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GET IN BUSSINES WITH THE PLANTS WASTE

Raluca PENU[1], Andrei Valentin HOLBAN[1], Victor Andrei GERGELY VARGA[1], Simona SPÎNU[1], Ionuţ MORARU[2]

Scientific Coordinator: Assoc. Prof. PhD Alina ORŢAN

[1]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăşti Blvd, District 1, 011464, Bucharest, Romania.
[2]SC Laboratoarele Medica SA, Otopeni, Romania

Corresponding author email: holban_andrei123@yahoo.com

Abstract

All over the world, especially in countries with a very strong tradition in cultivating medicinal plants, production of bio-products based on natural compounds leads to the transformation of plants in large quantities of waste, mostly unexploited. The majority of the wastes are underutilized and may cause severe environmental problems if not properly handled. Lack of cheap technological solutions for biochemical and organic remediation that could achieve gradual adaptation to environmental standards of generating pollution entities and macro-entities is the main obstacle that hampers implementation of European environmental directives. Valorization of these compounds from plants waste not only reduces environmental concerns but also improves sustainability and economic competitiveness of agro-food industries. The present paper represents a short review of the possible ways of valorization of plants waste such as lavender, mint and sage into value - added by – products.

***Key words**: lavender, mint, sage, valorisation, waste.*

INTRODUCTION

Several experiments have been carried out over time to highlight the relative performance of waste in many areas, but the interest of the researchers has focused considerably on the sustainable valorisation of plant waste, especially medicinal and aromatic plants.

The aim of the present work is a review using public domain literature on the sustainable valorisation of vegetable waste such as lavender waste (Figure 1), sage waste (Figure 2) and mint waste (Figure 3), a set of herbal and medicinal herbs with multiple applications.

Lavender (*Lavandulaangustifolia L., Lavandula latifolia L.*) , Mentha (*Menthapipperita L., Menthaarvensis L.*) and Sage (*Salvia Officinalis L.*) are part of the Lamiaceae family and lately in Romaniathe crops of these plants have grown.

Phenolic compounds are bioactive compounds with essential benefits, especially in health, therefore vegetal waste is maximal exploited to recover the entire phenols using as many as possible green extraction techniques.

Figure 1. Lavandulaangustifolia L. waste (stems and leaves) (left) and herbal (flower) (right)

Figure 2. Salvia officinalis L. waste (stems)

Figure 3. Menthapiperita L. waste (stems)

EXTRACTION AND IDENTIFICATION METHODS OF TARGETED COMPOUNDS FROM SELECTED PLANT WASTE

Essential oil of lavender leafy stems (*'Blue River'* and *'Ellegance Purple'* varieties) (Adaszyńska-Skwirzyńska et al., 2014) was extracted by hydrodistillation (Deryng's apparatus) and studied by Gas Chromatography-mass spectrometry (GC-MS) (Agilent 6890, Column HP-5MS 30m, 0.25mm, 0.25μm) in order to identify the chemical composition (main compounds are borneol, caryophyllene oxide, epibicyclosesquiphellandrene, eucalypt-tol, linalool,geraniol acetate and β-pinene), the total flavonoids content (expressed as mg quercetin equivalents / 100g dry weight and extracted with acetone, HCl, ethyl acetate as extraction solvents) by spectrophotometer and sesquiterpene acids (valerenic and acetoxyvalerenic acids using methanol as extraction solvent) by HPLC Chromatography (Shimadzu chromatograph, SPD-M20A detector, UV-Vis). Also, total phenolics (Folin–Ciocalteu reagent) and flavonoids (aluminium chloride method) content from lavender leafy stalks (*Lavandulaangustifolia* - 'Blue River' and 'Ellagance Purple) was identified by UPLC-ESI-MS device (Adaszyńska-Skwirzyńska et al., 2017).

Méndez-Tovar et al. (2015)conducted a study of determination of total phenolics content (Folin–Ciocalteu method) and antioxidant activity (1,1-Diphenyl-2-picryl-hydrazylhydrate (DPPH) and ferric reducing antioxidant power (FRAP) methods) from *Lavandulalatifolia* waste material obtained after removing the essential oils through distillation and from spike lavender waste; using HPLC (Agilent Technologies 1200 series /DAD/ ZORBAX Eclipse XDB-C18 column (150 mm × 4.6 mm i.d., 5 μm)).

In *Lavandulaangustifolia* waste extract with 70% ethanol, performed by ultrasound-assisted extraction method (VWR, Malaysia; 45 kHz, 30 W); was elaborate protein identification by Kjeldahl method with automated nitrogen analyzer (UDK152 VelpScientifica); total polyphenol and flavonoid content (Folin-Ciocalteu method and Al(NO3)3 reagent for flavonoids); and antioxidant activitiy (DPPH, FRAP, ORAC (Oxygen Radical Absorbance Capacity) and HORAC (Hydroxyl Radical Averting Capacity)) (Vasileva et al., 2018).

Has been reported that lavender (*Lavandulaangustifolia L.*)wastes from essential oil industry (steam distilled lavender - SDL) and subcritical CO2 extraction of lavender (CO2-L) showed high antioxidant activity (ORAC, DPPH, FRAP and HORAC methods), polyphenol and flavonoid content (Agilent 1220 HPLC system/ Agilent TCC18 column /5 μm/ 4.6 mm x 250 mm) and aroma metabolites (Gas Chromatograph Agilent GC 7890/detector Agilent MD 5975/column HP-5ms (30 m/0.32 mm /0.25 μm) (Slavov et al., 2018).

The *Menthaarvensis* waste (distilled lignocellulosic biomass) obtained after essential oils extraction by distilation, was analysed regardingcrystallinity by XRD (X-Ray Diffraction - Rigakudiffractometer/CuKα radiation/40 kV/130 mA); devolatilization by TGA (Thermal Gravimetric Analysis - PerkinElmer instrument, Pyris Diamond TG/DTA) and chemical analysis by FTIR (PerkinElmer make, FT-IR spectrum GX), ICP-MS (PerkinElmer, Optima 530 V) and CHNS (PerkinElmer Elementar CHNS analyzer). More, was developed a new process for the identification and separation of cellulose, hemicellulose and lignin(Prakash et al., 2018).

Sage (*Salvia officinalis L.*) by-product exploitation as sage herbal dust, obtained in filter tea processing, is considered sage waste. This sage waste was the aim of Pavlić et al.

(2018, 2017) studies to analyse essential oil and lipid extracts obtained by hydrodistillation, maceration, Soxhlet extraction, ultrasound-assisted (UAE - EUP540A, Euinstruments, France), microwave-assisted (MAE), subcritical water extraction (SWE - 4848BM, Parr Instrument Company, USA) and supercritical fluid extraction (SFE - HPEP, NOVA, Swiss, Effretikon). They worked for indentification compounds as volatile compounds, terpenes (camphor, γ-terpinene, (+)-limonene, geraniol, eucalyptol, α-terpineol, carvacrol, α-pinene, β-pinene, eugenol, α-thujone, linalool and methyl chavicol, viridiflorol, epirosmanol), polyphenol content (Folin-Ciocalteu method) and total flavonoids (aluminum chloride colorimetric method) through GC–MS (Agilent GC890N - Agilent MS 5759/HP-5MS column 30 m/0.25 mm/0.25μm) and GC-FID (Gas Chromatography with Flame-Ionization Detection).

POSSIBLE APPLICATIONS OF COMPOUNDS SEPARATED FROM SELECTED PLANT WASTE

The essential oils from the lavender leafy stem hasantimicrobial activity (against *Pseudomonas aeruginosa*, *Escherichia coli*, *Staphylococcus aureus and Enterococcus faecalis*) and sedative action (Adaszyńska-Skwirzyńska et al., 2014).Spike lavender waste is a source of natural antioxidants (Méndez-Tovar et al., 2015). Vasileva et al. (2018) investigated *Lavandulaangustifolia* waste effects in bread preparation, functionalization and shelf life.

In the distilled biomass from *M. arvensis* was found a very good glucose content (with *Cellic CTec2* and *T. reesei* enzymes), but also xylose, galactose, mannose and arrabinose (Prakash et al., 2018).

According to Khammour et al. (2018), waste mint is useful even to increase thermal stability characteristics of plywood panel adopting a new adhesive formulation of urea formaldehyde resin, seen by TGA and DSC (Differential Scanning Calorimetry).

Furthermore,Ainane et al. (2014) applied mint waste to bio-adsorb methylene blue from aqueous solution, phenomena characterised by FTIR spectroscope (Vertex 70).

Antioxidant activity proovedsage herbal dust in lipid extracts, determined by DPPH, ABTS (2,2'-azino-bis(3-ethylbenzothiazo-line-6-sulphonic acid)) and FRAPis mainly due to the high content of polyphenols. Moreover, antimicrobial activity tested against gram-positive bacteria as *Staphylo-coccusaureus* ATCC 25923, *Staphyloco-ccussaprophyticusw*, *Bacillus cereus* ATCC11778,*Bacillus cereusw*, *Listeriaivanovii* ATCC 19119, *Listeria monocytogene-sw*, *Enterococcus faecalis* ATCC 19433, *Enterococcus faecalisw* (w- wild strain). Both activities were recorded in extracts obtained by SFE, MAE, UAE, maceration and hydrodistillation (Pavlić et al., 2017).

Antimicrobial and antioxidant activity identified to these plant wastes can be regarded as potential biopreservative agents.

CONCLUSIONS

Medicinal and aromatic plants as lavender, mint and sage have a variety of benefits, therefore the waste obtained after the main usage of them became very valorised due to the fact that are still full of important compounds which can be used in areas as food (addition in foodstuffs), dietary supplements, pharmaceutical purpose, cosmetics, perfumery or other industries.

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