Bulletin of the*Transilvania* University of Braşov
Series II: Forestry•Wood Industry• Agricultural Food Engineering• Vol. 10 (59) No.2 - 2017

OVERVIEW OF MOST POPULAR ROMANIAN MEDICINAL AND AROMATIC PLANTS AS POTENTIAL SOURCES OF BIOMATERIALS

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Abstract: *Nowadays, human society search for a balance between multiple socio-economic forces including the consumption, overuse of resources, traditional resource depletion, climatic changes and the approach of renewable resources usage or environmental protection. Exploiting Medicinal and Aromatic Plants (MAPs) as raw material, by-products and waste derived there from, can take advantage of greater collaboration between research and industry, applying the processing systems necessary to treat large volumes of biomass characterized by specific economic values, requiring new processing technologies capable of reducing solvent consumption and increase overall environmental sustainability cycle. The category of biomaterials as raw materials, products and waste from the processing of MAPs is a resource for obtaining: compounds (polyphenols, flavonoids, lysine, inulin and terpenes. etc.), essential oils, substances for pharmaceutical use, dietary supplements, nutraceuticals, cosmetics and personal care products for plant protection/crop plants. These can be used as a resource for non-food industries such as the production of biofuels, preparation of vegetable polyesters and biopolymers, rubber and textiles. In conclusion, the use of biomaterials and MAPs subsumed them represent a direction that brings the balance to some extent sought or at least pave the way towards this balance.*

Key words: *Medicinal and Aromatic Plants (MAPs),biomass,biomaterials.*

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1. Introduction

The whole world is full of herbs and plants, which are used in all areas starting with the classics ones and continuing with the complex and more advanced domains nowadays, creating a bridge between humans and the environment. Therefore, plants with aromatic properties (aroma, fragrant and sweet-smells) are used in medicinal purposes, and their effects have been tested since the earliest times, each time confirming their benefits and giving them the term of Medicinal and Aromatic Plants (MAPs). Given the usage of MAPs in various areas, recently, their waste materials resulted became of really interest and therefore make the subject of this study. MAPs as *Leonurus cardiaca* L., *Amaranthus caudatus* L., *Plantago media* L., *Apium graveolens* L., *Ocimum basilicum* L., *Origanum vulgare* L., *Mentha x piperita* L., *Helianthus tuberosus* L. are popular in Romania and are present in this work due to the reach compounds found in raw materials, by-products and waste from their processing.

Leonurus cardiaca L. (motherwort) is a medicinal and aromatic plant (MAP) derived from *Lamioideae* subfamily and *Lamiaceae* herb family. This plant was described by Herodotus in the 5th century B.C. spread all over Romania [5].

Amaranthus caudatus L. (foxtail amaranth) is one of the most important cultivated species nowadays in Romania, part of *Amaranthiodae* subfamily and *Amaranthaceae* family. *Plantago media* L. (hoary plantain) is a MAP part of *Plantaginaceae* family that can be found all over Romanian wet grasslands [5], [6], [8], [15], [24].

Ocimum basilicum L. (commonly known as „sweet basil") is an herbaceous and annual plant, from *Lamiaceae* family, widely grown in different parts of Asia, Africa, America and Europe. In Romania, it is growing in all the regions, especially in southern and south-western parts of the country. *Apium graveolens* L. (commonly known as „celery") is a MAP species in the family *Apiaceae* and is among the most frequently used spices in Romanian cuisine.

Mentha x piperita L. (peppermint) is MAP species in the family *Lamiaceae* that grows in entire Romanian territory and it is used as food spice as well as for therapeutic activities as antimicrobial, antifungal, cytostatic [12], antispasmodic, tonic, vasodilator, digestion promoter (stimulates liver, gall bladder, kidney) and respiratory disorders [22]. *Origanum vulgare* L. (oregano) is a MAP part of *Lamiaceae* family with predominant presence in south of Romania. *Helianthus tuberosus* L. (Jerusalem artichoke) is a MAP part of *Asteraceae* family, found in Romania (mainly in crop) and it is well-known for its polysaccharides, oligosaccharides, coumarins, polyacetylenes, inulin and sesquiterpenes contents.

2. Materials and Methods

This paper represents a short overview of the published literature data regarding the use of selected medicinal and aromatic plants that can be found on Romanian territory (*Leonurus cardiaca* L., *Amaranthus caudatus* L., *Plantago media* L., *Apium graveolens* L., *Ocimum basilicum* L., *Origanum vulgare* L., *Mentha x piperita* L., *Helianthus tuberosus* L.) for the obtaining of valuable bio-materials.

This paper is intended to help readers discover the potential of the selected plants for obtaining innovative biomaterials. The literature data reviewed comprised of technical studies published as scientific journal articles, books, theses and reports; the relevant information was searched

through various electronic databases or publisher's archives (Science Direct, Springer, Taylor and Francis, MEDLINE, Scopus and Google Scholar) using keywords such as "medicinal plants"; "aromatic plants"; "biomaterials", "extraction techniques", scientific name of the plants, etc. The focus of the search was on the last decade. As it is not possible to incorporate all the information recovered, we selected information that could be easily accessible to researchers, highly relevant for the selected topic and belonging to trusted scientific sources. Due to space limitations, a number of 40 papers were selected to be presented, mainly presenting Romanian or Balkan plant varieties. Where such results were not available, studies on varieties from the rest of the world are presented. Also, a survey of the bio-products available on the Romanian market based on the selected medicinal plants was performed.

The vegetal materials used for the extractions can cover all parts of the plants, while the extraction techniques mostly encountered are ultrasound-assisted extraction [2], microwave-assisted extraction (MAE) [2], supercritical carbon dioxide (SC-CO2) extraction [15], [35], liquid–liquid extraction (LLE) [12] and pressurized liquid extraction (PLE) [23].

The usual methods of analysis encountered are represented by the UV/VIS spectrophotometry [4], [13], [29], [27], liquid chromatography–mass spectrometry (LC-MS/MS) [23], high-performance liquid chromatography with electrospray ionization mass spectrometry (HPLC-ESI-MS) [30], chemiluminescence analyses [16], high-performance thin-layer chromatography (HPTLC) [1], high-performance liquid chromatography (HPLC) [13], [17], [20], gas chromatography–mass spectrometry (GC-MS) [3], [12], high-performance liquid chromatography-mass spectrometry (HPLC-MS) [29], [30], thin layer chromatography (TLC) [3] and a series of tests carried to establish the properties of the obtained materials, such as the Folin-Ciocalteu method [1], [4], [29], determination of the antioxidant properties using the free radical diphenylpicrylhydrazyl (DPPH) assay [1], [4], [13], [20] etc.

3. Results and Discussions

Biomaterials that can be obtained from plants are: essential oils, substances for pharmaceutical use, dietary supplements, nutraceuticals, pigments and dyes, cosmetics and personal care, products for plant protection/crop plants. Biomass residues and wastes are a renewable energy and raw mate-rials easy to find in nature as a good option for fossil resources as chemical and fuel production.

Helianthus tuberosus L. is a viable biorefinery crop [16] due to its high content in valuable components (especially inulin and sugars), for the development of high value products with medical applications [16]. Its potential use also covers the production of bio-ethanol, through the fermentation of the Jerusalem artichoke hydrolysates [26] or by an innovative one-step fermentation, as proposed by [9]. Jerusalem artichoke components can also be found in a series of pharmaceuticals available on the Romanian market (i.e. Redigest Plus, Alphalpha Complex, Condartroz-Plus and Hof.Lipomin).

The vegetal products from *Apium graveolens* L. are the fruits, roots and leaves, with a rich chemical composition such as volatile oils, vitamins B1, B2, C, carbohydrates, proteins, fats, carotenoids, flavones glycosides, bitter principles, monoterpenes (myrcene, α limonene, α and β pinene etc.) in significant quantities, sesquiterpenes, (β-cariophyllene, α and β-

selinene etc.) representing a very valuable industrial crop [19], [32].

Spiridon et al. [31] describes the incorporation of biomass fibres recovered from celery root wastes into a polylactic acid matrix, thus obtaining innovative green materials; the obtained material showed a high sorption capacity and an increased specific surface, compared with the polymer. [34] describes the potential use of celery extract as a bio-herbicide (by determining the influence of the aqueous extract on the seeds germination of several species). Celery components can be found in several therapeutic recipes in hospitals [10] and bio-products found on the Romanian market (i.e. Activmod Plus Medicin®, Protein Power) [10].

Biopolymers packed like amylose and amylopectin forms the natural plant polymer named starch, found in *Amaranthus caudatus* L. grains, is used for obtaining the biodegradable starch based products such as wound dressings in the regeneration of skin, vascular and cartilage regeneration, carrier or drugs or hormones in delivery system and have in vitro biocompatibility with 3T3 fibroblast cells [36]. SC-CO_2-based bio-refineries are important pillars for producing bio-fuels by grains from plants (*A. caudatus*) and waste streams increasing the bioeconomy and decreasing the energy requirements [9]. *A. caudatus* is a potentially source of bioactive chemicals founded in pharmaceutical and food industries or some daily dietary regimes because of his rich content of lysine, as found by Vujacic et al. on a study of 10 amaranth genotypes [38], and a source of hevein-like peptides with 6 cysteine residues containing Ac – AMPs (antimicrobial peptides) which includes inhibition fungal growth properties, as presented by [18]. About 50% of *Amaranthus*'s seed proteins at maturity are globulin and albumin and are different types of it that contains vitamin C, nitrogen and minerals, being an important source of biomaterials such as red food colorants, antioxidants and valuable phytochemicals [7]. In the Romanian market, this MAP is found in the composition of several pharmaceuticals (tablets Fiamarant, Antioxidant Complex and Reglacid).

The chemical compositions of aerial parts of *Ocimum basilicum* L., such as volatile oil (especially linalool, estragol and eugenol), hydroxycinnamic acid derivatives (rosmarinic acid), flavonoids (quercetin and kaempferol glycosides, xanthomicrol and salvigenin) and triterpenes (ursolic and oleanolic acids) are responsible for the antimicrobial, diuretic, and digestive-stimulative properties of the drug [3], [4], [13], [33]. [39] presented application of volatile oils (obtained by hydrodistillation) of two *O. basilicum* population as potential antimicrobial and anti-fungal bio-material. [25] developed innovative biomaterials by coating *O. basilicum* on different polymeric supports and tested them for prevention of bacterial adhesion (*Staphylococcus aureus*, *Staphylococcus epidermidis*, *Escherichia coli* and *Pseudomonas aeruginosa*) and biofilm formation and biofilm formation [25]. In the Romanian market, *O. basilicum* is found in the composition of several pharmaceuticals (i.e. Natural Detoxifying Complex).

Mentha x piperita L. is used widely for flavouring a lot of bioproducts in food, cosmetic and pharmaceutical industry like chewing gum, candies, mouthwashes or toothpaste [10], [12] also in clinical aromatherapy [22] and biocosmetic industry [10].

These widespread use is due to *M. piperita*'s complex composition in bioactive compounds as monoterpenoids (p-menthone, iso-menthone, limonene, menthol, carvone, cis-piperitoneoxid, 1, 8-cineole) [12]. [28] recently proposed the

use of peppermint essential oil in a bio-compound used for the preservation of stored minced beef meat. In the Romanian market, pepper-mint compounds are found in the composition of several pharmaceuticals (i.e. Natural Detoxifying Complex and Catinofort).

The main compound of *Origanum vulgare* L. used in food and pharm industries (for its well-known antioxidant and antibacterial activity) is the plant's essential oil rich in phenolic and flavonoid compounds [20]. There is used *O. vulgare* compounds, with cellulose, as edible biofilms for life extenders of food bioproducts [37]. This plant has high antioxidant activity due to its high value of total phenols [1], [29], [30], [16] (rosmarinic acid, luteolin-7-O-glucuronide, luteolin, syringic acid). Main compounds present in *O. vulgare* essential oil are phenolic monoterpenes, carvacrol and thymol. *O. vulgare* is used as food spices and for medicinal purpose as antimicrobial, antiseptic, expectorant and digestive activity [20] and part of several pharmaceuticals (i.e. Evitus and Natural Salicylol).

Leonurus cardiaca L. and *Plantago media* L. plants, even though under-used, have a hyper diversified biological activity therefore studies showed its presence in different biomaterials used as treatment like tincture, infusion, alcoholic liquid extract or dry extract [40].

Flowers and twigs from *L. cardiaca* are rich in biologically active substances like essential oils, flavonoids, vitamins, polyphenolic acids, carbohydrates and are used to treat various disorders as hypertension, lung diseases, digestion [5], hypertiroidism, bronchial asthma, amenorrhoea, hypotonic and sedative effects, gynaecological disorders, skin abrasions or burns the plant has important sec-ondary compounds as iridoids, clerodane, furanolabdane, labdane, ursolic acid, oleanolic acid, lavandulifolioside, stachydrine, leonurine, known for its possible cardioactive principle that is absent in the fruits of L. cardiaca, flavonoids, phenolic acids, volatile oils, sterols and tannins [1], [17], [40]. Furthermore, this MAP in Romania is found in the composition of several pharmaceuticals (i.e. cap-sulesAntistres, Antistres D Tea or Hyper-Antistres and tablets Passisclerotin) [10].

The leaves from *P. media* are used in medicine to treat various disorders as atherosclerosis, laryngitis, stomatitis, hyperacidity gastritis and bleeding [5]. It is a rich source of aucubin and its derivatives [14]. The review paper of [11] exhaustively presents the characteristics and potential applications of several *Plantago* species, including *P. media*, while [21] mentions the antifungal potential of *P. media* bio-materials obtained through extraction. In Romanian market is found in the composition of several pharmaceuticals (i.e. Tusimun potion).

4. Conclusions

Most of selected plants in our study, commonly found in Romania, and used medicinally, industrial or alimentary are basic pillars for biomaterials world. Plants that contain large amounts of oils (*Mentha x piperita* L., *Ocimum basilicum* L. and *Origanum vulgare* L.) are often used for their antibacterial properties. Also, these three MAP plants are used in cosmetic and fragrance industries for their essential oils.
Plants as *Amaranthus caudatus* L. and *Helianthus tuberosus* L. are dominants for their applications in biorefineries and plants as *Ocimum basilicum* L., *Apium graveolens* L., *Plantago media* L., *Leonurus cardiaca* L., *Origanum vulgare* L., *Mentha x piperita* L. for their biomedical application as biomaterials. Also, wastes obtained after the extraction

of the active principles from all the selected plants can be considered a very good raw material of cellulose.

All the MAP plants studied are vegetal materials or biomaterials used as invaluable resources in people's life and are inexhaustible raw material resources for pharmaceuticals, medicine, agriculture, cosmetics, bio-fuels and food industries at high levels.

Acknowledgments

The authors gratefully acknowledge the support obtained through the project SusMAPWaste, SMIS 104323, Contract No. 89/09.09.2016, from the Operational Program Competitiveness 2014-2020, project co-financed from the European Regional Development Fund.

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