

Ascorbic Acid and Element Contents of Foods of Trabzon (Turkey)

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The ascorbic acid (or vitamin C) content of the fruits and vegetables grown in the district of Trabzon (Turkey) was determined by UV–vis spectrophotometry. Fe, Cu, and Zn contents of the same materials were measured by atomic absorption spectrophotometry, and a comparison was made between the values of local and imported produce.

Keywords: *L-Ascorbic acid; iron; copper; zinc; determination; dry-ashing; atomic absorption; spectrophotometry; vegetable; fruit*

INTRODUCTION

Fruits and vegetables are the major sources of vitamin C in diets. The principal biologically active form of vitamin C is ascorbic acid; its primary oxidation product, L-dehydroascorbic acid, is also active; however, its level is generally low. One of the principal biochemical reactions of L-ascorbic acid, the molecule responsible for preventing scurvy, is to destroy toxic free radicals (hydroxyl and perhydroxyl) resulting from the metabolic products of oxygen. The uses of L-ascorbic acid, including those in foods, continue to increase because of the compound's vitamin C activity, useful properties, and low toxicity. Total synthesis of L-ascorbic acid has been made by means of a sequence of reactions (Eckert-Maksic et al., 1985).

On the other hand, each of the elements copper, iron, and zinc is considered to be essential to animal and human physiology. Copper, although possessing an emetic action in large doses, is essential for growth. Iron is found in hemoglobin, which has a major role in the transfer of oxygen, myoglobin, and cytochromes. Main sources of iron in the diet are liver, meats, eggs, cereals, and dried fruit. Zinc is found to be involved in enzymatic oxidation processes in the human body (Crawford, 1982; Liao, 1988).

The aim of this work was to determine the ascorbic acid, Fe, Cu, and Zn contents of the vegetables and fruits grown in the district of Trabzon (Turkey) and to compare these with the values obtained for imported produce from Adana, which is located in the Mediterranean region of Turkey.

MATERIALS AND METHODS

Apparatus. Deionized water was obtained from doubly distilled water passed through an ion exchanger and used throughout the experiments. Ascorbic acid determinations were performed by a Carl-Zeiss PM 4 UV–vis spectrophotometer at 520 nm. For the determination of Cu, Fe, and Zn a Perkin-Elmer Model 403 atomic absorption spectrophotometer assembled with a 10 cm air–acetylene burner head and single-element hollow cathode lamps were used for all elements.

Reagents. All of the reagents used were purchased from Merck AG (Darmstadt, Germany): oxalic acid solution (w/v, 0.4% in water); stock ascorbic acid solution (1000 ppm in oxalic acid solution); acetate buffer solution (300 g of anhydrous sodium acetate + 700 mL of deionized water + 1000 mL of

glacial acetic acid); 2,6-dichlorophenolindophenol disodium salt (DCPI) solution (12 mg of salt in 1000 mL of deionized water).

Working Standards. Standard solutions (10, 20, 30, 40, and 50 ppm) were prepared from stock ascorbic acid solution by diluting with oxalic acid solution.

Stock Fe³⁺ Solution (1000 ppm, Prepared from FeCl₃·6H₂O): stock Cu²⁺ solution (1000 ppm, prepared from CuCl₂·2H₂O); stock Zn²⁺ solution (1000 ppm, prepared from Zn stick).

Working Standards. For Fe and Cu, 1, 2, 3, 4, 5; and for Zn, 0.2, 0.4, 0.6, 0.8, and 1.0 ppm solutions were prepared from stock solutions.

Determination of Ascorbic Acid. All of the samples were obtained freshly from the village's market (as local produce) and from the central fruit and vegetable market (as imported) of Trabzon (Turkey). To the edible portions of the samples of a certain amount sliced were added equivalent weights of oxalic acid solution (w/v, 0.4%), and the mixture was then homogenized in an electrical high-speed homogenizer. A certain amount of homogenized mixture was diluted with oxalic acid solution (10 g of food material/50 mL). According to the ascorbic acid contents of the samples, more diluted or more concentrated solutions were prepared. The mixture was then filtered.

The instrument was adjusted to zero using deionized water. The absorbance of oxalic acid solution (1 mL) + acetate buffer solution (1 mL) + DCPI solution (8 mL) was recorded exactly at the end of 15 s. This value was noted as L_1 . Then, the instrument again was adjusted to zero with a mixture of standard ascorbic acid solution of 10 ppm (1 mL), acetate buffer solution (1 mL), and deionized water (8 mL). Soon after, the absorbance of standard ascorbic acid solution (1 mL) + acetate buffer solution (1 mL) + DCPI (8 mL) was recorded as L_2 . Here, L_1 is the absorbance of all DCPI, and L_2 is the absorbance value of the remaining DCPI after its reaction with ascorbic acid. L_2 values were similarly recorded for the other standard ascorbic acid solutions (20, 30, 40, and 50 ppm). $L_1 - L_2$ values are the absorbances of each working standard. The calibration graph was constructed by plotting the absorbance values versus concentration (ppm) of standard ascorbic acid solutions (Pearson, 1976; Bajaj and Kaur, 1981; Muralikrishna and Murty, 1989; Pandey, 1982).

For the absorbance measurements of the sample solutions, zero adjustment was done by means of a mixture of sample solution (1 mL), acetate buffer (1 mL), and deionized water (8 mL). The absorbance of sample solution (1 mL) + acetate buffer (1 mL) + DCPI (8 mL) was recorded exactly after the addition of DCPI at the end of 15 s. This is the L_2 value of the sample solution. $L_1 - L_2$ values represent the absorbance of the sample. From the calibration graph, the ascorbic acid concentration of the sample was determined. All of the measurements were recorded at 520 nm. The ascorbic acid contents of the 17 local and imported food materials are given in Table 1.

Determination of Cu, Fe, and Zn. *Sample Preparation.*

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Table 1. L-Ascorbic Acid, Fe, Cu, and Zn Contents of the Fruits and Vegetables (Results Expressed on Fresh-Weighted Basis as Milligrams per 100 g)^a

foodstuff	botanical name	moisture (%)			L-ascorbic acid			Fe			Cu			Zn		
		I ^b	L ^b	lit. ^b	I	L	lit.	I	L	lit.	I	L	lit.	I	L	lit.
green pepper bitter	<i>Capsicum annum</i>	97.1	96.6		145	85		0.45	0.93		0.00	0.01		0.29	0.27	
green pepper sweet, for stuffing		97.4	97.4		104	95		0.55	1.17		0.01	0.05		0.21	0.39	
potato	<i>Solanum tuberosum</i>	77.6	75.4	75.8–77.8	25	20	17–30	0.82	0.78	0.7	0.21	0.22	0.16	0.28	0.39	0.2
green bean	<i>Phaseolus vulgaris</i>	90.9	90.8	88.9–91.6	20	15	19–20	1.14	1.29	1.1	0.16	0.16		0.58	0.13	
marrow	<i>Cucurbita pepo</i>	92.3	93.7		14	9		0.50	0.61		0.07	0.22		0.34	0.57	
peach	<i>Prunus persica</i>	87.2	84.4	86.2–86.9	12	8	8	0.32	0.54	0.6	0.06	0.15		0.09	0.16	
pear	<i>Pirus communis</i>	84.0	81.7	82.7–83.4	6	3	3–4	0.29	0.36	0.3–0.4	0.11	0.18	0.13	0.19	0.16	0.16
corn	<i>Zea mays</i>	85.9	85.9		6	4	12	0.56	0.91	0.5–3.6	0.14	0.49	0.45	0.47	1.41	2.5
grape	<i>Vitis vinifera</i>	81.4	80.9	79.3–81.6	6	4.5	4	0.55	0.74	0.6	0.18	0.10	0.09	0.30	0.17	
tomato	<i>Solanum lycopersicum</i>	93.9	94.2	93.4–94.1	20	28	20–23	0.73	0.62	0.6	0.17	0.09	0.09	0.06	0.15	
apple	<i>Malus communis</i>	82.0	83.6	84.1–85.6	4	7.5	5	0.67	0.57	0.3	0.05	0.03		0.01	0.01	
fig	<i>Ficus carica</i>	85.5	85.7	84.6	1	2	2	0.87	0.78	0.8	0.25	0.14	0.06	0.23	0.31	0.25
quince	<i>Cydonia vulgaris</i>	84.0	83.8	84.0–84.2	13	13		0.31	0.33		0.21	0.28		0.54	0.32	
cucumber	<i>Cucumis sativus</i>	96.7	96.3	96.1–96.4	12	12	8	0.33	0.28	0.3	0.08	0.05		0.25	0.26	
carrot	<i>Daucus carota</i>	90.4	90.6	88.2–91.2	6	4	3–6	0.38	0.78	0.7–0.8	0.14	0.14		0.34	0.40	0.5–3.6
eggplant	<i>Solanum melongena</i>	94.4	95.9	92.7–93.4	4	4	5	0.51	0.41	0.4–0.5	0.19	0.05		0.39	0.34	
plum	<i>Prunus domestica</i>	86.6	85.1	84.1–85.7	1	1	3–5	0.37	0.45		0.13	0.07	0.09	0.20	0.18	0.03

^a Each value is a mean of three determinations. ^b L, local produce; I, imported produce; lit., values reported in the literature (Pearson, 1976; Lange, 1967; Keskin 1981).

Air-dried food material was kept in oven at 80 °C to a constant weight, and moisture percentages were estimated. Dried samples ground and thoroughly powdered were kept in a desiccator.

Destruction of Organic Matter. Dry-ashing procedure was applied (Rowan et al., 1982). The powdered samples were redried at 80 °C for 24 h. A 1 g portion of the samples was weighed on the Mettler analytical balance and placed in a nickel crucible. The samples were heated at 300 °C for 15 min in a muffle furnace; nickel lids were maintained half-covered. The temperature was increased gradually by keeping the furnace door open. After the smoking had stopped, heat was increased to 500 °C and fixed for 3 h. The resulting white ash was dissolved subsequently in HCl (5 mL, 20%) by heating gently for 30 min. A clear solution was filtered and diluted to a concentration suitable for the working range of the instrument. The wavelengths were 248, 325, and 214 nm for Fe, Cu, and Zn, respectively.

Determinations of Fe, Cu, and Zn have been done by flame atomic absorption spectrophotometric method (Demir et al., 1990; Evans et al., 1980; Heanes, 1981; Crosby, 1977; Robles and Lachica, 1971; Nielson et al., 1988) in which sample solutions were aspirated directly into flame. The instrument's linearity was determined as to 5 ppm for Fe and Cu and to 1 ppm for Zn. In addition, pH values of standard solutions and sample solutions were matched.

Because the triplicate measurement values are very close to each other, the sensitivity of the method used in analyses can be accepted as reliable.

RESULTS AND DISCUSSION

The ascorbic acid, Fe, Cu, and Zn contents of 17 fruits and vegetables analyzed by UV and atomic absorption spectrophotometry are given in Table 1. The values were compared for local and imported foodstuffs.

The iron contents of the local food materials such as green pepper (bitter), green pepper (sweet, for stuffing), green bean, marrow, peach, pear, corn, grape, and carrot were estimated higher than that of imported produce. The vitamin C level of these foodstuffs is lower. The Cu content of the local foodstuffs such as green pepper, marrow, peach, pear, corn was found higher than that of imported ones. The ascorbic acid content of these samples was lower than that of imported produce.

In a previous work (Mocan et al., 1990) it has been reported that Fe and Cu contents of the soil in the district of Trabzon, which is a central city and represents the Eastern Black Sea region of Turkey, were found to be higher than those of other regions. We expected that high Fe and Cu contents in the soil would

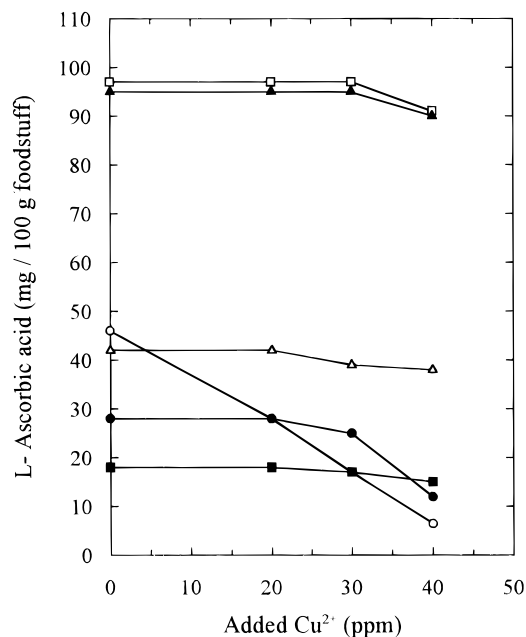
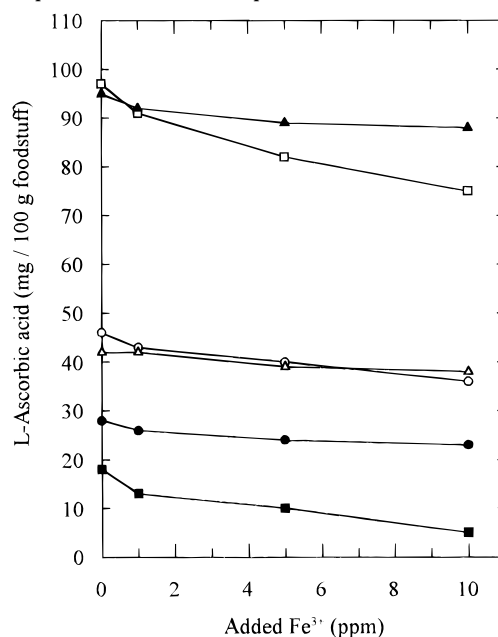


Figure 1. Effect of Fe and Cu on ascorbic acid contents: (○) lemon; (●) tomato; (□) cabbage; (■) radish (white); (△) spinach; (▲) sweet pepper.

cause the ascorbic acid amount in the fruits and vegetables grown in that region to decrease. It is well-known that metal ions such as Fe and Cu have destructive effects (Saublich et al., 1982) on ascorbic acid. We established these effects by adding Fe^{3+} and Cu^{2+} solutions to the solutions prepared from foodstuffs. Two hours after the addition of ion solutions, marked decreases in ascorbic acid contents of the food samples were observed. Results are given in Figure 1. It was determined that ascorbic acid contents decreased to lower values when the solutions were exposed to Fe^{3+} and Cu^{2+} for 1 day. However, in the case of Zn^{2+} addition to the sample solutions, there was no indication of any decrease in ascorbic acid concentrations.

The lower ascorbic acid contents of local food materials in comparison to that of imported ones, which are obtained from Adana (Mediterranean region of Turkey), seem to be consistent with the higher Fe and Cu contents of the soil of Trabzon. However, there were some exceptions. The ascorbic acid contents did not show any difference, although Fe and Cu contents in imported materials are a little higher.

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Received for review August 14, 1996. Revised manuscript received March 10, 1997. Accepted March 12, 1997.®

JF9606159

® Abstract published in *Advance ACS Abstracts*, May 1, 1997.