THE CONTENT OF ESSENTIAL OIL IN HOP CONES AND POSSIBILITIES IF ITS USAGE

Pokorná T.[1], Pluháčková H.[1], Kocourková B.[1], Kleinová J.[2]

[1]Department of Crop Science, Breeding and Plant Medicine, Faculty of Agronomy, Mendel University in Brno, Zemedelska 1, 613 00 Brno, Czech Republic

[2]Department of Chemistry and Biochemistry, Faculty of Agronomy, Mendel University in Brno, Zemedelska 1, 613 00 Brno, Czech Republic

E-mail: xpokor16@node.mendelu.cz

ABSTRACT

The aim of this work was to determine the essential oil content in hop cones of the Saaz variety, harvest years 2010 and 2011. The essential oil content was determined by the means of steam distillation. Analysis of individual components was performed via gas chromatography / flame ionisation detection (GC/FID). Gas chromatograph HP-4890D with FID was used for the identification and ratio determination of the analytes of interest. The differences in the essential oil content were found in both evaluated years. The essential oil content found in the samples from 2011 was much higher compared to the year 2010. The amount of selected components – myrcene, caryophyllene, farnesene and humulene – was determined in the essential oil. The highest content of myrcene was found in samples from 2011 from hop-growing region Tršice (56.9 %). The highest content of caryophyllene was found in samples from 2011 from hop-growing region Saaz (18.3 %). The content of farnesene wasn't statistically significantly different in both evaluated years in hop-growing regions Tršice and Úštěk. The content of farnesene in these samples varied in the range of 12.0 – 12.5 %. Humulene was the second highest contained component in the essential oils. The results indicate that the content and composition of the essential oil depends on the growing region and on the weather course during the harvest year. Hop essential oils have, among others, antibacterial effects and could be used also for the stabilisation of non-beer beverages from the view-point of microbial purity.

Key words: hops, essential oils, myrcene, caryophyllene, farnesene, humulene

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INTRODUCTION

Hops essential oils are the most important group of compounds responsible for the hops aroma (Prugar 2008). It is a mixture of several hundred compounds of different chemical composition, volatility and polarity. Some of them occur in tens of percent (myrcene, α-humulene), many others in small or trace amounts, but all of them take part in creating the characteristic hops aroma (Krofta 2008). The composition of essential oil depends mostly on genetic characteristics of the variety, growing conditions, but also on the harvest and storage (Basařová 2010). According to Nováková et al. (1996) hops essential oil has strong calming effects in hysteria and helps also against insomnia, bronchitis, asthma, irritant cough and dissolves mucus. It affects intestinal problems of neural origin positively, lowers the blood pressure and for some people works also as aphrodisiac. In cosmetic industry, hops essential oil is a part of hair tonics and shampoos. Essential oils and other hop extracts are used for the aromatisation of tobacco, yeast, frozen milk products, sweets, jelly, pudding, pastry, chewing gum or as a beverage taste additives (Duke 1985). In Europe, the hops essential oil is part of recipes for the production of creams and lotions for its alleged softening effects (Small 2006).

MATERIALS AND METHODS

The samples of the Saaz variety were taken from three hop-growing regions (Saaz, Úštěk and Tršice) from harvest years 2010 and 2011. The essential oil content in hop cones was determined using steam distillation according to Krofta's (2008) method, modified by Pluháčková et al. (2010). Distillation apparatus recommended by Czech Codices 2009 for the determination of essential oil in plant drugs was used. Analysis of individual components was performed via gas chromatography / flame ionisation detection (GC/FID). Gas chromatograph HP-4890D with FID was used for the identification and ratio determination of the analytes of interest. The separation was carried out at the column HP-INNOWAX (30 m x 250 µm x 0,5 µm polyethylenglycol film). 1 µl of the essential oil solution in hexane was injected to the column with split ratio 50:1. The helium flow-rate was 1 $ml.min^{-1}$, injector temperature 240 °C and detector temperature 250 °C. Following temperature program was used: T_1 = 60 °C, t_1= 0,01 s, 1,5 °C.$min.^{-1}$, T_2 = 80 °C, t_2 = 0,01 s, 40 °C.$min.^{-1}$, T_3 =240 °C, t_3 = 8 min., total time 25,33 min. Humulene, farnesene, caryophylene and myrcene were determined with n=2. Statistical software StatSoft, Inc. (2011) STATISTICA, version 10 was used for the evaluation of results. All results were evaluated by single-factor analysis of variance, followed by testing the differences in average values by LSD test (Fisheruf LSD test).

RESULTS AND DISCUSSION

Evaluation of essential oil content and selected essential oil components in the Saaz variety in compared hops-growing regions:

Tab. 1 Analysis of variance for total content and individual components of essential oils of the Saaz variety, comparison for Tršice, Úštěk and Saaz growing regions in 2010 and 2011

Source of variance	d.f.	Resin content	myrcene	β-caryophyllene	t-β-farnesene	α-humulene
		MS				
Region	2	120853***	1728,00***	329,94***	94,17***	1117,07***
Year	1	258403***	111,11***	4,11	1,13	132,35***
Region*Year	2	58503***	161,07***	0,16	0,63	145,54***
Error	30	822	11,51	2,16	2,44	3,79

Note.: * - $p \leq 0,05$; ** - $p \leq 0,01$; *** - $p \leq 0,001$

The analysis of variance shows a highly significant effect of region on the essential oil content and the amount of selected components of essential oils. The effect of the harvest year was very highly significant for the content of essential oils and the amount of essential oil components myrcene and humulene, for the other monitored components of the essential oil (caryophyllene and farnesene) the effect of not proven. As well as the influence of the year, also the interaction of evaluated factors had very highly significant influence on the content of essential oils and essential oil components myrcene and humulene.

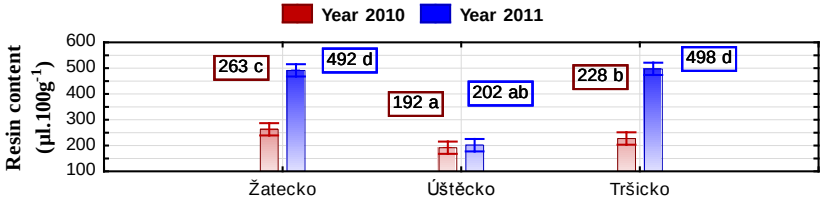

Fig. 1 Average essential oil content in the Saaz variety, comparison for Tršice, Úštěk and Saaz growing areas in 2010 and 2011

The subsequent testing of the interaction of factors Year x Location (see Fig. 1) indicates that the highest content of essential oil was in the samples from 2011, region Tršice (498 µl.100g^{-1}). However, these results did not differ significantly from samples from the same year, Saaz region (492 µl.100g^{-1}). In 2010 the highest content of essential oil was in Saaz region samples (263 µl.100g^{-1}). Lowest content of essential oil in evaluated years 2010 and 2011 was found in samples from hop-growing region Úštěk (192 a 202 µl.100g^{-1}).

Tab. 2 Average content of myrcene, caryophyllene, farnesene and humulene in the Saaz variety samples, comparison for Tršice, Úštěk and Saaz growing regions in 2010 and 2011

Year	Region	Myrcene (%)	t-caryophyllene (%)	t-β-farnesen e(%)	α-humulene (%)
2010	**Tršicko**	46,1 b	8,0 a	12,5 b	33,4 c
	Úštěcko	54,0 cd	9,2 ab	12,4 b	24,3 a
	Žatecko	29,2 a	17,9 c	7,9 a	45,1 e
2011	**Tršicko**	56,9 d	8,8 ab	12,0 b	22,4 a
	Úštěcko	50,2 c	10,1 b	12,5 b	27,2 b
	Žatecko	32,8 a	18,3 c	7,1 a	41,8 d

Note.: Aver. values denoted with different letters in the columns differ statistically significantly at P=0.05

The most contained component of the essential oil, myrcene, was found in highest concentration in the essential oil from 2011, region Tršice (56.9 %), i.e. in the sample with highest essential oil content. These values did not differ significantly from samples from the harvest year 2010, region Úštěk (54.0 %) and 2011, region Úštěk (50.2 %). Lowest content of myrcene was found in Saaz samples, both 2010 and 2011. Highest content of caryophyllene was in Saaz samples, medium values were found in Úštěk region samples and lowest for Tršice region both in 2010 and 2011. The amount of caryophyllene in Saaz hops varied in the range 8.0 – 18.3 %. As for farnesene, there were no statistically significant differences among the Tršice and Úštěk samples in both 2010 and 2011. The amount of farnesene in these samples varied in the range 12.0 – 12.5 %. Lowest content of farnesene was found in Saaz region samples from 2010 and 2011 (7.9 and 7.1 %, resp.). The second most contained component of the essential oil was humulene. Highest concentrations were found in samples from the year 2010, Saaz region, lowest values were observed in samples from the year 2011, Tršice region. However, they were not statistically significantly different from samples from the year 2010, Úštěk region.

According to Basařová (2010) the hops contain 0.5 – 3.0 % of essential oil. Prugar (2008) states that the essential oil content is usually < 1 %, according to Nesvadba´s (2012) study the Saaz variety hops contained 0.4 – 1.0 % of the essential oil in harvest years 2010 and 2011. Saaz variety hops had highest average essential oil content from all Saaz region samples (378 µl.100g^{-1}). Lowest values were found in Úštěk hop-growing region (197 µl.100g^{-1}). Tršice (362 µl.100g^{-1}) and Saaz hop-growing regions (378 µl.100g^{-1}) were not significantly different. Prugar (2008) states that Saaz hops contain relatively low amount of myrcene. According to the Hop Reseach Institute (2012) the relative content of myrcene in Saaz hops is 25 – 40 %. As for our results, the lowest content of myrcene in the harvest year 2010 was found in samples from the Saaz hop-growing region (29.2 %) and the highest in Úštěk hop-growing region (54.0 %). In 2011 the lowest content of myrcene was found again in the Saaz hop-growing region (32.8 %). Highest amount of myrcene was in the essential oil from hop cones from Tršice hop-growing region (56.9 %). Prugar (2008) states that Saaz hops contain important level of farnesene (15 – 20 % rel.). According to the Hop Reseach Institute (2012) the relative content of β-farnesene in Saaz hops is 14 – 20 % rel., which is in good accordance with Nesvadba (2012). Jelínek et al. (2011) states that the high content of β-farnesene is typical for the Saaz variety. The value is almost always > 10 % rel.; the variety can be identified easily thanks to this fact. As for our results, the Saaz hops contained 7.1 – 12.5 % of farnesene in 2010 and 2011. According to the Hop Reseach Institute (2012) the relative content of β-caryophyllene in Saaz hops is 6 – 9 % rel. In our samples the amount of caryophyllene varied in the range of 8.0 - 18.3 %. Second most contained compound in the essential oil was α-humulene. The Hop Reseach Institute (2012) gives the value of 15 – 30 % rel. for α-humulene. According to Nesvadba (2012) this value was 15 – 25 % rel. for the Saaz variety in 2010 and 2011. As for our results, the content of α-humulene varies in the range 22.4 – 45.1 %. There were no statistically significant differences among the samples from the Saaz region in both evaluated years. Lowest values were found for the samples from 2011, Tršice hop-growing region, but the results did not differ significantly from samples from 2010, Úštěk hop-growing region.

CONCLUSIONS

The aim of this work was to determine the content of the essential oils in hop cones of Saaz variety hops, harvest years 2010 and 2011. In general the lowest essential oil content was found in samples from Úštěk region. There were no statistically significant differences between Tršice and Saaz regions. The amount of selected components – myrcene, caryophyllene, farnesene and humulene – was determined in the essential oil. The highest content of myrcene was found in samples from 2011, Tršice region (56.9 %). Lowest content was found in Saaz region samples both in 2010 and 2011 (29.2 and 32.8 %, resp.). The highest content of caryophyllene was found in samples from 2011, Saaz region (18.3 %) and the lowest in Tršice region (8.0 %). In the Úštěk region, average values were determined in both harvest years (9.2 a 10.1 %). The content of farnesene wasn't statistically significantly different in both evaluated years in hop-growing regions Tršice and Úštěk. The content of farnesene in these samples varied in the range of 12.0 – 12.5 %. Lowest content of farnesene was found in Saaz region (7.9 and 7.1 %). Humulene was the second highest contained component in the essential oil. The highest amount occurred in Saaz region (45.1 %). Lowest values were found in samples from 2011, Tršice region (22.4 %), Úštěk region (24.3 %). The results indicate that both the growing region and the influence of harvest year are important for the content and composition of the essential oil. This monitoring should be performed in a longer time period so that the components of essential oils could be used also for non-traditional purposes.

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