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Short Communication

Development of anthocyanin and chlorogenic acid concentrations in grapes grown at high latitudes – Short communication

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Polyphenols of grapes and wine have been observed to have many health-promoting effects. Their concentrations are affected by the growth environment, such as the geographical location, climate, the amount of light and length of day during the growing season and the cultivated grape variety. In this study, the anthocyanins (ANC) and chlorogenic acids (CGA) from grape, juice and vine samples of the hybrid grape variety *Vitis* 'Zilga', grown in the Helsinki region in Northern Europe at the latitude of 60°N, were studied by liquid chromatography (HPLC-DAD). They were at the same level as those in Central and Southern Europe. In fresh grapes and pressed grape juice the concentrations of anthocyanins and chlorogenic acids were higher than in the wine, so the use of grapes and fresh juice as such may have a better health effect than the vine made from them.

Key words: Nordic wine growing, grapevine, anthocyanin, chlorogenic acid, hybrid grape varieties.

INTRODUCTION

Anthocyanins belonging to the flavonoid group and chlorogenic acid belonging to phenolic acids are antioxidants that are abundant in blue and red fruits and berries. They have been found to delay the release of glucose into the bloodstream after meal, prevent cardiovascular diseases, inhibit the growth of cancer cells, and protect against recurrent urinary tract infections in women (Meng et al., 2013). Anthocyanins and chlorogenic acids are most abundant in dark grapes. The blue colour intensity of grape berries is directly proportional to their anthocyanin concentrations, because they contain very few other flavonoids. In the cool climate of Northern Europe, polyphenol concentrations in wild bilberries, lingon-berries and black-berries have been higher than the same wild varieties in Central and Southern Europe (Jaakola and Hohtola, 2010).

The vine is a new crop tested in Northern Europe whose polyphenol content has not been studied. There have been several recent studies on the polyphenol content of grapes grown in mountain regions in Asia or South-America, where climate conditions correspond to the climatic conditions of the southern parts of northern Europe (Coklar, 2017; Jin et al., 2017; Zhang et al., 2019). Many of the studied varieties are old local varieties, *Vitis vinifera* -varieties transported from Europe or new hybrid varieties (Kayesh et al., 2013). The obvious reason for the research is that, when the climate warms, the vine growing location will have to be moved higher from sea level; on the northern hemisphere, they will move to the more northern latitudes and, respectively, on the southern hemisphere to the more southern latitudes (Santor et al. 2017).

MATERIAL AND METHODS

In the conducted study, the anthocyanins of the freeze-dried grape, juice and wine samples from the Helsinki region at 60°N were analysed as Cyanidin 3-O-Glucoside -equivalents and chlorogenic acids were analysed as 5-O- Caffeoylquinic acid -equivalents by High-Performance Liquid Chromatography with Diode-Array Detection (HPLC-DAD and declared as fresh weight (FW), which is one of the most common instrumental methods in chemical analytics with extensive applications in wine chemistry. Crushed grape samples included skins, pulp and seeds. In addition, the study also looked at how the

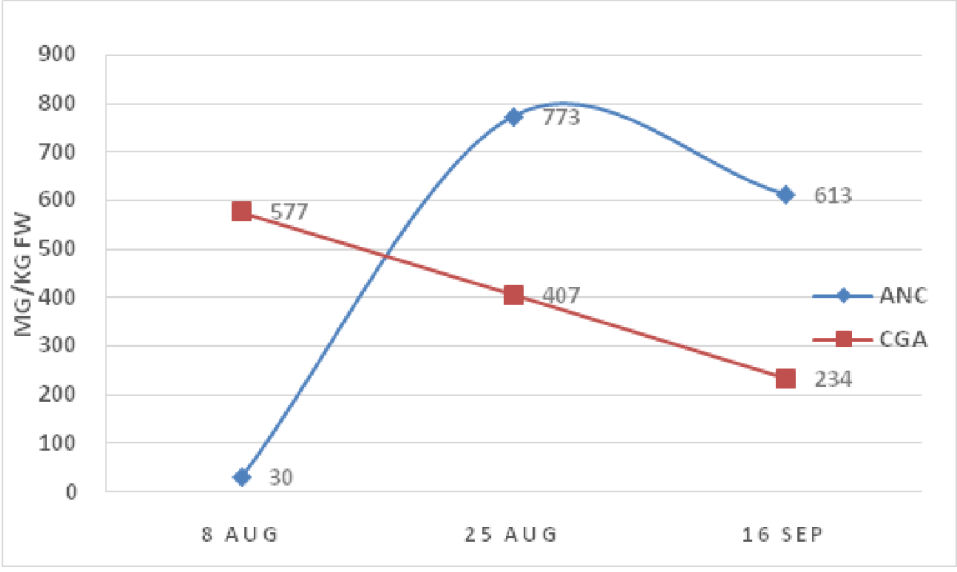

Figure 1. Anthocyanin and chlorogenic acid concentrations in grapes before harvest 16 Sep 2019 (mg/kg FW).

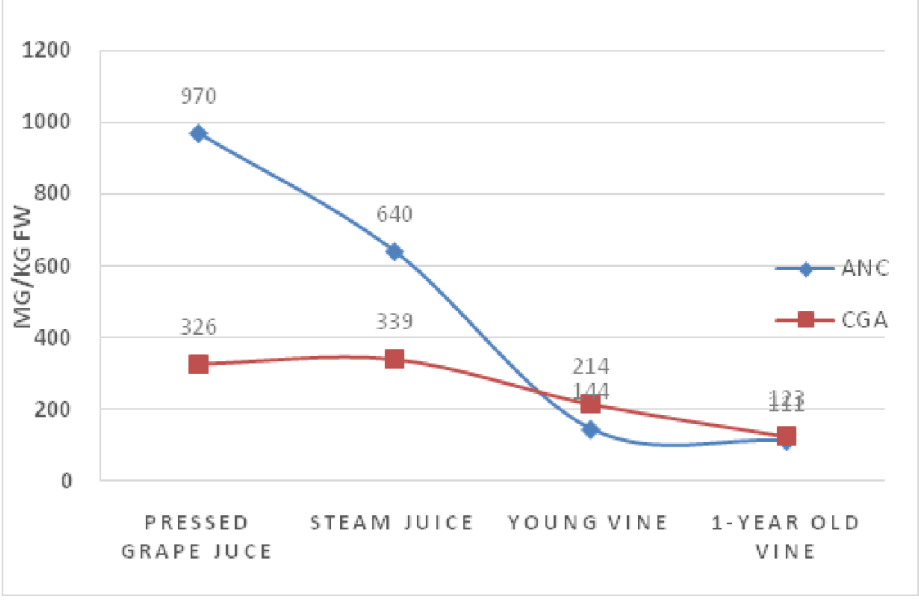

Figure 2. Anthocyanin and chlorogenic acid concentrations in juice and wine after harvest 16 Sep 2019 (mg/kg FW).

anthocyanin and chlorogenic acid levels change in the ripening grapes before harvesting, and in juice and wine after harvesting.

RESULTS AND DISCUSSION

The anthocyanin content of grapes was lowest in samples from early August and highest in unripe grapes at the end of August, after which it decreased towards harvest (Figure 1). Anthocyanins are most abundant in grape skins, so their concentration increases while dark grapes ripen. Slightly lower anthocyanin levels were measured in ripe grapes at harvest which may be explained by increased grape size. Chlorogenic acid levels decreased steadily as the growing season progressed, which may be due to the same reason, i.e., the larger grapes have a larger liquid volume.

In this study, the anthocyanin content of the Zilga grapes changed during ripening as Kayesh et al. (2013) reported in the Grenache noir, Syrah, Agiorgitiko and Xinomavro red wine grapes during growth and ripening, but great variety-specific differences have also been found in the anthocyanin and non-flavonoid content between fully ripe grapes (Costa et al., 2014). In studies on the phenolic compounds of Merlot wine, the anthocyanin content has been observed to increase when the altitude of the growing

place increases. The highest increase of anthocyanin content was determined for Cabernet Sauvignon wine grown at an altitude of 2,608 m, where the total anthocyanin content was 455 mg/L. This was almost twice the anthocyanin content of 258 mg/L when grown at an altitude of 2,282 m (Jin et al., 2017). These contents were four and two time higher compared to wine grown at sea level in the Helsinki region (Figure 2).

The anthocyanin content of the pressed juice was higher than that of the steamed juice because the anthocyanins were found to be easily degraded by the effects of heat. In wine samples, the content of polyphenols, especially anthocyanins, was lower than in juices, because anthocyanins are reactive compounds and are sensitive to oxidation (Figure 2).

In wine, anthocyanins are known to react with proanthocyanidins, among other things, and form of new colour compounds. Chlorogenic acid, which belongs to the group of phenolic acids, is always present in grapes and wine (Hennig and Burkjardt, 1960). In juice, its concentration is influenced by the temperature of the maceration and the amount of enzyme during the juice production process (dos Santos Lima et al., 2015). In this study of Zilga grapes, the content of chlorogenic acid in steam and grape juice was approximately the same, since phenolic acids are more durable on average.

The human health-promoting effect of these and other polyphenols has been extensively studied since Renaud and de Lorgeril (1992) published their study on the cardiovascular diseases preventing the effects of resveratrols in red wines. *In vivo* studies, high doses of resveratrol were also found to promote physical performance and muscle strength, and one glass of red wine was concluded to have the same effect on health as one hour of strength and endurance training (Dolinsky et al., 2012). Since then, these issues have often been questioned, as Semba et al., (2014) presented in their extensive study.

CONCLUSIONS

The content of anthocyanins and chlorogenic acid in the examined hybrid grape variety and juices and wine were at the same level as in Central and Southern Europe but distinctly lower than grapes grown at an altitude over 2,000 m. According to this study, anthocyanins and chlorogenic acids were more abundant in grapes and fresh grape juice than in wine, so in order to maximise their potential health effects, they should be enjoyed as such.

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