# Phenolic and multi-elemental profiles as a tool for quality assessment of Serbian blackberry wines

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## 1 Introduction

Blackberry wine is produced by a yeast fermentation of natural saccharides present in blackberry juice. This wine is traditionally consumed in Balkans, mostly as a dessert wine, but in recent years it is gaining more attention due to unique flavour and potential health benefits. Blackberries are a natural source of many minerals and bioactive phytochemicals such as vitamins, folic acid, anthocyanins, and phenolics [1,2].

**Aim of this study** was to evaluate quality of Serbian blackberry wines through determination of phenolic and multi-elemental profiles, antioxidant and antimicrobial activity.

## 2 Methodology

This quality assessment was investigated through determination of:

a) the phenolic profile by high-performance thin layer chromatography (HPTLC);
b) total phenolic (TPC) and anthocyanin content (TAC) by spectrophotometric assays;
c) *in vitro* antioxidant activity by DPPH and ABTS radical scavenging assays and total antioxidant capacity by spectrophotometric assays;
d) *in vitro* antimicrobial activity against six strains by the agar diffusion test;
e) the content of macro, micro and toxic elements by inductively coupled plasma mass spectrometry (ICP-MS).

## 3 Results

**Figure 1.** Phenolic profile of blackberry wines.

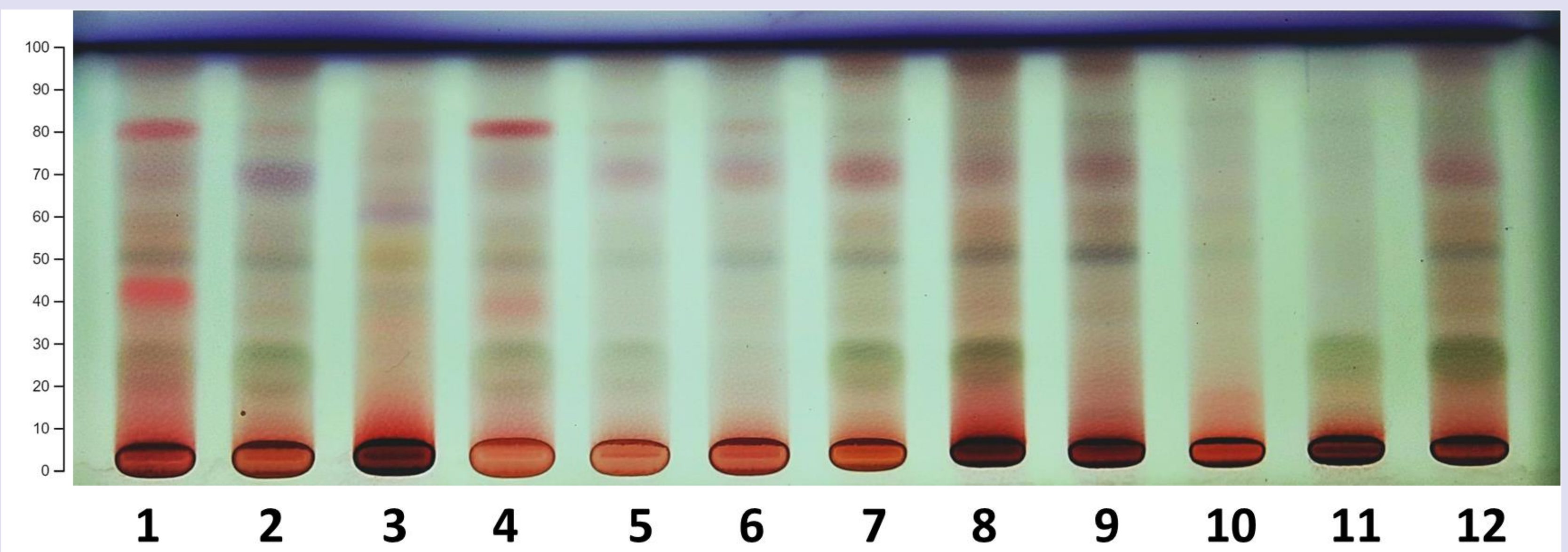


**Figure 2.** Spectrophotometric assays.

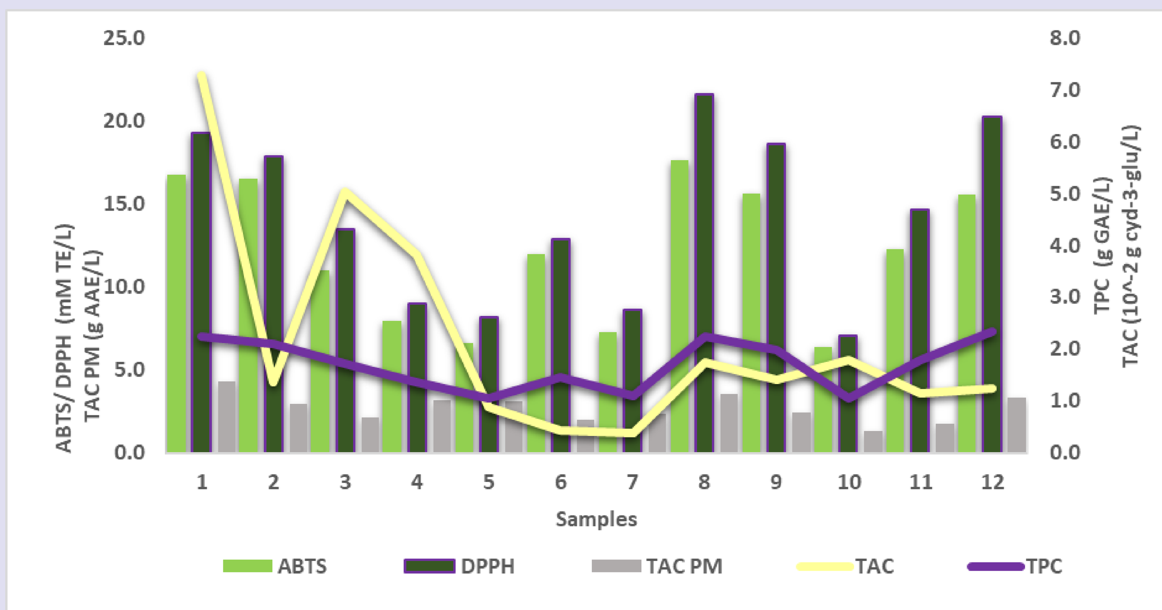


**Table 1.** *In vitro* antimicrobial activity of blackberry wine samples against six strains.

| | Samples | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tested stains | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| *Bacillus subtilis* ATCC 6633 | ++ | + | + | ++ | + | + | + | ++ | ++ | + | ++ | ++ |
| *Bacillus cereus* ATCC 14579 | ++ | ++ | ++ | ++ | ++ | ++ | ++ | ++ | ++ | + | ++ | ++ |
| *Staphylococcus aureus* ATCC 6538 | +++ | +++ | +++ | +++ | ++ | ++ | ++ | +++ | ++ | + | ++ | +++ |
| *Micrococcus lysodeikticus* ATCC 4698 | +++ | +++ | +++ | +++ | +++ | +++ | +++ | +++ | +++ | ++ | +++ | +++ |
| *Klebsiella pneumoniae* ATCC 29665 | ++ | + | ++ | + | + | + | + | ++ | ++ | + | + | ++ |
| *Escherichia coli* ATCC 35218 | +++ | ++ | ++ | +++ | ++ | ++ | ++ | +++ | ++ | ++ | ++ | ++ |

According to the zone of inhibition, the results are presented with no inhibition (-), zone of inhibition up to 15mm (+), zone of inhibition 15-20mm (++), zone of inhibition greater than 20 mm (+++).

**Table 2.** Content of macro, micro and toxic elements in berry wines.

| | Ca | K | Mg | Na | P | S | Al | Cd | Co | Cr | Cu | Fe | Mn | Mo | Ni | Pb | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mg/L | | | | | | µg/L | | | | | | | | | | |
| 1 | 14.7 ± 0.2 | 90 ± 2 | 16.0 ± 0.3 | 1.39 ± 0.02 | **13.1 ± 0.1** | **18.7 ± 0.1** | <LOD | 0.066 ± 0.002 | 0.20 ± 0.05 | 4.6 ± 0.7 | 6.4 ± 0.5 | **101 ± 3** | 207 ± 3 | <LOD | 11.3 ± 0.3 | <LOD | **103.7 ± 0.7** |
| 2 | 17.4 ± 0.2 | **100.6 ± 0.8** | **20.2 ± 0.4** | 0.49 ± 0.05 | 10.83 ± 0.05 | 12.65 ± 0.05 | <LOD | 0.05 ± 0.01 | 0.86 ± 0.03 | 3.4 ± 0.3 | 17.9 ± 0.5 | 4.4 ± 0.3 | 566 ± 5 | <LOD | 29.6 ± 0.2 | <LOD | 91 ± 3 |
| 3 | 10.7 ± 0.2 | 61.3 ± 0.4 | 7.51 ± 0.03 | **8.15 ± 0.05** | 8.99 ± 0.02 | 5.62 ± 0.01 | 259 ± 4 | 0.12 ± 0.01 | 0.36 ± 0.01 | 3.98 ± 0.09 | 25.0 ± 0.7 | 79.5 ± 0.9 | 140 ± 1 | <LOD | <LOD | 14.1 ± 0.5 | 28.1 ± 0.3 |
| 4 | **25.0 ± 0.7** | 87 ± 3 | 13.7 ± 0.2 | 0.863 ± 0.004 | 3.99 ± 0.01 | **23.7 ± 0.1** | 5.80 ± 0.01 | 0.11 ± 0.01 | 0.20 ± 0.02 | **4.49 ± 0.08** | 19.2 ± 0.3 | 73 ± 3 | 360 ± 30 | 0.3 ± 0.1 | 17.14 ± 0.08 | <LOD | **127.0 ± 0.6** |
| 5 | 12.9 ± 0.2 | 63 ± 2 | 9.3 ± 0.1 | 0.515 ± 0.002 | 4.63 ± 0.03 | 5.16 ± 0.04 | 10.5 ± 0.3 | 0.38 ± 0.03 | 0.71 ± 0.04 | 3.6 ± 0.1 | **31.4 ± 0.7** | 12.4 ± 0.7 | **1507 ± 3** | <LOD | 33.7 ± 0.2 | <LOD | 50 ± 1 |
| 6 | 15.2 ± 0.3 | 76.2 ± 0.5 | 16.4 ± 0.3 | 0.469 ± 0.004 | 9.4 ± 0.1 | 8.6 ± 0.1 | <LOD | 0.03 ± 0.01 | <LOD | 3.27 ± 0.09 | 12.0 ± 0.1 | 20.6 ± 0.1 | **817 ± 8** | <LOD | 28.0 ± 0.3 | <LOD | 89.7 ± 0.9 |
| 7 | 13.5 ± 0.5 | 66 ± 2 | 13.2 ± 0.4 | **14.3 ± 0.4** | 4.5 ± 0.1 | 4.0 ± 0.1 | 16.88 ± 0.01 | <LOD | 0.15 ± 0.03 | 2.0 ± 0.2 | 14.1 ± 0.5 | 33.8 ± 0.7 | 260 ± 20 | <LOD | 3.21 ± 0.05 | <LOD | 30.6 ± 0.2 |
| 8 | 14.4 ± 0.2 | 79.1 ± 0.4 | 16.84 ± 0.02 | 0.565 ± 0.005 | **13.31 ± 0.04** | 4.00 ± 0.02 | <LOD | 0.10 ± 0.03 | 0.28 ± 0.02 | 2.99 ± 0.04 | 16.1 ± 0.3 | 27.0 ± 0.9 | 507 ± 2 | <LOD | 44.2 ± 0.2 | <LOD | 32.4 ± 0.6 |
| 9 | **24.3 ± 0.2** | **103.1 ± 0.3** | **19.9 ± 0.2** | 1.089 ± 0.002 | **15.1 ± 0.3** | **14.4 ± 0.4** | 48.4 ± 0.1 | 0.04 ± 0.02 | 0.46 ± 0.04 | 3.50 ± 0.06 | 34 ± 1 | 84.2 ± 0.2 | 654 ± 3 | <LOD | 24.2 ± 0.7 | <LOD | **160 ± 2** |
| 10 | 12.8 ± 0.3 | 35.3 ± 0.6 | 7.59 ± 0.01 | 2.71 ± 0.02 | 4.0 ± 0.1 | 6.7 ± 0.1 | **107.9 ± 0.7** | 0.13 ± 0.05 | 0.34 ± 0.03 | 3.5 ± 0.5 | 20.35 ± 0.03 | 49 ± 1 | 151 ± 2 | <LOD | <LOD | <LOD | 37.6 ± 0.9 |
| 11 | 8.0 ± 0.1 | 9.5 ± 0.1 | 2.6 ± 0.02 | 2.5 ± 0.03 | 4.1 ± 0.1 | 8.7 ± 0.2 | 51.2 ± 0.1 | 0.03 ± 0.01 | 0.18 ± 0.01 | 2.8 ± 0.5 | **56.5 ± 0.5** | **229 ± 3** | 40.8 ± 0.4 | <LOD | <LOD | <LOD | 59 ± 1 |
| 12 | 17.2 ± 0.4 | 88.0 ± 0.1 | 18.0 ± 0.1 | 0.526 ± 0.003 | 11.5 ± 0.1 | 6.54 ± 0.02 | <LOD | <LOD | 0.37 ± 0.03 | **4.47 ± 0.03** | 25.4 ± 0.3 | 13.3 ± 0.1 | 412 ± 3 | 0.20 ± 0.01 | 20.6 ± 0.4 | <LOD | 65.9 ± 0.5 |

## 4 Discussion

In this study, twelve blackberry wines from different geographical regions were tested. Various phenolic profiles were observed (Figure 1.) indicating diverse phenolic composition. All samples showed great antioxidant and antimicrobial activity, especially samples 1, 8 and 12. Strong positive correlation was confirmed between TPC and antioxidant activity determined by DPPH and ABTS assays (Figure 2). While low correlation was observed between TAC and all antioxidative assays, since anthocyanins were present in high concentrations only in few samples (1,3 and 4). High levels of antibacterial activity were shown against all six tested strains, but primarily against *Staphylococcus aureus* and *Micrococcus lysodeikticus* (Table 1.). Samples 1 and 9 were the richest in macroelements, such as Ca, K, Mg, Na and P and sample 11 was rich in microelements Cu and Fe, while Mn was the most abounded in sample 5 (Table 2.). Toxic metals Cd and Pb were present in low concertation in all samples.

## 5 Conclusion

These results indicate great quality of Serbian blackberry wines concerning minerals, phenolics, antioxidant and antimicrobial activity, which support its health potential.

References

1. D. Amidžić Klarić, I. Klarić, A. Mornar, N. Velić, and D. Velić, *Foods.* **2020**, *9* (11), 1623.
2. M.H. Johnson, and E. Gonzalez de Mejia, *J. Food Sci.* **2012**, *77*(1), 141-148.

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