

The mode of antibacterial action of essential oils

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The antimicrobial activity of essential oils and their components has been recognized for a very long time. Essential oils (EOs) are made from a very complex mixture of volatile molecules that are produced by the secondary metabolism of aromatic and medicinal plants and can be obtained by distillation of different parts of plants. The large number of studies on the antimicrobial activity of EOs has allowed the scientific recognition of these compounds on the control of a wide range of microbial pathogens. The progresses made on the investigation of the mode of action of EOs against bacterial cell targets give us new perspectives to combat persistent and antimicrobial resistant bacterial pathogens. The recent investigation on the activity of EOs disruption of quorum sensing process is an excellent example. On the other hand proteomic analysis show that bacterial pathogens respond to EO sublethal doses using known mechanisms of adaptation to several environmental stress conditions.

Keywords essential oils; bacterial cell target

1. Introduction

The prevention of food borne disease has lead to the construction of sophisticated food safety and food control systems, mainly in developed countries, but world-wide, the majority of countries are aware that foodborne disease continues to be a major public health issue. Severe implications both on the health of individuals and on the development of modern society can arise from foodborne diseases. This fact is recognized by the World Health Organization (WHO) [1] and claims from each member state allow the development of systems to assure a real reduction in the burden of foodborne disease.

Since ancient times, the antimicrobial impact of essential oils and their components isolated from aromatic and medicinal plants, both on health and food preservation has been recognized. During the last decades these properties have been confirmed. The control of food spoilage and pathogenic microorganisms is achieved mainly by chemical control but the use of synthetic chemicals is limited due to a number of undesirable aspects which include carcinogenicity, teratogenicity, acute toxicity and the requirement of extended degradation periods with the consequent development of environmental pollution problems. The awareness of modern consumers about these problems has resulted in a "green" consumer profile that demands the absence of synthetic chemicals in food preservation accompanied by the requirement for extended shelf life in the majority of food products in conjunction with the scientific community and agro-industries and pharmaceutical industries to search for natural compounds that may satisfy consumer requests. Essential oils may be included in this group.

The use of essential oils (EOs) in food and food products, in addition to being recognized as GRAS practice (Generally Recognized As Safe) [2], must be applied with caution and firstly approved by food regulation organizations. This question is particularly sensitive due to different perceptions about toxic effects that most of the times are related with mass usage of the essential oils [3].

The usage of EO to combat hospital-acquired infections and to control epidemic multi-resistant bacteria such as methicillin-resistant *Staphylococcus aureus* is promising [4,5]. The EO of eucalyptus, tea tree, thyme white, lavender, lemon, lemongrass, cinnamon, grapefruit, clove bud, sandalwood, peppermint, kunzea and sage oil were tested against several MRSA strains, *Streptococcus* and *Candida* strains and the EO of thyme white, lemon, lemongrass and cinnamon oil demonstrated to be effective against these problematic bacteria [4].

2. Essential oil composition

Essential oils are made from a very complex mixture of volatile molecules that are produced by the secondary metabolism of aromatic and medicinal plants and can be obtained by different methods, including the use of low or high pressure distillation of different parts of plants or the employment of liquid carbon dioxide or microwaves. Several factors influence the quality and quantity of the extracted product, in particular the soil composition, plant organ, vegetative cycle phase and climate [6-8]. EO composition can be differentiated in two component groups (examples in Fig. 1). The main group has terpene and terpenoid origin and the second is constituted by aromatic and aliphatic components. Terpenes are the major group of plant natural products characterized by an extensive variety of structural types and the most valuable compounds [9]. Monoterpenes (C_{10}), sesquiterpenes (C_{15}) and diterpenes (C_{20}) are the main terpenes, but hemiterpenes (C_5), triterpenes (C_{30}) and tetraterpenes (C_{40}) also can be found. A terpene containing

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**Akebe Luther King Abia, Sabiha Yusuf
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The Mode Of Antibacterial Action Of Essential Oils:

Antimicrobial compounds from natural sources Mirian A. F. Hayashi, Fernando César Bizerra, Pedro Ismael Da Silva Junior, 2014-08-29 Nature is a generous source of compounds with the potential to treat diseases including infectious diseases which is of utmost importance for modern medicine as antimicrobial resistances increase Known sources of natural compounds with valuable antimicrobial activity include medicinal plants and marine and terrestrial organisms such as fungi and bacteria Nevertheless there is still a vast fauna and flora that once systematically explored could provide additional antimicrobial leads and drugs Investigators are welcome to contribute original research and or review articles in this area specifically with studies exploiting the mechanism of action and the structure activity aspects of natural compounds with antimicrobial activity that provide insights into potential ways to overcome antimicrobial resistance *Antimicrobial Compounds* Tomás G. Villa, Patricia Veiga-Crespo, 2013-10-19 Since penicillin and salvarsan were discovered a number of new drugs to combat infectious diseases have been developed but at the same time the number of multi resistant microorganism strains is increasing Thus the design of new and effective antibacterial antiviral and antifungal agents will be a major challenge in the next years This book reviews the current state of the art in antimicrobial research and discusses new strategies for the design and discovery of novel therapies Topics covered include the use of genetic engineering genome mining manipulation of gene clusters X ray and neutron scattering as well as the antimicrobial effects of essential oils antimicrobial agents of plant origin beta lactam antibiotics antimicrobial peptides and cell wall affecting antifungal antibiotics Antibacterial Drug Discovery to Combat MDR Iqbal Ahmad, Shamim Ahmad, Kendra P. Rumbaugh, 2019-11-09 This book compiles the latest information in the field of antibacterial discovery especially with regard to the looming threat of multi drug resistance The respective chapters highlight the discovery of new antibacterial and anti infective compounds derived from microbes plants and other natural sources The potential applications of nanotechnology to the fields of antibacterial discovery and drug delivery are also discussed and one section of the book is dedicated to the use of computational tools and metagenomics in antibiotic drug discovery Techniques for efficient drug delivery are also covered The book provides a comprehensive overview of the progress made in both antibacterial discovery and delivery making it a valuable resource for academic researchers as well as those working in the pharmaceutical industry Aromadermatology Janetta Bensouilah, Philippa Buck, 2021-07-28 This comprehensive evidence based guide promotes an integrative approach to using complementary therapies with conventional medicines It increases awareness of the sound scientific basis to aromatherapy with a wealth of data and contains practical information for treatment Contents include Skin structure and function Essential oil sciences in context Aromadermatology and safety issues The essentials of aromatic formulations Skin care essentials Skin and the psyche Skin infections Childhood skin complaints Inflammatory disorders Wound care Nails hair and sebaceous glands With the growing interest in aromatherapy it is important that therapists and healthcare professionals

are able to offer a valid rationale when integrating essential oils into clinical care Sound knowledge of bio chemical principles and the ability to critically appraise and apply relevant research are fundamental requirements This book offers a comprehensive in depth view of current knowledge The authors have skilfully woven research and clinical application A range of therapeutic possibilities is explored and offers practitioners alternative approaches to the management of skin conditions These include detailed discussions on different methods of application I hope that this book will become a standard text on both pre qualifying and CPD courses in aromatherapy Angela Avis in her Foreword This well illustrated thorough and authoritative text is written in a language and style that is clear and accessible to a variety of healthcare practitioners A thorough understanding of dermatology underpins the book and both current research and clinical knowledge are elegantly applied to the skin conditions discussed Robert Tisserand in his Foreword

Russell, Hugo and Ayliffe's Principles and Practice of Disinfection, Preservation and Sterilization Adam P. Fraiese, Jean-Yves Maillard, Syed Sattar, 2013-02-18 The new edition of this established and highly respected text is THE definitive reference in its field It details methods for the elimination or prevention control of microbial growth and features New chapters on bioterrorism and community healthcare New chapters on microbicide regulations in the EU USA and Canada Latest material on microbial resistance to microbicides Updated material on new and emerging technologies focusing on special problems in hospitals dentistry and pharmaceutical practice Practical advice on problems of disinfection and antiseptics in healthcare A systematic review of sterilization methods with uses and advantages outlined for each Evaluation of disinfectants and their mechanisms of action with respect to current regulations The differences between European and North American regulations are highlighted throughout making this a truly global work ideal for worldwide healthcare professionals working in infectious diseases and infection control

Microbial Secondary Metabolites: Recent Developments and Technological Challenges Bhim Pratap Singh, Mostafa E. Rateb, Susana Rodriguez-Couto, Maria de Lourdes Teixeira de Moraes Polizeli, Wen-Jun Li, 2019-08-02 Research on microbes plays an essential role in the improvement of biotechnological and biomedical areas It has turned into a subject of expanding significance as new organisms and their related biomolecules are being characterized for several applications in health and agriculture Microbial biomolecules confer the ability of microbes to cope with a range of adverse conditions However these biomolecules have several advantages over the plant origin which makes them a suitable target in drug discovery and development The reasons could be that microbial sources can be genetically engineered to enhance the production of desired natural products by large scale fermentation The interaction between microbes and their biotic and abiotic environment is fundamental to numerous processes taking place in the biosphere The natural environments and hosts of these microorganisms are extremely diverse being reflected by the fact that microbes are widespread and occur in nearly every biological community on Earth This metabolic versatility makes microbes interesting objects for a range of economically important biotechnological applications Most of the biotechniques are established but

inefficient genetic engineering strategies are still a bottleneck for selected microbe producing industrial scale biomolecules Therefore untapped microbial biodiversity and related metablomics give a noteworthy wellspring of biologicals for the advancement of meds immunizations enhanced plants and for other natural applications The present eBook volume contains articles on microbial secondary metabolites microbial biosynthetic potential including biosynthetic gene expression and metagenomics obtained from microorganism isolated unique from habitats like marine sources endophytes thermal springs deserts etc

Applications of Essential Oils in the Food Industry Charles Oluwaseun Adetunji, Javad Sharifi-Rad, 2023-12-02 Applications of Essential Oils in the Food Industry delivers detailed information on the application of essential oils derived from underutilized crops and herbs for the development preservation and safety of food products The book covers post harvest fruits and vegetables and their adjuvant and plasticizers when applied as an edible coating as well as their mechanism of action as preservatives for foods such as fish meats and yogurts The book highlights the use of essential oils as anti microbials bio preservatives and antioxidants and also examines their effectiveness against several food borne pathogens and in enhancing the aroma of food products Presents the latest research information on essential oils as anti microbials bio preservatives and antioxidants Describes how essential oils can be used for the management of mycotoxins especially for the management of toxigenic strains producing higher level of aflatoxin Includes information on the utilization of essential oils in beverages drinks and semi liquid foods Demonstrates the synergetic effect of nanotechnology together with essential oils including information on nano ceutical nano emulsion and nano pharmacology

Decontamination of Fresh and Minimally Processed Produce Vicente M. Gómez-López, 2012-05-01 Attempts to provide safer and higher quality fresh and minimally processed produce have given rise to a wide variety of decontamination methods each of which have been extensively researched in recent years Decontamination of Fresh and Minimally Processed Produce is the first book to provide a systematic view of the different types of decontaminants for fresh and minimally processed produce By describing the different effects microbiological sensory nutritional and toxicological of decontamination treatments a team of internationally respected authors reveals not only the impact of decontaminants on food safety but also on microbial spoilage vegetable physiology sensory quality nutritional and phytochemical content and shelf life Regulatory and toxicological issues are also addressed The book first examines how produce becomes contaminated the surface characteristics of produce related to bacterial attachment biofilm formation and resistance and sublethal damage and its implications for decontamination After reviewing how produce is washed and minimally processed the various decontamination methods are then explored in depth in terms of definition generation devices microbial inactivation mechanisms and effects on food safety Decontaminants covered include chlorine electrolyzed oxidizing water chlorine dioxide ozone hydrogen peroxide peroxyacetic acid essential oils and edible films and coatings Other decontamination methods addressed are biological strategies bacteriophages protective cultures bacteriocins and quorum sensing and

physical methods mild heat continuous UV light ionizing radiation and various combinations of these methods through hurdle technology The book concludes with descriptions of post decontamination methods related to storage such as modified atmosphere packaging the cold chain and modeling tools for predicting microbial growth and inactivation The many methods and effects of decontamination are detailed enabling industry professionals to understand the available state of the art methods and select the most suitable approach for their purposes The book serves as a compendium of information for food researchers and students of pre and postharvest technology food microbiology and food technology in general The structure of the book allows easy comparisons among methods and searching information by microorganism produce and quality traits

Aflatoxin B1 Occurrence, Detection and Toxicological Effects ,2020-06-03 This book consists of 11 chapters divided into four parts The chapters are written by experts in the field of aflatoxins Select topics are presented here to provide a snapshot of current understanding of the occurrence and metabolism of aflatoxin B1 the contamination exposure and detection of aflatoxin B1 and the toxicological effects and detoxification of aflatoxin The book is intended for students and scientists working in the field of aflatoxins

Sustainable Use of Feed Additives in Livestock Georgios Arsenos,Ilias Giannenas,2023-12-28 This book offers a comprehensive collection of cutting edge research on feed additives for a sustainable animal production including insects and aquaculture In five clearly structured sections the sources of feed additives details on their biochemistry feed security as well as specific applications for individual farm animal species livestock health and product characteristics meat milk and eggs find attention International expert authors provide a full description on the use of aromatic plants extracts and essential oils as feed additives alone or in combination with functional feeds of different categories Readers will explore the potential of feed additives to tackle environmental issues Practical examples include the use of local feedstuffs in combination with herbal additives and enzymes Emphasis is placed on the consequences of using local feed sources versus imported feedstuffs on global warming potential primary energy use nutrient excretion and the feedadditive influence on lessening the pollution from animal operations The results presented will support realization of the Sustainable Development Goals in particular SDG 12 which stands for Responsible Consumption and Production worldwide The use of novel and different feed additives can be an important tool to enhance sustainability support productivity and match increased food demands around the globe Animal production depends on feed efficiency to sustain growth and profitability Along these lines the present volume is an essential reading for all future oriented veterinarians animal nutritionists agricultural scientists and moreover the feed food and plant industry

Antimicrobial Research and One Health in Africa Akebe Luther King Abia,Sabiha Yusuf Essack,2023-02-27 Antimicrobial resistance is recognised among the world s most challenging problems Despite its global spread Africa specifically sub Saharan Africa is the most affected by this malaise Poor living conditions and inadequate access to sanitation and potable water supplies are among contributing factors that have influenced a high disease burden on the continent requiring extensive antimicrobials

Weak health systems and the absence of firm policies further aggravate the problem as the use of antimicrobials is mostly unregulated. The increasing demand for animal protein to meet the starving populations' demands has also influenced the use of these antimicrobials, including those banned on other continents for food animal production. The ripple effect of indiscriminate use in humans and animals is the massive discharge of antimicrobials, their residues, antimicrobial-resistant microorganisms, and their associated genes into the environment. This 14-chapter unique masterpiece presents the AMR problem in Africa, addressing the various compartments of the One Health: humans, animals, and the environment, to illustrate the need for concerted efforts in the fight against AMR, especially in Africa. Authors from the four cardinal points present diverse aspects of AMR in Africa, starting with behavioural and social drivers of AMR in Africa. Antimicrobial stewardship in an African context is also discussed. AMR in humans is presented through studies on antibiotic-resistant neonates and nontyphoidal *Salmonella* infections and the clinical relevance of the genetics of viral resistance. Topics on AMR in mastitis, biosecurity in animal farming, and the linkage between disinfectants and AMR are discussed. The environmental dimension of AMR is discussed notably in the aquatic environment and its implication for aquaculture and irrigation, and using nanomaterials to treat polluted waters from such environments are highlighted. Finally, Africa's rich floral diversity is portrayed as an eco-friendly and cost-effective approach to combat AMR. Hopefully, the work presented will spur greater collaboration between scientists, environmental, animal, and human health practitioners, the general population, and policymakers to assimilate and implement the One Health approach to combating AMR rather than working in silos on their various sectors.

Application of Alternative Food-Preservation Technologies to Enhance Food Safety and Stability

Antonio Bevilacqua, Milena Sinigaglia, 2010. The book covers the applications of some alternative approaches for prolonging food shelf life. The book describes the role of food safety objectives, natural compounds such as oils and microbial enzymes, pressure, and atmospheric techniques, and alternatives.

Bio-Based Nanoemulsions for Agri-Food Applications Kamel A. Abd-Elsalam, Kasi Murugan, 2022-08-04. Recent agricultural food and pharmaceutical research focuses attention on the development of delivery systems that can encapsulate, protect, and deliver natural compounds. Nanoemulsions are recognized as the best delivery systems for natural origin nutraceuticals and phytochemicals, having many agri-food applications. *Bio-based Nanoemulsions for Agri-Food Applications* provides information on food-grade nanoemulsions and their application in agriculture and the food industry. This book covers concepts, techniques, current advances, and challenges in the formulation of the application of emerging food-grade nanoemulsions. Particular attention is placed on food-grade nanoemulsion production methods and components used, such as plant microbial products, biosurfactants, cosurfactants, emulsifiers, ligand targets, and bioactive functional ingredients. This is an important reference source for materials scientists, engineers, and food scientists who are looking to understand how nanoemulsions are being used in the agri-food sector. Provides an overview of a range of bio-based nanoemulsions used in the agrifood sector. Explores how nanotechnology improves the properties of bio-

based emulsions Assesses the major challenges of manufacturing nanoemulsions at an industrial scale **Bio-management of Postharvest Diseases and Mycotoxigenic Fungi** Neeta Sharma,Avantina Bhandari,2020-08-31

There is an ever increasing demand for more food but one of the stumbling blocks to achieving this goal is quality and quantity losses due to various pests and pathogens and the mycotoxins synthesized by these harmful biotic entities Thus far strategies employed to manage these post harvest diseases and mycotoxins decontamination include established physical cultural and chemical methods Recently the application of chemicals to reduce decay and deterioration caused by various pathogens has been impeded as these hazardous chemicals contaminate the environment enter the food chain and destroy beneficial microorganisms and pests by aiming at non target microorganisms In light of this the usage of eco friendly and non polluting alternatives to chemical pesticides is the call of the hour Bio management of Postharvest Diseases and Mycotoxigenic Fungi deals with the current state and future prospects of using various bio management techniques that are natural eco friendly and environmentally safe It aims to increase awareness of their potential as well as sensitizing readers to the various aspects of biologicals in pest control Key Features Highlights classical versus new techniques adopted to manage postharvest diseases Discusses novel approaches in managing fungal spoilage and mycotoxin decontamination Provides readers with a 360 degree perspective of the pre and post harvest quality mycotoxin decontamination research being conducted Details proposals of new ideas to ensure a food secure and pesticide free world This book disseminates notable and diversified scientific work carried out by leading experts in their own field Written by qualified scientists in each of their respective disciplines it can serve as a current and comprehensive treatise on the emerging field of bio management of postharvest diseases and mycotoxin decontamination by products that are generally regarded as safe **The Therapeutic Properties**

of Medicinal Plants Megh R. Goyal,Hafiz Ansar Rasul Suleria,Ademola Olabode Ayeleso,T. Jesse Joel,Sujogya Kumar Panda,2019-12-12 This volume provides informative research on the scientific evidence of the health benefits that can be derived from medicinal plants and how their efficacies can be improved It is divided into three sections that cover the phytochemistry of medicinal plants disease management with medicinal plants and novel research techniques in medicinal plants The pharmacological benefits of several specific plants are discussed addressing health issues such as metabolic and mental disorders acute mountain sickness polycystic ovarian syndrome and specific diseases such as Huntington s It also looks at the role of antioxidants in disease management Additionally the book covers recent problems of drug resistance and how medicinal plants can serve as antibiotic anthelmintic and antiparasitic drugs that will be helpful for human and animals

[Aromatherapy for Health Professionals E-Book](#) Shirley Price,Len Price,Penny Price,2019-09-07 Now entering its 5th edition Aromatherapy for Health Professionals is an essential read for any professional wishing to practice aromatherapy in a clinical setting It covers the theory and practice of essential oil science and the application of aromatherapy for specific conditions giving an evidence based and in depth presentation of the subject Written by a highly experienced team of

aromatherapists it is an authoritative guide for those wishing to use essential oils in a modern health care setting Contains an A Z of essential oils including their chemistry and properties allowing therapists to select the most effective oils for use in a clinical situation Includes a table giving the appropriate essential oils for different health conditions Includes case studies to help the reader understand how to put the theory into practice The text is fully referenced and evidence based for use in a clinical setting

Harm and Benefit of Plant and Fungal Secondary Metabolites in Food Animal Production

Michael D. Flythe, Glen Eris Aiken, Arthur Louis Goetsch, 2018-06-21 Livestock species are either herbivores or omnivores that are maintained largely on plant based diets We have long appreciated the importance of understanding dietary plants from both nutritional and agronomic perspectives However it is increasingly clear that the fungi bacteria and other microorganisms that live in the plants and animals are also significant factors in the ecology of agricultural animals Many of the effects exerted on animals by dietary plants are attributable to secondary metabolites produced by the plants themselves or commensal microorganisms Some fungal and plant secondary metabolites have multiple biological effects We must be careful not to categorize a plant as strictly beneficial or harmful Furthermore we must be careful not to categorize even a particular plant or fungal compound as strictly beneficial or harmful Rather the harm or benefit of secondary metabolites are often dependent on the metabolic status of the animal the interaction with other dietary factors including other secondary metabolites and the dose received through the diet This collection examines a range of agriculturally important plant and fungal products including essential oils alkaloids isoflavones and nitrates

Annual Plant Reviews, Functions and Biotechnology of Plant Secondary Metabolites Michael Wink, 2010-01-26 This important volume commences with an overview of the modes of action of defensive secondary metabolites followed by detailed surveys of chemical defense in marine ecosystems the biochemistry of induced defense plant microbe interactions and medical applications A chapter is also included covering biotechnological aspects of producing valuable secondary metabolites in plant cell and organ cultures This is a comprehensive and fully updated new edition edited by Professor Michael Wink and including contributions from many internationally acknowledged experts in the field

Antimicrobial Resistance Vinay Kumar, Varsha Shriram, Atish Paul, Mansee Thakur, 2022-01-03 Antimicrobial resistance AMR is a global public health threat that needs immediate attention and action from the scientific community This book compiles and presents the latest and most important aspects of AMR including the biology involved its persistence and spread and novel approaches to tackle this threat The book first describes the mechanisms and spread of AMR and then discusses the various approaches and strategies for combating it Important topics include microbial pathogenesis AMR traits and major mechanisms underlying drug resistance and the emerging strategies and technologies for combating AMR Emphasis has been given on current developments about natural products including potent phyto molecules antimicrobial peptides and endophytes effective against the drug resistant microbes and target the main drug resistance determinants efflux pumps biofilms quorum sensing plasmids etc in these

bacterial pathogens Other exciting topics include applications of nanomaterials in tackling AMR and CRISPR Cas based precise sequence specific antimicrobials This informative book is meant for students and researchers in basic and medical microbiology and biotechnology It is also useful to public health professionals and industry experts involved in AMR research and related drug designing

Extraction Processes in the Food Industry Seid Mahdi Jafari, Sahar

Akhavan-Mahdavi, 2023-10-19 Extraction Processes in the Food Industry a volume in the Unit Operations and Processing Equipment in the Food Industry series explains the processing operations and equipment necessary for extraction of different food ingredients and nutraceuticals including conventional and modern extraction techniques These processes and unit operations are very important in the manufacture of products such as edible oils sugars coffee tea essential oils and other products Divided in three sections Different extraction equipment and technologies Application of extraction in the food industry and Design control and efficiency of extraction systems all chapters emphasize basic texts relating to experimental theoretical computational and or applications of food engineering principles and the relevant processing equipment for extraction unit operations Written by food engineering experts Extraction Processes in the Food Industry is a useful resource for industrial engineers working in the field of food processing and within food factories providing information on particular food processing operations and equipment Thoroughly explores novel applications of extraction unit operations in food industries Helps readers improve the quality and safety of food ingredients using optimum extraction processes Brings different alternatives for extraction operations

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