

Effect of Commercially Defatted Rice Bran Extract on Browning of Vegetable and Fruit Puree

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ABSTRACT

The effects of commercially defatted rice bran extract (CDRBE) on browning of potato, apple and banana puree compared with distilled water (DW) were investigated by measuring the color changes of the potato, apple and banana puree. CDRBE-treated potato puree had a lower browning value than that treated with DW after storage for 6 h ($P \leq 0.05$) with browning values of 44.8 and 55.8, respectively. The L^* value of potato puree treated with CDRBE was significantly higher while the a^* value was lower than that treated with DW ($P \leq 0.05$) during storage for 1–3 h. The browning value of apple puree treated with CDRBE was significantly lower than that treated with DW ($P \leq 0.05$) after storage for 5 h with browning values of 43.4 and 47.0, respectively. The L^* and b^* values of apple puree treated with CDRBE were significantly higher than those treated with DW ($P \leq 0.05$) during storage. However, the browning value of banana puree treated with CDRBE was equal to that treated with DW ($P > 0.05$) after storage for 4 h with both having browning values of 21.4. The results indicated that CDRBE could reduce browning in potato puree more than in apple puree, but not effectively in banana puree.

Keywords: enzymatic browning, commercially defatted rice bran extract, potato, apple, banana

INTRODUCTION

Browning, in response to mechanical wounding, is one of the most important undesirable reactions of potato (*Solanum tuberosum*), apple (*Malus domestica* Borkh.) and bananas [*Musa* (AAA Group) ‘Gros Michel’] and can lead to the development of off-flavors and losses in nutritional quality. It is mainly due to the activity of the enzyme polyphenol oxidase (PPO), which catalyzes the oxidation of phenolic compounds into quinones, which then polymerize into brown products (Jayaraman *et al.*, 1982). As plants are a rich source of bioactive chemicals and mostly free of harmful side effects, there is an increasing

demand by consumers for the substitution of synthetic compounds with natural substances as food ingredients (Jang *et al.*, 2002). Various extracts from natural sources, such as honey (Oszmainski and Lee, 1990), grapefruit seed extract (Park *et al.*, 1999), rhubarb juice (Son *et al.*, 2000), enokitake extract (Jang *et al.*, 2002) and onion extract (Kim *et al.*, 2005) have been investigated for use in the prevention of enzymatic browning.

Commercially defatted bran from rice (*Oryza sativa*) is a byproduct from the extraction of edible oil from whole rice bran and is used as an ingredient in animal feeds (Wiboonsirikul *et al.*, 2007). It is a good source of insoluble dietary

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fiber, protein, phytic acid, inositol and vitamin B (Devi and Arumughan, 2007b). Some researchers have reported that commercial defatted rice bran contains phytochemicals such as oryzanols, tocopherols and ferulic acid that are related to possible health benefits as antioxidants which promote a high capacity for free radical scavenging and lipid peroxidation (Devi and Arumughan, 2007a; Devi and Arumughan, 2007b; Devi *et al.*, 2007; Devi *et al.*, 2008). However, commercially defatted rice bran extract (CDRBE) has not been previously reported as a browning inhibitor in potato, apple and banana. Therefore, the objective of this study was to investigate the inhibitory effects of CDRBE on browning of potato, apple and banana puree.

MATERIALS AND METHODS

Preparation of commercially defatted rice bran extract

Commercially defatted rice bran (100 g) was obtained from the Patum Rice Mill and Granary Public Co. Ltd., Thailand, homogenized with 400 mL of distilled water (DW) using an overhead stirrer at 700 rpm for 30 min at 25 °C and then centrifuged at 12,000×g for 20 min. The supernatants obtained after centrifugation were defined as commercially defatted rice bran extract (CDRBE).

Potato, apple and banana puree preparation and treatment

Potato, apple and banana puree samples purchased from a local market in Bangkok, Thailand were prepared by blending 160 g of sample pulp for 30 sec with 80 mL of CDRBE and a second sample with DW as the control, and the puree samples were stored at room temperature (25 °C) for 6 h. The color values (L^* , a^* and b^*) of the samples were measured with a spectrophotometer (CM-3500D, Minolta) at 0 (initial condition), 0.5, 1, 2, 3, 4, 5 and 6 h of storage time and the browning values were calculated using

Equation 1 (Labuza *et al.*, 1990):

$$\text{Browning Value} = \Delta L^* / L_0^* \times 100 \quad (1)$$

where: $\Delta L^* = L_0^* - L^*$; L^* = L^* value at the time measured; and L_0^* = the initial L^* measurement. L^* is the luminosity, a^* is the position on the green (-) to red (+) axis and b^* is the position on the blue (-) to yellow (+) axis (Girelli *et al.*, 2004).

Statistical analysis

Three replications of each experiment were performed. All data were analyzed and tested by one-way analysis of variance. Significant differences ($P \leq 0.05$) among various treatments were detected using Duncan's multiple range test.

RESULTS AND DISCUSSION

Effect of commercially defatted rice bran extract on browning in potato puree

Browning values and the changes in the L^* , a^* and b^* values of the potato puree blended with DW and CDRBE and stored at 25 °C for 6 h are shown in Figure 1. The brown color of the potato puree developed rapidly within 4 h and there were increases in the changes of L^* , a^* and b^* values of the puree. There was a slight increase after storage for 4–6 h. Lower browning values indicated greater effectiveness of browning inhibition. The CDRBE-treated potato puree had significantly lower browning values than that treated with DW ($P \leq 0.05$) after storage for 0.5, 1, 3, 4 and 6 h. The browning values of potato puree treated with CDRBE and DW after storage for 6 h were 44.8 and 55.8, respectively. The results indicated that CDRBE decreased the development of browning in potato puree during storage. The decrease in the L^* value signified a darker color and the increase of a^* value signified a redder color. Thus, the decrease in the L^* value and the increase in the a^* value indicated a high browning color (Moline *et al.*, 1999). The L^* value of potato puree treated with CDRBE was significantly

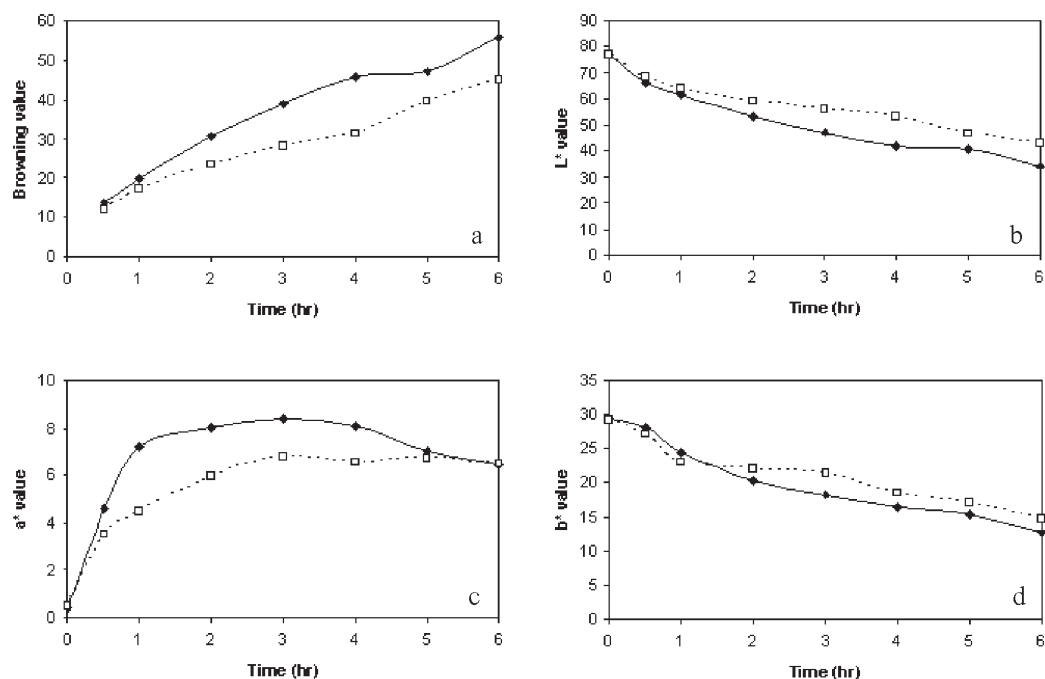


Figure 1 Browning (a); (b) L^* ; (c) a^* ; and (d) b^* values of potato puree blended in defatted rice bran extract (---□---) and distilled water (—◆—) stored at room temperature (25 °C) for 0–6 h.

higher than that treated with DW during storage for 0–6 h. The a^* value of potato puree treated with CDRBE was significantly lower than that treated with DW after storage for 1–3 h, while its b^* value was significantly higher than that treated with DW after storage for 5 h. A slight change in the L^* , a^* and b^* values of the puree was observed after storage for longer than 6 h (data not shown). The results showed that the changes in the L^* , a^* and b^* values in potato puree treated with CDRBE were lower than in DW during storage. The results revealed that CDRBE showed effective browning inhibition in potato puree during storage.

Effect of commercially defatted rice bran extract on browning in apple puree

The browning values and the changes in the L^* , a^* and b^* values of apple puree blended with DW and CDRBE and stored at 25 °C for 6 h are shown in Figure 2. The brown color of apple

puree developed rapidly within 2 h and there were a increases in the changes of L^* , a^* and b^* values of the puree. There was a slight change in the L^* , a^* and b^* values of the puree after storage longer than 6 h (data not shown). The browning value of the purée treated with CDRBE (43.4) was significantly lower than that treated with DW (47.0) after storage for 5 h. The results indicated that CDRBE was able to prevent browning in apple puree during storage. The L^* and b^* values of apple puree treated with CDRBE were significantly higher than apple purée samples treated with DW during storage. The a^* value of apple puree treated with CDRBE was similar to that treated with DW after storage for 0, 0.5, 1 and 4 h ($P > 0.05$). The results showed that changes in the L^* , a^* and b^* values in the apple puree treated with CDRBE were lower than in samples treated with DW during storage. The results suggested that CDRBE showed an inhibitory effect on browning in apple puree during storage.

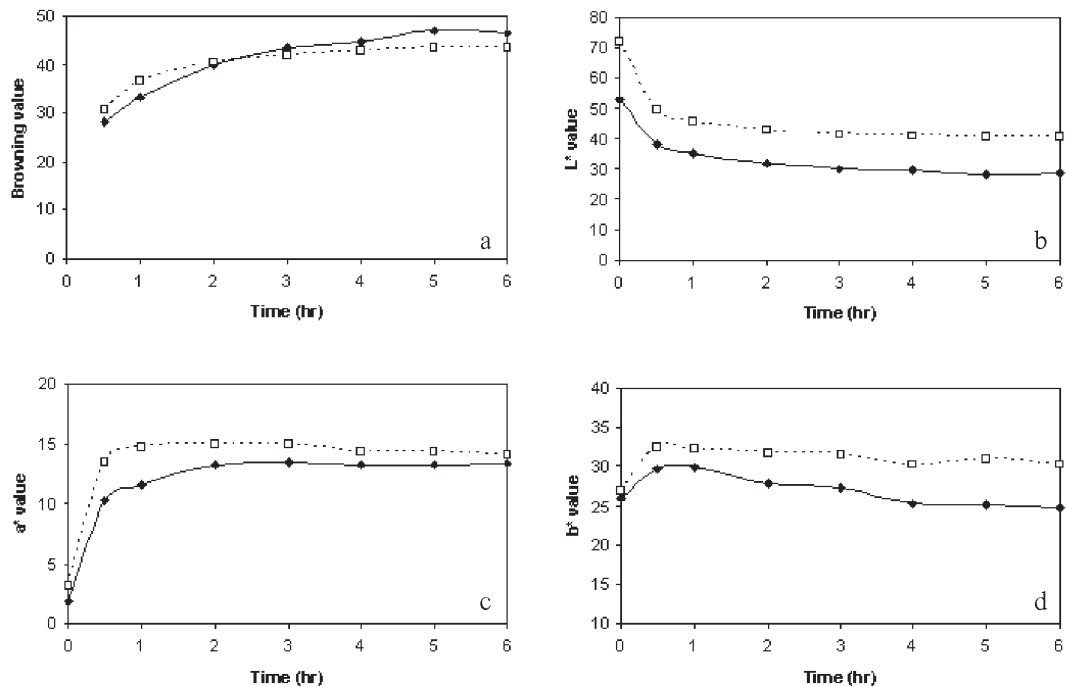


Figure 2 Browning (a); (b) L^* ; (c) a^* ; and (d) b^* values of apple puree blended in defatted rice bran extract (—□—) and distilled water (—◆—) stored at room temperature (25 °C) for 0–6 h.

Effect of commercially defatted rice bran extract on browning in banana puree

The browning values and the changes in the L^* , a^* and b^* values of banana puree blended with DW and CDRBE and stored at 25 °C for 6 h are shown in Figure 3. The brown color in the banana puree developed rapidly within 2 h and there were increases in the changes of L , a^* and b^* values of the banana puree. There was a slight increase after storage for 2–6 h. However, there was a slight change in the L , a^* and b^* values of the puree after storage for longer than 6 h (data not shown). The browning value of banana puree treated with CDRBE was similar to that treated with DW ($P > 0.05$) after storage for 4 h with a value of 21.4 for both samples. The L^* value of banana puree treated with CDRBE was similar to that treated with DW ($P > 0.05$) after storage for 1, 4 and 5 h. Likewise, the b^* value was also similar to that treated with DW ($P > 0.05$) after storage for 0, 0.5 and 3 h. The a^* value of banana

puree treated with CDRBE was not significantly lower than that treated with DW after storage for 0.5, 1 and 4–6 h. The results indicated that browning in banana puree treated with CDRBE was not lower than that treated with DW during storage. In conclusion, CDRBE could not inhibit browning in banana puree during storage.

The overall results demonstrated that CDRBE had an inhibitory effect on the browning reaction of potato and apple puree but had no effect on the banana puree during the 6 hr storage period. This might have been due to the inhibition of some phytochemical compounds in CDRBE on the PPO isozymes of potato and apple. The PPO isozymes in different plants were reported to be different (Labuza *et al.*, 1990). Theerakulkait and Boonsiriphat (2007) also found that full-fatted rice bran extract had a greater inhibitory effect on the PPO activity of potato than that of banana and apple. The inhibitory effect of CDRBE on the browning of potato and apple might have been due

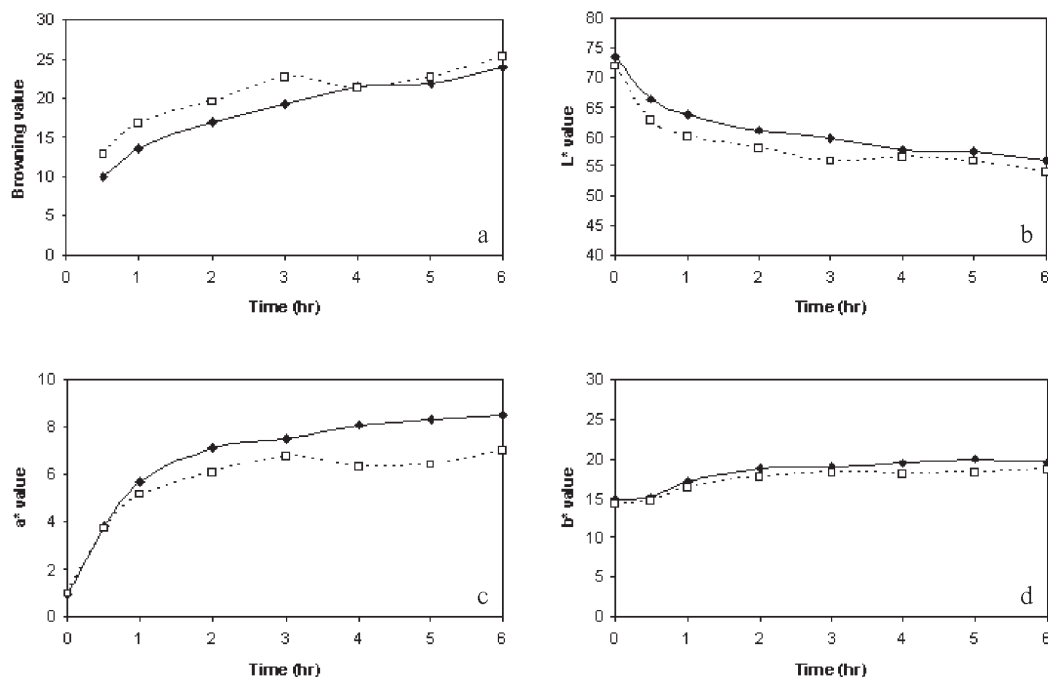


Figure 3 Browning (a); (b) L*; (c) a*; and (d) b* values of banana puree blended in defatted rice bran extract (—□—) and distilled water (—◆—) stored at room temperature (25 °C) for 0–6 h.

to phenolic compounds present in CDRBE. Some researchers reported that methanolic extracts of CDRBE contained major phytochemicals, such as oryzanols, tocopherols, tocotrienols and ferulic acid, which provided the inhibitory effect on lipid oxidation (Devi and Arumugan, 2007a; Devi *et al.*, 2007; Devi *et al.*, 2008) and scavenging effects on positive superoxide radicals (Devi and Arumugan, 2007b). Some phenolic phytochemicals, such as *p*-coumaric acid, ferulic acid and sinapic acid, were effective in the inhibition of enzymatic browning in potato (Macrae and Duggleby, 1968) and apple (Pifferi *et al.*, 1974; Walker and Wilson, 1975). *p*-Coumaric acid exhibited competitive inhibition with monophenol for binding to the active site of the enzyme and mixed-type inhibition with *o*-diphenol, while ferulic acid exhibited competitive inhibition for the oxidation of monophenol and non-competitive inhibition for the oxidation of *o*-diphenol by potato PPO (Macrae and Duggleby,

1968). The results showed that CDRBE contained certain compounds which prevent browning by decreasing the initial browning of the puree and decreasing the rate of browning during storage in vegetable and fruit puree. CDRBE could potentially be used as a natural inhibitor for puree preparation in some frozen vegetables and in the fruit puree industry.

CONCLUSION

Commercially defatted rice bran extract (CDRBE) showed more potent ability to reduce the browning values in potato puree than in apple puree during storage for 6 h. However, it could not reduce the browning value in banana puree. The results suggested that CDRBE may be a potential natural antibrowning agent for short-time storage of some vegetable and fruit purees, especially potato puree.

ACKNOWLEDGEMENTS

The authors would like to express sincere gratitude to the Kasetsart University Research and Development Institute (KURDI), Thailand for financial support, and special thanks to Patum Rice Mill and Granary Public Co. Ltd., Thailand for providing the rice bran for the research.

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