Dietary Anticarcinogens and Antimutagens

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Edited by

I.T. Johnson and G.R. Fenwick
Institute of Food Research, Norwich, UK

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Minimal Processing of Fruit and Vegetables: Influence on Concentration and Activity of Some Naturally Occurring Antioxidants in Orange Derivatives

M.C. Nicoli,[1] A. Piga,[1] V. Vacca,[1] F. Gambella,[1] S. D'Aquino[2] and M. Agabbio[1]

[1] DIPARTIMENTO DI SCIENZE AMBIENTALI AGRARIE E BIOTECNOLOGIE AGRO-ALIMENTARI, UNIVERSITÀ DEGLI STUDI DI SASSARI, VIALE ITALIA 39, 07100 SASSARI, ITALY
[2] ISTITUTO PER LA FISIOLOGIA DELLA MATURAZIONE E DELLA CONSERVAZIONE DEL FRUTTO DELLE SPECIE ARBOREE MEDITERRANEE, CNR, VIA DEI MILLE 48, 07100 SASSARI, ITALY

1 Introduction

Nutritional factors are widely proved to be critical for human health. Overwhelming, evidence from epidemiological studies showed that diets rich in fruit and vegetables are associated with a reduced risk of degenerative diseases.[1] This is attributed to the fact that these foods may provide an optimal mix of phytochemicals, such as antioxidants and their precursors.[2] However, it is widely recognised that the health promoting capacity of fruit and vegetables strictly depends on their technological history. Processing is expected to affect content, activity and bio-availability of naturally occurring antioxidants. Although some experimental evidence has recently demonstrated that processing may have many effects, not always resulting in a loss of the health promoting capacity of fruit and vegetables, uncertainty still exists about the effective incidence of the various technological steps.[3] This aspect, which is generally neglected or scarcely considered in present nutritional and epidemiological studies, is of great importance, considering that only a small amount of fruit and vegetables are consumed as fresh, whilst most of them need to be processed for safety, quality and economic reasons.[4] Thus, investigation on the effects of processing on the activity of naturally occurring antioxidants is a key factor in order to find out the best technological conditions for preserving the

above cited beneficial properties and to achieve a correct interpretation of data on dietary habits and human health.

In the present investigation fresh and pasteurised orange juices, chosen by virtue of their high content in naturally occurring antioxidants and their widespread consumption, were considered. The changes in ascorbic acid concentration and in the overall antioxidant properties during juice preparation and storage, the latter carried out under different temperature conditions, were studied.

2 Materials and Methods

The study was carried out using fresh Italian oranges (*Citrus sinensis* L. cv. Salustiana) which were squeezed and immediately bottled in screw capped flasks in presence of air. Samples of fresh orange juice were than stored under refrigerated conditions (4 °C). Additional samples were subjected to pasteurisation in a water-bath at 90 °C for 9 minutes and than stored at 20 °C. Ascorbic acid was measured following the AOAC methodology.[5] The antioxidant activity of the aqueous phase of the samples was assessed following the bleaching rate of a stable polar radical $DPPH^{\bullet}$, as previously described.[6] The redox potential was measured using a platinum indicating electrode and a Ag/AgCl, Cl^{-}_{sat} reference electrode connected with a voltmeter. Total polyphenol content was assessed following Folin-Ciocalteu methodology.

3 Results and Discussion

Table 1 shows changes in ascorbic acid concentration measured in fresh orange juice samples during chilled storage. Although samples were bottled in presence of air, a moderate loss in ascorbic acid which did not exceed 12% was detected up to 15 day storage.

In Figure 1 the changes in the overall antioxidant capacity of the aqueous phase of the fresh orange juice as affected by storage is reported. It is interesting to observe that despite the slight reduction in ascorbic acid concentration, an

Table 1 *Changes in ascorbic acid concentration (expressed as mg g^{-1} of dry matter) of fresh orange juice during storage at 4 °C*

Storage time (days)	*Ascorbic acid (mg g^{-1}_{dm})*
0	5.03 ± 0.07
1	4.71 ± 0.03
4	4.80 ± 0.03
7	4.50 ± 0.02
11	4.52 ± 0.02
15	4.44 ± 0.03

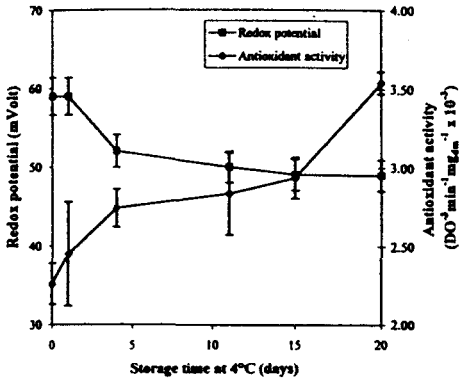

Figure 1 *Evolution of the antioxidant capacity and of the redox potential of fresh orange juice during chilled storage*

increase in the overall antioxidant properties of the product was detected. These results were also confirmed by the progressive reduction of the redox potential, indicating an increase in the reducing properties of the product.

Although ascorbic acid is the predominant identifiable antioxidant in orange juice, it is likely that other antioxidants such as polyphenols may play a significant contributory role. In particular, it has been recently observed that polyphenols constituents, by virtue of their antioxidant capacity, exhibit an ascorbate-sparing effect.[7] The progressive oxidation of polyphenols, whose concentration in the samples was found to be of 8.2 mg g^{-1} of dry matter, can explain the increase in the antioxidant properties of the fresh orange juice within 15 days of cold storage.

In fact, it has been recently stated that some polyphenols can exhibit, for intermediate oxidation level, higher radical scavenging efficiency than the non-oxidised ones. However, as the oxidation proceeds to the final stage, a progressive further loss in the antioxidant properties has been detected, due to the decreased ability of polyphenols, in their polymeric oxidised structure, to donate a hydrogen atom and/or to support an unpaired electron.[8–10] The changes in the antioxidant properties as well as in ascorbic acid concentration of orange juice samples subjected to pasteurisation and further storage at room temperature are shown in Figure 2.

It can be noted that, despite the dramatic decrease in ascorbic acid concentration, a moderate reduction in the antioxidant capacity, which did not exceed 30%, was detected. Results suggest that different and opposite events could be involved in determining the observed moderate changes in the antioxidant activity of the pasteurised orange juice. Considering the quantitative predominant role of ascorbic acid in determining the overall antioxidant capacity of the orange juice, it is likely that the expected dramatic loss in the antioxidant capacity, due to ascorbic acid thermal degradation, could be counterbalanced by the increased antioxidant ability of some partially oxidised polyphenol.

In conclusion, the changes in the antioxidant properties of orange juice

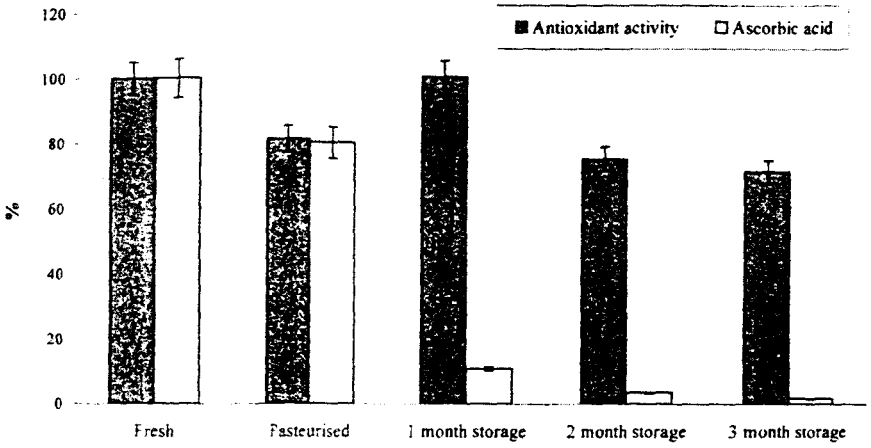

Figure 2 *Changes in ascorbic acid concentration and evolution of the antioxidant capacity of orange juice samples as affected by pasteurisation and storage. Data are expressed as a percentage referred to the fresh orange juice*

subjected to different technological conditions were found to be scarcely related to the content in ascorbic acid. Results would confirm the ascorbate-sparing effect of other minor naturally occurring antioxidants and suggest the role of these compounds in the maintenance of high values of antioxidant capacity, even after intense technological treatments. According to recent literature data, these effects could be mainly attributed to the polyphenol constituents.

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