LOSSES ASSOCIATED WITH POST-HARVEST AND PRE-DELIVERY CONDITIONS

By

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Abstract

Conditions for post-harvest microbial infection are reviewed. Potential degradation products are indicated and a qualitative assessment of their application for loss estimates is discussed.

Introduction

The post-harvest link in the supply chain represents the interface between field and factory where cultural, harvesting, delivery and cane-storage practices can have a profound effect on the quality of juice entering the factory as well as impacting on the efficiency of subsequent processing operations and, ultimately, on sugar quality. The loss of recoverable sucrose during harvesting and delivery can become a serious economic problem. There is a vast literature on the subject and this discussion treats the topic in broad outline.

Conditions for infection

The occurrence of microorganisms in soil, air and water is a natural phenomenon. It is when conditions are conducive to the rapid growth of these microorganisms, that their presence becomes a nuisance. Sugarcane before harvest carries a small but diverse microbial population growing on the stems and leaves, or deposited from the air or splashed up from the soil. Healthy growing cane is not infected with Leuconostoc, the cane stalk being coated with a waxy substance that protects the inner stalk from infection. Whenever the stalk is damaged—by borers, burning, freezing or cutting—it is immediately infected with Leuconostoc which begins to multiply rapidly. Experiments in Australia have indicated that Leuconostoc can penetrate 7.5 cm from the point of cutting within 10 minutes. Rates of deterioration are related to field and harvest conditions and are mainly functions of the degree of mechanical damage, cut to crush delay, environmental conditions, degree of burn and delay of harvest after burning, degree of frost or freeze damage and combinations of these factors. These factors have been covered at length elsewhere (McNeil and Bond, 1980; Atkins and McCowage, 1984).

Sucrose losses due to cane deterioration have been reported at between 1 and 3% of the initial content, depending on the harvest method used. Losses as high as 10 to 13% have been estimated.

Polysaccharides

The most significant bacteria in post-harvest infection are the Leuconostoc species. The major microbial source of sucrose loss is the formation of dextran by Leuconostoc mesenteroides, together with other heterofermentative metabolic products including lactic acid, ethanol and CO₂. As with all microbial action, the life cycle consists of four phases—lag phase, growth phase of organism, enzyme producing phase, enzyme/sucrose reaction phase. The ratio of sucrose destroyed to dextran formed varies throughout these phases, but if left to grow out, a yield of about 25% dextran and 30% lactic acid is eventually reached from a 10% sucrose solution (Table 1). By contrast, under local conditions, the dextran to lactic acid ratio has been found to be 5:1, indicating the preferential formation of dextran rather than lactic acid—despite the possibility that lactic acid has also been produced from other sources. This implies that the sucrose losses are probably considerably higher than the 4:1 sucrose/dextran ratio for the ‘grown out’ phase which is frequently used to estimate sucrose loss. More sucrose will be lost subsequently in process as a result of the impact of dextran on processing efficiency.

Oligosaccharides

The accumulation of oligosaccharides during post-harvest delays is also indicative of enzymic, bacterial or microbial activity. The kestoses (1-, 6- and neo-kestose) were found to be the main oligosaccharides formed. With whole stalk cane, 6- and neo-kestose formed more rapidly in burnt than green cane. When burnt cane deteriorated, one unit of purity drop corresponded to the formation of about 200 ppm on Bx of 6- or neo-kestose (Morel du Boil, 1995). Eggleston et al. (2000) have also recently reported increased kestose levels in stored cane from various harvesting conditions, but have suggested that part of this may be chemically generated.

Table 1—Change in sucrose/dextran ratio with incubation time.

<table>
<thead>
<tr>
<th>Time (h)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>9</th>
<th>15</th>
<th>18</th>
<th>24</th>
<th>48</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sucrose lost : dextran made ratio</td>
<td>24</td>
<td>28</td>
<td>32</td>
<td>38</td>
<td>39</td>
<td>39</td>
<td>23</td>
<td>11</td>
<td>7.7</td>
<td>4.3</td>
<td>4.4</td>
</tr>
</tbody>
</table>

Data from de Guglielmone et al., 2000.

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Ethanol

In South Africa under normal conditions, ethanol has been used as an indicator of cane delay, with 1000 ppm ethanol indicative of 2 to 3% loss of the original sucrose (de Robillard et al., 1990). Clarke (1998) has postulated that deterioration of cane in small piles is more likely a result of yeast growth under aerobic conditions.

Biocides

The application of inhibitors (biocides) to freshly harvested cane to prevent deterioration is attractive.

Attempts to date have met with limited success—largely as a result of logistical difficulties.

Conclusions

The role of environment is predominant over every other factor in post-harvest deterioration, so that control of sucrose loss becomes one of regional management. A statement made by Tiemann at the turn of the last century is relevant (Sugar Cane in Egypt, 1903)—“It should be remembered that sugar cane, when once cut, is a very perishable raw material, and requires immediate treatment if all the sugar is to be obtained without loss.”

REFERENCES


