The natural product content of the selected Cabernet Franc wine samples originating from Serbia: a case study of phenolics

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ABSTRACT
This work aimed to evaluate the content of selected phenolic natural products in the wine samples made of three new Serbian Cabernet Franc clones (Nos. 02, 010 and 012, respectively) and mother vine (used as the relevant standard) during the period 2008–2012. Compared with all other wine samples, the Cabernet Franc wine of the clone No. 010 was found to have the highest total content of polyphenolics (1.85 ± 0.02 g/L) and anthocyanins (178.55 ± 3.75 mg/L). In addition, its Folin–Ciocalteu index (36.86 ± 0.12) stood out among the examined samples. Finally, the same wine was enriched with ellagic and gallic acids (3.44 ± 0.29 and 27.46 ± 0.21 mg/L, respectively), catechin (135.16 ± 6.47 mg/L) and epicatechin (51.33 ± 2.33 mg/L), the natural products known to exert significant lipid-lowering effects. Taken all together, the clone No. 010 developed in Serbia may offer new Cabernet Franc wine with geographical indication.

1. Introduction
Viticulture and enology form an integral part of human society. Grape is actually the most important fruit crop grown in the world. It has many uses, such as fresh fruit, dried fruit, fresh...
glove juice, concentrated grape juice, wine, distilled liquors, grape seed oils, anthocyanin pigments and ethanol production. While the family Vitaceae include 11 genera (about 600 species), *Vitis* is the only food-bearing genus in the family. Among its European species, Cabernet Franc and Viognier are of particular importance (Kurtural 2015).

Till date no any recognised Cabernet Franc clone developed in Serbia does exist. This work aimed to determinate the content of selected phenolic natural products in the wines made of three new Serbian Cabernet Franc clones (Nos. 02, 010 and 012, respectively; long lasting clonal selection) and mother vine (used as the relevant standard) during the the period 2008–2012 (Danicic 1988; Lee et al. 2005; Vujovic et al. In press). The overall aim is to successfully make the first Cabernet Franc wine of Serbian origin (introduced variety) with geographical indication.

## 2. Results and discussion

In comparison with both the standard Cabernet Franc wine and the wines obtained from other two clones (Nos. 02 and 012, respectively), the Cabernet Franc wine of the clone No. 010 contained the highest content of the analysed phenolic acids (Table 1). This was especially true for ellagic and gallic acids (3.44 ± 0.29 and 27.46 ± 0.21 mg/L, respectively). The presence of significant amounts of gallic acid in red wines is to be expected since it is formed mainly through the hydrolysis of flavonoid gallate esters (Gris et al. 2013). Compared with Cabernet Franc wine samples originating from southern Brasil, the wine sample No. 010 has showed to be richer in ellagic acid (Gris et al. 2013).

The same trend was observed also for other screened phenolic natural products, with stress on the contents of anthocyanins (178.55 ± 3.75 mg/L), catechin (135.16 ± 6.47 mg/L) and epicatechin (51.33 ± 2.33 mg/L), respectively. Finally, its value of Folin-Ciocalteu (FC) index (36.86 ± 0.12) stood out among the examined wine samples (Tables 2 and 3).

Anthocyanins isolated from the red grape berries (*Vitis vinifera*) have the simplest chemical structure of all the anthocyanins found in higher plants. Their structural simplicity and long-lasting colour of red wine is known as ‘French Paradox II’ (Brouillard et al. 2003). They participate in both wine colour and organoleptic properties due to their complex interactions with other phenolic compounds, as well as with proteins and polysaccharides (Fournier-Level et al. 2011). The current findings suggest that the anthocyanin pattern of grapes is closely related to genetic characteristics assuming these compounds as chemical markers

| Phenolic acids      | Standard Cabernet Franc winea | Cabernet Franc 02 wineb | Cabernet Franc 010 wineb | Cabernet Franc 012 wineb |
|---------------------|-------------------------------|--------------------------|--------------------------|--------------------------|
| Gallic acid (mg/L)  | 26.69 ± 0.24                  | 20.40 ± 0.19             | 27.46 ± 0.21             | 22.44 ± 0.25             |
| Protocatechuic acid (mg/L) | 3.51 ± 0.31                  | 2.50 ± 0.21              | 3.64 ± 0.29              | 2.50 ± 0.27              |
| Hydroxybenzoic acid (mg/L) | 0.93 ± 0.01                  | 0.79 ± 0.04              | 1.05 ± 0.02              | 0.80 ± 0.01              |
| Vanillic acid (mg/L) | 5.39 ± 0.40                   | 4.32 ± 0.28              | 5.93 ± 0.16              | 4.87 ± 0.14              |
| Ferulic acid (mg/L)  | 0.07 ± 0.00                   | 0.07 ± 0.00              | 0.11 ± 0.00              | 0.10 ± 0.00              |
| Ellagic acid (mg/L)  | 2.06 ± 0.19                   | 1.82 ± 0.16              | 3.44 ± 0.29              | 2.51 ± 0.23              |

aMother wine.
bClone wine.
for differentiation of grape cultivars. Their concentration in wines varies highly according to the age of the wine and the variety (Revilla et al. 2013).

The improved content of polyphenolics in the wines of all three clones is likely to contribute to their medicinal properties (Bisson et al. 2002; Tenore & Ciampaglia 2013; Correia & Jordão 2015), in particular to lipid-lowering effects. Indeed, ellagic and gallic acids have been recently identified as bioactive components which lowers triglyceride and cholesterol levels, respectively (Ngamukote et al. 2011; Okla et al. 2015). Furthermore, catechins are also claimed to be safe and effective lipid-lowering therapeutic agents (Koo & Noh 2007).

### 3. Experimental

See supplementary material.

### 4. Conclusion

According to the obtained experimental data, the clone No. 010 may have a real potential to offer new Cabernet Franc wine with geographical indication (Barbera et al. 2013). The further research work will be focussed on the natural product chemistry of the grapes of all three aforementioned Cabernet Franc clones including the mother vine.

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### Table 2. Total content of selected natural products of the tested Cabernet Franc wines (2008–2012).

| Organic compounds                  | Standard Cabernet Franc wine* | Cabernet Franc 02 wine** | Cabernet Franc 010 wine** | Cabernet Franc 012 wine** |
|------------------------------------|------------------------------|--------------------------|---------------------------|---------------------------|
| $\bar{X} \pm sX$                   |                              |                          |                           |                           |
| Total anthocyanins (mg/L)          | 167.97 ± 3.21c               | 167.45 ± 3.36c           | 178.55 ± 3.75a            | 173.20 ± 4.61b            |
| Total polyphenolics (g/L)          | 1.63 ± 0.02c                 | 1.74 ± 0.03b             | 1.85 ± 0.02a              | 1.73 ± 0.03b              |
| Folin-Ciocalteu (FC) index         | 35.45 ± 0.12d                | 36.54 ± 0.08b            | 36.86 ± 0.12a             | 36.58 ± 0.07c             |

Note: Within the same row, indicated letters mean significant differences, $p < 0.05$ (ANOVA, Fisher’s LSD).

*Mother wine.
**Clone wine.

### Table 3. Content of other phenolics of the tested Cabernet Franc wines (2008–2012).

| Other phenolics | Standard Cabernet Franc wine* | Cabernet Franc 02 wine** | Cabernet Franc 010 wine** | Cabernet Franc 012 wine** |
|-----------------|------------------------------|--------------------------|---------------------------|---------------------------|
| Catechin (mg/L) | 97.65 ± 4.78                 | 89.10 ± 4.27             | 135.16 ± 6.47             | 116.61 ± 5.68             |
| Epicatechin (mg/L) | 39.26 ± 1.76               | 31.17 ± 1.44             | 51.33 ± 2.33              | 35.15 ± 1.71              |
| Syringaldehyde (mg/L) | 1.63 ± 0.03                | 1.53 ± 0.03              | 1.73 ± 0.03               | 1.62 ± 0.03               |
| Naringenin (mg/L) | 0.28 ± 0.00                 | 0.23 ± 0.00              | 0.34 ± 0.00               | 0.28 ± 0.00               |
| trans-Resveratrol (mg/L) | 4.52 ± 0.16                | 3.41 ± 0.12              | 4.68 ± 0.16               | 3.69 ± 0.13               |
| 2-Phenyl-1,4-benzopyrone (mg/L) | 0.55 ± 0.01                | 0.51 ± 0.01              | 0.59 ± 0.01               | 0.52 ± 0.01               |

*Mother wine.
**Clone wine.
Disclosure statement
No potential conflict of interest was reported by the authors.

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