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Storage Stability of Sugarcane Stalks

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ABSTRACT

Background: Sugarcane (*Saccharum officinarum* L.) is a giant grass, belonging to the Poaceae family, and is considered as a crop of economic importance. It is the second largest agro based industry involving nearly 50.00 million farmers, their dependent and a large mass of agriculture labours. It is also known as noble cane, due to its high sucrose content and is mostly used for manufacturing of jaggery and crystalized sugars. Its consumption is very popular worldwide but there are few studies that focus on post-harvest storage of sugarcane stalks. The objectives of this study was to evaluate the quality of stored sugarcane stalks as well as fresh juice extracted from stored canes.

Methods: During the investigation sugarcane variety Co238 were cleaned and grouped into bundles containing 5 stalks for each replicate (3) and then stored under both ambient (17-22°C temperature and 45-52% RH) and refrigerated temperature (4±1°C temperature and 60-65% RH). The parameter studied were weight loss, juice yield, total soluble solids, titratable acidity and pH at every 15 days interval for 120 days.

Result: Study showed that among both the storage, refrigerated condition for storage of sugarcane stalks was found better to retain the maximum juice yield (40.09%) with minimum weight loss (5.15%) and maintain the quality for longer period as compared to ambient storage condition.

Key words: Cane storage, Post-harvest, Quality parameters.

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) a perennial long duration crop which belongs to family Poaceae, is widely cultivated as a major crop in tropical and subtropical regions of the world (Panwar, 2006). At present, sugarcane is cultivated in about 100 countries. India, Argentina, Australia, Brazil, Barbados, China, Cuba, Mexico, Egypt, Jamaica, Peru, South Africa and Hawaii, Florida and Louisiana are the major sugarcane producing countries. The world's sugarcane production is reported to be 1949.31 million tonnes from an area of 26.77 Mha (Department of Agriculture and Family Welfare, 2022). India ranks as second largest producer of sugarcane in the world next to Brazil followed by China, Thailand and Pakistan (Yadira *et al*., 2005). Sugarcane, an important cash crop in agriculture sector shares 7.00 per cent of the total value of agriculture output and occupies 2.50 per cent of India's gross cropped area. India's contribution to the world's sugarcane production is about 19.00 per cent. India is the second largest producer of sugarcane having 5.06 Mha area under cultivation and annual crop production of 497.57 million tonnes (Department of Agriculture and Family Welfare, 2022). Among the states, Uttar Pradesh has the largest area in the country followed by Maharashtra, Karnataka, Tamil Nadu Andhra Pradesh, Gujarat and Punjab. In India, sugarcane occupies a prominent position in the Indian Agricultural scenario on account of its wider adoption in different agro-climatic conditions of the country. The Sugarcane Research and Training Institute, Ishurdi, has released nearly 30 sugarcane varieties, covering approximately 95 per cent of total sugarcane land in sugar mill zones and 25 per cent in non-mill zones. The notable varieties are Isd 1/53, Isd 1/54, Isd 16, Isd 17, Isd 18, Isd 19, Isd 20, Isd 25, Isd 28, LJC (Latari-Java-C) and so on. The majority of these varieties produce 110-120 m tonnes of sugarcane per ha, with a sugar content of 12-13%. Local varieties such as Mishrimala and Gendari are primarily grown for chewing.

Sugarcane is a long duration crop and requires 10 to 15 or even 18 months to mature depending upon the geographical conditions. In North India, it is harvested during October to March while in Southern part of country it is harvested during December to August. Sugarcane requires hot and humid climate with average temperature of 21- 27°C and 75-150 cm rainfall, where too heavy rainfall results in low sugar content and deficiency of rainfall results in fibrous crop. Sugarcane is grown mainly for producing sweeteners such as sugar, jaggery and khandasari (Srivastava, 2011).

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Apart from this, most notable is sugarcane juice, which has nutritional and energy quotient.

Sugarcane is one of the most important agro-industrial crops of our country providing employment and contributing to the growth of rural economy. But harvesting of post maturing crop has detrimental effect on sugar recovery and a serious economic problem to sugar mills. As sugarcane is a perishable commodity so, it should be processed immediately after harvesting. In sugar recovery process, sucrose losses after harvest of canes due to delayed transport and unfavorable environment conditions are the serious problems.

Nearly 20-30% of total sucrose synthesized by sugarcane plant is lost during handling and sugar processing (Reddy *et al*., 2015). The quality of harvested sugarcane has also got significant importance due to the payments are made on weight basis. Weight of sugarcane is important as it gives idea about the health of the cane. Since sugarcane contains 72-76% water by weight and after harvesting of sugarcane will lead to loss of weight due to evaporation of water content which is directly correlated with the temperature conditions and also due to loss of sucrose through desperation and inversion (Mehrotra and Sharma, 2020).

The loss in quality of sugarcane is also due to chemical and enzymatic inversion which are caused by microbes that entered throughout ends (Egglestion, 2002). Another factors such as ambient temperature, variety, maturity status and storage period are responsible for post-harvest deterioration of sugarcane (Solomon *et al*., 2007). Canes starts deteriorating immediately on harvest and the rate of deterioration depend upon the weather conditions (Uppal, 2003). As the need of the day, studies on storage stability of sugarcane stalks is essential to assess post-harvest losses.

MATERIALS AND METHODS

During the experiment sugarcane variety Co238 were cleaned thoroughly after harvesting to remove dry leaves tops, part of roots and damaged or infected nodes. Harvested canes were brought immediately to the laboratory. Sugarcane stalks were further cleaned and cut into uniform length of about 2.5 feet long and washed with fresh water to remove the dust and dirt particles. The clean and air dried pieces were grouped into bundles containing 5 stalks for each replicate (3) and then stored at ambient (17-22°C temperature and 45-52% RH) and refrigerated temperature (4±1°C temperature and 60-65% RH) in refrigerated van and were evaluated for different quality parameters. The storage studies were conducted at every 15 days intervals for 120 days.

Determination of quality parameters

Juice yield (%)

Juice of canes was extracted mechanically by crushing in three-roller stainless steel power crusher machine (Datir and Joshi, 2015). Juice yield expressed in per cent was calculated as follows:

$$\text{Juice yield (\%)} = \frac{\text{Weight of juice extracted}}{\text{Weight of fruit taken}} \times 100$$

Weight loss (%)

Average weight loss of sugarcane stalks was determined as the ratio of loss in weight to the total weight of the sugarcane stalks and expressed in per cent (Datir and Joshi, 2015). Per cent loss in cane weight was calculated from initial weight and final weight using following formula:

$$\text{Weight loss (\%)} = \frac{\text{Initial weight - Final weight}}{\text{Initial weight}} \times 100$$

Total soluble solids (TSS)

TSS of fresh and processed sugarcane juice was determined by hand refractometer of 0-32 and was expressed as °Brix.

Titratable acidity (%)

The titratable acidity was expressed as per cent citric acid (AOAC, 2004).

pH

Prior to pH measurement, the instrument was calibrated with buffer solutions of 4.0, 7.0 and 9.2. The pH of the samples was estimated directly (AOAC, 2004). Three replications were taken for each sample and the mean value was reported.

RESULTS AND DISCUSSION

Results regarding changes in quality characteristics of sugarcane stalks during storage are in Table 1.

Weight loss

Gradual loss in cane weight was evidenced throughout the storage period of 120 days from no weight loss at zero days to 21.13 per cent and 8.40 per cent at ambient and refrigerated conditions respectively on 120th day of cane storage. The overall effect of storage conditions on weight loss was found significant and reveal that lesser weight loss of sugarcane stalks was found under refrigerated condition as compared to ambient conditions. The loss in weight may be due to by drying out at high temperature due to evaporation losses and increased respiration. Similar results were recorded by (Mahadevaiah and Dezfuly, 2013 and Datir and Joshi, 2015).

Juice yield

Juice yield obtained from stored stalks shows decrease with increase in storage period at both ambient and refrigerated conditions. The yield started to decrease from day zero continuously until the end of the storage period. It was found that relatively less decrease of 12.12% was observed under refrigerated condition as compared to ambient storage condition shows decrease of 32.27% after 120 days. These observations are in agreement with the findings of (Yusof *et al*., 2000 and Krishna kumar *et al*., 2013).

Titratable acidity

The titratable acidity of juice obtained from stored canes were found to increase from 0.12 to 0.34 per cent and 0.12 to 0.19 per cent at ambient and refrigerated condition

Table 1: Effect of storage on quality characteristics of sugarcane stalks.

Storage conditions	Storage interval	Weight loss (%)	Juice yield (%)	Titratable acidity (%)	pH	TSS (°B)
Ambient storage	0 Day	0.00	59.19	0.12	5.74	19.00
	15 Day	4.10	55.69	0.11	5.74	19.33
	30 Day	7.23	53.99	0.09	5.75	19.50
	45 Day	9.86	50.07	0.12	5.74	19.81
	60 Day	12.00	48.01	0.16	5.73	20.20
	75 Day	14.40	47.87	0.18	5.72	20.55
	90 Day	15.72	45.43	0.22	5.72	20.89
	105 Day	18.60	43.60	0.31	5.71	21.00
	120 Day	21.13	40.09	0.34	5.70	22.80
Refrigerated storage	0 Day	0.00	59.19	0.12	5.74	19.00
	15 Day	2.20	59.01	0.12	5.74	19.20
	30 Day	3.20	57.32	0.10	5.74	19.35
	45 Day	4.91	55.72	0.10	5.74	19.48
	60 Day	6.07	53.50	0.08	5.73	19.54
	75 Day	6.80	53.07	0.11	5.73	19.60
	90 Day	7.10	52.83	0.13	5.72	19.81
	105 Day	7.73	52.14	0.16	5.72	19.90
	120 Day	8.40	52.02	0.19	5.72	20.00

respectively after 120 days of storage. Initially titratable acidity decreased from 0.12 to 0.09 per cent after 30 days at ambient condition and 0.12 to 0.08 per cent after 60 days at refrigerated conditions which than gradually increased under both the conditions. The initial decrease in titratable acidity after cane harvest might be due to the utilization of acids for the conversion of sucrose to reducing sugars (Jain *et al*., 1986; Singh *et al*., 2006 and Bhardwaj and Nandal, 2014). The increase in titratable acidity during storage might be due to the evaporation of moisture from the stalks and concentration of stored metabolities. Similar results of increase in titratable acidity during storage has been reported by (Agarkar, 2017 and Yusof *et al*., 2000).

pH

There was non-significant change in pH of juice extracted from stored sugarcane stalks under both the storage conditions during 120 days of storage. Similar trend of decreasing pH during storage has been reported by (Paull and Huang, 2015 and Yusof *et al*., 2000).

Total soluble solids

Storage of canes caused increase in TSS of the extracted juice under both the storage conditions. Total soluble solid of juice extracted from stored canes increased from 19ÚB to 22.80°B and 20.00°B under ambient and refrigerated storage condition respectively. The increase in total soluble solids during storage might be due to decrease in moisture content and increase in reducing sugars. The results of increase in total soluble solids were similar to the finding of (Densay *et al*., 1992; Yusof *et al*., 2000 and Saxena *et al*., 2010).

CONCLUSION

The yield and quality of juice obtained are essential economic criteria in sugarcane juice business. Keeping in view the changes in weight and juice yield of stored sugarcane stalks under both the conditions, it is clear that comparatively high weight loss of 21.13 per cent was observed under ambient condition as compared to only 5.15 per cent under refrigerated condition during 120 days. Further 32.27 per cent juice yield decreased under ambient conditions and only 12.12 per cent under refrigerated condition throughout the storage of 120 days. Thus, refrigerated conditions was found suitable for the storage of canes.

Lastly, It concludes that agricultural producers can use a variety of refrigeration systems to extend the shelf life of commodity. Cooling not only reduces the potential for spoiling due to bacterial growth but also reduces humidity levels. In India, cold chain and refrigeration is another major emerging sector. As a result, the preservation of sugarcane stalks can be rapidly expanded during transport and storage. Improving energy efficiency of refrigeration systems can therefore lead to significant savings. There is scope to enhance the energy efficiency of the cold chain sector whilst selecting new refrigerants which are economically viable and environmentally sustainable.

Conflict of interest

The authors declare that there are no conflicts of interest in the course of conducting the research. All the authors had final decision regarding the manuscript and decision to submit the findings for publication.

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