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# SOME BIOCHEMICAL CHARACTERISTICS OF ORANGE JUICE

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Citrus fruit rank first in the world with respect to production among fruits. They are grown commercially in more than 50 countries around the world. Orange juice is dominant among the various citrus juices. Initial product quality is dependent on the conditions of processing and variables associated with the biochemistry of the fruit. One of the most popular orange varieties for juice production is «Valencia», therefore biological characteristics of orange juice variety «Valencia» was studied with time. The orange juice was tested during two month. Studies have carried out at the Greece "BIOFRESH" laboratory, Sparta. In orange juice like pulp, sugars, organic acids, ratio and essential oil are observed during two month.

The study results show that on May orange NFC «Valencia» has minimum sugars - 8.59 ˚Brix and on June orange NFC «Valencia» has 12,28 ˚Brix. The acid decreased from 1,03g $100g^{-1}$ on May to 0,79g $100g^{-1}$ on June. On May, orange juice has 10,58 Ratio, but on June «Valencia» orange juice has maximum Ratio 13,86 The pulp parameter was stable during both months. The essential oil concentration in orange juice was from 272 ppm to 340 ppm.

*orange variety «Valencia», juice, sugars, acid, ratio, pulp, essential oil*

## INTRODUCTION

Oranges *(Citrus sinensis)* are an important food source in many parts of the world for several reasons. They are delicious and nutritious citrus fruit much liked by the people [1]. Oranges are generally available from winter through summer with seasonal variations depending on the cultivars. For many cultivars of citrus, the fruit will mature from 7 (lemon, limes) to 10 months (orange, grapefruit, tangerines) after tree flowering [2]. Flowering in citrus lasts for a month or so under subtropical climate. For a long time, fruits have been valued by man for their attractive appearance, refreshing flavour, and nutritional qualities. Before harvest, fruit stores different metabolites, which are later utilized, and some more metabolites are formed after harvest as the development takes place towards, maturity and senescence.

Orange fruit are non-climacteric: they ripen on the tree. As in most of the fruits the maturity of citrus heralds the accumulation of sugars and the loss of acidity and host of other biochemical changes. The most important compounds that influence the quality of orange juice are sugars and acids, flavor and colour components, and vitamin C. These compounds, plus cloud, are analyzed to define and grade juice.

Greece is situated in the eastern part of the Mediterranean basin. Citrus grown mostly in the central and southern parts of the country in Crete, Peloponnesus (Corinth, Achaia, Laconia and Argelis districts), Central Greece, and Ipiros [3]. Laconia region, Navel cultivars mature from October to March; the cultivars «Valencia» mature from March to October.

The sugar content of juice is normally expressed as soluble solids or ˚Brix (degree Brix). Nearly 75 to 85 percent of the total soluble solids of orange juice are

sugars. The sugars are mainly sucrose, glucose and fructose in a ratio approximating to 2:1:1. After sugars, acids are the most abundant class of soluble solids in orange juice. The acids comprise mainly citric acid and to a lesser degree malic acid. Citric is an important and abundant acid in citrus fruit. Some of the acids are in the form of salts, which give orange juice a buffering capacity. The ˚Brix: acid ratio is very important for taste as it is a measure of the balance between the sweet and sour sensation. As oranges ripen, the acidity decreases while the sugars increase. The ratio decides the maturity of the fruit before harvesting. When the fruit matures, this ratio increases as sugars are formed and the acid content decreases. Maturity standards for oranges in Greece require a minimum ˚Brix of 9.0 and minimum ˚Brix: acid ratio of 10. Consumers prefer a ratio around 15 and therefore it is often necessary to increase the ratio. This is done by blending it with juice of higher ratio extracted at other times of the season [4].

Major pigments that give color to citrus fruits are chlorophylls (green), carotenoids (yellow, orange, and deep orange), anthocyanins (blood red), and lycopene's (pink or red). During grown and maturation, especially in the immature stage, chlorophylls predominate in the peels of all citrus fruit [3]. With ripening, total carotenoids increase in the peel as well as in the pulp. In the fruit of early season «Valencia» oranges, there is a qualitative difference between carotenoids in pulp and peel. Development of pigments and color is mainly dependent on weather conditions and citrus variety. In warm and humid areas, abundant red anthocyanins are produced, whereas in dry areas, color intensity is lower. The concentration of anthocyanins increases rapidly in fruit as they near maturity. The major glycoside flavonoids in citrus are hesperidin, naringin, and neohesperidin. In general, concentration of flavanones decreases as fruit matures. Hesperidin is a main flavonoid of oranges [5]. The flavonoid compound naringin has a bitter taste. The bitter taste of naringin was found to be due to the structure of the disaccharide moiety [6]. Flavonoid content of citrus fruits increases to a maximum during early stage of fruit development and then remains constant. With an increases in fruit size, the flavonoid concentration decreases.

The main contribution of citrus fruits in human nutrition is their supply of vitamins, especially ascorbic acid (vitamin C). The recommended amount of vitamin C is 60 to 90 milligrams per day [7]. Vitamin C content of juice of different citrus fruits varies considerably. Green - colored oranges have less vitamin C than the orange - colored ones when harvested at the same time. Fruits from the north side of the tree have considerably lower concentration than those from the south side. There is no difference in vitamin C content of fruits picked from inside the tree. A significant correlation between ascorbic acid content and the contents of reducing sugars (hexose sugars) suggest that these constituents are associated in ascorbic acid synthesis. Vitamin C (ascorbic acid) – is the most important nutrient in orange juice. One of the reasons for this is that consumers regard oranges as a good source of vitamin C. Typical values for vitamin C in freshly extracted juice range from 450 to 600 mg $l^{-1}$ [4]. Juice content is an important measurement of internal quality. Under or over – ripe fruit tend to be less juicy, which directly affects quality. During the course of the development of orange fruit, starch is found in all components of the fruit including the juice vesicles. As the fruit grows older, the starch begins to disappear. As «Valencia» oranges ripened, the water - soluble pectin in both the albedo and the pulp increased to a peak and then decreased while the acid extracted while the acid - extracted pectin material continued to decrease. The total pectin showed only a slight decrease when the fruit was fully

ripened. The total pectin in the juice shows a similar trend to that of the albedo and the pulp. The content of dietary fiber in fruit changes with maturity [8].

The main goal of the research was to determine the changes of orange Not-From Concentrate juice (NFC) «Valencia» quality parameters during two month.

## MATERIALS AND METHODS

The study was carried out at the orange juice production company "BIOFRESH" S.A. at the plant laboratory, during the period from May 2009 to June 2009.

Changes in quality parameters: pulp, Brix, acid, ratio, essential oil in «Valencia» orange NFC were studied with time. The oranges NFC samples were collected from extractor in production line and were tested the fresh oranges juices quality parameters in the laboratory:

- ˚Brix (mg $100g^{-1}$) was determined by Refractometer [9].

The °Brix (degree Brix) scale, which was developed by the sugar industry, relates the sucrose concentration of a pure sucrose solution to its density at 20°C [5].

Calculate the ˚Brix by the formula (1, 2 ).

°Brix = % soluble solids (w/w) (1)

°Brix, corrected = % sugar (w/w) (2)

- Acid content by titration with Sodium hydroxide solution.

Total acidity determined by using by titration against 0,1 NaOH (or 0,3125N NaOH) and is often expressed as grams citric acid per liter juice [9].

Calculate the total titratable acidity by putting the values in the following formula (3):

$$\text{Acidity (\%)} = \frac{\text{Titre X Normality of alkali X Volume made up X Equivalent weight of citric acid (64) x 100}}{\text{Volume of sample taken for estimate juice/pulp taken X Weight of Volume of X 1000}} \quad (3)$$

- The Brix / acid ratio is obtained by dividing the total soluble solids (°Brix corrected for acids and temperature) by the total titratable acid (% acid, w/w) at 20°C, formula (4).

$$\text{Ratio} = \frac{°Brix}{\text{\% (w/w) citric acid}} \quad (4)$$

- Pulp – the juice sample is centrifuged in graduated tubes for a known time and speed. The sediment quantity is expressed as volume percent. USDA method [10].
- Essential oil measured by a simpler titration method, the Scott method. The oil level is expressed as % v/v in 11,8 ˚Brix juice [9].

Data were statistically elaborated using SPSS for Windows and MS Excel variance analysis, significance level at $P < 0,05$.

## RESULTS AND DISCUSSION

°Brix of citrus juices indicates all the soluble solids. It is not measure of sugars only. Soluble solids in juice can be measured from the refractive index, and refractometer is calibrated to give °Brix or percent total soluble solids values directly. Study results show that concentrations of the total sugars were low in the beginning of the season on May but rapidly increased in July in orange NFC «Valencia». On May orange NFC «Valencia» has minimum sugars 8,59˚Brix and on June orange NFC «Valencia» has 12,28 ˚Brix (fig. 1).

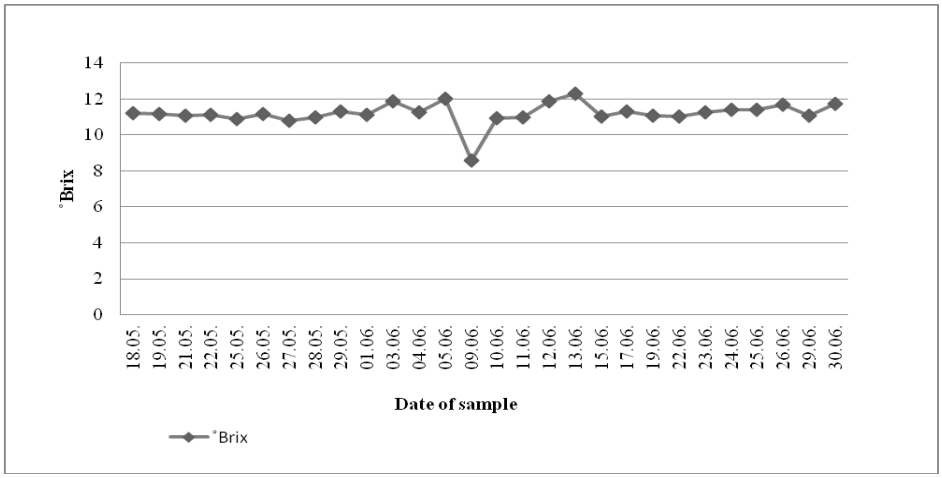


Fig. 1. Changes of Brix % in orange juice «Valencia»

Рис. 1. Изменение показателя Brix в % в соке из апельсинов сорта «Валенсия»

Orange's juice ˚Brix depend on the orange maturity time and cultivar. It is lower in the beginning of the season. Sugar accumulation and acid degree has been observed in both cultivars during ripening, this is mainly due to an increase of sucrose in the juice and reducing sugars in the rind. As the early and mid - season oranges ripen on the tree, the total sugars in the juice increase rapidly due to an accumulation of sucrose. There is generally an increase in reducing sugars with maturity [3].

The acid decreased from 1,03g $100g^{-1}$ on May to 0,79g $100g^{-1}$ on June (fig. 2).

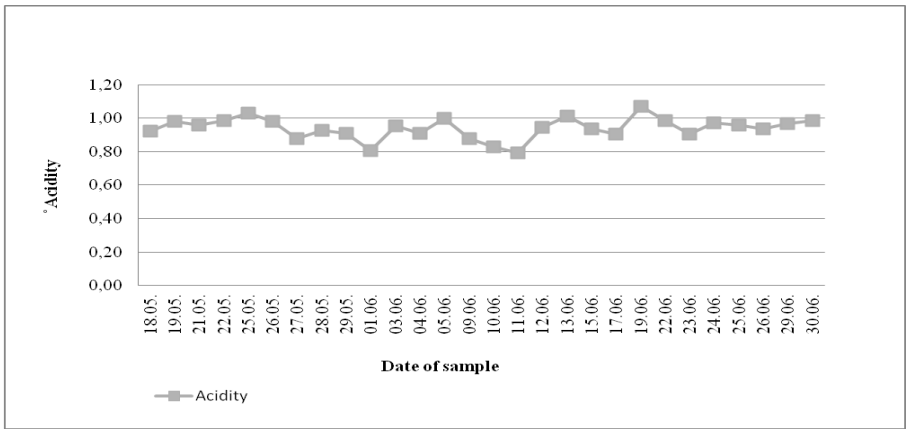


Fig. 2. Changes of acidity in orange juice «Valencia»

Рис. 2. Изменение кислотности в соке из апельсинов сорта «Валенсия»

Citric acid is the most predominant acid in citrus, accounting for 80-90 percent of the total acids in various citrus fruits [3]. In oranges free acid per fruit increased in early growth and then became more or less constant. The decrease in titratable acidity was considered to be due to dilution as the fruit increased in size and in juice content.

The relative sweetness or sourness of citrus fruit is determined by its ratio of sugars to acids. This is a maturity index and used to determine the legal maturity of oranges.

The Ration of «Valencia» oranges NFC was unstable, approximately on May orange juice has 10,58 Ratio, but on June «Valencia» orange juice has maximum Ratio 13,86 (fig. 3) because the content of sugar and acidity also fluctuated during two month.

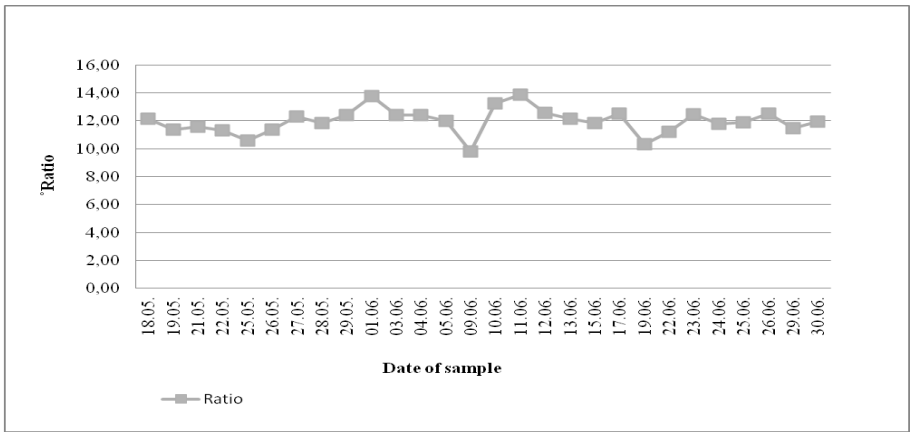


Fig. 3. Changes of Ratio in orange juice «Valencia»

Рис. 3. Изменение показателя Ратио в соке из апельсинов сорта «Валенсия»

The ratio gives relative measure of the fruit maturity and this standard varies with preference of people in different countries. A higher ratio indicates decreasing acid content. There is a limit of this higher ratio. Usually fruit with ratios higher than 19-20 are not liked by the people because the taste is quite sweet or flat with so much less acid.

Important contributor of juice is the suspended solids also known as pulp. The very small pulp particles called “sinking pulp” are closely related to cloud.

Sinking pulp, comprising particulate fibres, gradually settle out with time. The pulp is found in all oranges juices and is an important part of orange juice cloud. Typical values in NFC juice range from 5 % to 12 %.

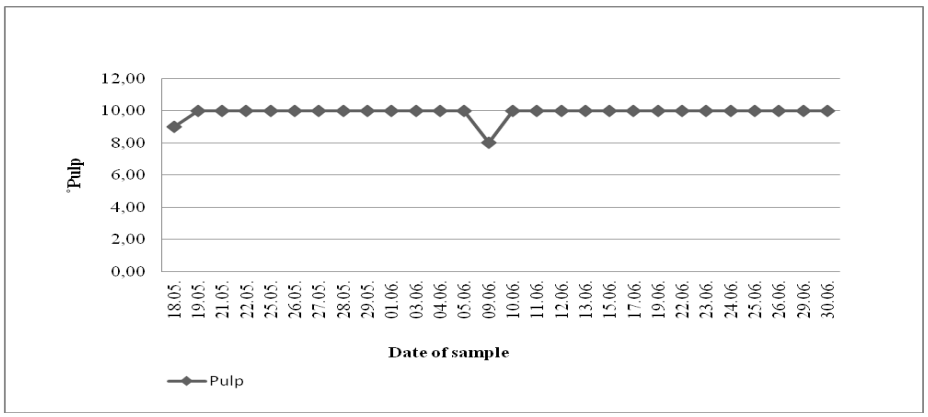


Fig. 4. Changes of pulp in orange juice «Valencia»

Рис. 4. Изменение содержания пульпы в соке из апельсинов сорта «Валенсия»

The pulp parameters of orange juice Valencia were stable during both month and range from 5 % till 10 % (fig. 4).

The oil content is often equated to d-limonene concentration since d-limonene is the dominant compound present in both peel oil and essence oil. d-limonene acts as a carrier of flavours but contributes little to the flavour itself. However, excess of d-limonene can give a burning taste to juice.

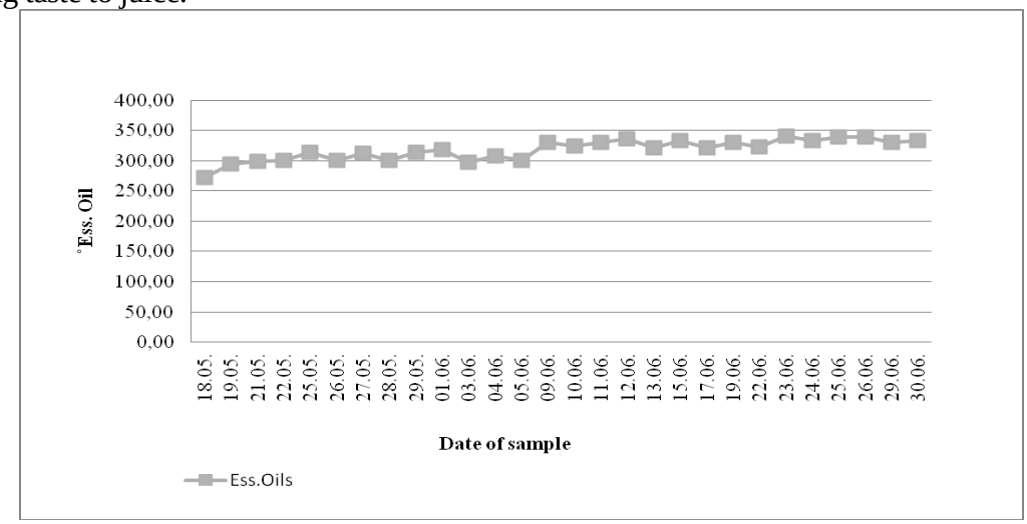


Fig. 5. Changes in orange juice «Valencia» oils

Рис. 5. Изменение содержания эфирного масла в соке из апельсинов сорта «Валенсия»

The essential oil concentration in orange juice was from 272 ppm to 340 ppm (fig. 5). High levels of oil in juice result from squeezing the fruit too hard when extracting the juice (for increased yield).

## CONCLUSIONS

The study results show that on May orange NFC Valencia has minimum sugars – 8,59 ˚Brix and on June orange NFC «Valencia» has 12,28 ˚Brix. The acid decreased from 1,03g.100g$^{-1}$ on May to 0,79g 100g$^{-1}$ on June. On May, orange juice has 10,58 Ratio, but on June «Valencia» orange juice has maximum Ratio 13,86 The pulp parameter was stable during both months. The essential oil concentration in orange juice was from 272 ppm to 340 ppm.

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## БИОЛОГИЧЕСКИЕ ХАРАКТЕРИСТИКИ АПЕЛЬСИНОВОГО СОКА

Г. Зваигзне, Д. Карклиня

Цитрусовые соки – самые популярные в мире. Главными факторами качества соков и концентратов являются сорт цитрусовых, места произрастания, период созревания и способ производства. Наиболее важными показателями качества сока для потребителей являются вкус, аромат и цвет, а также содержание функционально активных веществ.

Целью данного исследования было изучение особенностей содержания биологически активных компонентов апельсинового сока, полученного из концентрата (NFC – Not-From Concentrate), приготовленного из апельсинов сорта «Валенсия», в течение двух месяцев созревания плодов. Исследования проводились в Греции, в лаборатории завода "BioFresh". Тестировались такие показатели NFC апельсинового сока, как содержание мякоти, сухих веществ, органических кислот, эфирного масла и ратио.

Результаты исследования показали, что концентрации сухих веществ были низкими в начале сезона в мае, но быстро увеличились в июле в NFC апельсиновом соке «Валенсия». В мае NFC апельсинового сока имеет минимум сухих веществ (Brix 8,59 ˚), а в июне брикс апельсинового сока вырос до 12,28 ˚. Содержание органических кислот уменьшалось по мере созревания фруктов, и в мае кислотность составляла $1{,}03*100^{-1}$г, а уже в июне кислотность NFC-апельсинового сока снизилась до $0{,}79*100^{-1}$г. Показатель ратио также повышался по мере созревания фруктов. В мае апельсиновый сок имел минимальное значение ратио 10,58, в июне с возрастанием уровня накопления сахаров ратио увеличивался до 13,86˚ Brix. Показатели содержания мякоти оставались стабильными на уровне 10%, при этом концентрация эфирных масел равнялась от 272 до 340 частей на миллион. Таким образом, апельсиновый сок будет иметь наивысшее содержание биологически активных веществ и наиболее благоприятные органолептические показатели в том случае, если он будет изготовлен из плодов июньского сбора.

*апельсины сорта «Валенсия», сок, сахар, кислоты, ратио, целлюлоза, эфирные масла*

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