG	NG	NG
		Final	3.0	4.0	3.0	2.0	3.0	2.0
2	Fungi x 10^3 cfu/g	Initial	NG	NG	NG	NG	NG	NG
		Final	3.0	3.0	2.0	2.0	3.0	2.0
3	Yeast x 10^4 cfu/g	Initial	NG	NG	NG	NG	NG	NG
		Final	4.0	4.0	4.0	4.0	4.0	3.0

NG - No observable growth

Sugarcane juice
↓
Filtering
↓
Addition of citric acid (0.5%)
↓
Boiling
(End point - 70^{o}Brix)
↓
Filtration
↓
Cooling
↓
Packing
↓
Capping/sealing
↓
Storage (Room temperature)

Figure No.1: Flow chart for processing of sugarcane syrup

Sugarcane syrup **Sugar syrup (Control)**

Plate No.1: Processed sugarcane syrup and sugar syrup

CONCLUSION

The standardized sugarcane syrup can be used as an alternative natural sweetener in place of refined sugar. The study revealed that sugarcane syrup packed in glass bottles (P_3) and 400 guage polyethylene pouch (P_1) retained the quality characteristics better than the syrup packed in polyethylene terephthalate (PET) jars (P_2). The sugarcane syrup has a high potential for commercialization and marketability.

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CONFLICT OF INTEREST

We declare that we have no conflict of interest.

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