

Shade netting on raspberry and blackberries produced from south-east region of North Macedonia: effect on morphological characterization, chemical composition and antioxidant activity

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Introduction

Extreme weather conditions and climate changes, such as very high temperatures, extreme UV radiation and global warming, have detrimental effects on berry fruit orchards [1, 2]. The main object of this study is the effect of the green shade nets on the morphological characterization, chemical composition and "in vitro" antioxidant activity of raspberry and blackberry grown in the 2022 and 2023 years in the village Psača, south-east region of Republic of North Macedonia.

Materials and Methods

Spectrophotometric analysis was performed with a Varian Cary 100 spectrophotometer (Agilent Technologies Inc., Palo Alto, CA, USA) as described (Rigo et al., 2000). Total polyphenols (TPs) were estimated by Folin-Ciocalteu reagent reduction to blue pigments caused by phenols in alkaline solution. Concentrations of total polyphenols were determined using a calibration curve as (+)-catechin in mg kg⁻¹ grape fresh weight (FW) or mg L⁻¹ berry fruits.

Results and Discussion

Our results showed significantly lower amounts of citric and malic acid for blackberries from 2022, while in blackberries and raspberries from 2023, the citric acid was bellowing limit of detection. As we can noticed from Table 1, the highest amounts of total anthocyanins were measured for red covered and uncovered raspberries (558.1 and 626.2 mg/kg, respectively). Those amounts were in complete agreement with the results from absorbance at 520 nm. The highest amount of total polyphenols was measured for uncovered blackberries from 2023 while difference with and without shading nets was not statistically significant for raspberries. The same tendency was detected for amounts of lower and higher molecular proanthocyanidins. presented in Table 2, the amount of cyanidin-3-O-glycoside is more affected in blackberries from 2023. Results presented in Table 2 indicated significantly higher amount of cyanidin-3-O-glycoside in blackberries covered by shading nets. Both of them were significantly higher in uncovered blackberries from 2023. The antioxidant activity determined by DPPH radical indicated the highest antioxidant activity for blackberries due to the fact that blackberries are richer source of pigmented phenolic compounds but, the effect of shading nets was statistically not significant.

Table 1. Chemical composition and antioxidant potential of berry fruits

	Blackberry 2022		Blackberry 2023		Raspberry 2023	
	Without shading net	With shading net	Without shading net	With shading net	Without shading net	With shading net
Organic acids (g/kg)						
Acetic	0.02±0.01 ^b	0.03±0.01 ^b	0.03±0.00 ^b	0.01±0.00 ^b	0.11±0.02 ^a	0.11±0.02 ^a
Citric	0.92±0.13 ^a	0.00±0.00 ^b	0.00±0.00 ^b	0.00±0.00 ^b	0.00±0.00 ^b	0.00±0.00 ^b
D-gluconic	0.20±0.03 ^a	0.05±0.01 ^b	0.05±0.00 ^b	0.03±0.00 ^b	0.04±0.01 ^b	0.04±0.01 ^b
Lactic	0.04±0.00 ^a	0.01±0.00 ^a	0.00±0.00 ^a	0.00±0.00 ^a	0.00±0.00 ^a	0.00±0.00 ^a
Malic	2.14±0.02 ^b	3.08±0.04 ^a	3.12±0.06 ^a	0.67±0.09 ^c	0.72±0.10 ^c	0.72±0.10 ^c
Total acidity (g/kg)	11.90±0.49 ^b	9.19±0.11 ^c	11.31±0.07 ^b	21.93±2.03 ^a	20.19±3.21 ^a	20.19±3.21 ^a
pH	3.23±0.01 ^a	3.33±0.05 ^a	3.06±0.04 ^b	3.02±0.03 ^b	3.10±0.01 ^b	3.10±0.01 ^b
Sugars (g/kg)						
D-glucose + D-fructose	63.00±1.44 ^a	36.98±3.21 ^c	48.34±2.51 ^b	38.83±1.56 ^c	39.48±1.71 ^c	39.48±1.71 ^c
Color						
A ₄₂₀	4.74±0.69 ^a	3.33±0.10 ^b	1.93±0.22 ^c	3.15±0.29 ^b	3.21±0.34 ^b	3.21±0.34 ^b
A ₅₂₀	6.14±0.81 ^c	4.43±0.27 ^d	3.98±0.41 ^d	10.00±2.01 ^a	9.83±2.21 ^b	9.83±2.21 ^b
A ₆₂₀	1.99±0.11 ^a	0.53±0.31 ^b	0.16±0.02 ^d	0.18±0.00 ^d	0.32±0.02 ^c	0.32±0.02 ^c
Polyphenolic content (mg/kg)						
Total anthocyanins	469.0±83.81 ^c	457.5±17.22 ^c	323.1±10.05 ^d	626.2±21.43 ^a	558.1±41.92 ^b	558.1±41.92 ^b
Cyanidin-3-O-glucoside (mg/g fresh fruit)	0.74±0.05 ^b	0.97±0.06 ^b	1.22±0.09 ^a	0.21±0.03 ^a	0.28±0.04 ^a	0.28±0.04 ^a
Cyanidin-3-O-sophoroside (mg/g fresh fruit)	n.d.	n.d.	n.d.	0.48±0.09 ^b	0.66±0.08 ^a	0.66±0.08 ^a
Total polyphenols	278.0±14.50 ^a	294.3±23.93 ^a	256.6±12.97 ^{a,b}	223.5±31.81 ^b	217.4±13.99 ^b	217.4±13.99 ^b
Low molecular proanthocyanidins	445.1±10.11 ^b	512.7±31.24 ^a	462.9±14.53 ^b	388.0±22.92 ^c	365.2±12.41 ^c	365.2±12.41 ^c
High molecular proanthocyanidins	868.0±14.71 ^b	931.5±21.09 ^a	872.4±13.2 ^b	772.9±30.0 ^c	713.6±13.21 ^c	713.6±13.21 ^c
Antioxidant activity	87.1±2.1 ^b	94.0±12.3 ^a	92.1±9.1 ^a	84.1±10.0 ^b	82.1±11.4 ^b	82.1±11.4 ^b

Conclusion

The shading nets had a significant influence on the amounts of organic acids (in particular citric acid), sugars, total and particular anthocyanins and higher and lower proanthocyanidins in covered and uncovered blackberry and raspberry from the south-east region of the Republic of North Macedonia. The amount of acetic acid was the most affected by shading nets in raspberries, while total acidity and sugars (glucose+fructose) were the most affected parameters in blackberries. Due to the decreased tendency of total anthocyanins and proanthocyanidins in covered raspberries and blackberries and the increase tendency of the particular anthocyanins (cyanidin-3-O-glucoside and cyanidin-3-O-sophoroside), the effect of shading nets on the total antioxidant potential was not statistically significant. The higher antioxidant potential of blackberries in comparison to raspberries was linked to different polyphenolic profiles and different amounts of particular phytochemicals in examined berry fruits.

References

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