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Minimization of sucrose losses in harvested cane with spraying of electrolyzed water and pine oil

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ABSTRACT

Spraying of electrolyzed water and pine oil on the harvested cane showed relatively lesser decline in commercial cane sugar compared to water sprayed & trash covered control during late crushing period. The CCS% in untreated, electrolyzed water (EW) and Pine oil treated canes after 240 hours of storage was 9.84, 10.84 and 11.10 respectively. A marked increase in acid invertase activity and mannitol formation was noticed with the duration of storage. The treated canes showed appreciable reduction in the invertase activities, dextran and mannitol formation. Deterioration of harvested cane could be minimized to a considerable extent by spraying of electrolyzed water or pine oil followed by covering it with trash.

Key words: Electrolyzed water, Post-harvest losses, Commercial cane sugar, Mannitol, Pine oil.

Sugar industry worldwide suffers from the monetary losses due to inordinate delays in crushing of harvested cane. The delivery of consignments of stale sugarcane to factories can detrimentally affect multiple process units, and reduces sugar recovery. Sugar industry is one of the largest users of biocides and a huge quantity of this chemical is consumed every year in sugar mills to minimize sugar losses during processing. In India, a large spectrum of biocides (QUAT, thiocarbamate, halogen compounds) is used to minimize biological losses in milled juice(s). In recent times, use of chemicals in production and processing of food commodities is being restricted due to environmental and socio-economic concerns. Use of eco-friendly chemicals such as electrolyzed water, pine oil, beta acids, hops etc. could minimize the use of hazardous chemicals in food processing industries. Pine oil, an essential oil obtained from *Pinus sylvestris*is, is a phenolic disinfectant that is mild antiseptic and antibacterial. Eco-friendly chemical i.e. electrolyzed water (EW) is also a biocidal formulation produced through an electrochemical process. It contains a mixture of oxidizing compounds predominantly hypochlorous acid and sodium hypochlorite, has a pH of 5-7 and an oxidation reduction potential (ORP, redox) of around 1000mV. The high redox potential allows for the quick and efficient destruction of microbes. The use of EW is an emerging technology with considerable potential. Antibacterial effect of electrolyzed water on oral bacteria has also been reported by Lee and Choi (2006). Priyanka and Solomon (2010) have shown its positive effect on the shelf life of harvested sugarcane under sub-tropical conditions.

MATERIALS AND METHODS

The study was carried out in the month of April (ambient temperature 35-40 ^{0}C) at IISR, Lucknow. Sugarcane variety 'CoSe 92423' (a mid- late, medium sugar) was raised under normal cane husbandry practices prevailing in north India. Cane stalks of uniform size were harvested, topped, detrashed and kept in separate bundles in small heaps under natural field conditions in three replicates. First heap was mist sprayed with water and covered with thick layers of trash (5 cm) and used as control (T-1), second heap (T-2) was sprayed with electrolyzed water (Sterisol-C, Faith Biotech, New Delhi, India) and covered with trash, third heap (T-3) was sprayed with aqueous formulation of pine oil (5 ml/l) and covered with thick layer of trash. Ten canes from each heap were selected and juice was extracted at the interval of 0, 48, 96,144,192 and 240 hr in a clean power operated vertical crusher. The deterioration of cane was recorded by observing juice quality parameters. Commercial Cane Sugar (CCS %) in juice was calculated by the formula CCS% = {1.022 x (pol% juice) – 0.292 x (brix)} (Bakshi Ram *et al*. 2001). Acid invertase activity in the primary expressed juice was assayed by the method described by Rosario and Santisoparsi (2003). Mannitol was estimated by the method of Eggleston et al (2009) using mannitol dehydrogenase (MDH) and nicotinamide- adenine- dinucleotide (NAD). Dextran was estimated by rapid Haze method (Clarke *et al.* 1987).

RESULTS AND DISCUSSION

The loss in sugar after harvest has been depicted by CCS% content, and is highly correlated with the sucrose content in cane on a fresh weight basis (Muchow *et al.* 1996). The loss in CCS% in water sprayed + trash covered cane (T-1) after 96 and 240 hours on storage was 1.7 and 4.02 units, in EW treated cane+ trash covered (T-2) CCS loss was 0.41 and 3.02 units.

In pine oil treated cane + trash covered (T-3) CCS loss was reduced to 0.16 and 2.76 units. It indicated the effect of electrolyzed water (EW) and pine oil treatment in minimizing post-harvest sugar losses (Fig 1).

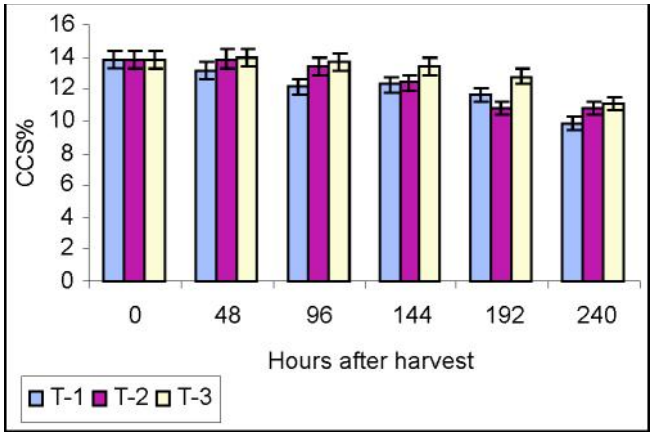

Fig 1 Effect of Pine oil & EW treatment on CCS% in harvested cane juice

Dextran concentration was 93 mg/l, which increased by 1.61,1.46 and 1.19 folds in T-1,T-2 and T-3 canes after 240 hours of harvest. These data also show that formation of dextran was reduced by 98% and 125% when treated with electrolyzed water and pine oil compared to untreated canes (Fig 2).

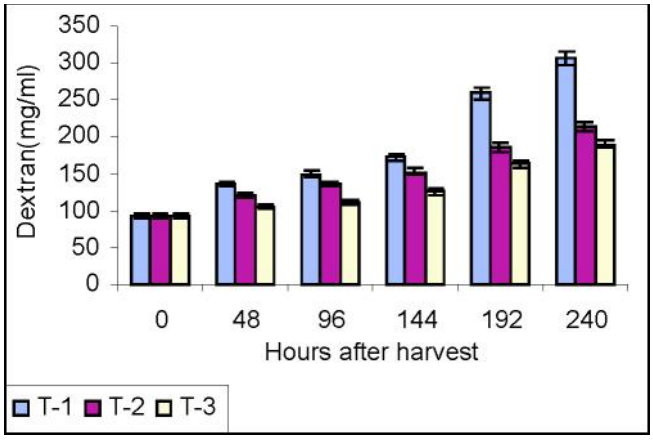

Fig 2 Effect of pine oil and EW on Dextran formation in harvested cane

Long term storage of harvested cane showed appreciable mannitol production, which is a useful indicator of cane deterioration. Mannitol concentration in T-1, T-2 and T-3 canes was 28693.23, 17359.83 and 2807.95 ppm/Brix after 240 hours of harvest (Fig 3). Mannitol is a major degradation product of *Leuconostoc mesenteroides* deterioration of both sugarcane and sugar beet and a sensitive marker that can predict processing problems. Eggleston *et a*l (2002) first reported that mannitol was a major deterioration product in sugarcane. An enzymatic method (Eggleston 2009) was used to measure

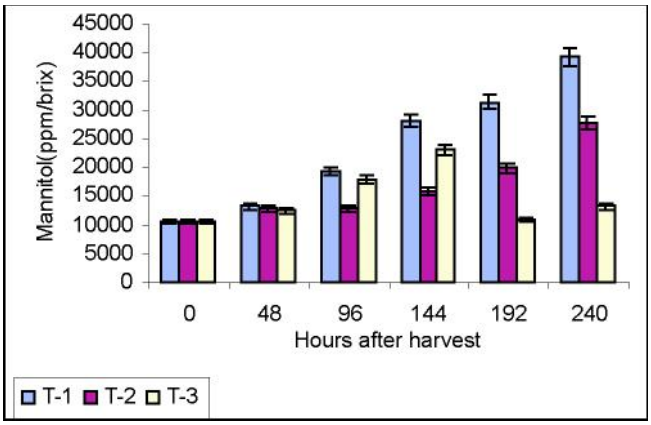

Fig 3 Effect of EW and Pine oil spray on Mannitol formation in harvested cane

mannitol in juice collected from stale cane and our results are also in agreement with their studies (Priyanka & Solomon 2011). Mannitol formation in pine oil treated cane was low, which probably indicates its antibacterial activity.

Soluble acid invertase activity assayed in the primary extracted juice of harvested cane increased by 1.48 and 3.7 units after 96 and 240 hours of harvest in untreated cane (T-1). In EW treated (T-2) canes it showed marginal increase ie; 0.434 and 1.9 units after 96 and 240 hours, in pine oil treated cane (T-3) the increase was 0.444 and 1.7 units after 96 and 240 hours respectively (Fig 4). A high activity of acid invertase in the harvested cane could be due to combined expression of plant and microbial acid invertases, in untreated cane . This seems treatment of electrolyzed water (EW) and pine oil suppressed acid invertase activity. The higher acid invertase activity favored sucrose inversion which is responsible for loss of sucrose in the harvested stored cane (Priyanka *et al*, 2008). The endogenous invertases get activated due to loss of moisture and lack of control mechanism and this situation is further compounded by release of invertases from microbes. A sharp increase in acid invertase leads to increased sucrose inversion and consequently there is a drop

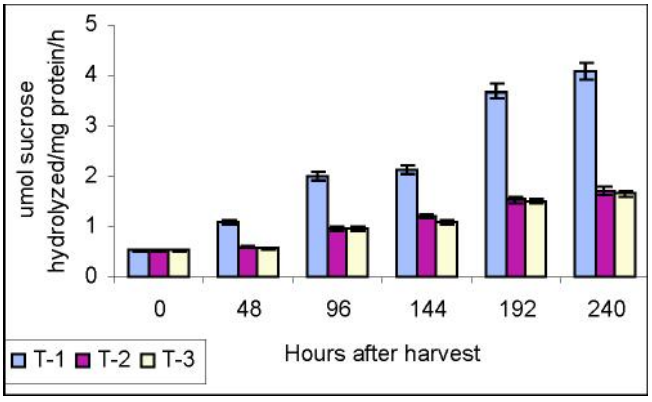

Fig 4 Effect of EW and pine oil treatment on acid invertase activity in harvested cane juice

in Commercial Cane Sugar (Solomon *et al*. 1997) in harvested cane.

Initial studies conducted by Solomon and Priyanka (2009 and 2011) have shown that application of EW on harvested cane had beneficial effects on its keeping quality, a mist spray of EW on cut cane and covering with trash was found to be effective. Unlike pesticides, electrolyzed water and pine oil is safe, environment friendly and has a low running cost and therefore they can be easily used, to preserve the quality of raw material after harvest.

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