Journal homepage: www.fia.usv.ro/fiajournal
Journal of Faculty of Food Engineering,
Ştefan cel Mare University of Suceava, Romania
Volume XIV, Issue 2 - 2015, pag. 157 - 161

FOOD AND ENVIRONMENT SAFETY

THE INFLUENCE OF PROCESSING BY CRUSHING AND BOILING ON ASCORBIC ACID CONTENT IN SOME PLANT SPECIES

*Marcel AVRĂMIUC[1], Silvia MIRONEASA[2]
[1,2]*Faculty of Food Engineering, Stefan cel Mare University of Suceava, Romania*
avramiucm@fia.usv.ro
[*]Corresponding author
Received February 15[th] 2015, accepted May 25[th] 2015

Abstract. *In this work the influence of processing (crushing and boiling) on ascorbic acid content in four plant specie was searched on . The biological material was represented by: green onion (leaves and bulbs), 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 crushing and one hour exposure to air (20-22°C), the largest reduction in ascorbic acid content was registered in pear fruits (50%), and the lowest one in spinach leaves (11.7%). As compared to fresh samples, under thermal processing (boiling) the ascorbic acid content has decreased most in pear fruits (by 52.6%) and least in spinach leaves (by 38.5%). The presence of sugar (10%) in the boiling liquid made ascorbic acid decrease less than in its absence, both in plant tissue and in the boiling fluid.*

Keywords: *ascorbic acid, green onion, spinach, pear, kiwi*

1. Introduction

Spread in fruits and vegetables, vitamin A, C, and E are bioactive compounds with antioxidant activities, which have a high antioxidant capacity [1, 2]. According to some authors [3, 4, 5, 6], 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 [7, 8].
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 [9]. According to Ball [10], 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 [11].
By Zia-Ur-Rehman et al. [12]; Zhang and Hamauzu [13], 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.

2. Experimental

The biological material used in this work was represented by four plant species: green onion (leaves and bulbs), spinach leaves, pear (peeled fruits) derived from vegetable farms around Suceava town, and kiwi (peeled fruits) purchased from supermarket.

The ascorbic acid evaluation was carried out 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-DCPIP) to the corresponding leucoderivate. The result was expressed as mg ascorbic acid per 100 g or 100 ml (mg%) product [14, 15].

The data obtained from four replications 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, the factorial Analysis of Variance in the condition specified was applied[16].

3. Results and discussion

In Fig. 1 the ascorbic acid mean values from raw material (whole) and processed (by crushing), and left at room temperature for one hour are presented comparatively. As shown in the graph, in the raw plant material the highest value of ascorbic acid was recorded in spinach (30.45±0.09 mg%), followed, in order, by kiwi (23.51±0.04 mg%) and green onion (22.35±0.15 mg%), the lowest one being in pears (6.87±0.08 mg%).

By crushing and exposure to air at 20-22°C, the ascorbic acid content was reduced in the all four 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 crushed plant samples, for all kinds of analyzed materials, the material status significantly influencing the ascorbic acid content.

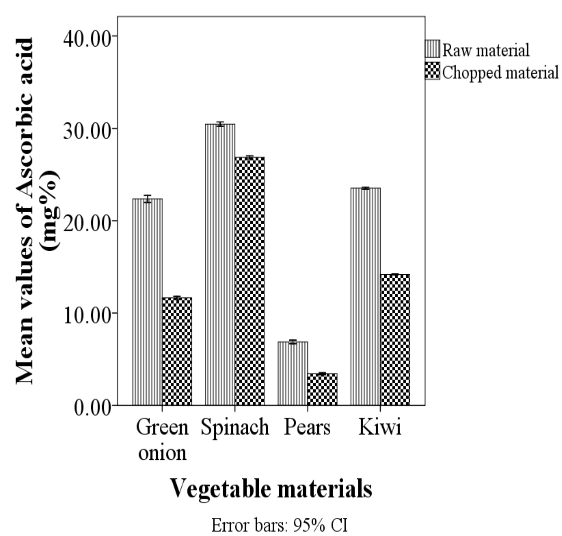

Fig. 1. The ascorbic acid mean content in raw and chopped plant material

By crushing 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. [9], cabbage and carrots simple cutting has lead to loss of vitamin C for up to 75%.

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

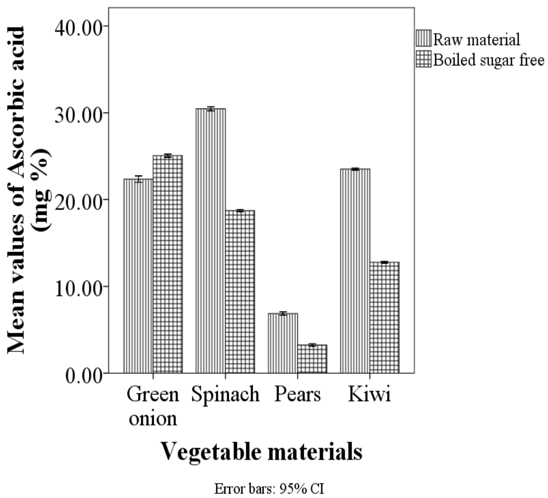

Fig. 2 Mean values of the ascorbic acid content in sugar free cooked plant materials, as compared to the raw material

The unprocessed material, regardless of its type, 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 ($p < 0.05$) from those ones in boiled sugar free samples, for all types of plant materials studied: green onion (r=0.962), spinach (r=–0.976), pears (r=–0.998), kiwi (r=–0.985).

As compared to 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).

Searching a mixture of orange-carrot, Torregrosa et al. [17], cited by Cortés et al. [18], observed that after pasteurization the remaining concentration of vitamin C was 83% of the concentration of the untreated juice.

Under the same conditions (boiling), in green onion sample the ascorbic acid content has increased by 10.8%. As this percentage increase was verified by repeated measurements (over 10), it is not a human error, and the explanation could be that after boiling, substances with reducing potentials are formed. These substances (reductones), reacting with the dye (2.6-DCPIP), can give a falsely high result for the vitamin C content of the sample [10]. Reductones are only likely to be found in processed foods after prolonged boiling or in canned foods after standing at elevated temperatures [19, cited by 10].

In Fig.3 the ascorbic acid mean values in pears and kiwi cooked with sugar, compared with unprocessed plant material are shown.

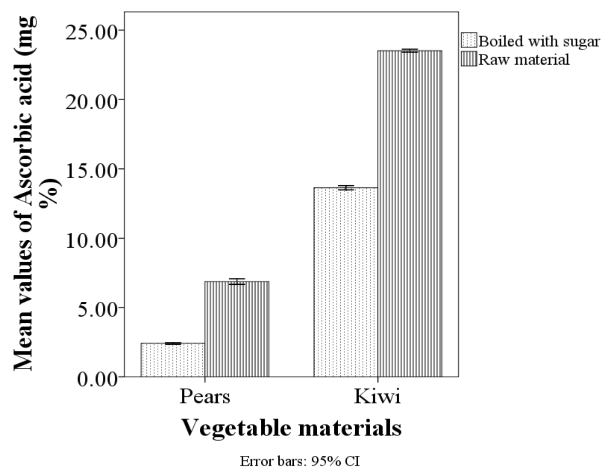

Fig. 3. Mean values of the ascorbic acid content in pears and kiwi cooked with sugar, as compared to the raw material

As seen from the graph, as compared to the raw material (unprocessed), in the samples boiled with sugar, the percentage of ascorbic acid decreases by 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 fruits cooked with sugar, as compared to the boiling liquid from the same plant material cooked without sugar.

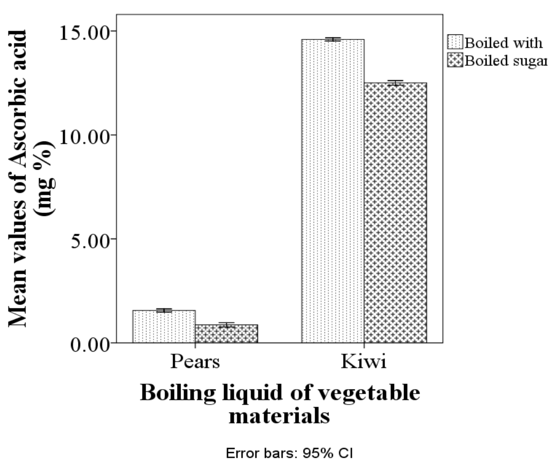

Fig. 4. Mean values of the ascorbic acid content in the boiling liquid from sugar and sugar-free plant materials

From Fig. 4 it can be seen that in the boiling liquid with sugar, the ascorbic acid values were 14.59±0.03 mg% in kiwi, and 1.55±0.03 mg% in pears. In the boiling liquid sugar free, the ascorbic acid values were 12.5±0.04 mg% in kiwi, and 0.86±0.04 mg% in pears. The 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 [9].

4. **Conclusions**

Researching the influence of processing on the content of ascorbic acid in samples of plant material belonging to four species (green onion, spinach, pears and kiwi) differences between these species were found, compared to the fresh products (unprocessed) .
Through grinding and one hour exposure to air at 20-22°C, the largest reduction in ascorbic acid content was registered in pear fruits and the lowest one in spinach leaves.
By means of thermal processing (boiling) the total content of ascorbic acid has decreased mostly 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.

5. References

[1] HASSIMOTO N.M.A., GENOVESE M.I., LAJOLO F.M.– *Antioxidant of dietary fruits, vegetables and commercial frozen fruit pulps.* Journal of Agricultural and Food Chemistry, **53,** pp. 2928-2935 (2005)
[2] SANCHEZ-MORENO C., PLAZA L., de ANCOS B., CANO P.– *Nutritional characterization of commercial traditional pasteurized tomato juices: carotenoids, vitamin C and radical-scavenging capacity*. Food Chemistry, **98**, pp. 749-756 (2006)
[3] DILLARD C.J., GERMAN J.B. – *Phytochemicals: nutraceuticals and human health. Review.* Journal of Science and Agriculture, **80**, pp. 1744-1756 (2000)
[4]VINSON J.A., SU X., ZUBIK L., BOSE P.– *Phenol antioxidant quantity and quality in foods:*

fruits. Journal of Agricultural and Food Chemistry, **49**, pp. 5315-5321 (2001)

[5] CANO P., PLAZA L., SANCHEZ-MORENO C., de ANCOS B. – *Elaboración y conservación de zumos de naranja: efectos de nuevas tecnologias sobre su calidad sensorial y nutricional*. Alimentación, Nutrición y Salud, **10**, pp. 108-119 (2003)

[6] CHAOVANALIKID A., WROLSTAD R.E. – *Total anthocyanins and total phenolics of fresh and processed cherries and their antioxidant properties*. Food Chemistry and Toxicology, **69**, pp. 67-72 (2004)

[7] GARDNER P.T., WHITE T.A.C., MCPHAIL D.B., DUTHIE G.G. – *The relative contributions of vitamin C, carotenoids and phenolics to the antioxidant potential of fruit juices*. Food Chemistry, **68**, pp. 471-474 (2000)

[8] ZULUETA ANA, ESTEVE MARIA J., FRASQUET ISABEL, FRIGOLA ANA – *Vitamin C, vitamin A, phenolic compounds and total antioxidant capacity of new fruit juice and skim milk mixture beverages marketed in Spain* – Food Chemistry, **103**, pp. 1365-1374 (2007)

[9] BANU C., IORDAN M., NOUR V, MUSTEAŢĂ G. – *The processing of raw materials and the loss of biologically active substances*. Ed. „TEHNICA" UTM. Chişinău, p. 91-93 (2003)

[10] BALL G.F.M.– *Vitamins in Foods, Analysis, Bioavailability, and Stability*. CRC Press, Taylor & Francis Group 6000, Broken Sound Parkway NW, Suite 300, Boca Raton, FL 33487-2742, p. 292-305; 369-371 (2006)

[11] ANESE M., MANZOCCO L., NICOLI M.C., LERICI C.R. – *Antioxidant properties of tomato juice as affected by heating*. Journal of the Science of Food and Agriculture, **79**, pp. 750-754 (1999)

[12] ZIA-UR-REHMAN Z., ISLAM M., SHAH W.H. – *Effect of microwave and conventional cooking on insoluble dietary fibre components of vegetables*, Food Chemistry, **80**, pp. 237–240 (2003)

[13] ZHANG D.L., HAMAUZU Y. – *Phenolics, ascorbic acid, carotenoids and antioxidant activity of broccoli and their changes during conventional and microwave cooking*, Food Chemistry, **88**, pp. 502–509 (2004)

[14] ARTENIE V., TĂNASE ELVIRA – *Practicum of general biochemistry*. Replication Center of "Al. I. Cuza" University, Iaşi, pp. 56-58 (1980)

[15] INDYK H. and KONINGS E., Eds – *Official Methods of Analysis of AOAC International*, 17th ed., AOAC International, Gaithersburg, MD, pp. 45-60 (2000)

[16] TABACHNICK B.G., FIDELL L.S. – *Using multivariate statistic* (5th ed.) Pearson, London, New York (2007)

[17] TORREGROSA F, ESTEVE M.J., FRÍGOLA A., CORTÉS C. – *J. Food Eng.*, **73,** pp. 339-345 (2006)

[18] CORTÉS CLARA , ESTEVE J. MARÍA, FRÍGOLA ANA – *Effect of refrigerated storage on ascorbic acid content of orange juice treated by pulsed electric fields and thermal pasteurization*, European Food Research and Technology Zeitschrift für Lebensmittel-Untersuchung und-Forschung A© Springer-Verlag 200710.1007/s00217-007-0766-x, Published online: 11 October 2007

[19] Roe J.H. – *Ascorbic acid*, in The Vitamins. Chemistry, Physiology, Pathology, Methods, György, P. and Pearson, W.N., Eds., 2nd ed., Vol. 7, Academic Press, New York, 1967, pp. 27.