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RESEARCH ARTICLE

Pre milling cane preparation for high sugar recovery and reduction of post harvest losses in sugarcane

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Abstract Pre milling preparation of canes was done by two methods and the effect of these methods on sugar recovery and post harvest quality changes during storage were studied under two environmental conditions i.e February and April. In method one cane was topped by sickle without removal of any internode, while in method II, tops along with 3-4 internodes were removed by sickle/hand. More extraction %, Purity, pol % cane and less reducing sugars were present in fresh canes prepared by method II as compared to method I. Storage of harvested sugarcane prepared by both the methods for six days resulted in decrease in cane weight, extraction %, purity, pol % cane with increase in the invert sugars, activities of enzymes invertases and dextran regardless the envirenmental condition. Percent loss in extraction, purity, pol % cane , percent gain in reducing % brix and their rate of change per day was found to be more in method I than method II. Similarly increase in activities of both acid and neutral invertases as well as dextran were also found higher in method I as compared to method II. Therefore the present study indicated that method II for preparation of canes for milling was superior over the method I since higher sugar recovery and less post harvest deterioration was found in canes prepared by method II as compared to canes prepared by method I.

Keywords Sugarcane, Post harvest deterioration, Cane weight, Pol % cane , Invert sugars, Invertases, Dextran

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Introduction

During survey of sugar mills of Punjab for two crushing seasons 2005-2006 and 2006-2007, it was found that the mills were crushing canes with excess binding material, topmost immature internodes and partial leaf sheaths which amount to 2-5% of the cane weight as compared to recommended one percent. This is a serious hurdle in achieving higher sugar recovery. Moreover, nearly one fourth of cane crushed in sugar factories was observed to be stale in quality (Sharma and Batta 1993). This could be due to time lag between harvesting and crushing of canes due to constraints in transport and/or factory hold up, resulting in lower sugar recovery. A large number of factors such as ambient temperature, humidity, variety, period of storage, maturity status etc. are responsible for the difference in post harvest deterioration (Uppal and Sharma, 1999; Uppal *et al.*, 2000; Solomon, 2003; Solomon *et al.*, 2007). Since preparation of canes for milling plays a crucial role in sustaining the recoverable sugars, so the present study was undertaken to see the effect of methods of pre- milling preparation of canes on cane quality as well as on post harvest deterioration in sugarcane during storage under two environmental conditions.

Materials and Methods

A high sugar early-mid maturing variety, CoJ 88, was raised at Research Farm of University at Ladhowal (Punjab) under recommended cultural practices. The investigation was carried out in the months of February and April. The average maximum and minimum atmospheric temperatures were 25.3 and 10.9 °C in February and 37.6 and 17.1 °C in April respectively. The mean relative humidity was 67 % in February and 40 % in April. No rainfall was recorded during this period.

Canes were prepared for milling by two methods. In method I tops are cut with sharp sickel (without edges). In this method, no internode was removed rather some part of leaf sheath were also remained intact. In second method, tops alongwith soft part having 3-4 internodes were removed with sickel or manually. Tops of canes were weighed separately under both the practices. Topped canes were subsequently stored separately, in heaps under natural conditions. Weight of 20 canes in each replication of two methods were measured daily for six days. Representative samples of 10 stalks in each replication were crushed daily for 6 days and extraction % measured. Juice and bagasse was analysed by standard methods (Chen,1985). Reducing sugars in juice were estimated by the method of Nelson (1944). Dextran in cane juice was estimated by modified rapid haze method after enzymatic removal of starch (Solomon, 2003). Juice was dialysed and invertase activity was measured by the method of Hatch *et al.* (1963). The linear regression coefficients (b values) were calculated (Gomez and Gomez, 1984).

Result and Discussion

Effect of pre milling preparation methods on cane quality

Pre milling preparation of fresh canes by method II was found to be superior over method I during both the environmental conditions as higher extraction %, purity, pol % cane were found in fresh canes prepared by method II as compared to canes prepared by method I. Lower amount of reducing sugars in canes prepared by method II than method I again indicated the better quality of canes prepared by method II (Table 1). However in method II cane weight was less as compared to method I, but it could be easily compensated by increase in pol % cane in method II.

Preparation of fresh canes for milling by method II caused profit to sugar mill over method I practice due to higher sugar by 62 Rs./ ton in February and Rs.50 / ton in April, while loss to farmers due to loss in cane weight was Rs. 15.9 / ton in February and Rs.22.6 / ton in April which can be compensated by the sugar mills easily. These calculations were done assuming rate of cane Rs. 1250/tn cane, rate of cane tops Rs. 800/ton and rate of sugar Rs.20/kg.

Table 1. Quality parameters of fresh canes prepared by two different methods for milling

Quality	February			April		
	Method I	Method II	% Change	Method I	Method II	% Change
Cane weight (kg)	14.17	13.67	0.50 (3.52%)	13.01	12.36	0.65 (5.03%)
Extraction (%)	54.05	54.60	0.55	50.55	51.72	1.17
Purity(%)	88.30	88.93	0.63	87.83	88.85	1.05
Pol % Cane	14.44	14.75	0.31	15.58	15.83	0.25
Reducing Sugars % Brix	0.41	0.36	0.05	3.24	2.24	1.00

Effect of cane storage on cane quality

Storage of harvested sugarcane for 6 days resulted in decrease in weight, extraction %, Purity, Pol % cane with increase in the invert sugars and activities of enzyme invertases regardless of treatment or environment condition. The loss in cane weight during storage for 6 days was relatively more in method I than method II. The rate of cane weight loss for method I and method II was 1.37 and 1.32 per cent day $^{-1}$ in February and it increased to 2.15 and 2.05 in April (Tables 2&3). The weight loss is mainly attributed to evaporatory losses and respiratory losses (Alexander, 1973). Irrespective of treatment, cane weight loss was always found to be more in April (13.08 % for method I and 12.44 % for method II) than that of February (8.17 % for method I and 8.00 % for method II). Much higher moisture losses during late crushing season. have also been reported earlier (Solomon *et al.*, 1997). Reduction in extraction % and pol % cane was also high in method I as compared to method II in both the environmental conditions. The losses were found to be much higher if the calculations were based on original cane weight. According to Uppal (2003) results expressed on original /fresh cane weight basis give better and clear information regarding deterioration in cane quality. Rate of loss of Pol % cane was significantly high in method I than that of method II and also in April than February. During 6 days storage period, purity % decline was higher in method I than method II irrespective of months indicating method I causing higher processing losses to mill.

Sucrose inversion to reducing sugars is an important indicator of cane quality deterioration. During six days storage, percent increase in reducing sugars % brix and rate of % change per day was much more in method I as compared to method II indicating less deterioration in canes prepared by method II. Activity of both enzymes increased with storage of cane and pattern of relative activity of the two enzymes remained same

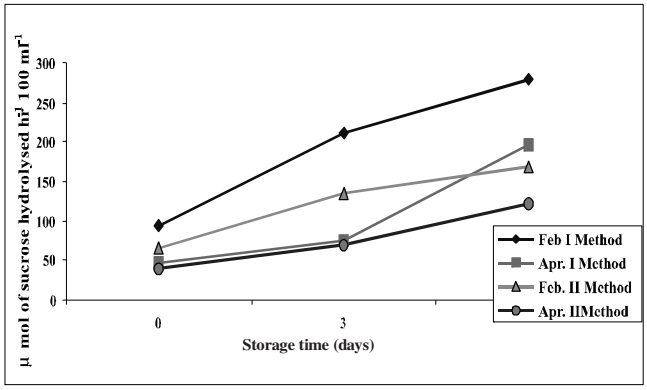

Fig. 1. Activity of Acid Invertase at different storage times

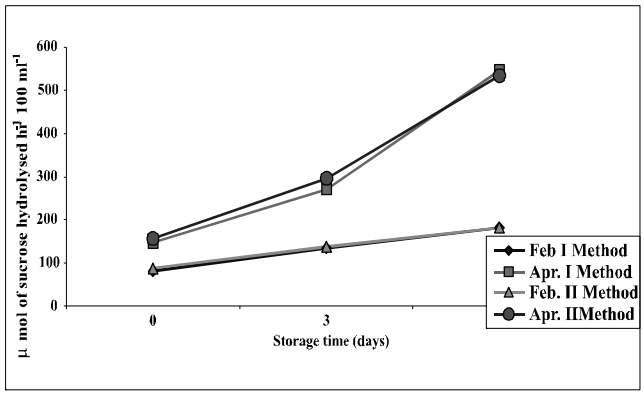

Fig 2. Activity of Neutral Invertase at different storage times

during staling (Fig 1 and 2). On storage , due to loss in moisture level, juice gets concentrated (Uppal ,2003) which probably result in increase in invertase activity (Fig. 1 and 2). Since fresh cane contains higher water content, which provides an

Table 2. Changes in quality parameters during six days of storage in February

Quality	Method I			Method II		
	% Change	Rate of % Change per day^{-1} (b value)	R^2	% Change	Rate of % Change per day^{-1} (b value)	R^2
Loss of Cane weight	8.17	1.37	0.989	8.00	1.32	0.994
Loss in Extraction	12.35	1.85	0.875	9.64	1.39	0.784
Loss in Purity	26.87	4.06	0.891	24.47	3.82	0.909
Loss in Pol % Cane	19.25	2.86	0.838	17.49	2.54	0.808
Gain in Reducing Sugars % Brix	3437	559	0.869	2462	460	0.94

insulating effect on cellular temperature, so on storage due to loss in moisture level such effect is diminished. This effect also resulted in increase in activity of invertases (Batta and Singh,1991) and thereby, invert sugar level. Additionally the activity of exo-invertase of *Leuconostoc mesenteriods,* which has been reported to infect harvested canes (Egan,1965), may be additive to host invertase activity. Increase in activity of invertases is higher in method I than that of method II as also the increase in invert sugars (Table 2 and 3). Immature internodes at top have high acid invertase activity (Sachedeva *et al.,* 2003) which resulted in higher acid invertase activity in Method 1 (Fig 1 and 2) causing more loss in available sucrose in method I as compared to method II (Table 1,2 and 3).

Besides inversion of sucrose by invertases, dextran formation by microorganisms are largely responsible for loss

Table 3. Changes in quality parameters during six days of storage in April

Quality	Method I			Method II		
	% Change	Rate of % Change per day^{-1} (b value)	R^2	% Change	Rate of % Change per day^{-1} (b value)	R^2
Loss of Cane weight	13.08	2.15	0.976	12.44	2.05	0.984
Loss in Extraction	13.46	2.10	0.959	12.44	2.10	0.960
Loss in Purity	22.81	3.86	0.966	21.96	3.82	0.936
Loss in Pol % Cane	19.13	3.07	0.957	18.95	3.00	0.967
Gain in Reducing Sugars % Brix	663	113	0.870	590	101	0.940

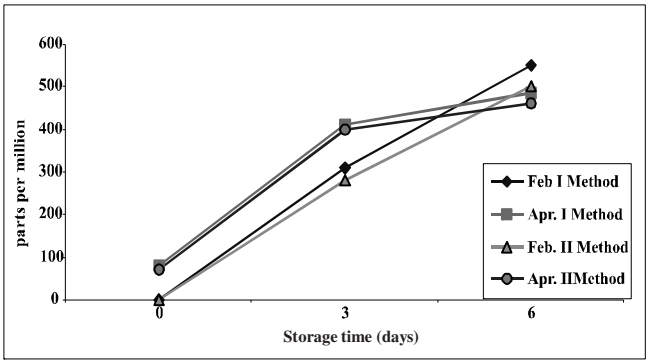

Fig. 3. Dextran (ppm) formation during post-harvest storage of cane

of recoverable sugar, thus act as indicator of quality deterioration (Singh *et al.,* 2006). Level of dextran also increased during six days storage of canes prepared by both the methods (Fig. 3), being more in method I than method II. The results indicated that method II of milling of canes was superior over method I as more sugar recovery and less post harvest deterioration was found by former method.

References

Alexander AG (1973) Sugarcane Physiology. Elsevier- Scientific Publishing company, Amsterdam. P. 573-609.

Batta SK, Singh R (1991) Post harvest deterioration in quality of sugarcane. Bharatiya Sugar 49-51.

Chen JCP (1985) Cane sugar handbook. Wiley interscience Publication. New york. P. 13-16 and 788-790.

Egan BT (1965) The infection process of sour storage rot. Proc Int Soc Sugarcane Technol 32 : 21-24.

Gomez KA, Gomez AA (1984) Statistical procedures for Agricultural Research. Wiley Interscience Publication. New York. P. 357-423.

Hatch MD, Sacher JA, Glasziou KT (1963) Sugar accumulation cycle in sugarcane. Studies on enzymes of the cycle. Plant Physiology 38: 338-343.

Nelson N (1944) A photometric adaptation of the somogyi method for determination of glucose. J Bio Chem 153: 375-380

Sachedeva M, Mann APS, Batta SK (2003) Sucrose metabolism and Expression of key enzyme activities in low and high sucrose storing

sugarcane genotypes. Sugar Tech 5: 265-272.
Sharma KP, Batta SK (1993) Declining trend in sugar recovery in Punjab-causes and cures, III. Post harvest loss in cane sugar due to staling. Proc. Natl. Symp. On sugarcane quality IISR, Lucknow, India, P. B15-16.
Singh I, Solomon S, Shrivastava AK, Singh RK, Singh J (2006) Post – harvest quality deterioration of cane juice: Physio-biochemical Indicators. Sugar Tech 8:128-131.
Solomon S, Shrivastava AK, Shrivastava BL, Madan VK (1997) Premilling sugar losses and their management in sugarcane. Technical Bull No.37, IISR, Lucknow. P 1-217.
Solomon S, Ramaduri R, Shanmugnathan S, Shrivastava AK, Deb S, Singh I (2003) Management of biological losses in milling tandem to improve sugar recovery. Sugar Tech 5 : 137-142
Solomon S, Shrivastava AK, Yadav RL (2007) Strategies to Minimize Post Harvest Sucrose Losses in Sugarcane: An Overview. Proceedings of the 68th Annual Convention of STAI, Goa, India: 112-121.
Uppal SK, Sharma S (1999) Relative performance of genotypes to post harvest inversions in subtropical region. Indian Sugar 49: 345-348.
Uppal SK, Sharma S, Sidhu GS (2000) Response of sugarcane genotypes to post harvest deterioration under natural field conditions exposed to sun vs. shade. Crop Research 19 : 13-16.
Uppal SK (2003) Post harvest losses in Sugarcane. Sugar Tech 5: 93-94.