Scientific Papers, Series B, Horticulture, Vol. LVI, 2012
CD-ROM ISSN 2285-5661, ISSN-L 2285-5653

THE CONTENT OF PLANT PIGMENTS IN RED AND YELLOW BELL PEPPERS

Mara DUMA, Ina ALSINA[1]

[1]*Latvia University of Agriculture, Jelgava, LV-3001, Latvia*
Phone+371 63005662,Fax. +371 6305685, E-mail: Mara.Duma@llu.lv; Ina.Alsina@llu.lv

Corresponding author email: mara.duma@llu.lv

Abstract

Carotenoids are plant pigments that are widespread in vegetable and fruit and have many important functions, especially in relation to human health and their role as biological antioxidants. Bell peppers are very low in saturated fat, cholesterol and sodium. It is also a good source of vitamin K, thiamin, riboflavin, niacin, potassium and manganese, and a very good source of dietary fiber, vitamin A, vitamin C, vitamin E (alpha tocopherol), vitamin B6 and folate.The aim of this research was to determine the content of β-carotene and lutein in red and yellow peppers, using different solvents - acetone, hexane, petroleum ether (PE), tetrahydrofuran (THF) for carotenoids extraction. The amount of carotenoids was established spectrophotometrically.The acquired results of current research demonstrate that total content of carotenoids is in average two times higher from yellow peppers comparing with red peppers. The highest total content of carotenoids 5.81±0.02 mg g^{-1} was obtained from yellow peppers using THF as solvent. The relation between β-carotene and lutein is higher in red peppers, in average 0.13 mg g^{-1} compared with 0.075 mg g^{-1} in yellow peppers.

Key words: β-carotene, lutein, red peppers, solvents, yellow peppers, *Capsicum annuum*.

INTRODUCTION

Pigments are chemical compounds which reflect only certain wavelengths of visible light. The light that is absorbed may be used by the plant to power chemical reactions, while the reflected wavelengths of light determine the color the pigment will appear to the eye. There are many different plant pigments, and they are found in different classes of organic compounds. Plant pigments give color to vegetables and fruits, its leaves and flower and are also important in processes of photosynthesis, growth and development. Carotenoids are plant pigments that are widespread in vegetable and fruit and have many important functions, especially in relation to human health and their role as biological antioxidants. They are essentially C40 terpenoid compounds formed by the condensation of eight isoprene units. There are two general classes of carotenoids – carotenes and xantophylls. Carotenes consist only of carbon and hydrogen atoms, while xantophylls have one or more oxygen atoms.

Sweet bell peppers (*Capsicum annuum* L.) are very low in saturated fat, cholesterol, sodium and also a fineness source of ascorbic acid and carotenoids. Bell pepper is not only an excellent source of carotenoids, it contains more than 30 different carotenoids, including concentrated amounts of beta-carotene and zeaxanthin. Both of these carotenoids provide antioxidant and anti-inflammatory health benefits. More over peppers are rich in flavonoids [6] and other phytochemicals [2]. A recent study about vitamin C, vitamin E, and six of carotenoids (alpha-carotene, beta-carotene, lycopene, lutein, cryptoxanthin and zeaxanthin) content in commonly eaten foods found that only two vegetables contained at least two-thirds of all the listed nutrients. One of these foods was tomato, and the other was sweet bell pepper. Bell pepper alone provided 12% of the total zeaxanthin found in the participants' diets. Bell pepper also provided 7% of the participants' total vitamin C intake [3].

Most extraction methods of carotenoids from plant samples use different polar and non-polar

organic solvents such as hexane, ethanol, methanol, acetone, tetrahydrofuran, benzene and petroleum ether. Additionally, mixtures of hexane with acetone, ethanol or methanol are often used [7], [11].
Carotenoid analysis in plant samples may be carried out by different analytical methods. Although HPLC is the very often used for separation and quantification of β-carotene, it requires exhaustive sample purification steps and complicates equipment. Therefore spectrofotometric methods are popular, reliable and low cost.
In the present work, the content of β-carotene and lutein in red and yellow peppers was determined, using different solvents - acetone, hexane, petroleum ether (PE), tetrahydrofuran (THF) for carotenoids extraction.

MATERIAL AND METHOD

Investigations were carried out at the Latvia University of Agriculture, Institute of Soil and Plant Sciences.
The objects of the research were red and yellow bell peppers *Capsicum annuum* cv 'California Wonder' red, and cv 'California Wonder' yellow.
All the reagents used were of analytical grade. A UV Visible spectrophotometer with 1 cm quartz cell was used for the absorbance measurements.
Plant pigments were extracted using different organic polar and non polar solvents: acetone, hexane, petroleum ether (PE) and tetrahydrofuran (THF). For extraction a representative portion of sample (0.5 g) was accurately weighted in a glass test tube. Then 5 mL of each solvent was added to it and the test tubes were held for 15 min with occasional shaking at room temperature and finally centrifuged.
The carotenoids content were analyzed spectrophotometrically by absorption measurements at 350 to 700 nm with 1 nm interval and calculated in accordance with Nagata and Yamashita [8] and Seow-Mun Hue at all [10].
Investigations were carried out in three replications. The data was processed using MS EXCEL.

RESULTS AND DISCUSSIONS

The absorption spectra of extracts from red and yellow peppers in different organic polar and non polar solvents - acetone, hexane, petroleum ether and tetrahydrofuran were analyzed. The obtained results are showed in Fig. 1. and Fig. 2.

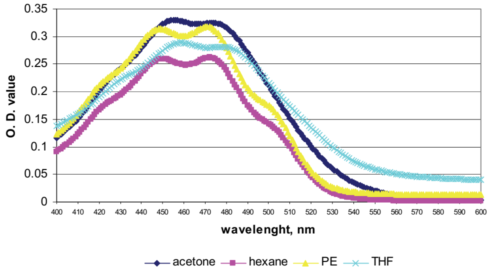

Fig.1. Absorption spectra of extracted carotenoids using different solvents in red peppers

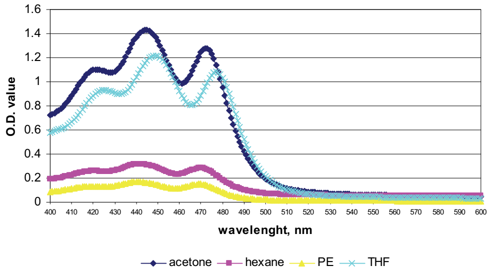

Fig.2. Absorption spectra of extracted carotenoids using different solvents in yellow peppers

Comparison of absorption spectra of extracts obtained from red peppers (Fig.1.) has shown that all investigated organic solvents give the similar characteristic bands in 400- 500 nm region. The higher absorption (O.D.) values were obtained using acetone, the less O.D. values gives extracts with hexane, but these differences are not significant ($p>0.05$). Therefore the conclusion can be drawn that all investigated organic solvents are corresponding for carotenoids extraction in red peppers.
The obtained results in yellow pepper were different (Fig.2.). The absorption spectra of carotenoids in acetone and THF differed from the spectrum of these pigments in hexane and PE and these differences are significant ($p<0.05$). Analyzing acetone and THF extracts of carotenoids the obtained absorption were 4-5 times higher. Considering these results the

use of acetone and THF can be recommended for carotenoids extraction from yellow pepper.

Further the amount of β-carotene and lutein were calculated in red and yellow bell peppers and the contribution of different organic solvents to the extraction of these compounds was examined comparatively.

Table 1 shows the content of β-carotene (C), lutein (X), as well as the total content of extracted carotenoids and ratio between β-carotene and lutein (C/X) in red and yellow peppers.

Table 1. Content of carotenoids in extracts from peppers

Sample	Solvent	Carotenoids, mg g^{-1} ± SD			
		lutein (X)	β-carotene (C)	total	C/X
Red pepper	acetone	2.33 ± 0.16	0.26 ± 0.01	2.59 ± 0.08	0.11
	hexane	1.19 ± 0.09	0.17 ± 0.01	1.36 ± 0.04	0.14
	PE	2.07 ± 0.11	0.27 ± 0.01	2.34 ± 0.07	0.13
	THF	3.39 ± 0.10	0.44 ± 0.02	3.83 ± 0.11	0.13
Yellow pepper	acetone	3.73 ± 0.13	0.52 ± 0.02	4.25 ± 0.14	0.14
	hexane	2.24 ± 0.06	0.11 ± 0.004	2.35 ± 0.06	0.049
	PE	3.44 ± 0.10	0.098 ± 0.002	3.54 ± 0.10	0.028
	THF	5.37 ± 0.16	0.44 ± 0.02	5.81 ± 0.02	0.082

The calculated amount of lutein in red peppers differs from 1.19 mg g^{-1} (as solvent using hexane) till 3.39 mg g^{-1} in the case of THF. Thereby the THF is in average 2.8 times more efficient than hexane for lutein extraction. In the case of other examined solvents acetone and PE the level of lutein was practically similar – it was determined in average 2.2 mg g^{-1}. The similar results we observed analyzing the content of β-carotene. THF is the most corresponding solvent for β-carotene extraction in red pepper.

This study has also demonstrated that the content of lutein from yellow peppers is 1.6 times higher than from red pepper compared together applying solvents. The examined solvents can be arranged following lutein extraction efficiency: THF > acetone > PE > hexane.

Literature data for lutein and β-carotene content differs, probably due to influence of variety, weather conditions, ripening stage or other factors [1], [4], [5], [9].

The acquired results of current research demonstrate that total content of carotenoids is in average two times higher from yellow peppers comparing with red peppers. The highest total content of carotenoids 5.81±0.02 mg g^{-1} was obtained from yellow peppers using THF as solvents. The calculated relation between the content of β-carotene and lutein is higher in red peppers, in average 0.13 mg g^{-1} compared with 0.075 mg g^{-1} in yellow peppers.

CONCLUSIONS

Results showed that all investigated organic solvents are corresponding for carotenoids extraction in red peppers, but acetone and THF are the most corresponding solvents for carotenoids extraction in yellow pepper. These solvents are in average 2.5 times more efficient than PE and hexane. The acquired results demonstrate that yellow peppers are richer of total carotenoids comparing with red peppers. The highest total content of carotenoids 5.81±0.02 mg g^{-1} was obtained from yellow peppers using THF as solvent. The relation between the content of β-carotene and lutein is in average two times higher in red peppers.

ACKNOWLEDGEMENTS

This work was supported by the Latvian Council of Science, project 09.1456.

REFERENCES

[1] Damaso Hornero-Mendez, Ricardo Gomez-Ladron de Guevara, M.Isabel Minguez-Mosquera, 2000. *Carotenoid biosynthesis changes in five red pepper (Capsicum annuum L.) cultivars during ripening. Cultivar selection for breeding. Journal of Agricultural and Food Chemistry*, 48 :3857-3864.

[2] Duke, J. A., 1992. *Biologically Active Phytochemicals and Their Activities*. CRC Press, Boca Raton, FL

[3] Garcia-Closas, R., Berenquer, A., Sanchez, M.J. , 2004. *Dietary sources of vitamin C, vitamin E and specific carotenoids in Spain*. The British Yournal of Nutrition. Cambridge, 91 (6): 1005-1011.

[4] Hallmann, E., Rembialkowska, E., 2008. *The content of slected antioxidant compounds in bell pepper varieties from organic and conventional cultivation before and after freezing process*. 16th IFOAM Organic Congress materials, Modena, Italy, June 16-20, 2008. Archived at http://orgprints.org/12516.

[5] Howard, L.R., Talcott, S.T., Brenes, C.H., Villalon, B., 2000. *Changes in phytochemical and antioxidant activity of selected pepper cultivars (Capsicum species) as influenced by maturity*. Journal of Agricultural and Food Chemistry, 48: 1713-1720.

[6] Lee, Y., Howard, L. R., and Villalon, B.,1995. *Flavonoid and ascorbic acid content and antioxidant activity of fresh pepper (Capsicum annuum) cultivars*. IFT Abstract: 55, 79.

[7] Lin, C.H., Chen, B.H., 2003. *Determination of carotenoids in tomato juice by liquid chromatography*. Journal of Chromatography, 1012: 103-109.

[8] Nagata, M., Yamashita, I., 1992. *Simple method for simultaneous determination of chlorophyll and carotenoids in tomato fruit*. Journal of Japan Food Science and Technology, 39: 925-928.

[9] Perry, A., Rasmussen, H., Johnson, E.J., 2009. *Xantophyll (lutein, zeaxanthin) content in fruits, vegetables and corn and egg products*. Journal of Food Composition and Analysis, 22: 9-15.

[10] Seow-Mun Hue, Amru Nasrulhag Boyce, Chandran Somasundram, 2011. *Influence of growth stage and variety on the pigment levels in Ipomoea batatas (sweet potato) leaves*. African Journal of Agricultural Research, Vol. 6(10): 2379-2385

[11] Van den Breg, H., Faulks, R., Fernando, H., Hirschberg, J., Olmedilla, B., Sandmann, G. et al, 2000. *The potential fot the improvement of carotenoids levels in foods and the likely systemic effects*. Journal of the Science of food and Agriculture, 80,: 880-912.