

Stability of the vitamin C content of commercial orange juice

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Seven brands of orange juice have been analysed for their ascorbic acid content over a 14-day period during which they were handled under conditions similar to the home. The ascorbic acid content was found to decrease slightly during storage, with the loss of ascorbic acid being dependent on the handling method used. Six of the brands tested contained sufficient ascorbic acid at the end of the study to approximately meet the minimum requirements for unopened juice.

Advertisements for orange juice usually describe the product as a source of vitamin C necessary to meet human daily requirements. This claim is based on a minimum vitamin C content of 40 mg/100 mL juice (National Health and Medical Research Council 1975). Since ascorbic acid is a rather unstable substance, undergoing aerobic oxidation catalysed by cupric, silver, ferrous and stannous ions (György & Pearson 1967), it is possible that the ascorbic acid level of orange juice will be dependent on the rate of consumption of the juice, the method of handling and storage and the nature of preservatives used.

The stability of ascorbic acid in beverages has been studied for a wide variety of products and containers. Conditions of storage and their effect on ascorbic acid stability were investigated (Bissett & Berry 1975) and it was found that the temperature of storage and the type of container used influenced ascorbic acid retention. Further studies have indicated that ascorbic acid stability in reconstituted orange juice was not dependent on refrigeration (Lopez, Krehl & Good 1967) or the amount of light reaching the sample, but that storage time after reconstitution was the most important factor (Andrews & Driscoll 1977). A comparison of ascorbic acid retention in naturally derived orange juice and reconstituted juice (Beston & Henderson 1974) showed that ascorbic acid stability was similar in both products. This study also demonstrated that the loss of ascorbic acid was accompanied by an increase in the level of dehydroascorbic acid (which is an active form of vitamin C) except in canned orange juice, where the presence of metal ions was believed to catalyse further degradation of dehydroascorbic acid. It has also been reported (Haddad 1977) that the ascorbic acid content of preservative-free juices was somewhat less stable than that of juices containing preservatives. The present study reports on the stability of ascorbic acid in a range of commercial juices when the juice is stored and handled under conditions similar to those encountered in the home. The manufacturers of the juices sampled had used a variety of preservation methods and several different types of containers.

The juice was analysed for ascorbic acid by a titrimetric procedure using 2,6-dichlorophenolindophenol (2,6-DPIP) as titrant and as indicator. This reagent reacts with ascorbic acid via a redox process, and the titration is therefore susceptible

to error from other mild reducing agents present in the solution, especially SO_2 , which is sometimes used as a preservative in the juice. The interference of SO_2 can, however, be masked by addition of a small amount of formaldehyde which does not interfere in the 2,6-DPIP titration. This titrimetric procedure was selected as the analytical method in view of the large number of analyses required — up to 70 per day. The inherent errors in the method are of limited significance in a study as this where comparison of results, rather than their absolute magnitude, forms the basis of any conclusions reached.

Materials and methods

Seven brands of juice were selected as being representative of the range of containers and preservatives used by juice manufacturers and details of these products are listed in Table 1. Two one litre containers of each juice were purchased and decanted separately into two sealed glass or PVC storage vessels, labelled A and B, and stored in a refrigerator at 3°C. All the samples labelled A were swirled gently and inverted twice daily, whereas those labelled B were shaken vigorously for 5 sec twice daily. This procedure was adopted so that the effect of different handling procedures on ascorbic acid stability could be determined.

Samples were treated as follows before titration. A 70 mL aliquot of juice was poured from the container, 0.2 g of oxalic acid added and the juice gently swirled. The sample was then filtered using Celite as filter aid and 5 mL aliquots of filtered juice were pipetted into conical flasks and 30 mL of distilled water added. For brands 4, 5 and 7 (which contained SO_2), 2 mL of a 1:1 mixture of 40% formaldehyde and 2M H_2SO_4 was also added to each aliquot before titration. Solutions were titrated with 10^{-3}M 2,6-DPIP which was standardised daily with freshly prepared 10^{-3}M ascorbic acid solution. Samples of group A and group B were analysed on alternate days over a 14-day period, with at least five replicate titrations being performed for each daily analysis.

Results and discussion

The results are shown in Table 1 which lists the initial and final concentrations of ascorbic acid over the course of the study. More detailed data are not deemed necessary since the decrease in concentration with time was approximately linear in all cases. The precision of the titrimetric procedure was found to be good, with an average relative standard deviation of 1.12% for the replicate titrations performed each day. It was also observed that the concentrations of ascorbic acid initially

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Table 1. Stability of the ascorbic acid content of commercial orange juices

Brand	Packaging	Preservative present	Handling method*	Ascorbic acid content (mg/100 mL)		
				Initial†	Final‡	Loss
1	Tinplate	None	A	53.0	46.5	6.5
			B	56.7	46.5	10.2
2	Cardboard carton, coated	None	A	44.9	41.1	3.8
			B	45.0	39.0	6.0
3	PVC	None	A	65.5	54.5	11.0
			B	62.1	48.4	13.7
4	PVC	Sorbic acid, calcium sorbate, SO ₂ , trace	A	43.7	40.4	3.3
			B	42.5	38.3	4.2
5	Cardboard carton, coated	Sorbic acid, benzoic acid, SO ₂ , trace	A	71.6	67.4	4.2
			B	73.1	60.3	12.8
6	PVC	Sorbic acid, sodium benzoate	A	44.4	38.3	6.1
			B	51.2	42.3	8.9
7	PVC	Sodium benzoate, SO ₂	A	29.5	24.6	4.9
			B	27.5	22.0	5.5

*Method A involved daily gentle swirling, Method B involved daily vigorous shaking

†Measured immediately after opening purchased juice

‡Measured after 14 days storage; decrease was approximately linear with time over the 14 day period

present in the two containers of each brand were in close agreement (except for brand 6) and that all brands (except brand 7) complied with the minimum ascorbic acid content of 40 mg/100 mL juice when the container was first opened, although the content in some samples fell below this level after 14 days.

The loss of ascorbic acid was greatest when the juice was shaken vigorously each day; however, all of the brands tested (except brand 7) contained sufficient ascorbic acid at the end of the study to approximately meet the minimum requirement for the juice when sold. It is not justifiable to relate the results obtained to the nature of the preservatives and packaging used because of the additional unknown variable of conditions of storage before the juices were examined. Effects of poor storage conditions on orange juice quality may continue after the conditions have been improved, therefore, it is not safe to compare juices without knowledge of their previous history. This point is emphasised by the low ascorbic acid content of brand 7 juice, marketed by a company with a good reputation in the industry.

Conclusions

The ascorbic acid content of the commercial orange juices tested was relatively stable over a two-week period, however, stability was dependent to some extent on the method of shaking adopted to mix the juice. The results obtained indicated that the majority of juices tested remained satisfactory sources of ascorbic acid over the storage period.

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