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Nutrition and utilization of a new sweetpotato cultivar for tops

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Abstract. A new variety, Suioh, was released for vegetable use by the National Agricultural Research Center for Kyushu Okinawa Region, Japan in 2001. The nutritional value of the flour made from the tops of Suioh and the characteristics of its processed foods, bread and green tea, were evaluated to develop a new use of sweetpotato tops. The protein, lipid, sodium, iron, zinc, carotene, total ascorbic acid, vitamin E, and vitamin K_1 contents were the highest in the leaves. The highest content of ash, potassium and carbohydrate were the highest in petioles or stems. The dietary fiber, energy, phosphorous and magnesium contents did not much differ among the portions. The contents of the components in each portion of the tops in the Jul. 15 harvests did not change appreciably in Aug. 27 harvests. The flour from whole tops, consisting of leaves, petioles and stems, seemed to have a well-balanced nutritional value. Addition of flour from whole tops at 2% of the bread ingredients was the optimal amount for swelling, color, hardness and bread aging in bread processing. The green tea made from the tops contained high amount of polyphenols and showed high activity of radical scavenging activity. Thus, sweetpotato tops can be used as an ingredient of processed foods and green tea in addition to its use as a leafy vegetable.

Introduction

Sweetpotato (*Ipomoea batatas* L.) has long been an important crop in Japan. Its tuber can be processed into foods, starch, juice and alcoholic beverages, in addition to table use (Yamakawa, 2002). Recently, some researches on the beneficial physiological functions of sweetpotato tuber have been reported (Yoshimoto *et al*., 1999; Suda *et al*., 2002). On the other hand, sweetpotato tops have limited use compared to the tubers. The tops were used as a vegetable during famine in Japan. A small amount of tops, however, has only been used as an animal feed or as a green manure in recent years, except for a few provinces where tops are used as a vegetable. Sweetpotato tops, however, have much potential as food, because their protein, vitamins and minerals are comparable to other commercial vegetables (Woolfe, 1992). The tops also contain much higher level of polyphenols, which have many physiological functions, than other commercial vegetables (Islam *et al*., 2002). Therefore, sweetpotato tops seem to be a suitable vegetable for summer when most leafy vegetables are scarce in the market. There is only one cultivar, however, that has good taste petioles in Japan. Thus, we have developed a new sweetpotato cultivar Suioh whose tops are acceptable as a vegetable.

In this paper, we produced flours from the leaves, petioles and stems of the new cultivar and analyzed their nutritional value. We also processed bread and green tea to increase the product range of sweetpotato tops. The appropriate amount of flour as an additional ingredient in bread processing was determined and the polyphenol content as well as its physiological function as a radical-scavenging nutrient of the tea were evaluated.

Materials and Methods

Cultivation. Sprouts produced from storage roots of Suioh were transplanted to two blocks in an experimental field in Upland Farming Research, the National Agricultural Research Center for Kyushu Okinawa Region in April 2002. Twenty sprouts were transplanted into each block at a spacing of 0.75 x 0.35 m. A fertilizer mixture (48.0 kg N, 31.5 kg P, 99.6 kg K per hectare) and compost (10 t/ha) were applied to the soil before planting. First harvesting of tops was done in July 2002. Then more fertilizers in form of a mixture (48.0 kg N, 31.5 kg P, 99.6 kg K per hectare) and ammonium sulfate (106 kg N/ha) were applied in August. The tops were cut at five cm from the ground level in both harvesting.

Flour processing and nutrition. The harvested tops from 10 plants (five plants per block) were separated into leaves, petioles, and stems. The samples were washed and frozen at -35 °C for a few days. The frozen samples were dried in vacuo using a freeze drier (model TR-PK-3-80, Trio Sciences), milled, and the flours kept in a freezer at -35 °C until use. The protein, lipid, ash, carbohydrate, dietary fiber, energy, mineral [sodium (Na), phosphorous (P), iron (Fe), calcium (Ca), potassium (K), magnesium (Mg) and zinc (Zn)], and vitamins (carotene, total vitamin C, vitamin E and vitamin K_1) contents of the flours were analyzed by the Japanese Food Research Laboratories.

Processing of bread. The Bread-mix (SD-MIX100, Nissin Foods), consisting of wheat, sugar, vegetable oil, skim milk and salt, and dry yeast, was used in making bread. The flour produced from whole tops was sieved through the 100 mm sieve and used as an ingredient in the bread. Two hundred ml of water was added to 315 g of the Bread-mix, 2.7 g of dry yeast with either 0 g (control), 6.3 g (2% of the weight of bread mix), 12.6 g (4%) or 18.9 g (6%) of the flour and they were set to Home Bakery (SD-BT6, National). The total processing time was 4 h and 15 min. The top height of baked breads was measured as an index of swelling, and the color value was determined by a colorimeter (CR-221, MINORTA). The bread was cut into four pieces (3 x 2 x 2 cm) and its hardness was measured by Digital force gauge (FGC-2, SIMPO) at 0 (the day of baking), 1 and 2 d after storage. Two-way analysis of variance for the amount of flour added to the bread mix and storage duration of the bread was analyzed and the means of four replicates were compared using the least significant difference (LSD).

Processing of sweetpotato green tea. The harvested tops were washed well and steamed for 5 min. After cooling and withering, the tops were chopped into tiny pieces, kneaded, and dried at 80°C. The total content of polyphenols, extracted by hot water (100°C), was measured according to the Folin-Ciocalteu method, with a slight modification (Islam *et al*., 2002). The procedure used by Brand-Williams *et al*. (1995) for evaluating the radical scavenging activity was followed with a slight modification. Fifty ml of the sweetpotato green tea, extracted by hot water, was transferred into a 96-well micro plate, then 50ml of 200mM MES buffer (pH 6.0), 50 ml of 20 % ethanol and 50 ml of 800mM 1,1-diphenyl-2-picrylhydrazyl (DPPH) solution (in ethanol) were added. After 20 min, the absorbances of the reaction mixture and standard Trolox were measured at 520 nm.

Results and Discussion

Flour nutrition. Flours made from the leaves, petioles, and stems of Suioh tops both in July and August in 2002 harvests were prepared by freeze drying, and their nutritional values evaluated. The protein, lipid, sodium, iron, zinc, carotene, total ascorbic acid, vitamin E and vitamin K_1 contents were the highest in the leaves. The highest content of ash, potassium and carbohydrates were in petioles or stems. Dietary fiber, energy, phosphorous and magnesium contents did not differ much among the portions. The contents of the components in each part of the tops in the

both harvests did not change appreciably. The nutritional value of whole tops was calculated by dry matter distribution of the leaves, petioles and stems. Based on the estimated value, the flour from whole tops contained a well-balanced nutrition, indicating that it can be a good ingredient for processed foods.

Processing of bread. The flour made from whole tops was used for bread processing. The top height of the bread containing the flour decreased as added amount increased, although there was no difference between 0% (control) and 2% addition. The L* value of the bread decreased and a* value increased as added amount increased, although a* value of 2 % addition was lower than that of the control. b* value increased until 4% but decreased at 6% addition. Although 2% addition of tops flour was acceptable in color, the color of 4 % and 6 % addition were too dark. Hardness of bread was measured at 0 (the day of baking), 1 and 2 d after storage. Two-way analysis of variance showed significant difference among added amount of tops flour and storage period. The hardness of the bread did not differ between control and addition of tops flour at 2% of the bread mix but significantly increased at 4% and 6%. As storage time increased, bread hardened significantly, but the hardness of 2 % added bread was lower than those of 4 % and 6 % addition and did not differ with that of the control. From these results, 2 % addition of tops flour to bread ingredients was the optimum amount for better swelling, color, hardness and bread aging in bread processing.

Processing of sweetpotato green tea. Sweetpotato tops were processed into green tea using the methods of processing green tea from tea plants. The tea extracted by hot water was yellowish green with a good taste. The total polyphenol content of sweetpotato green tea was 17.6 mg chlorogenic acid equivalent per gram and DPPH radical scavenging activity was 57.6 ?mol Trolox equivalent per gram. Since the polyphenol oxidase became inactive during steaming, most of the polyphenol in tops would have been maintained through processing. Green tea is the most popular drink in Japan, therefore, sweetpotato green tea would be easily accepted and might prevent a lot of diseases related to radicals by the function of the polyphenols.

Implications

We processed the flour using tops of the new cultivar for tops utilization. The leaves were the best nutritionally, but the flour from whole tops was estimated to have well-balanced nutrition and was a good ingredient for making bread. The flour could be used for other processed foods, such as noodles, pudding, jelly, candy, cookies and a nutrition supplement for health. Sweetpotato green tea, which had much content of polyphenols and radical scavenging activity, was also processed. This might be accepted to the people mindful of their health or having any diseases. The potential for more product development from sweetpotato tops is high and we will pursue it further.

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