

EFFECT OF GENOTYPE AND SEASON ON ANTIOXIDANT ACTIVITIES OF HOP EXTRACTS FROM LEAVES



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INTRODUCTION

Hops contain a large number of biologically active compounds such as bitter and polyphenolic compounds and essential oils. In the last decade, much attention has been focused on polyphenols and flavonoids, which have been shown to exhibit different biological activities, such as antioxidant (AA), anticancer, antiviral and antimicrobial properties. Other studies were aimed at studying prenylated flavonoids as promising substances for cancer prevention (Vanhoenacker *et al.* 2001, Zhao *et al.* 2005), enhancing activity of cancerogen-detoxifying enzymes or inhibition of early tumor growth (Henderson *et al.* 2000). The amount and composition of hop polyphenols depends on the growing site location, the agricultural technology, and the method of sample processing. Differences in antioxidant activities within hop cultivars have been also reported (Krofta *et al.* 2008, Nesvadba & Krofta 2009). The aims of our study were: i) to compare the AAs of extracts from hop leaves in hydrophilic conditions during the vegetation season ii) to compare the AAs of extracts from hop leaves in lipophilic conditions during the vegetation season iii) to determine the correlation values between AAs of extracts from hop leaves and cones, respectively.

MATERIALS AND METHODS

The analyzed samples were extracted from hop (*Humulus lupulus* L.) plants originated from the *ex vitro* collection of virus-free hop genetic resources maintained at the Genebank of Slovak Republic in Piešťany, SK. All extracts were prepared from leaves or cones of hop cultivars Bor, Sládek, Premiant and clones derived from the Žatecký poloraný červeňák (Saazer) - Oswald's clones Aromat, Lučan, Siřem, Zlatan, K-31, K-72, and K-114. Samples were collected three times during the vegetation season (in May, July, and September 2010). The samples were dried at 50°C, homogenized, extracted by methanol (3 grams of dry sample with 60 ml of methanol), and stored before analysis in dark at 4°C. The antioxidant activity was determined by the DPPH and BCLM methods.

RESULTS

Comparison of the antioxidant activity of hop leaf extracts during the vegetation season in hydrophilic and lipophilic conditions

The antioxidant activity of hop extracts was measured during the vegetation season from plant material collected in May, July, and September 2010. During the vegetation season, increasing AA values were observed, with a maximum at the end of the season in September in all cultivars, except for Siřem (DPPH, Fig. 1) and Bor (BCLM, Fig. 2).

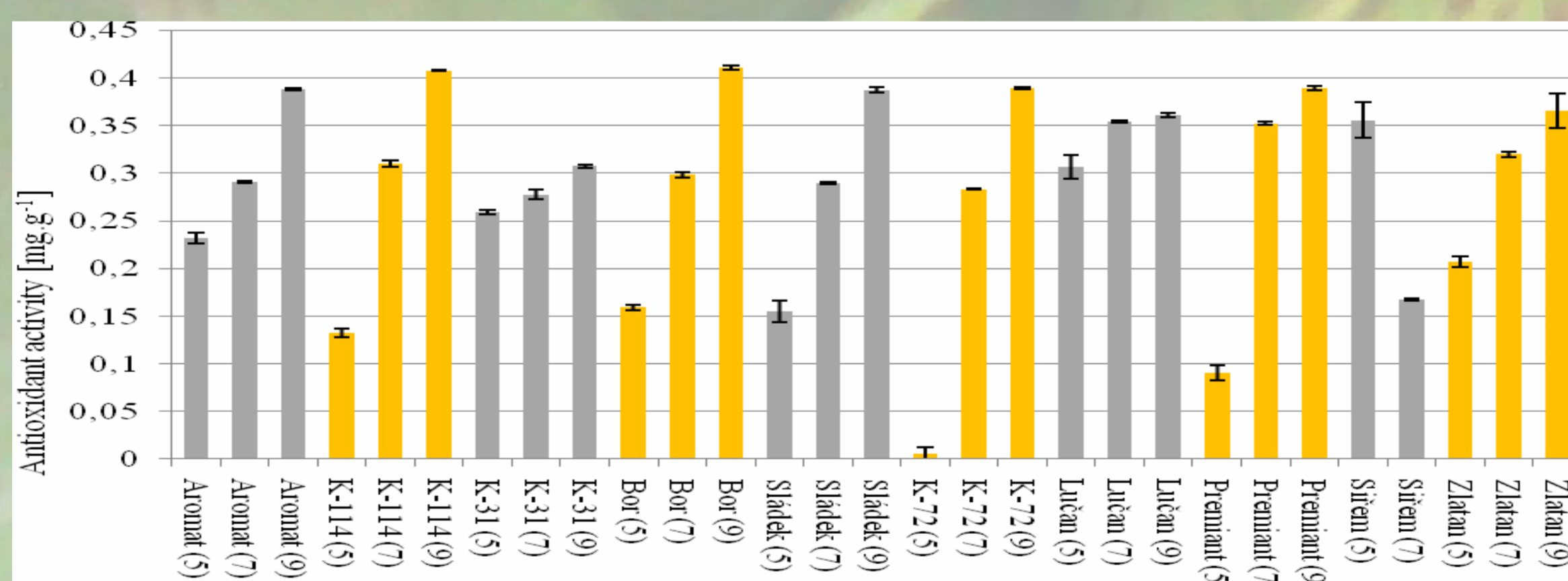


Fig. 1: Comparison of antioxidant activities in extracts from hop leaves during the vegetation season and measured by the DPPH method (values±SD, n=3, samples of hop cultivars and clones:sampled in May -5, July -7, September-9).

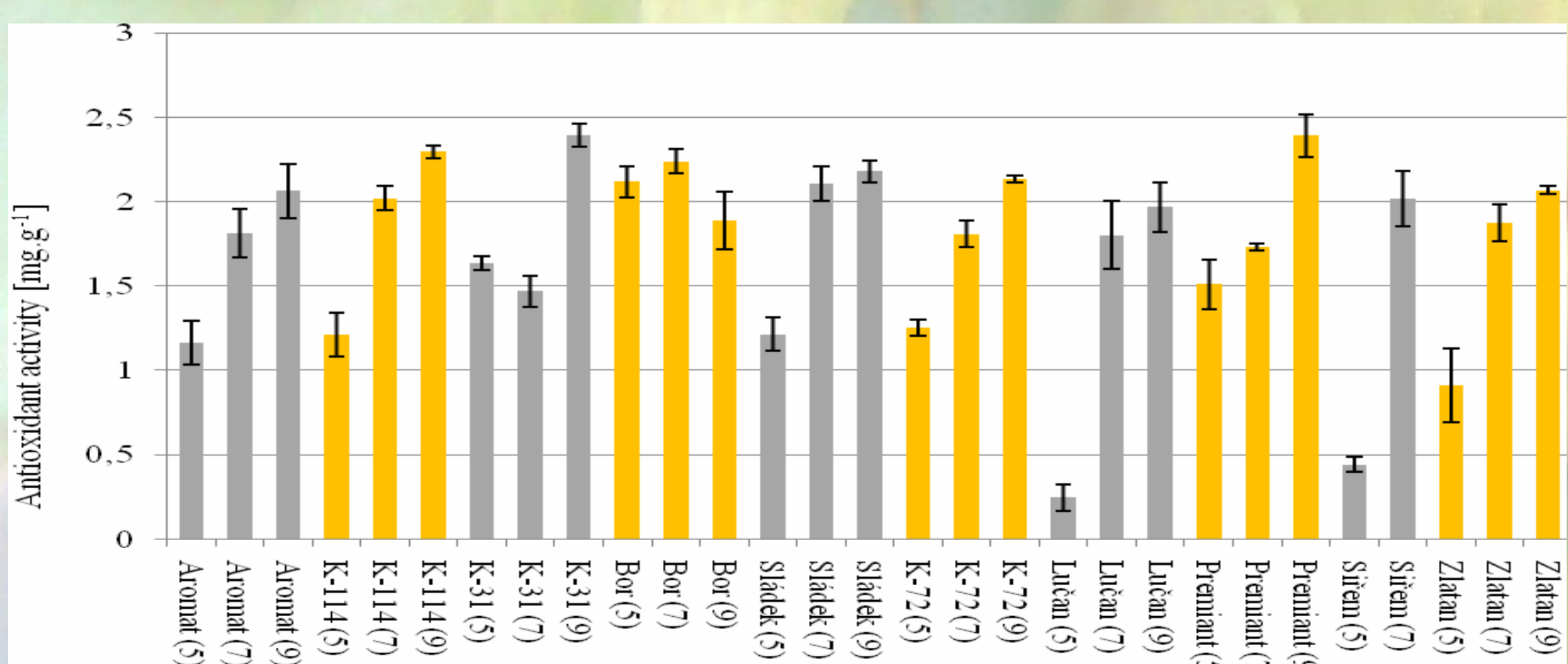


Fig. 2: Comparison of antioxidant activities in extracts from hop leaves during the vegetation season and measured by the BCLM method (values±SD, n=3, samples of hop cultivars and clones:sampled in May -5, July -7, September-9).

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Analysis of correlations between AAs of extracts from hop leaves and cones

Statistically significant ($P < 0.01$) correlation was detected between the average values of AAs measured in extracts from leaves and AAs in extracts from cones only when the BCLM method was used (Fig. 3). No significant correlation between the AAs of hop extracts from leaves vs. cones was detected using the DPPH method.

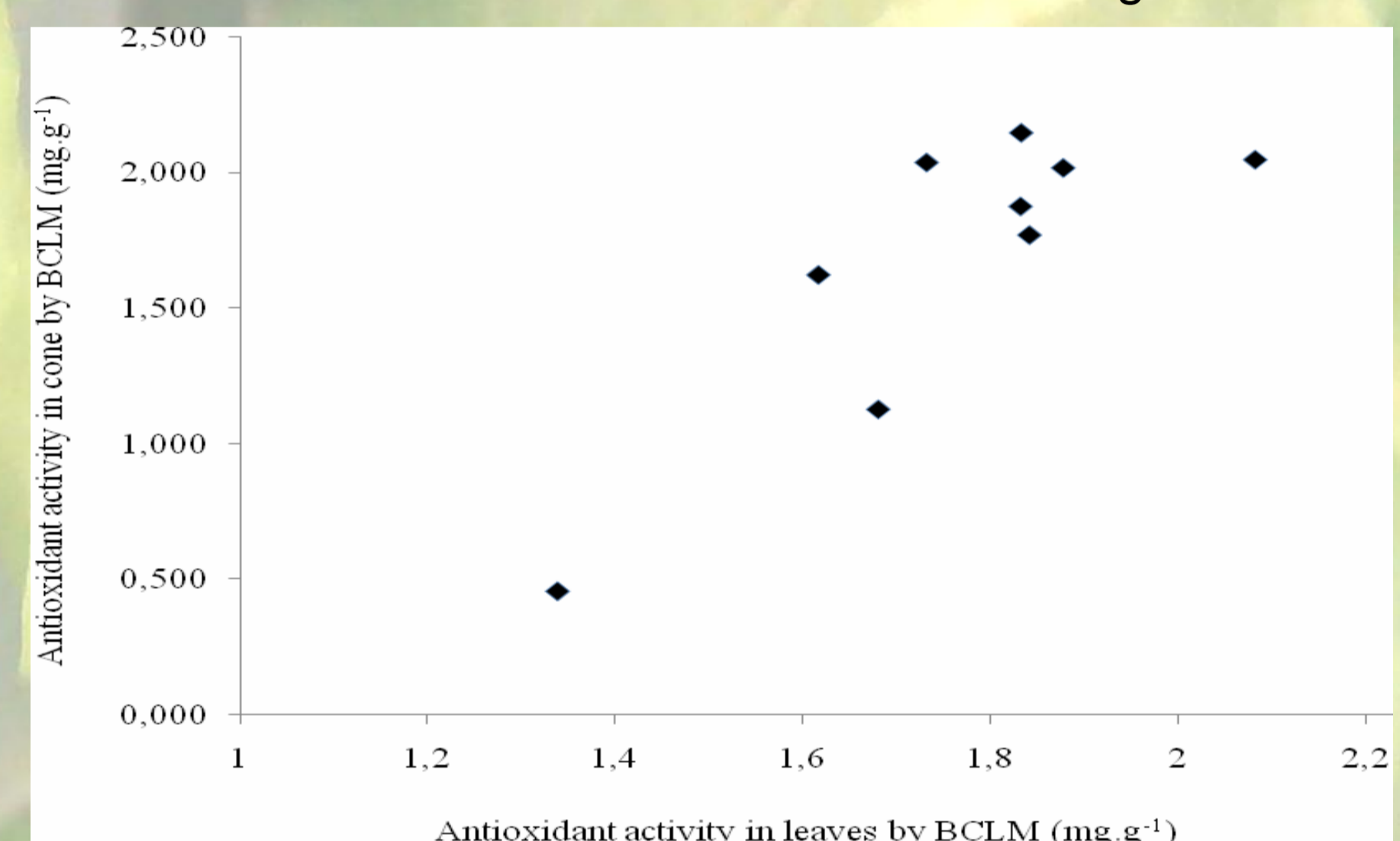


Fig. 3: Correlation between the mean values of AAs in extracts from leaves (collected during the vegetation season) and cones (collected in September) measured by the BCLM method.

Correlations between the total contents of polyphenols, flavonoids, and AAs of extracts from hop cones

Antioxidant activity detected in cone extracts and determined by the BCLM method showed statistically significant correlation with total contents of polyphenols ($P < 0.01$), similarly as reported by Krofta *et al.* (2008), and statistically significant correlation with total content of flavonoids ($P < 0.05$) (Fig. 4). Values of AAs measured by the DPPH method showed statistically significant correlation only with the total content of flavonoids ($P < 0.05$) (Fig. 4). If extracts from leaves were analysed, there was correlation neither between AAs and total content of polyphenols nor between AAs and total content of flavonoids. These results suggest a shift of antioxidant activity during the vegetation period of plants from leaves to cones of hops.

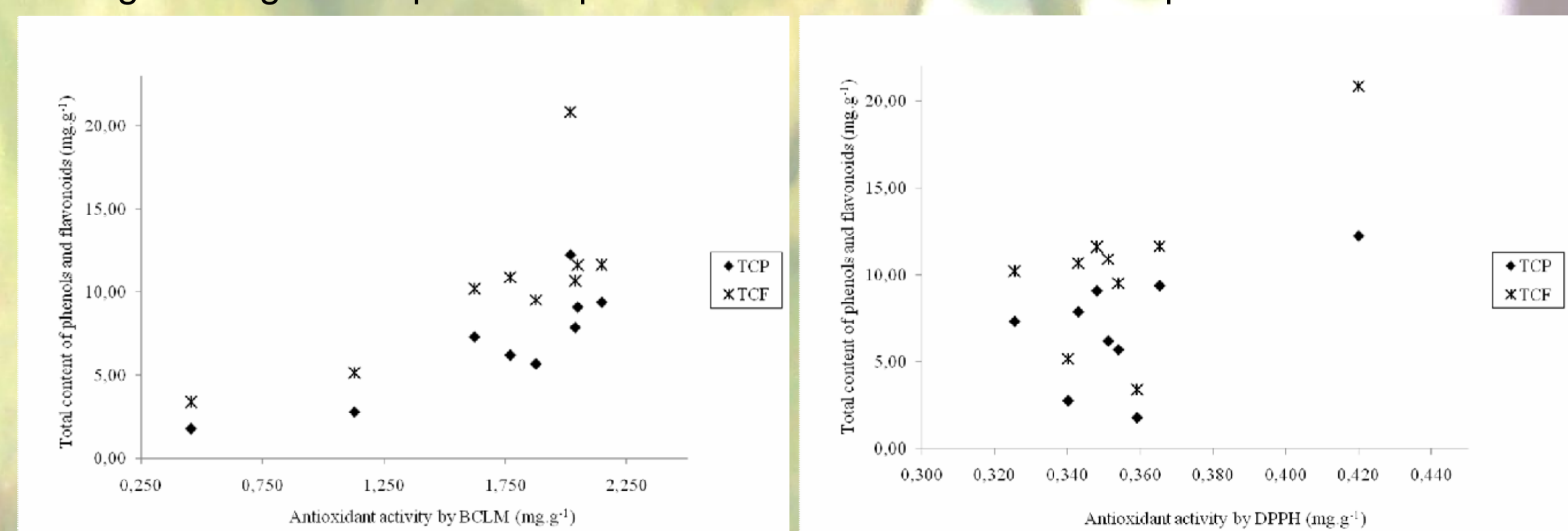


Fig. 4: Correlation between AAs measured by the BCLM and the DPPH methods, total content of polyphenols (TCP) and total content of flavonoids (TCF) in extracts from hop cones collected in September 2010.

CONCLUSION

Chemical constituents of hops are of considerable importance not only in the brewing industry, but they can serve as sources of biologically active substances such as polyphenols, flavonoids and prenylated chalcones. These substances have great potential for different pharmaceutical applications. Our study showed that compounds with antioxidative activities accumulate during the vegetation period also in hop leaves, which are now a useless waste product during hop harvest.

Acknowledgements

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