

FSL 1: Comparative investigation of 11 *Achillea collina* Becker accessions concerning phenological, morphological, productional features and active agent content



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Abstract

Eleven *Achillea collina* Becker accessions of different origin were tested in open field plots during three years for their phenological, morphological, productional features and active material content in Budapest, Hungary. Among the tested plant materials European selected cultivars, Hungarian cultivated stocks and populations from wild growing habitats were investigated.

Concerning flowering time, two types (early and late) were distinguished. Flowering time of the less abundant late type, represented by Hungarian variety 'Azulenska' and 'Gb22', started approximately 2 weeks later than that of the early flowering type. Plant height and length of flowering horizon varied only slightly among taxa, and increased after the first year of cultivation. The proportion of useful plant organs in the drug was stable. Biomass and drug production of the investigated genotypes was variable, late flowering types providing higher yields. Essential oil, proazulene, total phenolic and flavonoid content varied on a large scale among accessions and years.

Results demonstrate the high intraspecific variability of *A. collina* and also the role of valuable genotypes in drug production. Selected cultivars may provide stable and good yields and drug quality under particular environmental conditions, while genotypes of wild origin may be valuable sources of future breeding programs.

Keywords: *Achillea collina*, azulene, production, drug quality, essential oil, flowering horizon

Introduction

Yarrow (*Achillea*) species are widely known and popular medicinal plants all over the world. The most important active agent of the drug (*Millefolii herba*) is the essential oil with proazulenes, but further compounds are also present, like flavonoids, phenolics and non volatile sesquiterpenes. Numerous therapeutic effects of yarrow have been demonstrated, among others spasmolytic, analgesic, anti-inflammatory and digestive activities (NÉMETH and BERNÁTH, 2008). Although the drug is officially listed in Ph. Eur., the drug quality seems to be often inadequate (BENEDEK et al., 2008). This can be traced back to the high chemical diversity of the collected natural populations and sometimes even the cultivated ones. Therefore in the present study, 11 different *A. collina* taxa were tested including registered cultivars, wild originating populations and cultivated stocks to gather more information about the morphological and productional features and the drug quality of yarrow.

Materials and Methods

The comparative investigation of the 11 accessions (Table 1) was carried out in open field for three years, from 2012 to 2014. The experiment was installed in perennial stands in small plots in 3 replications. Phenological and morphological characteristics of the populations were compared, plant height and length of flowering horizon (flowers of appr. 20-30 cm stems) in 6 replications, the proportion of useful plant organs in the drug and the drug yield were measured (3 replications). The essential oil content was detected by the method described in Ph.Hg.VII (*Achilleae herba*) and the proazulene content of the oil by the method recommended in Ph. Hg. VIII. (*Millefolii herba*), both in 3 replications. The total phenolic content was determined in 3 replications by the method

of SINGLETON and ROSSI (1967), while determination of total flavonoid content was carried out by the method recommended in PH. HG. VIII. (*Crataegi folium cum flore*) in 3 replications. Samples were taken in each year, but in 2014 only essential oil and proazulene content were measured. The trial was carried out at the experimental field and in the laboratory of the department.

Tab1 Origin and flowering time of the examined *A. collina* taxa.

Taxa name	Taxa code	Origin	Flowering time
'Azulenka'	T1	Hungarian variety	late
'Alba'	T2	Slovakian variety	early
'Proa'	T3	German variety	early
'Spak'	T4	Swiss variety	early
'Földes'	T5	cultivated stock from Földes, Hungary	early
'Gyula'	T6	cultivated stock from Gyula, Hungary	early
'Kál'	T7	cultivated stock from Kál, Hungary	early
'Gb9'	T8	wild originating population from Aszód, Hungary	late
'Gb10'	T9	wild originating population from Remeteszőlös, Hungary	early
'Gb22'	T10	wild originating population from Nagymaros, Hungary	early
'Gb47'	T11	Wild originating population from Mikóújfalú, Romania	early

Results

A fortnightly shift in flowering time was observed between the earlier and later ('Azulenka' and 'Gb22') genotypes (Table 1.). Morphological, productional features and active agent content of the taxa are presented in Table 2. The plant height was relatively stable among the taxa, only 'Gb47' reached higher values (67.5 cm in 2013) than others. Otherwise height was found to be higher from the 2nd year, when plants reached their full development. Flowering horizon of the plants varied on a larger extent (between 15.8 and 31.9 in 2013) among accessions and similarly to plant height, increased slightly after the first year by 6 cm in the average. The proportion of useful plant organs (flowers and leaves) in the drug was found to be stable (60.4-67.8 %) among years and accessions. Highest drug yields were measured in genotype 'Azulenka' both in 2012 and in 2013 (2.02 and 3.91 kg/10m², respectively). The yields increased after the 1st year of cultivation by 36-120 %, the production remained stable only in case of genotypes 'Alba' and 'Gb47'.

The essential oil content of the flowering horizon varied between 0.140 and 0.407 ml/100 g in d.w. In 2012 and 2013 the best results were achieved in accessions of wild origin: 'Gb 47' (0.395 and 0.290 ml/100 g), while in 2014 the highest content was measured in population 'Gyula' (0.407 ml/100 g). The proazulene content exceeded the requirements (0.02 % EO) of European Pharmacopoeia VII. in each population and showed maximum values in 'Gb22' (0.174 and 0.122 %) in 2012- 2013, and in 'Gyula' (0.150 %) in 2014.

The phenolic content of the studied populations varied from 139 to 220 mg GAE/100 g. In 2012 highest value was determined in 'Proa' (220 mg GAE/100 g), while in 2013 'Gb22' (185 mg GAE/100 g) was found to be outstanding. Total flavonoid content of the taxa showed big differences, the values varied from 0.46 to 2.34 %, with highest concentrations in genotypes of wild origin: 'Gb 22' (2.06 %) and 'Gb47' (2.39 %). Both phenolic and flavonoid contents were unstable and their content changed inconsistently during the examined years.

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Tab2 Characteristics of the examined genotypes (average values and standard deviation of experimental years)

Taxa	Plant height (cm)	Length of flowering horizon (cm)	Drug yield (kg/10 m ²)	Essential oil content (mg/ 100 g)	Proazulene content (%)	Total phenolic content (mg GAE/100 g)	Total flavonoid content (%)
T1	47.3 +/-4.9	15.3+/- 0.9	2.97 +/- 1.33	0.277 +/- 0.029	0.099 +/- 0.016	181.5 +/- 36.1	1.57 +/- 0.19
T2	50.1 +/-5.8	19.3 +/-3.2	1.96 +/- 0.02	0.232 +/- 0.041	0.077 +/- 0.012	158.5 +/- 9.2	1.69 +/- 0.54
T3	48.4 +/-9.0	18.7 +/-3.0	1.70 +/- 0.55	0.219 +/- 0.047	0.114 +/- 0.018	188.0 +/- 45.3	1.78 +/- 0.61
T4	47.8 +/-11.2	18.6 +/-8.1	1.44 +/- 0.57	0.195 +/- 0.057	0.097 +/- 0.032	167.5 +/- 12.0	1.97 +/- 0.36
T5	48.6 +/-8.4	23.1 +/-1.7	2.06 +/- 1.02	0.277 +/- 0.030	0.089 +/- 0.035	174.5 +/- 16.3	1.95 +/- 0.15
T6	45.5 +/-5.8	24.5 +/-7.1	2.14 +/- 0.98	0.302 +/- 0.092	0.102 +/- 0.043	154.0 +/- 11.3	0.98 +/- 0.74
T7	46.1 +/-5.8	19.0 +/-2.3	1.92 +/- 0.41	0.202 +/- 0.050	0.056 +/-0.30	171.0 +/- 43.8	1.44 +/- 0.44
T8	46.7 +/-5.2	20.7 +/-1.1	1.95 +/- 0.42	0.177 +/- 0.033	0.065 +/- 0.020	149.0 +/- 14.1	1.63 +/- 0.58
T9	47.4 +/-5.9	19.6 +/-4.1	2.09 +/- 0.86	0.203 +/- 0.013	0.082 +/- 0.016	175.5 +/- 29.0	0.91 +/- 0.42
T10	47.7 +/-4.3	14.3 +/-2.1	2.58 +/- 1.36	0.287 +/- 0.051	0.148 +/- 0.026	173.0 +/- 17.0	2.02 +/- 0.06
T11	56.8 +/-15.2	23.2 +/- 11.7	1.67 +/- 0.09	0.354 +/- 0.056	0.113 +/- 0.026	147.0 +/- 29.7	2.11 +/- 0.40

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