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Isolation and characterization of functional components from peel samples of six potatoes varieties growing in Ontario

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ABSTRACT

Potato processing industry generates high amounts of peel as a byproduct. It is a good source of several beneficial functional ingredients including antioxidant polyphenols. A study was undertaken to estimate the polyphenolic content and antioxidant properties of peel samples from potatoes grown in Ontario, Canada. Peel samples from Vivaldi, Yukon Gold, Dakota Pearl, FL 1533, Siècle and Purple Majesty varieties of potatoes were extracted with methanol and analyzed for their polyphenolic contents and antioxidant properties using Folin–Ciocalteu reagent, ferric-ion reducing antioxidant power (FRAP), Trolox equivalent (6-hydroxy-2,5,7,8-tetramethylchromane-2-carboxylic acid) and free radical scavenging activity (FRSA). Specific phenolic compounds present in potato peel samples were measured using HPLC. Results of total phenolic compounds from both spectrophotometric and chromatographic analyses were statistically compared to validate methods of extraction and determination. Red-colored potato varieties; Siècle and Purple Majesty, had the highest antioxidant potential compared to other varieties. Chromatographic data showed differences in the amounts, but not in types of phenolic compounds in the potato peel samples.

1. Introduction

Potato (*Solanum tuberosum* L.) is one of the most important staple crops grown worldwide. Because of its low cost, low fat content and a good source of carbohydrates, high quality protein, fibre and vitamins, it plays an important role in human nutrition (FAO statistical yearbook, 2005–2006). Although potatoes are consumed directly, processed potato products represent majority of the consumption. Processing potatoes generates large amounts of peel that is perishable and cause many management problems in terms of disposal and sanitation. Potato peel, however, contains several beneficial phytochemicals such as the polyphenols and carotenoids that can have potential applications in the formulation of functional foods. A number of byproducts from vegetable processing industry have been previously studied as potential sources of antioxidants (Azizaha, Ruslawatin, & Tee, 1999; Lu & Foo, 1999, 2000; Saura-Calixto, 1998; Visioli et al., 1999). However, little work is reported relating to the utilization of the potato peel for the recovery of phenolic compounds. Effectiveness of extraction, stability and activity of the phenolic compounds and their suitability for food use are the important considerations in their recovery and utilization from industrial byproducts (Peschel et al., 2006). Potato peel provides an excellent source for the recovery of phenolic compounds, since almost 50% of phenolics are located in the peel and adjoining tissues and decrease toward the center of the tuber (Freidmen, 1997). Some works had been done previously on potato peel as a source of dietary fibre (Arora & Camire, 1994; Kaack, Pedersen, Laerke & Meyer, 2006; Singh, Kamath & Rajini, 2005), and as an antioxidant for the prevention of oxidation of meat products (Mansour & Khalil, 2000) and soy bean oil (Kanatt, Chander, Radhakrishna, & Sharma, 2005; Rehman, Habib, & Shah, 2004). The current study was undertaken with the objective of developing a reliable and simple procedure to extract the phenolic compounds, to identify and quantitate their amounts and to measure their antioxidant capacity from the peel samples of selected verities of potatoes grown in Ontario, Canada.

2. Materials and methods

2.1. Materials

All solvents, reagents and standards used in this work were HPLC grades (purity ⩾96%) obtained from Sigma–Aldrich, Canada. All reagents and standard solutions were prepared using Milli Q deionised water (Millipore, Bedford, USA).

2.2. Potato peel samples

Six potato varieties; three table use (Siècle, Vivaldi and Yukon Gold), and three processing type (Purple Majesty, Dakota Pearl

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and FL 1533) were obtained from Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), Guelph, Ontario, Canada. Tubers were washed with tap water to remove soil. Uniform shape and size samples without any physical damage were selected. After cleaning, potato samples were peeled with a mechanical peeler to obtain uniformity of thickness. Potato peel samples were weighed and lyophilized (Labconco Co. Freeze-dryer, USA) until constant weight was obtained. After complete dryness, they were ground to a powder and sieved using a standard 50 μm sieve to insure symmetry of particle size. Freeze-dried powder samples were weighed and kept in dark glass color bottles, tightly closed, at −20 °C until the day of analysis.

2.3. Potato peels extraction

One gram of freeze-dried potato peel powder of each variety was refluxed with 50 ml of methanol for 30 min at 75 °C with frequent shaking. After allowing the samples to cool they were centrifuged at 10,000 rpm for 20 min (room temperature), supernatants filtrated through filter paper and kept in dark colored containers tightly stoppered at −20 °C.

2.4. Determination of total phenolic compounds

Folin–Ciocalteu reagent is widely used to estimate amounts of total Phenolics in vascular plant tissues. The method described by (Kähkönen et al., 1999) was used with slight modifications. Briefly, 0.5 ml of potato peels extract was added to 1 ml of Folin reagent followed by 1 ml of 7.5% sodium carbonate, mixed well and left to stand at room temperature for 30 min for the greenish-blue color to develop. Absorbance was measured at 765 nm against a blank (UV–Visible spectrophotometer model Ultrospec 2000, Pharmacia biotech, USA). A standard curve was used to measure phenolic compounds in the sample. Results were expressed as milligram of gallic acid equivalent per gram of freeze-dried powder.

2.5. Ferric-reducing antioxidant power (FRAP)

Method as described by (Ozgen, Reese, Tulio, Scheerens, & Miller, 2006) was used to measure the ferric-ion reducing power of the extracts. 50 μl of extract was added to 3 ml of 2,4,6-tris(2-pyridyl)-*s*-triazine (TPTZ) solution. 10 mM of TPTZ, 20 mM of $FeCl_3$ were mixed with sodium acetate buffer pH 3.6 at ratio 1:1:10, respectively. The absorbance at zero time and the developed blue color after 5 min was measured at 593 nm. Results were expressed as gallic acid equivalent, milligram per gram of potato peel samples dried powder.

2.6. Trolox equivalent antioxidant capacity (TEAC)

Method as described by (Ozgen et al., 2006) with some change, was used to measure antioxidant capacity of potato peels extracts. 7 mM of ABTS; 2,2-azinobis(3-ethylbenzothiazolin-6-sulfonate) diammonium salt, dissolved in 50 ml of acetate buffer pH 4.6 and 2.45 mM of potassium persulphate dissolved in the same amount of buffer. Both solutions were added to each other and stored at 4 °C in dark for 12–16 h until reaching a stable oxidative state. This reagent was stable for several weeks when stored in the dark. On the day of analysis, the ABTS solution was diluted with the same buffer to an absorbance of 0.700 ± 0.02 at 734 nm. For the spectrophotometric assay, 3 ml of the ABTS solution and 100 μl of extract were mixed and the absorbance was determined at 734 nm at zero and 1 min after mixing. For the standard curve, Trolox (6-hydroxy-2,5,7,8-tetramethylchromane-2-carboxylic acid) was prepared in ethanol and serial dilutions were mixed with ABTS, reading was taken after zero and 1 min, then standard curve was developed.

2.7. Free radical scavenging activity (FRSA%)

Method described by (Spanou, Manta, Komiotis, Dervishi, & Kouretas, 2007)was used with some modifications. 3 ml of 0.1 mM 2,2-diphenyl-1-picrylhydrazyl radical (DPPH) in methanol was added to 250 μl of extract. Tubes were vortexed and incubated at room temperature for 20 min. The absorbance was measured at 517 nm against blank (DPPH solution with methanol) and free radical scavenging activity calculated from the equation,

$$\mathrm{FRSA}\% = A_o - A_c/A_o \times 100$$

where A_o is absorbance of control (DPPH solution with standard) and A_c is the absorbance of the sample (DPPH with extract).

2.8. HPLC analysis

Phenolic compounds in potato peels samples extracts were measured using HPLC. Waters, USA, Symmetry C_{18} column (5 μm pore size, 4.6 × 150 mm), CTO-6A Shimadzu column oven, 600 series PerkinElmer Interface, UV-Visible detector model SPD-10A Shimadzu and PerkinElmer's 410 series pump were used in analysis. Method of (Escarpa & González, 2000) was used. Samples were filtered with 0.45 μm Acrodisc syringe filter (Pall Corp., USA).

2.9. Statistical analysis

Interpretation of all results were done by using GraphPad Prism version 5.00 for Windows, GraphPad Software, San Diego, California, USA. Correlation coefficient was estimated between total phenolic compounds and Trolox assay as antioxidant potency of potato peel samples. A two-way ANOVA was used to estimate the statistical significances of total phenolic compounds measurements.

3. Results and discussion

3.1. Phenolic compounds

In recent years, there has been a great deal of interest in the role of oxidative stress and antioxidants in human health. In the current study phenolic compounds were extracted and estimated from potato peel samples. Antioxidant properties of the phenolic compounds in the potato peel samples were measured using several published methods.

Although petroleum ether has been used by other investigators to extract phenolic compounds from potato peel samples, methanol under reflux was used in our study since it combines percolation and immersion techniques to achieve efficient extraction. As shown in Table 1 the total phenolic content ranged from 1.51 to 3.32 mg of gallic acid equivalent per gram of dry potato peel powder. Rodriguez De Sotillo, Hadley, and Holm (1994)) reported the total phenolic compounds in potato peel waste to be 48 mg/100 g. Kähkönen (1999) reported 4.3 mg of gallic acid equivalents of phenolics per g of dry potato peel samples. The differences in total phenolic content reported are due to the color and variety

Table 1
Total phenolic compounds in potato peel extracts.

Potato varieties	Gallic eq (mg/gm of freeze-dried powder)
Siècle	3.33 ± 0.12
Purple majesty	2.96 ± 0.16
Dakota pearl	2.04 ± 0.17
FL 1533	2.04 ± 0.12
Vivaldi	2.04 ± 0.13
Yukon gold	1.51 ± 0.17

Mean of duplicates ± SD.