Effect of spray-dried rice bran extract on inhibition of enzymatic browning in potato puree

Supakit Threranukool¹, Supatcha Kubglomsong² and Chockchai Theerakulkait¹*

¹Department of Food Science and Technology, Faculty of Agro-Industry, Kasetsart University, Bangkok 10900, Thailand
²School of Human Ecology (Program in Food, Nutrition and Applications), Sukhothai Thammathirat Open University, Nonthaburi 11120, Thailand

ARTICLE INFO

Article history:
Received 31 July 2018
Received in revised form 07 October 2018
Accepted 10 October 2018

Keywords:
Browning inhibition
Potato puree
Rice bran extract
Spray-drying

ABSTRACT

Enzymatic browning is a major problem in the quality loss of fruits and vegetables. It is also deleterious flavor, nutritional values and consumer’s acceptance. Sulfites are widespread agents used to control browning reaction. Due to adverse health effects, they could be a problem for human health. Thus, non-sulfite antibrowning agents are searched for food industry. Rice bran is a by-product from rice milling industry. It is a good source of natural antioxidants and phenolic acids. Therefore, the objective of this research was to investigate the effect of rice bran extract prepared by spray-drying on enzymatic browning inhibition in potato puree. Rice bran extract (RBE) was prepared by distilled water (DW) extraction. It was spray-dried to obtain spray-dried RBE powder (SD-RBE). The solution of SD-RBE powder was investigated for its enzymatic browning inhibition in potato puree by color measurement at room temperature for 6 hr. The browning values were calculated. Potato PPO inhibition was studied by measuring absorbance at 420 nm with catechol as substrate. SD-RBE solution showed greater enzymatic browning inhibitory efficiency than DW. Browning values and a* values of potato puree treated with SD-RBE solution were lower; whereas, L* and b* values were higher than those treated with DW during storage for 6 hr (p≤0.05). Its browning, a*, L* and b* values at 6 hr storage were 25.35, 4.05, 54.12 and 18.93, respectively; while those of DW treatment were 38.12, 5.47, 45.55 and 12.41, respectively. SD-RBE showed high potato PPO activity inhibition with the value of 66.12%. The results revealed that SD-RBE exhibited enzymatic browning inhibition in potato puree. Thus, SD-RBE has a potential to be used as a natural antibrowning agent for potato puree.

© 2018 School of Agro-Industry, Mae Fah Luang University. All rights reserved.
INTRODUCTION

Potato (Solanum tuberosum L.) is the world’s fifth largest food crop after sugar cane, corn, rice and wheat. In 2016, global potato production was about 380 million tonnes (FAO, 2018). It is rich in vitamins, minerals, high quality starch and protein (Li et al., 2017). However, potato turns brown after mechanical injury during processing, resulting in deleterious flavor, nutritional values and consumer’s acceptance (Severini et al., 2003).

Enzymatic browning reactions are primarily catalyzed by polyphenol oxidase (PPO) in the presence of oxygen (Martinez and Whitaker, 1995). The most widespread agent used to control browning is sulfiting agents. Due to the adverse health effects, they could cause the problems for human health (Sapers, 1993). Thus, the researches of finding non-sulfite anti-browning agents for food industry have been interested. Rice bran is a by-product from rice milling industry. It is a good source of natural phytochemicals. Rice bran contained phenolic compounds such as ferulic acid, p-coumaric acid, vanillic acid and sinapic acid that might be responsible for the enzymatic browning (Sukhonthara et al., 2016). Rice bran extract (Theerakulkait and Boonsiripiphat, 2007; Sukhonthara et al., 2016) could reduce the enzymatic browning in potato. In addition, Kuhglomsong and Theerakulkait (2014a, b); Kuhglomsong et al. (2018) also found that rice bran protein and rice bran protein fraction could inhibit enzymatic browning. However, there is limited information about the enzymatic browning inhibition in vegetables and fruits by spray-dried rice bran extract.

Spray drying is widely applied to preserve the natural extracts. This technique has been used for drying aqueous or organic solutions, emulsions etc., in chemical and food industry. It has been successfully employed with many food products such as coffee, milk and egg (Bhandari et al., 1993). In addition, there have been several studies investigated for applying spray drying technique to produce powder from natural extracts such as grape seed extract, apple polyphenol extract and olive leaf extract (Kosaraju et al., 2008), green tea extract (Tang et al., 2011; Susantikarn and Donlao, 2016) and black mulberry juice (Fazaeli et al., 2012). Spray drying is an economical, flexible, continuous operation (Susantikarn and Donlao, 2016). Therefore, the main purpose of this research was to investigate the effect of rice bran extract prepared by spray-drying on the inhibitory effectiveness of enzymatic browning in potato puree.

MATERIALS AND METHODS

Materials and chemicals

Potato (Solanum tuberosum L.) was purchased from local market in Bangkok, Thailand. Full-fatted rice bran from the aromatic rice (Oryza sativa L. cv. Khao Dawk Mali 105) was obtained from Patum Rice Mill and Granary Public Co., Ltd., Thailand. Catechol, Triton X-100 and Folin-Ciocalteu reagent were purchased from Fluka Chemika (Buchs, Switzerland). Sodium carbonate was purchased from Merck Laboratories (Darmstadt, Germany). Polyvinylpyrrolidone was purchased from Sigma Chemical (St Louis, MO, USA). The other chemicals and solvents in this study were analytical grade.

Preparation of spray-dried RBE powder (SD-RBE)

Full-fatted rice bran was ground and sieved through a 50-mesh screen, and then extracted with distilled water (DW) at a ratio of rice bran to DW of 1:3 (w/w) using overhead stirrer at 700 rpm for 30 min. The supernatant was separated by centrifugation at 8,000×g at 25°C for 20 min, and then consequently spray-dried. The obtained powder was spray-dried rice bran extract powder (SD-RBE). SD-RBE was determined for moisture content according to the method of AOAC (934.06) (AOAC, 1990). The color values (L*, a* and b*) of SD-RBE was measured by colorimeter (CM-3500D, Minolta, Japan). Total soluble solid (TSS) was measured by refractometer. SD-RBE was dissolved with water, and then total phenolic content was measured. Total phenolic content of SD-RBE solution was adjusted to be equal to that of sample before spray-drying.

Determination of total phenolic content

Total phenolic content was determined according to the modified method of Zhou and Yu (2004) with catechol as a standard phenolic compound. Fifty µL of SD-RBE solution was mixed with 3 mL of DW and 0.25 mL of Folin-Ciocalteu reagent. The reaction mixture was let to stand at room temperature for 10 min. Then, 0.75 mL of 20% (w/v) of sodium carbonate was added and mixed. The reaction mixture was then let to stand at 40°C in water bath for 20 min, then stopped the reaction by immersing in ice bath. The absorbance at 765 nm was measured against blank (DW).

Determination of browning inhibition

Potato puree was prepared by peeling potato and blending pulp for 30 s with DW or SD-RBE at ratio of 2:1 (w/w). The color values (L*, a* and b*) of the samples were measured with colorimeter (CM-3500D, Minolta, Japan) at 0, 0.5, 1, 2, 4 and 6 hr (s) that were sufficient storage times to distinguish between treatments. Browning values ((ΔL*/L* x 100) were calculated; when ΔL* was L*-L*; L* was the L* value at any storage time, and L* was the initial L* measurement (Labuza et al., 1990).

Potato PPO preparation

Potato PPO was prepared following the modified method of Galeazzi et al. (1981). Twenty five grams of potato was homogenized in blender for 20 s with 50 mL of 0.2 M phosphate buffer pH 6.5 containing with 1% polyvinylpyrrolidone and 0.5% Triton X-100, and then centrifuged at 25,560g at 4°C for 20 min. The supernatant was collected and used as crude enzyme.

Determination of PPO inhibition

The reaction mixture containing 3.0 mL of 0.2 M catechol in phosphate buffer pH 6.5, and 0.2 mL of SD-RBE solution or control (DW) were mixed and incubated for 30 s, then 0.02 mL of crude potato PPO was added and mixed. The increasing in absorbance at 420 nm was immediately recorded (Duangmal and Apenten, 1999). One unit of PPO activity was defined as the activity of control - activity of treatment) / activity of control x 100
Statistical analysis

Three replicates of all experiments were performed. Statistical significance was assessed by one-way analysis of variance. Significant difference (P≤0.05) among treatments was detected using Least Significant Difference (LSD) tests.

RESULTS AND DISCUSSION

Some characteristics of SD-RBE

Rice bran extract (RBE) was prepared by distilled water (DW) extraction, then spray-dried RBE powder (SD-RBE) was obtained. Its color values and moisture content were measured. It was found that L*, a* and b* value of SD-RBE were 88.93, 0.06 and 11.27, respectively. Moisture of SD-RBE was 15.29%. Total phenolic content of SD-RBE was 997 mg/L. To investigate the enzymatic browning inhibition efficiency of SD-RBE, it was prepared as solution with equal in concentration of phenolic compounds that exist in RBE before spray-drying (1,517 mg/L). Total soluble solid (TSS) of SD-RBE solution was 14.9°Brix.

Effect of SD-RBE on enzymatic browning inhibition of potato puree

Effect of SD-RBE on the inhibition of enzymatic browning in potato puree was determined by color measurement. Browning values of potato puree that treated with SD-RBE solution and DW and stored at 25°C for 6 hr are shown in Figure 1. It was found that browning values of potato puree treated with SD-RBE solution were lower than those treated with DW during the storage time of 4 to 6 hr (P≤0.05). Browning value of potato puree treated with SD-RBE solution and DW at 6 hr storage was 25.35 and 38.12, respectively.

L* values of potato puree that treated with SD-RBE solution and DW and stored at 25°C for 6 hr are shown in Figure 2. L* values of potato puree treated with SD-RBE solution were higher than those treated with DW during the storage time of 4 to 6 hr (P≤0.05). L* value of potato puree treated with SD-RBE solution and DW at 6 hr storage was 54.12 and 45.55, respectively.

In addition, a* values of potato puree that treated with SD-RBE solution and DW and stored at 25°C for 6 hr are shown in Figure 3. It was found that a* values of potato puree treated with SD-RBE solution were lower than those treated with DW during the storage time of 0.5 to 6 hr (P≤0.05). The a* value of potato puree treated with SD-RBE solution and DW at 6 hr storage was 4.05 and 5.47, respectively.

Moreover, b* values of potato puree that treated with SD-RBE solution and DW and stored at 25°C for 6 hr are shown in Figure 4. It was found that b* values of potato puree treated with SD-RBE solution were higher than those treated with DW during the storage time of 0 to 1 hr and 4 to 6 hr (P≤0.05). The b* value of potato puree treated with SD-RBE solution and DW at 6 hr storage was 18.93 and 12.41, respectively.

The higher L* and b* values mean lighter color; and the lower a* value means decreased the development of browning occurring during storage. Regarding to browning, L*, a* and b* values, it revealed that SD-RBE solution exhibited enzymatic browning inhibition greater than DW.
The authors would like to express sincere gratitude to the Kasetsart University Research and Development Institute (KURDI), Thailand and Thailand Toray Science Foundation (TTSF) for the financial support. Special thanks for Patum Rice Mill and Granary Co., Ltd, Thailand, for kindly providing rice bran for this research.

REFERENCES


