

INTRODUCTION AND PHYTOCHEMICAL ANALYSIS OF MEDICINAL AND AROMATIC PLANTS IN VYTAUTAS MAGNUS UNIVERSITY 1924-2018

Ona RAGAŽINSKIENĖ^{1*}, Audrius Sigitas MARUŠKA², Lina Danutė ZUTKIENĖ³

¹Sector of Medicinal and Aromatic Plants of Botanical Garden at Vytautas Magnus University, Lithuania

²Instrumental Analysis Open Access Center, Faculty of Natural Sciences, Vytautas Magnus University, Lithuania

³Vytautas Magnus University Institute of Foreign Languages; Kaunas, Lithuania

*Corresponding author: ona.ragazinskiene@vdu.lt

Abstract

Medicinal (aromatic) plants (MAPs) are playing an important role for the solution of World Health Organization Problem *Health for everyone in 21st Century*. In Lithuania, since 1924 until, medicinal plants collections have been developed in the Sector of Medicinal and Aromatic Plants in Botanical Garden at Vytautas Magnus University (SMAPs BG VMU). In Europe unique collection of MAPs is a base for scientific researches, project-based activities, national and international studies and the object of public education. The topics and tendencies of the research on medicinal herbs have varied since that time quite a lot. Collections of medicinal plants are still an important constituent and object of the phytochemical scientific research process. The methods of chemical investigations have been changing during the distinct research periods (1st – 1924–1949, 2nd – 1949–1984, 3rd – 1984–1999, 4th – 1999–2018). The main objective of research is the introduction and phytochemical investigation of MAPs. Biodiversity of plant resources, scarce information on biologically active compounds and their properties in many species including those naturally growing in Lithuania or introduced, as well as increasing demand for natural food, food supplements and homeopathic medicine have been the main motivation aspects of the ongoing study. MAPs are sources of raw materials, required in pharmacy and phytotherapy are a part of genetic resources of Lithuania. Phenological observation, phytochemical investigation of raw material of MAPs from SMAPs BG VMU revealed that new species from foreign and local flora can be successfully introduced in Lithuania. Lithuania has good growing conditions for a great variety of MAPs.

Keywords: *Medicinal and aromatic plants, introduction, phytochemical analysis, Lithuania*

Introduction

In addressing the issue of the development of high-quality, healthy and environmentally-friendly food technologies raised by the World Health Organization in the European Health Policy document "*WHO Traditional Medicine Strategy 2013-2023*" and in the priority research, the variety of MAPs, rational, sustainable use of them is promoted.

Recently, more and more attention has been paid to the biological properties of introduced as well as local flora plants, their cultivation, medicinal plant raw materials and their phytochemical research (Briskin, 2000). In accordance with the requirements of the World Health Organization and Good Manufacturing Practice, medicinal plant raw materials and plant products must comply with safety, efficacy and stability parameters (GASP, 2003; Ph. Eur., 2013;).) MAPs grown in industrial plantations can control and ensure the good quality of medicinal plant material: by conducting plant biological tests, standardizing cultivation conditions, determining the optimum time of preparation of medicinal plant raw materials, drying and other conditions. Now and in the future it is necessary to study the biological properties of the introduced plants, expand the range of these plants, increase their biological diversity and accumulate national genetic resources (Radušienė and Janulis, 2004; Motiekaityte, 2006). For this purpose, since 1924 in the climate conditions of the Republic of

Lithuania, research on the introduction of medicinal plants and herbs has been carried out at SMAAPs BG VMU. Based on national and international complex, interdisciplinary research, a collection of medicinal plants has been developed, which is the subject of studies and research. In 1924-2018, the collection of medicinal plants, research issues and research trends in individual periods (1st - 1924-1949, 2nd - 1949-1984, 3rd - 1984-1999 and 4th - 1999-2018) changed, but the main tasks have remained significant, preparing scientific recommendations for medicinal plant growers and pharmaceutical raw material processing companies (Juknevičienė and Juronis 2000; Ragažinskienė *et al.*, 2007).

The *aim of this work* is to carry out the long-term (1924-2018) scientific activities in researching the introduction of MAPs, as well as summarizing and evaluating scientific issues and developments.

The aim of the research was to carry out a retrospective analysis of the chemical composition of MAPs, in separate periods: 1st - 1924-1949, 2nd - 1949-1984, 3rd - 1984-1999 and 4th - 1999-2018 during plant introduction period, *ex situ* long-term outdoor collections at SMAAPs BG VMU in Central Lithuania.

Material and Methods

The object of the research is the development of studies and methods of MAPs their introduction and chemical composition in separate periods. The retrospective analysis of the explorations and methods of chemical composition of prospective MAPs and hop varieties was performed by theoretical descriptive method using scientific publications and reports as well as archival data of Botanical Garden of Vytautas Magnus University (Juknevičienė and Juronis, 2000; Maruška and Kornyšova, 2006; Ragažinskienė *et al.*, 2007; Ragažinskiene and Rimkienė, 2003; Stankevičius *et al.*, 2011). MAPs research is carried out according to the scheme presented in Fig. 1.

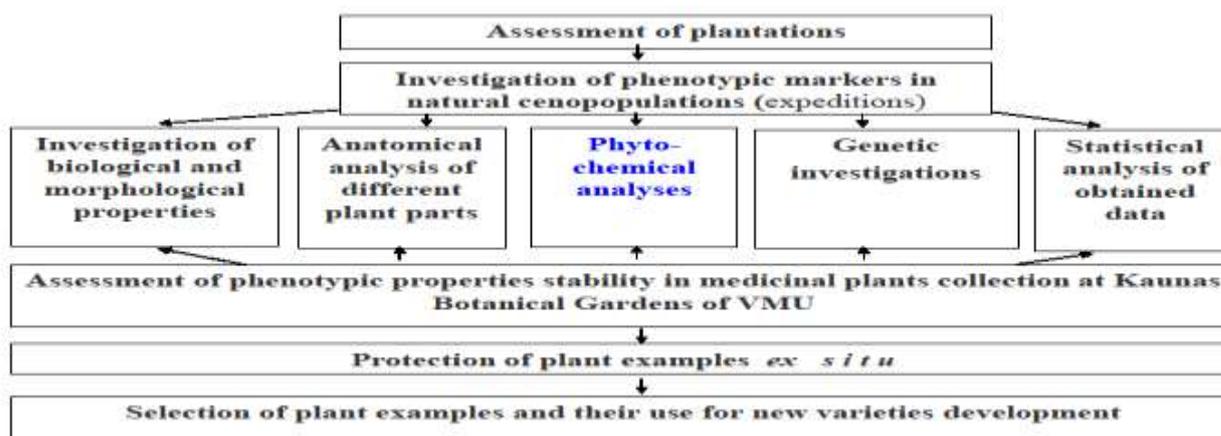


Fig. 1. Schema and Methods of the Introduction and Phytochemical Investigation of MAPs.

Results and Discussion

Retrospective analysis of the development of scientific research on the chemical composition of prospective MAPs. There were four research periods of chemical composition of medicinal (aromatic) plants: the 1st (1924-1949), the 2nd (1949-1984), the 3rd (1984-1999) and the 4th (1999-2018), which took place in the field of plants during introduction, *ex situ* field collections, at SMAAPs BG VMU, Central Lithuania. This analysis highlighted the

development of research methods for plant chemical composition at separate periods and the possibility of using medicinal (aromatic) plants and their raw material.

During the 1st period chemical composition of the medicinal, technical and forest medicinal plants and medicinal herbs was carried out in the time of the introduction. 224 plant species accumulated in the collection of medicinal plants, the chemical composition of which is the quantitative analysis of essential oils, was carried out by hydro distillation. These studies supported the selection of 77 viable plant species and their cultivation in Lithuania (Grybauskas, 1954).

During the 2nd period phytochemical laboratory was founded. The chemical composition of medicinal, technical, oil, fermentation plant was investigated - the amount of essential oils by hydrodistillation method, their quality by gas chromatography, during plant introduction. The research direction was "*Sustainable use of the plant world and their protection biological bases*". During this period, the following collections of plants were created and equipped: medicinal plants, hops, rare vegetables, spice and honey plants (Penkauskienė and Rimkienė, 1991).

The 3rd period carried out research in *The consistent of functionality of variety and phytocyanosis and their sustainable use in the improvement of feed*. During this period, the chemical composition of MAPs was investigated: the amount of essential oils - by hydrodistillation method – for arotherapy for sanatorium treatment. The quality of the medicinal plant raw material was evaluated: the qualitative analysis of flavonoids and phenolic carboxylic acids was carried out using a plane paper chromatography method. Flavanols and leaven were determined quantitatively in the terrestrial and underground parts of the plant by colorimetric methods, nitrates were titrated using ionometric methods and ascorbic acid was evaluated titrimetrically. Also, the sum of oxycinamines was calculated by recounting the chicory acid. All chemical analysis data was counted for an absolutely dry raw material (Juknevičienė and Juronis 2000; Penkauskienė and Rimkienė, 1991).

Field of research of **the 4th period** investigations of MAPs diversity and their introduction, assessment of raw material and rational, sustainable use in medicine, food industry and veterinary.

The value of medicinal plant collections. Since 1924 the pharmacognomic principle has been the development of a long-term inventory and documented collection of medicinal plants. It has already introduced 594 plant species belonging to 373 genera and 88 families. This collection contains 31 rare and endangered species of medicinal plants in Lithuania. Based on long-term introduction and chemical properties, more than 128 species of MAPs have been investigated for the status of Lithuanian national genetic resources. 54 medicinal plant species are on the list of plant genetic resources (ANGI). The 25 varieties and forms of hops are included on the list of medicinal plants and aromatic plant field collections that are assigned to Lithuanian plant genetic resources. Studies were carried out on the basis of the project "*Plant Genetic Resources Research 2000-2008*" (Grant No. 12) of the Ministry of Education and Science of the Republic of Lithuania (Ragažinskienė *et al.*, 2007; 2010; Ragažinskienė and Rimkienė, 2003).

There is an exchange of medicinal plant seeds with more than 400 Botanical Gardens from different countries.

Scientific activity. Medicinal plants in collections are the subject of scientific research. Here, complex, innovative, interdisciplinary, interdisciplinary scientific work is being carried out for research of biologically active substances of medicinal (aromatic) plants together with Instrumental Analysis Open Access Center of Faculty of Natural Sciences at Vytautas Magnus University on the basis of scientific projects (Kaškonienė *et al.*, 2011; Maruška and Kornyšova, 2006; Maruška *et al.*, 2010; Stankevičius *et al.*, 2011).

The study of the methods of preparation of the medicinal plant raw material and the improvement of the drying technology in the medicinal plant raw material determined the dependence of the content of the bioactive substances – essential oils and flavonoids on the conditions of drying (natural ventilation, air velocity and flowing air flow and temperature), which are selected according to the plant's composition of the raw material components (leaves, stems, grass) and the groups of biologically active substances (Kaškonienė *et al.*, 2011; Maruška *et al.*, 2010).

Based on the research of these plants, 37 medicinal plant species which are promising for the pharmaceutical and food industry have been selected: *Achillea millefolium* L., *Agrimonia eupatoria* L., *Alchemilla vulgaris* L., *Althaea officinalis* L., *Angelica archangelica* L., *Arctium lappa* L., *Arnica chamissonis* Lessing., *Arnica montana* L., *Aronia melanocarpa* (Michx.) Elliott, *Artemisia absinthium* L., *Bidens tripartita* L., *Borago officinalis* L., *Calendula officinalis* L., *Chamaemelum nobile* (L.) All. = *Anthemis nobilis* L., *Convallaria majalis* L., *Melissa officinalis* L., *Mentha piperita* L., *Echinacea purpurea* (L.) Moench, *Echinacea pallida* (Nutt.) Nutt., *Glycyrrhiza glabra* L., *Geranium macrorrhizum* L., *Hyssopus officinalis* L., *Humulus lupulus* L., *Inula helenium* L., *Juglans regia* L., *Leonurus cardiaca* L., *Nigella damascena* L., *Nigella sativa* L., *Origanum vulgare* L., *Perilla frutescens* (L.) Britton, *Potentilla erecta* (L.) Raeusch., *Potentilla fruticosa* L., *Rhaponticum carthamoides* (DC.) Iljin, *Schisandra chinensis* (Turcz.) Baill., *Scutellaria baicalensis* Georgi, *Viola tricolor* L.

The research findings are presented in monographs, scientific and popular science articles, national and international scientific conferences and recommendations (Bartkienė *et al.*, 2015; Ligor *et al.*, 2014; Šulniūtė *et al.*, 2017; Venskutonis *et al.*, 2007).

Scientific knowledge for herbalist business. In the area of herbal development there is cooperation with rural communities. The geographic regions of Lithuania, under various ecological conditions, have been equipped with collections of medicinal plants and testing areas for their cultivation. In addition, scientific methods for the preparation of medicinal (aromatic) plants and medicinal plant raw materials have been introduced. A modern herbal dryer was developed, using alternative solar energy: the European Agricultural Fund for Rural Support Project: Lithuanian Rural Development Programme 2007-2013 project "Cultivation of medicinal plants and innovative technology using of solar energy for preparation medicinal plant raw materials" (Grant No. 1 PM-PV-10-1-003015-PR001 (2011-2014) (Raila *et al.*, 2009; Maruška *et al.*, 2014).

Legislative justification for science and business. Participating with the Ministry of Health of the Republic of Lithuania in the legislative process, starting from 2013, *Supplemental and Alternative Health Care Act* is being developed.

Conclusion

Introduction studies of medicinal, (aromatic) plants have been carried out at Vytautas Magnus University since 1924.

In the 1st collection, 77 (out of 224) promising medicinal plant species were selected by investigating their chemical composition with hydrodistillation method.

The 2nd period founded the phytochemical laboratory, and the chemical, technical, oil, tartar chemical composition (essential oil content) was investigated by distillation method, their qualitative composition was determined by the gas chromatography method.

The 3rd (1984 – 1999) Chemical composition of medicinal (aromatic) plants: the amount of essential oils was investigated by hydrodistillation method. The quality of the medicinal plant raw material was evaluated: the quality of flavonoids and phenolic carboxylic acids was determined by plane paper chromatography, quantitatively flavonols and leaven - colorimetric, nitrates - by the ionometric method.

During the 4th period the following methods and apparatus are used for the evaluation of the chemical composition of MAPts and hop varieties: the amount of essential oil is determined by methods of hydro-distillation, super-liquid extraction and carbon black microextraction, their qualitative composition - gas chromatography and mass spectrometry, phenolic compounds – effective liquid chromatography, standard spectrophotometry and capillary electrophoresis, the activity of binding of free radicals to plant extracts was evaluated spectrophotometrically, the antioxidant and radical components of the individual extracts.

References

- Bartkienė E., Mozūrienė E., Juodeikienė G., Žadeikė D., Maruška A., Stankevičius M., Ragažinskienė O., Čižeikienė D. (2015). Pork meat products functional value and safety parameters improving by using lactic acid fermentation of savory plants. *Journal of food science and technology*, Vol. 52, Iss. 11, p. 7143-7152.
- Briskin D.P. (2000). Medicinal Plants and Phytomedicines. *Linking Plant Biochemistry and Physiology to Human Health*, Plant Physiology, 124. 507-514.
- European Pharmacopoeia 8.0, (2013). Strasbourg.
- Grybauskas K. (1954). Vaistingųjų augalų auginimas ir atranka LTSR Mokslų akademijos Botanikos sode. *Lietuvos TSR Mokslų akademijos Biologijos instituto darbai*. 2, 123–149.
- Juknevičienė G, Juronis V. (2000). Medicinal plants Collections of Kaunas Botanical Garden of Vytautas Magnus University. Kaunas.
- Maruška A, Kornjšova O. (2006). Application of monolithic (continuous bed) chromatographic columns in phytochemical analysis. *Journal of Chromatography A.*, Vol. 1112(1-2), 319–330.
- Maruška A, Prosevičius J, Bimbraitė-Survilienė K, Kornjšova O, Ragažinskienė O, Ratautaitė V. (2010). Comparison of phytochemical composition of medicinal plants by means of chromatographic and related techniques. *Procedia Chemistry*. Vol. 2(1), 83–91.
- Maruška A., Ragažinskienė O., Vyšniauskas O., Kaškonienė V., Bartkuvienė V., Kornjšova O., Briedis V., Ramanauskienė K. (2014). Flavonoids of willow herb (*Chamerion angustifolium* (L.) Holub) and their radical scavenging activity during vegetation. *Advances in medical sciences*. Vol. 59, Iss. 1, 2014, 136-141. <https://doi.org/10.1016/j.advms.2013.10.002>
- Kaškonienė V, Kaškonas P, Maruška A, Ragažinskienė O. (2011.) Chemical composition and chemometric analysis of essential oils variation of *Bidens tripartita* L. during vegetation stages. *Acta Physiologiae Plantarum*. Vol. 33(6), 2377–2385.
- Ligor M., Stankevičius M., Wenda-Piesik A., Obelevičius K., Ragažinskienė O., Stanius Ž., Maruška A., Buszewski B. (2014). Comparative gas chromatographic–mass spectrometric evaluation of hop (*Humulus lupulus* L.) essential oils and extracts obtained using different sample preparation methods. *Food analytical methods*. 7(7), 1433-1442. <http://link.springer.com/article/10.1007/s12161-013-9767-5>
- Penkauskienė E, Rimkienė S. (1991). Ecological and biological characteristics of wild and cultivated sorts of officinal plants of Lithuania. Monograph. Vilnius.
- Raila A, Lugauskas A, Kemzūraitė A, Zvicevičius E, Ragažinskienė O, Railienė M. (2009). Different Drying Technologies and alternation of Mycobiots in the Raw Material of *Hyssopus officinalis* L. *Annals of Agriculture and Environmental Medicine*, Vol. 16, 93–101.
- Ragažinskienė O, Bumblauskienė L, Šeinauskienė E, Praškevičius A, Janulis V. (2007). Multiannual dynamics of *Perilla frutescens* (L.) Britton terraneous part productivity and increment during vegetation cycles in Middle Lithuania. *Ekologija*. Vol. 53(3), 45–50.

- Ragažinskienė O, Lapinskienė N, Kornyšova O, Maruška A. (2008). Introdokavimo metodų taikymas vaistinių augalų biologinėms savybėms nustatyti. Jaunųjų mokslininkų darbai. T. 3(19), 113–117.
- Ragažinskienė O, Rimkienė S. (2003). Medicinal and aromatic plants: genetic resources and cultivation in Lithuania. *Journal of Medicinal & Spice Plants*. Vol. 8(4), 189–191.
- Stankevičius M, Akuneca I, Jacobsone I, Maruška A. (2011). Comparative analysis of radical scavenging and antioxidant activity of phenolic compounds present in everyday use spice plants by means of spectrophotometric and chromatographic methods. *Journal of Separation Science*, Vol. 34, 1261–1267.
- Šulniūtė V., Baranauskienė R., Ragažinskienė O., Venskutonis PR. (2017). Comparison of composition of volatile compounds in ten *Salvia* species isolated by different methods. *Flavour and fragrance journal*, Vol. 32(4), 254–264. <http://onlinelibrary.wiley.com/doi/10.1002/ffj.3389/epdf>
- Venskutonis R, Škėmaitė M, Ragažinskienė O. (2007). Radical scavenging capacity of *Agrimonia eupatoria* and *Agrimonia procera*. *Fitoterapia*. Vol. 78(2), 166–168.
- WHO Guidelines on Good Agricultural and Collection Practices (GACP) for Medicinal Plants. (2003), WHO, Geneva.
- WHO traditional medicine strategy: 2014-2023. (2013). WHO.