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Standardization and Preservation of Sugarcane Juice by Hurdle Technology

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Abstract: Preservation of sugarcane juice was examined to reduce the spoilage and to increase the shelf life of the juice using hurdle technology. The intelligent use of combinations of different preservation factors or techniques to make a product shelf-stable, to improve quality and safety of food products is known as hurdle technology. The present work focuses on preservation of the juice was carried out using potassium metabisulphite (KMS), natural preservation and mild heat treatment at different combinations under refrigeration temperature.

The result showed that good quality beverage from sugarcane juice of variety Co8603 (Nayana) with satisfactory storage stability of 60 days at refrigeration packed in glass bottles was prepared from pasteurized juice at 70°C for 10 min after addition of 0.6 ml ginger, 0.3 ml lemon, 0.7 ml mint and 1.0 gm salt per 100 ml of sugarcane juice. Addition at the rate of 225 ppm of potassium metabisulfite (KMS) was found to be the best anti microbial agent. The lemon was able to lower the pH of sugarcane juice to 3.0 which gave a preservative action and ginger, mint and salt acts as flavor enhancer and inhibit the growth of micro-organisms during storage period. Potassium metabisulphite is also a known yeast and mold inhibitor and is being used widely for the preservation of foods.

Keywords: Sugarcane juice, Natural preservative, Heat treatment, Hurdle technology

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1. Introduction

In India, Sugarcane juice is commonly used as a delicious drink in both urban and rural areas. It is excellent substitutes for aerated drinks and cola; it refreshes and energizes the body instantly as it is rich in carbohydrates. Even the diabetic can enjoy this one sweet drink without fear. It is because it has no simple sugars. Sugarcane juice is a great preventive and healing source for sore throat, cold and flu. It has a low glycemic index which keeps the body healthy. It hydrates the body quickly when exposed to prolong heat and physical activity (Ashish *et al.*, 2012).

In general, presence of simple sugars in sugarcane juice gives spoilage quickly. The sugarcane juice can be introduced as delicious beverages by preventing the spoilage of juice with appropriate technology. After the harvest of sugarcane; endogenous invertase enzyme is activated and acts as a cause of deterioration. These organisms convert sucrose into poly-saccharides, such as dextran (Krishnakumar and Devadas, 2006).

Food preservation refers to all measures taken against any spoilage of food. Factors which are used for food preservation are called hurdles. The microbial stability and safety of most traditional and novel foods is based on a combination of several preservative factors which microorganisms present in the food are unable to overcome. This is known as hurdle effect. The hurdle effect is of fundamental importance for the preservation of foods. From an understanding of the hurdle effect, hurdle technology was derived, which allows improvements in the safety and quality of foods using deliberate and intelligent combinations of hurdles (Leistner, 1999).

Preservative hurdles used in the preservation of foods can be divided into physical, physicochemical, microbial derived and miscellaneous hurdle. Among these hurdles, the most important ones are high temperature, low temperature, water activity, acidity, redox potential (Eh), competitive microorganism (e.g. lactic acid bacteria) and preservatives (e.g. nitrite, sorbate, sulphite) (Leistner and Gorris, *1995*). Recently, about 50 additional hurdles have been used in food preservation. Hurdle technology has arisen in response to number of developments and

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therefore provides a framework for combining a number of milder preservation techniques to achieve an enhanced level of product safety and stability.

The present work mainly focuses on preservation of the juice was carried out using potassium metabisulphite (KMS), natural preservation and mild heat treatment at different combinations under refrigeration temperature.

2. Materials and Methods

2.1Sample Collection

2.1.1 Preparation of sugarcane *(Saccharum officinarum*) extraction

Sugarcane of Co8603 (Nayana) variety were cut close to the ground at a plantation in Thanjavur, Tamil Nadu, India during the period of June 2015. Fresh sugarcane was used for the extraction of sugarcane juice. Graded sugarcane was then washed by running tap water to get sugarcane free from any dust and dirt. Then skin and node of sugarcane stem were removed with the help of curved blade knife. Sugarcane juice was extracted by power operated sugarcane crusher machine. The collected sugarcane juice was filtered through muslin cloth to remove the extraneous matter.

2.1.2 Preparation of lemon (*Citrus aurantifolia*) extract

Commercially available lemons were bought from local market. Lemons were cut into two pieces with the help of sharp blade knife. Then lemon pieces were squeezed by squeezer and lemon extract was filtered through the muslin cloth to remove the extraneous matter and seeds.

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2.1.3 Preparation of ginger (*Zingiber officinale*) extract

Gingers were bought from commercially available local market. Gingers were peeled with the help of sharp blade knife. Then peeled ginger pieces were cut into small pieces. Then ginger extract was extracted by put into in muslin cloth and apply force to help in ease of extraction. After that ginger extract were filtered through muslin cloth and shreds of ginger were discarded.

2.1.4 Preparation of mint (*Mentha piperita*) extract

Commercially available mint leaves were bought from local market. Mint leaves were washed first under running tap water to get sugarcane free from any dust and dirt. Then washed mint leaves were cut into small pieces. Extract was extracted by power operated juice extractor. After that mint extract were filtered through muslin cloth and shreds of mint were discarded.

2.2 Standardization of Preservatives and Optimization of sugarcane juice formulation per 100 ml of juice

After the extraction of sugarcane juice, ginger extract, lemon extract and mint extract optimization of sugarcane juice beverage formulation was done by the addition of ginger extract, lemon extract and black salt to sugarcane juice in proper concentration as per the calculation made in table 1.0. Based on sensory evaluation, best combination was chosen. KMS (potassium metabisulphite) was added in different proportion as 150, 175, 200, 225 ppm. The sugarcane juice was then filled in sterilized glass bottles. The bottles after being filled were loosely covered with the tin crowns. The partially sealed glass bottles were exhausted at high temperature. After complete exhausting the glass bottle were sealed by double seamers and pasteurized. For the heat treatment purpose in bottle pasteurization method were used to heat treat the sample. The heat treatment temperature (60, 65, 70 and 75^{o}C) for 10 min was studied for optimization of treatments based on sensory evaluation of juice.

Optimization of KMS (potassium metabisulphite) quantities was done based on physico-chemical and sensory characteristics changes during the storage life of sugarcane juice.

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Sugarcane juice at different level (150, 175, 200, 225 ppm) of KMS (Potassium metabisulphite) were subjected to storage studies at refrigeration temperature for a period of two months by drawing samples for determination of changes in physico-chemical, microbiological and sensory evaluation (Ranganna,1986), at ten days intervals to evaluate changes in chemical and micro-biological parameters.

2.3 Physico-chemical and microbiological analysis of sugarcane juice

Selected samples were subjected to storage studies at refrigerated for determination of changes in physico-chemical, microbiological and sensory evaluation (Ranganna, 1986), (AOAC, 2005) after ten days regular intervals.

3. Result and Discussion

3.1 Proximate, microbiological and sensory analysis of raw sugarcane juice

Physico-chemical characteristics of raw sugarcane juice without addition of flavoring were analyzed. The total sugarcane juice content of was found to be 65.0%. The TSS of Juice was 19.0 ^{o}Brix, which is lower than that found in the study of (Krishnakumar & Devadas, 2006). These variations in juice yield, and TSS might be attributed to cultivation process and crushing methods.

All the chemical characteristics was also analyzed, the sugarcane juice is acidic in nature pH 5.73.The vitamin C content were 3.18 mg/100 g. The total sugar was found to be 16.32 %.

Total Plate Count (TPC) yeast and mould count, and coliform count test was performed after preparation of sugarcane juice. The sugarcane juice just after preparation was awarded sensory scores 6.0, 6.5, 7.0, 7.5, 8.0 and 8.5 for appearance, flavor and overall acceptability respectively by the panelist. The sensory evaluation was based on three parameter flavor, appearance and overall acceptability. The data of various proximate characteristics, microbiological and sensory analysis are given in Table 1.

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3.2 Optimization of sugarcane juice formulation per 100 ml of juice

In the optimization of sugarcane juice formulation mainly the quantity of ginger, lemon, mint and salt in sugarcane juice was optimized based on sensory evaluation. The sensory evaluation was based on three parameter flavor, appearance and overall acceptability. For the optimization process different ratio of ginger (0.5- 0.7 ml), lemon (2.5-3.0 ml), mint (0.5-0.7 ml) and salt (1.0-3gm) were formulated. The average score obtained by each ratio are given in Table 2, in which the sample no. 6 (ginger 0.6 ml, lemon 3.0 ml, mint 0.7 ml, and salt 3 gm) obtained the best scores. The sensory evaluation was based on three parameter flavor, appearance and overall acceptability. This optimized was used for shelf life study.

3.3 Proximate and microbiological changes during storage of sugarcane juice

Changes in proximate characteristics and microbiological growth are shown in Table 3 and Figures.1. The total soluble solids (reduced by 3%) during storage of sugarcane juice at refrigeration temperature, however, the decrease was of lesser extent in sample no. 4 which contained 225ppm of KMS. The decrease in total soluble solids is due to conversion sugars to acids during storage because of biochemical reactions in the sugarcane juice. The content of reducing sugars in juice increased significantly during storage due to the hydrolysis of non-reducing sugars. Addition of ginger, lemon and mint to heat treated sugarcane juice restricted the degradation of total soluble solids and total sugars and also reduce the growth of microorganisms during storage at refrigeration temperatures. The pH decreased whereas acidity increased significantly during storage of sugarcane juice. Addition of potassium metabisulphite to sugarcane juice reduced the microbial growth during storage resulting in significantly less reduction in pH and less increase in acidity especially in the juice containing 225 ppm KMS which is microbial reduction found in the study of (Ashish Khare *et a.,l* 2012). Total Plate Count (TPC), yeast and mould count and coliform count test was performed periodically after 10 days upto 60 days. The bacteria, yeast and mold count increased during storage of sugarcane juice. coliform count was found to be absent during storage of sugarcane juice. The least microbial

growth was observed in the sample no. 4 whereas the sample no. 1 showed the highest microbial growth.

3.4 Changes in sensory analysis during storage of sugarcane juice

The sugarcane juice just after preparation was awarded sensory scores 7.0, 8.0 and 8.5 for appearance, flavor and overall acceptability respectively by the panelist. The sensory scores reduced significantly with the advancement of storage time. The lowest reduction in sensory scores was observed in sample no. 4 whereas in sample no. 1 maximum after 2 months. The sensory changes are given in Table 3 and Figure 1.

4. Conclusion

From the present study it was observed and concluded that good quality from sugarcane juice of variety Co8603 (Nayana) with that shelf life of sugarcane juice can be increased up to 60 days at refrigeration packed in glass bottles was prepared and pasteurized juice at 70^{o}C for 10 min after addition of 0.6 ml ginger, 0.3 ml lemon, 0.7 ml mint and 1.0 gm salt per 100 ml of sugarcane juice. Addition at the rate of 225 ppm of potassium metabisulfite (KMS) was found to be the best anti microbial agent. The lemon was able to lower the pH of sugarcane juice to 3.0 which gave a preservative action and ginger, mint and salt acts as flavor enhancer and inhibit the growth of micro-organisms during storage period. Potassium metabisulphite is also a known yeast and mold inhibitor and is being used widely for the preservation of foods. Therefore heat treatments, use of preservatives, addition of flavouring were found to be good hurdles in preventing the growth of microorganisms in sugarcane juice. The present study conducted was a preliminary step for preservation of sugarcane juice.

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Table1. Proximate, microbiological and sensory analysis of raw sugarcane juice

S.No	Characteristics	Analysis
1.	Juice yield (%)	65.0
2.	Total sugars (%)	16.32
3.	Reducing sugars (%)	0.50
4.	Non-reducing sugars (%)	15.82
5.	Total soluble solids (%)	19.0
6.	Vitamin C (mg)	3.18
7.	Acidity (%)	0.70
8.	pH	5.73
9.	Total plate count (cfu/ml)	3000 cfu/ml
10	Yeast and mould count (cfu/ml)	180 cfu/ml
13.	Appearance	7.5
14.	Flavor	7.5

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Table 2. Optimization of sugarcane juice beverage formulation per 100 ml of juice

Sr. no	Ginger (ml)	Lemon (ml)	Mint (ml)	Salt (gm)	Overall sensory score
1.	0.5	2.50	0.5	1.00	6.0
2.	0.5	2.75	0.6	1.00	6.5
3.	0.5	3.00	0.7	1.00	7.5
4.	0.6	2.50	0.5	1.00	7.0
5.	0.6	2.75	0.6	1.00	6.5
6.	0.6	3.00	0.7	1.00	8.5
7.	0.7	2.50	0.5	1.00	6.5
8.	0.7	2.75	0.6	1.00	8.0
9.	0.7	3.00	0.7	1.00	7.0
10.	0.5	2.50	0.5	2.00	7.5
11.	0.5	2.75	0.6	2.00	6.5
12.	0.5	3.00	0.7	2.00	6.0
13.	0.6	2.50	0.5	2.00	6.5
14.	0.6	2.75	0.6	2.00	7.5
15.	0.6	3.00	0.7	2.00	7.0
16.	0.7	2.50	0.5	2.00	6.0
17.	0.7	2.75	0.6	2.00	6.5
18.	0.7	3.00	0.7	2.00	6.0
19.	0.5	2.50	0.5	3.00	7.5
20.	0.5	2.75	0.6	3.00	7.0
21.	0.5	3.00	0.7	3.00	6.5
22.	0.6	2.50	0.5	3.00	6.5
23.	0.6	2.75	0.6	3.00	6.5
24.	0.6	3.00	0.7	3.00	7.0
25.	0.7	2.50	0.5	3.00	7.5
26.	0.7	2.75	0.6	3.00	6.5
27.	0.7	3.00	0.7	3.00	6.5

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Table 3. Proximate, microbiological, and sensory analysis of prepared sugarcane juice during storage period

S.No	DAYS						
	0	**10**	**20**	**30**	**40**	**50**	**60**
Total sugars (%)	20.7	20.9	21.0	21.4	21.8	21.9	22.0
Reducing sugars (%)	0.5	0.7	0.9	1.1	1.5	1.8	2.1
Non-reducing sugars (%)	19.2	19.2	19.1	19.3	19.3	19.1	19.1
Total soluble solids (%)	20.0	19.8	19.7	19.5	19.2	19.0	18.0
Vitamin C (mg)	3.20	3.00	2.80	2.54	2.32	2.20	2.10
Acidity (%)	0.10	0.15	0.18	0.2	0.23	0.28	0.3
pH	4.66	4.30	4.0	3.8	3.5	3.2	3.0
Total plate count (cfu/ml)	5	12	18	23	29	30	35
Yeast and mould count (cfu/ml)	3	5	9	11	12	14	15
Coil form count (100 ml)	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Appearance	8.5	8.5	8.5	8.0	8.0	7.0	7.0
Flavor	8.5	8.5	8.5	8.0	8.0	7.5	7.0
Overall Acceptability	8.0	8.0	8.0	8.0	7.5	7.5	7.0

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Figure 1. Changes in Proximate, microbiological and sensory analysis during storage of sugarcane juice.