Chitosan Enhances Control of Enzymatic Browning in Apple and Pear Juice by Filtration

G.M. SAPERS

ABSTRACT

Browning could be prevented in McIntosh apple juice by the addition of at least 200 ppm chitosan, irrespective of the chitosan product tested, followed by filtration with diatomaceous earth filter aid. Chitosan at 1000 ppm was required to prevent browning in juice from ripe Bartlett and Bosc pears. Juice from very ripe Bartlett pears did not respond to chitosan treatment. Chitosan addition interfered with the prevention of browning in apple and pear juice by centrifugation.

Key Words: apple, pear, browning, chitosan, filtration, centrifugation

INTRODUCTION

STUDIES in our laboratory demonstrated that enzymatic browning in apple and pear juices could be prevented by removing particulate matter by filtration or centrifugation. Filtration treatments (other than micro- or ultrafiltration) were ineffective unless preceded by addition of Bentonite™ and/or Celite™, a diatomaceous earth. Filtration with Celite Analytical Filter Aid (CAFA) prevented browning of juice of Granny Smith, Red Delicious and Golden Delicious apples, but both filter aids were required to control browning in the juice of McIntosh apples and Bartlett and Bosc pears (Sapers, 1991). Chitosans, biopolymers derived from shellfish chitin, have been proposed as "fining" agents for apple juice (Soto-Peralta et al., 1989; Boguslawski et al., 1990) and as coagulants for suspended solids in vegetable (Bough, 1975), seafood (No and Meyers, 1989), and other processing wastes (Knorr, 1984). Boguslawski et al. (1990) also reported that chitosan could reduce microbial counts during the "fining" of apple juice. Our objective was to determine whether the addition of chitosan to apple and pear juices would increase the effectiveness of filtration and centrifugation treatments in controlling browning.

MATERIALS & METHODS

RAW JUICE samples (300-500 mL represented 4-6 fruits) were prepared from ripe Granny Smith, Golden Delicious and McIntosh apples and Anjou, Bartlett and Bosc pears, as described previously (Sapers, 1991). Ascorbic acid (500 ppm for Granny Smith and 1100 ppm for the other cultivars) and 0.1% Sigma Antifoam A (Sigma Chemical Co., St. Louis) were added during juicing to control browning during the application of chitosan treatments. Chitosan solutions were prepared from low, high, and extra high viscosity chitosan flakes (Sea Cure F, Protan, Inc., Commack, N.Y.) and from practical grade chitosan from crab shells (Sigma) by slurrying the flakes in water (2 g/100 mL). The slurry was combined with an equal volume of 2% malic acid solution, and the chitosan dispersed with a Polytron homogenizer (Brinkmann Instruments Co., Westbury, NY). The dispersion was heated to 60 °C with stirring, and filtered through Whatman No. 541 paper under vacuum to remove a small amount of insoluble material.

Chitosan treatments were applied by adding aliquots of each chitosan filtrate, equivalent to 0–1000 ppm chitosan, to 50 mL portions of freshly prepared juice. This was stirred 10 min at 300 rpm, and 2% CAFA added (Manville Corp., Denver, CO), and filtered through Whatman No. 541 paper under vacuum. Alternatively, chitosan-treated juices were centrifuged at 6000 or 28,000 rpm (4600 and 100,000 × *g*, respectively) for 10 min at 4 °C.

Untreated controls, others treated by filtration or centrifugation without chitosan addition, and chitosan-treated filtrates or supernatants were transferred to beakers and stirred at 300 rpm on a multiposition magnetic stirrer (Cole-Parmer Instrument Co., Chicago, IL). These were observed at 1 hr intervals for visual indications of browning during storage at 20 °C. Treatments that resulted in no visible discoloration after about 24 hr when controls browned within several hours were considered to be effective in preventing browning. Treatments were replicated with raw juice samples prepared from several lots of fruit.

RESULTS & DISCUSSION

AS REPORTED previously (Sapers, 1991), McIntosh apple juice was subject to rapid browning, even if partially clarified by addition of CAFA and filtration through Whatman No. 541 paper (Table 1). Browning in McIntosh juice was prevented by addition of 200 ppm low or high viscosity chitosan prior to filtration with CAFA. Similar results were obtained with the other chitosans tested (data not shown). At least 500 ppm chitosan was required to produce a clear juice. Soto-Peralta et al. (1989) obtained maximum clarity in apple juice, treated with a low viscosity acid-soluble chitosan, at a treatment level of 700 ppm.

Chitosan treatments were effective in controlling enzymatic browning in pear juice, which, like McIntosh apple juice, also had not responded to filtration with CAFA (Sapers, 1991). A treatment level of 400 ppm was required with Anjou juice, irrespective of chitosan source (data for Protan Low Viscosity, Protan Extra High Viscosity and Sigma chitosans not shown). Bartlett and Bosc juices, which brown more rapidly than Anjou

Table 1—Control of enzymatic browning in apple and pear juice by chitosan addition and filtration

Juice	Treatment	Level (ppm)	Onset of browning (Hr at 20 °C)
McIntosh apple	Control	–	5
	Filtered with CAFA	–	4
	Low viscosity chitosan	100	4
		200	>22[a]
	High viscosity chitosan	100	4
		200	>22[a]
Anjou pear	Control	–	4
	Filtered with CAFA	–	5
	High viscosity chitosan	400	>23[a]
Bartlett pear	Control	–	2
	Filtered with CAFA	–	2-3
	High viscosity chitosan	400	6
		1000	>16[a]
Bartlett pear, very ripe	Control	–	2
	High viscosity chitosan	1000	2
	High viscosity chitosan + 0.22 μm membrane	1000	4
Bosc pear	Control	–	2-3
	Filtered with CAFA	–	1-2
	High viscosity chitosan	400	2
		1000	>16[a]

[a] No browning observed when experiment terminated at indicated time.