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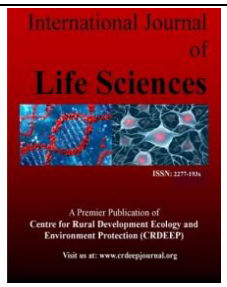

Full Length Research Paper

The study of the content of Carbohydrates, Organic acids, Vitamin C in some varieties of Tangerine juice introduced in Ajara using High Pressure Liquid Chromatography

Inga Kartsivadze[1]; Aleko Kalandia[2]; Maia Vanidze[3]; Merab Ardzenadze[4] and Darejan Chikovani[5]

[1] *PhD student,Chemistry Department, Batumi Shota Rustaveli State University, Georgi.*
[2] *Professor, Chemistry Department, Batumi Shota Rustaveli State University, Georgia.*
[3] *Associate Professor, Chemistry Department, Batumi Shota Rustaveli State University, Georgia.*
[4] *Chief Research Worker, Batumi Shota Rustaveli State University, Georgia.*
[5] *Senior Researcher , Batumi Shota Rustaveli State University, Georgia.*

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Corresponding Author:
Inga Kartsivadze

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ABSTRACT

Citrus fruit is a very important product for human consumption. Its chemical characteristics are important. Citrus fruit production is of particular importance for various regions of Georgia, especially for Adjara, since most of their annual income depends on the quantity and quality of citrus crops. Due to the difficult geographical position of the region, early frosts, citrus fruits cannot ripen until the end of November, and,correspondingly, their quality also becomes low. To facilitate the production of citrus fruits in the region, the introduction of fast-growing, frost-resistant and highly productive early ripening varietiesis of particular importance. The physicochemical characteristics, the composition of carbohydrates, organic acids and vitamin C in the juice of some varieties of rare ripe tangerine, introduced in Ajara,have been studied using the high-pressure liquid chromatography. In particular, glucose, fructose and sucrose were identified among carbohydrates, while the citric acid was determined as the dominant one among organic acids. The concentration of vitamin C was determined as well. In particular, the highest content was recorded in the Nova juice - 1,046 mg / ml, the lowest - 0.245 mg / ml – in the Taguchi Vase.

Introduction

Citrus are a large group of evergreen trees that belong to the botanical species "Citrus". This is a widespread and popular culture in the world, which is produced in 140 countries. According to the 2016-2017 data of the US Department of Agriculture (Foreign Foreign Service, January 2017), the global citrus production increased by 2.4 million tons and compared with the previous year it was 49.6 million tons, the tangerine production increased to 28.4 million tons: in Japan it increased by 7% (to 1 million), in Turkey increased by 20,000 tons (the total production is 1.1 million tons); lemon and lime production increased by 4% to 7.3 million tons, and grapefruit production increased by 6 million tons (Citrus: World Markets and Trade)(3, 4).

Citrus fruit is a very important product for human consumption(1).Its chemical characteristics are important, because they determine the value of nutritional and organoleptic properties, such as taste, aroma and other indicators(11, 12).

One of the main substances of citrus fruit is organic acids and carbohydrates, the nature and quantity of which significantly define the fetal organoleptic and qualitative indicators,as well as the terms and conditions of storage(2).

The content of organic acids and carbohydrates varies depending on the type and variety, climatic conditions and development.(7) According to the literary data, acidity of citrus fruit is mainly due to citric acid content. The concentration of organic acids decreases with the ripening of the fetus (for example, the acidity of a tangerine fruit of the Okutsu Vase variety grown in the Mediterranean is relatively low, namely: the content of citric acid is 5.66 g / l), but the amount of total sugars increases simultaneously (fructose - 29.69 g / l, glucose - 25.39 g / l, sucrose - 46.36 g / l (regular sugar - 101.45 g / l).This ratio of dry matter and acidity leads to a higher index of sugar acid, which largely determines the high quality and taste properties of citrus

fruits. They also contain biologically active flavonoid glycosides(5, 6).

Tangerine was introduced in the early twentieth century in Georgia. Citrus fruit production is of particular importance for various regions of Georgia, especially for Adjara, since most of their annual income depends on the quantity and quality of citrus crops. Due to the difficult geographical position of the region, early frosts, citrus fruits cannot ripen until the end of November, and,correspondingly, their quality also becomes low. Therefore, in order to increase potential, it is necessary to increase the competitiveness of citrus fruits and improve the local range. To facilitate the production of citrus fruits in the region, the introduction of fast-growing, frost-resistant and highly productive early ripening varietiesis of particular importance; it will allow farmers to produce high-quality and competitive raw materials, what in turn will significantly increase the export of Georgian citrus fruits.

New promising citrus varieties have been introduced in Ajara from Japan, China and Spain (13). They were grown at the Agroservice Center of Chakvi Experimentally-Demonstrative Citrus Nursery. Unlike other citrus fruits, atangerine dominates in the area of planted plantations and has an industrial significance. Among its early ripening varieties, the Kovano-Vase, the Miagava-Vase, the Okitsu-Vase, the Mikho-Vase, the Tiakhara Unshiu and others are widely known; their fruits ripen in the first half of October. Hybrid varieties are characterized by a number of advantages over local varieties, namely, they begin to ripen 30-35 days earlier, what improves and facilitates fruit picking and its timely implementation; they can be bred in the second year after planting, and at the age of 10 years they reach full yield(13). Compared with the Unshiu variety, they are distinguished by larger fruits (80-85 grams) and a goodmarketable presentation. Also, they are easy to care for and collect, what significantly reduces the time of collection, the cost of them and, accordingly, increases the profitability of the sector(14).

Despite the fact that the plants are well adapted to local climatic conditions and the appearance of the fruit meets the requirements of the standard, such significant chemical characteristics of citrus fruits as the qualitative and quantitative content of organic acids, carbohydrates, ascorbic acid and other compounds have not been studied yet (9, 10). The aim of our research was to study the physicochemical characteristics, as well as the content of carbohydrates, organic acids, and vitamin C in some rareripe tangerine varieties introduced in Ajara, using the method of high-pressure liquid chromatography(8).

Materials and methods

The object of study was the fruits of such tangerin varieties, grown at the Agroservice Center of Chakvi Experimentally-Demonstrative Citrus Nursery, as the Taguchi Vase, the MiagavaVase,the OkitsuVase, the Nankani-20, the Mukoiama, the Satsuma, the Tiakhara Unshiu, the Ivasaki, the Klemenulesi and the Nova.

The research methods:

Dry substances have been determined in juice by a refractometer - Digital Refractometer # PA202 (Palm Abbe) MISCO.

pH and titrated acidity were determined by theMETTLER TOLEDO digital potentiometer by AOAC method (Laboratory Manual, Procedures for analysis of citrus products - 2011).

Carbohydrates were determined bytheWaters (USA)high-pressure liquid chromatograph (Waters HPLC system equipped with a model 525 pump); they were identified by2414 Refractive Index Deteqtor and Carbohydrate column; the motion phase was 75 % Acetonitrile (SIGMA-ALDRICH); the solvent speed - 0,7 ml / min; the column temperature - 40 ^{0}C;the sample quantity 20 µl; the duration of chromatography - 10 min.

Organic Acids and Vitamin C were determined bythe Waters (USA) high-pressure liquid chromatograph (Waters HPLC system equipped with a model 525 pump); they were identified in the ultraviolet area of the spectrum - 214 µm(Organic Acids) and 254 Nm (Vitamin C) by the Waters 2489 UV / Visible detector and column RSpak KC811 (Shodex), where the motion phase is - 0,1% orthophosphoric acid; the solvent speed is 0,7 ml / min; the column temperature – 30^{0}C; the sample quantity is 20 µl;the duration of chromatography is 10 min.

In a sample of juice taken for chromatography, 96% ethyl alcohol was added in a ratio 2:1 to settle the pectin. The sample was then centrifuged and diluted using an appropriate mobile phase in a 2: 1 ratio. Before injecting, the sample was filtered in 0,45-µmpore sizeWaters membrane filters.

Results and discussion

Juice isolated from the fruits of tangerine, ranges from 29 to 58%. Fruits of Miagawa Vases (52%) and Nankan-20 (58%) are distinguished by a high level of juice production. The ratio of sugars and acids in tangerine juice (sugar-acid index) is one of the most important features for the maturity, organoleptic and qualitative evaluation of a fetus.

The samples of the Taguchi Vase, the Nankan-20, the Satsuma, the Tiakhara Unshiu, the Ivasaki and the Klamanulesi were characterized by a high content of dry substances (9,7 to 10.2%) and low content of titrated acids (0,59 - 0,96%), what determines the highest indicator of the sugar-acid content (10,1 - 17,28) and, therefore, the tangerine quality (Table 1), while a high concentration of titrated acidity (1,22 and 1,03%) in the juice of Mukoiama and Miagava Vase causeda lower indicator of sugar-acid index (8,03 - 8,6), what is not in compliance with the standard (market demand). Vitamin C concentration(Figure 1) in tangerine juice has also been determined by the high pressure liquid chromatography method particularly, a high concentration was recorded in the Nova juice -1,046 mg / ml, the lowest – in the Taguchi Vase - 0,245 mg / ml, in the juice of the Nankan - 0,285 mg / ml and the Mukoiama -0.225 mg / ml, while in the other samples there are almost equal quantities (Table 2).

Glucose, fructose and sucrose (Figure 2) have been identified among the tangerine juice carbohydrates. The total quantity of sugar in the juice was 81,67 - 97,66 g / l, where glucose and fructose are almost equal and the concentration of sucrose is 55 - 63% of total sugars.

Table 1. Physico-chemical characteristics of some varieties of tangerine juice

Sample Name	Juice productivity %	Acidity, %	Dry Substance, % Brix	Sugar-acid -index
Taguchi Vase	46,0	0.82	9.7	11.8
Okitsu Vase	48,0	0.95	9,0	9.5
Miagava Vase	52,0	1.03	8.9	8.6
Nankan-20	58,0	0.88	9.9	11.25
Mukoiama	49,0	1.22	9.8	8.03
Satsuma	36,5	0,59	10,2	17,23
Tiakhara Unshiu	43,6	0,80	8,3	10,38
Ivasaki	29,4	0,69	8,6	12,5
Klemenulesi	31.3	0,96	9,7	10,10
Nova	38,6	1,09	10,0	9,19

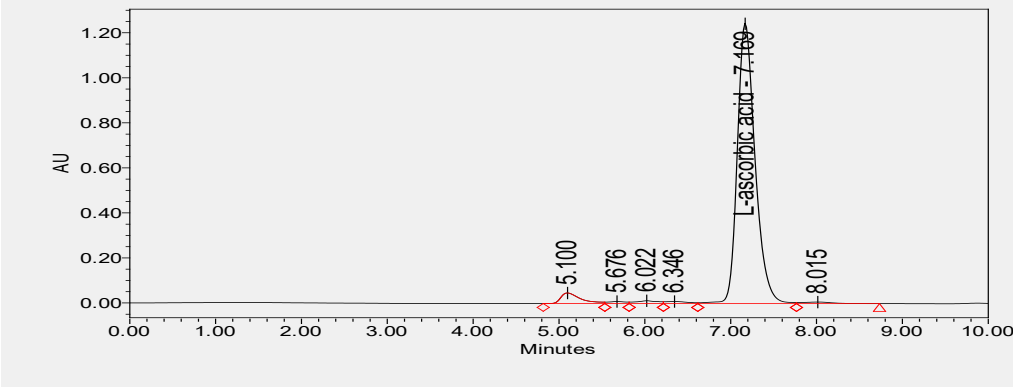

Fig 1. Vitamin C chromatogram of tangerine juice

Table 2. Vitamin C content in tangerine juice

Sample name–juice	Vitamin C mg/ml
Taguchi Vase	0.245
Okitsu Vase	0.427
Miagava Vase	0.323
Nankan-20	0.285
Mukoiama	0.258
Satsuma	0,495
Tiakhara Unshiu	0,531
Ivasaki	0,621
Klemenulesi	0,88
Nova	1,046

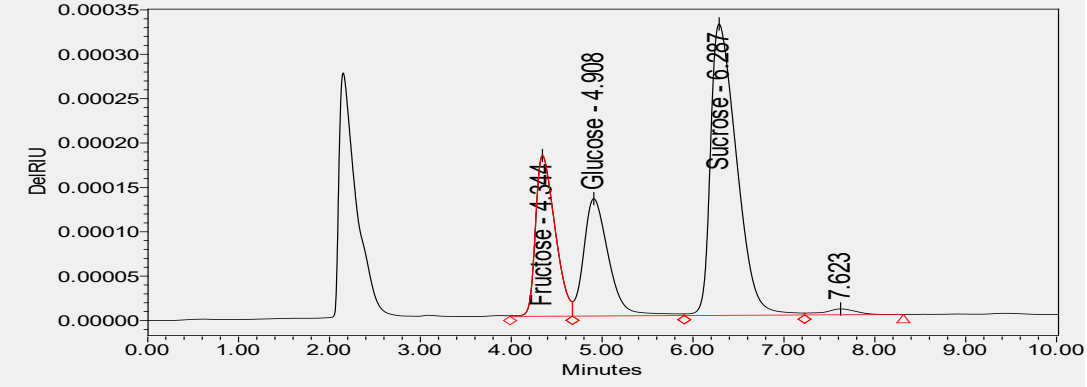

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Fig.2. Carbohydrates Chromatography of tangerine juice

Table 3. Fructose Glucose Sacrose in the juice of the Taguchi Vase tangerine

	Name	Fructose g/l	Glucose g/l	Sacrose g/l	Total sugars g/l
1	Taguchi Vase	20,37	16,27	59,25	95,89
2	Okutsu Vase	18,62	15,64	50,12	84,38
3	Miagava Vase	21.49	18.06	48.78	88,33
4	Nankan-20	19.66	16.47	61.05	97,13
5	Mukoiama	22.65	20.13	53.13	95,91
6	Satsuma	24,75	21,48	52,71	98,94
7	Tiakhara Unshiu	17,35	18,79	45,55	81,67
8	Ivasaki	16,5	17,9	50,2	84,6
9	Klemenulesi	18,15	19,69	56,32	94,16
10	Nova	20.74	18.34	58.58	97,66

Particularly, the fructose in the juice of the Taguchi Vase tangerine is represented by 24% of total sugars (21,498 g / l), the glucose- by 21,3% (19,061 g / l) and the sucrose - by 54,6% (48,788 g / l). It is similar to the Okutsu Vase and the Mikho Vasetanderine juice (Table 3).

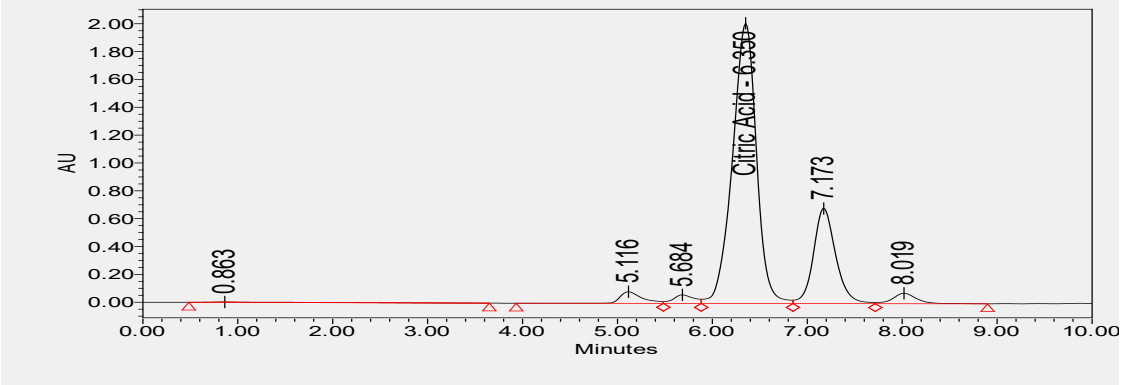

Fig. 3. Chromatography of organic acids of tangerine juice

Citric acid content in the tangerine juice Among organic acids, there has been identified citric acid as a dominant one. The total number of organic acids was determined by 5,7 to 8,7 g / l % (Table 4).

Table 4. Citric acid content in the tangerine juice

Sample name – juice	Citric acid g/l
Taguchi Vase	5,74
Okitsu Vase	6,46
Miagava Vase	6,85
Nankan–20	6,12
Mukoiama	8,7
Satsuma	5,8
Tiakhara Unshiu	6,02
Ivasaki	4,72
Klemenulesi	6,09
Nova	8,1

Conclusion

The physicochemical characteristics, the composition of carbohydrates, organic acids and vitamin C in the juice of some varieties of rareripe tangerine, introduced in Ajara,have been studied using the high-pressure liquid chromatography. In particular, glucose, fructose and sucrose were identified among carbohydrates, while the citric acid was determined as the dominant one among organic acids. The concentration of vitamin C was determined as well. In particular, the highest content was recorded in the Nova juice - 1,046 mg / ml, the lowest - 0.245 mg / ml – in the Taguchi Vase.

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