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Solid–liquid extraction of bioactive compounds as a green alternative for developing novel biostimulant from *Linum usitatissimum* L.

Agnieszka Szparaga^{1,2}, Sławomir Kocira^{3,4*}, Ireneusz Kapusta⁵ and Grzegorz Zagula⁶

Abstract

Background The interest expressed by the agriculture in the category of innovative biostimulants is due to the intensive search for novel preparations based on natural substances (i.e. allelochemicals). Scientific research into the design and testing of next-generation biostimulants marks advances for sustainable agricultural production.

Results Our research represents an innovative and comprehensive approach to the use of *Linum usitatissimum* L. seed extracts in soybean cultivation using foliar treatments. A multi-tiered approach was adopted, involving both the assessment of soybean responses at the agronomic, morphological and biochemical levels. It was hypothesized that the extract would improve the growth and yield of soybean through mechanisms based on improved physiological and biochemical processes. The study showed that the extract was rich in micro- and macro-nutrients (in particular potassium and zinc), amino acids (with the largest proportion of glutamic acid), fatty acids (predominant oleic + elaidic acids) and carbohydrates (sucrose and glucose). Soybean responded positively by increased in plant height, number of pods and seed yield. The results confirmed that the tested biostimulant is not only an environmentally friendly product, but also is capable of increasing the growth and productivity of soybeans, thus increasing farmers' profit. The obtained yield was characterized by a lower total proteins pool (average decrease approx. 2%). The extract caused changes in the amino acid profile (especially in the case of proline and lysine) and fatty acid composition (significantly higher content of acids: heptadecanoic, octadecanoic, eicosanoic, eicosapentaenoic, docosanoic, erucic, tricosanoic).

Conclusions All the observations made confirm that the extract positively affected the soybean crop. Based on the study, it was concluded that solid–liquid extraction could be considered as a green alternative for prototyping a novel and ecological biostimulant.

Keywords Flaxseed, Biostimulant, Prototyping, Soybean, Water extraction, Infusion, Partial budget

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High Value Fermentation Products, Volume 1 Saurabh Saran, Vikash Babu, Asha Chaubey, 2019-03-12 Green technologies are no longer the future of science but the present. With more and more mature industries such as the process industries making large strides seemingly every single day and more consumers demanding products created from green technologies it is essential for any business in any industry to be familiar with the latest processes and technologies. It is all part of a global effort to go greener and this is nowhere more apparent than in fermentation technology. This book describes relevant aspects of industrial scale fermentation an expanding area of activity which already generates commercial values of over one third of a trillion US dollars annually and which will most likely radically change the way we produce chemicals in the long term future. From biofuels and bulk amino acids to monoclonal antibodies and stem cells they all rely on mass suspension cultivation of cells in stirred bioreactors which is the most widely used and versatile way to produce. Today a wide array of cells can be cultivated in this way and for most of them genetic engineering tools are also available. Examples of products operating procedures engineering and design aspects economic drivers and cost and regulatory issues are addressed. In addition there will be a discussion of how we got to where we are today and of the real world in industrial fermentation. This chapter is exclusively dedicated to large scale production used in industrial settings.

Extracting Bioactive Compounds for Food Products M. Angela A. Meireles, 2008-12-16 The demand for functional foods and nutraceuticals is on the rise leaving product development companies racing to improve bioactive compound extraction methods a key component of functional foods and nutraceuticals development. From established processes such as steam distillation to emerging techniques like supercritical fluid technology.

Natural Product Extraction Juliana M Prado, Mauricio A Rostagno, 2022-07-20 Natural products are used by the food pharmaceutical and cosmetics industries and extraction technologies and potential applications for plant extracts are of interest to many industrial sectors. Extraction of natural products in an economic and environmentally friendly way is of high importance to all industries involved. The second edition of this book presents an updated holistic in depth view of the more environmentally benign techniques available for the extraction of natural products along with their newest applications and case studies. Conventional and emerging extraction techniques are discussed in detail. New topics include enzymes pulsed electric energy and on line in line analysis. Written for academics and industrialists working in both natural product extraction and green chemistry this new edition provides a valuable update on current trends in the field.

Handbook of Natural Bioactive Compounds Rakesh K. Sindhu, Sumitra Singh, Dinesh Kumar, 2026-03-02 Natural bioactive compounds have a wide range of therapeutic potential. They are the basis for many life saving drugs and have the potential to treat and manage a variety of diseases. Handbook of Natural Bioactive Compounds provides a broad overview of techniques for the extraction isolation and identification of bioactive compounds from natural sources such as plants marine organisms and microorganisms.

WASTES: Solutions, Treatments and Opportunities IV Candida

Vilarinho, Fernando Castro, Margarida J Quina, 2023-09-06 WASTES Solutions Treatments and Opportunities IV contains selected papers presented at the 6th edition of the International Conference Wastes Solutions Treatments and Opportunities that took place on 6-8 September 2023 in Coimbra Portugal. The Wastes conference which takes place biennially is a prime forum for sharing innovations, technological developments and sustainable solutions for waste management and recycling sectors worldwide with the participation of experts from academia and industry. The papers included in this book cover a wide range of topics including Management of waste streams, Environmental, economic and social aspects in waste management, Logistics, policies, regulatory constraints and markets in waste management, Waste to energy technologies, Life cycle assessment and carbon footprint, Biological treatment techniques, Waste treatment and valorization technologies, Circular economy and industrial symbioses, Smart technologies and digital tools in waste management, Recycling of wastes and resources recovery, Wastes refineries, Food waste management and bioeconomy, Plastic waste impacts management strategies and solutions, Wastes as critical raw materials resources. WASTES Solutions Treatments and Opportunities IV is aimed at academics and professionals involved in waste management and recycling sectors globally.

Forest Fungi Ahmed M. Abdel Azeem, Marieka Gryzenhout, Soumya Ghosh, Teroj A. Mohammed, 2024-09-04 Forest Fungi Biodiversity Conservation Mycoforestry and Biotechnology explores sustainable options, aspects of forest fungal research from the selection of hosting plants, isolation, identification, fermentation, identification of secondary metabolites, omics tools for better understanding the plant fungus interactions. Forests are the world's greatest repository of terrestrial biomass, soil carbon and biodiversity. They provide a variety of provisioning, supporting, regulatory and cultural ecosystem services which are crucial for the survival of human beings. Fungi play key roles in forest ecosystems as mutualists, saprobes and pathogens. Focuses on the biodiversity of forest fungi and their potential biotechnological application for sustainable development. Includes high quality illustrations and figures for enhanced ease of understanding the process mechanism.

Herbs, Spices and Medicinal Plants Mohammad B. Hossain, Nigel P. Brunton, Dilip K. Rai, 2020-10-05 The latest research on the health benefits and optimal processing technologies of herbs and spices. This book provides a comprehensive overview of the health benefits, analytical techniques used and effects of processing upon the physicochemical properties of herbs and spices. Presented in three parts it opens with a section on the technological and health benefits of herbs and spices. The second part reviews the effect of classical and novel processing techniques on the properties of herbs and spices. The third section examines extraction techniques and analytical methodologies used for herbs and spices. Filled with contributions from experts in academia and industry. Herbs, Spices and Medicinal Plants Processing, Health Benefits and Safety offers chapters covering thermal and non-thermal processing of herbs and spices, recent developments in high quality drying of herbs and spices, conventional and novel techniques for extracting bioactive compounds from herbs and spices and approaches to analytical techniques. It also examines purification and isolation techniques for enriching bioactive phytochemicals, medicinal properties of herbs and

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current use and future potential for industrial scale applications Offers a thorough introduction to plants as sources of drugs highlighting strategies for the discovery of novel bioactive constituents of botanicals **Material Science Technology and Global Sustainability II** Syed Shatir A. Syed-Hassan,2019-03-28 4th International Conference on Global Sustainability and Chemical Engineering ICGSCE 2018 Selected peer reviewed papers from the 4th International Conference on Global Sustainability and Chemical Engineering ICGSCE 2018 September 5 6 2018 Kuala Lumpur Malaysia *Bioactive Extraction and Application in Food and Nutraceutical Industries* Tanmay Sarkar,Siddhartha Pati,2024-01-13 This volume details state of the art methods on sustainable food extractions Chapters guide readers on traditional and novel extraction techniques as well as exploring diverse sources of bioactive compounds Additionally chapters provide a holistic view of the field catering to the needs of researchers industry professionals and students who are interested in this rapidly evolving area Written in the format of the Methods and Protocols in Food Science series chapters list necessary materials and methods for readily reproducible protocols Authoritative and cutting edge *Bioactive Extraction and Application in Food and Nutraceutical Industries* aims to be a foundation for future studies and to be a source of inspiration for new investigations in the field

Proceedings of the XIth International Symposium on the Processing Tomato John Mumford,Ron Pitblado,Janisse Routledge,2009 *Novel Processing Methods for Plant-Based Health Foods* Megh R. Goyal,N. Veena,Ritesh B. Watharkar,2023-03-10 This new volume presents an array of new and emerging techniques in the food processing sector focusing on the extraction encapsulation and health benefits of bioactive Compounds It illustrates various applications of novel food processing extraction and encapsulation techniques along with the health and safety aspects of plant derived bioactive compounds and functional foods Some of the sustainable and green extraction techniques discussed include novel extraction techniques such as microwave assisted extraction MAE ultrasonic assisted extraction UAE supercritical fluid extraction SFE accelerated solvent extraction ASE and rapid solid liquid extraction RSLE The volume also covers the principles and methods of encapsulation its role and application in protection and stabilization and as a targeted delivery system for enhanced nutritional health benefits Various encapsulation methods such as spray drying spray cooling chilling fluidized bed coating coacervation liposome entrapment extrusion inclusion complexation etc are discussed in detail for application in the food industry *Novel Processing Methods for Plant Based Health Foods Extraction Encapsulation and Health Benefits of Bioactive Compounds* also highlights the potential of nutraceuticals and biological active compounds in human health various sources consumers acceptance safety aspects and their application in development of functional foods This volume offers many tremendous applications in different areas of the food industry including in food processing preservation health promoting properties and safety and quality evaluation of plant based foods The book provides a wealth of information and will be an excellent reference material for researchers scientists students growers traders processors industry professionals and others on the emerging food processing approaches for extraction and encapsulation of plant based

bioactive compounds and health promoting properties of plant derived nutraceuticals and safety aspects in production of functional foods **Towards Bridging Science and Herbal Industry** ,2001 *Comprehensive Analytical Chemistry* Cecil Leeburn Wilson,David Woodburn Wilson,2008 *Environmental Toxicology and Chemistry* ,2008 **Toxicology Research Projects Directory** ,1980 An indexed directory of current research project abstracts in toxicology and related fields

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