Changes in Consistency of Tomato Juice during Concentration

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Abstract

Processing tomatoes are typically harvested during a ten to twelve week season in California, and tomato juice is concentrated to stabilize the product for use during the remainder of the year. Manufacturers of value-added products formulated with concentrated tomato paste often note that there is a loss of consistency during the process and storage. To understand the reasons for this, samples of unconcentrated juice, processing intermediates, and concentrated paste were collected from an industrial processing plant during normal commercial production. All samples were diluted with water to 5°Brix then analyzed for consistency and pectin content. Whole juice consistency, measured with a Bostwick consistometer, decreased through the course of juice concentration, with the largest change occurring early in the process, as the juice was concentrated from 5 to 10°Brix. This decrease in consistency occurred during the production of paste from both hot- and cold-break juices. Total pectin content did not change as the juice was concentrated to paste but the proportion of the total pectin that was water soluble increased. The greatest increases in pectin solubility occurred during the hot-break and late in the process where the evaporator temperature was the highest.

INTRODUCTION

Pectins are important in several aspects of tomato product quality. In fluid or semi-solid products such as catsup and sauces, the amount, solubility, and molecular size of the pectins greatly influences the consistency. A better understanding of pectins in different tomato products and the changes that they undergo during processing is desirable in understanding product quality.

Pectins are a heterogeneous family of complex polysaccharides polymers found in the plant cell wall. While tremendous variability in overall pectin composition exists across the plant kingdom, in most common fruits and vegetables including tomatoes, galacturonic acid comprises >80% of the total pectin carbohydrate, occurring either as homogeneous α-1,4-linked polymers (homogalcturonan) or in conjunction with the sugar rhamnose (rhamnogalcturonans). Neutral sugars, primarily galactose, arabinose, rhamnose and xylose, make up the remaining carbohydrate, forming several additional types of branched polymers (Ridley et al., 2001).

The purpose of this project was to measure the changes in pectin, in terms of galacturonic acid content, during the process of concentrating tomato juice to paste at a commercial processing facility.

MATERIALS AND METHODS

Sample Collection

Tomato samples were collected at the Morning Star Packing Co. processing plant in Williams, California during the 2006 and 2007 seasons. Tomato samples were collected 3 times (once in 2006 and twice in 2007) during production of hot-break paste using Heinz cultivars, 2 additional times (once each in 2006 and 2007) during hot break production using a mixture of other tomato varieties, and once in 2007 during cold-break production. Samples taken from various points in the concentration process were immediately cooled on ice, and soluble solids were determined. Soluble solids of the raw juice varied from 5.0 to 5.5°Brix. Sufficient water was added to all samples, and they

were mixed, to bring all samples to 5.0°Brix.

Consistency

Bostwick values were determined at 25±0.5°C.

Pectin Analysis

Pectin analysis followed the procedure described in Anthon and Barrett (2008). Each sample of juice was analyzed in triplicate. For raw tomatoes, fruit was homogenized in phosphate buffer (pH 2) containing 1 g/L SDS to inactivate endogenous enzymes and prevent pectin breakdown.

RESULTS AND DISCUSSION

Samples were taken throughout the juice concentration process and soluble solids, approximate temperature and residence time were determined at every sampling step (Fig.1). Average soluble solids increased from 5.1°Brix in the raw tomatoes to 28°Brix in the concentrated paste. The highest temperatures in the process occurred during the break tank (90-95°C) and at the high density evaporator (80-90°C) stages. Average residence times in the break tank and flash evaporators was fairly short (5-10 min.), while the 3rd, 2nd, 1st and high density evaporator stages were 30-40 min. each.

Processing intermediates were diluted with water back to the °Brix level of the original hot-break juice, and the Bostwick values determined. The largest change in Bostwick occurred at the early stages of concentration, between 5 and 10°Brix (Fig. 2). Analysis of the pectin content of these juices revealed that the total amount of pectin was the same as that in raw tomatoes and did not change during the concentration process (Fig. 3). However, the relative amounts of soluble and insoluble pectin did change. The percentage of the total pectin that was water soluble, i.e. recovered in the supernatant, was highest in the hot break juice, then dropped significantly in the initial stages of juice concentration (Fig. 4). This is the same point in the process where the Bostwick value increased the most. Soluble pectin content increased to between 40-50% of the total pectin at later stages of the concentration process.

ACKNOWLEDGEMENTS

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Literature Cited

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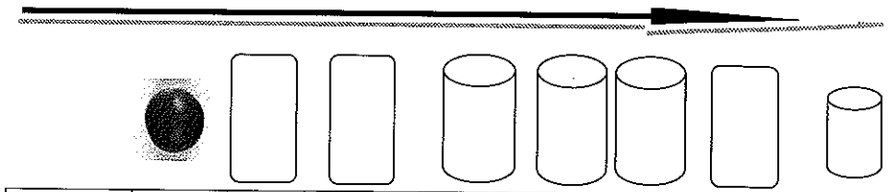
Ridley, B.L., O'Neill, M.A., Mohnen, D. 2001. Pectins: Structure, biosynthesis, and oligogalacturonide-related signaling. Phytochemistry 57:929-967.

Figures



Parameter	Tomato	Break tank	Flash evaporator	3rd effect evaporator	2nd effect	1st effect	High density evaporator	Product
Ave. °Brix	5.1	-	5.1	7.7	10.9	20.3	-	28
Approx. temp. (°C)	Ambient	90-95	60-75	50	74	91	80-90	ambient
Approx. residence time (min.)		5	10	30	40	40	30	

Fig. 1. Average soluble solids (°Brix), approximate temperature and time at various steps in the process from tomato juice to paste.

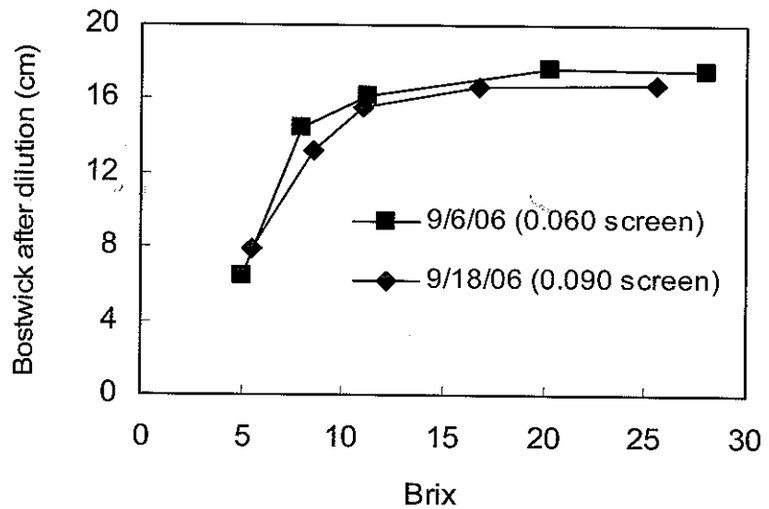


Fig. 2. Increase in Bostwick values during concentration of tomato juice to paste. Screen sizes in use on day of sampling indicated.

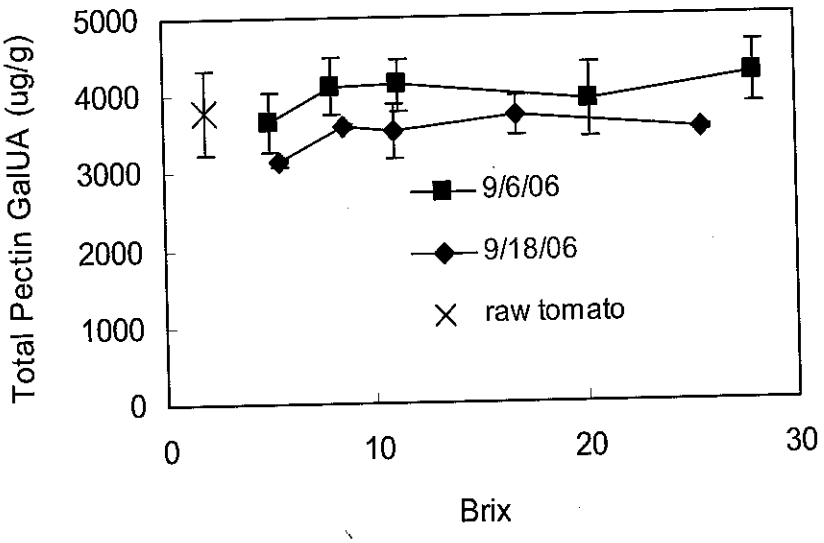


Fig. 3. Changes in total pectin content, measured as galacturonic acid, during concentration of tomato juice to paste.

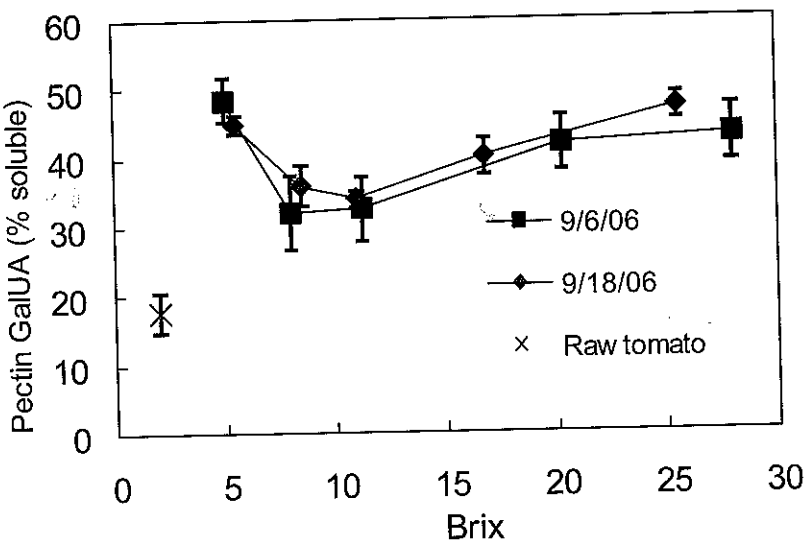


Fig. 4. Percent of total pectin existing in the soluble form during concentration of tomato juice to paste.