Concentration of ascorbic acid, carotenoids, total phenolics and total anthocyanins in cooked potatoes

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Abstract

Potatoes are referred to as a good source of antioxidants like ascorbic acid (AA), carotenoids and polyphenols, however there is scarce information regarding the antioxidant concentration in cooked potatoes. In this study, the effect of cooking on the concentrations of ascorbic acid, carotenoids, total phenolic and total anthocyanins of diverse varieties were evaluated by spectrophotometry and HPLC. Cooking significantly reduced the AA concentration of all the varieties with boiling reducing the AA concentration to a lesser degree than either baking or microwaving . One hundred g of boiled potatoes of the variety 704393 could provide between 17 and 20% of the RDA of AA. Comparison of the carotenoid compositions of raw and cooked tubers of some varieties revealed that cooking significantly reduced the violaxanthin and antheraxanthin concentration of all the varieties. However the lutein and zeaxanthin concentration of cooked tubers of some of the varieties evaluated was higher than in raw tubers. One hundred grams of the cooked yellow fleshed varieties provide a significant amount of zeaxanthin (above 500 ug) to the human diet. The total phenolic and total anthoacyanin concentrations of the pink and purple fleshed varieties evaluated were higher in cooked than raw potatoes. It seems that cooking has no a negative effect on the lutein, zeaxanthin, total phenolic and total anthocyanin concentration of potatoes.

Cooked potatoes have a significant amount of vitamin C cooked yellow fleshed potatoes are a good source of zeaxathin, and cooked red and purple fleshed potatoes are a good source of anthocyanins.

Keywords: Potato, cooking, vitamin C, carotenoid, total phenolics, total anthocyanins.

Introduction

Dietary antioxidants include ascorbic acid (AA), carotenoids and polyphenols. They are believed to play a key role in the body's defense system against reactive oxygen species, which are known to be involved in the pathogenesis of aging and many degenerative diseases such as cardiovascular diseases and cancers.

Potato contains important concentrations of AA, carotenoids and polyphenols. Freshly harvested raw, peeled potato tubers have been reported to contain up to 46 mg AA / 100 g FW (Han et al., 2004; Burgos et al., 2008) depending upon the variety, the maturity of the tubers at harvest, procedures for sampling and almost to as great an extent, upon the environmental conditions under which they were grown. Significant and predominant amounts of zeaxanthin and anteraxanthin have been reported in deep yellow fleshed potatoes while in yellow potatoes the reported carotenoid profile is composed of violaxanthin, antheraxanthin, lutein and zeaxantin; and in cream fleshed potatoes of lutein and betacarotene (Burgos et al., 2008). The principal phenolic acid in potatoes is chlorogenic acid. Red and purple potatoes also contain anthocyanins. Whole unpeeled potatoes with fully-pigmented flesh can have up to 40 mg / 100 g FW total anthocyanins. Red-fleshed potatoes contain acylated glucosides of pelargonidin while purple potatoes contain in additon, acylated glucosides of malvidin, petunidin, peonidin, and delphinin (Brown 2005).

In recent years, considerable information has been published about the composition of raw potatoes, but little or no attention has been given to the composition of cooked potatoes. In this context, the objective of this study was to determine the effect of cooking on the concentration of ascorbic acid, carotenoids, total phenolic (TP) and total anthocyanin (TA) concentrations of cooked potato.

Materials and methods

The AA concentration of raw and cooked tubers of 6 varieties was determined using a spectrophotometric method using the method developed by Egoaville et al., 1988. Tubers were cooked by 3 different methods: boiling, baking and microwaving.

The individual carotenoid concentrations of raw and cooked (boiled) tubers of 2 light yellow fleshed varieties, 2 yellow fleshed varieties and 2 deep yellow fleshed varieties was determined by HPLC using the method described in Burgos et al., 2008.

The TP and TA concentration of raw and cooked (boiled) tubers of 5 different colored-fleshed potatoes was analyzed by spectrophotometry using the methods reported by Waterhouse, 2002 and Jansen and Flamme, 2006; respectively.

The effects of cooking were analyzed by ANOVA, considering the genotypes as random effects, and cooking (cooked vs. uncooked) treatments as fixed effects, and means were compared by Tukey's test. All statistical tests were performed using SAS/STAT (version 9.1) software.17 (SAS, 1999).

Results and discussion

Ascorbic acid

ANOVA indicated a significant non-crossover interaction between cooking method and variety. For the 6 varieties, boiling reduced the AA concentration to a lesser degree than either baking or microwaving (Figure 1). The percentage of AA retention ranged from 53 to 97%, from 6 to 66% and from 6 to 39% in boiled, baked and microwaved potatoes, respectively. A similar percentage of AA retention in boiled potatoes (53 to 97%) was found by Augustin et al (1978a) who also used potatoes cooked with their peels. However the percentages of AA retention in baked and microwaved potatoes found in this study are lower than those found by Augustin et al (1978a) (from 69 to 77% and from 77 to 58% in baked and microwaved potatoes respectively. A recent study reported higher percentage of retention of the AA concentration when potatoes are microwaved (67 to 79%) than boiled (12 to 23%) (Han et al., 2004). However this difference is likely due to the different methods used to prepare the boiled samples. Han et al. (2004) boiled plugs obtained from the central parts of tubers by penetrating the tuber with a cork borer from the stem end to the rose end while in the present study tubers were boiled with their skins intact, peeled after cooking, quartered longitudinally and sliced for taking the laboratory sample.

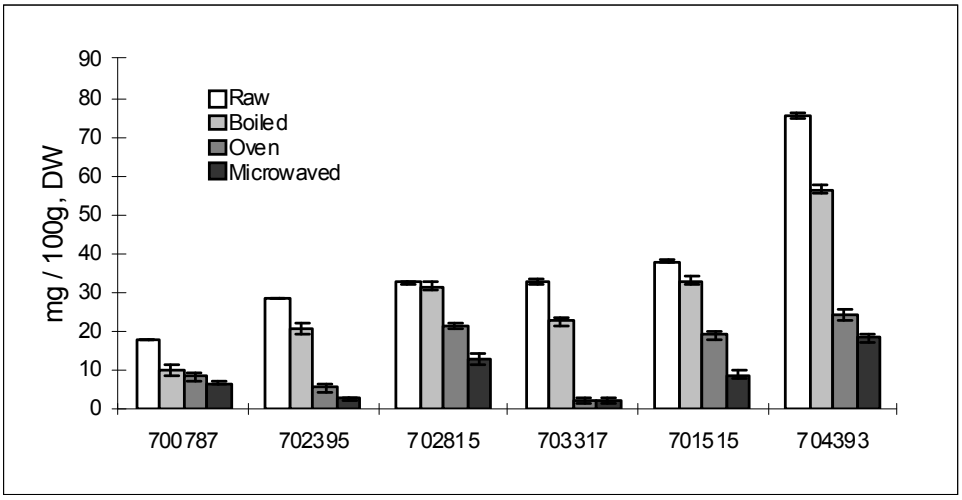

Figure 1. Effect of 3 methods of cooking on the ascorbic acid concentration of tubers of 6 native varieties

The native variety 704393 showed the highest AA concentration after boiling. One hundred g of boiled potatoes of this variety could provide between 17 and 20% of the RDA of AA, which is suggested to be 100 - 120 mg / day, to achieve cellular saturation and optimum risk reduction of heart disease, stroke and cancer in healthy individuals (Naidu, 2003).

Carotenoids

Combined analysis of variance of the individual carotenoid concentrations of raw and cooked tubers revealed a significant interaction between cooking and variety, showing that the effect of cooking on the concentration of violaxanthin, anteraxanthin, lutein, zeaxanthin and betacarotene varies among varieties.

The 6 varieties showed significantly reduced violaxanthin and anteraxanthin concentration after cooking (Figure 2) with retention percentages ranging from 0 to 17% and from 0 to 54%, respectively. Similarly, previous studies have shown that epoxide carotenoids of mango, white fleshed sweetpotatoes, tomatoes and several green vegetables, are very sensitive to most food preparation conditions (Gody and Rodriguez-Amaya, 1987; Almeida and Panteado, 1988 and Khachick et al., 1992).

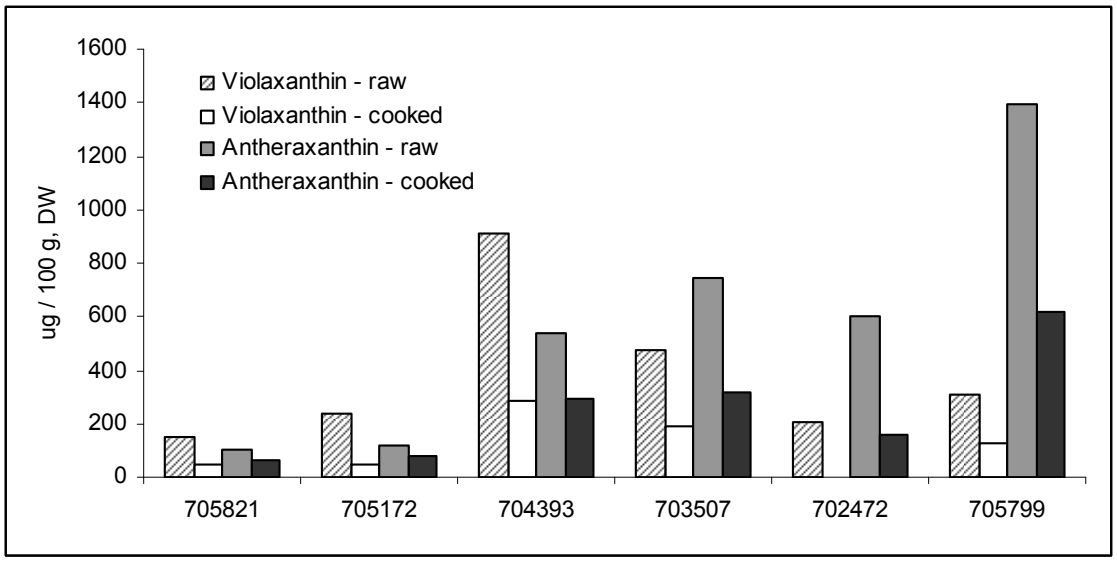

Figure 2. Effect of boiling on the violaxanthin and antheraxanthin concentration of potato tubers

The 2 deep yellow fleshed varieties evaluated in this study and 1 of the yellow fleshed varieties showed no significant diferences in the lutein and zeaxanthin concentration of raw and cooked tubers. However the yellow fleshed variety 703507 showed a significant increment in the concentration of both carotenoids after cooking. The light yellow fleshed varieties also showed a tendency toward increase lutein concentrations after cooking but the increment was not statistically significant. Since enzymes are inactivated by the heat treatment during cooking, these results are difficult to explain. However they may be attributable to the fact that lutein and zeaxanthin were stable after cooking and cooking facilitated the extraction of these carotenoids.

The lutein and zexanthin concentration of cooked potatoes ranged from 73 to 178 ug / 100 g, FW and from 0 to 551 ug / 100 g, FW. Lutein and zexanthin provide protection againts age related macular degeneration. The cooked potatoes of the deep yellow fleshed varieties showed significant amount of zeaxanthin (above 500 ug / 100 g, FW). The fact that the cooked tubers of the deep yellow fleshed varieties showed high zeaxanthin concentration is interesting since zeaxanthin is found in significant levels in relatively few dietary components including some maize cultivars and yellow orange pepper varieties (Minguez-Mosquera and Hornero-Mendez, 1994). However future studies should include evaluation of the bioavailabity of potato zeaxanthin to have a better idea of its contribution to the diet.

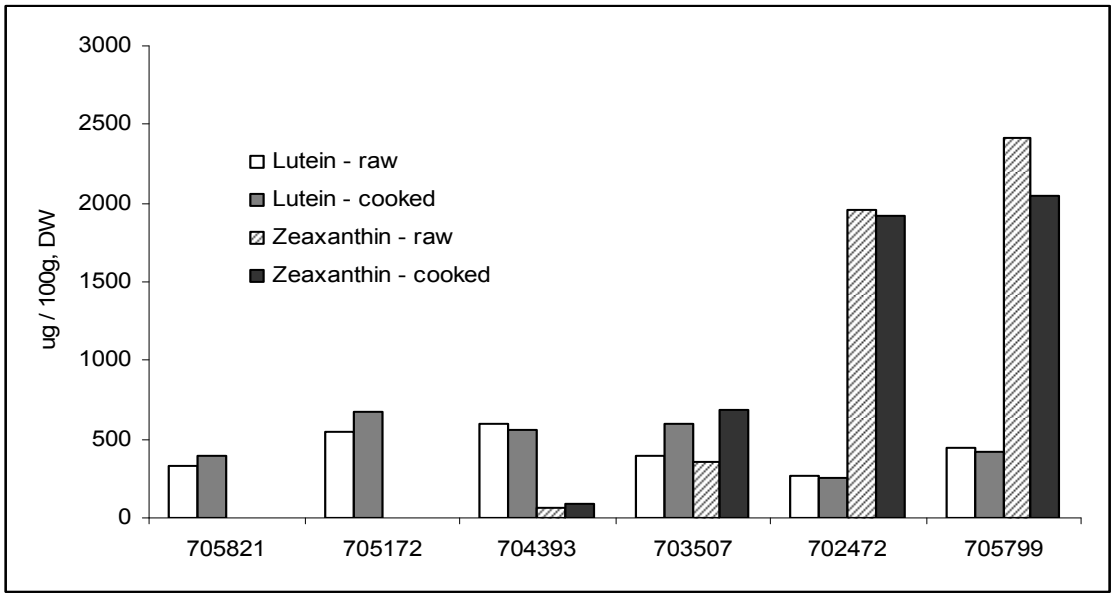

Figure 3. Effect of boiling on the lutein and zeaxanthin concentration of potato tubers

Total phenolic compounds and total anthocyanin

Combined analysis of variance of the TP and TA concentrations of raw and cooked tubers revealed a significant interaction between cooking and variety showing that the effect of cooking on the concentration of TP and TA varies among varieties.

The cream and yellow fleshed varieties showed lower TP after cooking. The pink and purple fleshed varieties showed a higher TP and TA after cooking while in the deep purple fleshed variety the TP increased after cooking and the TA showed no significant differences. The higher concentration of TP and TA in cooked tubers may be attributable to more efficient extraction from cooked samples (Figure 4).

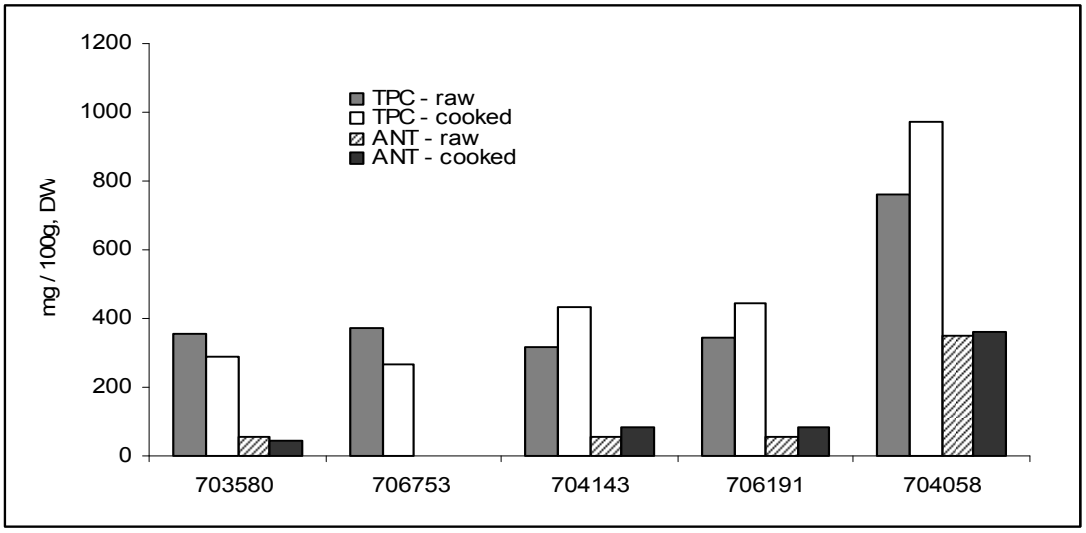

Figure 4. Effect of boiling on the total phenolics and total anthocyanin concentration of potato tubers

The total phenolic compound concentration of raw and cooked potatoes ranged from 78.10 to 169.77 and from 65.03 to 211.43 mg / 100 g, FW, respectively with the deep purple fleshed variety 704058 showing the highest total phenolic concentration. The highest value of TP reported in this study is similar to the highest value reported by Reyes et al, 2005 (181 mg / 100 g, FW) for red and purple fleshed potatoes. Previous studies in raw potatoes have reported that chlorogenic acid dominates the polyphenolic profile of potato cultivars (Andre et al, 2007; Lewis et al, 1998). Future studies are needed to confirm if chlorogenic acid dominates the polyphenolic profile of cooked potatoes. In addition it will be important to evaluate the bioavailabity of potato polyphenols and anthocyanins.

The total anthocyanin concentration of raw and cooked potatoes ranged from 0 to 77.83 and 0 to 78.10 mg / 100 g, FW; respectively, with the deep purple fleshed variety 704058 showing the highest total anthocyanin concentration.

This research demonstrates that the degree and sometimes the direction of effects of cooking on the concentration of AA, carotenoid, TP and TA vary among varieties.

Boiled tubers had higher AA concentration than baked or microwaved tubers. One hundred g of boiled potatoes of the variety with the highest AA concentration 704393 could provide adults with 17 – 20 % of the RDA of AA, but the actual contribution can be higher depending on the amount of potato consumed.

Cooked yellow fleshed potatoes are a good source of zeaxathin while cooked red and purple fleshed potatoes are a good source of anthocyanins.

Acnowledgements

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