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Research Article

Influence of Cooking Methods on Chlorogenic Acid Content of Potato Peels (*Solanum tuberosum* L.)

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ABSTRCT

One of the major phenolic components of potato peels is chlorogenic acid. In this experiment, the influence of cooking methods on the content of chlorogenic acid in potato peels and the distribution of chlorogenic acid in the whole potato tuber was studied. Cooking methods employed include boiling, steaming, frying and baking. The chlorogenic acid was analyzed by HPLC. Chlorogenic acid in potato peel under studied was 1.007 mg/g. Its content after boiling, steaming, frying and baking was 56 %, 161 %, 98 % and 21 % compared to fresh peel. The chlorogenic acid was distributed throughout the potato tuber tissue with the highest distribution in the peel but not in the epidermal layer. Methanol extract obtained from all part of potato tissue exhibited radical scavenging activity tested using DPPH method. The radical scavenging capacity was still retained in extract obtained from potato peels after treatment with various cooking methods.

Key words: Potato peel, cooking, chlorogenic acid, radical scavenging activity

INTRODUCTION

Potato peel is a waste in the preparation of potato chips or crisps. But now some of the restaurants serve fried potato peels as snacks. It is believed that fried potato peels have beneficial effects for health due to its antioxidant content. One of the major antioxidant present in potato peels is chlorogenic acid. In addition to chlorogenic acid, potato peels also contain caffeic acid, protocatechuic acid and conjugated ferulic acid.[1,2] Aqueous extract of potato peel has strong antioxidant, radical scavenging and heavy metal chelating capacity.[3] The antioxidant activity is comparable with butylated hydroxyanisole (BHA)[4]. The antioxidant activity of extract obtained from potato peels is much higher compared to that obtained from the flesh and this activity is correlated with the phenolic content[2]. Potato peel extract is non mutagenic antioxidant, can retard lipid peroxidation in irradiated lamb. The extracts have also hepatoprotective effect. [5,6,7]

Heat treatments will influence the content of secondary metabolites, especially phenolic compounds such as flavonoid, chlorogenic and other phenolics present in the plant tissue. Kaempferol-3-O-gentibiose in *Cassia alata* leaves increase after heating at 85 ºC for 40 minutes and kaempferol also increase upon drying at elevated temperature.[8,9,10] Rutin, a pure flavonoid glycoside itself is stable upon boiling, even for 300 minutes[11] or heated at 100 ºC for 3 hours but degraded when heated at 180 ºC. [12,13] It was reported that luteolin of willow (*Salix purpurea*) was stable upon heating but apigenin was unstable.[14] Both compound are flavone type and different only in hydroxylation pattern at ring B. It was surprising that roasting was also reported to substantially increase total phenol and procyanidin level in peel almond.[15] On the other hand, flavonoid of mulberry leaves decreased when heated at high temperature under the sun, air oven or microwave.[16,17]

It seems that heating of plant material may increase or decrease the content of phenolic compounds. Therefore the method of potato peel cookings will also affect their chlorogenic acid content. The aim of this research was to evaluate the influence of cooking methods on the chlorogenic acid content of potato peels and their antioxidant activity.

MATERIALS AND METHODS

Plant materials: Potato tubers with fresh weight in the range of 40-50 g each were obtained from Cikawari village, Bandung regency, West Java. Potato peels were obtained by peeling potato tubers using a knife with the thickness between 1.2 – 2.0 mm.

Cooking Methods: The cooking treatments employed in this experiment included: a) boiling in water for 10 minutes, b) frying in palm oil for 10 minutes, c) baking at 200 °C for 45 minutes and d) steaming for 15 minutes.

Extraction and the determination of chlorogenic acid: Chlorogenic acid was extracted by crushing 1.0 g of fresh or cooked potato peels in methanol and the final volume adjusted to 10 mL, shake well and let the solid materials to precipitate. The aliquot was then filtered through 0.50 □m nylon membrane before injection to HPLC machine (HP 1100 series). Chromatography was performed by injecting 20 □L extract on chromatograph supported with ODS (Agylent) column 5 □m particle size, 250 mm length, 4 mm id., temperature 30 ºC, flow rate 0.8 ml/min and detection at 325 nm (DAD). Gradient elution was performed for 20 minutes using HOAC 5% (A) and

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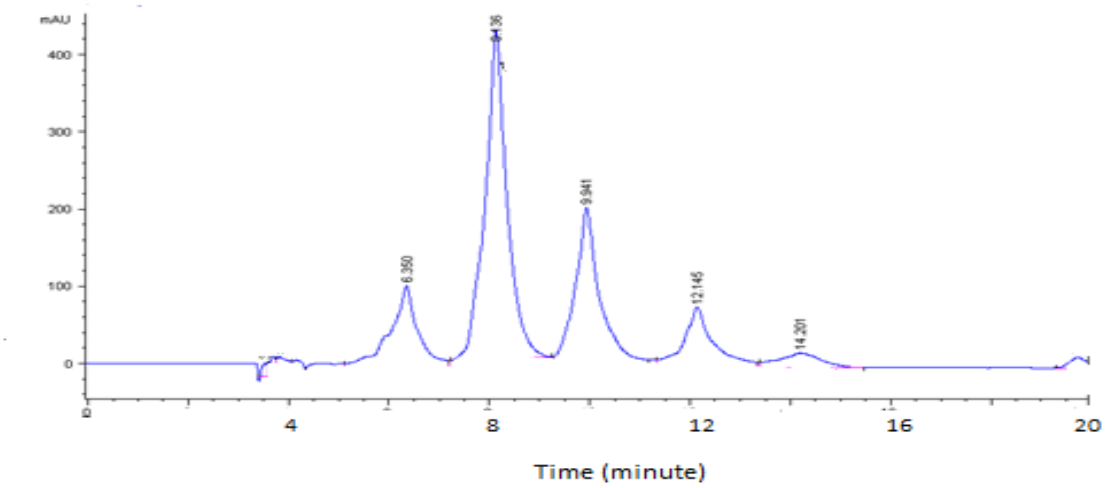

Fig 1. Chromatogram of the methanol extract of steamed potato peel

Table 1 Chlorogenic acid in potato peels after various cooking treatments

No	Cooking method	Chlorogenic acid content (mg/g)
1	Fresh	1.007 ± 0.10
2	Boiled	0.566 ± 0.12*
3	Steamed	1.620 ± 0.17*
4	Baked	0.214 ± 0.07*
5	Fried	0.986 ± 0.49

*Note= measurement was conducted in triplicates, *significantly different to fresh (P < 0.05)*

Table 2. Inhibition of DPPH by potato peel extract

No	Source of potato peel extract	Inhibition of DPPH (%)
1	Fresh	62.25 ± 2.37
2	Boiled	60.77 ± 0.57
3	Steamed	61.93 ± 0.96
4	Baked	50.09 ± 0.01
5	Fried	50.93 ± 1.37

Note= measurement was conducted in triplicates

MeOH (B) with composition at minutes (% B) as follows: 0 (10%), 4 (30% B), 9 (50%), 15 (70%), 16 (100%) and 20 (10%). Chlorogenic acid was identified based on the retention time, UV spectrum of the peak and comparing with the authentic marker. Quantitative measurement of chlorogenic acid in each sample was conducted in triplicates.

Antioxidant activity: Antioxidant activity of potato extract was determined using DPPH method.[18] Extracts were tested at 50 □g/mL in MeOH and reacted with 50 □g/mL DPPH (in MeOH). The absorption of DPPH was measured at 517 nm (Ao) and to the tested sample was added DPPH solution (1:1) and the absorption at 517 nm measured after incubation for the period of 30 minutes (A30). The inhibition of DPPH was calculated according to the following equation.

$$I = \frac{Ao - A30}{Ao} \; x \; 100\%$$

RESULT AND DISCUSSION

Methanol extract of potato peel was well separated on the HPLC system used in this experiment (Fig 1). Chlorogenic acid that was identified by comparing the retention time and UV spectra of the peak with the authentic marker appeared as the biggest peak with retention time at 8.12 minutes. There were at least other four peaks accompanying chlorogenic acid but they were not further identified. Their UV spectra similar to that of chlorogenic acid and probably caffeic acid or ferulic acid and their conjugates. It has been reported that potato peel contains phenolics with the major components consist of chlorogenic, gallic, protocatechuic, caffeic and bound ferulic acids.[1,2]

The quantity of chlorogenic acid present in fresh and cooked potato peels was analyzed by weighing the same amount of fresh potato peel that was then each cooked in different methods. As shown in Table 1, fresh potato peel contained approximately 1.0 mg/g (0.1 %). This content was almost four times higher than that of reported by Kannat.[6] Since the water content of the tissue is around 85 %, the dried potato peels may contain 6.7 mg/g or 0.67 %. Steaming significantly increased the chlorogenic acid content of potato peel and the increase reached 62 %. The increase of phenolic compounds upon heating has been reported by a number of workers.[8,10,11,15] Boiling on the other hand reduced the amount of chlorogenic acid by 44 %. This decrease might due to the washing of the chlorogenic acid in the potato peel tissue by the boiling water. From the temperature point of view, boiling will not be much different compared to steaming. In this experiment, the chlorogenic acid present in the boiling water was not measured. If the total chlorogenic acid present in both tissue and the boiling water was measured, the total quantity might be higher compared to the amount in fresh tissue. Similar results were observed with the amount of flavonoid in boiled *Cosmos caudatus* leaves.[19]

Table 3. Chlorogenic acid in different part of potato

No	Potato tissue	Chlorogenic acid content	
		mg/g	mg/tuber
1	Fresh peel	0.710 ± 0.24	2.522 ± 0.88
2	Fresh flesh	0.079 ± 0.01	3.098 ± 0.48
3	Epidermal layer from steamed potato	0.306 ± 0.07	1.314 ± 0.41
4	Steamed flesh	0.118 ± 0.02	4.433 ± 0.06

Note= measurement was conducted in triplicates

Table 4. Inhibition of DPPH by extract of potato tissues

No	Source of potato extract	Inhibition of DPPH (%)
1	Fresh peel	50.59 ± 0.26
2	Fresh flesh	50.04 ± 1.39
3	Epidermal layer from steamed potato	51.26 ± 1.01
4	Steamed flesh	52.79 ± 0.25

Note= measurement was conducted in triplicates.

Baking potato peel at 200 °C substantially reduced chlorogenic acid content and the decrease reached approximately 80 %. This decrease might due to the degradation of chlorogenic acid. Removal of chlorogenic acid by roasting has been practiced in processing coffee bean. Frying on the other hand maintained the chlorogenic acid content. The amount of chlorogenic acid in fried potato peels was not significantly different from the fresh peels ($P < 0.05$). Since frying was conducted in oil and chlorogenic acid may not soluble in oil, most of the chlorogenic acid was probably retained by the tissue.

It was expected that the antioxidant activity of extract obtained from potato peels after cooking will correspond with their chlorogenic contents. Results presented in Table 2 showed that the antioxidant activity of extract obtained from fresh, boiled and steamed potato peels were not significantly different, while those from baked and fried were lower compared to the extract from fresh peels.

The distribution of chlorogenic acid in potato tuber was studied in this experiment. It was expected that the chlorogenic acid accumulated in the epidermal layer that was easily separated from the flesh in boiled or steamed potato. Data presented in Table 3 showed that chlorogenic was distributed throughout the potato tissue. Although the concentration of chlorogenic acid was much higher in the peel compared to the flesh, the total amount for the whole tuber in the flesh was still higher than in the peel. Epidermal layer obtained from steamed potato contained lower chlorogenic acid compared to the peel. This suggests that the highest concentration of chlorogenic is not in the epidermal layer. It is more likely that the chlorogenic acid is produced and concentrated in the cambial layer of potato tuber.

Attempt to evaluate the free radical scavening activity of the extract from potato tissues had been conducted. It was surprising, although the chlorogenic acid content of different tissue were varies, the radical scavenging activity were not significantly different. This suggest that the radical scavenging activity of the extract is not contributed by chlorogenic acid only, but also other components of the extract.

The whole part of potato tuber has antioxidant activity. Potato peel that is considered as a waste is still useful as source of chlorogenic acid that has strong antioxidant activity. Method of cooking influences the chlorogenic acid of potato peels but the antioxidant activity is still maintained. Other compounds and the degradation product of chlorogenic acid may also contribute in the radical scavenging activity of extracts from fresh and cooked potato.

CONCLUSSION

Chlorogenic acid in potato tuber is highest in the peel but not in the epidermal layer. Chlorogenic acid content in potato peel increased upon steaming, decreased upon boiling and baking, and remained constant upon frying. The whole part of potato tissue had similar antioxidant activity, various cooking treatments still maintained its antioxidant activity.

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