

Lycopene and flesh colour differences in grafted and non-grafted watermelon

D. Fekete

e-mail: david.fekete86@gmail.com,
david.fekete@uni-corvinus.hu

M. Stéger-Máté

e-mail: monika.stegernemate@uni-corvinus.hu

V. Böhm

e-mail: viktor.bohm@uni-corvinus.hu

G. Balázs

e-mail: balazs.gabor@uni-corvinus.hu

N. Kappel

e-mail: noemi.kappel@uni-corvinus.hu

Corvinus University of Budapest, Faculty of Horticultural Science
Department of Vegetable and Mushroom Growing,
Budapest, 1118, Villányi str. 29-43, Hungary

Abstract. The experiment was carried out in three regions in Hungary (Jászszentandrás, Cece, Újkígyós) in 2013 to determine the fruit quality of grafted watermelon (*Citrullus lanatus* Thunb.). The “RX 467” seedless watermelon variety was grafted on two commercial rootstocks “FR STRONG” [*Lagenaria siceraria* (Mol.) Standl.] and “RS 841” (*Cucurbita maxima* Duchesne × *Cucurbita moschata* Duchesne). The lycopene and flesh colours are important quality characteristics even of the self-rooted and grafted watermelon. Some differences can be attributed to different environments, technological methods and to the type of rootstock-scion combination. Lycopene is a strong antioxidant; therefore, we considered to examine the content change. Regardless of growing location, the lycopene concentration and the chroma (C*) showed the best result in the case of interspecific rootstock. The result also showed that in two regions (Jászszentandrás, Cece) we can find negative correlation between the lycopene concentration and the L* value of the flesh colour.

Keywords and phrases: grafting, watermelon, lycopene, flesh colour.

1 Introduction

The aim of the study was the determination of the lycopene amount and the colour sense in grafted and self-rooted watermelon as well as to find a positive or negative relationship between them. The other aim of the experiment was to see the lycopene influence on the intensity and “deepness” of the red colour. The sample collection was set in three places with the same varieties and grafting combinations but with different technological backgrounds. Beside the goals mentioned above, we were interested whether the result of the different technologies and regions would be the same.

We can find a high amount of lycopene in red-fleshed watermelons (*Perkins-Veazie et al.*, 2001). This carotenoid pigment can behave like an antioxidant by quenching free radicals formed in normal metabolism (*Sies & Stahl*, 1998). We can see the lycopene content as another quality attribute of watermelon (*Perkins-Veazie & Collins*, 2004). Watermelon is a well-known refreshing fruit in the Mediterranean basin and also in Northern Europe. We can find different varieties of antioxidants such as lycopene and β -carotene, vitamins, phenols and amino acids (*Perkins-Veazie*, 2002; *Perkins-Veazie et al.*, 2007).

The low caloric value and health benefits of eating watermelon make it a popular fruit. The antioxidant and bioactive compound identification and quantification of many vegetables and fruits are well-defined, but the antioxidant and phytotechnical properties quantification and characterization of watermelon are limited. It has been reported that the external factors and genotype differences strongly influence the fruits’ and vegetables’ antioxidant and health-promoting bioactive compound activity (*Waterman & Mole*, 1994; *Abushita et al.*, 2000; *Dumas et al.*, 2003; *Lenucci et al.*, 2009).

One of the most important quality traits is the watermelon’s flesh colour. The flesh coloration is attributable to the carotenoid content and composition. Carotenoids are very important antioxidants which can reduce the risk of cardiovascular diseases and certain cancers (*Bramley*, 2000; *Gerster*, 1997; *Giovannucci et al.*, 2002). The flesh colour can be categorized as coral red, scarlet red, salmon yellow, canary yellow, white and orange flesh (*Gusmini & Wehner*, 2006).

2 Materials and methods

2.1 Materials

The experiment was carried out in 2013 in three different regions of Hungary (Jászszentandrás, Cece and Újkígyós). The scion was “RX 467” seedless watermelon. This variety was grafted on two well-known rootstocks: “FR STRONG” [*Lagenaria siceraria* (Mol.) Standl.] and “RS 841” (*Cucurbita maxima* Duchesne $\times$ *Cucurbita moschata* Duchesne). We used chroma meter (Konika Minolta CR 300) to measure the colour of the fresh-cut watermelons’ flesh surface. The lycopene content was measured from the cut and squeezed watermelon flesh.

2.2 Methods

We tried to harvest and measure those watermelon fruits which were fully ripe. The methodology of the colour measurement: The harvested watermelons were cut in four parts and the chroma meter was put on the surface of the fruit flesh to measure the colour. The methodology of lycopene measurement: After the harvest, the watermelons were cut in four parts and the fruit flesh was squeezed and put in a 50-ml falcon pipe. The amount of lycopene, after hexane extraction, was evaluated by spectrophotometric process (Sadler *et al.*, 1990). The measurements were carried out at 502 nm. In order to calculate the lycopene content, we used molar extinction coefficient ($M \cdot cm^{-1}$) in hexane (158500, Merck & Co, 1989). The sample lycopene content was given in mg/100g fresh weight and we normalized it in 6 Brix° dimensions (Barrett-Anthon, 2001). An SPSS-programme-based analysis was executed on the statistical data with the level of 95% confidentiality.

3 Results and discussion

In *Figure 1*, we can state that in the case of lycopene the plants grafted on interspecific rootstock showed the best results and the plants grafted on the *Lagenaria* rootstock had the lowest amount of lycopene. If we compare the regions, we can see that the lowest lycopene concentration (4.85 mg/100g) was measured in the Újkígyós Region on *Lagenaria* rootstock and the highest in the Jászszentandrás Region on interspecific rootstock. Differences among cultivars were also detected in other studies. *Thili et al.* (2011) measured the lowest amount of lycopene (4.45 mg/100g fresh weight) in Crimson sweet cultivar,

followed by P403 (4.48 mg/100g fw), Dumara (4.71 mg/100g fw), Giza (6.26 mg/100g fw) and finally P503 (6.45 mg/100g fw) cultivars at the red-ripe stage. The β -carotene, lipophilic antioxidant activities (LAA) and lycopene concentration markedly increased with ripening. The data showed that the antioxidant potential of watermelons is determined by genetic background and ripening stage (Tlili et al., 2011).

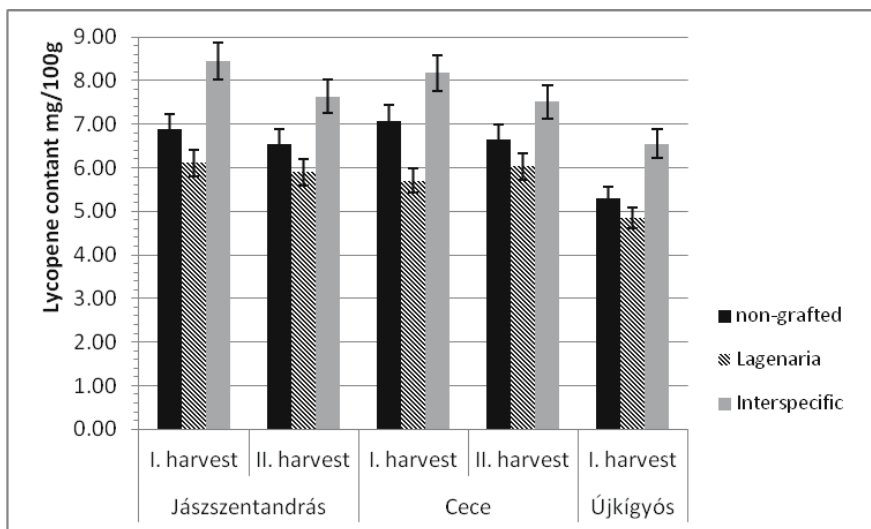


Figure 1: Lycopene average results

The added nutrient quantities were very different in the three regions (Figure 2), but in the case of lycopene we can see in Figure 1 that in two regions (Jászszentandrás, Cece) the lycopene concentrations are very similar. The highest (double the amount compared to other regions) amount of potassium was given in Újkígyós nevertheless; the result was lower in the case of lycopene compared to the other two regions because the harvest was early and the watermelons were not fully ripe.

If we compare the non-grafted and grafted plant's fruits to each other (Table 1), then we can see that the *Interspecific x scion* grafting combination fruits' colour value L^* (lightness) and b^* (yellow colour) increased in two regions (Cece, Jászszentandrás) and decreased in the Újkígyós Region. From the harvest data of Újkígyós, we can find positive correlation, but in the case of the other two regions the four harvest data results showed the opposite because there is a negative correlation between the L^* and lycopene concentration.

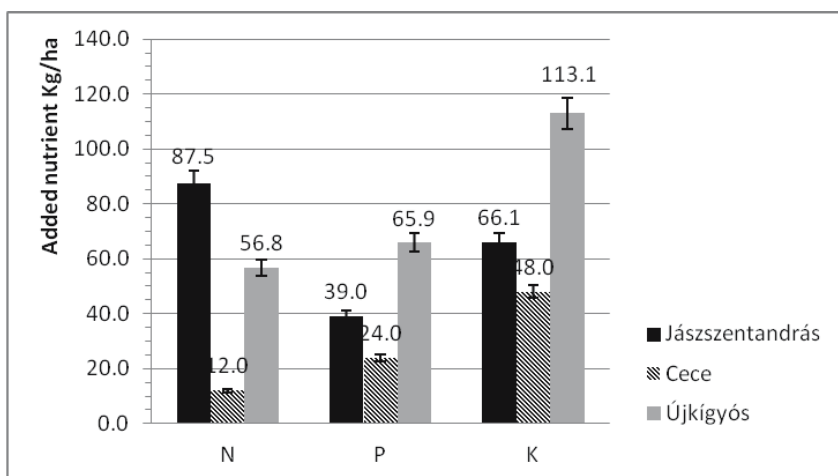


Figure 2: Added nutrient quantities in 2013

Table 1: Measured and calculated colour data according to region and harvest

Region	Harvest	Combination	L*	a*	b*	C*	h*
Cece	I.	non-grafted	35.48	26.13	20.65	33.32	0.67
		Lagenaria	33.21	25.14	19.97	32.12	0.67
		Interspecific	35.17	27.80	22.03	35.48	0.67
	II.	non-grafted	37.32	24.15	22.09	33.00	0.73
		Lagenaria	37.31	22.71	20.95	30.92	0.75
		Interspecific	38.39	25.90	22.83	34.55	0.72
Jászszentandrás	I.	non-grafted	35.41	24.83	19.52	31.59	0.67
		Lagenaria	36.06	26.34	20.08	33.13	0.65
		Interspecific	37.62	29.62	22.29	37.08	0.65
	II.	non-grafted	36.63	25.25	21.82	33.40	0.71
		Lagenaria	38.58	26.12	22.15	34.27	0.70
		Interspecific	42.71	29.49	24.57	38.41	0.69
Újkígyós	I.	non-grafted	40.35	25.87	22.44	34.25	0.72
		Lagenaria	41.28	25.27	21.75	33.37	0.71
		Interspecific	37.48	27.53	21.27	34.80	0.66

Negative correlation between L* and lycopene concentration was also reported by *Perkins-Veazie & Collins* (2004). Independently from region or harvest,

the interspecific rootstock combination fruits had the highest score by a^* (red colour); this means that the fruit flesh was redder than the other combinations. The chroma (C^*) value also changed by the grafting. The colour values L^* , a^* , b^* and chroma in our study showed similar data to another report (Perkins-Veazie & Collins, 2004). The hue (ratio of a^* and b^*) mostly decreased by the grafting, but just a few percents. Based on this experiment, we can make the conclusion that it is worth to graft on the interspecific rootstock in the case of this watermelon type because the lycopene concentration and the colour sense have been both influenced in a positive way. The *Lagenaria x scion* grafting combination produced lower quality in the case of lycopene and colour than the ungrafted plants. Experiments showed that there is a correlation between the lycopene amount and colour sense.

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