

# The Role of Fruit Drinks in Daily Diet of Some Osijek Inhabitants, Croatia

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## ABSTRACT

*The aim of the study was to assess the role of fruit drinks in daily diet of Osijek inhabitants. A special questionnaire was administered to 199 patients visiting a family physician's office during December 2003. The concentration of vitamin C (L-ascorbic acid) was determined in 42 commercially available fruit drinks. Only 11% (22/199) of study subjects did not take fruit drinks. The mean concentration of vitamin C in all samples was 150.10±166.83 mg/L. The questionnaire revealed that 89% (177/199) of study subjects using fruit drinks were taking a mean of 0.4 L of fruit drink per day, yielding a mean of 60.04 mg of vitamin C, i.e. 100% of the recommended daily allowance of 60 mg. Study results indicated fruit drinks to be a significant source of vitamin C in daily diet, however, great variation in vitamin C intake according to socioeconomic status of study subjects and type of fruit drink should be noted.*

**Key words:** vitamin C, L-ascorbic acid, fruit drinks, diet, Osijek, Croatia

## Introduction

Vitamin C or ascorbic acid belongs to the group of water soluble vitamins and vitamins with coenzymatic action. Vitamin C is one of the most important and thoroughly investigated vitamins. While first isolated and described around 1930, its important role had been recognized long before, at the beginning of the 16<sup>th</sup> century, when physicians, although unaware, detected the consequences of vitamin C deficiency when describing scurvy<sup>1</sup>.

Most living organisms synthesize vitamin C from D-glucose or D-galactose; however, humans lack this ability and are completely dependent on vitamin C intake by food<sup>2</sup>. According to the new Croatian by-law on foodstuffs for special dietary needs, released in June 2004, the recommended daily allowance (RDA) of vitamin C for healthy adults (men and women) is 60.0 mg per day<sup>3</sup>, while the minimal and maximal daily allowance is 9.0 and 350.0 mg per day, respectively. The main dietary form of vitamin C is L-ascorbic acid. Most fresh fruits

and vegetables are rich in ascorbic acid. L-ascorbic acid and its fatty esters are also used as additives in various foods, e.g., as antioxidants, preservatives, reduction substances, taste and color stabilizers. In Croatia, there is a by-law allowing such use of vitamin C in foodstuffs<sup>4</sup>.

In the east Croatian geographic region with Osijek as the largest city, the most important dietary sources of vitamin C are pepper, Brussels sprouts, strawberry, spinach, cabbage, Savoy cabbage, orange, lemon, mandarin and tomato. Besides these, due to the enormous marketing activities of various dietary supplement manufacturers and pharmaceutical industries, people of the upper socioeconomic group in Osijek often take vitamin C as a dietary supplement. The majority of Osijek inhabitants belonging to either middle or low socioeconomic group cannot afford these usually expensive dietary supplements, thus depending exclusively on vitamin C intake by food in daily diet. So, for this group of Osijek inhabit-

ants proper diet and proper selection of foodstuffs are essential for the intake of necessary micronutrients, considering that these foodstuffs should be rather inexpensive and rich in all the necessary healthy ingredients.

Vitamin C deficiency is today very rarely reported to cause scurvy, however, some other symptoms may occur, e.g., malaise, fast wearing, susceptibility to infections, arthralgia, etc. Vitamin C deficiency may be associated with dryness of the skin, capillaries prone to rupture, and retarded healing of wounds and fractures. In cold weather, even without physician's advice, most people who can afford it use to take extra amounts of vitamin C in diet or as dietary supplements, as an agent to protect them from cold or at least to relieve its symptoms<sup>1</sup>.

During the last few years, due to previously mentioned aggressive marketing activities launched by numerous pharmaceutical industries and dietary supplement manufacturers, various vitamin products available on the market have been presented as the only proper way to acquire adequate vitamin C body supply. This presumption, although completely wrong, is very hard to dispute in public. Following this ridiculous presumption, the majority of the people in Osijek have systematically neglected the use of many foodstuffs by which vitamin C is very easily and readily taken to human body.

As emphasized in numerous studies conducted in various countries, fruit drinks are rich sources of vitamin C in everyday life, particularly when consumed on a regular basis<sup>2,5–10</sup>. In spite of this, there also are reports claiming that health benefits of fruit drink consumption remain quite poorly understood<sup>2</sup>.

Therefore, we embarked upon the present study in an attempt to answer some interesting and yet poorly investigated questions, and to facilitate the public to participate more actively in improving their own health status by adopting healthy dietary habits with proper selection of foodstuffs. The main purpose of the study was to assess the level of vitamin C in various fruit drinks available on the Croatian market, daily use of fruit drinks among patients attending a general practitioner's (GP) office in Osijek, and their vitamin C intake with the fruit drinks consumed.

## Materials and Methods

### Materials

The study included 199 randomly selected (every fifth patient visiting GP office was included in the survey) patients attending a GP office in Osijek during December 2003. The patients were asked to fill out a special questionnaire on a voluntary basis. A total of 199 questionnaires were collected. Out of 199 subjects included in the study, 22 (11%) subjects who did not drink fruit drinks were excluded from further analysis. Among the remaining 177 (89%) subjects there were 108 (61%) female and 69 (39%) male subjects, mean age  $39.89 \pm 15.66$  (range 15–79) years. According to age groups, there were 42 (23.7%) subjects aged 15–24, 32 (18.1%) aged 25–34, 34

(19.2%) aged 35–44, 38 (21.5%) aged 45–54 years, 13 (7.3%) aged 55–64, and 18 (10.2%) aged  $\geq 65$ . According to occupation there were 42 (23.7%) pupils and students, 117 (66.1%) employed, and 18 (10.2%) retired subjects.

According to the reason for visiting the GP office, 45 (25.5%) subjects came for regular check up or counseling about their health, 54 (30.5%) for drug prescription and blood pressure control for their chronic disease (mostly hypertension and other circulatory disorders), and 78 (40.0%) for acute disease and injuries (mostly acute respiratory infections). None of these subjects used vitamin supplements.

According to the type of fruit drinks consumed daily, study subjects were divided into three groups: group 1 of 45 (25.4%) subjects drinking clear fruit drinks; group 2 of 99 (56.0%) subjects drinking thick fruit drinks; and group 3 of 33 (18.6%) subjects drinking pulpy fruit drinks.

### Questionnaire

An anonymous questionnaire was used to determine daily use of fruit drinks among patients attending the GP office in Osijek. The questionnaire contained questions on the subject age, sex, occupation (as a measure of socioeconomic status), reason for visiting GP office, type of the possible acute or chronic disease, consumption of vitamin supplements, average daily intake of fruit drinks, and type of fruit drink consumed.

### Analytical methodology

The most popular and most widely available 42 fruit drinks in Croatia were collected in grocery stores in the Osijek area. All specimens were classified into three categories of clear, thick and pulpy drinks, according to the By-Law on the Quality of Fruit, Vegetable and Mushroom Products and Pectin Products<sup>11</sup>. Of these 42 specimens, there were 17 (40.5%) clear, 15 (35.7%) thick, and 10 (23.8%) pulpy fruit drinks.

The concentration of L-ascorbic acid (vitamin C) in 42 specimens of commercially available fruit drinks was determined by the method of high-performance liquid chromatography (HPLC) with UV detector on a Varian instrument (Walnut Creek, USA, 1993)<sup>12</sup> with a UV/VIS Star 9050 detector and Star 9012 pump, in the following chromatography conditions: room temperature; Supelco-sil LC-18 column, 5  $\mu$ L, 250 mm x 4.6 mm, with Superguard LC-18 precolumn (20 mm x 4.6 mm); mobile phase 0.1% metaphosphorous acid; flow rate 1 mL/min; wavelength 243 nm; injection volume 20  $\mu$ L<sup>13</sup>; and limit of detection 0.10 mg/L.

Immediately upon opening, fruit drink specimens were prepared for injection. Clear and thick drinks were simply filtered through a 0.45- $\mu$ m membrane filter, whereas pulpy drinks were diluted 1:2 with metaphosphorous acid (2 g/L) and then filtered<sup>13</sup>. All specimens were injected within 15 minutes from opening and treatment. Dilutions and L (+)-ascorbic acid standard (Riedel-de-Haën) were also done with metaphosphorous acid and demineralized water in a Pure lab Ultra Genetic system (Elga, USA, 2002).

## Results

Study results are presented in Tables 1–5. The mean concentration of L-ascorbic acid in all fruit drink specimens was  $150.10 \pm 166.83$  mg/L. The mean concentration of L-ascorbic acid varied according to type of fruit drinks from  $121.91 \pm 211.10$  mg/L in clear fruit drinks through  $222.66 \pm 135.37$  mg/L in thick fruit drinks to  $89.26 \pm 68.39$  mg/L in pulpy fruit drinks. The difference was statistically significant (median test;  $\chi^2=8.682$ ;  $p=0.013$ ) (Table 1).

The study showed all study subjects to take a mean of 0.40 L fruit drink daily. The mean daily-pooled intake of vitamin C taken with fruit drinks was 60.04 mg, i.e. 100% RDA. Daily vitamin C intake varied according to type of fruit drink: clear fruit drinks (group 1) yielded a mean daily vitamin C intake of 48.76 mg (81.27% RDA),

thick fruit drinks (group 2) of 89.06 mg (148.43% RDA), and pulpy fruit drinks (group 3) of 35.70 mg (59.50% RDA) (Table 2).

Analysis of daily vitamin C intake with fruit drinks according to sex showed an intake of 48.76 mg (81.27% RDA) with clear fruit drinks in 14/69 (20.3%), of 89.06 mg (148.43% RDA) with thick fruit drinks in 40/69 (58.0%), and of 35.70 mg (59.50% RDA) with pulpy fruit drinks in 15/69 (21.7%) male subjects. In female subjects, the respective figures were recorded in 31/108 (28.7%), 59/108 (54.6%) and 18/108 (16.7%) subjects. There was no statistically significant sex difference ( $\chi^2=1.837$ ;  $p=0.399$ ) (Table 3).

Analysis of vitamin C intake with fruit drinks according to age groups showed the majority (52.4%–65.8%) of subjects from 15–24, 25–34, 35–44, 45–54 and 55–64 age

**TABLE 1**  
VITAMIN C CONCENTRATION IN SPECIMENS OF FRUIT DRINKS COMMERCIAALLY AVAILABLE IN THE OSIJEK AREA ACCORDING TO TYPE OF FRUIT DRINK

Type of fruit drink	Number of samples	Vitamin C concentration X±SD (mg/L)	Median	Statistical analysis <sup>a</sup>		
				>median ≤median		
				Clear	Thick	Pulpy
Clear	17	121.91±211.10 (0.10–675.70)		5 12	12 3	4 6
Thick	15	222.66±135.37 (15.10–431.20)	84.60	$\chi^2=8.682$ , $p=0.013$		
Pulpy	10	89.26 ±68.39 (16.70–267.00)				

<sup>a</sup> Median test

**TABLE 2**  
MEAN DAILY INTAKE OF VITAMIN C WITH FRUIT DRINKS ACCORDING TO TYPE OF FRUIT DRINK CONSUMED DAILY IN PATIENTS ATTENDING A GENERAL PRACTITIONER'S OFFICE IN OSIJEK

Group of study subjects	No. of subjects	Daily intake of vitamin C (mg/day)
Group 1 (clear fruit drinks)	45	48.76 (81.27% RDA)
Group 2 (thick fruit drinks)	99	89.06 (148.43% RDA)
Group 3 (pulpy fruit drinks)	33	35.70 (59.50% RDA)
RDA		60.0

RDA – recommended daily allowance

**TABLE 3**  
MEAN DAILY INTAKE OF VITAMIN C WITH FRUIT DRINKS ACCORDING TO SEX OF PATIENTS ATTENDING A GENERAL PRACTITIONER'S OFFICE IN OSIJEK

Sex	Daily intake of vitamin C (mg/day)			Total
	48.76 (81.27% RDA)	89.06 (148.43% RDA)	35.70 (59.50% RDA)	
Male	14 (20.3%)	40 (58.0%)	15 (21.7%)	69
Female	31 (28.7%)	59 (54.6%)	18 (16.7%)	108
Total	45 (25.4%)	99 (55.9%)	33 (18.6%)	177
Statistical analysis ( $\chi^2$ -test)	$\chi^2=1.837$ ; $p=0.399$			

RDA – recommended daily allowance

**TABLE 4**  
MEAN DAILY INTAKE OF VITAMIN C WITH FRUIT DRINKS ACCORDING TO AGE GROUP OF PATIENTS ATTENDING  
A GENERAL PRACTITIONER'S OFFICE IN OSIJEK

Age group (yrs)	Daily intake of vitamin C (mg/day)			Total
	48.76 (81.27% RDA)	89.06 (148.43% RDA)	35.70 (59.50% RDA)	
15–24	13 (31.0%)	22 (52.4%)	7 (16.7%)	42
25–34	9 (28.1%)	17 (53.1%)	6 (18.8%)	32
35–44	4 (11.8%)	22 (64.7%)	8 (23.5%)	34
45–54	7 (18.4%)	25 (65.8%)	6 (15.8%)	38
55–64	4 (30.8%)	7 (53.8%)	2 (15.4%)	13
≥65	8 (44.4%)	6 (33.3%)	4 (22.2%)	18
Total	45 (25.4%)	99 (55.9%)	33 (18.6%)	177

GP – general practitioner, RDA – recommended daily allowance

**TABLE 5**  
MEAN DAILY INTAKE OF VITAMIN C WITH FRUIT DRINKS ACCORDING TO OCCUPATION OF PATIENTS ATTENDING  
A GENERAL PRACTITIONER'S OFFICE IN OSIJEK

Patient occupation	Daily intake of vitamin C (mg/day)			Total
	48.76 (81.27% RDA)	89.06 (148.43% RDA)	35.70 (59.50% RDA)	
Pupils and students	13 (31.0%)	22 (52.4%)	7 (16.7%)	42
Employed	24 (20.5%)	71 (60.7%)	22 (18.8%)	117
Retired	8 (44.4%)	6 (33.3%)	4 (22.2%)	18
Total	45 (25.4%)	99 (55.9%)	33 (18.6%)	177

GP – general practitioner, RDA – recommended daily allowance

groups to take a mean of 89.06 mg or 148.43% vitamin C RDA with fruit drinks daily. It was an almost twofold vitamin C amount taken daily with fruit drinks by the oldest age group (≥65), where the respective level of vitamin C intake with fruit drinks was recorded in only 33.3% of study subjects (Table 4).

Analysis of vitamin C intake with fruit drinks according to occupation as an indirect measure of the subjects' socioeconomic status indicated fruit drinks to be a major source of vitamin C in the groups of pupils and students and of employed individuals, where 52.4% and 60.7% of study subjects, respectively, consumed 89.06 mg of vitamin C with fruit drinks daily. In the group of retired persons, the respective amount of vitamin C was taken with fruit drinks daily by only 33.3% of study subjects (Table 5).

## Discussion

As essential dietary components, vitamins are necessary for normal functioning of many biochemical reactions in the human body. Different studies have shown that vitamin C plays an important role in human health<sup>2</sup>. Vitamin C has been demonstrated to help in body defense against various infections, especially in the prevention and treatment of common cold, and has been mainly

used for this purpose<sup>14</sup>. Besides this, the beneficial effects of vitamin C include effects on the immune system<sup>15</sup> and on cataract formation<sup>16</sup>. Recent studies have also shown that this important micronutrient plays a role in decreasing the risk of Alzheimer's disease<sup>17</sup>. The more so, some studies have shown an almost twofold relative risk of ischemic heart disease in men with low plasma vitamin C (<22.7 μmol/L) combined with low plasma carotene, and a fourfold risk of stroke<sup>6</sup>. Recent reports suggest that drinking generous amounts of a mixture of various fruit juices improves the blood lipid profile, reduces oxidative stress, prevents atherogenic modifications of LDL cholesterol and platelet aggregation, and improves HDL-cholesterol concentration<sup>2</sup>. With strong development of mass media the public is well informed on all the possible health effects of malnutrition and vitamin deficiency, however, being »well informed« need not always mean correctly informed. Pharmaceutical industry and various food supplement manufacturers invest large amounts of money in campaigns tending to convince the public that it is necessary to consume various food supplements in the form of pills or tablets, which are regularly very expensive, to remain healthy. Besides this, the shortage of time is one of the main characteristics of modern lifestyle, especially in large cities such as Osijek, the largest city in eastern Croatia. Modern men and women tend to simplify some of the essential human

needs such as feeding to have more time for work and other activities. Following this way of reasoning, it is by far easier to take one or two pills to meet daily requirements for various minerals and vitamins than to eat proper diet which is well balanced and adjusted to one's needs and health status.

The present study revealed that the majority of subjects were taking fruit drinks in a mean daily amount of 0.4 L *per* day, yielding a mean of 60.04 mg of vitamin C, i.e. 100% RDA of 60 mg, advised by the new Croatian By-Law on Foodstuffs for Special Dietary Needs, released in June 2004<sup>3</sup>. The study also highlighted great variation in vitamin C intake according to type of fruit drink. The amount of vitamin C taken daily with fruit drinks varied between 35.70 mg *per* day in the group of subjects taking pulpy fruit drinks through 48.76 mg *per* day in the group of subjects taking clear fruit drinks to as much as 89.06 mg *per* day in the group of subjects taking thick fruit drinks. These findings are comparable to those reported from a study conducted in Denmark. This study investigated the effect of the intake of flavonoid-containing black currant and apple juice on urinary excretion of quercetin and on oxidative status markers. A daily intake of ascorbic acid from the juice was found to range from 149.0 to 298.1 mg *per* day in subjects drinking between 0.75 and 1.5 L of fruit drink *per* day<sup>18</sup>.

Our study results pointed to fruit drinks as a significant source of vitamin C in daily diet of Osijek inhabitants. It is no surprise, knowing that there is the respective by-law in Croatia allowing the use of vitamin C as an additive, antioxidant or acidity regulator in fruit drinks<sup>4</sup>, even when the fruit that a particular fruit drink is made of is not rich in vitamin C, it is added in order to increase the level of this important vitamin in the final product.

Another very important issue highlighted in this study were significant differences in the fruit drink consumption according to occupation as an indirect measure of socioeconomic status. In the groups of employed subjects and of pupils and students, more than 50% (60.7% and 52.4%, respectively) showed an intake of 89.06 mg of vitamin C daily with fruit drinks *versus* only 33.3% in the group of retired subjects. The obvious reason for this were socioeconomic differences between these study groups, which is consistent with literature data, e.g., a study conducted during the 1990s in Sweden<sup>19</sup>. Despite these socioeconomic differences and the fact that the majority of Osijek inhabitants belong to middle or low socioeconomic groups, the present study has shown them to consume fruit drinks quite often because they simply cannot afford more expensive food supplements. It seems that people have intuitively reached to fruit drinks as a source of vitamin C in their daily diet. This action should be further encouraged because of the scientific evidence

showing the expensive food supplements to be as valuable in providing the necessary amounts of micronutrients as some foodstuffs<sup>20</sup>.

Besides vitamin C from fruit drinks, other foodstuffs taken by study subjects in their daily diet that also contribute to adequate vitamin C body supply should be taken in consideration, despite the fact that vitamin C is most unstable of all water soluble vitamins and is being readily degraded by oxygen, alkali and high temperature, resulting in great losses of ascorbic acid by food treatment (varying with food kind and treatment)<sup>1</sup>. Some new studies have shown that fruit drinks also include some other ingredients that are beneficial for human health, particularly in body combat with free oxygen radicals that are responsible for inducing carcinogenesis<sup>21</sup>. Some studies involving school children demonstrated that individuals taking fruit drinks also showed a higher rate of developing some other healthy habits<sup>5</sup>. A similar nutritional study conducted in 161 healthy volunteers from east Croatia, published in 2005, showed a marginally low mean calcium intake in this population, emphasizing the need of extensive nutritional education of the population at large<sup>22</sup>. A study dealing with nutritional attitudes of GPs in Croatia revealed them to consider smoking and alcohol as more important public health issues than unbalanced nutrition and physical activity, thus rarely advising their patients about the significance of proper diet<sup>23</sup>. Furthermore, there are a limited number of nutritional studies published in Croatia, especially those conducted in the east part of the country. Considering all these facts, the findings collected in the present study, although in a rather small population sample, appear to be of public health relevance. The study pointed to the need of public education on healthy dietary habits as one of essential public health actions in the Osijek community, yet noting that the majority of study subjects had considerable sources of vitamin C and other healthy ingredients included unintentionally in their daily diet in the form of relatively inexpensive fruit drinks. This is even more important considering the fact that cardiovascular and cerebrovascular disorders are the leading cause of mortality in east Croatia<sup>24</sup>, which, according to literature reports, can be favorably influenced by appropriate dietary habits including reasonable amounts of vitamin C and other antioxidants that efficiently reduce the risk of these diseases<sup>6,7,18,20</sup>. General practitioners should take the main role in conducting this education. They are expected to overcome their misjudgment of the significance of nutrition consultation<sup>23</sup>, and should urgently include public health programs concerning healthy lifestyles in their daily practice, emphasizing that people who follow such a program have an opportunity to influence their health status, with appropriate dietary habits and physical activity being the major contributory factors.

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## ULOGA VOĆNIH SOKOVA U SVAKODNEVNOJ PREHRANI NEKIH STANOVNIKA OSIJEKA

### SAŽETAK

Cilj istraživanja bio je utvrditi ulogu voćnih sokova u svakodnevnoj prehrani stanovnika Osijeka. Tijekom prosinca 2003. godine anketirano je 199 osoba koje su posjetile ordinaciju svog obiteljskog liječnika. U 42 tržišno dostupna voćna soka metodom tekućinske kromatografije visokog učinka određena je količina C vitamina (L-askorbinske kiseline). Svega 11% (22/199) ispitanika izjasnilo se kako uopće ne pije voćne sokove. Srednja vrijednost C vitamina u svim uzorcima voćnih sokova iznosila je 150,10±166,83 mg/L. Anketom je utvrđeno kako ispitanici koji piju voćne sokove, njih 89% (177/199), prosječno na dan popiju 0,4 L voćnog soka, čime prosječno u organizam na dan unesu 60,04 mg C vitamina, tj. 100% preporučene dnevne količine koja iznosi 60 mg. Dobiveni rezultati ukazuju na to kako su voćni sokovi značajan izvor C vitamina u svakodnevnoj prehrani nekih stanovnika Osijeka, pri čemu valja istaknuti kako postoje velike razlike u njegovom unosu putem voćnog soka s obzirom na socioekonomski status ispitanika te tip konzumiranog soka.