

Antibacterial Activity and Increased Freeze-Drying Stability of Sialyllactose-Reduced Silver Nanoparticles Using Sucrose and Trehalose

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The resistance to current antibiotics results in the emergence of health-threatening bacteria. Silver nanoparticles are known to exhibit broad-spectrum antibacterial activities without the development of resistance. Herein, we developed a green synthetic method for the preparation of silver nanoparticles with sialyllactose instead of toxic chemicals as a reducing agent, which would improve its therapeutic applicability and increase its biocompatibility. Oven incubation, autoclaving and microwave irradiation methods were applied to prepare the silver nanoparticles. High resolution-transmission electron microscopy and atomic force microscopy images revealed mostly spherical and amorphous silver nanoparticles with an average diameter of 23.64 nm. Fourier Transform-infrared spectra suggest that the N-H amide of sialyllactose might be involved in the binding of silver nanoparticles. Based on thermogravimetric analyses, 2,3-sialyllactose-reduced silver nanoparticles are composed of 54.3 wt% organic components and 45.7 wt% metallic silver. Enhanced antibacterial activities of silver nanoparticles of approximately 8-fold were observed against *Pseudomonas aeruginosa*, *Escherichia coli* and *Salmonella typhimurium* (minimum inhibitory concentration 16 µg/mL). Next, we employed the use of carbohydrate stabilizers to increase the stability of silver nanoparticles during a freeze-drying process. It was found that sucrose and trehalose were the most effective stabilizers. In addition, silver nanoparticles possessed excellent salt stability as well as on-the-shelf stability in the presence of these stabilizers. Derivatives of sialic acid are known to be anti-influenza agents; therefore, the newly prepared silver nanoparticles may serve as useful antibacterial and antiviral agents to cope with both pathogenic bacteria and viruses in the near future.

Keywords: Silver Nanoparticles, Sialyllactose, Antibacterial Activity, Freeze-Drying, Sucrose, Trehalose.

1. INTRODUCTION

Multidisciplinary research in nanotechnology, biology and medicine has given rise to mimetics of natural molecules in the nanoscale range. Among the mimetics, metallic nanoparticles have received great attention due to their potential applications. Silver (Ag) has been used for centuries in the treatment of bacterial infections, especially wound infections in burn patients, as well as for hygiene, personal care and healthcare.¹ The development of novel

Ag nanomaterials have been found to be applicable to diverse medical applications such as Ag-coated medical devices and Ag dressings.^{2,3} Due to the frequent occurrence of multi-drug resistance to antibiotics, silver nanoparticles (AgNPs) have emerged as potential inorganic antibacterial agents with a broad spectrum. AgNPs possess antibacterial activity against a variety of drug-resistant pathogenic bacteria such as methicillin-resistant *Staphylococcus aureus* (MRSA), ampicillin-resistant *Escherichia coli* O157:H7, erythromycin-resistant *Streptococcus pyogenes* and multidrug-resistant *Pseudomonas aeruginosa*.^{4,5}

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Advanced Energy Materials Ashutosh Tiwari, Sergiy Valyukh, 2014-02-12 An essential resource for scientists designing new energy materials for the vast landscape of solar energy conversion as well as materials processing and characterization Based on the new and fundamental research on novel energy materials with tailor made photonic properties the role of materials engineering has been to provide much needed support in the development of photovoltaic devices Advanced Energy Materials offers a unique state of the art look at the new world of novel energy materials science shedding light on the subject s vast multi disciplinary approach The book focuses particularly on photovoltaics efficient light sources fuel cells energy saving technologies energy storage technologies nanostructured materials as well as innovating materials and techniques for future nanoscale electronics Pathways to future development are also discussed Critical cutting edge subjects are addressed including Non imaging focusing heliostat state of the art of nanostructures Metal oxide semiconductors and their nanocomposites Superionic solids polymer nanocomposites solid electrolytes advanced electronics Electronic and optical properties of lead sulfide High electron mobility transistors and light emitting diodes Anti ferroelectric liquid crystals PEEK membrane for fuel cells Advanced phosphors for energy efficient lighting Molecular computation photovoltaics and photocatalysts Photovoltaic device technology and non conventional energy applications Readership The book is written for a large and broad readership including researchers and university graduate students from diverse backgrounds such as chemistry materials science physics and engineering working in the fields of nanotechnology photovoltaic device technology and non conventional energy

Formulating Pharma-, Nutra-, and Cosmeceutical Products from Herbal Substances Anupama Singh, Hitesh Kulhari, Vikas Anand Saharan, 2025-08-12 A practical and up to date discussion of the formulation and design of dosage forms and delivery systems containing herbal ingredients In Formulating Pharma Nutra and Cosmeceutical Products from Herbal Substances Dosage Forms and Delivery Systems a team of distinguished researchers delivers a step by step approach to preparing and manufacturing dosage forms and delivery systems Intuitively organized with comprehensive coverage of the fundamentals functional materials manufacturing and marketing of pharmaceutical nutraceutical and cosmeceutical products the book also examines regulatory issues of quality safety and efficacy The authors discuss essential formulation development and delivery information for novel and controlled delivery systems of herbal ingredients Readers will also find A thorough introduction to the basic principles of developing modern pharma nutra and cosmeceutical products from herbal substances Comprehensive explorations of conventional formulations including issues of stability Practical discussions of advanced formulations including chronotherapeutic delivery systems liposome based delivery of phytoconstituents and nanoparticle mediated delivery of herbal actives Complete treatments of regulatory challenges including nonclinical characterization and documentation for marketing authorizations of herbal formulations Perfect for professionals working in the herbal drug natural product and dietary supplement industries Formulating Pharma Nutra and

Cosmeceutical Products from Herbal Substances will also benefit academic researchers and graduate students studying herbal research cosmetics and pharmaceutical sciences

Handbook of Nanomaterials for Industrial Applications
Chaudhery Mustansar Hussain, 2018-07-19 Handbook of Nanomaterials for Industrial Applications explores the use of novel nanomaterials in the industrial arena The book covers nanomaterials and the techniques that can play vital roles in many industrial procedures such as increasing sensitivity magnifying precision and improving production limits In addition the book stresses that these approaches tend to provide green sustainable solutions for industrial developments Finally the legal economical and toxicity aspects of nanomaterials are covered in detail making this is a comprehensive important resource for anyone wanting to learn more about how nanomaterials are changing the way we create products in modern industry Demonstrates how cutting edge developments in nanomaterials translate into real world innovations in a range of industry sectors Explores how using nanomaterials can help engineers to create innovative consumer products Discusses the legal economical and toxicity issues arising from the industrial applications of nanomaterials

Functional Food Product Development
Jim Smith, Edward Charter, 2011-03-08 According to an August 2009 report from PricewaterhouseCoopers the United States market for functional foods in 2007 was US 27 billion Forecasts of growth range from between 8.5% and 20% per year or about four times that of the food industry in general Global demand by 2013 is expected to be about 100 billion With this demand for new products comes a demand for product development and supporting literature for that purpose There is a wealth of research and development in this area and great scope for commercialization and this book provides a much needed review of important opportunities for new products written by authors with in depth knowledge of as yet unfulfilled health related needs This book addresses functional food product development from a number of perspectives the process itself health research that may provide opportunities idea creation regulation and processes and ingredients It also features case studies that illustrate real product development and commercialization histories Written for food scientists and technologists this book presents practical information for use in functional food product development It is an essential resource for practitioners in functional food companies and food technology centres and is also of interest to researchers and students of food science Key features A comprehensive review of the latest opportunities in this commercially important sector of the food industry Includes chapters highlighting functional food opportunities for specific health issues such as obesity immunity brain health heart disease and the development of children New technologies of relevance to functional foods are also addressed such as emulsion delivery systems and nanoencapsulation Includes chapters on product design and the use of functional ingredients such as antioxidants probiotics and prebiotics as well as functional ingredients from plant and dairy sources Specific examples of taking products to market are provided in the form of case studies e.g microalgae functional ingredients Part of the Functional Food Science and Technology book series Series Editor Fereidoon Shahidi

Cutting-Edge Enabling Technologies for Regenerative Medicine
Heung Jae Chun, Chan Hum Park, Il Keun Kwon, Gilson

Khang,2018-10-24 This book explores in depth the latest enabling technologies for regenerative medicine The opening section examines advances in 3D bioprinting and the fabrication of electrospun and electrosprayed scaffolds The potential applications of intelligent nanocomposites are then considered covering for example graphene based nanocomposites intrinsically conductive polymer nanocomposites and smart diagnostic contact lens systems The third section is devoted to various drug delivery systems and strategies for regenerative medicine Finally a wide range of future enabling technologies are discussed Examples include temperature responsive cell culture surfaces nanopatterned scaffolds for neural tissue engineering and process system engineering methodologies for application in tissue development This is one of two books to be based on contributions from leading experts that were delivered at the 2018 Asia University Symposium on Biomedical Engineering in Seoul Korea the companion book examines in depth novel biomaterials for regenerative medicine

Microorganisms for Functional Food, 2nd Edition Fabio Minervini, Maria De Angelis, 2019-11-26 Nowadays most of Western consumers are aware that a targeted diet could be an important tool for fighting ageing and diseases such as hypertension diabetes and obesity Microorganisms may be exploited for setting up novel foods that beside their nutritional value may positively impact on consumers health Some microorganisms may benefit host when ingested as viable cells carried by food and beverages This falls in the intriguing field of probiotics recently brought forward by the numerous probiotic claims rejected by the European Food Safety Authority This research topic includes research articles and reviews perspectives that i contribute to understand the mechanism underlying the health effects of probiotic microorganisms ii show integrated approaches for selecting new probiotics iii report about non dairy food items as novel carriers of probiotics and iv deal with biologically active compounds from microorganisms Essential Oils in Food Preservation, Flavor and Safety

Victor R Preedy, 2015-09-28 Essential Oils in Food Preservation Flavor and Safety discusses the major advances in the understanding of the Essential Oils and their application providing a resource that takes into account the fact that there is little attention paid to the scientific basis or toxicity of these oils This book provides an authoritative synopsis of many of the complex features of the essential oils as applied to food science ranging from production and harvesting to the anti spoilage properties of individual components It embraces a holistic approach to the topic and is divided into two distinct parts the general aspects and named essential oils With more than 100 chapters in parts two and three users will find valuable sections on botanical aspects usage and applications and a section on applications in food science that emphasizes the fact that essential oils are frequently used to impart flavor and aroma However more recently their use as anti spoilage agents has been extensively researched Explains how essential oils can be used to improve safety flavor and function Embraces a holistic approach to the topic and is divided into two distinct parts the general aspects and named essential oils Provides exceptional range of information from general use insights to specific use and application information along with geographically specific information Examines traditional and evidence based uses Includes methods and examples of

investigation and application *Insect Immunity* Dan Hultmark,1982 *Inhibition and Inactivation of Vegetative Microbes* Frederick Arthur Skinner,William Barry Hugo,1976 The inactivation of vegetative bacteria by chemicals The inactivation of vegetative micro organisms by chemical in the dairyng industry Bacterial inhibitors in milk and other biological secretions with special reference to the complement antibody transferrin lactoferrin and lactoperoxidase thiocyanate hydrogen peroxide systems Inactivation of non sporing bacteria by gases The antimicrobial activity of SO₂ with particular reference to fermented and non fermented fruit juices Inactivation by cold Thermal injury and inactivation in vegetative bacteria Effect of temperature on filamentous fungi Inhibition of micro organisms in food by water activity The inactivation of vegetative bacterial cells by ionizing radiation Some aspects of the effects of hydrostatic pressure on microorganisms Inactivation of yeast The survival of bacteria in toiletries Resuscitation of injured bacteria in foods Inactivation of bacteria by freeze drying Practical and legislative aspects of the chemical preservation of food **Parenteral Dosage Forms** Carolyn G. Hall,Kenneth E. Avis,1969 946 selected references arranged in classified order under 11 major headings Intended to cover pharmaceutical literature between the demise of Pharmaceutical abstracts 1947 and the beginning of International pharmaceutical abstracts 1964 Author index Food Science and Technology Abstracts ,1985 Monthly References from world literature of books about 1000 journals and patents from 18 selected countries Classified arrangement according to 18 sections such as milk and dairy products eggs and egg products and food microbiology Author subject indexes **Plants with Antimicrobial Properties: Antifungal properties** D. J. Cousins,C.A.B. International,1995 *Microbiology Abstracts* ,1977 **Parenteral Dosage Forms** ,1959 Material Research and Applications Duan Ling Li, Da Wei Zheng, Jun Shi,2014-02-27 Selected peer reviewed papers from the 2012 International Conference on Advanced Material and Manufacturing Science ICAMMS 2012 December 20 21 2012 Beijing China *Abstracts of World Medicine* ,1948

Antibiotic Resistance Adriel R. Bonilla,2009 Antibiotic resistance is the ability of a micro organism to withstand the effects of antibiotics There are three mechanisms that can cause antibiotic resistance prevention of interaction of drug with target decreased uptake due to either an increased efflux or a decreased influx of the antimicrobial agent and enzymatic modification or destruction of the compound In the past couple years antibiotic resistance has become an increasing public health concern Tuberculosis gonorrhoea malaria and childhood ear infections are just a few of the diseases that have become hard to treat with antibiotic drugs This book addresses the concern that over the past few years there has been a major rise in resistance to antibiotics among gram negative bacteria New antibacterial drugs with novel modes of actions are urgently required in order to fight against infection Novel antibiotics such as linezolid carbapenem ertapenem daptomycin and gemifloxacin are examined in this book The genetic approaches used in risk assessment of antibiotic resistance dissemination are looked at as well Furthermore this book discusses the present studies on the use of veterinary antibiotics in agriculture on the occurrence of antibiotic compounds and resistant bacteria in soil and water and clearly demonstrates the need for

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