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Ascorbic acid content of commercial fruit juices and its rate of loss upon storage

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Abstract

Ascorbic acid content of commercial fruit juices and its rate of loss with respect to time and temperature of storage were determined. Ascorbic acid content of commercial fruit juices ranged from 2.4 to 43 mg/100 ml of juice. Storage of commercial fruit juices in closed containers at room temperature for 4 months resulted in ascorbic acid losses ranging from 29 to 41%. Commercial orange juice when stored in open containers in the refrigerator for 31 days lost 60 to 67% of its ascorbic acid while fresh orange juice lost ascorbic acid at the much slower rate of 7 to 13%. Open containers of commercial fruit juice, when stored outside the refrigerator for 10 days, lost 12.5% of their ascorbic acid content, while refrigerated for the same period, the ascorbic acid losses amounted to 9%.

Keywords: Ascorbic acid; Fruit juices; Storage

1. Introduction

Fruit juices are a significant source of ascorbic acid for humans and their consumption in the last years increased at very quick rates. However, ascorbic acid of fruit juices is readily oxidized and lost during staying of the juices, at rates depending on the conditions of storage. It is evident therefore that the quality of any fruit juice and its value as a source of vitamin C depends on its content and its rate of loss upon staying. There are many studies for determining the ascorbic acid content in fruit juices (Finley & Duang, 1981; Karayannis & Farasoglou, 1987; Ozgur & Sungur, 1995) but only a few aiming at determining the amounts of ascorbic acid lost from different fruit juices under different storage conditions (Haddad, 1977; Jova & Yankov, 1986). This fact is of great importance to the consumer who must know how to store the juice containers and when to consume them in order to get the maximum benefit of their vitamin C content. The objectives of this work were: (a) to determine the ascorbic acid content of several commercial fruit juices and (b) to measure the amount of ascorbic acid lost under different storage conditions, namely, open and closed containers, storage in the refrigerator and at room temperature.

2. Materials and methods

2.1. Reagents

The reagents were ascorbic acid, sodium dichlorophenolindophenol 0.04% aqueous solution, oxalic acid 0.4%, potassium iodide *50%,* HC1 1 N, sodium thiosulphate 0.0 1N, starch as indicator. All reagents were of analytical grade.

2.2. Fruit juices

Long-life commercial fruit juices, without preservatives: orange 100%, grapefruit 100%, cocktail A 100% (orange, peach, grapefruit, pineapple, apple, mango, kiwi), lemon 17%, cocktail B 50% (orange, apple, apricot). For the recovery experiment the following juices were used: grapefruit A 100%, orange A 100%, orange 50%, orange 30%, cocktail C 50% (apple, orange, apricot, peach, grapefruit, pineapple).

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Short-life commercial fruit juices (refrigerated) without preservatives: orange 100%, lemon 9%.

Fresh fruit juice: Orange.

2.3. Ascorbic acid determination

The method of Lees (1975) was employed, which involves the following steps:

a. A 10 ml aliquot of sample is placed into a 100 ml volumetric flask and brought to volume with 0.4% oxalic acid solution.
b. The solution is filtered through a Whatman No. 4 filter paper.
c. A 10 ml aliquot of the filtered solution is pipetted into a conical flask along with 15 ml of 0.4% oxalic acid solution.
d. Solution in (c) is titrated, using a microburette, with 0.04% aqueous sodium dichlorophenolindophenol solution to the first pink shade.

The sodium dichlorophenolindophenol solution is standardized with sodium thiosulfate 0.01 N, in a matrix of potassium iodide (50%) and HCl 1 N using starch as indicator. This titration method only determines ascorbic acid and not dehydroascorbic acid (DHAA). The normal level of DHAA, in commercial orange juice, however, ranges from 0 to 0.2% relative to ascorbic acid level (Nisperos-Carriedo, Busling & Shaw, 1992) and therefore the error that is introduced in assessing vitamin C activity is negligible.

3. Results and discussion

3.1. Standard ascorbic acid solution

Accuracy and precision of the titration method for ascorbic acid determination was tested by running analysis of standard solutions prepared from ascorbic acid, pro analysi reagent. The results are presented in the form of correlation analysis in Fig. 1. The coefficient of correlation was 0.9999, significant at the 0.1% level of confidence and the linear regression equation had an intercept and slope values equal to 0 and 1, respectively. A known amount of ascorbic acid was added to various commercial fruit juices and the recovery was tested using the titration method and seven replicates of each fruit juice. The data showed satisfactory reproducibility and recovery (Table 1).

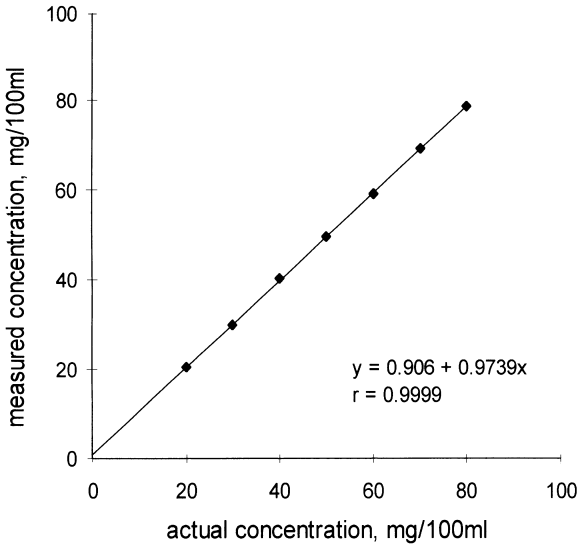

Fig. 1. Correlation of ascorbic acid actual (x) vs measured (y) concentrations, determined by the titration method used.

Both results provided strong evidence that the titration method is accurate and reliable for the routine determination of ascorbic acid in fruit juices.

3.2. Fruit juices

Two experiments were conducted. In the first experiment, ascorbic acid content of several kinds of juices was determined and is shown in Tables 2 and 3. The days before the expiration date are also shown (Tables 2 and 3) in order to make the comparison between the values meaningful, since the concentration of ascorbic acid in the juice depends on the period of staying. So, a loss of ascorbic acid is observed in short-life orange juice 100%, as the expiration date is approached (Table 3).

In the second experiment, the loss of ascorbic acid at definite time periods and at different storage temperatures

Table 1
Reproducibility and recovery of ascorbic acid to samples of various commercial fruit juices, using the titration method

Fruit juices			Ascorbic acid		
Sample	Mean value[a] mg/100 ml	CV	Added	Found	% Recovery
Grapefruit A 100%	41.1	2.28	5 mg/100 ml in all	45.6	98.9
Orange A 100%	33.4	1.41	samples	37.7	98.1
Orange 50%	22.7	1.18		27.7	98.1
Orange 30%	15.2	3.90		19.7	97.5
Cocktail C	6.5	4.96		11.1	96.5

[a] Seven replicates.

Table 2
Ascorbic acid content of long-life commercial fruit juices

Juice	Days before expiration	Ascorbic acid (mg/100 ml)
Orange 100%	161	42.4
Grapefruit 100%	161	43.4
Cocktail A	170	13.5
Cocktail B	245	16.0
Lemon 17%	328	7.1

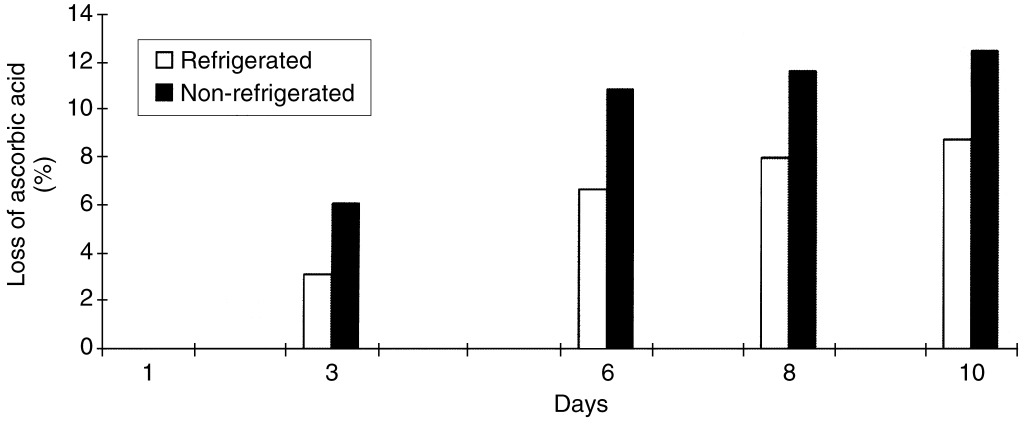

Fig. 2. Comparison of ascorbic acid loss in commercial orange juice remaining in and out of the refrigerator.

was determined. In Table 4 the loss of ascorbic acid during a storage period of 4 months in closed containers at room temperature is shown. Containers from the same lot of each kind of juice were used for this determination. After the initial measurement of ascorbic acid content, closed containers from each juice were kept at room temperature for 4 months and then opened for the respective measurement. It is seen that in dilute lemon juice, losses of ascorbic acid can be as high as 41.4% while in more concentrated juices the losses are lower.

Table 5 shows the loss of ascorbic acid from fresh and long-life commercial orange juice 100% during a 31 day period, with measurements made every 1 to 3 days. The samples were refrigerated into containers which after the initial measurement remained either open or with closed cup until the next measurement. The magnitude of ascorbic acid loss did not differ significantly between open and closed cap containers for both juices. In contrast, when ascorbic acid losses between the two juices are compared it becomes evident that upon staying, commercial orange juice can lose high amounts of ascorbic acid (60–67%) whereas in fresh orange juice these losses are kept to a minimum (7–13%). As Nisperos-Carriedo et al. (1992) reported, decreases of ascorbic acid upon storage did not correspond to increases in DHAA levels. In fact, while ascorbic acid in aseptically packaged orange juices (similar to those of this study) decreased from 34.1 mg/100 g to 20.4 mg/100 g, DHAA levels increased from 0 to 1.3 mg/100 g. This means that the overall nutritional quality of orange juices is affected upon storage.

Finally, the losses of the ascorbic acid content in a commercial long-life orange juice 100% stored in and out of the refrigerator for a period of 10 days in open containers (after a 10 day staying out of the refrigerator, the juice deteriorated considerably) were found to be 8.8 and 12.5%, respectively (Fig. 2).

Table 3
Ascorbic acid content of short-life commercial fruit juices and fresh orange juice

Juice	Days before expiration	Ascorbic acid (mg/100 ml)
Orange 100%	26	42.7
Orange 100%	8	38.9
Lemon 9%	8	2.4
Fresh orange juice	–	52.3

Table 4
Loss of ascorbic acid in long-life commercial fruit juices after storage for 4 months at room temperature in closed containers

Fruit juices	mg Ascorbic acid/100 ml		% Loss of ascorbic acid
	Initial	After 4 months	
Orange 100%	42.6	30.3	28.9
Lemon 17%	7.1	4.2	41.4
Cocktail B	16.0	10.5	34.4

Table 5
Loss of ascorbic acid in commercial and fresh orange juice, stored in the refrigerator for 31 days

Days	Commercial orange juice (100%)		Fresh orange juice	
	Open cap	Closed cap	Open cap	Closed cap
	Loss (%)			
1	0.00	0	0.00	0.00
2	4.51	4.51	0.00	0.00
3	5.89	5.67	0.76	0.57
4	9.63	9.47	1.13	0.90
7	11.74	11.29	1.88	1.57
9	13.04	11.84	2.54	1.78
11	15.45	13.04	3.85	2.05
14	25.49	22.20	4.07	2.53
16	29.27	26.92	4.63	2.81
18	33.04	30.45	5.10	3.68
21	44.05	38.05	5.97	4.42
24	51.08	44.9	8.17	4.63
28	60.41	54.75	12.25	6.45
31	67.39	60.41	13.27	7.03

4. Conclusion

Ascorbic acid content of commercial fruit juices ranged from 2.4 to 43 mg/100 ml of juice. Loss of ascorbic acid from different commercial fruit juices stored in closed containers for a period of 4 months at room temperature ranged between 29 and 41%. When the containers are opened for consumption and then stored in the refrigerator for 31 days, commercial orange juice 100% can lose up to 60–67% of its ascorbic acid whereas under the same conditions, ascorbic acid losses from fresh orange juice are much lower (7–13%). When open containers of commercial orange juice were kept outside the refrigerator for 10 days, ascorbic acid losses were as high as 12.5%, decreasing to about 9% if the containers were refrigerated for the same period.

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