Herbal sector of Serbia: General Overview

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1. Introduction

Medicinal plants have been essential resources for human health from ancient times to the present day. According to the World Health Organization (WHO), the majority of the world's population depends on traditional medicine for primary health care needs.

More than 35.000 plant species are used in herbal medicine and as spices, out of the most are of a local importance due to traditional use. Due to their increasing appliance in pharmaceutical, food, cosmetic and beverage industry, as well as use in folk and official medicine, veterinary and plant protection, herbal industry has been recognized as an important element of global economy.

Herbal industry involves a range of different activities, such as collecting of wild herbs, cultivation, processing and trade. Strong expansion of world's herbal industry and increasing demand for herbs and spices and their products, affect the genetic variability of MAP populations even causing depletion and disappearance of some species.

Nowadays, many European commercially interesting medicinal plants are endangered due to overexploitation, destructive collecting practices, climate change, pollution and alterations in their habitat structure or complete habitat loss. It is assumed that over 150 MAPs is threatened at least in one of EU countries, out of the following could be stressed: pheasant's eye (*Adonis vernalis*), common bearberry (*Arctostaphylos uva-ursi*), Iceland moss (*Cetraria islandica*), common sundew (*Drosera rotundifolia*), yellow gentian (*Gentiana lutea*), liquorice (*Glycyrrhiza glabra*), bog-bean (*Menyanthes trifoliata*), followed by many orchid species (*Orchidaceae*), etc. (Lange, 1998).

Some of relevant international documents related to either global biodiversity protection (naturally targeting wild herbs as well) or exclusively MAP conservation are: CBD (Convention on Biological Diversity, 1993), CITES convention (Convention on international trade of wild flora and fauna, 1975), Millennium declaration UN and plan of Agenda 21 implementation (UN Developmental Program, 2000) and Guidelines on the conservation of medicinal plants (WHO, IUCN, WWF, TRAFFIC, 2005). Some specific documents are related to use, trade, quality control and standardization in herbal sector, such as Cartagena protocol on biosafety (2003), EU Directive on genetic resources (2008), Directive 2001/83/EC on the Community code relating to medicinal products for human use and Directive 2004/24/EC of the European parliament and of ther council of 31 march 2004 amending, as regards traditional herbal medicinal products.

2. Diversity and quality of medicinal plants from Serbia

Territory of Serbia amounts for 88.766 km^2. In addition to its position in the Balkans, Serbia also occupies the southeastern part of the Pannonian plain in the Vojvodina

region. It is thus divided into two distinct geographical and orographic entities: northern lowland and rest, the hilly-mountainous regions, characterized as well by high- and low-input agriculture, respectively.

According to the most recent estimates (Stevanovic *et al.,* 1995) the flora of Serbia contains 3662 taxa, i.e. 3272 species and 390 subspecies, which make Serbia a country with very high floristic diversity and density per unit area, compared to other European countries. All plant species are included in 141 families and 766 genera. The newest data suggest even higher number of plant taxa, reaching near 4000 of plant species (Tomovic, 2007). The highest floristic richness is particularly characteristic for high-mountain regions of the country. It is well documented that the highest floristic diversity exhibit mountain massifs such as Kopaonik (about 1500 plant species), Fruska Gora (1400), Suva planina (1200), Tara (1100), followed with canyons and gorges, out of the Sicevacka gorge has more than 1000 plant species, etc.

High diversity of vascular flora refers also to medicinal and aromatic species (MAP) which occur in a range of different ecosystems, mainly forests and grasslands, but also in some of relic and endemic plant communities and in specific habitats, such as saline, sand, very wet, and very dry. More than 700 species are considered as medicinal (Saric, 1989), which accounts for 17.29% of the total flora. Among those, 420 plant species are officially registered (10.75% of the total flora), while over 280 appear on Serbian market (Dajic, 2001). Medicinal plants of Serbia encompass 89 families, including Lamiaceae (41 species), Asteraceae (40), Apiaceae (20), Ranunculaceae (19), Scrophulariaceae (17), Malvaceae (15), Rosaceae (15), Brassicaceae (10), Polygonaceae (10), etc.

Among 550 endemic species listed for Serbia (mainly Balkan endemics), over 50 could be treated as "medicinal", out of few grow only within the territory of the country ("stoenoendemic species"), such as: *Nepeta rtanjensis, Althaea kragujevacensis, Thymus adamovicii*, *Achillea alexandri-regis* and *Helleborus serbicus.* Such species strongly contribute to value of Serbian MAP biodiversity. Preliminary results regarding active compounds and their biological effects in some of endemics of Serbia indicate a high potential and challenge for future research (e.g. Kundakovic, 2006; Ljaljevic *et al.*, 2008).

In Serbia, the most used medicinal herbs are: chamomile (*Chamomila recutita*), mint (*Mentha* x *piperita*), yarrow (*Achillea* spp.), nettle (*Urtica dioica*), sage (*Salvia officinalis*), St. John's worth (*Hypericum perforatum*), marshmallow (*Althaea officinalis*), cowslip (*Primula* spp.), elder (*Sambucus nigra*), rosehip (*Rosa* spp.), linden (*Tilia* spp.), wild thyme (*Thymus serpyllum*), savory (*Satureja montana*), hawthorn (*Crataegus* spp.), basil (*Ocimum basilicum*), plantain (*Plantago* spp.) and many others.

It is well assumed that medicinal herbs from Serbia are characterized by high quality, i.e. high content and adequate composition of active substances. This is due to very favorable environmental conditions, in first climate (precipitation, temperature, number of sunny days, air humidity, etc.) and soil quality. In addition, because of performing of a low input agriculture, especially in hilly-mountainous part of the country where wild MAP collecting is carried out, the soil, air and water resources are not affected by pesticides, heavy metals, fertilizers and other harmful synthetic substances. Therefore, the most of the territory is suitable not only for gathering herbs

from the wild, but also for ecologically friendly and organic production of medicinal plants.

3. **Wild collecting**

Most of medicinal herbs on Serbian market are gathered from the wild. Due to over-harvesting in former period, some of them are now endangered and thus under legal protection (Low on Nature protection, 2009 and related bylaws, including Directive on control of use and trade of wild plant and animal species, 1993, 1996, 1999, 2005, 2011). Some important endangered and vulnerable MAPs of the Serbian flora are: *Drosera rotundifolia* L., *Gentiana punctata* L., *Gentiana lutea* L., *Prunus laurocerasus* L., *Acorus calamus* L., *Adonis vernalis* L., *Helichrysum arenarium* DC., *Lycopodium clavatum* L., *Menyanthes trifoliata* L., *Orchis militaris* L., *Ruta graveolens* L., *Glycyrrhiza glabra* L., *Veratrum nigrum* L., etc.

Biodiversity protection is performed *in situ* and *ex situ*. *In situ* protection of MAP species refers to habitat and landscape protection in the frame of 489 nature protected areas, out of 5 national parks. Protected area reaches 5.9% of the whole territory. *Ex situ* conservation of MAP species includes field collections, herbaria, seeds and *in vitro* cultures. In national Gene Bank is currently kept a total of 389 accessions of over 130 MAP species (Dajic Stevanovic, 2009).

There are about 4,000 organized collectors (or rather collector families) in Serbia. Since family members of the collectors are also involved, the actual number of individual collectors can be estimated at 12,000. Additionally, there are also people for whom collection is only a part-time activity with much less economic importance. These “sporadic” collectors only collect during certain periods, i.e. when prices and demand for certain plants are high (Donnelly *et al*., 2003). Lastly there are collectors in rural and urban areas, who collect MAPs for their own consumption or for direct sale in markets and even roadsides. Accurate estimates for the number of both the last groups cannot be made. The amount of herbs collected per day varies but can reach up to 50 kg of dried herbs. Some collectors can produce several tons of dried herbs per year while others only sell some kg.

Collection of MAPs in Serbia is mainly concentrated in the South-East part of the country, along the Bulgarian border with Sokobanja being the most important center (Fig. 1).

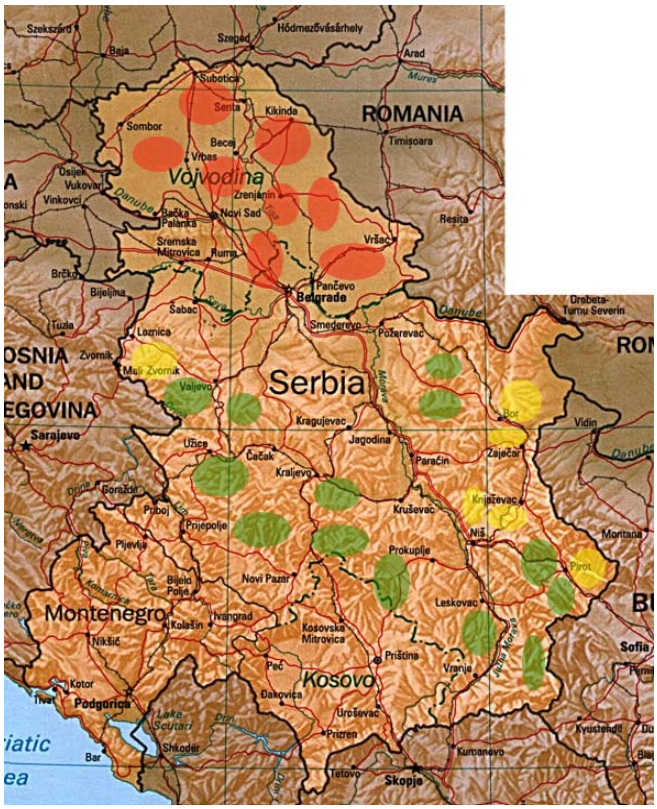

Fig 1. *Map of medicinal plant production in Serbia: red spots – cultivation area; yellow – wild collectin;, green- sporadic collecting, but rich natural resources*

4. **Cultivation of MAP**

There are several advantages of MAP cultivation, such as production of raw material of standard quality, use of available machinery, existing of simple processing facilities, more rational utilization of soil resources, yield planning, financial effects, preservation of species whose collection has been prohibited, etc. Medicinal plant production, especially of species with moderate or low ecological requirements, is totally justifiable in regions where is not possible or worthwhile to produce the standard crops (rocky, sandy, saline, poor and waterlogged soils, abandoned mountainous pastures, etc.). Besides production of medicinal plant raw material, seed production and the sale of transplants can also generate a significant income. Nevertheless, some problems could occur in MAP cultivation, like slow acclimatization of the plant, heterogeneous seed material, pest/disease-susceptible plant populations and low yields.

Conditions for MAP cultivation in Serbia are favorable, including soil fertility, climate and relatively solid infrastructure and processing capacities, mainly in Vojvodina (Photo 1.). In addition, for large number of species the cultivation technology has been acquired. Continual research on introduction of wild MAP species into cultivation systems is ongoing and led primarily by the Institute for Medicinal Plant Research “Dr Josif Pancic”, Belgrade, and Department for hops, sorghum and medicinal plants, Institute for field crops and vegetables, Novi Sad. Due to efforts of Serbian scientists, nowadays the fields under yellow gentian, arnica, wild thyme, rosehip, elder, Echinacea and some other attractive MAP species increase.

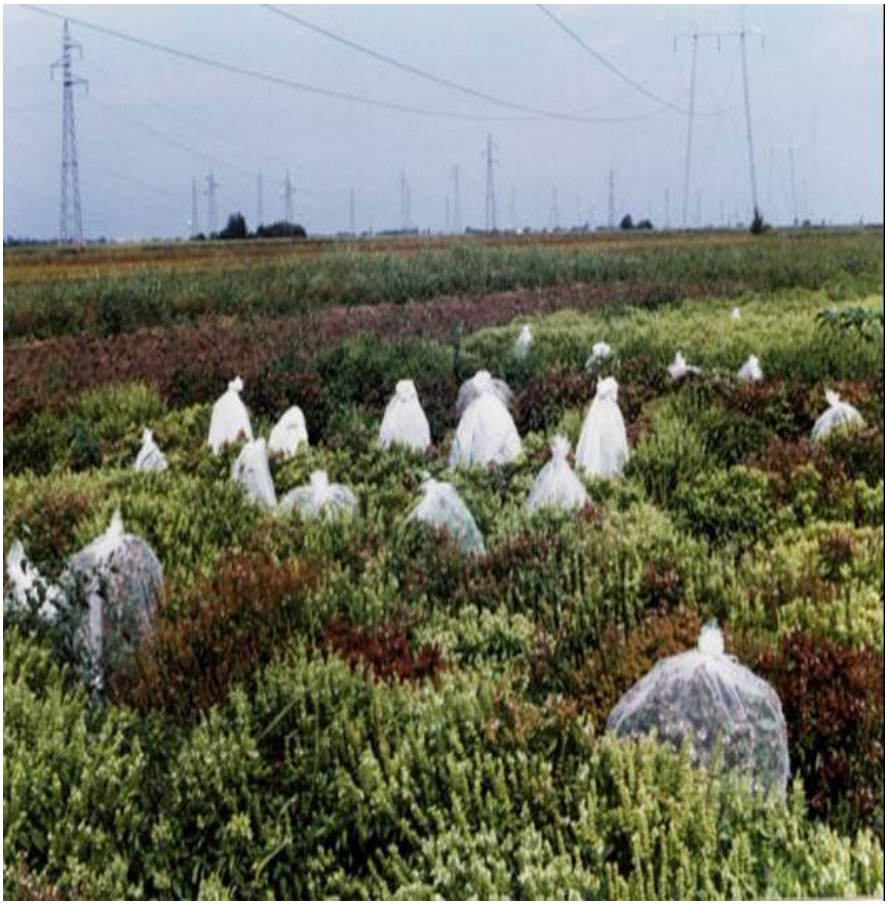

Photo 1. *Cultivation of MAP in northern Serbia (Vojvodina)*

The accurate area under MAP in Serbia is not easy to determine, since only registered farmers and their plantations are counted within official state statistics, and thus, smaller solitary fields are excluded from the data bases. The size of area under MAP showed certain fluctuations from year to year (Fig 2). It was assumed that at the end of the last centaury the area under medicinal and aromatic plants was about 3500 ha. However, cultivation MAP area decreased, nowadays reaching something above 2000 ha. Some confusion in precise estimation of area under cultivated MAP is approach of inclusion or exclusion of aromatic - spicy plants. Nevertheless, concerning increased demand for spices, herbs and herbal remedies, it could be expected that plantations under medicinal and aromatic plants in Serbia will enlarge in the near future.

The commonest cultivated MAPs in Serbia are: chamomile, mint, basil, marshmallow, valerian, lemon balm, poppy, sage, thyme, marigold, as well as the group of spicy species (parsley, dill, anis, caraway, fennel, sweet marjoram, lovage, celery, black mustard, coriander etc.).

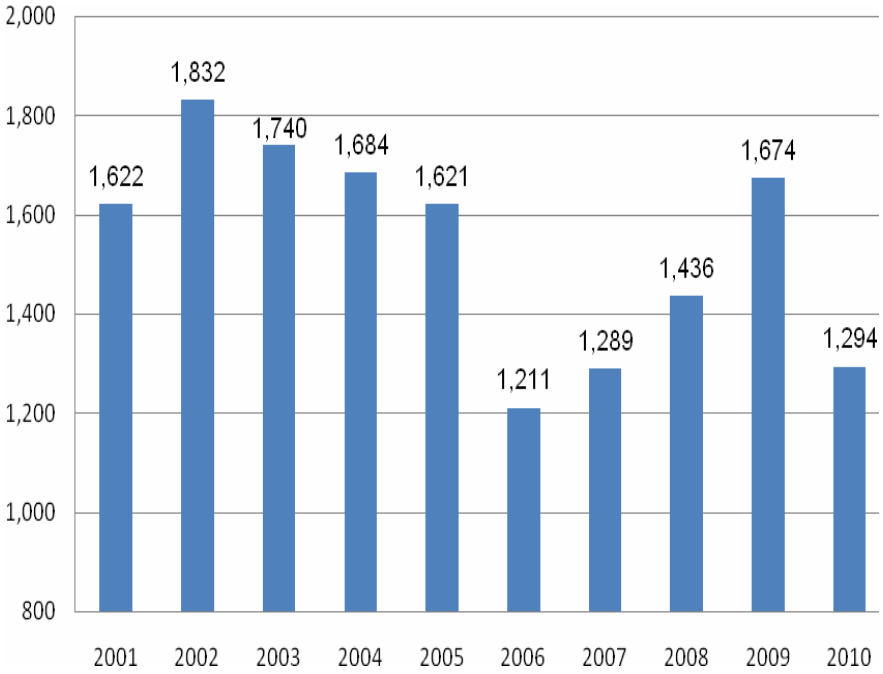

Fig.2. *Area under cultivated medicinal plants in Serbia (data obtained thanks to Chamber of Commerce of Serbia)*

5. **Trade of Serbian medicinal herbs**

There is a global tendency of strong increase in use of MAP, whereas total trade of herbs, herbal remedies and herbal food supplements on the world market has reached about 60 billion of USA $. During few last decades there was rapid growing demand for herbs and their products, especially in EU, US and Canada. European Union represents the largest global market for medicinal and aromatic plants with annual average import of about 120.000 tones in value of 200 million of USA $ for period 1991-2000 (Donnelly et al., 2003). Annual rate of demand increases for 5% to 10%. EU is also the largest producer of herbs with total area under MAPs of 62.700 ha. The most important suppliers of herbs in EU are US (15,8%), India (8,1%), China (7,45%), Bulgaria (6,44%), Egypt (5,47%) and recently Turkey.

Although former Yugoslavia was the major supplier of medicinal and aromatic plants into EU, Serbia lost its markets during last twenty years. During the last decade Serbian share in the total EU import increase from 0,43% to 1-2%, indicating solid potential and prospects of Serbian herbal industry. Production of teas and other herbal products progressively increase in Serbia as well. Members of the largest Serbian association of herbs producers, processors and exporters, the “Serbian flora”, represent about 80% of total herbal sector. Members of Serbian flora (are already known at national and regional market, whereas few of them have entered markets of US and EU. Production of teas and other herbal remedies is in accordance with international standards (HACCP, ISO). Production of essential oil and dry extracts is in an expansion, as well as the interest for MAP cultivation.

In the period of 2005 to 2007 the foreign trade of herbs and teas had a trend of increase with annual rate of 22%, whereas the export was much more dominant. The raw herb material trade was the most excessive (87%), while trade of teas has much lesser share in total foreign trade of MAPs. In 2010 total foreign trade reached 24,3 million US$, out of export and import were 19 and 5,3 millions of US$, respectively. Comparing to 2009, the export of herbs increased for 10,4%. The average price per kg of item was 4 US$. Import of MAP decreased for 8% and average price per kg of the imported item was 3 US$. Successful foreign trade resulted in surplus of 13,7 million of US$, indicating a necessity of further state support into the herbal industry. The group of "spicy herbs" contributes with almost two thirds in the export, while the "medicinal herbs" *sensu stricto* with 27% or 5,4 million US$. Export of teas was only 3% from the total export with 603,7 thousands US$. The most significant partners in trade of herbs are EU (62%) and CEFTA countries (35%). In 2009 the share of trade with EU increased for 5% comparing to 2008. Similar trend continues in 2010. Among EU countries, the biggest importer of Serbian herbs is Germany (Fig.3).

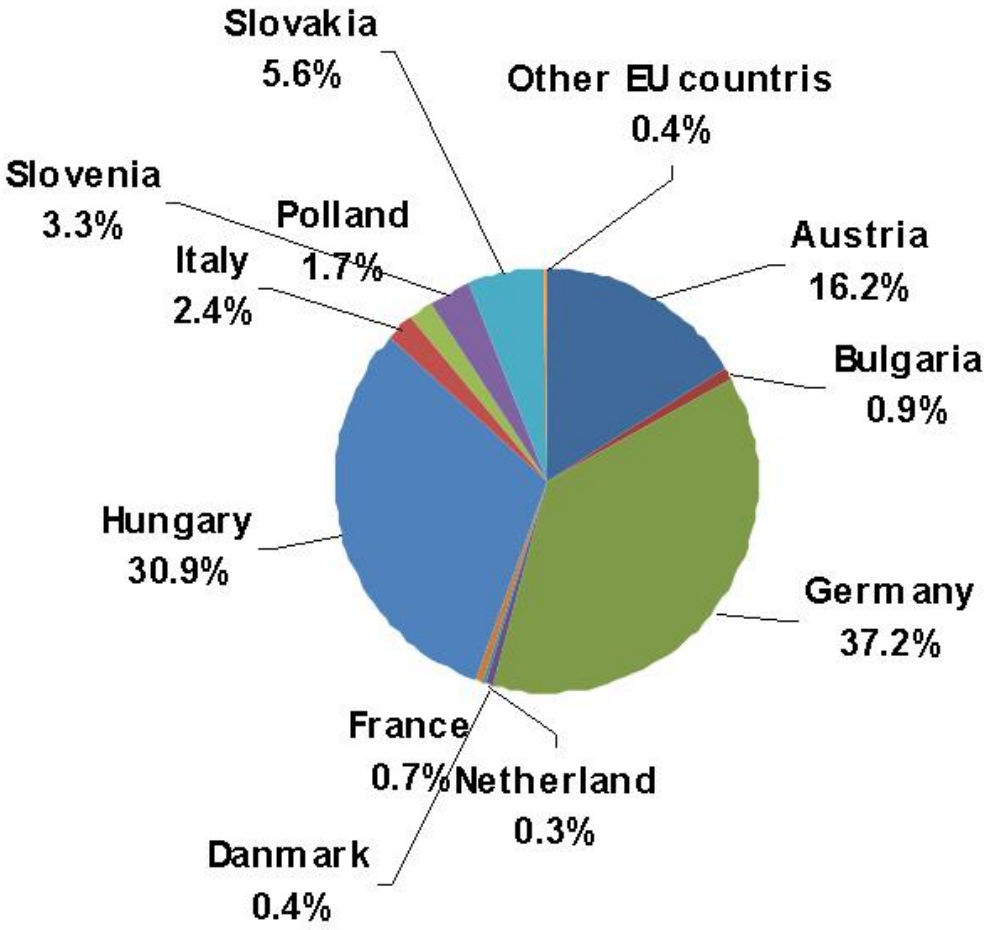

Fig.3. *Export of MAP from Serbia into EU countries, data obtained thanks to Serbian Chamber of Commerce*

Regarding medicinal plant processing, it is known that the world's annual production of essential oils is at least 45 000 tones (Verlet 1993). However, Serbian producers do not operate on the world market because of variable yields and quality, and lack of capacities, knowledge and marketing (Menkovic *et al.*, 1997). The essential oils are obtained from species both indigenous and cultivated in Serbia, such as mint, juniper tree, lemon balm, thyme, chamomile, dill, parsley and valerian.

Only recently, mostly in the private sector, more attention has been paid to essential oil distillation from plants such as *Levisticum officinale, Angelica archangelica, Ocimum basilicum* and *Lavandula officinalis* (Dajic and Stevanovic, 2001). Unfortunately, it is very difficult to estimate the amount of essential oils produced annually in Serbia, but it is believed to range between a few hundred kg and up to 10 000 kg.

6. **Current research on MAP in Serbia**

In addition to investigations on MAP biology, diversity and population mapping, significant research is conducted on breeding, selection and introduction of wild MAPs. The main achievements in MAP breeding and selection in Serbia refer to creation of over 90 varieties of different MAP species (Dajic, 2004).

Since the establishment of the Institute for Medicinal Plant Research "Dr Josif Pancic" (1948), much has been learned about the pharmacological features of Serbian MAPs. Other institutions also deal with evaluation of chemical content, active substances and qualitative composition of MAP drugs (e.g. Pljevljakusic *et al.*, 2011; Zdunic *et al.*, 2011; Godjevac *et al.*, 2010; Jankovic *et al.*, 2009; Dajic-Stevanovic *et al.*, 2009; Menkovic *et al.*, 2009), as well as their influence on cells of bacteria, fungi and cancer, and other biological interactions (e.g. Brankovic *et al.*, 2011, Stevic *et al.*, 2010, Samoljik *et al.*, 2010, Menkovic *et al.*, 2010). Application of molecular genetics technologies to MAP studies could provide further possibilities for evaluation of suitable genotypes and quality evaluation of MAP products. No serious research at the molecular level on MAPs has been conducted in Serbia, except research on wild thyme populations (Dajic and Sostaric, 2006; Sostaric *et al.*, – work in preparation). Research on MAP in Serbia is conducted by the Faculty of Pharmacy, Faculty of Technology, Faculty of Chemistry, Faculty of Biology and Faculty of Agriculture of Universities of Belgrade, Novi Sad and Nis.

The special challenge in the near future would be cultivation and/or improvement of new technologies for production of endangered medicinal plants, because many of them are still not cultivated in Serbia. Among them, the following species could be stressed: St John's wort, eyebright, yarrow, Lady's mantle, chicory, uva ursi, digitalis, agrimony, borage, centaury and many others.

7. Conclusion

In developed countries, agriculture produces a surplus of traditional crops and this is to be restricted. Council regulation EEC 1765/92 and its updates established a support system for producers of certain arable crops. Although cereal areas should be reduced, it is permitted to use set-aside land for "non-food" crops; medicinal plants and spices

belong to this category. Sustainability of Serbian herbal sector is not only depending on size and structure of natural MAP populations and position of MAP collectors as key but marginalized element in the whole herbal chain. However, there is a need for a long-term and complex strategy, able to ensure implementation of standards, certification and quality control system harmonized with those in EU. Ecologically favorable and not polluted rural areas, especially in mountain regions of Serbia are notably suitable for both collecting and cultivation of medicinal plants. In medium term period, activities concerning MAP production could develop a network of small and medium enterprises, farms, collecting centers and ethno-villages aiming to revive abandoned and insufficiently utilized rural landscapes in the country. High priority to programs for the conservation of medicinal plants should be justified on the basis of savings that the plants generate for national health expenditure and thus to the national economy.

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References

Brankovic, S., Kitic, D., Radenkovic, M., Veljkovic, S., Jankovic, T., Savikin, K., Zdunic, G. 2011. Spasmolytic Activity of the Ethanol Extract of Sideritis raeseri spp. raeseri Boiss. & Heldr. on the Isolated Rat Ileum Contractions. Journal of Medicinal Food 14: 495-498.

Dajic Stevanovic, Z. 2009. Genetic resources of medicinal and aromatic plants in Serbia – status 2007. In: Lipman E, editor. 2009. Report of a Working Group on Medicinal and Aromatic Plants. Second Meeting, 16-18 December 2004, Strumica, Macedonia FYR / Third Meeting, 26–28 June 2007, Olomouc, Czech Republic. Bioversity International, Rome, Italy., Pp: 199-201.

Dajic Stevanovic, Z., Nastovski, T., Ristic, M., Radanovic, D. (2009): Variability of essential oil composition of cultivated Feverfew (*Tanacetum parthenium* (L). Schultz Bip.) populations. Journal of Essential Oil Research 21: 292-294.

Dajic Stevanovic, Z., Sostaric, I. 2006. Review of some useful methods in taxonomical interpretation of difficult taxa of medicinal and aromatic plants. Case: *Thymus* L. Proceedings of the 4th Conference on Medicinal and Aromatic Plants of South-East European Countries, 28-31 May, Iasi, Romania, Pp. 63-71.

Dajić, Z. 2001. The current situation and further prospects in domain of medicinal and aromatic plants in Serbia. In: Aktualne problémy pestovania lieččivých, tonizújucich a koreninových rastlín. Zbornik z odborného seminara s medzinarodnou účast'ou., 28 November 2001, Agricultural Institute Nitra, Slovakia. Pp. 48-54.

Dajic, Z. 2004. Genetic resources of medicinal and aromatic plants of Yugoslavia - current situation and further prospects. ECP/GR Report of a Working Group on Medicinal and Aromatic Plants. First meeting 12-14 September 2002, Gozd Martuljek, Slovenia, International Plant Genetic Resources Institute, Rome, Italy, Pp.: 130-143.

Dajic, Z., Stevanovic, T. 2001. Les plantes aromatiques et médicinales en Serbie [Aromatic and medicinal plants in Serbia]. Info-Essences. Bulletin sur les huiles essentielles et autres extraits végétaux 18:10-12. Université du Québec à Chicoutimi, Canada.
Donnelly, R., Helberg, U., Dajic, Z. 2003. Balkan Herbal Development Initiative – Phase 1. Final Summary Report. SEED, CCF, Belgrade.

Godjevac D., Menkovic N., Vujisic Lj., Tesevic, V., Vajs V., Milosavljevic, S. 2010. A new triterpenoid saponin from the aerial parts of Cephalaria ambrosioides. Annalytical Letters 43: 2487-2495

Jankovic, T., Krstic-Milosevic, D., Aljancic, I., Savikin, K., Menkovic, N., Radanovic D., Milosavljevic, S. 2009. Phytochemical re-investigation of Gentiana utriculosa. Natural Product Research 23: 466-469.

Kundakovic, T. 2006. Secondary metabolites and its activity in Achillea alexandri-regis. Zaduzbina Andrejevic, Belgrade (in Serbian).

Lange, D. 1998. Europe's medicinal and aromatic plants; their use, trade and conservation. Traffic International, Cambridge, UK.

Ljajevic Grbic., M., Stupar, M., Vukojevic, J., Sokovic, M., Misic, D., Grubisic, D., Ristic, M. 2008. Antifungal activity of Nepeta rtanjensis essential oil. Journal of the Serbian Chemical Society 73: 961-965.

Menkovic, N., Juranic, Z., Stanojkovic, T., Raonic-Stevanovic, T., Savikin, K., Zdunic, G., Borojevic, N. 2010. Radioprotective Activity of Gentiana lutea Extract and Mangiferin. Phytotherapy Research 24: 1693-1696.

Menkovic, N., Savikin, K., Zdunic, G., Gojgic-Cvijovic, G. 2009. Chemical Composition and Antimicrobial Activity of Essential Oil of Physocaulis nodosus (L.) WDJKoch. Journal of Essential Oil Research 21: 89-90.

Menkovic, N., Tasic, S., Ristic, M. 1997. Cultivated aromatic plants of Sarplanina mountain – realistic basis for distillation. 40/III, Serbian Academy of Science, Belgrade (in Serbian).

Pljevljakusic, D., Savikin, K., Jankovic, T., Zdunic, G., Ristic, M., Godjevac, D., Konic-Ristic, A. 2011. Chemical properties of the cultivated Sideritis raeseri Boiss. & Heldr. subsp raeseri. Food Chemistry 124: 226-233.

Samojlik, I., Lakic, N., Mimica-Dukic, N., Djakovic-Svajcer, K., Bozin, B. 2010. Antioxidant and Hepatoprotective Potential of Essential Oils of Coriander (Coriandrum sativum L.) and Caraway (Carum carvi L.) (Apiaceae). Journal of Agricultural and food Chemistry 58: 8848-8853.

Saric, M., editor. 1989. Medicinal plants of Serbia, Serbian Academy of Science, Belgrade (in Serbian).

Stevanovic, V., Jovanovic, S., Lakusic, D. Niketic, M. 1995. Diversity of the vascular flora of Serbia with review of species of international significance. In: Biodiversity of Yugoslavia with review of species of international significance (V. Stevanovic and V. Vasic, eds). Ekolibri and Faculty of Biology, Belgrade (in Serbian). Pp. 183-217.

Stevic, T., Savikin, K., Zdunic, G., Stanojkovic, T., Juranic, Z., Jankovic, T., Menkovic, N. 2010. Antioxidant, Cytotoxic, and Antimicrobial Activity of Alnus incana (L.) ssp incana

Moench and A. viridis (Chaix) DC ssp viridis Extracts. Journal of Medicinal Food 13: 700-704.

Tomovic, G. 2007. Phyto-geographical affiliation, distribution and centers of diversity of Balkan's endemic flora in Serbia. PhD thesis, Faculty of Biology, University of Belgrade (in Serbian).

Verlet, N. 1993. Essential oils: supply, demand and price determination. Acta Horticulturae 344: 9-16.

Zdunic, G., Godjevac, D., Savikin, K., Novakovic, M., Milosavljevic S., Petrovic S. 2011. Isolation and identification of phenolic compounds from Hypericum richeri Vill. and their antioxidant capacity. Natural Product Research 25: 175-187.