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A Study on The Phenolic Content of Potatoes

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감자에서의 페놀화합물에 대한 연구

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Abstract

Two varieties, Lasoda and Sebago potatoes, were studied. Different cooking methods, conventional oven baking at 218°C and microwave oven baking, have been used to compare the retention of the phenolic compounds.

Peeled cortex samples of fresh and cooked potatoes were analyzed for total phenols, phenolic constituents, and moisture loss. Phenolic content was higher in fresh potatoes than in cooked potatoes. Laasoda had higher phenolic content (3.63mg) than Sebago (1.71mg). Potatoes with higher phenols (Lasoda) also had larger quantities of chlorogenic acid. There was a greater moisture loss in conventional oven baking potatoes than in microware oven.

Introduction

The phenolic content of many fruits has been correlated with the sensations of astringency and bitterness. Some fruits which have a high phenolic content and are known to be bitter and astringent are unripe persimmons.[1]

Since potatoes contain a wide variety of phenolic compounds, it seems possible that astringency and bitterness may be correlated with the phenolic content.

Polyphenolic compounds play an important role in metabolism, respiration and biological functions of plant materials. They are involved in enzymatic browning and astringent flavor of fruits.[2]

In slices of potato tubers the synthesis of chlorogenic acid is closely related to protein synthesis. Both processes are stimulated by light.[3] Kaukol and Conn[4] have described an enzyme that catalyzes the deamination of 1-phenyl-alanine into caffeoyl moiety of chlorogenic acid. The discovery of the enzyme allows a direct comparison to be made between enzyme levels and phenolic biosynthesis in tuber tissue.[5]

Cheng and Hanning[6] observed that relatively high concentrations of phenolic substances such as tyrosine, chlorogenic acid and caffeic acid, which could serve as substrate for enzymes involved in discoloration have been found in potatoes. Discoloration of potatoes increased with storage duration and was accompanied by an increase in phenolic content and cytochrome oxidase activity and a decrease in polyphenol oxidase activity.

Phenolic compounds present in potatoes can be chemically classified as: 1) lignin, 2) coumarins, 3) anthocyanins and flavones, 4) tannins, 5) mono-

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hydric phenols, and 6) polyphenols. Factors affecting the phenolic content of potatoes are: 1) variety and maturity, 2) climate, 3) specific gravity, 4) glucose, sucrose, and fructose, 5) oxygen, 6) storage temperature, 7) light, 8) formation of lignin, which thought to be formed from chlorogenic and caffeic acids which were accompanied with wound healing of potatoes.

The purpose of this study was to determine the phenolic content of two varieties of potatoes, which is responsible for bitter and astringent flavor, and to compare the phenolic content under different cooking conditions of potatoes.

Experimental

Two varieties of potatoes, Lasoda and Sebago, were studied. Lasoda potatoes were grown in the Red Valley area of Minnesota and Sebago potatoes in Canada. They are washed and blot dried before putting in the mashed bags and stored in a cold room at 4.4°C

1. Determination of total phenols

Three potatoes of each variety were selected at random for each extract used in phenol determinations. A 50g sample of cortex and peel cut from the potatoes, from bud end to the stem end, was weighed. For each extraction, 100ml of 95% ethanol was added into a Waring blender after placing cortex tissue and blended for 3 minutes. The total volume of slurry was measured in a 250ml graduated cylinder. The remaining slurry in the blender was rinsed twice with 25ml ethanol each time and the volume was recorded on a 50ml glass-stoppered Erlenmeyer flask. The slurry was filtered through Whatman 3 folded filter paper into a 50ml graduated cylinder until 35ml of extract was obtained and transfered to the marked flask.

Total phenolic contents were determined by the method of Rosenblatt and Peluso[8] using tannic acid as the standard. A 100ml volumetric flask was filled with about 80ml distilled water and set on the tray by varieties and by different levels of extracts in duplicate. Potato extracts of 0.5, 0.6, and 0.7ml were pipetted into the flasks. From a burette, 2.0ml of Folin-Denis reagent was added to each flask. Then 5.0ml saturated sodium carbonate was added from a pipette and immediately diluted to volume and mixed. It was allowed to stand for one hour and ten minutes from start of addition of sodium carbonate to allow full development of blue color. Optical density was read on the Spectronic 20 at 660nm using red filter. Total phenolic content was calculated from the standard curve of tannic acid.

Folin-Denis reagent is made with 112g sodium tungstate hydrate, 20g phosphomolybdic acid and 128.5g solid metaphosphoric acid, which has been dried in an oven at 75°C overnight. It was refluxed in a 2-liter round bottomed flask with 750ml distilled water for two hours and cooled and diluted to one liter in volumetric flask. The reagent is used in the presence of alkali. Blue color formed in a positive test is assumed to be the reduction of phosphomolybditungstic acid in the reagent in the presence of alkali.

2. Thin Layer Chromatography

Alcoholic extract prepared for total phenolic analysis was used. A 10ml of extract was pipetted into a small test tube marked at the 5ml level and evaporated to 5ml level in a vacuum oven for 20 hours.

Eastman prepared chromatogram sheet was activated in the drying oven at 100°C for at least one hour before using. For developing solvent, 160ml n-butanol, 40ml glacial acetic acid, and 40ml distilled water were used. The solvent should be made fresh.

Spot positions were marked on the chromatogram sheet using pencil and the spots should be higher than 2 cm from the bottom and 2 cm from the sides. The spots should be at least 2 cm apart each other.

Standard chlorogenic acid and caffeic acid (0.1% solutions with 95% ethanol) were spotted at both ends and concentrated 6 potato extracts spotted in between using 20 lambda micro-pipette under chromatogram spot dryer to hasten evaporation of the spots.

The solvent was filled to the horizontal line into the bowl. Using the Eastman Sandwich apparatus, the spotted chromatogram was placed between the glass plates, clamped together, and immersed the open end into the bowl. The chromatogram was developed for 6 hours, then removed the glass plates from the solvent and took out the chromatogram and hang in the hood to dry the solvent. Spots were observed under the ultraviolet light in a dark chamber and marked spots with a pencil. Sketches of the chromatogram were made.

3. Moisture Loss

The potatoes were cut into small pieces and placed in a weighed petri dish. It was dried in a vacuum oven at 65°C for 24 hours. Moisture loss was calculated.

4. Cooking method

Two different cooked potatoes were studied. Three potatoes were baked at 218°C in a conventional oven for 45 minutes. Another batch of three potatoes were cooked in a microwave oven for 3 minutes. They were analyzed for total phenolic content, TLC, and moisture loss. Fresh potatoes were used as controls.

5. pH determination

About 5g of chopped potato tissues were placed in a small beaker and 5ml of glass-distilled water was added. It was stirred with a stirring rod and read the pH on SS Century Beckman pH meter. The pH was determined on cortex, pith, stem end, and bud end.

Results and Discussion

1. Phenolic content

1) Effect of variety

Fig. 1. shows the result of total phenolic content of the cortex from two varieties of potatoes, Lasoda and Sebago. Lasoda (3.63 mg/gm D.W.) had higher concentration of phenols than Sebago (1.71 mg/gm D.W.). The difference between the varieties was highly significant ($p<0.001$).

2) Effect of different cooking methods

The conventional oven baking at 218°C and microwave oven baking were compared. Phenolic content of Lasoda was higher in microwave oven baked potatoes than in conventional baking. The difference was significant at 0.1 level. Phenolic content of Sebago was higher in conventional baked potatoes than in microwave baked potatoes, but there was no significant difference at 0.1 level. The fresh potatoes had much higher phenolic content in two varieties than the cooked potatoes and the differences were significant at 0.01 level.

3) Effect of baking time

One of the advantages of microwave cooking is shorter time requirement and the nutrient retention. Retention of nutrients are greater with microwave heating because of relatively uniform heat distribution in the foodstuffs plus reduced leaching-out of foodstuffs. Another advantage is the greater retention of flavors.[9]

In microwave cooking it required 3 minutes instead of 45 minutes in conventional oven. In Lasoda potatoes, microwave baking showed higher phenolic content than in conventional baking. The lower phenolic content for baked potatoes were probably due to the elevated temperature in the oven which increased the production of volatiles.[10]

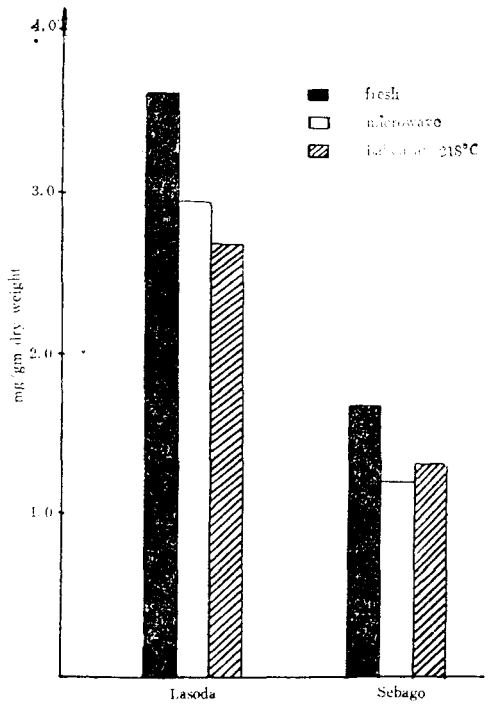

Fig. 1. Total phenolic content of Lasoda and Sebago potatoes by different cooking methods compared with the control.

Lower temperature baking at 149°C showed higher phenol values than the one at 218°C and at the same temperature at 218°C, the potatoes with foil showed higher values than the one without.[11] In Sabago potatoes, microwave baked ones had the lower value.

2. Moisture loss

Fig. 2 shows the moisture loss of the fresh. the baked, and microwave baked potatoes. In general, Sebago potatoes had higher moisture content than Lasoda potatoes. Cooked potatoes had lower moisture content than the fresh because, during cooking, dehydration occurs. Baked potatoes had lower value

than the microwave baked and this indicates that longer cooking time affects the moisture level.

3. Thin Layer Chromatography

TLC was used to compare the separations of potato extracts with standard caffeic and chlorogenic acids. All extracts of fresh and cooked cortex samples of Lasoda chromatographed showed chlorogenic acid and a trace of caffeic acid(Fig. 3). In Sebago, all extracts of fresh and cooked cortex samples showed chlorogenic acid but none was shown caffeic acid (Fig. 3).

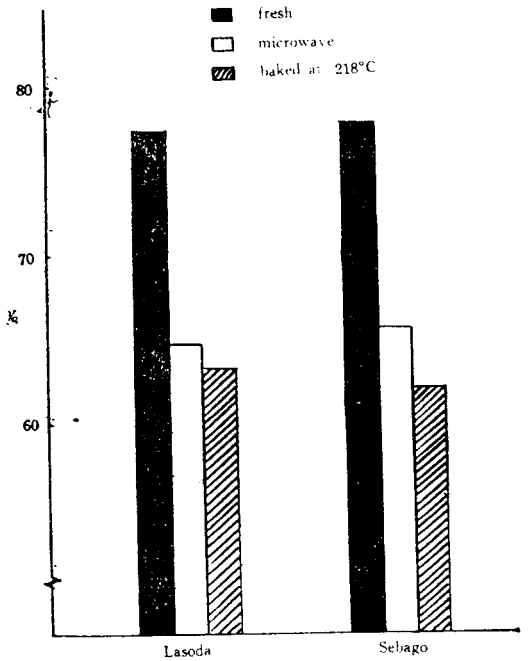

Fig. 2. Moisture loss of Lasoda and Sebago potatoes by different cooking methods compared with the control.

It also showed varietal difference. Extracts of Lasoda had more intense colors than Sebago extracts of three different samples. Higher chlorogenic acid concentration was observed in extracts of fresh cortex than cooked cortex samples. All the extracts of Lasoda samples had the faint caffeic acids. Extracts of microwave baked and the baked samples had almost the same intensities that could not compare the differences. Extracts with higher concentration of chlorogenic acid also had higher phenolic content.

4. Determination of pH

The pH was measured on fresh potatoes only on Lasoda and Sebago. Table 1. shows the results of pH

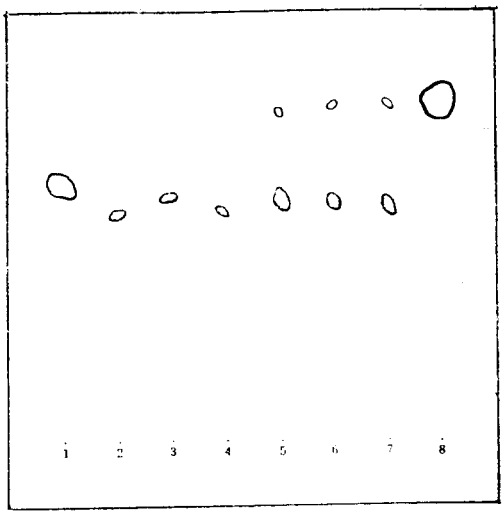

Fig. 3. Chromatogram(TLC) of Lasoda and Sebago potatoes by different cooking methods compared with the control and standard acids.

1. Chlorogenic acid, standard
2. Sebago, fresh
3. Sebago, microwave
4. Sebago, baked at 218°C
5. Lasoda, fresh
6. Lasoda, microwave
7. Lasoda, baked at 218°C
8. caffeic acid, standard

determination. In general, Sebago was higher in pH than Lasoda. The pH of the cortex was the highest in Lasoda, the lowest in pith. Stem end was higher in pH than bud end. In Sebago, it was similar to Lasoda, except that the bud end was the lowest in pH.

Table 1. pH of fresh potatoes.

	Lasoda	Sebago
pith	6.34	6.40
cortex	6.55	6.56
stem	6.50	6.58
bud	6.35	6.39

要 約

Lasoda와 Sebago 두 종류의 감자를 사용하여, 조리 조건을 달리 하여 conventional oven에 218°C에서와 microwave oven에서 구어내어 껍질을 베끼고 cortex 부분만 취하여 전체 phenol을 분석하였다.

또한 chlorogenic acid와 caffeic acid를 표준으로 하

여 thin-layer chromatography로 감자의 phenol화합물을 분석 하였다.

Phenol양은 구운 감자보다 생 감자에 더 많았고, Sebago 보다 Lasoda에 많았다. 수분손실은 conventional oven에서 구운 감자에 컸고, microwave oven에서 구운 Lasoda에는 phenol양이 많았다. 또한 phenol양이 많은 Lasoda가 chlorogenic acid도 많았다.

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