



# Evaluation of fine aroma Saaz Shine hop variety

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## Abstract

The Saaz Shine variety was registered in 2019. It was tested in two areas, Chrášťany (no irrigation) and Stekník (with irrigation), between 2017 and 2021. An average hop yield in Stekník is 2.62 t/ha and in Chrášťany it is 2.54 t/ha. No conclusive difference in yields was determined. An average content of alpha acids was 4.67% in Chrášťany and 3.18% in Stekník, therefore the content of alpha acids in Saaz from Chrášťany has been proven to be higher than in Stekník. There is a conclusively higher content of essential oils in hops from Chrášťany (0.65 g/100 g) than from Stekník (0.34 g/100 g), but the composition of the essential oils is not conclusively different. The aroma of hop cones from both areas is identical. Their moderately intense scent can be described as a fine hop one with a background hint of fruit and citrus.

**Keywords:** hop; *Humulus lupulus* L.; variety; yield; hop resins; hop essential oils

## 1 Introduction

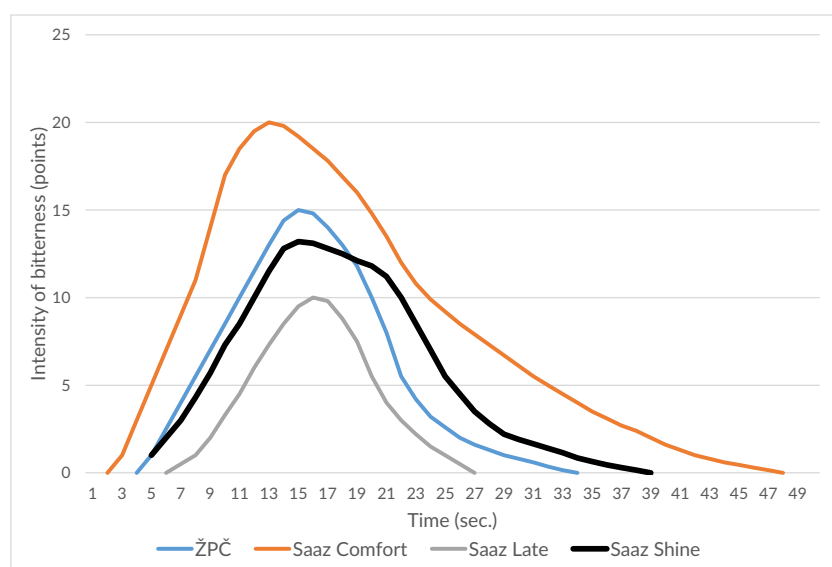
Breeding of fine aroma hops has a long tradition in the Czech Republic. The first clone selection was conducted by Kryštof Semš from Vrbice u Roudnice in the Úštěk population in 1853 and Semš carried a positive selection in his hop growth there. Still, it is Doc. Karel Osvald who is the founder of modern breeding methods. He applied clone selection in original regional hop growth and was interested in clone selection from 1927. Czech hop breeding gained three clones thanks to his long-standing effort and these were called after their breeder as Osvald clone 31, Osvald clone 72 and Osvald clone 114 (Fric, 1992). Nowadays the clones cover 90% of the total hop growing area in the Czech Republic. Hybridisation, i.e. cross breeding, started to be applied in hop growing from the 1960s (Neve, 1991). Breeding of fine aroma hops is based on cross breeding of Saaz with the genotypes which originate from Saaz and pass fine aroma signs onto their descendants. Thanks to this Saaz Late, grown on the area of 32 ha, was registered in 2010.

A programme for breeding new aroma hop varieties originating in Saaz was set off in 1995. This resulted in a registration of three new varieties of Saaz Brilliant, Saaz

Comfort and Saaz Shine which display a range of signs identical to *Žatecký poloraný čeveňák*, usually translated as Saaz (Nesvadba et al., 2020). All new varieties are currently bred in semi-operational conditions, brewing tests are performed on them and testing batches brewed in operations breweries. Authors Nesvadba et al. (2021a) assessed an intensity and character of bitterness in Saaz Shine and compared this to Saaz Late and Saaz Comfort. Figure 1 clearly shows that there is a difference in the time when the beer reached the highest intensity of bitterness. Saaz Comfort reached the maximum intensity after 12 sec., ŽPC and Saaz Shine after 15 sec. and Saaz Late after 16 sec. As for the commencement and reaching the intensity of bitterness, Saaz Shine and ŽPC are very similar, but they differ in the character of fading. It is obvious that Saaz Shine keeps the higher intensity of bitterness for the longest time out of all varieties and its gradual decrease starts only after 21 sec.; its character of fading is identical to ŽPC after this time.

Hop breeding has generally been focused on resistance towards biotic and abiotic effects in recent years, mainly resistance towards drought (Nesvadba et al., 2021b). Expedi-

tions to dry areas collect samples of wild hops (Nesvadba et al., 2009), that can consequently be utilised for breeding in dry conditions. At the same time the genotypes must show resistance towards downy mildew of hop. Genetic hop sources constitute an initial breeding material (Charvátová et al., 2017). Hop varieties need to be resistant towards fungal diseases (Trefilová et al., 2022), tolerate drought (Nesvadba et al., 2022), and they need to fulfil required agrotechnical properties. Also they must be storable, have high yields and the necessary resin content (Čerenak et al., 2015).



**Figure 1** Intensity and character of fading bitterness in fine aroma varieties

## 2 Materials and methods

Saaz Shine was registered in 2019 as a fine aroma hop variety for Czech Beer. It was bred through selection of descendants from mother plant Sládek and male plant *Žatecký poloraný červeňák* (further as ZPC). The plant has a medium size and a regular oval shape. Bines are red-green, 14–18 mm thick. Stems with hops are medium long and hop cones have a high density starting at 0.5 m from the ground. The yield is between 2.0 and 2.6 t/ha. Its scent is moderately intense and its character is assessed organoleptically. Saaz Shine is well applied in lager and IPL style brewing.

### Saaz Shine has been planted in two areas:

- Stekník – Žatec area nearby the Ohře river with medium-heavy soil and an irrigated hop field,
- Chrástany – dry Rakovník area with medium-heavy soil where the hop field is not irrigated.

Tests started in the autumn of 2016. A hop yield was only assessed between 2018 and 2021 as it is not eval-

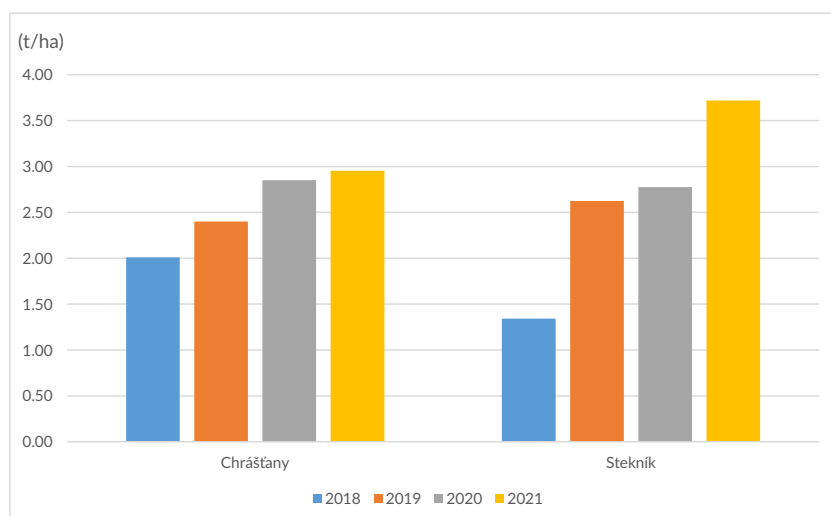
uated in the first year of growing. Hop picking was performed with a test Wolf hop-harvester. The yield is given in kilogrammes of fresh hops (further only as kg/plant). A conversion of the hop yield is given by the number of plants on 1 ha, which with a spacing 1.14 × 3.00 m is 2,900 plants). A coefficient of dry matter on dry hops is 4. A content and composition of hop resins (EBC 7.4 in Krofta, 2008) and a content and composition of hop essential oils through liquid chromatography were assessed between 2017 and 2021.

A basic statistic was calculated: average ( $\bar{x}$ ) and standard deviation ( $s$ ). A relative rate of variability is used to compare varying levels in a group. Received rates of variability are dimensionless numbers (usually in %) which allow to compare a variability of statistical signs having a different unit of measure. A variation coefficient ( $V_k$ ), giving an extent of variation in %, was applied to process the data. T-test was used to determine a conclusive difference between varieties. A stated difference between groups is based on a level of importance  $\alpha$ , which defines a probability of difference between tested groups (Meloun and Militký, 1994). E.g.

a stated level of importance where  $\alpha = 0.01$  tells that the evaluated groups are 99% likely to be different.

## 3 Results and discussion

An experiment intended to compare the varieties was conducted in two areas: in Stekník, close to the Ohře river, where irrigation is used, and in Chrástany in the Rakovník region, which is a dry region without irrigation. The yields were evaluated between 2018 and 2021. The average hop yield in Stekník was 2.62 t/ha and in Chrástany it was 2.54 t/ha. No conclusive difference between the yields was determined. The yields in individual years are given in Figure 2. The hop yield in Chrástany ranged from 2.01 to 2.96 t/ha and in Stekník it was between 1.34 and 3.72 t/ha. Saaz Shine in Chrástany shows a lower variability of 17.14% over the four-year period. Contrary to this, the variability in Stekník is higher, i.e. 37.36%. Saaz Shine seems to be a plastic variety whose yields do not swing in unirrigated conditions.



**Figure 2** Hop yields

The average content of alpha acids was 4.67% and ranged from 3.33% to 5.36% in Chrášťany (Table 1). In Stekník the average content of alpha acids was 3.18% and ranged from 2.58% to 4.17% (Table 2). The results show that the content of alpha acids was conclusively higher in Chrášťany than in Stekník. Further, it is obvious that both the content of beta acids, xanthohumol, alfa/beta ratio, shares of cohumulone and colupulone

are almost identical (not statistically conclusively different). A variability of the content and composition of hop resins is on the same level, except for the xanthohumol content (the variability in Stekník is twice as high as in Chrášťany). We should point to the fact that Saaz Shine has a higher content of alpha acids in dry conditions and at the same time it keeps the content and composition of other resin particles.

**Table 1** Content and composition of hop resins in the Chrášťany area

Year	Alpha acid (% w/w)	Beta acid (% w/w)	Ratio alpha/beta	Cohumulone (% rel.)	Colupulone (% rel.)	Xanthohumol (% w/w)
2017	5.36	3.59	1.49	22.80	43.10	0.28
2018	3.33	2.28	1.46	24.20	43.80	0.22
2019	4.08	2.81	1.45	24.40	46.50	0.26
2020	5.34	2.77	1.93	23.90	44.70	0.28
2021	5.25	2.86	1.84	23.40	45.20	0.30
<b>Average</b>	<b>4.67</b>	<b>2.86</b>	<b>1.64</b>	<b>23.74</b>	<b>44.66</b>	<b>0.27</b>
<b>s</b>	<b>0.83</b>	<b>0.42</b>	<b>0.21</b>	<b>0.58</b>	<b>1.17</b>	<b>0.03</b>
<b>Vk</b>	<b>17.66</b>	<b>14.66</b>	<b>12.63</b>	<b>2.44</b>	<b>2.62</b>	<b>10.12</b>

**Table 2** Content and composition of hop resins in the Sketník area

Year	Alpha acid (% w/w)	Beta acid (% w/w)	Ratio alpha/beta	Cohumulone (% rel.)	Colupulone (% rel.)	Xanthohumol (% w/w)
2017	2.58	2.29	1.13	24.0	42.2	0.13
2018	3.02	2.83	1.07	24.7	41.9	0.27
2019	3.33	2.59	1.29	26.4	42.8	0.22
2020	2.81	1.96	1.43	21.8	42.1	0.19
2021	4.17	2.51	1.66	22.6	48.6	0.19
<b>Average</b>	<b>3.18</b>	<b>2.44</b>	<b>1.31</b>	<b>23.9</b>	<b>43.5</b>	<b>0.20</b>
<b>s</b>	<b>0.55</b>	<b>0.29</b>	<b>0.21</b>	<b>1,6</b>	<b>2.6</b>	<b>0.04</b>
<b>Vk</b>	<b>17.36</b>	<b>12.07</b>	<b>16.32</b>	<b>6.8</b>	<b>5.9</b>	<b>22.11</b>

The content and composition of hop resins was evaluated in both areas. It is 99% likely that Saaz Shine has a higher content of essential oils in Chrášťany (0.65 g/100 g) than in Stekník (0.34 g/100 g). Figure 3 shows that the shares of myrcene and selinenes are higher in Chrášťany. On the other hand the shares of caryophyllene and humulene are higher in Stekník. T-test helped us define that the essential oils are not conclusively different.

The aroma of hop cones in both areas is identical. It is defined by a gentle hoppy scent with a background hint of fruit and citrus. Its intensity is moderate (2022), as Figure 4 shows.

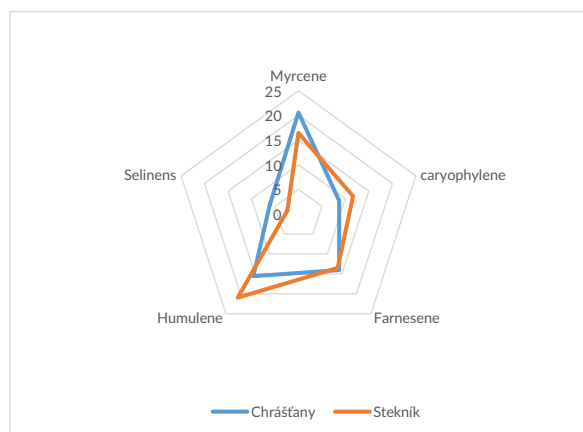


Figure 3 Composition of hop essential oils

#### 4 Conclusion

The achieved results show that Saaz Shine is a variety suitable for dry areas, where it reaches a higher alpha acid content and at the same time it maintains a nearly similar yield, content and composition. At present the variety of Saaz Shine is grown in Chrášťany on the area of 1 ha which will be increased by 3 ha in 2023. Several other hop growers, e.g. from Nesuchyně, Běsno and Staňkovic, have been testing the variety and semi-operational areas will be extended into other regions in 2022. Minibreweries and breweries are trying Saaz Shine and some have already included it in their beer production on regular basis. The variety is characterised by a pleasant bitterness which gently fades in beer for a longer time.

Currently craft breweries such as Pioneer Žatec, Cobolis Praha, Nomád Děčín, Máša Řevničov, Moravia Brno use the variety which has also been utilised in large breweries like Holba Hanušovice and Zubr Přerov. Achieved results indicate that the variety of Saaz Shine is gradually gaining a regular position in many breweries.

#### 5 Acknowledgement

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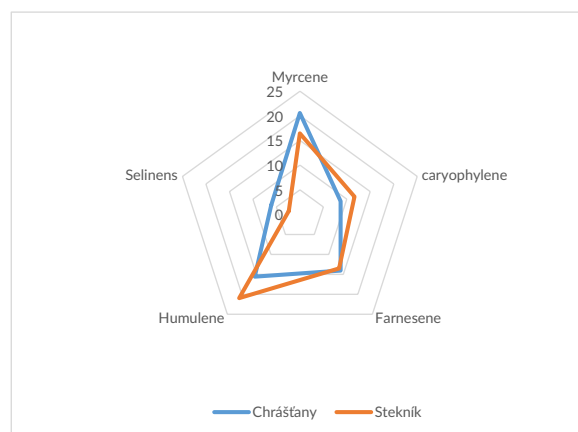


Figure 4 Character of Saaz Shine hop heads

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