Review article

CHAMOMILE IN REPUBLIC OF SERBIA

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Alternative Crops and Cultivation Practices

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SUMMARY

As one of the most common medicinal plants, chamomile is grown on approximately 20,000 ha in the world and on 350 -400 ha in Serbia. Good yields can be expected if the plant is grown up to 500 m altitude. The plant is adapted to various soils; it has modest nitrogen demands and tolerates drought and salinity. The usual yields are: 500-1,000 kg/ha of dry flower heads, 150 kg/ha of seed and up to 4.5-5 kg/ha of essential oil. Drug (*Chamomillae flos*) has moisture below 12%, appropriate physico-chemical and microbiological properties, referred low amount of heavy metals and at least 4 ml/kg of essential oil. The yield of flower heads and the essential oil quantity and quality depend on various environmental factors, as well as on the genetic background. There is more than forty chamomile cultivars realized in the world; three of them originate from the Institute of Field and Vegetable Crops in Novi Sad (Banatska, Tip 29 and Tetraploidna). Banatska and Tetraploidna are widely grown. The cultivars are characterized by high yield potential and appropriate essential oil content.

KEYWORDS: chamomile, cultivars, production, Republic of Serbia

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INTRODUCTION

Chamomile is one of the most commonly used medicinal plants. The term "chamomile" includes several plant species, however only two can be used for medical purposes: German (*Matricaria recutita* L., *Matricaria chamomilla* L., *Chamomilla recutita* L., *Matricaria suaveolens* L.; Hungarian chamomile, wild chamomile) and Roman (*Anthemis nobilis* L., *Chamaemelum nobile* L.; English chamomile, garden chamomile). Both belong to Asteraceae family, and the German is the most frequently used. Although originating from Europe and the Middle East, chamomile is naturalized and today it is grown in almost all over the world, mainly in Europe, South America and Africa.

According to available historical sources, chamomile has been used for medical purposes even 2.5 millennia ago; in Egypt, Greece and Rome. It has been described as a medicinal plant in the fifth century B.C. by Hippocrates, and included in the De Materia Medica in the first century A.D. by Dioscorides. The work is the precursor of today's pharmacopoeia and was in use until the release of the first, German Pharmacopoeia in 1882. Beneficial effects of the plant on human health were documented by Galen (second century), Palladius (fifth century), H. Bock, Matthiolus, Tabernaemontanus (sixteenth century) von Haller (eighteenth century), Hecker, S. Kneipp (nineteenth century) and R.F. Weiss (1942., Textbook of Phytotherapy). The blue essential oil has been mentioned at the end of the fifteenth century (S. von Asculum), approximately at the same time with the description of its distillation (H. Brunschwig). Today is chamomile, i.e. chamomile flower head recognized as an official drug in pharmacopoeias of at least 26 countries.

Pharmacological effects of the plant are due to numerous biologically active chemical compounds. Over 120 components are identified in the

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chamomile essential oil, mostly sesquiterpenes (α-bisabolol, bisabolol oxides A and B, chamazulene and farnesene) and phenols (flavonoids apigenin, quercetin, patuletin, luteolin, and their glycosides; coumarins herniarin and umbelliferone). According to the composition of the essential oil, there are six chamomile chemotypes: A (main component bisabolol oxide A), B (bisabolol oxide B), C (α-bisabolol), D (α-bisabolol, bisabolol oxides A and B in even amounts), α-bisabolone oxide A, and the type with green essential oil containing low amount of matricin. Chamomile can be used as water infusion and as essential oil. It is an ingredient of numerous commercial, products, including herbal teas, beverages, baked goods, cosmetic creams, lotions, perfumes, hair products, soaps and detergents. It was estimated that over 1 million cups of chamomile are consumed worldwide each day (Franz et al., 1986; Applequist, 2002; Franke & Schilcher, 2005; Mckay & Blumberg, 2006; Rubiolo et al., 2006; Baghalian et al., 2008; Maschi et al., 2008).

Areas under chamomile

In the world, chamomile is grown on about 20,000 ha; mostly in Argentina, Egypt, France, Germany, Hungary and in Balkan countries (Brabandt & Ehlert, 2011; Ehlert et al., 2011). There are no reliable data on areas under chamomile in Serbia. It is mostly grown in Vojvodina (Padej, Čoka, Kikinda, Pančevo, Bavanište, Bački Petrovac, Kulpin, Kula); despite favorable environmental conditions, production in central Serbia has never spread. It is estimated that chamomile together with peppermint occupies 50-60% of the total of 1,400 ha that are under medicinal and aromatic plants in Serbia (average for the 2005-2013, Figure 1), which is significantly less than in the previous period. In the eighties of the last century in Vojvodina, medicinal and aromatic plant species were cultivated on an area of about 1,500 ha; however, in the mid-fifties, in the former Yugoslavia, the plants were cultivated on about 8,000 ha. Around 10,000 ha in Serbia could be under medicinal plants (Adamović, 1994; Buha, 2012; RZS, 2014).

Chamomile plantation growing in our region began in the fifties; until then the exploitation was carried out mostly from natural habitats. Intensive using is linked to the beginning of the twentieth century and the construction of the first dryers in Kikinda. In the next seventy years, about fifty thermal dryers were constructed throughout Vojvodina. Annual needs of the pre-war Yugoslavia were satisfied with about 70 t of dry flower heads, while the rest of the produced 220 t (126-289 in 1928 and 1933, respectively) was exported. The drug was exported under the name *Chamomilla austriaca* or *Chamomilla hungarica*; only after the Second World War, thanks to Prof Jovan Tucakov, as *Chamomila yugoslavica*. The exported quantities significantly differed among the years; e.g. for the 1948-1958 period annual exports of both 240 t (1953) and 3 t (1958) were recorded. Similarly, the quantity of 144 t was exported in 1987, and 470 t in 1989. These fluctuations are related to the requirements of the international market, however also to the environmental conditions in the particular seasons which

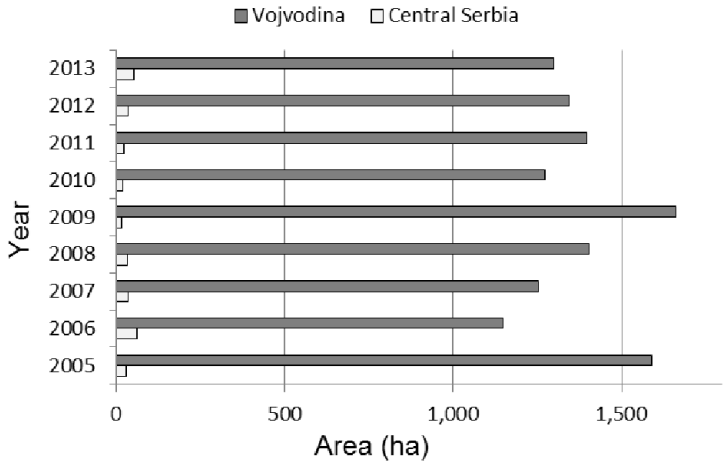

Figure 1. Area under medicinal, aromatic and spice plants in the Republic of Serbia, 2005-2013 period

reflected to the quantities of the collected and yields of the cultivated chamomile (Adamović, 1994; Bogdanović et al., 1997). There are no reliable data on the current exports of chamomile; however, the quantities are significantly lower. The overall export of medicinal, aromatic and spice plant was about 1,700 t in the first half of the year, average for 2012-2014 (Stevanetić, 2014).

Chamomile cultivation

Thanks to its adaptability to various soil and climatic conditions, chamomile has been successfully grown in almost all over the world. Good yields are obtained up to 500 m altitude, on both heavy and light soils, neutral-alkaline to acid pH reaction. It tolerates excessive salt and it is one of the rare plants that can be cultivated on saline soils without previous soil amelioration; moreover, chamomile itself can be considered as amelioration because uptakes salt and therefore remove it from the soil.

Sowing can be in the early autumn or in the spring, in Serbia autumn sowing is recommended, in mid-September. Chamomile can be grown in several consecutive years without sowing. Soil preparation involves plowing to a depth of 20-30 cm, and if there are no weeds only disking can be performed. Fertilization (P_2O_5, K_2O, N) rate should be adjusted to soil fertility. This measure is not necessary on fertile soils. Nitrogen should be applied carefully, since the excess cause undesirable leaf growth and delayed flower maturity. On the other hand, nitrate deficiency even stimulates the accumulation of certain phenolic metabolites. Sowing takes place in the surface, with the distance between the rows of 12.5 to 37.5 cm. The rate is 8-12 kg ha^{-1} of the mixture of seed and flower, or 1.5-2 kg ha^{-1} of pure seed. Plain roller should be used before and after sowing, in order to allow the proper seed-soil contact, i.e. to prevent seed dispersal by wind. If soil moisture is below the optimum, the crop should be irrigated after sowing and during the vegetation. There are differences among the chamomile genotypes with respect to drought tolerance, especially between wild populations and cultivars. Therefore, growing the appropriate cultivars in drought prone regions could provide good yields even without irrigation. Chamomile emerges 2-3 weeks after sowing. Strong leaf rosette should be formed before winter, which mitigates the effects of low temperatures. Vegetation lasts 150-180, and flowering 50-65 days. Harvest is from May to June, usually at intervals. From small areas the flowers are picked by hand, otherwise the harvest is mechanized. Serbian engineers have significantly contributed to the development of the combine harvesters for chamomile. Harvest is followed by calibration on sieves with 15-20 mm openings and drying. The flower heads are dried naturally or in thermal dryers, at 40-50°C temperatures (Martinov et al., 1992; Kišgeci & Adamović, 1994; Pajic et al., 2007; Baghalian et al., 2008; Bączek-Kwinta et al., 2010; Adamović, Jevđović, 2013; Kováčik, Klejdus, 2014).

Yield of dry flower heads vary from 400 to 1,500 kg/ha. Usual yields are 500-1,000 kg/ha of dry flower heads, 150 kg/ha of seed and up to 4.5-5 kg/ha of essential oil. The flowers used as drug (Chamomillae flos) should have moisture below 12%, appropriate physico-chemical and microbiological properties, referred low amount of heavy metals and at least 4 ml/kg of essential oil. The essential oil quantity and quality depend on plant developmental stage, part of the plant from which the oil was isolated, sampling time, the applied agro-technical procedures, locality, meteorological conditions, conditions of drying and storing the material, distillation conditions; as well as on the genetic background. Flower head yields also depend on soil quality, weather conditions, agro-technical procedures and the cultivar chosen for the production (Bogdanović i sar., 1997; Buha, 2012; Stamenković, Veličković, 2012).

Chamomile assortment

Growing chamomile began a little more than a century, together with the first attempts to breed the plant. However, only two cultivars (Quedlinburger Großblütige Kamille, Erfurter Kleinblütige Kamille) existed until 1962, when Bodegold, tetraploid German cultivar with high matricin/chamazulene and bisabolol oxide content, was released. In addition to the

a) b)

Picture 1. Chamomile cultivars
a) Banatska and b) Tetraploidna

improved flower head yield, disease tolerance, uniform maturation and other usual plant breeding goals; essential oil and drug quantity and quality improvement are of particular interest. In accordance to the specific requirements, there are more than forty diploid and tetraploid cultivars of different chemotype so far. There was even an attempt to release a triploid cultivar, in order to extend harvesting period and produce sterile seed, which would result in reduced chamomile growth in the next season. The majority of the cultivars are from breeding centers in Germany, Slovakia, Czech and Poland. Serbian cultivars Banatska, Tip 29 and Tetraploidna originate from the Institute of Field and Vegetable Crops, Novi Sad. Banatska and Tetraploidna (Picture 1) are in production.

Cultivar Banatska has yield potential of above 1,200 kg/ha dry flower heads, and essential oil content of 0.4-0.8%. Chamazulene content in essential oil is 5-10% and α–bisabolol is 15-20%. It was bred by selecting from the indigenous populations. Plants are of 50-70 cm height and there are up to about 50 flower heads on one plant. Tip 29 was bred from the introduced material. Plants are of lower height when compared to Banatska, with about 30 heads. The main component of the essential oil is bisabolol. Dry head and essential oil yields are about 800 and 4 kg/ha, respectively. The genetic yield potential of cultivar Tetraploidna is above 1,500 kg/ha of dry flower heads, essential oil content is 0.8-1.2%, and chamazulene in essential oil is 5-15%. The cultivar was bred from the introduced material. It is of about 80 cm height, with 45-50 heads on a plant. Timely harvest of the great importance, due to easy shattering of the heads (Adamović, 1996; Bogdanović et al., 1997; Franke & Schilcher, 2005; Hay Seyed Hadi et al., 2011; Adamović & Jevđović, 2013; Faehnrich et al., 2013).

Although environmental conditions (soil fertility, weather etc.) have significant effect on chamomile, using cultivar seeds and applying appropriate agro-technical procedures should provide satisfactory yield and quality. It is possible to collect the plant from its natural habitat; however, those areas are not always optimized for adequate production of biologically active components. There is a possibility that the material originates from the sites that are polluted by heavy metals, pesticide residues and other undesirable substances. In addition, uncontrolled collection of natural populations can cause their degradation and destruction. The above implies the cultivation as the method of choice for providing high quality plant material.

CONCLUSIONS

Chamomile is among the most frequently used herbs and it is a component of numerous commercial products. Exploitation of quality raw materials from natural habitats, as well as the successful cultivation of these plants for domestic and foreign markets have a long tradition in Serbia. It grows on less fertile soil, has modest nitrogen requirements, and tolerates excess salt and drought. Chamomile can be an important part in crop rotation; it can be grown as monoculture or intercropped. Therefore the current areas of 300-100 ha should be increased. It is grown mainly in Vojvodina, and the production should be extended to central Serbia.

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SAŽETAK

KAMILICA U REPUBLICI SRBIJI

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Kao jedna od najzastupljenijih lekovitih biljaka, kamilica se u svetu gaji na oko 20000 ha, dok se površine u Srbiji procenjuju na 350-400 ha. Najbolje uspeva na nadmorskim visinama do 500 m. Adaptirana je na različite zemljišne uslove, ima skromne potrebe za azotom, toleriše sušu i zaslanjena zemljišta. Uobičajeni prinos suvih cvetnih glavica je 500-1000 kg/ha, semena 150 kg/ha, a etarskog ulja do 4,5-5 kg/ha. Droga (*Chamomillae flos*) ima vlagu ispod 12%, odgovarajuće fizičko-hemijske i mikrobiološke osobine, propisano nizak sadržaj teških metala i najmanje 4 ml/kg etarskog ulja. Prinos cvetnih glavica, sadržaj i sastav etarskog ulja zavise od brojnih faktora sredine, ali i od genetske konstitucije materijala. U svetu je oplemenjeno četrdesetak sorti, od čega tri u Institutu za ratarstvo i povrtarstvo (Banatska, Tip 29 i Tetraploidna). U proizvodnji su zastupljene Banatska i Tetraploidna. Odlikuju se visokim potencijalom za prinos i odgovarajućim sadržajem etarskog ulja.

Ključne reči: kamilica, proizvodnja, Republika Srbija, sorte