## EXTENDED ABSTRACT

**Examination of Oligosaccharides, Organic Acids and High Molecular Weight Components in Beet Processing**

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### Introduction

At Sugar Processing Research Institute, we are interested in beet colorant for two reasons: (1) We wish to understand why beet colorant has such a low transfer of color into the crystal, and (2) we wish to understand the cause of color increase on storage of some thick juices and white sugars.

Beet raw juice is a "soup" that contains many components that enter the sugar manufacturing process along with the sucrose. These include organic acids, anions, cations, oligosaccharides, fatty acids, nitrogenous compounds, reducing sugars, enzymes, polyphenolics and polysaccharides. The stages of purification are intended to remove the majority of these constituents, but a portion remains to go through the process and to interact to form color. Color is created during carbonation under the high temperature and pH conditions. The color formed during beet sugar processing tends to be reactive and subject to increasing over time, which could be considered an "auto-catalytic" effect. In this study, the polysaccharides, oligosaccharides and organic acids in various processes were measured, and their tendency to interact and form color is discussed.

### Observations on Beet Sugar Color

Resin separation of beet colorant using increasingly stronger eluents showed that most beet colorant was moderately to strongly held by anionic exchange resin. The resin-held colorants were the most intensely colored ones. Gel permeation chromatography (GPC) showed that the weakly held color had a very high molecular weight, but was not so highly colored. This colorant is probably the same as a high molecular weight (HMW) colorant previously identified in white sugar, called BCC (beet crystal colorant), a complex of polysaccharide, calcium and colorant (Godshall,1992). GPC of colorant throughout the process showed that most of the HMW material coming in with the raw juice was low in color and high in polysaccharide. This was largely destroyed during carbonation. GPC also showed the development of HMW colorant during carbonation, which increased by up to 28% on evaporation, indicating the highly reactive nature of the colorant. A portion of this colorant, skewed to the higher molecular weight range with lower color also transferred into the white sugar.

The effect of color inside vs outside the crystal on color increase during heated shelf-life studies showed that surface film colorant contributed 50-75% of the increase in color on storage. Colorant inside the crystal contributed 25-50% of the color increase. Very well washed sugar crystals showed little color increase. Compounds identified in the surface film of beet sugars that increased color on storage included: Glucose, fructose, lactic acid, lactic acid dimer, pyroglutamic acid (pyrrolidone carboxylic acid), hydroxymethylfurfural (HMF), HMF dimer and betaine.

Examination of organic acids during processing showed oxalic, citric, galacturonic, aconitic, lactic, formic, acetic and pyroglutamic acids. Oxalic, citric, and aconitic were significantly reduced by clarification. Lactic, formic and acetic acids increased from diffusion juice to thin juice, indicating possibility of infection and alkaline degradation of glucose, in the case of lactic acid. Of interest was the significant increase of galacturonic and pyroglutamic acids during clarification. Galacturonic acid is hydrolyzed off pectin during purification, and, according to Fares, *et al.* (2003), can lead to color formation in sugar. Pyroglutamic acid is also formed in processing from the degradation of glutamine.

Examination of oligosaccharide behavior during processing indicated that these compounds are not significant in color formation.

**Summary**

This study showed that a major portion of the color in beet sugar is formed during carbonation, and that this color increases during processing. Some carbonation colorant, especially the higher MW portion, transfers into sugar crystals, but it is of low color intensity. However, it may play a role in color increase on storage. Galacturonic and pyroglutamic acids also may influence the formation of color, both in processing and on storage of thick juice and certain white sugars. The surface film on beet sugar crystals was shown to be more active in color formation during shelf-life studies than the color inside the crystal. Further studies should be done to determine the influence of pyroglutamic acid on color formation.

**References**

El Amrani, M., Fares, K., *et al.*, Composition and structure of cell wall polysaccharides from sugar beet grown under Mediterranean climate and relation with beet processing, 2003, Proc. Conference on Sugar Processing Research, SPRI publication, pp. 87-110.

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