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Original research article

# Analysis of protein amino acids, non-protein amino acids and metabolites, dietary protein, glucose, fructose, sucrose, phenolic, and flavonoid content and antioxidative properties of potato tubers, peels, and cortexes (pulps)

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ABSTRACT

The composition and antioxidative activity of whole potato tubers from five Korean cultivars, three peels from one cultivar, and eight pulps (cortexes) after peeling from six different cultivars were evaluated. Whole tubers were sectioned into three parts followed by analysis of the peels and pulps of each part. The following characteristics were determined: the dimensions and water content of whole tubers; nutritional protein content consisting of protein and free amino acids by an automated Kjeldahl nitrogen assay; free non-protein amino acids, metabolites, and fructose, glucose, and sucrose content by HPLC; phenolic compounds by HPLC and LC/MS; total phenolics and flavonoids by colorimetry; and antioxidative properties by ABTS, DPPH, and FRAP assays. The results demonstrate differences and similarities in the content of nutritional and bioactive compounds and in their bioactivities from whole potatoes, peels, and pulps. The present study reports for the first time the analysis of multiple potato nutrients and bioactive components as well the antioxidative properties of whole potatoes, peels, and pulps derived from the same tubers. The described methods are expected to facilitate the analysis of commercial and newly-developed potato cultivars, peels, and pulps and relate their composition and antioxidative activities to their reported nutritional, health-promoting, and industrial properties.

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## 1. Introduction

Potatoes are an important part of the human diet, but during heating in food preparation potentially toxic acrylamide and other undesirable compounds can be derived from the heat-inducing reactions between the amino group of the amino acid asparagine (Friedman, 2015a) and the carbonyl groups of carbohydrates as well as ascorbic acid (vitamin C) in potatoes and other plant-derived foods. In addition to adverse browning reactions, heat used to fry or grill potatoes also causes reduction in the content of phenolic compounds (Im et al., 2008) and vitamin C (Han et al., 2004).

Nutritional aspects and methods to reduce acrylamide require determination of free amino acid content (Rommens et al., 2008; Zhu et al., 2010; Bártová et al., 2015; Muttucumaru et al., 2015). Because asparagine and reducing sugars fructose and glucose are key participants in acrylamide formation, we previously determined the levels of these compounds in commercial potato varieties sold in the United States (22 varieties) and Italy (9 varieties) (Vivanti et al., 2006; Finotti et al., 2009, 2011). Because the commercial American varieties Kennebec, White, and Fingerling Ozette and the Italian varieties Agria, Merit, and Marabel had low levels of both asparagine and reducing sugars, we suggested they might form low levels of acrylamide during baking and frying.

In related studies we determined the free amino acid content of tomatoes (Choi et al., 2010; Choi et al., 2014) and jujubes (Choi et al., 2012; Finotti et al., 2015). In addition to inherent nutritional interest, the results of these and related studies by other investigators (Loaëc et al., 2014; Muttucumaru et al., 2015) make

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it possible for food processors and consumers to select plant varieties with a low content of asparagine.

To broaden the scope of this approach, the main objective of the present study was to determine the distribution of free amino acids including asparagine and the sugars glucose, fructose, and sucrose in whole tubers of five Korean potato samples, as well as three potato peels (skins) and eight cortexes (pulps, piths) derived from three sliced sections of the whole tubers. As part of this effort we also determined the individual and total phenolic and total flavonoid content and antioxidative properties of the 16 samples.

## 2. Materials and methods

### 2.1. Materials

Chlorogenic acid (catalogue no. C3878, lot no. 27H1006, ≥95%), caffeic acid (catalogue no. C0625, lot no. 020M1309, ≥98%), quercetin (lot no. 113K1051, ≥98%), tannic acid (lot no. 082K0037, ≥98%), 2,2-diphenyl-1-picrylhydrazyl (DPPH, catalogue no. D9132, lot no. 12K1944, ≥90%), 2(3)-*t*-butyl-4-hydroxyanisole (BHA, catalogue no. B1253, lot no. 098K0242, ≥95%), potassium persulfate (lot no. 216224, ≥99%), and 2,2′-azinobis-(3-ethyl-benzothiazoline-6-sulfonic acid) (ABTS, lot no. A1888, ≥98%), sucrose (lot no. BCBJ6029V, ≥99.5%), and fructose (lot no. SLBB6798V, ≥99%), were purchased from Sigma (St. Louis, MO). Glucose (lot no. 7D1165, ≥98%) was obtained from Junsei Chemical Co., Ltd. (Tokyo, Japan), Folin-Ciocalteu phenol reagent (lot no. OF1181, ≥95%) was purchased from Junsei Chemical Co., Ltd. (Tokyo, Japan). 2,4,6-Tris(2-pyridyl)-*s*-triazine (TPTZ, lot no. FHL01, ≥98%) was purchased from Tokyo Chemical Industries (Tokyo, Japan). All other reagents were from Sigma.

Acetonitrile (LC/MS grade) was obtained from Burdick & Jackson (Muskegon, MI), analytical grade formic acid was from DC Chemical Co. (Seoul, Korea). The solvents were filtered through a 0.45-$\mu$m membrane filter (Millipore, Bedford, MA) and degassed with an ultrasonic bath before use.

### 2.2. Sampling of potato tubers

The tubers of Superior; Atlantic; Goun; K1, K20 and K30 (temporary variety name in Korea) potato varieties were obtained from the field culture of Wangsan Potato Seeds Co. (Gangwon-do, Korea) (Fig. 1). Tubers were collected, weighed, and measured for size as shown in Table 1. Fresh potatoes from four to five uniform-sized tubers were pooled and separated into three parts: peels (~5 mm of peripheral tissue); cortexes (pulps, piths); and whole potato. Samples were then cut with a knife into 4–5 mm thick slices. Each sample was then immersed in liquid nitrogen and freeze-dried 10 min at −40 °C with an Ilsinbiobase Freeze-Dryer (model PVTFD 10R; Ilsinbiobase Co., Ltd., Korea). Water content

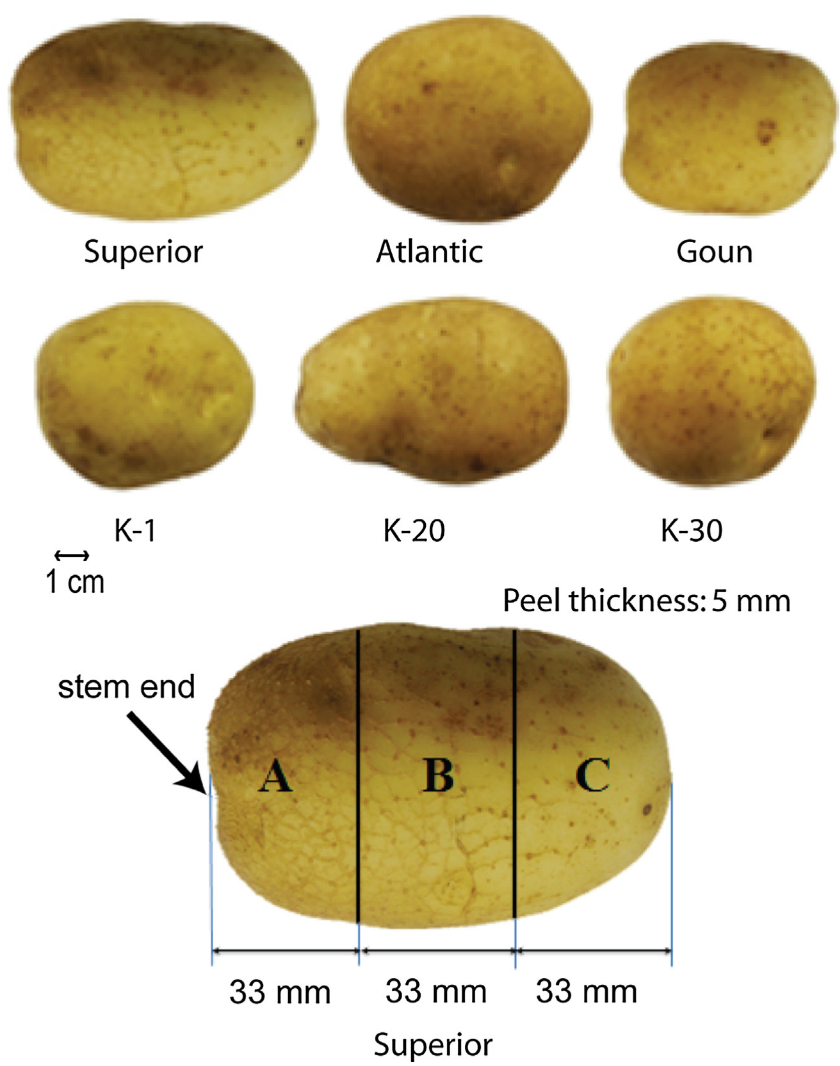


**Fig. 1.** Photographs of six whole potato tubers and three sections of the Superior tuber evaluated in the present study.