

PRODUCTION OF MEDICINAL, AROMATIC & SPICY PLANTS IN SLOVAK REPUBLIC AND ITS PERSPECTIVE

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INTRODUCTION

Slovakian Basic Facts:

Establishment: Republic headed by the President

Government: Parliamentary democracy

Area: 49,035 square km

Elevation: the Bodrog river 94 m above sea level, the lowest elevation; Gerlach, the highest peak of the Tatras 2,655 m above sea level, the highest elevation

Inhabitants: 5,395,000 (census 1999)

Density of population: 100 inhabitants per square km

Capital: Bratislava (449,500 inhabitants /1999/)



Slovak Republic is placed in the Central Europe. It lies in the climatically favourable mild zone of Northern hemisphere. Generally the nature of the country is very heterogenous and has some interesting features. In the territory two fundamental regions of flora can be observed. The thermophilic flora is present in the Pannonian region in warm basins with a great number of xerophytic species. The Carpathian flora is present in the majority of the Slovak mountains with a market differentiation of the plant cover according to the elevation above sea level (1).

WHY MEDICINAL, AROMATIC & SPICY PLANTS

THE 5th CONGRESS OF EUROPEAN SOCIETY OF AGRONOMY (June 1998, Nitra, Slovakia)

*One from the conclusions: * we have overproduction of main crops and foods in Europe. In regard to this fact the agricultural cultivation needs to start an introduction of profitable new crops (the medicinal & aromatic plants).*

THE INTERNATIONAL CONFERENCE "SUSTAINABLE AGRICULTURAL PRODUCTION ON THE REGIONAL LEVEL" (November 1998, Michalovce, Slovakia)

The East-Slovak Lowlands belong to the very intense agricultural part of Slovakia. Our results of economical calculation in this area are showed that the agricultural production per capita is 372 kg of cereals, 560 kg of sugar, 92 kg of fruits, 139 kg of meat and 337 l of milk. Overproduction of these commodities will be needed to sell their to another parts of Slovakia, to the international market or to introduce a new crop cultivation (the medicinal & aromatic plants).

HISTORICAL BACKGROUND

Since time immemorial medicinal plants have played the most important part in the composition of therapeutic and various preparations used in popular doctoring, the experience of simple people being the basis for the use of these medicinal plants. In past centuries about 600 or 800 species were used for curative purposes (6).

There exists evidence that as early as in the Old Slavonic period (about 900 AD) a lot of plants were used. In the course of the 17th century the peasants acquired the ability to produce vegetable and plant oils. These essential oils were exported by the so-called „oilmen“ of East and West Europe (4). The travelling „oilmen“ prepared the oils and peddled them along with other pharmaceutical preparations between villages. Essential oils, obtained by distillation or pressing of various herb parts, were used as the basis of many treatments with the practice becoming widespread during the 18th and 19th centuries.

In this short survey of traditions in popular doctoring it is necessary to mention also the herbalists, i.e. people who dispensed medicinal herbs in order to cure specific diseases. In the regions of their activity these „popular doctors“ were highly respected.



Picture 1: The using of herbs in the Old Slavic period (about 900 AD).

Because of the therapeutically effective substances contained in medicinal plants the latter are important aids in the therapy of diseases in our human medicine. In regard to Slovak history contemporary modern phyto-therapy in our country continues with the rich traditions of popular doctoring. Of course, the development of natural sciences with their exact methods of investigation makes the therapeutic effect of the substances contained in these plants and the therapeutic value of each plant more precise.

CURRENT SOURCES

Nowadays 150 and about 200 medicinal plants are used in the official therapy and in popular doctoring, respectively (6). The medicinal, aromatic and spicy plants are mainly used in Slovak Republic in : phyto-therapy, veterinary, medicine, cosmetics and food industry; they have additive, ecological, decorative and sanitary-hygienic functions and positive influence on water system, soil conservation and plant pasture for bees (15).



Picture 2: The Slovakian „Oilmen“.

The medicinal, aromatic & spicy plants in Slovak Republic are originated into the natural raw material resources of plants, which are the gene-pool of these plants and an introduction of new plants from abroad. Our present research and development is orientated to: -collecting expeditions of genetic resources, -determination of chemotypes, -protection of genetic resources in the Slovak Gene Bank and -visions of introduction to agricultural production with pharmaceutical proceeding and using (3).

Drugs, i.e. dried medicinal and aromatic plants or their parts (roots, leaves, flowers, fruits, seeds, greens) or plant products (balms, resins, glycosides, essential oils ...) are obtained from: - collection in the wild (individual or organized), - contracted deliveries of small-scale growers and - large-scale cultivation on the agricultural enterprises (15).

LARGE-SCALE CULTIVATION

The large-scale cultivation of medicinal and aromatic plants belongs to the special agricultural production (table 1). It is an only way of supply the contracted volume and quality of these crops (5).

Table 1: Special crop large-scale cultivation in Slovak Republic in 2000.

	Private Sector	Cooperative Farms	Total
Medicinal Plants [ha]	782.61	113.50	896.11
Caraway [ha]	82.00	56.00	138.00
Other Spices [ha]	58.50	-	58.50
Red Pepper [ha]	564.78	70.00	634.78
Tobacco [ha]	1,184.40	382.00	1,566.40
Poppy [ha]	2,369.56	540.00	2,909.50

This special crop production is of great importance from several points of view in the specialized agricultural farms: * rational (offering appropriate occasion for unemployed people), * production (better exploitation of problematic land resources /salty soil, lower quality soils in sub-mountainous or mountainous areas/) and * economic (from the viewpoint of market value the medicinal plants belong to the most effective agricultural crops) (7). Table 2 presents an actual situation in medicinal and aromatic plant cultivation in Slovakia.

Table 2 : Species of medicinal and aromatic plants and their produce volume.

Cultivate area [ha]	Volume of production [t]	Plant species
896.11	905.05	Chamomile, St. John's Worth, Marigold, Balm, Mint, Agrimony, Sage, Dill, Plantain, Hyssop, Marjoram, Yarrow, Coriander, Angelica, Basil, Lavender, Marshmallow, etc.

The Slovak Ministry of Agriculture mandated the Research Institute of Agroecology in Michalovce to elaborate „*The Development Programme of Medicinal, Aromatic and Spicy Plant Cultivation and Processing in the Slovak Republic*“ in the first half of the year 1999 (10). More than 60 specialists from the sector of medicinal plant cultivation, processing, business and science were contacted. All material has presented to the leadership of the Slovak Ministry of Agriculture. The program is a basis to the state support of this special crop production & development into the future long conception (table 3).

Table 3 : Medicinal and aromatic plant prediction of an increase cultivation in Slovak Republic.

Years		1970-1980	1980-1990	1990-2000	2000-2010	2010-2020
Cultivation area	ha	150	350	380	1,500	2,500
Raw-material production	t	165	385	410	1,650	3,000



Picture 3: The large-scale cultivation of German chamomile in Streda nad Bodrogom, the Eastern Slovakia.

Generally, the new development program should contribute to the solution of following tasks: * decrease a risk of production, * to improve variable profitability of the single medicinal plant species, * to propose and develop suitable special mechanization, chemical protection, high quality of seeds, determination of radiation and pollution, etc., * to design progressive trimming lines, store-rooms, extraction and distillation equipment – post harvest technologies, * to decrease a ration of manual labor, * to establish functioning relation between suppliers and customers, * to improve the skill of people working in the herb production (10).

The claims to the Slovak Ministry of Agriculture have been formulated in these points:

* in regard to the large-scale cultivation :

- n appropriate state subsidies,
- n suitable state grant to capacity of harvest and post-harvest technologies,
- n additional payment for the high quality of medicinal plant drug, which is determined by a quality certificate.

* in regard to the market support :

- n prevent an import of medicinal plant drugs from abroad,
- n suitable state additional payment to each kilogram of herbs, which is exported,
- n creation of market-manager companies or partnerships to arrangement of cultivation, processing and business of all herbal items.

* our general claim is :

- n support of complex cooperation and the exchanging information among all parts of the Slovak economy.

The Program SAPARD (the Special Access Program for Agriculture & Rural Development) has just become a very important aspect of the European Union, which sponsors this field of crop production, specially, in Slovak Republic.



Picture 4: Marigold flowers before their harvest in Streda nad Bodrogom.

TECHNOLOGICAL PROCESSING

At present good breeding methods, cultivation, harvesting and processing, produce plants with high quality of natural supplements and products. The leaders of this production in Slovakia are several companies, which are situated in the West and East part of Slovakia. This production are orientated to large-scale distillation of essential oils, extraction of wateralcoholic and propylenglycol extracts, dry powder extracts and isolation of clean substances.

The information about quality of several essential oils can be given as an examples (12,13):

The main qualitative and quantitative characteristics of Scot's pine (*Pinus silvestris* L.) essential oil are α -pinene (27.4 %), β -pinene (9.7 %), α -phellandrene (10.0 %), bornyl acetate (18.8 %), camphene (15.5 %) and limonene (6.1 %). The results show a similarity with the Siberian origin chemotypes, besides bornyl acetate and limonene contents.

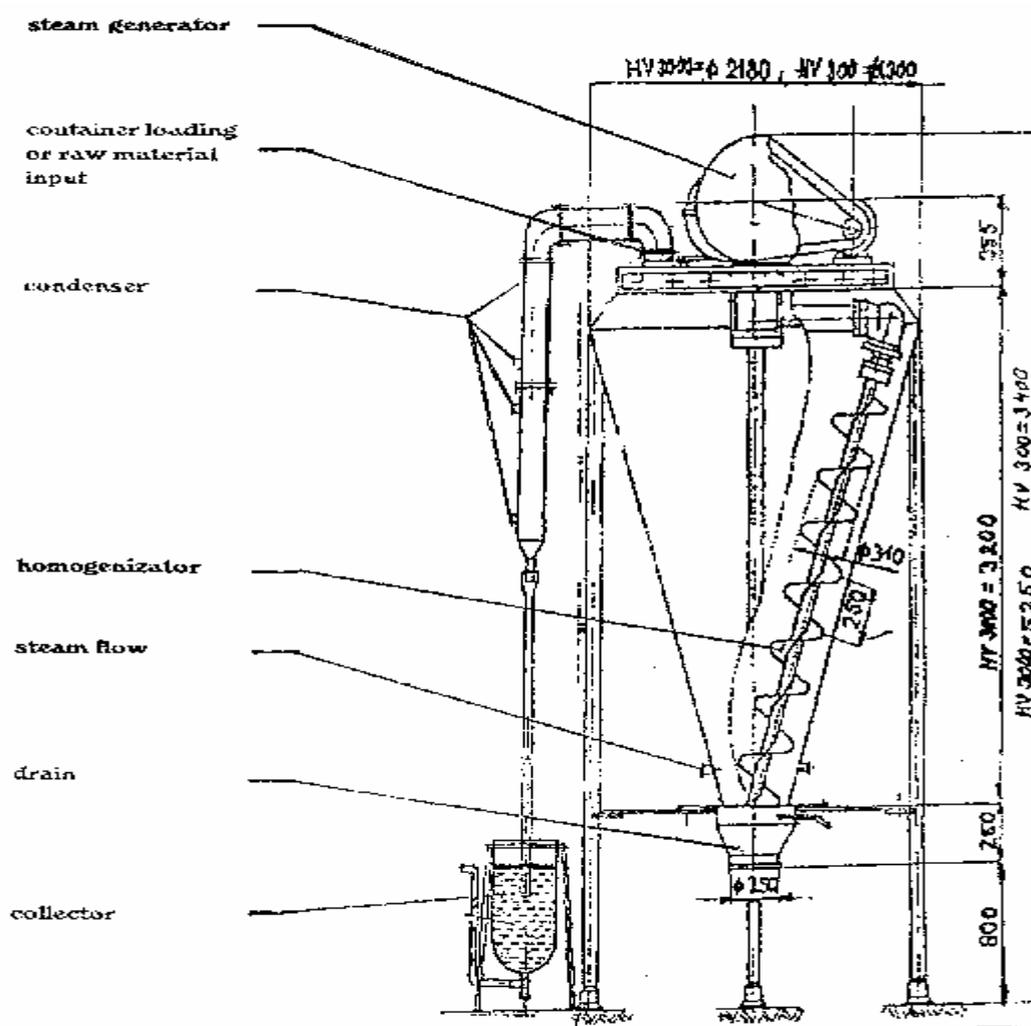
Peppermint (*Mentha x piperita* L.) plant material is usually obtained from large-scale cultivation in the West Slovakia. This essential oil contents up to 46 % of menthol, menthofuran: 22.6 %, (-)-mentylacetate: 3.5 %, neomenthol: 3.6 %, pulegone: 1.9 %, isomenthone: 8.8 % and linalool: 0.6 %.

The essential oil of coriander (*Coriandrum sativum* L.) is contained pinene (9.6 %), *p*-cymene (6.9 %), limonene (3.5 %), γ -terpinene (6.6 %), linalool (61.4 %), camphor (2.3 %) and isobornyl acetate (2.5 %).

Sage (*Salvia officinalis* L.) has just started to produce on the large-scale cultivation in several parts of Slovakia. In regard to the GC-MSD analyse of sage essential oil, the major compounds were α -pinene (9.2 %), 1,8-cineole (12.6 %), α -thujone (24.7 %), β -thujone (5.2 %), camphor (16.8 %), β -caryophyllene (5.0 %) and α -caryophyllene (2.8 %).

Hyssop (*Hyssopus officinalis* L.) is cultivated for medicinal uses or it is now grown mostly as an ornamental shrub. The levels of the two major ketones: pinocamphone (15.7 %) and isopinocamphone (36.0 %) are within normal limits.

Rosemary (*Rosmarinus officinalis* L.) is now widely cultivated for its aromatic leaves and as a kitchen seasoning. Sample of rosemary essential oil contained α -pinene (11.9 %), camphene (8.4 %), β -pinene (2.8 %), limonene (11.5 %), 1,8-cineole (34.4 %), camphor (7.4 %), borneol (4.4 %), α -terpineol (3.3 %) and boranyl acetate (4.4 %). No verbenone was found.



Picture 5: Schema of the large-scale distillation apparatus (2).

ENVIRONMENTAL FACTORS

a) heavy metals

The industrial pollution of agricultural lands belongs to the serious ecological problems in Slovakia. There are 9 localities in the Central Zemplin (a part of the East-Slovakian Low-lands), where the soils are contained by excessive amounts of these hazardous elements. Of course, a heavy metal contamination in these areas is characteristic into crop production too.

There was made a study of the heavy metal pollution into dry medicinal plant raw-materials, which were cultivated and collected in the Central Zemplin during the years 1997 – 2000 (8).

For determination 4 heavy metal contents (cadmium [Cd], lead [Pb], chrome [Cr], nickel [Ni]) were used 7 samples of medicinal plants (flowers, herbs, leaves, roots).

The samples of plant materials for our heavy metal determination were decomposed by 10 ml HNO₃ and 1 ml H₂O₂ into vessels, which were given in a pressure autoclave. Mineralization was taken place at the temperature 150 °C during 5 hours. The AAS results for Cd, Pb, Cr, Ni, were obtained using SHIMADZU, model 660, with Graphite fumace, Deuterium background corrector and autosamples. Sample volume was 20 ul.

Table 4 : The average content of heavy metals in medicinal plants in 1997-2000 [mg.kg⁻¹].

Medicinal plants :	Heavy metals:	Cadmium [Cd]	Lead [Pb]	Chrome [Cr]	Nickel [Ni]
German chamomile, <i>Matricaria recutita</i> L., flowers		0.186	0.551	0.446	2.595
Black elder, <i>Sambucus nigra</i> L., flowers		0.014	0.242	0.437	2.790
Shave grass, <i>Euqisetum arvense</i> L., herba		0.022	0.070	0.202	1.768
Agrimony, <i>Agrimonia eupatoria</i> L., herba		0.076	0.280	0.096	4.035
Mistletoe, <i>Viscum album</i> L., herba		0.163	0.318	0.278	0.543
Common dandelion, <i>Taraxacum officinalis</i> Web., roots		0.067	0.372	0.851	0.546
Stinging nettle, <i>Urtica dioica</i> L., leaves		0.056	0.092	0.075	0.099

The high accumulation ability were determined into these medical plant species: chamomile (Cd, Pb, Cr, Ni), mistletoe (Cd, Pb), common dandelion (Pb, Cr), black elder (Cr, Ni), agrimony (Ni) and the lowest accumulation ability of heavy metals were showed shave grass and stinging nettle (table 4). The heavy metal contents of these herb samples are not higher than the maximum permissible concentration of these elements into food - the standard tea, which is enacted by the Slovak Ministry of Agriculture in the Regulation No. 14/1996.

b) radioactivity

The largest catastrophe in history of civil using of nuclear energy was in Chernobyl, Ukraine, in April 26, 1986. In regard to special expertise the radioactivity, which was relieved with Chernobyl explosion, is corresponded to 50-times of bomb radioactivity from Hiroshima.

The medical quality and effect of medicinal plants are depended on the conditions of environment, which is influenced direct to their grow on the place of an occurrence and cultivation. The radioactivity has effected to vegetation in the Slovak Republic even if the Chernobyl crash was many years ago. In regard to medicinal plant market, it is very important to determine the radioactivity values of herb goods to foreign customers (9).

The conserve plant parts (flowers, herbs, leaves and roots) of 11 botanical species by drying were used to determination of the mass radio-nuclide activities. This plant material was originated from a wild plant collection and large-scale cultivation of these medicinal plants in Slovak republic in years 1997, 1998 and 1999 (14). The gama-spectrometric determination of selected medicinal plants by the HPGe detector with using of Cesium radio nuclides (¹³⁴Cs & ¹³⁷Cs) was carried out at the Special State Health Institute, Department of Health Protection against the Radioactivity, in Banska Bystrica, the Middle Slovakia.

The dry flowers of chamomile, elder, marigold and lime are determined the highest average activity of radio-nuclides (1.34 Bq.kg⁻¹). The lower average levels of radioactivity (0.96 Bq.kg⁻¹) are showed the agrimony, mistletoe, horsetail herbs and birch leaves and the lowest (0.79 Bq.kg⁻¹) the dandelion, burdock and nettle roots. In regard to medicinal plant species, the highest result of radioactivity, 2.45 Bq.kg⁻¹, was determined in the lime flowers in 1998, following the horsetail herb, when average per 3 years was 1.98 Bq.kg⁻¹ and in chamomile flowers with average result 1.42 Bq.kg⁻¹. The lowest results in general were evaluated in dandelion roots (0.50 Bq.kg⁻¹).

The regulation on the highest permissible radioactivity in food was notified in the Slovak Republic in January 2001. In spite of these facts, the trace radioactivity values of medicinal plants in this country were stated. This herbal raw-material is accepted on the market with medicinal plants in the world. In regard to next monitor radioactivity the very interesting results have been obtained; the topicality of this field solution is confirmed.



Picture 6: Leuzea plants and their successful introduction into large-scale cultivation.

RESEARCH AND DEVELOPMENT (R & D)

Modern phytotherapy is direct successor of the rich tradition of popular doctoring in Slovak Republic. It is based on the years of experience of people having direct contact with nature. Over the years this experience has been verified in practice, supplemented and classified – folk herbalist wisdom formed and passed from generation to generation. The use of natural drug resources and the experience of folk medicine has been a continuous subject of research & development at many universities and research institutes.

Generally, research & development should contribute to the solution of following tasks: * monitor of the Slovak gene-pool of herbs, * collecting expeditions of genetic resources, *determination of chemotypes, * protection of genetic resources in the Gene Banks, * breeding of medicinal, aromatic and spices plants, * development of seed production, * introduction of new medicinal plant species into large-scale cultivation, * improvement of the methods of large-scale cultivation, harvest and post-harvest technologies, * creation of extension offices, * giving of the quality certificates of the all herb items, * introduction of the without waste technologies,* presentation of the results of research and development at the domestic and foreign actions and exhibitions, *marketing investigation of the world market and presentation of information review about this situation (10).

Main medicinal plant which is the subject of our research & development are German chamomile (*Matricaria recutita* L.). It is the most popular and used medicinal plant. The research of this medicinal plant is continued with different aspects of chemotype determination, cultivation and processing (2,11).

The wild chamomile flowers in the East-Slovakian Lowlands are usual collected and sold by Gypsies to next pharmaceutical processing. The qualitative and quantitative characteristics of essential oil and its composition for these wild chamomile populations were determined. Results were statistically evaluated using a t-test at the 0.05 level and the exploratory analysis are illustrated their variations. The results show that there is a bisaboloxide chemotype of chamomile with a lower content of essential oil.

Additional research work is aimed at the compare of qualitative – quantitative characteristics of dry chamomile flower anthodia and chamomile essential oil coming from experimental cultivation in different areas of the world. The production of secondary metabolites of chamomile essential oil depends on exogenous and endogenous conditions of environs. Qualitative characteristics of essential oil received from different

cultivation areas in the world are genetic determined, however differences from each other depend on mutual interactions between plants and environment.

The quantitative and qualitative composition of chamomile essential oil were determined of a diploid and tetraploid variety after a large-scale distillation. Both the quantity and the constituents of the essential oil were modified by the raw material using: herb or flower-heads respectively fresh or dry. A major factor causing differences in yield of chamomile essential oil may be the time between harvest and distillation, and the variety origin of chamomile plants. Next differences may be have to resulted from using of various harvesting methods, size of green parts, drying and still size.



Picture 7: The Experimental Research Centre of Medicinal, Aromatic & Spices Plants Cultivation in Nova Lubovna.

CONCLUSION

In last years the awareness of therapeutics among the population in the Slovak Republic was investigated. From this investigation it followed that 95 % of those questioned believed in the beneficial effects of medicinal plants. Any way, worldwide demand for medicinal and aromatic plants and for products derived of them is permanently increasing. This is well documented in one of our old proverbs: „*There is not plant without use*“ and our prosperous work can decisively contribute the exploitation of the properties of the single plants to benefit mankind. In regard to this predication and the valuable experiences the production of medicinal and aromatic plants in Slovak Republic has a big perspective.

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