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Impacts of gibberellin (GA_3) on sensorial quality and storability of table grape (*Vitis vinifera* L.)

Denis RUSJAN [1]

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ABSTRACT

The eventual impacts of the gibberellin (GA_3) application on grapevine (*Vitis vinifera* L.) varieties 'Cardinal' and 'Michele Palieri', on grape quality and their storage potential were studied. The grape quality was determined as individual and total carbohydrates and organic acids, but also the external skin colouration was measured. The measurement of polyphenol oxidases (PPO) activity was contributed to clearly understand storage potential. During the grape maturation the statistical differences in grape quality were observed according to the treatments. The treatments with GA_3 showed similar and related impacts on grape quality at both varieties only at harvest, where the statistically highest total sugar concentration (223-226 g kg^{-1}) was determined at 50 ppm, followed by 20 ppm (216-223 g kg^{-1}) and the lowest 201-220 g kg^{-1} at control. The organic acid concentrations in the grape of both varieties did not show any similar correlation according to treatments. The PPO activities were slightly higher at mature grape of 'Cardinal' (2.5-3.0 $\Delta A\ min^{-1}g^{-1}$) compared to 'Michele Palieri' (1.0-1.2 $\Delta A\ min^{-1}g^{-1}$), and the activities at both varieties during storage decreased. At harvest the *CIRG* indices of 'Cardinal' (5.5-6.1) and of 'Michele Palieri' (6.6-6.9) did not statistically differ among treatments as at the end of storage, where the highest indices were calculated at treatment 50 ppm at both varieties. The grape quality of table grape responded differently to GA_3 applications, especially the different impacts were observed according to varieties.

Key words: carbohydrate, organic acid, gibberellin, PPO, quality

IZVLEČEK

VPLIV GIBERELINOV (GA_3) NA SENZORIČNO KAKOVOST IN SKLADIŠČENJE NAMIZNEGA GROZDJA (*Vitis vinifera* L.)

V poskusu smo vrednotili morebitne vplive uporabe giberelinov (GA_3) pri pridelavi žlahtnih vinskih trt (*Vitis vinifera* L.) na kakovost namiznega grozdja sort 'Cardinal' in 'Michele Palieri' in njun potencial za skladiščenje. Kakovost grozdja smo opisali z vsebnostjo posameznih in skupnih ogljikovih hidratov in organskih kislin, kot tudi z barvo kožice jagod. Potencial skladiščenja smo določili z merjenjem aktivnosti polifenol oksidaz (PPO). Med zorenjem grozdja so se v kakovosti grozdja med obravnavanji pokazale statistično značilne razlike. Tretiranja z GA_3 imajo enak vpliv na kakovost grozdja obeh sort, vendar samo ob trgatvi, ko so se statistično značilne največje vsebnosti skupnih sladkorjev (223-226 g kg^{-1}) pokazale pri 50 ppm, sledita še 20 ppm (216-223 g kg^{-1}) in najmanjša vsebnost pri kontroli (201-220 g kg^{-1}). Vsebnosti organskih kislin se niso odzvale na uporabo GA_3. Aktivnost PPO je bila nekoliko večja pri sorti 'Cardinal' (2.5-3.0 $\Delta A\ min^{-1}g^{-1}$), kot pa pri sorti 'Michele Palieri' (1.0-1.2 $\Delta A\ min^{-1}g^{-1}$), vendar se je le-ta pri obeh sortah med skladiščenjem precej zmanjšala. Povprečni *CIRG* indeks kožice jagod je bil pri sorti 'Cardinal' 5,5-6,1, medtem ko pri sorti 'Michele Palieri' 6,6-6,9 in statistično neznačilen med obravnavanji, čeprav se je povprečno največji indeks pri obeh sortah pokazal pri 50 ppm. Kakovost grozdja se pri različnih sortah različno odziva na uporabo giberelinov GA_3.

Ključne besede: ogljikovi hidrati, organske kisline, giberelini, PPO, kakovost

[1] University of Ljubljana, Biotechnical faculty, Group for viticulture, Jamnikarjeva 101, Ljubljana, Slovenia, e-mail: denis.rusjan@bf.uni-lj.si; Phone: +38614231161; Fax: +38612565287

1 INTRODUCTION

Table grapes (*Vitis vinifera* L.) are an important crop traditionally produced in the Mediterranean and in the last decades also all over the World, where total table grape production has increased, especially in Asia (China and India (O.I.V., 2007).

Grape quality is determined by primary metabolites as carbohydrate and organic acid concentrations, by secondary metabolites (phenols and aromatic compounds) and their ratios in grape berries, but also by morpho-physical parameters (colour, size) (Amerine *et al.* 1965; Shiraishi 1993, 1995); however, grapes are also an important source of minerals, vitamins and amino acids, and are therefore used not only for fresh consumption, but also in the food, pharmaceutical and cosmetic industries (Winkler *et al.,* 1974; Adams, 2006; Kennedy *et al.,* 2006).

Glucose, fructose and sucrose are the predominant sugars in grapes, which concentration depends of variety, cultivation practice, ecological condition and vintage (Winkler *et al*., 1974). The 90% concentration of total organic acids is consisted by tartaric and malic acids, which have important effects on the characteristics of grape quality, such as colour and microbiological stabilization and mouth-feel. High acidity also has a negative influence on the palatability of table grape.

The colouration of grape has been associated with the presence of phenol compounds, especially with anthocyannins in berry skins (Kennedy *et al.,* 2006; Rusjan *et al.*, 2008). In fruit, colouration is the basic quality parameter (visual appreciation) and according to the numerical evaluation the *CIRG* index of external skin colour and the CIE L*a*b* system can be evaluated. The *CIRG* index ((180-*h*)/(L*+C*)) has been proposed, which is based on the parameters L* (lightness), *h* (hue angle) and C* (chroma). Using this index, skin colour can be classified into five groups (Carreño *et al.,* 1997). Table grape is regularly stored in freezer chambers to prolong its quality, where different chemical and physical processes were observed (Winkler *et al.*, 1974). Polyphenol oxidases (PPO) are known to catalyse the oxidative reactions, what involve phenols, amino acids, quinons and other oxidizable substances (Wissemann and Lee, 1980; Hooper *et al.*, 1985). The enzymatic oxidation (browning) in grape is caused primarily by polyphenol oxidases (EC 1.10.3.1.; cateholasa) which decrease grape quality (Carvajal-Millán *et al.*, 2001).

Use of gibberellic acids (GA_3) is quite common in table grape production, where the impacts on grape quality are mentioned. Gibberellins influence berry size and weight (Perez, 1994), colour of berry surface (Bianchi *et al.*, 1991) and a yield per vine (Winklet *et al.*, 1974).

Postharvest grape deterioration effects morpho-physical and chemical factors, especially berry dehydration because of vapour pressure deficit (Nelson, 1985), skin browning (Vial *et al.*, 2005), changes in carbohydrates and phenols concentrations (Zoffoli *et al.*, 2009). Skin browning and consequent changes in skin colour are frequently caused by enzymes such are polyphenol oxidases (Ryan *et al*., 1982).

The GA_3 impacts on table grape quality were involved in many studies, but not at 'Cardinal' and 'Michele Palieri' varieties. The main focus of this study was to present the potential of table grape quality according to two varieties below of different GA_3 treatments during grape maturation and after in storage chamber.

2 MATERIALS AND METHODS

2.1 Plant materials

The study was carried out on two red table grape varieties (*Vitis vinifera* L.) from the Ampelographic vineyard owned by the University of Ljubljana, Biotechnical Faculty, situated in a sub-Mediterranean winegrowing region in Slovenia. The grapes from 10 plants of each grape variety 'Cardinal' ('Flame Tokay' x 'Ribier') and 'Michele Palieri' ('Ribier' x 'Red Malaga') were sampled according to the treatment in the year 2008.

2.2 Treatments

The 3 x 3 block experiment was done where ten vines in three rows were treated at full blossom with three different aqueous gibberellins concentrations of GA_3: 0 ppm (control; no gibberellins application), 20 ppm (20 mg GA_3 kg^{-1}) and 50 ppm (50 mg GA_3 kg^{-1}).

The vines were grown under the same agricultural practices and geographical and climatic conditions, while the guidelines of integrated pest management (IPM) in viticulture were considered.

2.3 Sampling

Bunches per each grapevine variety were randomly harvested at different ripe stages ('Cardinal' on 8th, 14th, 28th Aug., and 'Michele Palieri' on 8th, 14th, 21st, 28th Aug., 5th Sept.), where 100 berries per each variety and sampling were included additionally in the analysis. After picking, the grape samples were frozen and stored as rapidly as possible in PE bags in the

dark at –20 °C for further analysis. After harvest the main part of the grape was put separately per variety into boxes and into the storage chamber under controlled storage conditions (4 °C and 96% r. h.). During the storage bunches per variety were sampled ('Cardinal' on 1st, 8th 15th and 22nd Sept.; and 'Michele Palieri' on 11th, 18th, 22nd, 29th Sept., 5th Oct.) and stored in freezer until analysis.

2.5 Chemicals

The following standards prepared in aqueous solutions were used for the determination and quantification of quality parameters; fructose and tartaric acid from Fluka Chemie GmbH [Buchs, Switzerland], glucose, malic acid and H_2SO_4 from Sigma Chemical Co. [St. Louis, MO]. The water was additionally purified using Milli-Q water purification system [Millipore; Bedford, MA].

2.6 Extraction and analysis of carbohydrates and organic acids

The separate carbohydrates and organic acids were extracted according to Šturm *et al.* (1999) and analysed using a Thermo Separation Product with the HPLC system and a UV detector set at 210 nm for organic acids and with a differential RI detector for detection of carbohydrates. The grapes were pressed by hand, and 1 mL of grape juice per sample was diluted with MilliQ purified water (grape juice : water = 1 : 10 (*v/v*)). The mixtures were centrifuged for 7 min at 4200 rpm at room temperature (Eppendorf 5810 R, Hamburg, Germany). The supernatant was used and filtered through a 0.45 µm syringe filter (Chromafil A-25/25, Macherey-Nagel) and stored at –20 °C prior to injection. A Phenomenex (Rezex RCM-Monosaccharid Ca^+; 300 x 7.80 mm) column for carbohydrates and a Phenomenex (Rezex ROA-Organic acid H^+; 300 x 7.8 mm) column for acids were used and operated at 65 °C. The mobile phase for organic acids was an aqueous solution of H_2SO_4 (4 mM) and MilliQ purified water for carbohydrates. The volume of injection was 20 µL and the flow rate was 0.6 mL min^{-1}.

2.7 Identification and quantification of carbohydrates and organic acids

The carbohydrates (glucose and fructose) and organic acids (malic and tartaric) were quantified using standard solutions with known concentrations additionally combined with retention times as well as by the addition of external standard solutions in samples. The carbohydrate and organic acid concentrations were expressed as g per kg of fresh weight (g kg^{-1} FW).

2.8 Fruit Colour Determination

As soon as possible the colouration of grape skin was determined on fresh samples according to variety and treatment. On the 20 fresh berries, five colour measures per berry (around berry) and per variety were done. Surface colour of grape berries was recorded with a Minolta CR-300 Chroma portable colourimeter (Minolta Co, Osaka, Japan), where the colour was expressed in L*, C* and *h* and by calculating the *CIRG* index defined as *CIRG* = (180-*h*)/(L*+C*), where L* is lightness and represents the dark-light axis (0% = black; 100% = white), h is the hue angle, and $C^*=(a^{*2}+b^{*2})^{0.5}$ is the chroma and represents colour intensity. Before use the colourimeter was calibrated with a standard white calibration plate (Carreño *et al.* 1997).

2.9 Preparation of crude PPO extraction

The polyphenol oxidases were extracted from grape pomace samples according to the methods described by Donko (2001) with some modification. The grape was grinded in liquid nitrogen and 200 µL of of pomace was placed in 2.5 ml test tube (eppendorf) and homogenized for 15 min in 1 mL of ice-cold 0.1 M phosphate buffer (pH 7.3) containing 0.1 M Tris X-100, 1 mM PMFS, 3 g PVPP/100 mL and 1.5 g Tris X-100/100 mL. The samples were centrifuged for 15 min at 4 °C and 20,000 x *g*. Supernatant I (800 µL) was added to 600 µL Triton X-100 solution (8 g/100 mL) and heated for 10 min at 35 °C; sediment was rejected. The mixture was centrifuged again for 15 min at 20,000 x *g* and 4 °C. The obtained supernatant II was used as enzyme source.

2.10 Polyphenoloxidase assay

The assay procedure of PPO activities of cateholase was measured according to Sanchez *et al.*, (1988) and Valero *et al.*, (1989) with some modifications. The cateholase activity was measured by using 4-MC (methyl catechol) solution (64 mg/250 mL 0.1 M phosphate buffer; pH 7.3). Enzyme extract (100 µL) was added to 2.9 mL of 0.1 M phosphate buffer (pH 7.3) mixed and an aliquot was transferred immediately to a 1.0 cm path-length cuvette. Absorbance at 420 nm was measured using spectrophotometer UV/VIS Lambda Bio 20, against a same solution, but without enzyme extraction. The change of absorbance into 10 min at 420 nm was recorded. The activity was expressed as change in absorbance per minute per gram ($\Delta A\ min^{-1}\ g^{-1}$).

2.11 Statistical Analyses

Data are presented as means with standard errors (milligrams or grams per kilogram of fresh material). The one-way analysis of variance (ANOVA) to test the significance of the observed differences was performed using the Statgraphic plus 4.0 software. The differences in quantified concentrations were evaluated using LSD test at $P < 0.05$ and were considered to be statistically significant.

3 RESULTS AND DISCUSSION

3.1 Concentrations of carbohydrates

Carbohydrate concentrations in grapes according to variety, date of sampling and treatment are given in Table 1. The differences in carbohydrate concentrations were expected, especially between varieties, where 'Michele Palieri' is known as later mature variety (VCR, 2007). The statistical differences in carbohydrates concentrations among treatments were observed at both varieties. At the first grape samples the statistically highest fructose and glucose concentrations were determined at treatment with 50 ppm, followed by 20 ppm and the lowest at control. More frequent

differences in concentration were observed at fructose compared to glucose, at both varieties.

At harvest of 'Cardinal' the statistically highest fructose concentrations (116 g kg^{-1}) were determined in grape treated with 50 ppm and control, the lowest (111 g kg^{-1}) at treatment 20 ppm. 'Michele Palieri' was harvested one week later and the statistically highest fructose (110-113 g kg^{-1}) concentrations were determined at treatments with GA_3. Similar results were observed in glucose concentrations (113 g kg^{-1}). Comparing the total sugar contents at harvest, we can conclude that the GA_3 influenced the sugar contents, where treatment with 50 ppm gave the statistically highest concentration (223-226 g kg^{-1}), followed by treatment with 20 ppm (216 – 223 g kg^{-1}) and control (201-220 g kg^{-1}) at least, what has been already mentioned by Winkler *et al.* (1974) for other varieties. The average sugar concentration at harvest of both varieties can be compared to the concentrations already mentioned by Huai-Feng *et al.* (2006), but Rusjan *et al.* (2008) noticed quite lower concentrations in previous study.

During the storage in chamber the sugar concentrations increased, because of water losses from grape berries, what was expected according to Zoffoli *et al.* (2009) and to Carvajal-Millán *et al.* (2001). After a month of grape storage the statistically highest fructose (144 g kg^{-1}) and glucose (132 g kg^{-1}) were determined in 'Cardinal' grape treated with 20 ppm GA_3, while the lowest concentrations at control samples. The average concentrations at 20 ppm increased for 27 g kg^{-1} after a month of storage. At variety 'Michele Palieri' some differences in carbohydrates compared to 'Cardinal' were observed, where the highest concentrations were determined at control grape samples and the lowest at 20 ppm GA_3 treatment. The highest increase in sugar concentrations were at control samples, approximately around 31 g kg^{-1}. At the end of grape storage the similar effects of GA_3 applications on total sugar concentration in grape of both varieties were not confirmed (Table 1).

3.2 Concentrations of organic acids

The most important organic acids in table grape are tartaric and malic acids. The concentrations of mentioned acids in grape were screened during grape maturation and storage according to treatments and the results are presented in figures 1 and 2. At the first sampling the highest malic concentrations 8.8 g kg^{-1} at 20 ppm treatment of 'Cardinal' and 9.1 g kg^{-1} at 50 ppm treatment of 'Michele Palieri' were determined. The tartaric concentrations were quite lower, around 3.6 g kg^{-1} at 'Cardinal', and 4.2 g kg^{-1} at 'Michele Palieri'. As expected the organic acid concentrations decreased during grape maturation, especially malic acid (Zoffoli *et al.* 2009). The statistical differences in malic acid concentrations were observed at all samplings between control and treated grape with hormone. The statistically lowest malic concentration at harvest was observed at control grape of 'Cardinal', while the statistically highest at 50 ppm treatment of grape 'Michele Palieri'. The differences in tartaric acid concentrations among treatments at the same sampling were not observed. During the storage the organic acid concentrations drastically decreased after the first week and later stabilised to the end of storage. At the end of the storage the malic acid concentration around 2.0 g kg^{-1} at 'Cardinal' and around 1.0 g kg^{-1} were determined. The average concentration of tartaric acid was similar between varieties and ranged from 1.2 to 2.8 g kg^{-1} (figures 1, 2).

According to the results we can conclude that treatments with GA_3 hormone influence the malic acid concentration in grape during maturation, but differently according to the varieties. The influence of GA_3 applications on tartaric acid concentration in grape was minimal according to treatments and to varieties.

3.3 Evaluation of external skin colour

The average values of the *CIRG* index according to grape varieties and treatments have been studied and the results are presented in figure 3. At the first sampling the statistical differences in berry surface colour were shown only at variety 'Michele Palieri', where treatment with 20 ppm had the most colouration (5.0). At the harvesting at both varieties statistical differences in colouration were determined. The most coloured grape of 'Cardinal' was that treated with 20 ppm GA_3, while at 'Michele Palieri' the control and with 20 ppm GA_3 treated grape. Therefore we can conclude the treatments with GA_3 have a different influence on grape colouration during maturation among varieties. According to Carreño *et al.* (1996) the variety 'Cardinal' was classified as a red variety, while 'Michele Palieri' as a dark-blue coloured variety.

In the end of storage only differences in grape colouration were observed only at 'Cardinal' grape. The highest *CIRG* index 7.3 was calculated at grape treated with 50 ppm GA_3, whereas the lowest at 20 ppm. At 'Michele Palieri' the differences at the end of storage were not shown therefore we can conclude that treatments with GA_3 do not show the same influences on grape colouration at different varieties. Rusjan *et al.* (2008) cited the average *CIRG* index for non treated variety 'Michele Palieri' around 6.05, but quite lower 5.84 for 'Cardinal', what could be explained by vintage (clime conditions etc.) and cultivation practices.

Table 1: Carbohydrate concentrations (g kg^{-1}) in grape pomace of table grape varieties 'Cardinal' and 'Michele Palieri' according to treatment and sampling in year 2007. The means and standard errors are presented. The different letters indicate statistically significant difference at $P < 0.05$ (LSD test).

			Sampling								
Variety	Sugar	Treatment	8th Aug	14th Aug	21st Aug	28th Aug	1st Sep	8th Sep	15th Sep	22nd Sep	
'Cardinal'	Fructose	0 ppm	90 ± 3 c	97 ± 3 b	111 ± 4	114 ± 1 a	115 ± 1 b	116 ± 1 c	119 ± 1 c	123 ± 5 b	
		20 ppm	96 ± 3 b	106 ± 7 a	107 ± 4	111 ± 1 b	123 ± 5 a	135 ± 5 a	140 ± 6 a	144 ± 6 a	
		50 ppm	106 ± 1 a	112 ± 4 a	114 ± 6	116 ± 1 a	118 ± 5 ab	120 ± 1 b	129 ± 5 b	138 ± 2 a	
	Glucose	0 ppm	93 ± 1 b	97 ± 5	97 ± 6	106 ± 3	106 ± 3 b	107 ± 2 b	112 ± 1 b	119 ± 5 b	
		20 ppm	97 ± 4 b	99 ± 1	102 ± 1	112 ± 5	120 ± 2 a	120 ± 2 a	126 ± 2 a	132 ± 3 a	
		50 ppm	105 ± 2 a	104 ± 2	107 ± 6	110 ± 1	112 ± 4 b	119 ± 1 a	124 ± 4 a	134 ± 2 a	
			8th Aug	14th Aug	21st Aug	28th Aug	5th Sep	11th Sep	18th Sep	22nd Sep	29th Sep	5th Oct
'Michele Palieri'	Fructose	0 ppm	66 ± 1 c	75 ± 2 b	98 ± 4 b	98 ± 4 b	99 ± 3 b	108 ± 6	111 ± 1 b	128 ± 7	121 ± 6 b	142 ± 4 a
		20 ppm	76 ± 0 b	90 ± 3 a	109 ± 1 a	109 ± 5 a	113 ± 6 a	114 ± 4	118 ± 4 a	125 ± 4	124 ± 3 b	129 ± 2 b
		50 ppm	79 ± 1 a	89 ± 3 a	99 ± 2 b	107 ± 6 ab	110 ± 2 a	111 ± 6	114 ± 1 ab	125 ± 2	134 ± 5 a	141 ± 6 a
	Glucose	0 ppm	74 ± 1 c	78 ± 1 b	83 ± 5 b	92 ± 4	102 ± 5 b	102 ± 4 b	105 ± 1 b	109 ± 7 ab	114 ± 7 b	131 ± 5 a
		20 ppm	79 ± 1 b	91 ± 2 a	92 ± 1 a	102 ± 6	103 ± 2 b	109 ± 7 ab	109 ± 4 b	111 ± 1 b	112 ± 2 b	118 ± 6 b
		50 ppm	85 ± 1 a	87 ± 5 a	91 ± 1 a	101 ± 1	113 ± 3 a	116 ± 2 a	121 ± 5 a	123 ± 5 a	128 ± 4 a	130 ± 8 a

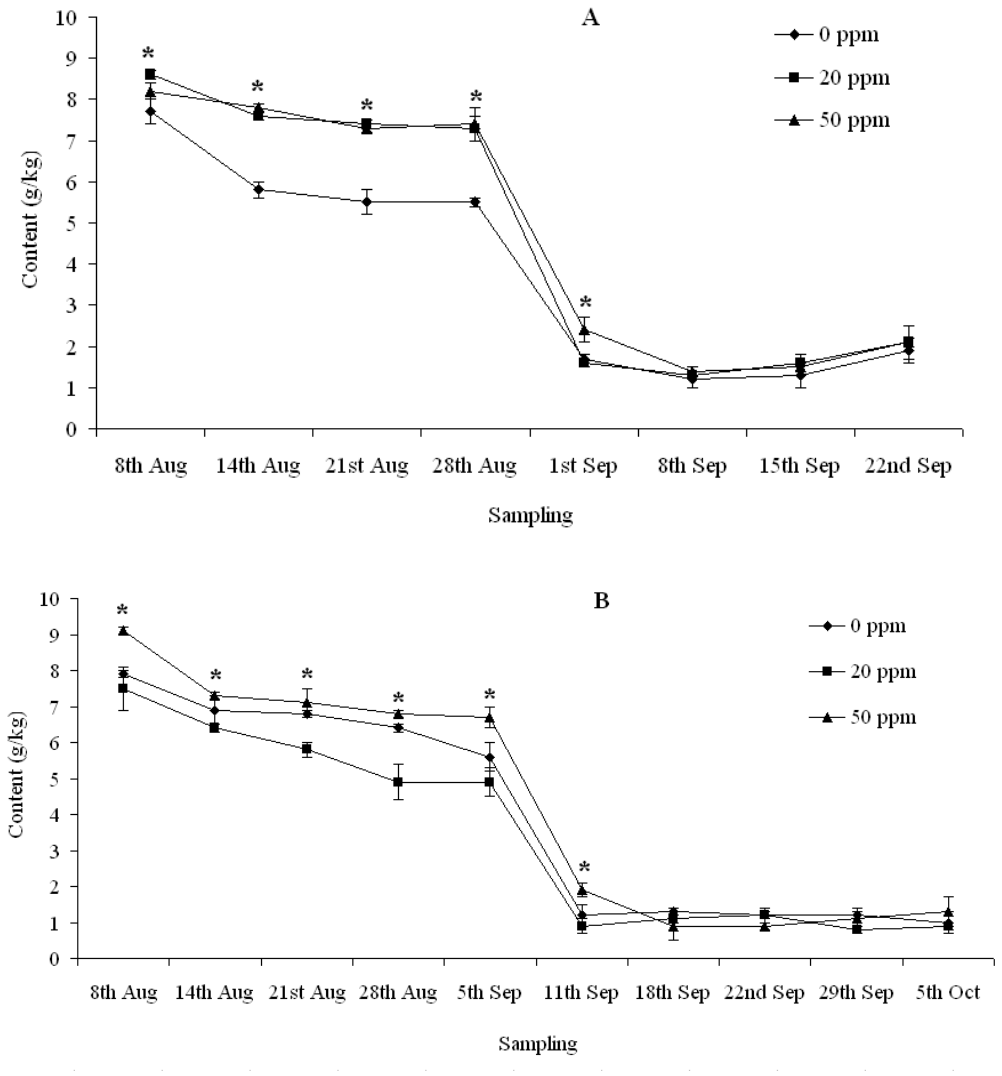

Figure 1: The concentrations (g kg^{-1}) of malic acid in grape pomace of table grape varieties 'Cardinal' (A) and 'Michele Palieri' (B) according to sampling and treatment. The means and standard errors are presented. The sign '*' indicates statistically significant difference at $P < 0.05$ (LSD test).

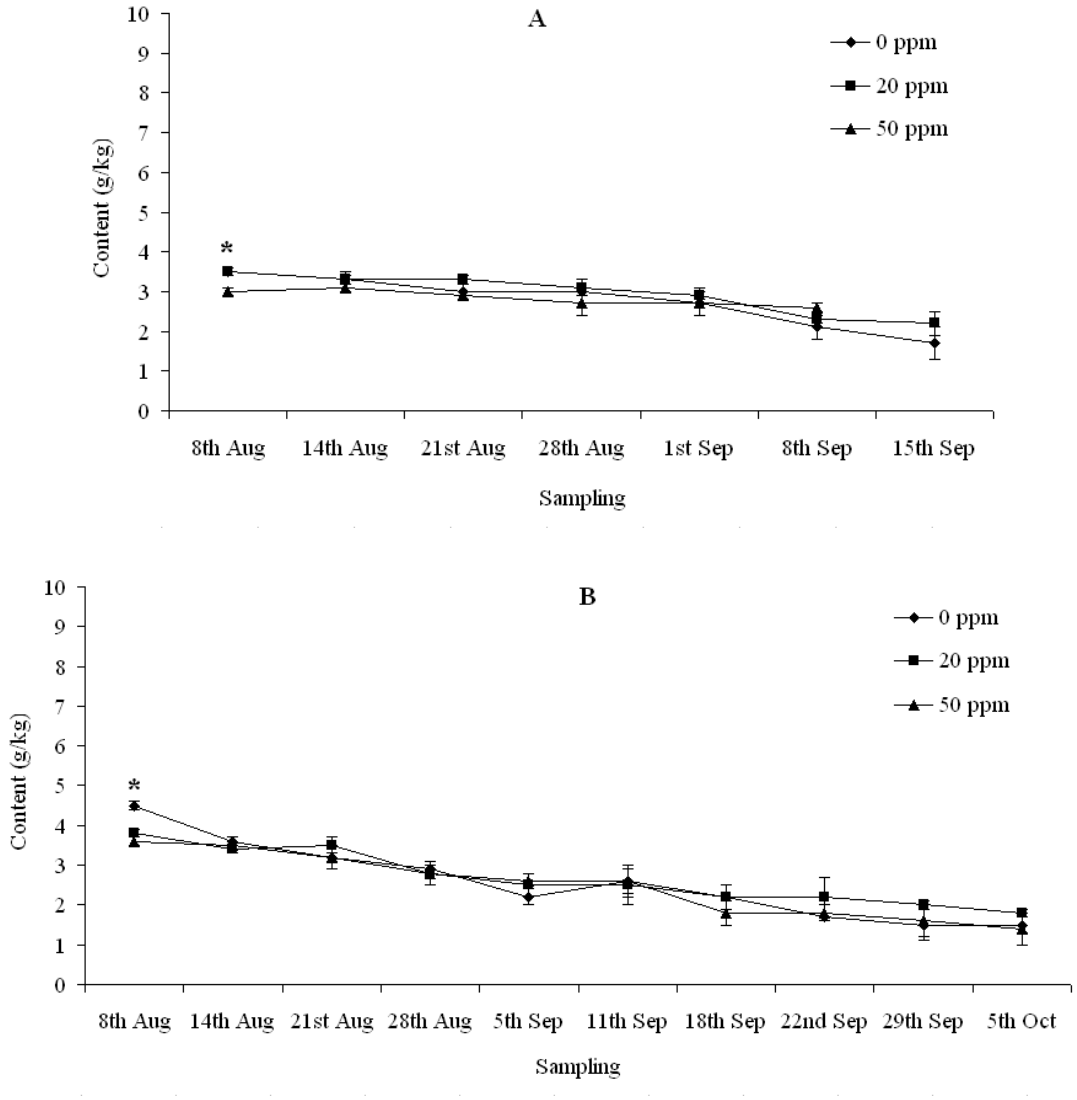

Figure 2: The concentrations (g kg^{-1}) of tartaric acid in grape pomace of table grape varieties 'Cardinal' (A) and 'Michele Palieri' (B) according to sampling and treatment. The means and standard errors are presented. The sign '*' indicates statistically significant difference at $P < 0.05$ (LSD test).

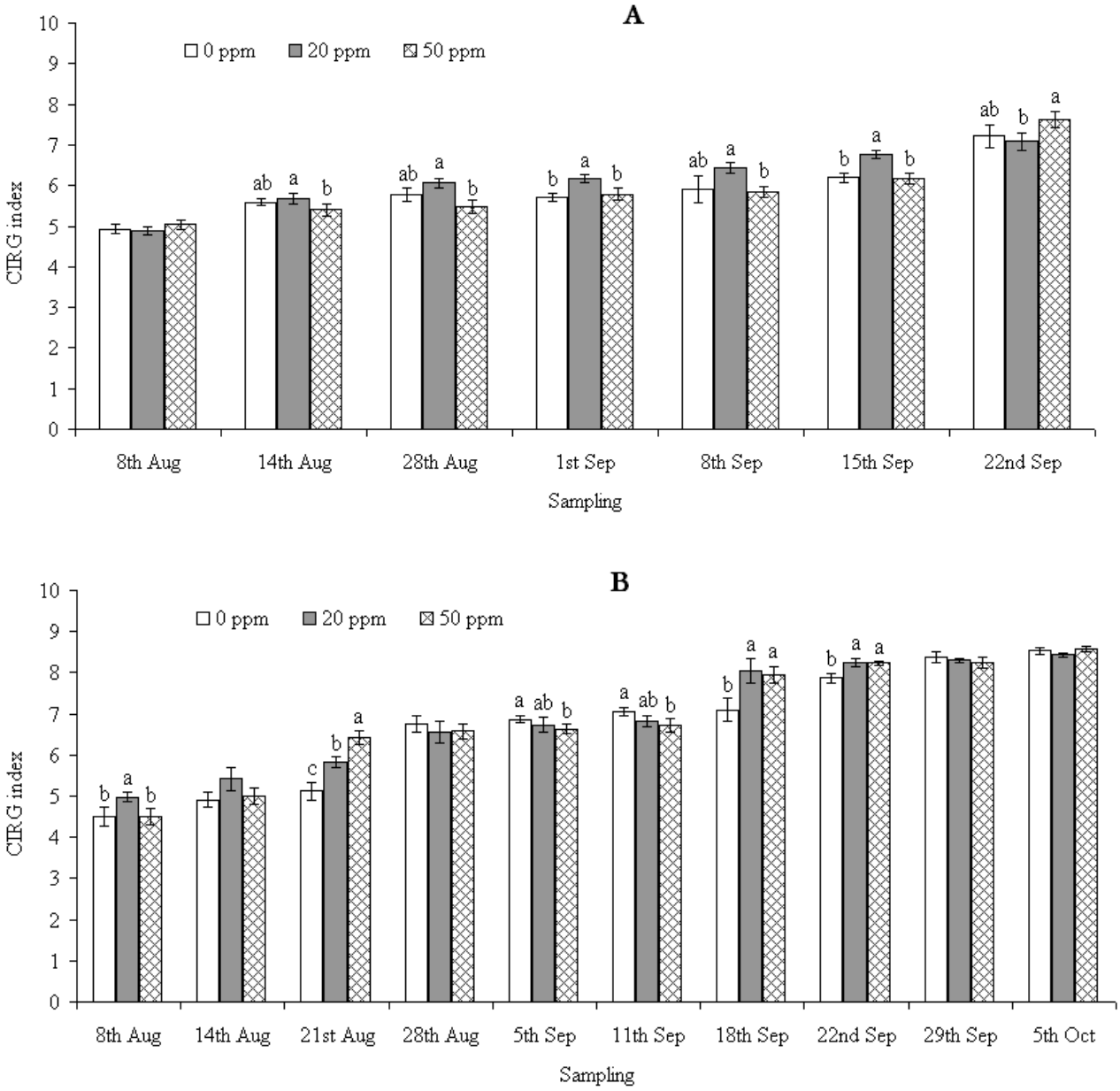

Figure 3: Average *CIRG* indices of external skin colour of table grape varieties 'Cardinal' (A) and 'Michele Palieri' (B) according to sampling and treatment. The means and standard errors are presented. The different letters indicate statistically significant difference at $P < 0.05$ (LSD test).

3.4 PPO activity

PPO activity according to treatments and variety was given in figure 4. The PPO activities were screened during grape maturation and storage to check theeventual effects of GA_3 on their activity. At the first grape sampling some similarities according to treatments and varieties were observed. Statistically highest PPO activity 1.2-2.3 $\Delta A\ min^{-1}\ g^{-1}$ was determined in grape treated with 50 ppm GA_3, followed by treatment with 20 ppm and the lowest activity 0.6-1.0 $\Delta A\ min^{-1}\ g^{-1}$ at the control. Generally during the grape maturation or subsequent samplings according to variety the similarities in PPO activities were not observed. The statistically highest activity of PPO at harvest in grape 'Cardinal' was determined at control, followed by 50 ppm and the lowest at treatment 20 ppm GA_3. But at harvest of 'Michele Palieri' grape the statistical differences in PPO activities followed from highest at 50 ppm, 20 ppm, to the lowest at control.

During the storage the average PPO activities slightly increased at both varieties, what was expected according

to storage conditions. The highest PPO activity was determined at 'Cardinal' grape compared to 'Michele Palieri'. The statistically highest activity of 'Cardinal' was determined at treatment with 50 ppm followed by control grape. At 'Michele Palieri' just the opposite PPO activities were shown, meaning the statistically lowest at treatment 50 ppm GA_3.

According to the results of the experiment we can conclude that direct influences of GA_3 on PPO activity were not determined, however we also have to stress the differences between the varieties.

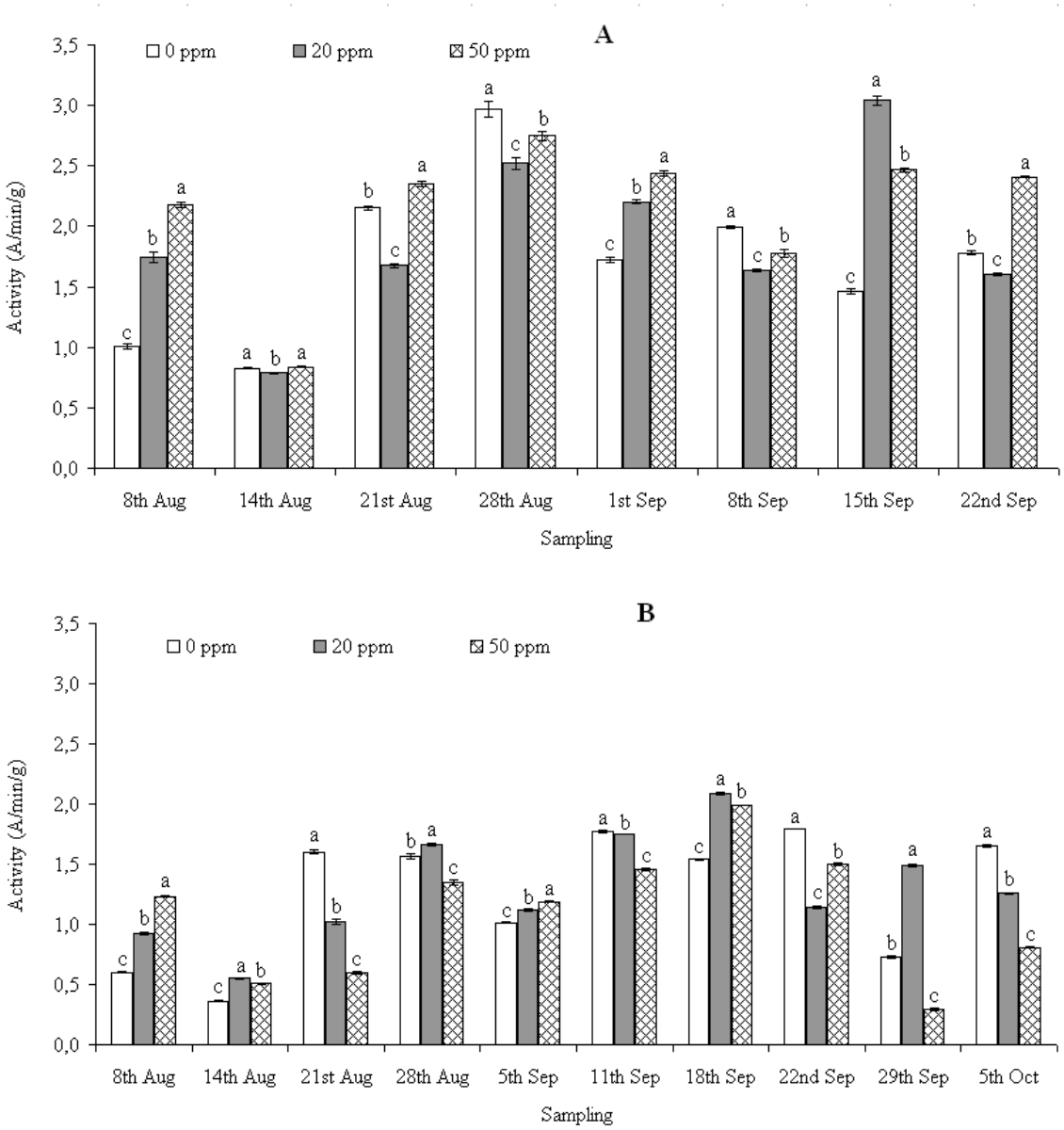

Figure 4: Average POP activity (ΔA/min/g) in grape pomace of table grape varieties 'Cardinal' (A) and 'Michele Palieri' (B) according to sampling and treatment. The means and standard errors are presented. The different letters indicate statistically significant difference at $P < 0.05$ (LSD test).

4 CONCLUSIONS

The application of GA_3 on grape is a quite frequent practice at table grape production, especially to increase the berry size of seedless varieties, but also their quality. The usage of GA_3 affects grape quality among table

grape varieties differently, what was also confirmed in our study. The higher concentrations of GA_3 applied on grape increased its sugar contents, compared to control, what was observed at both varieties. The separate organic acids did not show any response to GA_3 application, not during grape maturation, even less during storage. As organic acid also PPO activities were not linked to the use of GA_3, therefore we can conclude the grape browning was not influenced by GA_3, especially during storage. The grape colouration evaluated as CIRG index showed statistical differences among treatments at both varieties, but only at the end of storage. The most coloured grapes were those treated with 50 ppm of GA_3.

The results of the study confirmed the potential impacts of GA_3 application on grape quality. However, the use of GA_3 has to be adjusted according to each table grape variety, because they show different responses during grape maturation and its storage.

5 ACKNOWLEDGEMENTS

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