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**STUDY OF NUTRITIONAL INGREDIENTS OF ORANGES
(*CITRUS SINENSIS* (L.) OSB.) GROWN IN VIETNAM**

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This article presents the results of study on nutritional qualities of oranges (*Citrus sinensis* (L.) Osb) which are grown in Vietnam at the time of ripeness. The main nutrients in oranges include sugar, vitamins, amino acids, organic acids, citric acids, mineral elements, etc. The results of the study also showed that the most appropriate time for harvesting is when they are 30 weeks of age. If we harvest earlier or later, the quality of the fruit is reduced significantly. This conclusion helps consumers to collect and preserve the orange better.

Keywords: citrus sinensis, harvest, mineral elements, orange, preserve, quality, ripe fruit.

Introduction

Orange (*Citrus sinensis* (L.) Osb.) is a citrus orchard which is grown quite popular in tropical and subtropical climates. Vietnam is one of the countries in the citrus growing center (Southeast Asian Center) so the citrus orchard has been planted for a long time and widely distributed from the North to South (Le Thanh Phong et al., 1999). In Vietnam there are many varieties of oranges which are imported from overseas with the high quality and yield. They are planted commonly in many provinces and cities (Hoang Ngoc Thuan, 2004). However, nowadays the collection and preservation of oranges are not scientifically based on the experience of gardeners, which makes the orange in the market does not guarantee the quality which can affect the health of consumers.

Oranges is an important source of nutrients for the human's body like vitamins, sugar, mineral, etc. (Hoang Ngoc Thuan, 1995; P. Spiegel-Roy, E. E. Goldschmidt, 1996). Study of the nutritional ingredients of oranges has been studied extensively in the world, however, in Vietnam, this research problem is limited.

The determination of nutrient content of fruits at physiologic ripeness time is very important to help the consumers about nutritional, medicinal as well as economic values of the fruit for the most effective use. So we have collected samples and analysed the physiological and biochemical targets to determine the nutritional ingredients of oranges when they ripen to help consumers use and preserve fruit better.

Materials and research methods

Research subjects: The orange is collected on the orange garden of 1.5 hectares of family of Mr. Luu Quoc Tuan and Mrs. Dang Thi Hop planted in Thong Nhat farm, Thong Nhat town, Yen Dinh District, Thanh Hoa Province, Vietnam. The tree is nine years old. It has good growth and low pests with the high productivity and stability.

Research Methods: Determining water content, dry matter content in fruit by electronic scales and desiccator (Nguyen Duy Minh, Nguyen Nhu Khanh, 1982). The method of determining the fruit size, size of the segment and the thickness of the shell by pallet clamps (Nguyen Duy Minh, Nguyen Nhu Khanh, 1982). Determining the fruit volume by measuring the volume of water occupying the fruit in the measuring tubes (Nguyen Duy Minh, Nguyen Nhu Khanh, 1982). Determining the fruit fresh weight, the rates of fruit flesh, fruit seeds and fruit shells by the electronic balance with the precision of 10^{-4} g (Nguyen Duy Minh, Nguyen Nhu Khanh, 1982). Quantification of reducing sugar by Bertrand method (Nguyen Van Mui, 2001; Pham Thi Tran Chau et al., 1996). Quantification of starch by Bertrand method (Pham Thi Tran Chau et al., 1996). Quantification of total acid by Ermacov (Ecmacov N. A., 1972). Quantification of citric acid by Ermacov (Ecmacov N. A., 1972). Quantification of vitamin C by titration method (Nguyen Van Mui, 2001). The content of total amino acids was analysed at the National Institute for Food Control. Quantification of mineral elements (Ca, Mg, K, Fe, Na, P, Zn, Cu, Mn) by ICP — OES atomic emission spectroscopy (Nguyen Van Mui, 2001). Determining the content of vitamins B1, B2, vitamin B3, vitamin B5, vitamin B6, vitamin E, β -caroten, mineral elements, amino acids were analysed at the National Institute for Food Control. The remaining indicators are analysed at the laboratory of the Plant Physiology and Application Team, Biology Technology Team, Faculty of Biology, Hanoi National University of Education.

Results and discussion. Through the analysis process of physiological and biochemical targets of orange since the fruit was fertilized until fruit was 32 weeks of age, we found that at 29 weeks of age, the inverted sugar content reached 8,852% fresh fruit flesh, at 30 weeks of age reached 9,275% of fresh fruit and 32 weeks of age reached 9,015% of fresh fruit flesh. While vitamin C content at 29, 30, and 32 weeks of age, respectively 33,524; 35,175; 31,429 mg/100g fresh fruit flesh. This shows that the orange stops growing and achieve the best qualities at 30 weeks of age. After 30 weeks, the volume of the fruit increases a little due to increased water content but sugar content and vitamin C content in fruits reduce result in the quality of the fruit reduces. So the orange matures physiologically at 30 weeks of age.

To evaluate the quality of oranges at the time of ripeness, we carried out analysing some morphological and anatomical characteristics of fruits (Table 1), some nutritional components of fruits (Table2), amino acid composition (Table 3) and the content of some mineral elements (Table 4).

Table 1
Some morphological, anatomical characteristics of oranges

Physiological target	Value	Unit
Length of Fruit	6,851 \pm 0,081	cm
Diameter of Fruit	7,050 \pm 0,009	cm
Volume of Fruit	195,137 \pm 0,023	cm ³
Weight of Fruit	181,207 \pm 0,103	gam
Flesh of Fruit	74,142 \pm 0,075	% of fresh fruit weight

Peel of fruit	Weight	24,818 ± 0,017	% of fresh fruit weight
	Thickness	0,193 ± 0,002	cm
Seed	Amount	8,000 ± 0,037	
	Weight	1,040 ± 0,027	% of fresh fruit weight
Size of the segment	Length	6,237 ± 0,080	cm
	Width	2,723 ± 0,035	cm
	Back thickness	1,604 ± 0,007	cm
Color, shape of fruit		Fruit is sphere shape with the yellow peel and green. The yellow color represents one-third of the color of the peel.	

At the time of physiological ripeness, the orange has spherical shape with a length of 6,851 cm, a diameter of 7,05 cm. Fruit volume is 195,137 cm³ and average weight is 181,207g. About the composition of the fruit, the seed has the average number of seeds is 8 accounted for 1,04% of fresh fruit weight, which shows that the number of seeds is small and account low ratio. The fruit contains many cloves and accounts for 74,142% of fresh fruit weight. The colour of fresh fruit is characteristic light yellow, with 24,818% of fresh fruit with a thickness of 0,193 cm. The size (length, width, thickness) are respectively (6,237; 2,723; 1,604). This is the time when the fruit has the characteristic colours. When the fruit is ripe, it has orange-yellow mixed with blue colour and fruit almost reach maximum size. This result is consistent with the physiological characteristics of ripe fruit (Nguyen Nhu Khanh, 2009).

Table 2
Some nutritional ingredients in orange

No.	Nutritional ingredients	Content			Unit
		29 weeks	30 weeks	32 weeks	
1	Water	87,443 ± 0,022	87,835 ± 0,014	87,864 ± 0,004	%
2	Dry matter	12,557 ± 0,058	12,165 ± 0,009	12,136 ± 0,041	%
3	Invert sugar	8,852 ± 0,004	9,275 ± 0,034	9,015 ± 0,032	% of fresh fruit flesh
4	Starch	0,221 ± 0,041	0,135 ± 0,008	0,102 ± 0,004	% of fresh fruit flesh
5	Organic acids	55,238 ± 0,007	47,273 ± 0,005	45,217 ± 0,012	g/ 100g flesh of fresh fruit
6	Citric acid	0,354 ± 0,002	0,303 ± 0,031	0,289 ± 0,090	g/ 100g flesh of fresh fruit
7	Vitamin C	33,524 ± 0,005	35,175 ± 0,027	31,429 ± 0,093	mg/ 100g flesh of fresh fruit
8	Vitamin E	-	0,164 ± 0,025	-	mg/ 100g flesh of fresh fruit
9	Vitamin B ₁	-	0,035 ± 0,001	-	mg/ 100g flesh of fresh fruit
10	Vitamin B ₂	-	0,017 ± 0,001	-	mg/ 100g flesh of fresh fruit
11	Vitamin B ₃	-	0,183 ± 0,015	-	mg/ 100g flesh of fresh fruit
12	Vitamin B ₅	-	0,147 ± 0,047	-	mg/ 100g flesh of fresh fruit
13	Vitamin B ₆	-	0,049 ± 0,021	-	mg/ 100g flesh of fresh fruit

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14	β-caroten	-	6,200 ± 0,001	-	µg/ 100g flesh of fresh fruit
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Of which: -: are not analysed at 29 and 32 weeks of age

According to the data table, at the time of physiological ripeness, the oranges contain large sugar content of 9,275% fresh fruit flesh, then the amount of sugar decreases. Meanwhile, the amount of starch is low and decreased to 32 weeks of age to 0,102% of fresh fruit flesh. Besides that, the fruits contain large amounts of vitamin C (up to 35,175mg in 100g fresh fruit flesh) at the time of physiological ripeness. Because of the characteristic of orange is succulent fruit, so when the orange is 30 weeks of age (physiological ripeness), the water content in the fruit is large and 87,835%. As the fruit grows, the total organic acidity in the fruit increases and reaches a relatively high rate. At 30 weeks of age, the index reaches 47,273 g/100 g fresh fruit. Corresponding to the variation of total organic acids, the citric acid content also increases to 0,303g of 100g fresh fruit flesh at 30 weeks of age. The vitamin content in orange is not much, when it is physiological ripeness, vitamin B1 content reached 0,035mg/100g fresh fruit flesh, vitamin B2 reached 0,017mg/100g fresh fruit flesh with the relatively low vitamin content, while the content β-carotene (pre-vitamin) only reached 6,2 µg/100g fresh fruit.

Thus, the orange when is at the time of physiological ripeness, it contains high levels of vitamin C, citric acid, inverted sugars, total organic acids and a high level of water content (Nguyen Nhu Khanh, Le Van Trong, 2012). Meanwhile, the starch content, some vitamins such as B1, B2 have relatively low content.

Table 3

Composition of amino acids

No.	Amino acid	Content (mg/100g fresh fruit flesh)
1	Axit aspartic	85,2
2	Axit glutamic	19,0
3	Serin	33,5
4	Histidin*	7,0
5	Arginin	25,1
6	Glycin	10,6
7	Threonin*	13,0
8	Tyrosin	11,0
9	Alanin	13,4
10	Valin*	18,0
11	Methionin*	3,0
12	Phenylalanin*	17,0
13	Isoleucin*	12,1
14	Leucin*	22,3
15	Lysin*	19,3
16	Prolin	19,2
17	Tryptophan*	7,0
	Total	335,7

*Of which: *: are non-replaced amino acids*

According to the data table, the amino acid content in oranges at ripening time (30 weeks) was relatively high, with aspartic amino acids accounting for 85,2 mg/100 g fresh fruit flesh, follow by acids such as serine (33,5 mg/100 g fresh fruit flesh), arginine (25,1 mg/100 g fresh fruit flesh), leucine (22,3 mg/100 g fresh fruit flesh). The lowest concentration of amino acid is methionine (3,0 mg/100 g fresh fruit flesh), follow by histidine and tryptophan (7,0 mg/100 g fresh fruit flesh). Thus, in the oranges at the time of physiological ripeness, there is a full range of amino acids in a large proportion, which contains adequate amino acids that are not replaced.

Table 4

Composition of some mineral elements

No.	Mineral composition	Content	Unit
1	Na	4,4	mg/ 100g flesh of fresh fruit
2	Fe	4,1	mg/ 100g flesh of fresh fruit
3	K	118	mg/ 100g flesh of fresh fruit
4	Mg	11,4	mg/ 100g flesh of fresh fruit
5	Ca	20	mg/ 100g flesh of fresh fruit
6	P	31,7	mg/ 100g flesh of fresh fruit
7	Zn	0,12	mg/ 100g flesh of fresh fruit
8	Cu	0,06	mg/ 100g flesh of fresh fruit
9	Mn	0,05	mg/ 100g flesh of fresh fruit

The highest percentage of minerals in oranges at the time of physiological ripeness (30 weeks of age) is Kali, which reaches 118 mg/100 g fresh fruit flesh, followed by calcium reached 20 mg/100g fresh fruit flesh. Phosphorus has the lowest content of these elements and reaches 31,7 mg/100 g of fresh fruit flesh. There are also some elements with relatively high ingredients such as magnesium, sodium, iron. As such, orange contains many mineral elements and is high in content.

Conclusion

Throughout the process of study, we found that oranges at physiological ripeness (30 weeks of age) have good qualities, containing high levels of sugar and vitamin C. The fruit contains the full range of amino acids, including all 9 types of amino acids which are not replaced. Besides that, the orange also contains many high-quality mineral elements. Therefore, the time of 30 weeks of age is the most appropriate harvest time. If we harvest sooner or later, the quality of the fruit is significantly decreased.

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ИССЛЕДОВАНИЕ ПИТАТЕЛЬНЫХ ВЕЩЕСТВ АПЕЛЬСИНОВ (*CITRUS SINENSIS* (L.) OSB.) ВЫРАЩИВАЕМЫХ ВО ВЬЕТНАМЕ

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В статье представлены результаты исследования питательных веществ спелых апельсинов (*Citrus sinensis* (L.) Osb.), выращиваемых во Вьетнаме. Апельсины богаты питательными веществами такими, как: сахар, витамины, аминокислоты, органические кислоты, лимонные кислоты, минеральные элементы. Результаты исследования также показывают, что 30 недель после посадки апельсинов является наиболее подходящим временем для их сбора. Если собирают их раннее или позднее, их качество значительно снижается. Этот вывод помогает потребителям лучше собирать и сохранять апельсины.

Ключевые слова: *Citrus sinensis*; сбор урожая; минеральные элементы; апельсин; сохранение; качество; спелый фрукт.