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The study of the physical-chemical properties correlated to ascorbic acid from fresh juices of fruits

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Abstract

Fresh fruit juices are rich in vitamins, minerals, anthocyanins, polyphenols. Consumed fresh, they are considered a source of healthy energy for humans, for increasing the body's immunity. This paper presents the results of the study carried out on lemon, lime, orange, mandarine, kiwi juices. The fresh fruit juices were obtained by pressing the fruits and then centrifuging them. They were kept cold and analyzed to determine several physico-chemical properties: pH, TDS, acidity, redox potential, reducing character. The amount of ascorbic acid was measured by redox volumetric method and by the UV spectrophotometric method.

The results show a correlation between the total content of dissolved salts, acidity, pH and the amount of ascorbic acid present in the fruit.

The content of ascorbic acid in juices depends on the nature of the fruit, on the presence of other organic substances in the fruit, but also on the method of obtaining and storing the juice. The consumption of fresh juices is recommended because they bring an intake of ascorbic acid, a vitamin that our body needs, knowing that ascorbic acid cannot be produced by the human body.

Ascorbic acid is an essential nutrient of life, involved in the production of certain substances that allow the transmission of nerve impulses, respectively in functions that facilitate the absorption of iron in the digestive tract.

Keywords: physical-chemical analyzes, exotic fruits, fresh juices, spectrophotometry UV-VIS, ascorbic acid.

1.Introduction

Metabolic diseases also known as nutritional diseases are disorders that target a series of nutritional factors and are characterized by abnormal chemical reactions from which various changes in the metabolic process may result [1].

The biochemical role of vitamin C is based on the reversible reaction between ascorbate and the anion radical monodehydroascorbate (MDHA) which, at physiological pH, has an oxidation-reduction potential close to zero (figure 1).

Vitamin C or ascorbic acid plays an important role in the activity of some enzymes involved in biochemical reactions in the human body such as metallo-enzymes of the category of oxygenases (monooxygenases, intra- and intermolecular dioxygenases) containing iron and copper ions. For the operation of these metallo-enzymes, the active metal ions must be in a reduced state (Fe^{+2}, Cu^{+}). The function of ascorbic acid is to instantly reduce ferric (Fe+3) or cupric (Cu+2) ions, which tend to form in contact with oxygen.

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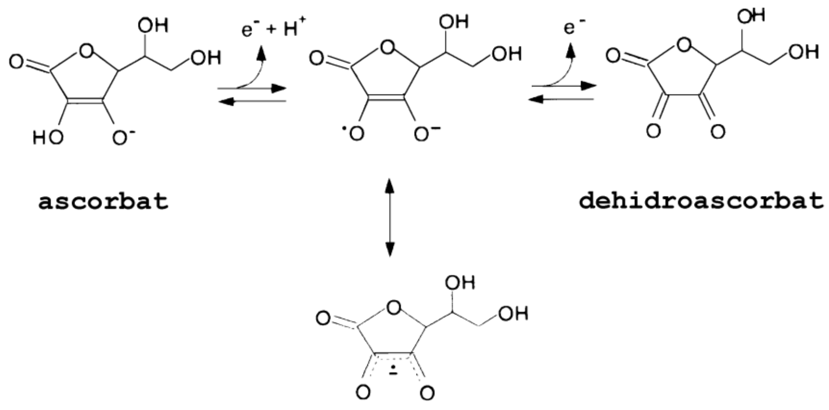


Figure 1. The reversible transformation of ascorbic acid

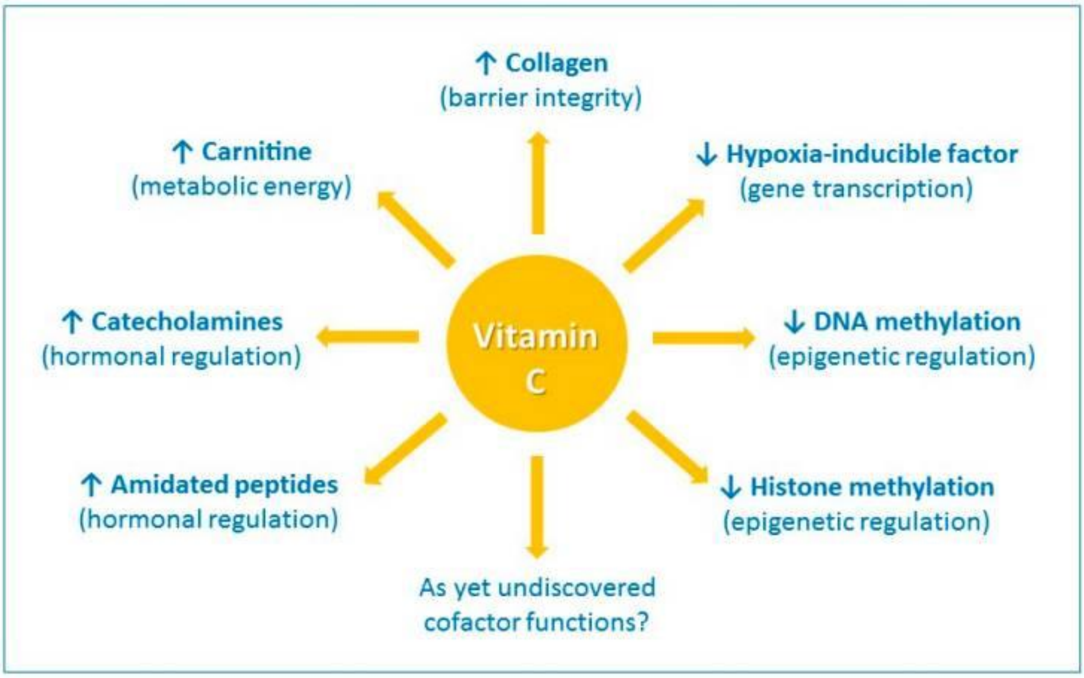


Figure 2. The enzyme cofactor activities of vitamin C [2]

Vitamin C is a cofactor of a family enzymes which are involved in the synthesis of collagen, carnitine, catecholamine hormones, and amidated peptide hormones. These enzymes also hydroxylate transcription factors, methylate DNA and histones, thus playing a role in gene transcription and epigenetic regulation (figure 2).

Many fresh and processed plants and fruits are studied for their health benefits. The health benefits are usually attributed to the presence of compounds with antioxidant properties.

One of the much-studied compounds to which antioxidant properties are attributed is ascorbic acid [3, 4].

There are numerous studies on the content of ascorbic acid in food as well as the presentation of the benefits of ascorbic acid and the synergism with other elements [5]. Its role in maintaining the body's immunity is also proven.

The usual methods by which vitamin C is dosed from various plant and medicinal sources are chromatographic methods [5], spectrophotometric methods [6] and volumetric/titration methods [7].

Ascorbic acid along with other organic acids and salts with acid hydrolysis contribute to the acidity of fruit juices. The presence of hydrogen ions (H^+) in fresh juices gives their pH and organic and inorganic salts can be evaluated by conductivity as total salt content (TDS).

The paper aims to evaluate some physicochemical properties of some fresh fruit juices and to correlate them with the ascorbic acid content.

2. Materials and Method

2.1. Obtaining fresh fruit juices

The fruits were bought from the supermarket and processed to obtain fresh juices, after which the samples for immediate analysis were kept in the dark at the room temperature (about 20° C). Samples for quantitative analysis were kept in the dark at 4°C until analysis.

Figure 3. Fruits transformed in juice

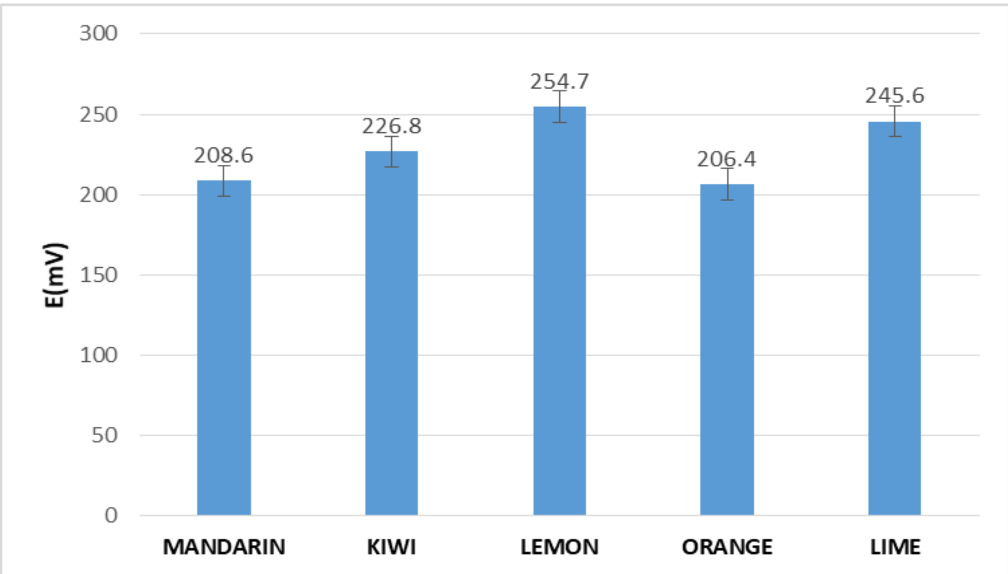


Figure 4. The redox potential of juice of fruits

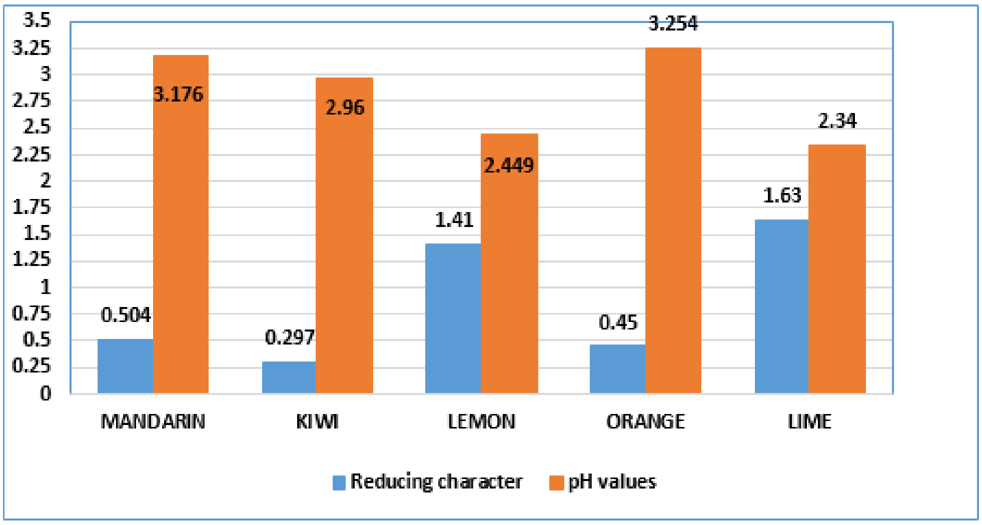


Figure 5. The reducing character and pH values of fresh juices

The oxidation-reduction potential of liquids is given by the presence of electrical charges, respectively anions, cations that have specific electrical potentials and that together contribute to the electrical potential of system. Since there are different fruits, with different chemical composition, results will be different.

The lower the values of the redox potentials, the more pronounced the reducing character is.

As can be seen from figure 4, the redox potential of fruit juices, expressed in mV, has low values and are included in the range 206,4 mV and 254,7 mV.

These results express the reducing character of juices. All the analyzed fruits have close values and it can be said that they have a comparable reducing character.

The pH value is given by the concentration of [H3O+] ions from system. Figure 5 shows that the pH of the analyzed samples is included in the range 2,34 si 3,254.

These values were also compared with the organoleptic characteristics (sour taste) and a positive correspondence was found.

Lemon and lime have the most pronounced sour taste, which is confirmed by the corresponding pH values. The total amount of dissolved salts, expressed with the TDS parameter, was determined by the conductometric method and gives important information on the composition of the analyzed juices. Figure 6 shows the TDS values each analyzed juice.

The TDS content was analyzed in the undiluted juices. According to the obtained data, kiwi is the fruit richest in salts. This result must also be correlated with the amount of water present in the fruit.

Oranges and tangerines have a higher percentage of water, a fact that is evident in the TDS values obtained.

The antioxidant character of the fresh juices was evaluate also using a qualitative analysis. Thus, the reaction with K3[Fe(CN)6] is used, which in reaction with reducing substances is reduced and a blue coloration is obtained that can be measured at □ =700nm.

An increase in the absorbance of the mixture indicates an increase in the antioxidant character.

A measured volume (2mL) of the fresh juice solution is mixed with an equal volume of phosphate buffer system (pH 6.6) and the same volume of trichloroacetic acid (10%), then centrifuged at 2000rpm. Potassium ferricyanide (1%) and double-distilled water in equal proportions are added to the clear solution obtained after centrifugation. Measure the absorbance at 700nm and write down the values for each sample thus prepared.

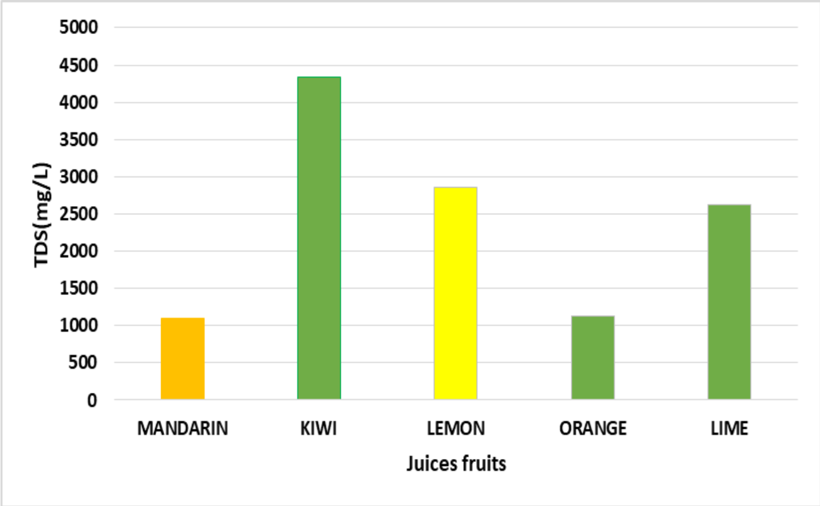


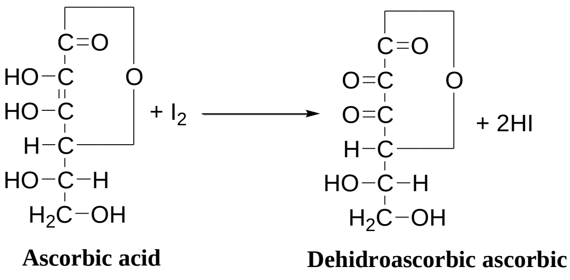
Figure 6. Total dissolved salts in the juice fruits

The obtained results can be found in figure 4. The antioxidant character varies, lemon and lime having the highest absorbance values, 1.41 and 1.63 respectively. The absorbance values correlated with the reducing character are consistent with the values obtained when measuring the redox potential of fresh juices.

The quantitative analysis of ascorbic acid was carried out by two methods: the volumetric method and the UV spectrophotometric method.

The volumetric method is based on redox reactions and uses KIO3, HCl, KI as reagents. Potassium iodate generates I2 in the reaction with HCl and KI and the molecular iodine will be reduced by ascorbic acid to the iodide ion (reactions 1 and 2). The equivalence point is indicated with starch solution that forms with excess molecular iodine (the drop of KIO3 added after consuming ascorbic acid) an inclusion complex, colored blue.

$$KIO_3 + 6\ HCl + 5\ KI \rightarrow 6\ KCl + 3\ I_2 + 3\ H_2O \quad (1)$$



(2)

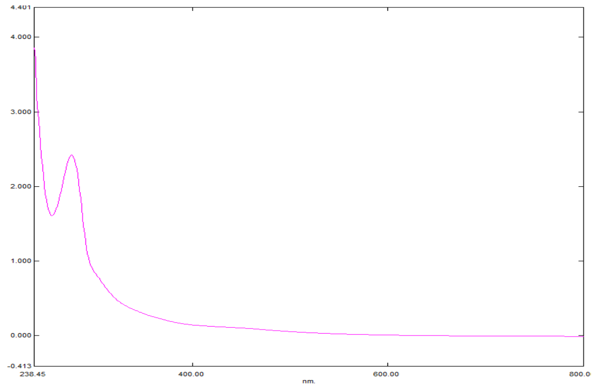


Figure 7. Absorbtion spectra of ascorbic acid

The spectrophotometric method of ascorbic acid dosage is based on the ability of ascorbic acid to absorb in the UV range at λ = 262nm. Figure 7 shows the absorption spectrum of ascorbic acid in the UV range, with the absorption maximum at 262nm.

For the quantitative analysis, a set of ascorbic acid samples, well-determined concentration solutions is made and a standard curve is drawn. With the help of the equation on the right side of the standard curve, the ascorbic acid concentration of a solution of unknown concentration can be found.

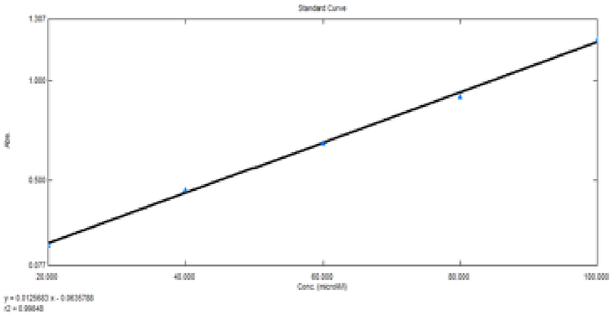


Figure. 8. Etalon curve of ascorbic acid solution

In figure 8 we have the standard scale with Y= 0.01256x – 0.06358, r^2 = 0.9985, where x represents the molar concentration of ascorbic acid and y is the absorbance value of the sample to be analyzed.

The results obtained in the two methods are presented in table 2. The amounts of ascorbic acid obtained by the two methods are comparable and also fall within the range of values found in the literature. Of course, sometimes there are differences, these being caused by the degree of maturity of the fruit, the climate in which the fruit trees grow, the nature of the soil in which they grow, the humidity of the soil, etc.

A statistical matrix of correlations between the physicochemical parameters was created from which some significant conclusions can be drawn.

Table 2. The amount of vitamin C from juice fruits, resulted by the tow methods: volumetric and spectrophotometric

Nr. crt.	Tipe of fruit	Volumetric analyse (mg vitamin C/100g fresh fruit)	Spectrophotometric analyse (mg vitamin C/100g fresh fruit)
1	Lemon	34,09	44,48
2	Lime	36,66	54,98
3	Mandarin	45,67	51,23
4	Orange	51,62	74,55
5	Kiwi	55,45	63,78

Table. 3. The statistical correlation matrix between fisical-chemical proprieties of juice fruits

	Amount (g)	V(mL) juice	% of juice	pH	E(mV)	TDS(mg/L)	A(700nm)
Amount(g)	1						
V(mL) juice	0.39	1.00					
% of juice	-0.13	0.86	1.00				
pH	-0.50	0.06	0.32	1.00			
E(mV)	0.65	-0.12	-0.48	-0.96	1.00		
TDS(mg/L)	0.16	-0.74	-0.90	-0.45	0.57	1.00	
A(700nm)cu FeCl3	0.83	0.64	0.26	-0.59	0.61	-0.24	
A(700nm)	0.51	0.26	0.02	-0.93	0.84	0.10	1

A positive correlation was found between the redox potential of the analyzed samples and the absorbance (0.84). The higher the potential, the higher the absorbance of samples treated with potassium ferricyanide. The absorbance value is an indicator of the antioxidant power characteristic of each analyzed sample.

A positive correlation is also noticed between TDS and redox potential. The presence of a quantity of inorganic salts is correlated with the antioxidant character. Salts of transition metals (Fe, Cu) have a decisive role on the reducing character of the samples subjected to analysis [8].

A negative correlation is observed between pH and redox potential. The higher the redox potential, the lower the pH is. In other words, the acid character is inversely proportional to the redox character.

4. Conclusion

The acidity and pH values of fresh fruit juices provide a real image of the acidic character of the analyzed samples. These parameters, although measured in a different way, lead to results that converge towards the same values regarding some chemical and organoleptic properties of fresh fruit juices.

The reducing character of fresh fruit juices was determined by potentiometric (E, mV) and spectrophotometric methods in the visible range. The results obtained in both methods are comparable.

The reducing character is given by the presence of ascorbic acid but also by the presence of other organic acids such as oxalic acid, malic acid, acetic acid, and tartaric acid and inorganic salts, such as salts of some transition metals with lower valence, present in fruits.

The results obtained for the quantitative analysis of ascorbic acid by the iodometric method and the ultraviolet spectrophotometric method are comparable to each other and to those in the specialized literature.

Fresh juices, obtained by pressing, are rich in vitamins, for example Vitamin C, minerals and other organic substances that through synergism confer the beneficial antioxidant character in maintaining a normal redox balance in the human body. These fruits are recommended especially in the cold season when indigenous fruits, that also maintain the mineral and vitamin balance, are missing in our country.

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human or animal subjects (if exist) respect the specific regulation and standards.

References

1. Ionică E., Costache M., Biochimie Generala: Vitamine si Elemente Minerale, Vol III, Ed. Ars Docendi, Universitatea din Bucuresti, ISBN: 973-558-134-5; 973-558-136-1, 2004.
2. Anitra C. Carr., Silvia Maggini, Vitamin C and Immune Function, Nutrients 2017, 9, 1211.
3. Habtamu Abera, Mitiku Abdisa, and Alemayehu P. Washe, International Journal of Food Properties, Spectrophotometric method to the determination of ascorbic acid in M. stenopetala leaves through catalytic titration with hexavalent chromium and its validation 2020, VOL. 23, NO. 1, 999–1015, https://doi.org/10.1080/10942912.2020.1775249
4. Nojavana S, Khaliliana F, Fatemeh Momen Kiaiec, Rahimic A, Arabanianc A, Soheila Chalavia, Extraction and quantitative determination of ascorbic acid during different maturity stages of Rosa canina L. Fruit. J Food Compos Anal, 2008, 21: 300–305.
5. Han, J. S.; Kozukue, N.; Young, K. S.; Lee, K. R.; Friedman, M. Distribution of Ascorbic Acid in Potato Tubers and in Homeprocessed and Commercial Potato Foods. J. Agric. Food Chem. 2004, 52, 6516–6521. DOI: 10.1021/jf0493270.
6. Dürüst, N.; Sümengen, D.; Dürüst, Y. Ascorbic Acid and Element Contents of Food of Trabzon (Turkey). J. Agric.Food Chem. 1997, 45, 2085–2087. DOI: 10.1021/jf9606159.
7. Verdini, R. A.; Lagier, C. M. Voltammetric-Iodometric Titration of Ascorbic Acid with Dead-Stop End Point Detection in Fresh Vegetables and Fruit Samples. J. Agric. Food Chem. 2000, 48, 2812–2817. DOI: 10.1021/jf990987s.
8. Sayers, M.H., S.R. Lynch and P. Jocobs, The effects of ascorbic acid supplementation on the absorption of iron in maize, wheat and soya. Br. J. Haematology, 1973, 24: 209-218.