Ukrainian Journal of Ecology

Ukrainian Journal of Ecology, 2021, 11(1), 234-240, doi: 10.15421/2021_35

ORIGINAL ARTICLE

Quality of raw material from camomile inflorescences depending on technological factors

T.O. Padalko[1*], M.I. Bakhmat, O.V. Ovcharuk, O.P. Horodyska

[1]State Agrarian and Engineering University in Podilia, Ukraine
**Corresponding author E-mail: krivapadalko@gmail.com*
Received: 02.01.2021. Accepted: 28.02.2021

Our primary task was to study the agrobiological features of the cultivation of chamomile plants in the Right Bank Forest-Steppe of Ukraine, mostly used in official and folk medicine among medicinal plants presence of various biologically active substances. Studies with samples of chamomile plants were conducted during 2017-2020 in the research field of IE "Prudyvus" branch of the Department of Plant Breeding and Forage Production of Podilsky State Agrarian Technical University according to the method of Kalenska (2016), Yeshchenko (2005). To determine the quality of the essential oil content used the TLC method; statistical - to assess the data's reliability. The research results show that the quality of raw material yield of chamomile on the content of biologically active substances depends on the genetic characteristics of the variety, soil type, climatic factors, sowing dates, and seeding rates. The highest content of essential oil was 7.88 ml/kg in Perlyna Lisostepu in the autumn sowing period with a seeding rate of 6 kg/ha, and the lowest (4.02 ml/kg) was in Bodegold in the summer sowing period with a sowing rate of 8 kg/ha. The content of flavonoids in dehydrated raw materials ranged from 1.23 to 2.37%. We found that in the solution of essential oil of chamomile flowers of the medicinal varieties Perlyna Lisostepu and Bodegold, the presence of - (-) α-bisabolol, en-yn-dicycloether, borneol, bornyl acetate, chamazulene, and guaiazulene was identified, and another non-enolizable aldehyde was found. The obtained results indicate that during the autumn sowing period with a seeding rate of 6 kg/ha, the maximum yield of 2.10 t/ha with the highest essential oil content of 7.88 ml/kg was provided Perlyna Lisostepu variety considering cultivation conditions.
Keywords: chamomile; variety; sowing dates; seeding rate; quality of raw materials; yield

Introduction

Chamomile is one of the oldest, most widely used, and well-registered medicinal plants; it is recommended for various healing properties (Kostina, 2005). Matricaria recutita L. has a vast ecological amplitude and geographical distribution of this species almost all over the world (Salamon, 2009). The main exports of chamomile were provided by Mexico, Argentina, and Egypt, where the harvest was collected mainly by hand (Ali et al., 2007). Due to its natural and climatic conditions, Ukraine is one of the priority regions in Europe for the growth of medicinal plant raw materials. Most of them (about 500 species) are used in traditional medicine, and the rest (about 150 species) are included in the European Pharmacopoeia and SPU (Grodzinsky, 1992). Raw materials are used in homeopathy, aromatherapy, cosmetics, veterinary medicine, and the food industry. Solid flower baskets without stems are used for medicinal purposes. Chamomile flower baskets contain up to 0.85% of essential oil. It contains more than 40 components, including chamazulene (C14H16), bisabolol, and oxide (Karomatov et al., 2018). About 120 chemical components have been identified in chamomile as secondary metabolites, including 28 terpenoids, 36 flavonoids, and 52 additional compounds (Salamon, 2009). Chamomile inflorescence oil mainly consists of sesquiterpene derivatives (75-90%), but only in a small number of monoterpenes and up to 20% of polyynes. The main components of the essential oil are β-farnesene (4.9–8.1%), terpene alcohol (farnesol), chamazulene (2.3–10.9%), α-bisabolol (4.8–11.3%), oxides of α-bisabolol A (25.5-28.7%) and from 12.2 to 30.9% of oxides of α-bisabolol B (Singh et al., 2011).
It is established that chamazulene is formed in flowering baskets from guaianolide matricin (prohamazulene). Due to its properties, chamomile is part of many drugs and herbal mixtures, and cosmetics. Describing the morphological features of chamomile, it should be noted that it has a bare inflorescence, hollow inside, hemispherical at the beginning of flowering, elongated until the end of flowering and fruit. This feature distinguishes a cultivated plant from a wild one (Birta et al., 2012). The species is widespread throughout Ukraine but is rare in Polissya, absent in the highlands (Perevozchenko et al., 1991). Widespread in Khmelnytsky, Zaporizhia, Mykolaiv, Kherson (especially in its Black Sea regions) regions and Crimea (Prysyvashshya), weeds vineyards in Transcarpathia. It also forms small thickets in the Dnieper part of the Poltava region. They are cultivated on plantations of medicinal plants without chemicals. According to English breeders, the most common varieties of world selection, including those studied, are Moscow, Manzana (4x), Lazur (4x), Bisabolol, Manzanilla, Bodegold (4x), Bohemia (2x), Bona (2x), Goral, Camoflora (2x), Degumill (2x), Robumille (4x), Zloty Lan (4x), Azulena (2x), Perlyna Lisostepu (4x) (State Register of Plant Varieties, 2020). Chamomile is sown in early spring, summer, autumn, or winter and simultaneously with early spring crops with vegetable planters to a depth of 0.5 cm, in a wide row (45 cm) (Upadhyay, R. K. et al., 2016). The best are the summer-autumn sowing dates, with sufficient soil moisture. The plants enter the winter in the rosette phase at these sowing dates, overwinter well, actively grow in spring, and bloom 15 - 20 days earlier than in winter and 20 - 30 earlier than in spring. Winter and early spring sowing should be carried out on permafrost (Zharinov et al., 1994; Padalko, 2018).
Originators of varieties and hybrids of crops recommend a specific density of standing plants per 1 ha, but not all producers know that this is the recommended density at the time of harvest (Kutsenko, 2016). For small-seeded crops - annuals, such as chamomile, sowing was carried out taking into account the weight of 1000 seeds, laboratory germination and the coefficient of field germination in weight, control of sown seeds in a row - only visually by counting the number of seeds per running meter (Padalko, 2020; Knyazyuk, 2015). The sowing rate is a rather dynamic component of crop production, which depends on many factors, particularly on moisture supply, temperature, and the conditions of the current season. In a drier spring, it is better to reduce the

seeding rate to eliminate plant competition for moisture, in more moisture - to increase, so in his research, S.A. Totska recommends sowing chamomile with a sowing rate of 4 kg/ha - 45 million units/ha, 6 kg/ha - 67 million units/ha and 8 kg/ha - 90 million units/ha (Totska, 2011).

Material and Methods

Studies with samples of chamomile plants were conducted during 2017-2020 in the research field of IE "Prudyvus" branch of the Department of Plant Breeding and Forage Production of Podilsky State Agrarian Technical University according to the method of Kalenska (2016), Yeshchenko (2005). Three factors were investigated – sowing: spring, summer, autumn; sowing rates: 4 kg/ha, 6 kg/ha, and 8 kg/ha; varieties: Perlyna Lisostepu and Bodegold. Variety of chamomile Perlyna Lisostepu, №: applications 92197001, tetraploid, medium-ripe, drought-resistant, high-yielding. Germination of seeds is simultaneous for 20 - 25 days after sowing seeds. The length of the growing season from sowing to seed ripening is 90 days. Yield of raw materials (inflorescences) - 0.75 t/ha, seeds - 120.0 kg/ha. The content of essential oil in raw materials is 0.7%, chamazulenes in essential oil - 12.3% (Experimental Station of Medicinal Plants of NAAS. Lubny, 2013).

Bodegold is a tetraploid variety with an essential oil content of 0.40 ml/100 g (low to medium and high) to over 1.0 ml/100 g (high). Hamazulene (Farhoudi and Lee., 2017) ranged from 6% (low to medium-high) to 19% (high), with a-bisabolol content in the range of 2 mg/100 g (very low) to approximately 200 mg/100 g of the drug (from high to very high). The percentage of essential oil and its composition (Pirzad et al., 2006) depend on irrigation regimes: from 55 to 85% of the field area. Inflorescence yield is high (Bundessortenamt, 2002).

As a result of our research, it was established how sowing's timing affected the realization of the resource biopotential of chamomile. During the winter sowing period, more favorable conditions are created to develop plants that make maximum use of environmental resources in the spring and thus ensure higher vitality in the summer. Most importantly, the ability to obtain raw materials in all growing seasons. According to the recommendations and research of S.A Totskaya (2011), the sowing rate of chamomile seeds, farmers-producers, and originators of varieties was optimal for the impact of changes in global warming today.

The soils of the studied field are gray forest medium-loamy on the carbonate forest. The humus content (according to Tyurin) is low; in the soil layer, 0–20 cm was 1.97%. The content of alkaline hydrolyzed nitrogen (according to Confield) was 65 mg/kg of soil, mobile phosphorus (according to Chirikov) - 149 mg/kg of soil, exchangeable potassium (according to Chirikov) - 90 mg/kg of soil. The reaction of the soil solution ranged from 5.2 to 5.5 pH. Humidification took place following precipitation, as the groundwater level is at a depth of 10 - 15 m. The dominant agroecological factor influencing the moisture supply of the agrophytocenosis of chamomile, in the absence of precipitation, is its yield, the removal of productive moisture, which is closely related to the studied factors. The meteorological conditions of 2017–2020 differed from the perennial averages, especially during the growing season of chamomile plants, and to varying degrees affected the growth, development, as a result - yield, content, and quality of essential oil.

Higher temperatures in winter with sufficient rainfall contributed to the excellent overwintering of plants. The air temperature varied to average long-term both by months and years of research. Average daily air temperatures ranged from -0.30C in January 2020 to +21.60C in August almost every year. Positive temperatures occurred in the third decade of February 2019 - 2020 and continued to persist throughout March. The hottest was August, where the indicators were higher than the average perennial mark of 2.7–3.260 C, and higher temperatures were observed in the autumn months. In November 2019, the average air temperature was + 6.80 C, which exceeded the long-term figures by 4.1. The highest rainfall of 198.3 mm fell in June (84 mm). The least moisture was September 11.0 mm, December 3.9 mm 2019, and September 10.0 mm 2020. In the third decade of November, we observed the cessation of plants' autumn vegetation with a decrease in temperature to -1.60C and sufficient moisture supply. Annual precipitation did not differ significantly from the long-term average and was compensated by variable average daily temperatures due to temperate-continental climate change.

Researching in years with different weather conditions made it possible to assess the studied agronomic measures studied in experiments of varietal technology of growing chamomile. Phenological observations were carried out in the main phases of plant growth and development following the "Methodology of state varietal testing of crops" (Yeshchenko et al., 2005). To determine the TLC (2.2.27) test essential oil of raw materials of the studied culture used reagent ethyl acetate P-toluene P (5:95) and anise aldehyde solution, applying samples of TLC plates Sorbfil with a layer of 10 µl strips, silica gel F_{254}, P (State Pharmacopoeia Of Ukraine: in 3 volumes, 2008; 2018). Data were analyzed with Statistica v. 6.0 software (Ermantraut et al., 2007).

Results and discussion

Soil and climatic conditions of the Right-bank Forest-steppe of Ukraine differ significantly from each other, which causes different sowing dates, different seeding rates, and varietal characteristics of the crop as essential elements of its cultivation.

The analysis of climatic conditions of the post-harvest period of intermediate crops indicates the possibility of growing chamomile in repeated sowing dates as insurance, post-harvest, and post-mowing crop. Obtaining three harvests a year from one area is characterized by high management intensity, increasing the productivity of 1 hectare by 30 - 80%. The weight of 1000 seeds is a technological indicator, an indicator of the crop structure, and, according to several scientists, an indicator of quality since it is in heavy seeds that there is a qualitative chemical composition. Since the studied crop is small-seeded, the weight of 1000 chamomile seeds over the years of research differed significantly relative to technological factors and ranged from 0.049-0.067 g (Table 1).

Analyzing the weight of 1000 seeds in the variety specimens of chamomile plants, it should be noted that under the conditions of 2019, a higher weight of 1000 seeds was observed compared to the conditions of 2017, which is associated with a uniform and better moisture supply during the critical period for the moisture consumption of chamomile (July-August, i.e., summer sowing period). Therefore, the weight of 1000 seeds in 2019 varied from 0.060 to 0.067 g, and in 2017 the weight of 1000 seeds varied from 0.048 to 0.052 g.

It should be noted that the highest weight of 1000 seeds characterized the varieties Perlyna Lisostepu - 0.067 g and Bodegold - 0.060 g during the autumn sowing period with a seeding rate of 6 kg/ha. The smallest variability was observed in the Bodegold variety, in which the range of variation was 0.003 g, and the coefficient of variation was 3.0% and turned out to be the lowest at a seeding rate of 8.0 kg/ha in the summer sowing period. It should also be noted that the autumn and spring sowing dates were characterized by higher coefficients of variation by variety compared with the summer terms of the studied seeding rates.

Table 1. Weight of 1000 seeds of varieties of chamomile plants depending on the sowing dates and seeding rate (average for 2017–2020).

Variety (factor A)	Sowing dates (factor B)	Seeding rate, kg/ha (factor C)	Weight of 1000 seeds, g	The scope of variation (R), g	Coefficient of variation (V),%
Perlyna Lisostepu (C)	spring (C)	4 (C)	0.059	0.007	5.3
		6	0.062	0.008	6.0
		8	0.057	0.006	4.6
	summer	4	0.054	0.004	3.3
		6	0.057	0.006	4.7
		8	0.052	0.005	3.1
	autumn	4	0.063	0.008	5.7
		6	0.067	0.009	6.7
		8	0.060	0.006	4.8
Bodegold	spring	4	0.053	0.006	5.0
		6	0.057	0.007	5.8
		8	0.051	0.005	4.3
	summer	4	0.052	0.003	3.1
		6	0.055	0.005	4.2
		8	0.049	0.003	3.0
	autumn	4	0.058	0.007	5.3
		6	0.060	0.008	6.2
		8	0.055	0.005	4.2

*(C) – Control: Perlyna Lisostepu variety, spring sowing dates, norm 4 kg/ha

The highest coefficient of variation of 6.7% was observed in the variety Perlyna Lisostepu during the autumn sowing period with a sowing rate of 6.0 kg/ha with a varied range of 0.009 g. However, one variety was characterized by increased plasticity compared to another seed seeding rate or one sowing date by weight of 1000 seeds. First of all, these are Perlyna Lisostepu variety, which has a coefficient of variation in 1000 seeds weight ranging from 3.1% to 6.7%, and the Bodegold variety with a coefficient of variation from 3.0% to 6.2%. In control, the coefficient of variation in 1000 seeds weight was observed in 5.3% with a range of variation of 0.007 g. So, the variety Perlyna Lisostepu has formed more seeds over the years of research compared to the other studied variety Bodegold with a slight error, which indicates their breeding value as a tetraploid to adaptive sources of drought resistance. This is because, under conditions of long daylight hours, the flowering period was extended, new inflorescences were formed, and seeds were formed in them; since the baskets and seeds were much more extensive, it is natural that the seeds are predominantly small.

According to the results of mathematical calculations on the influence of the variety on the weight of 1000 seeds, so Duncan's criterion distribution of these indicators on average over the years of research on different homogeneous groups proves a significant difference in factor A - variety, where the difference between the Perlyna Lisostepu variety and the studied variety Bodegold was 0,005 g, at F (1) = 82.00, p =0,00 (Table 2).

Table 2. Weight of 1000 chamomile seeds concerning the variety according to the Duncan test, g (average for 2017–2020).

№	Variety (factor A)	Weight of 1000 seeds	Homogenous groups	
			1	2
1	Perlyna Lisostepu	0.059	***	
2	Bodegold	0.054		***

The statistical analysis results show that for each subsequent sowing period, the value of the weight of 1000 seeds of chamomile varied, as all indicators without exception formed a separate homogeneous group. A significant value of the indicators on average in the experiment was for the autumn sowing period - 0.060 g, the lowest - 0.053 g for the summer sowing period, and 0.056 g for the spring period, with F (2) = 71.024, p = 0.00000. The criteria in the variance analysis demonstrate the significance of differences between the percentages of samples (sowing dates). The distribution of residual deviations is within the allowable error, 0.060 g in the autumn period increases - the differences are significant (Table 3).

Table 3. Weight of 1000 chamomile seeds relative to the sowing date according to the Duncan test, g (average for 2017 - 2020).

№	Sowing date (factor B)	Weight of 1000 seeds	Homogenous groups		
			1	2	3
1	summer	0.053	***		
2	spring	0.056		***	
3	autumn	0.060			***

For the reliability of the statistical assessment of the resultant trait dependence on the seeding rates, statistical hypotheses were tested against the average data in several general populations with a normal distribution (Table 4).

Table 4. Weight of 1000 chamomile seeds relative to the Duncan test's seeding rate, g (average for 2017–2020).

№	Seeding rate, кg/ha (factor C)	Weight of 1000 seeds	Homogenous groups		
			1	2	3
1	4	0.056	***		
2	6	0.060		***	
3	8	0.054			***

Analyzing the weight of 1000 seeds per plant, it should be noted that at a seeding rate of 6 kg/ha weight of 1000 - 0.060 g, which is 0.005 g higher than the rate of 8 kg/ha and 0.004 g - 4 kg/ha, the values obtained had insignificant differences, and the differences are caused by random factors (seeding rate), the samples are insignificant F (3) = 42,488, p =, 00000, so the hypothesis is valid. Analysis of variance of the obtained data showed that the formation of the weight of 1000 seeds of chamomile plants on average in 2017-2020 was most influenced by the sowing period (B), the share of which was - 44.3%, the seeding rate (C) – 26.5%, varietal characteristics (A) - 25.4%, other factors - 3.8% (Figure 1).
The yield of inflorescences of chamomile plants studied by us depended on all studied factors. According to the average yield on the years of research, the varieties of chamomile were different; the Perlyna Lisostepu variety in the years of research ranged from 0.41 to 2.10 t/ha, and the variety of Bodegold - 0.36–1.98 t/ha. The Perlyna Lisostepu variety provided the maximum yield at 2.10 t/ha during the autumn sowing period with a sowing rate of 6 kg/ha with a relatively insignificant correlation r = 49. On control, the yield of the studied crop over the years of research averaged 1.08 t/ha.

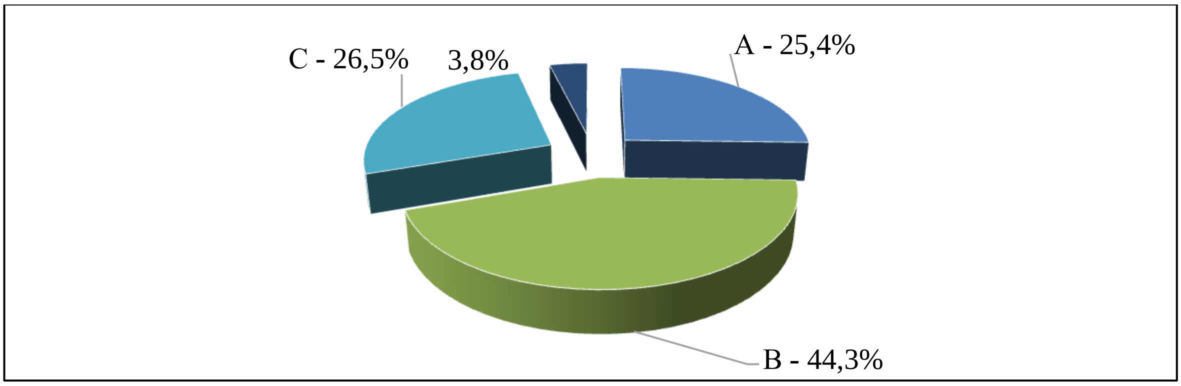


Figure 1. The share of the influence of factors on the weight of 1000 seeds of chamomile (A - variety, B - sowing date, C - seeding rate).

Qualitative assessment of raw materials of chamomile plants depends on the variety, sowing dates, and seeding rates in the technology of cultivation in interaction with soil and climatic conditions. The qualitative composition of raw materials on the content of biologically active compounds in plants does not change under environmental factors during research years. However, their quantitative composition may change, which is confirmed by our research.
According to the standards of SPU 2.0, Art. 445 (State Pharmacopoeia of Ukraine, 2018), chamomile flowers *(Matricariae flores)* are identified by the following indicators:

1. Identification A. Appearance (description).
2. Identification B. Microscopy.
3. Identification of S. TLC.

Freshly harvested, dried, dried fermented raw materials of chamomile were used to extract essential oils (Table 5).

Table 5. The influence of the studied factors on the content and quality of essential oil in plant samples of chamomile (average for 2017–2020).

Variety (factor A)	Sowing date (factor B)	Seeding rate, кg/ha (factor C)	Results of the analysis					
			Crumble %	Weight loss during drying, %	Common ash, %	Content of essential oil of blue color, in terms of dry raw materials, ml/kg	Impurities, %	Content of the amount of flavonoids in terms of rutin in dehydrated raw materials, %
Perlyna Lisostepu (C)	spring (C)*	4(C)	6.2	9.81	7.6	5.98	1.8	1.49
		6	7.7	10.12	8.9	7.01	2.1	2.12
		8	5.4	7.07	6.6	4.23	1.5	1.28
	summer	4	5.1	8.73	6.8	5.47	1.1	1.35
		6	6.8	9.16	7.4	6.38	1.8	2.02
		8	3.9	7.05	5.9	4.14	1.0	1.27
	autumn	4	7.3	10.11	8.9	6.12	2.0	1.98

		6	8.2	11.02	9.4	7.88	2.9	2.37
		8	5.9	8.70	7.5	4.98	1.7	1.42
Bodegold	spring	4	9.1	8.71	6.9	5.04	1.9	1.39
		6	10.0	9.34	8.4	5.98	2.3	1.95
		8	7.7	6.88	5.8	4.19	1.7	1.26
	summer	4	6.0	7.54	6.2	5.00	1.4	1.28
		6	7.9	8.08	7.0	5.14	1.9	1.64
		8	4.9	6.10	4.7	4.02	1.2	1.23
	autumn	4	11.1	9.76	8.0	5.72	2.7	1.67
		6	12.4	10.13	9.6	6.03	3.2	2.09
		8	9.2	7.09	6.7	4.97	1.4	1.34
Coefficient of variation *(V), %*			*30.0*	*16.4*	*18.1*	*19.0*	*32.4*	*22.8*

* (C) - Control: Perlyna Lisostepu variety, spring term, norm 4 kg/ha

Raw chamomile *(Matricariae flores),* according to the results of the analysis of the tested indicators, has macroscopic and microscopic characteristics, specified in tests A, B, and C of the section "Identification" and meet the requirements of SPU, 2.0, 3 vols., Art. 445. The highest results were demonstrated in 2019 in the variety Perlyna Lisostepu of the autumn sowing period with a seeding rate of 6 kg/ha. The rash was 8.2% at a rate of not higher than 25.0%, where the baskets are solid, do not crumble. The highest in the years of research, the content of essential oil content of 7.88 ml/kg of blue color in terms of dry raw material is the variety Perlyna Lisostepu in the autumn sowing period with a seeding rate of 6 kg/ha, and the lowest average the variety Bodegold in the summer sowing period with a seeding rate of 8 kg/ha - 4.02 ml/kg. The flavonoids content in dehydrated raw materials ranged from 1.23 to 2.37% (Srivastava et al., 2009).

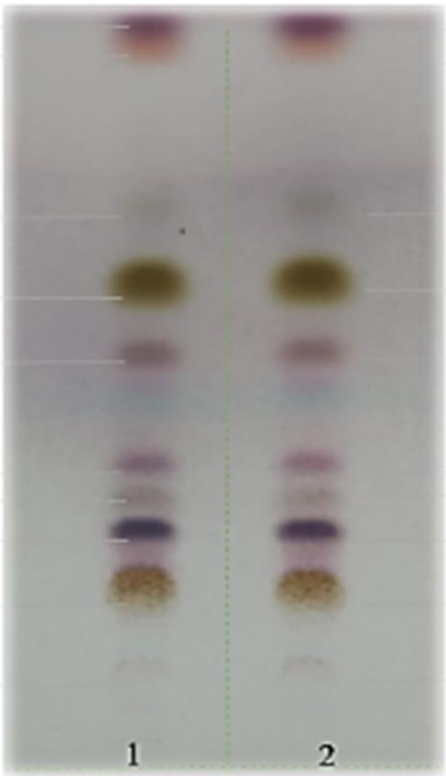
In the EP / SPU, the study of plant material by TLC is mandatory. To determine the TLC (2.2.27) test essential oil of the raw material of the studied culture, we used reagent ethyl acetate P-toluene P (5:95) and aniseed aldehyde solution, silica gel F_{254}, acids and alcohols (SE "Scientific Expert Pharmacopoeial Center", 2008). The tests were carried out by applying samples of TLC plates Sorbfil with a layer of 10 µl strips, silica gel F_{254}, P.

Drying: in the air.

Detection A: viewing in UV light at a wavelength of 254 nm.

Detection B: viewing in UV light at a wavelength of 365 nm.

Detection of C: spraying anise aldehyde with solution P and viewing in daylight after heating at a temperature of from 100 to 105 °C for 5–10 minutes (sampling protocol on the GAMAG Linomat 5 applicator), figure 2.



1 – Color	**2 – Identification**
blue-violet	guaiazulene
red-purple	chamazulene
brown-grey	unidentified
yellow-brown	bornyl acetate
purple-brown	borneol
purple	unidentified
brown	en-yn-dicycloether
blue-purple	((-)-a-bisabolol
brown	unidentified
light-purple	unidentified

Figure 2. TLC identification of essential oil of chamomile varieties (flowers) in xylene depending on the sowing date and seeding rate (Series 040320 from 02.08.2020).

Conditions for measurements: ambient temperature 25 ± 2 °C; relative humidity 80 ± 5 %; atmospheric pressure 84–106 kPa; frequency of alternating current 50 ± 1 Hz; mains voltage 220 ± 10 V.

Previously, the moisture content of all chamomile samples was determined gravimetric method. The humidity of the samples was 5 ± 1%. The central spot on the chromatogram obtained for the test solution was visually compared with the corresponding spot on the chromatogram obtained for the reference solution, comparing the color, size, and retention coefficient (R_f) of both spots (Gawde et al., 2014). In the solution of essential oil of chamomile flowers of medicinal varieties 1. Perlyna Lisostepu and 2. Bodegold, the presence of - (-) α-bisabolol, en-yn-dicycloether, borneol, bornyl acetate, chamazulene, and guaiazulene was identified, and other unidentified spots were found. The delay coefficient (R_f) was defined as the ratio of the distance from the point of application of the sample to the center of the spot after chromatography to the distance traveled by the front of the solvent from the point of application. After reviewing the plate, we determined the delay coefficient (R_f) for each of the ten stained in daylight spots of one variety and 10 of the second variety. Chamazulene of reddish-violet color, blue-violet color - (-) α-bisabolol and guaiazulene were detected by identifying the solution.

The retention coefficient (R_f) for each spot differed; however, no significant difference between varieties. In the variety №2 Bodegold, № spots 6 and 7 due to the distance from the line to the start by 3.0 mm was longer, and therefore the color of brown with pigments of purple and yellow was somewhat predominant, although ultimately the quality of raw materials was not affected and both varieties are eligible SPU, 2.0.

The study results are based primarily on other researchers' reports on the general problem of growth in the organic system. The agriculture system, which included crop rotation, selection of varieties, compliance with deadlines, and specified norms, is key to preserving plant flora's biodiversity in the agroecosystem.

Conclusions

Since the studied culture is small-seeded, the weight of 1000 seeds of chamomile over the years of research differed significantly in terms of technological factors and ranged from 0.049 to 0.067 g. On average, during the years of research of the Perlyna Lisostepu variety, the indicator fluctuated in the range of 0.052 - 0.067 g, which is 0.003 - 0.007 grams more than the Bodegold variety. In control, the coefficient of variation by weight of 1000 seeds of 0.0059 g was 5.3%, with a varied range of 0.007 g.

The variety Perlyna Lisostepu had the highest indicator of essential oil content during research. It was 7.88 ml/kg in the autumn sowing period with a seeding rate of 6 kg/ha, and the variety Bodegold had the lowest average indicator in the summer sowing period with a seeding rate of 8 kg/ha - 4.02 ml/kg. The content of flavonoids in dehydrated raw materials ranged from an average of 1.23 to 2.37%. In the solution of essential oil of chamomile flowers of medicinal varieties Perlyna Lisostepu and Bodegold, the presence of - (-) α-bisabolol, en-yn-dicycloether, borneol, bornyl acetate, chamazulene, and guaiazulene was identified, and other unidentified spots were found.

The results of the study show that the Chamomile culture, which was studied in our studies during 2017 - 2020, is quite suitable for growing in the Right Bank Forest-Steppe of Ukraine under the studied factors at a maximum of 2.10 t/ha of Perlyna Lisostepu variety in autumn sowing period at a seeding rate of 6 kg/ha and essential oil content of 7.88 ml/kg.

Acknowledgment

Determination of average quality indicators of essential oil content and TLC No.040320 from 02.08.2020, tests in plant samples of chamomile according to the requirements of SPU, 2.0, 3 volumes, Art. 445 (2018) was held with the participation of LLC "Research and Production Company" Vilarus " (Ukraine, Vinnytsia region, Ladyzhyn, 6, Khlibozavodska Str., phone (04343 6-17-66)), as part of the statutory activities.

References

Ali, M.S., Husien, M.S. (2007). Egyptian Chamomile – growing and industrial processing. Acta Hortic. 749, 81-91

Birta H.O., Burhu Yu.H. (2012). Commodity science of raw materials and means of production (Chapter 1. Commodity science of plant and animal raw materials). Textbook. Kyiv. Ukraine

Bundessortenamt. (2002). Beschreibende Sortenliste Arznei- und Gewürzpflanzen, 80-88. Available from: http://www.bundessortenamt.de/internet30/fileadmin/Files/PDF/bsl_arznei_2002.pdf .

Hrodzinskyi A. M. (1992). Medicinal plants: an encyclopedic reference book. «Ukrainian Encyclopedia» named after M.P. Bazhan, Ukrainian Production and Commercial Center "Olimp". Kyiv.

State Register of Plant Varieties Suitable for Distribution in Ukraine in 2020 (as of March 25, 2020). (2020). Ministry of Agrarian Policy and Food of Ukraine. Kyiv, (499). Availabel from: https://sops.gov.ua/reestr-sortiv-roslin .

State Pharmacopoeia of Ukraine. SE "Scientific and expert pharmacopoeial center". (2008). State enterprise "Scientific and expert pharmacopoeial center". Kharkiv.

State Pharmacopoeia of Ukraine. (2018). SE "Ukrainian Scientific Pharmaceutical Center for Drug Quality". Kharkiv: State enterprise "Ukrainian Scientific Pharmaceutical Center for Drug Quality". Kharkiv.

Research plant of medicinal plants of NAAS. (2013). Department of Breeding and Seed Production. Lubny.

Ermantraut Ye.R., Prysiazhniuk O.I., Shevchenko I.L. (2007) Statistical analysis of agronomic research data in the package Statistica 6.0. Methodical instructions. Kyiv.

Farhoudi, R, Lee, D.J. (2017). Chemical constituents and antioxidant properties of Matricaria recutita and Chamaemelum nobile essential oil growing in south west of Iran. Free Radic. Biol. Med., 108, 24

Gawde, A., Cantrell, C.L., Zheljazkov, V.D., Astatkie, T., Schlegel, V. (2014). Steam distillation extraction kinetics regression models to predict essential oil yield, composition, and bioactivity of chamomile oil. Ind. Crops Prod, 58, 61-67.

Yeshchenko V.O., Kopytko P.H., Optyshko V.P., Kostohryz P.V. (2005). Fundamentals of scientific research in agronomy. Textbook. "Diia". Kyiv.

Zharinov V.I., Ostapenko A.I. (1994). Growing medicinal essential oil, spice plants: Teaching manual. Kyiv.

Kalenska S.M. (2016). Research in agronomy. Book. 1. Theoretical aspects of research. Maidan. Kyiv.

Karomatov, I.D., Badritdinova, M.N., Yazmuradov, F.A., (2018). Chamomile is a well-known medicinal plant. Biology and Integrative Medicine, 7(24), 1–23.

Kniaziuk O.V. (2015). Influence of sowing dates and row spacing on the formation of productivity of chamomile plants (Matricaria Chamomilla L.). Agrobiology, 2(1), 107–110.

Kostina L. (2005). Chamomile treatment. LLC "ASS - Center", LLC "Aveont", Moscow.

Kutsenko N. I. (2016). Prospects for selection research of medicinal and essential oil plants in Ukraine. Agroecological journal, 85–92.

Mynbaeva R.O., Zhukenov E., Gorushkin N.P., Adekenov S.M. (1994). Agrotechnics of chamomile pharmacy in Central Kazakhstan. Karaganda: IFH MES RK.

Padalko T.O. (2020). Dependence of field germination and survival of chamomile plants on vegetation factors and agronomic techniques. Collection of scientific works "Agrobiology". 1(157), 128–136. doi: 10.33245/2310-9270-2020-157-1-128-136

Padalko T.O. (2018). Individual productivity of chamomile plants depending on technological measures in the conditions of Transnistria. Bulletin of Lviv National Agrarian University. Series: Agronomy. 22(1), 325–332.

Perevozchenko I.I., Zaveruha B.V., Andrienko T.L. (1991). Medicinal plants. Kyiv. Urozhay

Pirzad A., Alari H., Shakiba M. R., S. Zekhtab-Salmasi, S., Mohammadi, A. (2006). Content and composition of essential oils of German chamomile (Matricaria chamomilla L.) under different irrigation regimes. Journal of Agronomy, 5, 451- 455.

Ramazanov, A.K., Tleukenova, S.U., Babeshin, L.G. (2018). Introduction and cultivation technology (Matricaria Chamomilla L.). Actual problems of biology and ecology. Proceed. Int. Sc. Conf. Karaganda.

Salamon I. (2009) Biodiversity of chamomile essential oil, qualitative and quantitative characteristics. In: Schener B. (ed.) Innovations in Chemical Biology. Springer, Dordrecht. https://doi.org/10.1007/978-1-4020-6955-0_7

Singh O., Hanam Z., Misra N., Shrivastava M.K. (2011). Chamomile (Matricaria chamomilla L.): an overview. Pharmacognosy Reviews, 5 (9), 82–95. https://doi.org/10.4103/0973-7847.79103

Srivastava, J.K., & Gupta, S. (2009). Extraction, characterization, stability and biological activity of flavonoids isolated from chamomile flowers. Molecular and Cellular Pharmacology, 1, 138-147.10.4255 / mcpharmacol

Standard samples. State Pharmacopoeia of Ukraine. (2015). State Enterprise "Ukrainian Scientific Pharmacopoeial Center for Drug Quality»" Kharkiv,.

Totskaya S.A. (2011). Biological features and methods of increasing the yield and quality of seeds of large ammonia and chamomile. Thesis of Doctoral Dissertation. Moscow.

Upadhyay, R.K., Singh, V.R., Tewari, S.K. (2016). New agrotechnology to increase productivity of chamomile (Matricaria chamomilla L.). Ind. Crops and Prod, 89, 10–13.

Citation:
Padalko, T.O., Bakhmat, M.I., Ovcharuk, O.V., Horodyska, O.P (2021). Quality of raw materials from camomile inflorescences depending on technological factors. *Ukrainian Journal of Ecology, 11* (1), 234-240.