



## Article

# Evaluation of Catechin Synergistic and Antibacterial Efficacy on Biofilm Formation and *acrA* Gene Expression of Uropathogenic *E. coli* Clinical Isolates

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**Abstract:** Uropathogenic *Escherichia coli* has a propensity to build biofilms to resist host defense and antimicrobials. Recurrent urinary tract infection (UTI) caused by multidrug-resistant, biofilm-forming *E. coli* is a significant public health problem. Consequently, searching for alternative medications has become essential. This study was undertaken to investigate the antibacterial, synergistic, and antibiofilm activities of catechin isolated from *Canarium patentissimum* Miq. against three *E. coli* ATCC reference strains (ATCC 25922, ATCC 8739, and ATCC 43895) and fifteen clinical isolates collected from UTI patients in Baghdad, Iraq. In addition, the expression of the biofilm-related gene, *acrA*, was evaluated with and without catechin treatment. Molecular docking was performed to evaluate the binding mode between catechin and the target protein using Autodock Vina 1.2.0 software. Catechin demonstrated significant bactericidal activity with a minimum inhibitory concentration (MIC) range of 1–2 mg/mL and a minimum bactericidal concentration (MBC) range of 2–4 mg/mL and strong synergy when combined with tetracycline at the MBC value. In addition, catechin substantially reduced *E. coli* biofilm by downregulating the *acrA* gene with a reduction percent  $\geq 60\%$ . In silico analysis revealed that catechin bound with high affinity ( $\Delta G = -8.2$  kcal/mol) to AcrB protein (PDB-ID: SENT), one of the key AcrAB-TolC efflux pump proteins suggesting that catechin might inhibit the *acrA* gene indirectly by docking at the active site of AcrB protein.

**Keywords:** *Canarium patentissimum* Miq.; multidrug resistance; antibiofilm activity; AcrAB-TolC efflux pump; molecular docking; Autodock Vina



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## 1. Introduction

*Escherichia coli* is a Gram-negative multifaceted bacterium that comprises commensal *E. coli*, which normally colonizes in the gastrointestinal tract of humans and animals a few hours after birth [1], and pathogenic *E. coli*, which is the most common cause of gastrointestinal infections such as diarrheal disease caused by enterotoxigenic *E. coli* (ETEC) and extraintestinal infections such as urinary tract infections (UTI) caused by uropathogenic *E. coli* (UPEC) [2]. Some *E. coli* clones became pathogenic when they gain a number of specialized virulence factors, such as different adhesins, toxins, siderophores, and iron acquisition systems that interfere with the way the host cell works [3].

UTIs are commonly classified as community-acquired or healthcare-associated UTIs, and as complicated or uncomplicated UTIs, depending on the severity of the infection [4]. UTI is one of the most common bacterial infections worldwide, with an estimated 150 million UTI cases occurring each year [5]. Due to the anatomy of the female urinary tract, it is estimated that 50–60% of women will develop an UTI at some point in their lives [6]. UTIs are treatable in most cases. However, the progression of multidrug-resistant strains results in recurrent infections, treatment failure, and complications associated with increased rates of mortality and morbidity [7].

# Evaluation Of The Antibacterial Efficacy And The

**JR Anderson**



## **Evaluation Of The Antibacterial Efficacy And The:**

*Issues in Antibiotics, Antiinfectives, Antimicrobials, and Antivirals: 2013 Edition*, 2013-06-20 Issues in Antibiotics Antiinfectives Antimicrobials and Antivirals 2013 Edition is a ScholarlyEditions book that delivers timely authoritative and comprehensive information about Antimicrobials The editors have built Issues in Antibiotics Antiinfectives Antimicrobials and Antivirals 2013 Edition on the vast information databases of ScholarlyNews You can expect the information about Antimicrobials in this book to be deeper than what you can access anywhere else as well as consistently reliable authoritative informed and relevant The content of Issues in Antibiotics Antiinfectives Antimicrobials and Antivirals 2013 Edition has been produced by the world s leading scientists engineers analysts research institutions and companies All of the content is from peer reviewed sources and all of it is written assembled and edited by the editors at ScholarlyEditions and available exclusively from us You now have a source you can cite with authority confidence and credibility More information is available at <http://www.ScholarlyEditions.com>

**Antibacterial activity of the flower extracts of *Caesalpinia pulcherrima* L. against eye infection causing pathogens** Prem Jose Vazhacharickal, Noby Mathew, Athira T Rameshan, 2017-12 *Caesalpinia pulcherrima* flowers have excellent antibacterial property The present study aims to evaluate the antibacterial property *Caesalpinia pulcherrima* flower extract against clinically isolated eye infection causing *Staphylococcus aureus* The MIC minimum inhibitory concentration and MBC minimum bactericidal concentration was found to be 200 g/ml and 400 g/ml Antioxidant activity spectroscopic and phytochemical analysis of the extract was also studied This study concludes that *Caesalpinia pulcherrima* can be used as a potential natural remedy to treat eye infection

**Proceedings of the 3rd International Conference on Environmentally Sustainable Animal Industry 2022 (ICESAI 2022)** Eko Widodo, Vu Dinh Ton, Rugang Tian, Norsida Man, Mashudi Mashudi, 2023-10-23 This is an open access book The 3rd ICESAI aims to discuss issues related to the development of an eco friendly and sustainable livestock industry using smart farming which is related to scientific research and how it is applied The 3rd ICESAI offers opportunities for the for researchers and the livestock industry from all over the world to share experiences learn and expand networking on several matters relating to the development of a sustainable and environmentally friendly livestock industry especially with the implementation of smart farming

**Antibacterial Activity of Nanomaterials** Ana María Díez-Pascual, 2018-09-14 This book is a printed edition of the Special Issue Antibacterial Activity of Nanomaterials that was published in *Nanomaterials*

Quantitative Structure-Activity Analysis R. Franke, P. Ohme, 2022-02-21 Keine ausführliche Beschreibung für Quantitative Structure Activity Analysis verfügbar

**Nanostructures for Antimicrobial and Antibiofilm Applications** Ram Prasad, Busi Siddhardha, Madhu Dyavaiah, 2020-05-12 In the pursuit of technological advancement in the field of biotechnology and pharmaceutical industries to counteract health issues bacterial infections remain a major cause of morbidity and mortality The ability of bacterial pathogens to form biofilms further agglomerates the situation by showing

resistance to conventional antibiotics To overcome this serious issue bioactive metabolites and other natural products were exploited to combat bacterial infections and biofilm related health consequences Natural products exhibited promising results in vitro however their efficacy in in vivo conditions remain obscured due to their low solubility bioavailability and biocompatibility issues In this scenario nanotechnological interventions provide a multifaceted platform for targeted delivery of bioactive compounds by slow and sustained release of drug like compounds The unique physico chemical properties biocompatibility and eco friendly nature of bioinspired nanostructures has revolutionized the field of biology to eradicate microbial infections and biofilm related complications The green nanotechnology based metal and metal oxide nanoparticles and polymeric nanoparticles have been regularly employed for antimicrobial and antibiofilm applications without causing damage to host tissues The implications of these nanoparticles toward achieving sustainability in agriculture by providing systemic resistance against a variety of phytopathogens therefore plays crucial role in growth and crop productivity Also the advent of smart and hybrid nanomaterials such as metal based polymer nanocomposites lipid based nanomaterials and liposomes have the inherent potential to eradicate bacterial biofilm related infections in an efficient manner The recent development of carbon based nanomaterials such as carbon nanotubes CNTs and silica based nanomaterials such as mesoporous silica nanoparticles MSNs also exploit a target of dreadful healthcare conditions such as cancer immunomodulatory diseases and microbial infections as well as biofilm related issues owing to their stability profile biocompatibility and unique physio chemical properties Recently novel physical approaches such as photothermal therapy PTT and antimicrobial photodynamic therapy aPDT also revolutionized conventional strategies and are engaged in eradicating microbial biofilm related infections and related health consequences These promising advancements in the development of novel strategies to treat microbial infections and biofilm related multidrug resistance MDR phenomenon may provide new avenues and aid to conventional antimicrobial therapeutics

**Advances in Bioartificial Materials and Tissue Engineering Research and Application: 2011 Edition** ,2012-01-09 Advances in Bioartificial Materials and Tissue Engineering Research and Application 2011 Edition is a ScholarlyEditions eBook that delivers timely authoritative and comprehensive information about Bioartificial Materials and Tissue Engineering The editors have built Advances in Bioartificial Materials and Tissue Engineering Research and Application 2011 Edition on the vast information databases of ScholarlyNews You can expect the information about Bioartificial Materials and Tissue Engineering in this eBook to be deeper than what you can access anywhere else as well as consistently reliable authoritative informed and relevant The content of Advances in Bioartificial Materials and Tissue Engineering Research and Application 2011 Edition has been produced by the world s leading scientists engineers analysts research institutions and companies All of the content is from peer reviewed sources and all of it is written assembled and edited by the editors at ScholarlyEditions and available exclusively from us You now have a source you can cite with authority confidence and credibility More information is

available at <http://www.ScholarlyEditions.com>      Facing the Upcoming of Multidrug-Resistant and Extensively Drug-Resistant Bacteria: Novel Antimicrobial Therapies (NATs) Angel León-Buitimea, Jose Ruben Morones-Ramirez, Jason H. Yang, Rafael Peña-Miller, 2021-04-01      *The Pharmacist*, 2008      *Advances in Healthcare and Protective Textiles* Shahid Ul Islam, Abhijit Majumdar, Bhupendra Singh Butola, 2023-02-09 Advances in Healthcare and Protective Textiles addresses technologies that have had a major impact in industry for decades but which are currently attracting unprecedented attention due to their applications in the fight against the Coronavirus epidemic Recent advances in textile technology have opened new possibilities for textile researchers and scientists in antiviral textiles flame retardant textiles antimicrobial textiles insect repellent textiles breathable medical textiles aroma protective textiles high tech textiles smart textiles nano textiles and more This book provides systematic and comprehensive coverage of cutting edge research and developments on material design methodologies characterizations processes properties and applications of medical healthcare and protective textiles In addition sections pay special attention to advanced fabrication methodologies and materials used in apparel engineering Provides a thorough review of recent advances in personal protective equipment PPE design and manufacture in response to the requirements of the fight against Coronavirus Gives advice on improving sustainability through the use of reusable and recyclable medical textiles Explores innovative materials like biopolymers and their applications in medical textiles

*Microbiological Methods for Environment, Food and Pharmaceutical Analysis* Abhishek Chauhan, Tanu Jindal, 2020-09-18 This book provides a broad account of various applied aspects of microbiology for quality and safety evaluations in food water soil environment and pharmaceutical sciences The work is timely as the safety and quality of various commodities such as water and wastewater food pharmaceutical medications and medical devices are of paramount concern in developing countries globally for improved public health quality in areas ranging from food security to disease exposure The book offers an introduction to basic concepts of biosafety and related microbiological practices and applies these methodologies to a multitude of disciplines in subject focused chapters Each chapter offers experiments and exercises pertaining to the specific area of interest in microbiological research which will allow readers to apply the knowledge gained in a laboratory or classroom setting to see the microbiological methods discussed in practice The book will be useful for industrialists researchers academics and undergraduate graduate students of microbiology biotechnology botany and pharmaceutical sciences The text aims to be a significant contribution in effectively guiding scientists analysts lab technicians and quality managers working with microbiology in industrial and commercial fields      **Nanostructures for Antimicrobial Therapy** Anton Fica, Alexandru Mihai Grumezescu, 2017-05-29 Nanostructures for Antimicrobial Therapy discusses the pros and cons of the use of nanostructured materials in the prevention and eradication of infections highlighting the efficient microbicidal effect of nanoparticles against antibiotic resistant pathogens and biofilms Conventional antibiotics are becoming ineffective towards microorganisms due to their widespread and often inappropriate use As a result the development of antibiotic

resistance in microorganisms is increasingly being reported New approaches are needed to confront the rising issues related to infectious diseases The merging of biomaterials such as chitosan carrageenan gelatin poly lactic co glycolic acid with nanotechnology provides a promising platform for antimicrobial therapy as it provides a controlled way to target cells and induce the desired response without the adverse effects common to many traditional treatments Nanoparticles represent one of the most promising therapeutic treatments to the problem caused by infectious micro organisms resistant to traditional therapies This volume discusses this promise in detail and also discusses what challenges the greater use of nanoparticles might pose to medical professionals The unique physiochemical properties of nanoparticles combined with their growth inhibitory capacity against microbes has led to the upsurge in the research on nanoparticles as antimicrobials The importance of bactericidal nanobiomaterials study will likely increase as development of resistant strains of bacteria against most potent antibiotics continues Shows how nanoantibiotics can be used to more effectively treat disease Discusses the advantages and issues of a variety of different nanoantibiotics enabling medics to select which best meets their needs Provides a cogent summary of recent developments in this field allowing readers to quickly familiarize themselves with this topic area

Nanophytomedicine Parimelazhagan Thangaraj, Lucindo Jose Quintans Junior, N. Ponpandian, 2022-10-10 Nanophytomedicine is a branch of medicine that involves the application of nanomedicine based systems to phytotherapy and phytopharmacology and the use of phytonanoparticles for biomedical applications Nanophytomedicine covers recent advances in experimental and theoretical studies on various properties of nanoparticles derived from plant sources This book assesses the recent advancements and applications of plant based nanoparticles and also highlights emerging concepts of biomimetics The book contains 24 chapters encompassing various therapeutic applications of phytochemicals derived from plants ferns seaweeds and so on mediated through nanotechnology and its allied approaches A fervent attempt has been made to compile every significant advancement in the field of phytonanomedicine so as to accelerate its momentum in the pharmaceutical sector

Host-Guest Polymer Complexes Alan Edward Tonelli, Ganesh Narayanan, Alper Gurarslan, 2018-10-02 This book is a printed edition of the Special Issue Host Guest Polymer Complexes that was published in Polymers

Decontamination in Hospitals and Healthcare James T. Walker, 2014-02-13 Decontamination in Hospitals and Healthcare brings an understanding of decontamination practices and the development of technologies for cleaning and control of infection to a wide audience interested in public health including healthcare specialists scientists students or patients Part one highlights the importance and history of decontamination in hospitals and healthcare before exploring the role of standards in decontamination infection control in Europe and future trends in the area Part two focuses on decontamination practices in hospitals and healthcare It considers the role of the nurse in decontamination the issues of microbial biofilm in waterlines control of waterborne microorganisms and the use of gaseous decontamination technologies Further chapters explore decontamination of prions the use of protective clothing no touch automated room disinfection

systems and controlling the presence of microorganisms in hospitals Part three discusses practices for decontamination and sterilization of surgical instruments and endoscopes These chapters examine a range of guidance documents including the choice framework for local policy and procedures for decontamination of surgical instruments as well as novel technologies for cleaning and detection of contamination Decontamination in Hospitals and Healthcare provides a reference source on decontamination for public health professionals and students concerned with healthcare It is particularly useful for scientists in microbiology and disinfection decontamination laboratories healthcare workers who use disinfectants students in microbiology clinicians members of the Institute of Decontamination Sciences Central Sterilising Club and those employed in the Central Sterile Services departments of healthcare facilities Discusses decontamination processes in Europe Provides an in depth understanding into decontamination in healthcare settings specifically hospitals and dental practices Examines the decontamination of surgical equipment and endoscopes

**Infection Control Update, An Issue of Perioperative Nursing Clinics** George Allen,2010-12-28 This issue of Perioperative Nursing Clinics Guest Edited by George Allen features subject topics such as OR Attire s Potential for Infection Transmission Strategies for Preventing Sharps Injuries Managing Patients with MDROs Implementing Isolation Procedures in the Perioperative Setting Anesthesia Care Providers Identifying Mitigating Potential for Infection Transmission Urinary Catheter Insertion and Care in the Perioperative Setting Hand Hygiene and the Surgical Team Outlining Effective Strategies for Preventing SSI Environmental Sanitation Review of New Technologies Reprocessing Instruments Focus on Eye Surgery and TASS Toxic Anterior Segment Syndrome Skin Prepping to Maximize Positive Outcomes Improving the process of supplying instruments from central processing to the OR using the LEAN method Using Performance Improvement Methodology in Finding the Cause of Increase Biological Cultures in the Operating Room and Solutions for Corrections

*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

**Targeting**

**Biofilms in Translational Research, Device Development, and Industrial Sectors** Dustin L. Williams, 2019-11-06 This book offers a much needed discussion on the targeting of biofilm related infections Chapters include discussions on the impact of biofilm on medical implants industrial applications as well as wound and tissue infections It also offers discussions on regulatory management for industrial sectors and medical environments Given that there continues to be a paucity of effective antimicrobial products devices and coatings in clinical and industrial use that effectively reduce rates of infection or biofilm related problems Targeting Biofilms in Translational Research Device Development and Industrial Sectors offers a fresh and much needed perspective aimed at helping create healthier controlled environments and safer devices This comprehensive book is indispensable for industrial and academic translational researchers device developers and regulatory experts looking to create more effective antimicrobial products

*Micropropagation of Medicinal Plants: Volume 1* T. Pullaiah, 2024-02-20 This volume presents information about protocols for micropropagation of more than 40 species of medicinal plants The contents combine knowledge about the scientific principles of micropropagation with state of the art updates in tissue culture techniques presented by plant scientists The readers will learn about techniques required to grow plants in challenging conditions that aim to reduce the impacts of injudicious harvesting deforestation climate change pollution urbanization and other factors that limit the ability to meet current demand General topics such as biotization and pharmaceutical investigation are also included to guide readers about the significance of these plants in research and development for new medicines The book provides protocols for micropropagation of important medicinal plants like Rauvolfia serpentina Catharanthus roseus Withania somnifera Tylophora indica Bacopa monnieri Aloe vera Phyllanthus amarus Allium sativum Moringa oleifera Operculina turpethum Glycyrrhiza glabra Pterocarpus marsupium Vetiver grass Ruta graveolens Tinospora cordifolia Kaempferia Hedychium Decalepis hamiltonii Saraca asoca Wrightia tinctoria Wrightia arborea Artemisia absinthium Aegle marmelos Atropa acuminata Atropa belladonna Alpinia species Hedychium species and Cissus species This book is a handy reference for medicinal chemists horticulturists and pharmacists who want to learn about the growth and conservation of important medicinal herbs and plants Readership Medicinal chemists horticulturists and pharmacists

**Herbs, Shrubs, and Trees of Potential Medicinal Benefits** Azamal Husen, 2022-06-28 There has been a worldwide increase in the demand for medicinal plants that aid the immune system and considerable progress has been made in plant based drug development Herbs Shrubs and Trees of Potential Medicinal Benefits examines how plants are used in the development of drugs preventing and treating cancer hepatitis asthma influenza HIV and other diseases by manipulating a variety of bioactive molecules found in these plant parts The book analyses how plants may strengthen human immunity improve mood and brain function enhance blood and oxygen circulation boost the healing processes and maintain blood pressure Though many herbs shrubs and trees have been identified for developing healthcare products many of them require further exploration for potential usage This volume in the Exploring Medicinal Plants series presents information on



herbs shrubs and trees discussing traditional knowledge chemical derivatives and potential benefits of these items Features Identifies and highlights some medicinal herbs shrubs and or trees around the world presenting overall potential benefits to human health Explores important medicinal plants for their bioactive constituents and phytochemicals Discusses medicinal herbs shrubs and or trees for their uses in herbal drug preparation Written by an international panel of plant scientists this book is an essential resource to students pharmacists and chemists It provides valuable information on fundamental chemical principles modes of action and product formulation of bioactive natural products derived from plants for medical applications

## **Evaluation Of The Antibacterial Efficacy And The** Book Review: Unveiling the Magic of Language

In a digital era where connections and knowledge reign supreme, the enchanting power of language has be more apparent than ever. Its capability to stir emotions, provoke thought, and instigate transformation is really remarkable. This extraordinary book, aptly titled "**Evaluation Of The Antibacterial Efficacy And The**," published by a very acclaimed author, immerses readers in a captivating exploration of the significance of language and its profound impact on our existence. Throughout this critique, we will delve into the book is central themes, evaluate its unique writing style, and assess its overall influence on its readership.

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## Evaluation Of The Antibacterial Efficacy And The Introduction

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