THE COMPARISON OF ACID ASCORBIC CONTENT DURING PROCESSING OF SOME VEGETABLES AND FRUITS

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Received: 19 March 2015 / Revised: 04 May 2015 / Accepted: 20 May 2015 / Published: 1 July 2015

Keywords: Ascorbic acid, green onion, spinach, pears, kiwi

Abstract. In this work there was searched the ascorbic acid content variation in four plant species during processing. The biological material was represented by: green onion, spinach leaves, pear fruits (from vegetable farms around Suceava town) and kiwi fruits (from supermarket). The ascorbic acid content was determined through a method based on reduction (by the ascorbic acid) of 2.6-Dichlorphenol-indophenol to the corresponding leucoderivate. Through grinding and one hour exposure to air at 20-22°C, the largest reduction in ascorbic acid content was in pear fruits (50%), and the lowest one in spinach leaves (11.7%). By means of thermal processing (boiling) the ascorbic acid content of the analyzed species has changed in different proportions. Thus, as compared to fresh samples, in boiled ones the vitamin C content has decreased most in pear fruits (by 52.6%) and least in spinach leaves (by 38.5%). Under the same conditions, in green onion sample the ascorbic acid mean content has increased by 10.8%, compared to fresh sample. In the fruit species, under thermal processing conditions, the ascorbic acid mean content was different as against heat-unprocessed samples. Thus, at kiwi fruits both in samples poached with sugar and without sugar, the total content of ascorbic acid (from product and boiling liquid) was superior to the heat-unprocessed samples. In contrast, at pear fruits, under the same experimental conditions, the total content of ascorbic acid was lower than in heat-unprocessed samples.

INTRODUCTION

Spread in fruits and vegetables, vitamin A, C, and E are bioactive compounds with antioxidant activities, which have a high antioxidant capacity (Hassimoto et al., 2005; Sanchez-Moreno et al., 2006). According to some authors (Dillard and German, 2000; Vinson et al., 2001; Cano et al., 2003; Chaovanalikid and Wrolstad, 2004), the phenolic compounds are also good contributors to the total antioxidant capacity of the foods containing them, but both vitamin C, carotenoids and phenolics may be poorly absorbed and rapidly metabolized, thus limiting their antioxidant ability in vivo (Gardner et al., 2000; Zulueta et al., 2007).

The storage conditions, on the one hand, and processing technology, on the other hand, can influence the content of bioactive compounds and their antioxidant capacity. Thus, the freezing process can cause, sometimes, significant decrease in the level of vitamin C in legumes and fruits (Banu et al., 2003). According to Ball (2006), drying methods, exposing the food to air lead to the loss of vitamin C because of its oxidation.

The thermal treatments are the main cause of the depletion of natural antioxidants (Anese et al., 1999). By Zia-Ur-Rehman et al. (2003); Zhang and Hamauzu (2004), cooking, pasteurization and the addition of chemical preservatives guarantee vegetables and fruits safe, but bring not always desirable changes in their physical characteristics and chemical composition (ascorbic acid, phenolics, carotenoids etc.).

The aim of this paper was to search the ascorbic acid content variation in four plant species during processing, to see to what extent the content of this vitamin is influenced by processing mode, by the type of plant material, or by the both.

MATERIALS AND METHODS

The biological material used in this work was represented by samples belonging to the following plant species: green onion (leaves and bulbs), spinach (leaves) and pear (peeled fruits), coming from vegetable farms around Suceava town, as well as kiwi (peeled fruits) purchased from supermarket. The choice of material was based on increased consumption, in this period of early spring, of these vegetables and fruits containing different amounts of ascorbic acid.

Because both vegetables and fruits species, used in this research, are eaten either fresh (salads) or cooked, their ascorbic acid content was assessed in the following working variants: raw material, chopped material and left for 60 min. at room temperature, boiled material 30 min., with sugar and sugar free, and boiling liquid, with sugar and sugar free. As to boiling conditions, the ratio of vegetable material-to-water was 1:10 w/v, and the concentration of sugar used was 10%.

The ascorbic acid content was determined through a method based on reduction (by the ascorbic acid) of 2.6-

Dichlorphenol-indophenol (2.6-DCFIF) to the corresponding leucoderivate (Artenie and Tănase, 1980; Indyk and Konings, 2000). The result was expressed as mg ascorbic acid per 100 g or 100 ml (mg%) product.

The data obtained from four replications (for each sample) were analyzed using Statistical Package for Social Science software, version 16.0. The correlation analyses were performed at the probability levels of 95% and 99%. The differences between mean values of ascorbic acid were tested using Analysis of Variance ANOVA One-Way. In order to highlight the degree of influence of different factors, such as material status, the way of processing, and interaction between them on ascorbic acid content in each studied vegetable material, or upon ascorbic acid content from boiling liquid, there was applied factorial Analysis of Variance in the condition specified (Tabachnick and Fidell, 2007).

RESULTS AND DISCUSSIONS

In Fig. 1 are reproduced, comparatively, the ascorbic acid mean values from raw material (fresh) and processed (by crushing), and left at room temperature for one hour.

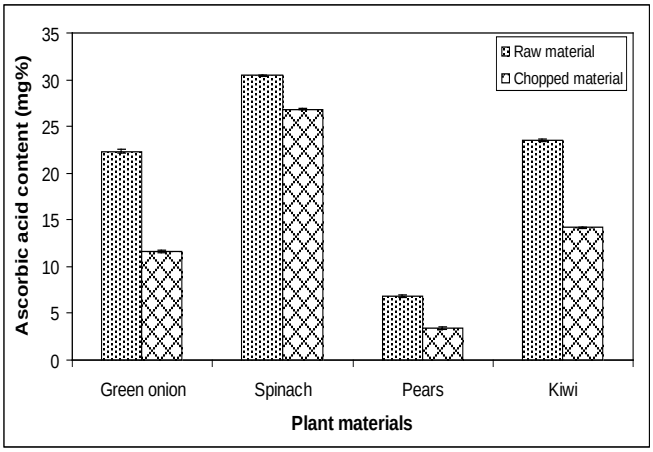

Fig. 1. The ascorbic acid mean content in raw and chopped plant materials

As shown in the graph, in the crude plant material the highest value of ascorbic acid was recorded in spinach (30.45±0.1 mg%), followed, in order, by kiwi (23.51±0.09 mg%) and green onion (22.35±0.15 mg%), the lowest one being in pears (6.87±0.11 mg%).

By grinding and exposure to air at 20-22°C, the ascorbic acid content was reduced in all 4 species examined, but with different percentages (Fig. 1). The F test result has shown a significant main effect (p=0.000), both of the variable material type, and of the variable material status on ascorbic acid content. Also, the value of F test has indicated a significant cumulative effect (p=0.000) of the factors material type and material status on ascorbic acid content. The ascorbic acid mean values in vegetable raw samples differ significantly (p=0.000) of those ones from grinded plant samples, for all kinds of analyzed materials, the material status significantly influencing the ascorbic acid content.

By grinding and in contact with air, the ascorbic acid content was reduced by 50% (in pears), by 47.8% (in green onion), by 39.7% (in kiwi) and by 11.7% (in spinach). According to Banu et al. (2003), cabbage and carrots simple cutting has lead to loss of vit. C up to 75%.

Fig. 2 shows, comparatively, the ascorbic acid mean values from unprocessed plant material and from thermally processed (cooked without sugar).

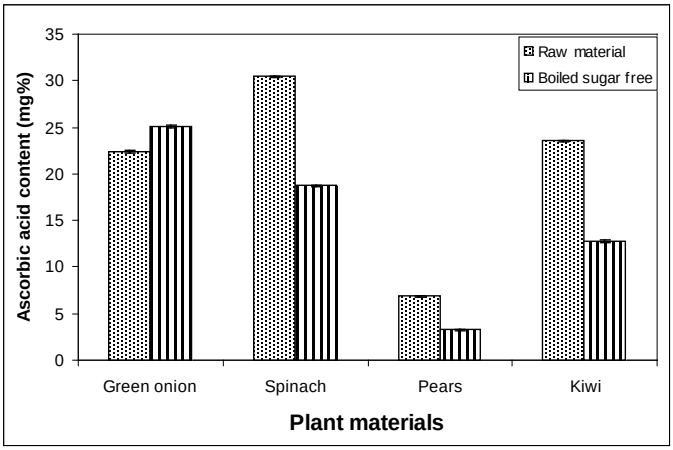

Fig. 2. Mean values of the ascorbic acid content in plant materials cooked sugar free, as compared to the raw material

As seen in the graph, the ascorbic acid values of the boiled material sugar free were: 25.05±0.12 mg% (green onion), 18.71±0.09 mg% (spinach leaves), 3.24±0.06 mg% (pear fruits) and 12.77±0.1 mg% (kiwi fruits). The unprocessed material, except green onion, indicates higher mean values for ascorbic acid content, as compared with the ascorbic acid content of the material boiled sugar free.

The average values of the ascorbic acid content in raw samples have differed significantly ($p<0.05$) of those ones in the samples boiled sugar free, for all types of plant materials studied: green onion ($r=0.968$), spinach ($r=–0.985$), pears ($r=–0.996$), kiwi ($r=–0.973$). As compared with fresh samples, in boiled samples the ascorbic acid content has decreased by 38.5% (in spinach), by 45.6% (in kiwi) and by 52.6% (in pears).

Under the same conditions (boiling), in green onion sample the ascorbic acid content has increased by 10.8%. This increasing, observed in heat-processed green onions could be explained by the fact that water, at high temperatures, has facilitated the destruction of cell walls and the release of ascorbic acid in an greater amount, than was achieved by grinding of the raw material. It is also possible that, in the case of green onion, the ascorbic acid to be present in cells as a complex with other molecules (protecting it from oxidation), and from that it is slower released, possibly through water action at these high temperatures.

In a study of an orange-carrot juice mixture, Torregrosa et al. (2006), cited by Cortés et al. (2007), observed that after pasteurization the remaining concentration of vitamin C was 83% of the concentration of the untreated juice.

In Fig. 3 are rendered the ascorbic acid mean values in pears (2.42±0.05 mg%) and kiwi (13.63±0.09 mg%) cooked with sugar, compared with unprocessed plant material.

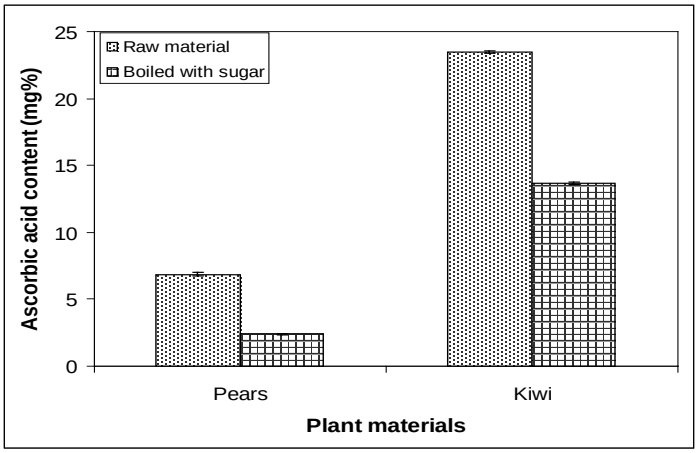

Fig. 3. Mean values of the ascorbic acid content in pears and kiwi cooked with sugar, as compared to the raw material

As seen from the graph, compared to the raw material (unprocessed), in the samples boiled with sugar, the percentage decreases of ascorbic acid were 64.9% (in pears) and 46.3% (in kiwi).

The material status (raw or boiled with sugar) and the type of material have significantly influenced ($p<0.001$) the ascorbic acid content in plant material. The results of ANOVA have revealed significant differences ($p<0.001$) between mean values of ascorbic acid from the material processed with sugar, and the raw material for the two types of plant material.

Comparing the values of ascorbic acid from samples cooked in the presence of sugar, with those ones from the samples processed without sugar it observes that, reported to raw material, a greater reduction in the content of this vitamin has occurred in pear samples in the presence of sugar (64.9%) as against 52.7% (in the absence of sugar), while in kiwi samples the percentages were close (46.3% in the presence of sugar, as against 45.6% in the absence of sugar).

Fig. 4 renders the mean values of ascorbic acid in the boiling liquid from pear and kiwi cooked with sugar, as compared to the boiling liquid from the same plant material cooked without sugar.

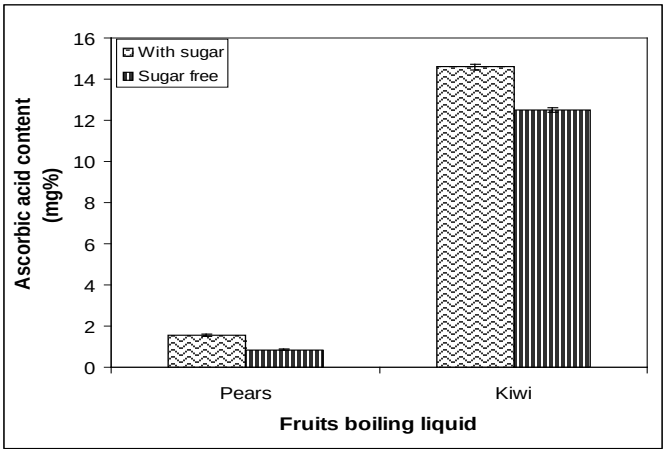

Fig. 4. Mean values of the ascorbic acid content in the boiling liquid from sugar and sugar-free materials

From Fig. 4 it can observe that in the boiling liquid with sugar, the ascorbic acid values were 14.59±0.12 mg% at kiwi, and 1.55±0.06 mg% at pears. In the boiling liquid sugar free, the ascorbic acid values were 12.5±0.09 mg% at kiwi, and 0.86±0.05 mg% at pears.

Making the amount of the ascorbic acid content from samples cooked with sugar and the boiling liquid with sugar, respectively from samples cooked without sugar and corresponding boiling liquid, is found a total of: 28.22±0.1 mg% in kiwi samples poached with sugar, respectively 25.27±0.09 mg% in kiwi samples poached without sugar ($p<0,05$), and 3.97±0.06 mg% in pears samples poached with sugar, respectively 4.1±0.06 mg% in pears samples poached without sugar ($p>0,05$). At kiwi fruits, both in samples poached with sugar and without sugar, the total content of ascorbic acid (from product and boiling liquid) was superior to the heat-unprocessed samples, and even to raw material. Like in onion, it seems that during boiling of kiwi fruits, the hot water has facilitated a more powerful destruction of cell walls and the release of a greater amount of ascorbic acid within the boiling fluid. Experimental version with added sugar (10%) has recorded higher values of ascorbic acid both in plant tissue and in boiling liquid as compared to sugar free version.

Large losses of vitamin C occur during blanching, boiling, when the water used for heat treatment is not used (mainly losses by solubilization), protective action on vitamin C having anthocyanins, sugar, starch (Banu et al., 2003).

CONCLUSIONS

The ascorbic acid content in green onion (leaves and bulbs), spinach leaves, pear and kiwi (peeled fruits) was influenced by processing mode and the type of plant material analyzed.

Compared to fresh (unprocessed) samples, grinding and exposure to air caused the greater decrease of ascorbic acid content in pears and onion, and the lowest one in spinach leaves.

The thermal processing (boiling) caused the greater decrease of ascorbic acid content in pear fruits and in spinach leaves. The presence of sugar (10%) in the boiling liquid made as

ascorbic acid to decrease less than in its absence, both in plant tissue and in the boiling fluid.

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