International Journal of Scientific Engineering and Technology (ISSN : 2277-1581)
Volume No.3 Issue No.12, pp : 1455-1458 01 Dec. 2014

Preservation of Sugarcane Juice Using Hurdle Technology

Kanishk Rawat[1] ,Shourya Pokhriyal[2]
[1,2]Agricultural Engineering Department,College of Technology,GBPUAT,Pantnagar,India[i]
rawatkanishk01@gmail.com[1], shouryapokhriyal@gmail.com[2]

Abstract: ***Sugarcane juice was subjected following treatmentsviz.pasteurizationat80ºCfor10 min + chemicaltreatments(KMS @ 150 ppm and citric acid @0.05%);pasteurizationat80ºCfor10 min + chemicaltreatments (KMS @ 150 ppm and citric acid @ 0.05%) + sterilization at 80ºC for 20 min. All the samples were packed in glass bottles, polyethylene Tetrapthelate (PET) bottles and low density polyethylene pouches (LDPE) and then irradiated at 0.25, 0.5 and 1.0 kGy and stored for 90 days at room and low temperature. On treatment moisture content, ascorbic acid, viable bacterial count and viable yeast and mold count were decreased significantly (P > 0.05) where as no significant effect was observed on reducing and total sugars in cane juice. Among the three packaging material used glass and PET was found to be at par in increasing the shelf life of sugarcane juice in comparison to LDPE pouches. On storage, ascorbic acid and total sugars were decreased significantly (P > 0.05).***

***Keywords*-Sugarcane juice Irradiation Hurdle technology Packaging**

Introduction

In India sugarcane is generally crushed to obtain juice which serves as a thirst quenching drink in hot summers. Being a nutritious product containing natural sugars, minerals and organic acids, sugarcane juice is great for recharging energy and has many medicinal properties. Sugarcane juice strengthens the stomach, kidneys, heart, eyes, brain and sex organs. It is beneficial in fevers. Sugarcane juice is very useful in scanty urination. It keeps the urinary flow clear and helps kidneys to perform their functions properly. It is also valuable in burning micturation due to high acidity, gonorrhea, enlarged prostrate and cystitis. Sugarcane juice is a fattening food. It is thus an effective remedy for thinness. Rapid gain in weight can be achieved by its regular use (Karthikeyan and Samipillai *2010*).
In general sugarcane juice is spoiled quickly by the presence of sugars (Krishnakumar and Devadas *2006a*). Microorganism present in juice leads to loss of sucrose by formation of organic acid and ethanol. Major bacteria responsible for spoilage are Leuconostoc, Enterobacter, Flavobacteruim, Micrococcus, Lactobacillus, Actinomyces. Among yeast and molds, Aspergillus, Cladosporium, Monilla, Penicillium, Saccharomyces, Candida, Pichia, Torulopsis are responsible for spoilage (Frazier and Westhoff *1995*).

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*).
Potential hurdles used in the preservation of foods can be divided into physical, physicochemical, microbially 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 therefore provides a framework for combining a number of milder preservation techniques to achieve an enhanced level of product safety and stability.

Materials and Methods

In the given experiment of preservation of sugarcane juice using hurdle technology following experiments were carried out which are listed as below.

Experimental Details

The experiment has been divided into four parts:

Experiment-I

Experiment I consists of standardization of treatments.

Standardization of Pasteurization Temperature

As sugarcane juice gets fermented very fast due to the presence of invertase enzyme, the juice was heated at 70, 80 and 90°C for 10 min. To estimate the activity of enzyme, reducing sugars content was analyzed using Lane and Eyon Method (AOAC *1965*). It was found that invertase enzyme was inactivated at 80°C for 10 min.

Standardization of Preservatives

Concentration of citric acid (0, 0.5, 1 and 1.5 gm/1,000 ml), potassium metabisulphite (KMS) (0, 50, 100, 150 and 200 ppm) were studied for optimization of treatments on the basis of sensory evaluation of juice. Concentrations of citric acid at 0.5 g/1,000 ml and KMS at 150 ppm were found to be optimum for the treatment of sugarcane juice.

Experiment-II

Experiment II consists of following treatments:
T_1 Untreated sugarcane juice
T_2 Pasteurization at 80°C for 10 min + chemical treatment (potassium metabisulphite @ 150 ppm and citric acid 0.05%)
T_3 Pasteurization at 80°C for 10 min + chemical treatment (potassium metabisulphite @ 150 ppm and citric acid 0.05%) + Sterilization at 80°C for 20 min

Experiment III

Experiment III consists of packaging details. Untreated (T_1) and treated (T_2 and T_3) samples of sugarcane juice were packed in glass bottles, PET bottles and LDPE pouches.

Experiment IV

Experiment IV consists of irradiation details. All the packed samples were irradiated at three different doses i.e. 0.25, 0.5 and 1.0 kGy.
After all treatments and irradiation, sugarcane juice was stored at room (30 ± 5°C) and low (4 ± 2°C) temperature for a period of 3 months for shelf life studies. Interval of analysis was 1 month for juice.

Methods of Analysis of Quality Parameters

a) **Moisture**
b) **Reducing Sugars and Total Sugars**
c) **Carbohydrates**
d) **Minerals**
e) **Microbial Examination**
f) **Organoleptic Evaluation**

Results and Discussion

Composition of Sugarcane Juice

Table

Composition	Amount analysed
Moisture	82.91%
Ascorbic acid	3.39 mg/100 ml
Reducing sugars	0.50%
Total sugars	16.32%
Total carbohydrates	9.23 gm/100 ml
Viable bacterial count	4.56×10^6 cfu/ml
Viable yeast and mold count	2.6×10^5 cfu/ml

Physico Chemical Parameters

Moisture Content

The results presented shows significant differences on shelf life of cane juice at 5% significant level. Among the treatments, juice with treatment T_3 was found to contain lowest moisture percentage. This may be due to heat treatments which lead to reduction in moisture content by evaporation during heating. Kumar, (*2004*) also reported similar results for sapota pulp. PET bottles helped in maintaining the moisture content of the cane juice because of their good water vapor and oxygen barrier properties. Irradiation doses at 1.0 kGy also helped in reducing the moisture content of the juice. Table 2

Moisture content of sugarcane juice during storage

Treatments	Irradiation doses	Packaging material	Shelf life at room temperature			Shelf life at low temperature			
			Zero day	30th day	60th day	Zero day	30th day	60th day	90th day
T_2	$I_{0.25}$	GLASS	82.09	83.15	83.32	82.33	82.75	82.95	83.25
		PET	80.40	82.68	83.56	80.40	81.86	82.09	83.64
		LDPE	82.44	85.76	–	82.44	84.05	86.77	–
	$I_{0.5}$	GLASS	81.92	82.81	83.00	82.29	82.60	82.78	82.68
		PET	80.31	82.51	83.48	80.31	81.74	82.47	83.57
		LDPE	82.38	85.43	–	82.38	83.54	86.53	–
	$I_{1.0}$	GLASS	81.84	82.77	82.88	82.17	82.48	82.64	82.89
		PET	80.23	82.34	83.35	80.23	81.66	82.34	83.43
		LDPE	82.15	85.03	–	82.15	83.25	86.14	–
T_3	$I_{0.25}$	GLASS	81.78	82.54	82.75	81.53	82.14	82.39	82.89
		PET	79.82	82.05	83.13	79.82	81.41	82.26	83.43
		LDPE	82.03	84.84	–	82.03	84.44	86.66	–
	$I_{0.5}$	GLASS	81.81	82.30	82.52	81.44	82.06	82.27	82.34
		PET	79.80	81.48	82.96	79.80	80.83	82.12	82.75
		LDPE	81.84	84.94	–	81.84	83.16	85.03	–
	$I_{1.0}$	GLASS	81.65	82.22	82.31	81.28	82.43	82.17	82.35
		PET	79.65	81.37	82.72	79.65	80.74	82.05	83.04
		LDPE	81.74	84.43	–	81.74	83.04	85.46	–
			T*P*S			T*P*S			
SEM±			0.017347			0.059828			
CD (5%)			0.04891			0.16772			
			S			S			

*S Significant level at 5%

Reducing Sugars

The results for reducing sugars are tabulated. Treatments, packaging material and irradiation doses showed no significant difference but on storage at room and low temperature for 3 months there was a significant increase in reducing sugar content of juice. The increase may be due to hydrolysis of sugars by acids or due to degradation of disaccharides to monosaccharides.

Reducing sugar content of sugarcane juice during storage

Treatments	Irradiation doses	Packaging material	Shelf life at room temperature			Shelf life at low temperature			
			Zero day	30th day	60th day	Zero day	30th day	60th day	90th day
T_2	$I_{0.25}$	GLASS	0.53	0.77	0.85	0.53	0.54	0.64	0.72
		PET	0.52	0.86	0.87	0.52	0.66	0.76	0.82
		LDPE	0.54	0.87	–	0.54	0.53	0.57	–
	$I_{0.5}$	GLASS	0.53	0.70	0.77	0.53	0.55	0.61	0.69
		PET	0.51	0.73	0.95	0.51	0.67	0.76	0.77
		LDPE	0.53	0.82	–	0.53	0.55	0.63	–
	$I_{1.0}$	GLASS	0.53	0.65	0.70	0.53	0.55	0.63	0.75
		PET	0.53	0.84	0.94	0.53	0.71	0.80	0.83
		LDPE	0.56	0.74	–	0.56	0.58	0.60	–
T_3	$I_{0.25}$	GLASS	0.55	0.85	0.93	0.55	0.61	0.65	0.79
		PET	0.54	0.74	0.87	0.54	0.66	0.82	0.80
		LDPE	0.54	0.86	–	0.54	0.55	0.64	–
	$I_{0.5}$	GLASS	0.56	0.86	0.94	0.56	0.62	0.68	0.76
		PET	0.56	0.73	0.94	0.56	0.63	0.77	0.86
		LDPE	0.55	0.74	–	0.55	0.56	0.66	–
	$I_{1.0}$	GLASS	0.53	0.81	0.95	0.53	0.61	0.67	0.83
		PET	0.55	0.66	0.95	0.55	0.69	0.82	0.88
		LDPE	0.50	0.90	–	0.50	0.55	0.63	–
			T*P*S			T*P*S			
SEM±			0.01625			0.01221			
CD (5%)			0.04582			0.03424			
			S			S			

*S Significant level at 5%

Total Sugars

Treatments, packaging material and irradiation doses showed no significant difference on total sugar content present in cane juice. Juice with treatment T_1 recorded highest total sugar content. A significant reduction in total sugar content was noticed at all irradiation doses and packaging materials. Irradiation dose at 0.25 kGy and LDPE pouches was found to maintain highest total sugar content in juice at zero day. Moreno et al. (*2007*) also reported reduction in total sugar content on irradiation at medium doses (1.5 kGy) in mango fruit.

Mineral Composition

There was no appreciable change in mineral content of sugarcane juice during storage. Untreated cane juice was analyzed for minerals (iron, calcium and phosphorus) before and after storage. Before storage, cane juice was found to contain 2.20 mg/100 ml of iron, 16.23 mg/100 ml of calcium and 7.6 mg/100 ml of phosphorus. Sankhla et al. (*1999*) also reported similar results for calcium and iron in sugarcane juice. After 90 days of storage among all treatments, juice with treatment T_3 at irradiation dose of 1.0 kGy was found to be best. Therefore the best treatment was subjected to mineral estimation after storage. At the end of the storage period, juice with treatment T_3 contained 1.23 mg/100 ml of iron, 14.07 mg/100 ml of calcium and 6.8 mg/100 ml of phosphorus (Table 6).

Table 6
Iron, calcium and phosphorus content of sugarcane juice before and after storage

Minerals composition (mg/100 ml)	Iron	Calcium	Phosphorus
Before storage	2.20	16.23	7.6
After storage	1.23	14.07	6.8

Spoilage of Juice

Untreated juice with or without irradiation stored at room and low temperature was spoiled within 2–3 days. Also juice stored in LDPE pouches was spoiled after 30 days at room temperature and after 60 days at low temperature. Juice stored in glass and PET bottles was spoiled after 60 days at room temperature.

Microbial Profile of Sugarcane Juice

Viable Bacterial, Yeast and Mold Count

The results obtained for bacterial, yeast and mold count are presented in . The bacterial, yeast & mold estimation showed significant differences ($P > 0.05$) among all treatments in all packaging materials at different irradiation doses. Highest microbial load was recorded in T_1 packed in LDPE pouches (4.88×10^6 cfu/ml) and least in T_3

.

Sensory Evaluation of Sugarcane Juice

The interaction between treatments, packaging and irradiation doses on sensory properties of juice was statistically found to be non- significant at 5% significant level . But decrease in scores for flavor and taste were observed during the storage at room and low temperature. The decrease in scores was less at low temperature. This decrease could be due to the loss of volatile aromatic substances responsible for taste as stated by Reddy (*2004*). Also presence of preservatives had lead to significant changes.

Conclusion

From the present study it was observed that shelf life of sugarcane juice can be increased up to 60 days at room temperature and up to 90 days at low temperature storage. Irradiation has further contributed in preservation of juice. Among the three packaging materials i.e. glass, PET and LDPE; both glass and PET were found to be best in increasing the shelf life of juice, without affecting its physico—chemical, nutritional and sensory properties.. Therefore heat treatment, use of preservatives, irradiation and different packaging material were found to be good hurdles in preventing the growth of micro-organisms in sugarcane juice. The present study conducted was a preliminary step for preservation of sugarcane juice.

References

i. *AOAC. 1965. Official methods of analysis, association of official analytical chemists, Washington, DC 12 ed. 31.054, 22:109.*

ii. *AOAC. 1990. Official methods of analysis, association of official analytical chemists. Washington, DC. 15 ed. 929:01.*

iii. *AOAC. 2005. Official methods of analysis, association of official analytical chemists, Washington, DC 18 ed. 940.13.*

iv. *Brennan, J.G. 2006. Pulsed electric field processing, power ultrasound and other emerging technologies, 201–232. Weinheim: Wiley-VCH Verlag GmbH & Co. KGaA.*

v. *Chauhan, O.P., Dheer Singh, S.M. Tyagi, and D.K. Balyan. 2002. Studies on preservation of sugarcane juice. International Journal of Food Properties 5(1): 217–229.CrossRef*

vi. *Chumillas, M.R., Y. Belissario, A. Iguaz, and A. Lopez. 2007. Quality and shelf life of orange juice aseptically packaged in PET bottles. Journal of Food Engineering 79(1): 234–242.CrossRef*

vii. *Clara, C., J.M. Esteve, and A. Frigloa. 2007. Effect of refrigerated storage on ascorbic acid content of orange juice treated by pulsed electric fields and thermal pasteurizations. European Food Research and Technology 227(2): 629–635.*

viii. *El-Sheikha, A.F., F. Ribeyre, M. Larroque, M. Reynes, and D. Montet. 2009. Quality of physalis (physalis pubescens l.) juice packaged in glass bottles and flexible laminated packs during storage at 5°C. African Journal of Food Agriculture Nutrition and Development 9(6): 1388–1405.CrossRef*

ix. *Farheen, F.(2004). Studies on the preparation of squash, nectar, RTS and juice blends from watermelon fruits. MSc. Thesis submitted to Acharya N. G. Ranga Agricultural University, Hyderabad.*

x. *Frazier, C.W., and C.D. Westhoff. 1995. Food microbiology, 187–195. New Delhi: Tata McGraw-Hill Publishing Company Limited.*

xi. *Karthikeyan, J., and S.S. Samipillai. 2010. Sugarcane in therapeutics. Journal of Herbal Medicine and Toxicology 4(1): 9–14.*