Journal of Food Biosciences and Technology,
Islamic Azad University, Science and Research Branch, 3, 23-28, 2013

The Effect of Different Methods of Heat Treatments on the Retention of Ascorbic Acid in Carrot and Corn

M. Yahyaei [a*], ***A. Ghavami*** [b], ***M. Gharachorloo*** [c], ***K. Larijani*** [d], ***S. Z. Mazhari*** [e]

[a] *M. Sc. Research Student of Food Science and Technology, Science and Research Branch, Islamic Azad University, Tehran, Iran.*
[b] *Senior Lecturer in Food Science & Nutrition, School of Human Sciences, Faculty of Life Sciences, Metropolitan University, London.*
[c] *Assistant Professor of the College of Food Science and Technology, Science and Research Branch, Islamic Azad University, Tehran, Iran.*
[d] *Assistant Professor of Chemistry Department, Science and Research Branch, Islamic Azad University, Tehran, Iran.*
[e] *Associate Professor of Nutrition Department, Science and Research Branch, Islamic Azad University, Tehran, Iran.*

Received 11 April 2012; Accepted 27 September 2012

ABSTRACT: The history of food science, technology and nutrition and their expansion in respect of raw material, processing, finished products and nutritional value goes back to many years and is still the interests of many researchers. In this work ascorbic acid has been taken not only as an important and vital vitamin to be investigated during the course of different heat processes but also as an index to other vital and sensitive micronutrients. Titration by 2, 6 dichloroindophenol that only measures the ascorbic acid concentration was adopted as the mean to evaluate this reducing compound. The results indicated that microwave heating caused the highest loss during 20 minutes of heating as compared to other methods of heat treatments and this might be explained by the degree of heat, length of treatment, migration of ascorbic acid to the media and oxidation of ascorbic acid to de-hydro-ascorbic acid and other subsequent products.

Keywords: *Ascorbic Acid, Carrot, Corn, Heating, Titration.*

Introduction

Vitamins are among the micronutrients that play important roles in the human nutrition. Some might be regarded sensitive to processing and preservation and thus might be reduced to a great extent (Pearson, 1973; Lesˇkova *et al*., 2003; Ball, 2006). Some vitamins are water soluble and some are fat soluble and depending on their solubility in different media they might act differently (Ball, 2006; Ottaway, 1993).The excess consumption of water soluble vitamins might not cause problems due to their solubility in water and can be removed from the body easily however this might not be the case for fat soluble vitamins (Fatemi, 1378). The effects of light, heat, metals, pH, oxygen, enzymes and moisture on the retention and decomposition of vitamins are important and have been studied to a great extent (Somogyi & Muller, 1989). The effect of cooking of food and decomposition of vitamins depending on the degree and time of heat treatment and factors involved has been studied in great detail (Pearson, 1973). In general water soluble vitamins are more sensitive than the fat soluble ones. The stability and sensitivity of both water and fat soluble vitamins are summerised into 4 groups and are shown in Table 1 (Somogyi & Muller, 1989).

*Corresponding Author: yahyaei_mah30ma@yahoo.com

Table 1. Stability of vitamins during food processing (1= unstable, 4= stable)

Fat soluble vitamins	Water soluble vitamins	Stability
	VitaminC	1
	Folic acid	1
	Vitamin B_1	2
	Viatamin B_2	2
	Pantotenic acid	3
Vitamin A(retinol)	Vitamin B_6	3
β-carotene	Niyacine	3
Vitamin E Vitamin D	Vitamin B_{12}	4
Vitamin K	Biotin	4

Ascorbic acid is a water soluble vitamin with a reducing power and is enable to take parts in oxidation reduction reactions (Ozkan *et al*., 2005; Ball, 2006). Human body is unable to synthesis the ascorbic acid and therefore this vitamin should be provided and supplied to the body by the consumption of fruits and vegetables (Ozkan *et al*., 2005). The consumption of required amount of this vitamin increases the body protection in respect of various diseases (Cameron *et al*., 1979; CRC Press, 2006).

It is the L form of this compound that has potent activity, the D form is devoided of these properties (Ball, 2006; Ottaway, 1993). Ascorbic acid might be employed as flour improver, preserve the color of meat and helps the tocopherols to stabilize the product (Ball, 2006). Although vegetables and fruits are the rich sources of this vitamin, liver and milk might be regarded as the only sources of animals that contain this vitamin to some extent. Ascorbic acid has been regarded as one of the most sensitive vitamins (Ottaway, 1993).The concentrations of ascorbic acid in carrots and corn are 5-10 and 14 mg/100g respectively (Macance & Widdowson's, 1993; Ottaway, 1993).

Vallejo *et al* in 2002 carried out the effect of cooking under and reduced pressure as well as microwave on the ascorbic acid content of broccoli and indicated a loss of 40% that was high concerning microwave cooking (Vallejo *et al.,* 2002). In another work Khatoon & Prakash compared the effect of under pressure and microwave cookings and concluded a loss of 29-62% of ascorbic acid that was higher than the effect of pressure cooking (Khatoon & Prakash, 2006). Due to the fact that ascorbic acid has been reasonably well investigated for a long time in term of various cooking operations and it is the most sensitive nutrient to heat oxidation in respect of different pH conditions, therefore this compound might be regarded as a useful index of the amount of nutritional loss and damage caused by various processing operations. Therefore this compound was selected to understand the effect of microwave as well as other methods of cooking procedures on the nutritional value of vegetables in particular carrots and corn (Bernhardt and Schlich, 2005).

Materials and Methods

- *Materials*

Carrots and corn were purchased from the open market and the primarily treatments namely cleaning and dicing in the case of carrots were carried out on the samples. The samples were kept frozen at -70°C until required.

- *Method*

- *Determination of ascorbic acid*

This was measured according to the AOAC method number 967.21based on the oxidation of ascorbic acid by titration with 2.6, dochlorophenolindophenol.

- *Cooking Procedure*

Three different methods of cookings namely, microwave, under pressure and conventional were employed as means to understand the effect of each method on the ascorbic acid. For general method of cooking, 200 ml of water was poured into a beaker and heated until the water boils. 50 gr of carrots and 50 gr of corn were placed separately in the beaker and kept for 10 and 20 minutes. For microwave cooking 50 gr of each product separately were put into 200 ml of boiled water for 10 and 20 minutes with the power of 1000 W. For under pressure cooking 50 gr of each product was cooked for 10 and 20 minutes in 200 ml of boiled water at 121°C and pressure of 1.2 to 1.4 atm.

Statistical Analysis SPSS software and Duncan Test were used for statistical analysis of the results.

Results and Discussion

Figures 1 and 2 show the ascorbic acid concentrations in raw carrots and corn and the effect of different methods of heat treatments on this valuable compound that has been chosen as an index to other micronutrient. Table 2 also indicates the percentage loss of this compound when the raw materials are cooked by conventional, under pressure and microwave cooking procedures. Considering the ascorbic acid content of carrots and the cooking methods applied, it might be concluded that 10 minutes of conventional cooking treatment preserves higher concentrations of ascorbic acid as compared to 10 minutes of pressure or microwave cooking. However it should be noted that minor differences are observed for the ascorbic acid preservation when the materials were cooked by conventional or pressure cooking for 10 minutes. In respect of figure 2, it was noticed that the higher ascorbic acid concentration was preserved when 20 minutes of pressure cooking was applied. The results indicated (Fig. 1) that highest losses were experienced in the carrot when microwave cooking was applied for 20 minutes. The losses that accounted for 45.4% of the ascorbic acid originally present. Ascorbic acid might be regarded as one of the most sensitive reducing agents. This compound might be changed to dehydroascorbic acid as the results of oxidation. Although this compound is in its oxidized form but shows vitamin C activity. The rate of the conversion of ascorbic acid to it oxidised form depends on many factors namely pH, exposure to oxygen, methods of preparation and cooking as well as some other factors.

Sometimes this vital and important micronutrient might be taken as an index to losses of other less sensitive micronutrients namely folates among others. In respect of corn and the effect of cooking and processing procedures on the ascorbic acid of this popular vegetable, one might conclude that cooking for a short period with minimum amount of water might be regarded as the most suitable method as the work carried out by Lesˇkova *et al.* (2003). This study stated that loss of ascorbic acid was minimum when heating was applied without the addition of water. Table 2 indicates that the longer the heat treatment the higher losses are observed and one might conclude that pressure cooking for 10 and 20 minutes preserved higher concentration of ascorbic acid, a result that cannot be explained since high amount of pressure and temperature are applied in the pressure cooker. From table 2 and figure 2, it is well clear that microwave cooking particularly for 20 minutes destroys the ascorbic acid concentration to a great extent, but as explained earlier some might be changed to dehydro ascorbic, that exhibit vitamin C activity.

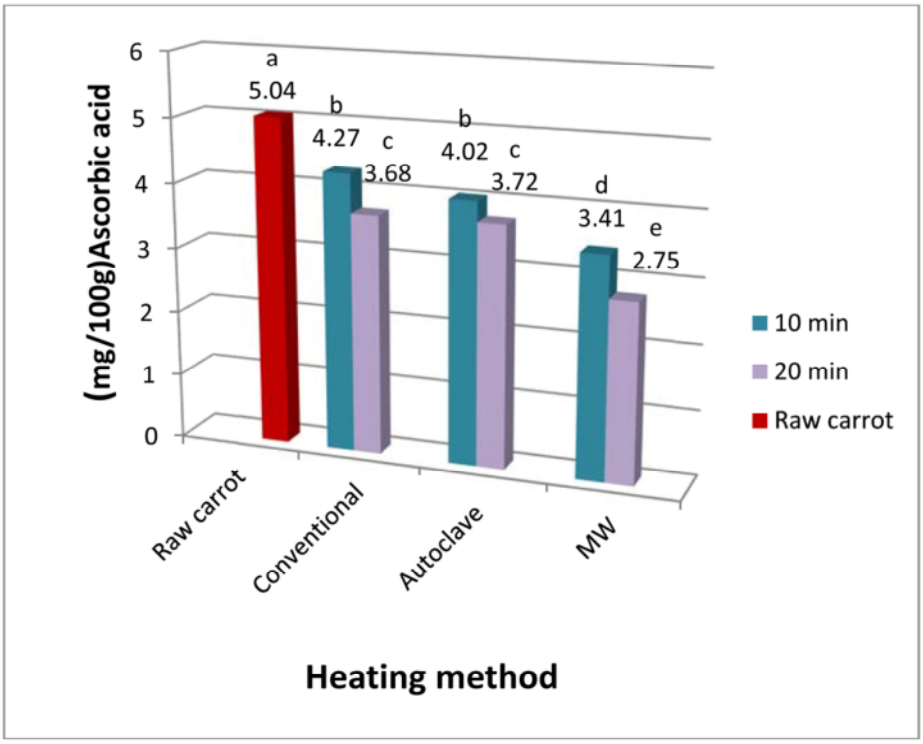

Fig. 1. Effect of different cooking methods on ascorbic acid content of carrot (mg/100g) (similar alphabets have no significant difference, p<0.05)

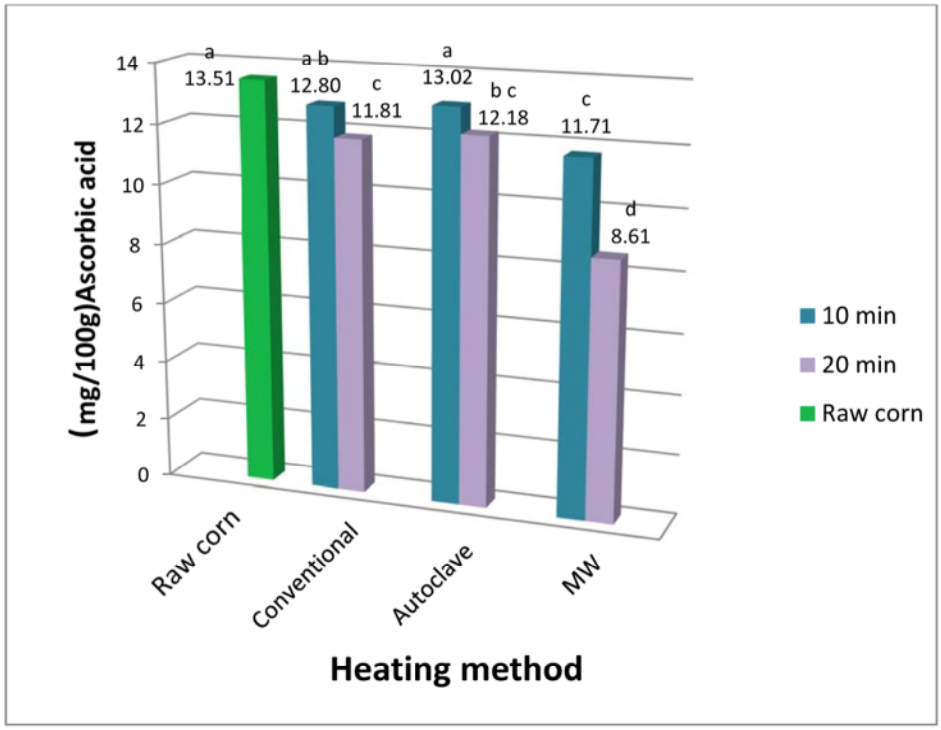

Fig. 2. Effect of different cooking methods on ascorbic acid content of corn (mg/100g) (similar alphabets have no significant difference, p<0.05)

Table 2. Percentage loss of ascorbic acid in carrot and corn during conventional, microwave and autoclave cooking for 10 and 20 minutes

Cooking Method	Time (minutes)	Percentage Loss of Ascorbic acid	
		Carrot	Corn
Conventional	10	15.27	5.27
	20	26.93	12.61
Autoclave	10	20.26	3.66
	20	26.32	9.86
Microwave	10	32.46	13.30
	20	45.35	36.23

Conclusion

In general water soluble vitamins are reduced and lost during washing, preparation and preservation such as canning, freezing, dehydration, cook freezing and cook chilling procedures. Ascorbic acid is a vital and important micronutrient that acts as a reducing agent and when oxidized is changed to dehydroascorbic acid. Both forms have important role in food industry and nutrition. Different methods of food preparation act differently on the preservation of this micronutrient. In this research work conventional procedure for 10 and 20 minutes were compared to both microwave and pressure cooking procedures for the same periods of treatments and it was concluded that all the cooking procedures affected this reducing agent but microwave cooking particularly for 20 minutes had a sever destruction effect on this micronutrient present in both carrot and corn.

References

AOAC. (1980). Official Method of Analysis of the Association of Official Analytical Chemists, 13th edn, (edited by W. Horowitz) p. 336. Washington, DC. AOAC.

Ball, G. (2006). Vitamins in Foods, Analysis, Bioavailability and Stability. CRC Press.

Bernhardt, S. & Schlich, E. (2005). Journal of Food Engineering. 327–333.

Cameron, E. P. & Leibovitz, B. (1979). Ascorbic Acid and Cancer: A Review. American Association for Cancer Research, 663-681.

CRC Press. (2006). Vegetables and fruits – Nutritional and Therapeutic values .

Fatemi, H. (1378). Food chemistry. Published in Tehran. 475.

Khatoon, N. & Prakash, J. (2006). Nutrient retention in microwave cooked germinated legumes. Journal of Food Chemistry. 115–121.

Lesˇkova, E., Kova´, J., Ikova´, E., Kosˇicka´, M., Porubska´, J. & Holcˇı´kova, K. (2003). Vitamin losses: Retention during heat treatment and continual changes expressed by mathematical models, Journal of Food Composition and Analysis, 252–276.

Macance and Widdowson's. (1993). The composition of foods-5th rev. and extended, Cambridge, UK: Royalsociety of chemistry: Ministry of Agriculture, Fisheries and food.

Okzan, A., Akbudak, B. & Akbudak, N. (2005). Microwave drying characteristics of spinach, Journal of Food Engineering, 577–583.

Ottaway, P. B. (1993). The Technology of Vitamins in Food. Published by Blackie Academic & Professional, an important of Chapman & Hall.

Pearson, D. (1973). Laboratory Techniques in Food Analysis. Fric, First Published.

Singh, G., Kawatra, A. & Sehgal, S. (2000). Nutritional composition of selected green leafy vegetables, herbs and carrots. Plant Foods for Human Nutrition, 359–364.

Somogyi, J. C. & Muller, H. R. (1989). Nutritional Impact of Food Processing.

Published by The Group of European Nutritions .

Vallejo, F., Toma´s-Barbera´ n, F. A. & Garcı´a-Viguera, C. (2002). Glucosinolates and vitamin C content in edible parts of broccoli florets after domestic cooking. European Food Research and Technology, 215, 310–316.

www.wikipedia-corn.com. 2010