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ISSN: 1424-8247 E-ISSN: 1424-8247

Subject area: Pharmacology, Toxicology and Pharmaceutics: Pharmaceutical Science | Pharmacology, Toxicology and Pharmaceutics: Drug Discovery | Biochemistry, Genetics and Molecular Biology: Molecular Medicine

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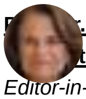

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Interests: carbohydrate small molecule synthesis; organic and biomolecular chemistry developments towards new therapeutic approaches for diabetes; Alzheimer’s disease and other amyloid diseases and carbohydrate-based antibiotics

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Section Editor-in-Chief

Department of Molecular Biology, Instituto de Parasitología y Biomedicina López-Neyra (IPBLN-CSIC), PTS Granada, Av del Conocimiento 17, 18016 Granada, Spain

Interests: antiviral nucleic acids; therapeutic RNA; aptamers; RNA inhibitors; structure/function of RNA; RNA viruses

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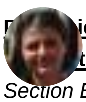

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Department of Environmental Biology, Sapienza University of Rome, Rome, Italy

Interests: medicinal plants; alkaloids; phytochemistry; HPLC; LC-MS; antiviral agents; antifungal agents; anticancer agents; Alzheimer’s disease; cholinesterases

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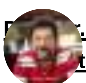

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te (https://louisville.edu/dentistry/departments/oralhealth/faculty/gill-diamond-phd)

Section Editor-in-Chief

Department of Oral Immunology and Infectious Diseases, University of Louisville School of Dentistry, Louisville, KY 40292, USA

Interests: regulation of innate immunity; antimicrobial peptides; antifungal peptides; defensins; cathelicidins; novel antiviral compounds

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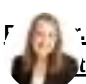

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te (https://people.tcd.ie/Profile?Username=mmeegan)

Section Editor-in-Chief

Trinity Biomedical Sciences Institute, School of Pharmacy and Pharmaceutical Sciences, Trinity College Dublin, 152−160 Pearse Street, Dublin 2 D02 R590, Ireland

Interests: anticancer drug design; breast cancer; novel antioestrogens; tubulin targeting agents; azetidinones; antioestrogen–drug conjugates; oestrogen receptor; Burkitt's lymphoma; chronic lymphocytic leukaemia

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Section Editor-in-Chief

INSERM (French National Institute of Health and Medical Research) U1026, The Laboratory of the Bioengineering of Tissues (BioTis), University of Bordeaux, 146 rue Léo Saignat, 33076 Bordeaux, France

Interests: photodynamic therapy; cancer; clinical evaluation; photosensitizer; dosimetry; fluorescencer; Dosimetry; fluorescence

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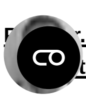

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Association between Prescribing and Intoxication Rates for Selected Psychotropic Drugs: A Longitudinal Observational Study (/1424-8247/17/1/143)

by Matej Dobravc Verbič (https://sciprofiles.com/profile/3315359?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name),
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Pharmaceuticals **2024**, *17*(1), 143; https://doi.org/10.3390/ph17010143 (https://doi.org/10.3390/ph17010143) - 22 Jan 2024

Abstract Psychotropic prescription drugs are commonly involved in intoxication events. The study's aim was to determine a comparative risk for intoxication in relation to prescribing rates for individual drugs. This was a nationwide observational study in Slovenian adults between 2015 and 2021. Intoxication events [...] Read more.
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Moringa oleifera: A Review of the Pharmacology, Chemical Constituents, and Application for Dental Health (/1424-8247/17/1/142)

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Pharmaceuticals **2024**, *17*(1), 142; https://doi.org/10.3390/ph17010142 (https://doi.org/10.3390/ph17010142) - 22 Jan 2024

Abstract *Moringa oleifera* L., commonly known as Kelor in Indonesia and miracle tree in English, has a rich history of utilization for medicinal, nutritional, and water treatment purposes dating back to ancient times. The plant is renowned for its abundance of vitamins, minerals, and [...] Read more.
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Toxicity and Toxicokinetics of a Four-Week Repeated Gavage of Levamisole in Male Beagle Dogs: A Good Laboratory Practice Study (/1424-8247/17/1/141)

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and
Yue Yu (https://sciprofiles.com/profile/929025?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)
Pharmaceuticals **2024**, *17*(1), 141; https://doi.org/10.3390/ph17010141 (https://doi.org/10.3390/ph17010141) - 22 Jan 2024

Abstract Levamisole (LVM) is considered an immunomodulatory agent that has the potential to treat various cancer and inflammation diseases. However, there is still much debate surrounding the toxicokinetic and toxicological information of LVM. Therefore, it is crucial to assess its toxicity to provide useful [...] Read more.
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A Comparison of the Anxiolytic Properties of Tofisopam and Diazepam: A Double-Blind, Randomized, Crossover, Placebo-Controlled Pilot Study (/1424-8247/17/1/140)

by Andrzej Kokoszka (https://sciprofiles.com/profile/1743233?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)
Pharmaceuticals **2024**, *17*(1), 140; https://doi.org/10.3390/ph17010140 (https://doi.org/10.3390/ph17010140) - 22 Jan 2024

Abstract New clinical reports have recently been published on tofisopam—an anxiolytic drug currently registered as a benzodiazepine—after a long break in this research area. Neurobiological studies concerning its properties, which differ from those of benzodiazepines, are underway. The analyses presented in this study aimed [...] Read more.
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Harnessing Biomaterials for Safeguarding Chimeric Antigen Receptor T Cell Therapy: An Artful Expedition in Mitigating Adverse Effects (/1424-8247/17/1/139)

by
Zhaozhao Chen (https://sciprofiles.com/profile/author/ZTdHSkNjcXRGSlR5WDdic1J1QjRFWUVZYVB0N2c3cEt6WU1CUk1RM0RzWT0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)
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Pharmaceuticals **2024**, *17*(1), 139; https://doi.org/10.3390/ph17010139 (https://doi.org/10.3390/ph17010139) - 22 Jan 2024

Abstract Chimeric antigen receptor T cell (CAR-T) therapy has emerged as a groundbreaking approach in cancer treatment, showcasing remarkable efficacy. However, the formidable challenge lies in taming the formidable side effects associated with this innovative therapy, among which cytokine release syndrome (CRS), immune effector [...] Read more.
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Microbial Biosurfactants: Antimicrobial Activity and Potential Biomedical and Therapeutic Exploits (/1424-8247/17/1/138)

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Pharmaceuticals **2024**, *17*(1), 138; https://doi.org/10.3390/ph17010138 (https://doi.org/10.3390/ph17010138) - 22 Jan 2024

Abstract The rapid emergence of multidrug-resistant pathogens worldwide has raised concerns regarding the effectiveness of conventional antibiotics. This can be observed in ESKAPE pathogens, among others, whose multiple resistance mechanisms have led to a reduction in effective treatment options. Innovative strategies aimed at mitigating [...] Read more.
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Open Access Review 19 pages, 1459 KiB (/1424-8247/17/1/137/pdf?version=1705742713)

Investigation of Potential Drug Targets Involved in Inflammation Contributing to Alzheimer's Disease Progression (/1424-8247/17/1/137)

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Pharmaceuticals **2024**, *17*(1), 137; https://doi.org/10.3390/ph17010137 (https://doi.org/10.3390/ph17010137) - 20 Jan 2024

Abstract Alzheimer's disease has become a major public health issue. While extensive research has been conducted in the last few decades, few drugs have been approved by the FDA to treat Alzheimer's disease. There is still an urgent need for understanding the disease pathogenesis, [...] Read more.
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Open Access Review 17 pages, 444 KiB (/1424-8247/17/1/136/pdf?version=1705738886)

Natural Products for Cancer Prevention and Interception: Preclinical and Clinical Studies and Funding Opportunities (/1424-8247/17/1/136)

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Pharmaceuticals **2024**, *17*(1), 136; https://doi.org/10.3390/ph17010136 (https://doi.org/10.3390/ph17010136) - 20 Jan 2024

Abstract Multiple agents derived from natural products (NPs) have been evaluated for cancer prevention and interception, either alone or in combination. The National Cancer Institute (NCI) is very interested in advancing research to identify additional agents that, alone or in combination, may prove useful [...] Read more.
(This article belongs to the Special Issue Naturally-Occurring Dietary Compounds for Cancer Prevention and Therapy (/journal/pharmaceuticals/special_issues/80I809T6B8))

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Harmaline to Human Mitochondrial Caseinolytic Serine Protease Activation for Pediatric Diffuse Intrinsic Pontine Glioma Treatment (/1424-8247/17/1/135)

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Pharmaceuticals **2024**, *17*(1), 135; https://doi.org/10.3390/ph17010135 (https://doi.org/10.3390/ph17010135) - 19 Jan 2024

Abstract Diffuse intrinsic pontine glioma (DIPG), affecting children aged 4–7 years, is a rare, aggressive tumor that originates in the pons and then spreads to nearby tissue. DIPG is the leading cause of death for pediatric brain tumors due to its infiltrative nature and [...] Read more.
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Open Access Article 20 pages, 6972 KiB (/1424-8247/17/1/134/pdf?version=1705663913)

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Exploring *Potentilla nepalensis* Phytoconstituents: Integrated Strategies of Network Pharmacology, Molecular Docking, Dynamic Simulations, and MMGBSA Analysis for Cancer Therapeutic Targets Discovery (/1424-8247/17/1/134)

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Pharmaceuticals **2024**, *17*(1), 134; https://doi.org/10.3390/ph17010134 (https://doi.org/10.3390/ph17010134) - 19 Jan 2024

Abstract *Potentilla nepalensis* belongs to the Rosaceae family and has numerous therapeutic applications as potent plant-based medicine. Forty phytoconstituents (PCs) from the root and stem through n-hexane (NR and NS) and methanolic (MR and MS) extracts were identified in earlier studies. However, the PCs **[...] Read more.**

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Combination Treatment with Liposomal Doxorubicin and Inductive Moderate Hyperthermia for Sarcoma Saos-2 Cells (/1424-8247/17/1/133)

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Pharmaceuticals **2024**, *17*(1), 133; https://doi.org/10.3390/ph17010133 (https://doi.org/10.3390/ph17010133) - 19 Jan 2024

Abstract Despite efforts in osteosarcoma (OS) research, the role of inductive moderate hyperthermia (IMH) in delivering and enhancing the antitumor effect of liposomal doxorubicin formulations (LDOX) remains unresolved. This study investigated the effect of a combination treatment with LDOX and IMH on Saos-2 human **[...] Read more.**

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Open Access Article 23 pages, 3803 KiB (/1424-8247/17/1/132/pdf?version=1705647709)

Combination Therapy of Cuban Policosanol (Raydel®, 20 mg) and Intensive Exercise for 12 Weeks Resulted in Improvements in Obesity, Hypertension, and Dyslipidemia without a Decrease in Serum Coenzyme Q_{10}: Enhancement of Lipoproteins Quality and Antioxidant Functionality in Obese Participants (/1424-8247/17/1/132)

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Pharmaceuticals **2024**, *17*(1), 132; https://doi.org/10.3390/ph17010132 (https://doi.org/10.3390/ph17010132) - 19 Jan 2024

Abstract Obesity and overweight, frequently caused by a lack of exercise, are associated with many metabolic diseases, such as hypertension, diabetes, and dyslipidemia. Aerobic exercise effectively increases the high-density lipoproteins-cholesterol (HDL-C) levels and alleviates the triglyceride (TG) levels. The consumption of Cuban policosanol (Raydel **[...] Read more.**

(This article belongs to the Special Issue **Bioactive Substances, Oxidative Stress, and Inflammation (/journal/pharmaceuticals/special_issues/90CI66403U)**)

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Open Access Article 15 pages, 6203 KiB (/1424-8247/17/1/131/pdf?version=1705644200)

Rapamycin as a Potential Alternative Drug for Squamous Cell Gingiva Carcinoma (Ca9-22): A Focus on Cell Cycle, Apoptosis and Autophagy Genetic Profile (/1424-8247/17/1/131)

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Pharmaceuticals **2024**, *17*(1), 131; https://doi.org/10.3390/ph17010131 (https://doi.org/10.3390/ph17010131) - 19 Jan 2024

Abstract Oral cancer is considered as one of the most common malignancies worldwide. Its conventional treatment primarily involves surgery with or without postoperative adjuvant therapy. The targeting of signaling pathways implicated in tumorigenesis is becoming increasingly prevalent in the development of new anticancer drug [...] Read more.

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Open Access Article 12 pages, 1019 KiB (/1424-8247/17/1/130/pdf?version=1705974077)

Influence of Long-Term Anti-Seizure Medications on Redox Parameters in Human Blood (/1424-8247/17/1/130)

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Pharmaceuticals **2024**, *17*(1), 130; https://doi.org/10.3390/ph17010130 (https://doi.org/10.3390/ph17010130) - 18 Jan 2024

Abstract Background: Epilepsy is a chronic brain disease affecting millions of people worldwide, but little is known about the impact of anti-seizure medications on redox homeostasis. Methods: This study aimed to compare the effects of the long-term use of oral anti-seizure medications in monotherapy [...] Read more.

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Open Access Article 19 pages, 1331 KiB (/1424-8247/17/1/129/pdf?version=1705583431)

The Adequacy of Anesthesia Guidance for Vitreoretinal Surgeries with Preemptive Paracetamol/Metamizole (/1424-8247/17/1/129)

by Michał Jan Stasiowski (https://sciprofiles.com/profile/1054865?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name),
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Pharmaceuticals **2024**, *17*(1), 129; https://doi.org/10.3390/ph17010129 (https://doi.org/10.3390/ph17010129) - 18 Jan 2024

Abstract Despite the possibility of postoperative pain occurrence, in some patients, vitreoretinal surgeries (VRSs) require performance of general anesthesia (GA). The administration of intraoperative intravenous rescue opioid analgesics (IROA) during GA constitutes a risk of perioperative adverse events. The Adequacy of Anesthesia (AoA) concept [...] Read more.

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Acute Kidney Injury Caused by Rhabdomyolysis Is Ameliorated by Serum Albumin-Based Supersulfide Donors through Antioxidative Pathways (/1424-8247/17/1/128)

by Mayumi Ikeda-Imafuku (https://sciprofiles.com/profile/2706636?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name),
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Pharmaceuticals **2024**, *17*(1), 128; https://doi.org/10.3390/ph17010128 (https://doi.org/10.3390/ph17010128) - 18 Jan 2024

Abstract Oxidative stress is responsible for the onset and progression of various kinds of diseases including rhabdomyolysis-induced acute kidney injury (AKI). Antioxidants are, therefore, thought to aid in the recovery of illnesses linked to oxidative stress. Supersulfide species have been shown to have substantial [...] Read more.

(This article belongs to the Special Issue Molecular Modification in Designing Next Generation Drug Delivery Systems (/journal/pharmaceuticals/special_issues/1YD02570T1))

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Tocilizumab Exerts Anti-Tumor Effects on Colorectal Carcinoma Cell Xenografts Corresponding to Expression Levels of Interleukin-6 Receptor (/1424-8247/17/1/127)

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Pharmaceuticals **2024**, *17*(1), 127; https://doi.org/10.3390/ph17010127 (https://doi.org/10.3390/ph17010127) - 18 Jan 2024

Abstract The use of tocilizumab against the interleukin-6 receptor (IL-6R) has been demonstrated as inhibiting the progression of diverse cancers in vitro and in vivo. Nonetheless, evidence regarding the anti-tumor effects of tocilizumab on human colorectal carcinoma (CRC) corresponding to IL-6R expression levels remains [...] Read more.

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Open Access Review 38 pages, 8279 KiB (/1424-8247/17/1/126/pdf?version=1705585025)

Recent Developments in Nanoparticle Formulations for Resveratrol Encapsulation as an Anticancer Agent (/1424-8247/17/1/126)

by Muhammad Ali (https://sciprofiles.com/profile/2741465?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Viviana Benfante (https://sciprofiles.com/profile/2103899?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Domenico Di Raimondo (https://sciprofiles.com/profile/818711?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Giuseppe Salvaggio (https://sciprofiles.com/profile/1347897?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Antonino Tuttolomondo (https://sciprofiles.com/profile/784741?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name) and Albert Comelli (https://sciprofiles.com/profile/977776?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)

Pharmaceuticals **2024**, *17*(1), 126; https://doi.org/10.3390/ph17010126 (https://doi.org/10.3390/ph17010126) - 18 Jan 2024

Abstract Resveratrol is a polyphenolic compound that has gained considerable attention in the past decade due to its multifaceted therapeutic potential, including anti-inflammatory and anticancer properties. However, its anticancer efficacy is impeded by low water solubility, dose-limiting toxicity, low bioavailability, and rapid hepatic metabolism. [...] Read more.

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Open Access Article 14 pages, 1659 KiB (/1424-8247/17/1/125/pdf?version=1705576499)

Promising Effects of Montelukast for Critically Ill Asthma Patients via a Reduction in Delirium (/1424-8247/17/1/125)

by
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Pharmaceuticals **2024**, *17*(1), 125; https://doi.org/10.3390/ph17010125 (https://doi.org/10.3390/ph17010125) - 18 Jan 2024

Abstract Background: Montelukast (MTK), a potent antagonist of cysteinyl leukotriene receptor 1, has shown therapeutic promise for the treatment of neuropsychiatric disorders. Delirium, a common complication in critically ill patients, lacks effective treatment. This study aims to explore the impact of pre-intensive care unit [...] Read more.

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Open Access Review 28 pages, 2573 KiB (/1424-8247/17/1/124/pdf?version=1705558879)

A Comprehensive Review on Deep Eutectic Solvents and Its Use to Extract Bioactive Compounds of Pharmaceutical Interest (/1424-8247/17/1/124)

by Cátia Ferreira (https://sciprofiles.com/profile/3200306?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name) and Mafalda Sarraguça (https://sciprofiles.com/profile/297368?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)

Pharmaceuticals **2024**, *17*(1), 124; https://doi.org/10.3390/ph17010124 (https://doi.org/10.3390/ph17010124) - 18 Jan 2024

Abstract The extraction of bioactive compounds of pharmaceutical interest from natural sources has been significantly explored in recent decades. However, the extraction techniques used were not very efficient in terms of time and energy consumption; additionally, the solvents used for the extraction were harmful [...] Read more.

(This article belongs to the Special Issue 20th Anniversary of Pharmaceuticals—Green Techniques for Organic and Organometallic/Coordination Synthesis and Medicinal Chemistry (/journal/pharmaceuticals/special_issues/XAE5626XPG))

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Open Access Article 14 pages, 1798 KiB (/1424-8247/17/1/123/pdf?version=1705492082)

Pharmacology of *Veratrum californicum* Alkaloids as Hedgehog Pathway Antagonists (/1424-8247/17/1/123)

by Madison L. Dirks (https://sciprofiles.com/profile/1736123?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name) and Owen M. McDougal (https://sciprofiles.com/profile/216715?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)

Pharmaceuticals **2024**, *17*(1), 123; https://doi.org/10.3390/ph17010123 (https://doi.org/10.3390/ph17010123) - 17 Jan 2024

Abstract *Veratrum californicum* contains steroidal alkaloids that function as inhibitors of hedgehog (Hh) signaling, a pathway involved in the growth and differentiation of cells and normal tissue development. This same Hh pathway is abnormally active for cell proliferation in more than 20 types of [...] Read more.

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Humoral and Cellular Immune Response after Three Doses of Sinopharm [Vero Cell]-Inactivated COVID-19 Vaccine in Combination with SARS-CoV-2 Infection Leads to Hybrid Immunity (/1424-8247/17/1/122)

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Pharmaceuticals **2024**, *17*(1), 122; https://doi.org/10.3390/ph17010122 (https://doi.org/10.3390/ph17010122) - 17 Jan 2024

Abstract Background: Several vaccines against COVID-19 have been developed and licensed to enhance the immune response against SARS-CoV-2. Similarly, previous infection with SARS-CoV-2 has been shown to provide significant protection against severe infection and hospitalization. Methods: We investigated the effect of three doses of [...] Read more.
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Open Access Article 20 pages, 1033 KiB (/1424-8247/17/1/121/pdf?version=1705485299)

Chemical Composition, Antioxidant, Anticancer, and Antibacterial Activities of Roots and Seeds of *Ammi visnaga* L. Methanol Extract (/1424-8247/17/1/121)

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Pharmaceuticals **2024**, *17*(1), 121; https://doi.org/10.3390/ph17010121 (https://doi.org/10.3390/ph17010121) - 17 Jan 2024

Abstract For centuries, plants and their components have been harnessed for therapeutic purposes, with *Ammi visnaga* L. (Khella) being no exception to this rich tradition. While existing studies have shed light on the cytotoxic and antimicrobial properties of seed extracts, there remains a noticeable [...] Read more.
(This article belongs to the Special Issue Therapeutic Potential of Natural Products in Internal Diseases (/journal/pharmaceuticals/special_issues/9NUU2R8I5I))

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Open Access Article 11 pages, 437 KiB (/1424-8247/17/1/120/pdf?version=1705484516)

In Vitro Evaluation of Drug–Drug Interaction Potential of Epetraborole, a Novel Bacterial Leucyl-tRNA Synthetase Inhibitor (/1424-8247/17/1/120)

by Afshin Shafiee (https://sciprofiles.com/profile/3324796?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name) and
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Pharmaceuticals **2024**, *17*(1), 120; https://doi.org/10.3390/ph17010120 (https://doi.org/10.3390/ph17010120) - 17 Jan 2024

Abstract Epetraborole (EBO) is a boron-containing inhibitor of bacterial leucyl-tRNA synthetase, with potent activity against nontuberculous mycobacteria (NTM) and Gram-negative bacteria, including *Burkholderia pseudomallei*. EBO is being developed for the treatment of NTM lung disease and melioidosis, administered in combination with other therapeutic [...] Read more.
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Open Access Article 11 pages, 726 KiB (/1424-8247/17/1/119/pdf?version=1705477574)

Functional Progression after Dose Suspension or Discontinuation of Nintedanib in Idiopathic Pulmonary Fibrosis: A Real-Life Multicentre Study (/1424-8247/17/1/119)

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Pharmaceuticals **2024**, *17*(1), 119; https://doi.org/10.3390/ph17010119 (https://doi.org/10.3390/ph17010119) - 17 Jan 2024

Abstract Background. Idiopathic pulmonary fibrosis (IPF) is a chronic interstitial lung disease with rapidly progressive evolution and an unfavorable outcome. Nintedanib (NTD) is an antifibrotic drug that has been shown to be effective in slowing down the progression of the disease. The aim of [...] Read more.
(This article belongs to the Special Issue Rheumatic Diseases: Pathophysiology, Targeted Therapy, Focus on Vascular and Pulmonary Manifestations 2023 (/journal/pharmaceuticals/special_issues/P8RCX06587))

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Open Access Article 15 pages, 2814 KiB (/1424-8247/17/1/118/pdf?version=1705406061)

Anti-Inflammatory Activity of APPA (Apocynin and Paeonol) in Human Articular Chondrocytes (/1424-8247/17/1/118)

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Pharmaceuticals **2024**, *17*(1), 118; https://doi.org/10.3390/ph17010118 (https://doi.org/10.3390/ph17010118) - 16 Jan 2024
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Abstract Osteoarthritis (OA) is a chronic joint disease leading to cartilage loss and reduction in the joint space which results in pain. The current pharmacological treatment of OA is inadequate and pharmacological interventions focus on symptom management. APPA, a combination of apocynin (AP) and **[...] Read more.**
(This article belongs to the Section **Pharmacology (/journal/pharmaceuticals/sections/pharm-pharmacology)**)

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Open Access Article 14 pages, 3062 KiB (/1424-8247/17/1/117/pdf?version=1705387902)

Assessment of Patient-Reported Outcomes at 48 Months of Treatment with Dupilumab for Severe Atopic Dermatitis: A Single-Center Real-Life Experience with 126 Patients (/1424-8247/17/1/117)

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Pharmaceuticals **2024**, *17*(1), 117; https://doi.org/10.3390/ph17010117 (https://doi.org/10.3390/ph17010117) - 16 Jan 2024
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Abstract Background: The main objective was to analyze patient-reported outcomes (PRO) trends over a four-year period in severe atopic dermatitis (AD) patients treated with dupilumab. Methods: data from 126 severe patients receiving dupilumab for at least 48 months were collected. The clinical scores assessed **[...] Read more.**
(This article belongs to the Topic **Research in Pharmacological Therapies (/topics/99X64ZT450)**)

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Open Access Article 11 pages, 222 KiB (/1424-8247/17/1/116/pdf?version=1705392145)

Regular and Irregular Use and Reasons for Discontinuation of Solifenacin Therapy in Patients with Overactive Bladder Managed by Urologists (/1424-8247/17/1/116)

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Pharmaceuticals **2024**, *17*(1), 116; https://doi.org/10.3390/ph17010116 (https://doi.org/10.3390/ph17010116) - 16 Jan 2024
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Abstract Solifenacin, a selective muscarinic receptor antagonist, is one of the best-tolerated and most effective medicines that relieve storage symptoms in patients with an overactive bladder (OAB). However, the persistence of solifenacin in daily clinical practice remains far below that reported in clinical trials. **[...] Read more.**
(This article belongs to the Section **Pharmacology (/journal/pharmaceuticals/sections/pharm-pharmacology)**)

Open Access Article 13 pages, 1653 KiB (/1424-8247/17/1/115/pdf?version=1705372744)

Retrospective Study on Genetic Diversity and Drug Resistance among People Living with HIV at an AIDS Clinic in Beijing (/1424-8247/17/1/115)

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Pharmaceuticals **2024**, *17*(1), 115; https://doi.org/10.3390/ph17010115 (https://doi.org/10.3390/ph17010115) - 16 Jan 2024
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Abstract (1) Background: The objective of this study was to investigate the prevalence of genetic diversity and drug resistance mutations among people living with HIV (PLWH) attending clinics in Beijing. (2) Methods: A retrospective analysis was conducted on PLWH admitted to the Fifth Medical **[...] Read more.**
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Open Access Article 19 pages, 7083 KiB (/1424-8247/17/1/114/pdf?version=1705372522)

Cofilin Inhibitor Improves Neurological and Cognitive Functions after Intracerebral Hemorrhage by Suppressing Endoplasmic Reticulum Stress Related-Neuroinflammation (/1424-8247/17/1/114)

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Pharmaceuticals **2024**, *17*(1), 114; https://doi.org/10.3390/ph17010114 (https://doi.org/10.3390/ph17010114) - 15 Jan 2024
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Abstract Neuroinflammation after intracerebral hemorrhage (ICH) is a crucial factor that determines the extent of the injury. Cofilin is a cytoskeleton-associated protein that drives neuroinflammation and microglia activation. A novel cofilin inhibitor (CI) synthesized and developed in our lab has turned out to be **[...] Read more.**
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Open Access Article 21 pages, 22514 KiB **(/1424-8247/17/1/113/pdf?version=1705309213)**

Zinc Oxide and Magnesium-Doped Zinc Oxide Nanoparticles Ameliorate Murine Chronic Toxoplasmosis (/1424-8247/17/1/113)

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Pharmaceuticals **2024**, *17*(1), 113; **https://doi.org/10.3390/ph17010113 (https://doi.org/10.3390/ph17010113)** - 15 Jan 2024

Abstract *Toxoplasma gondii* causes a global parasitic disease. Therapeutic options for eradicating toxoplasmosis are limited. In this study, ZnO and Mg-doped ZnO NPs were prepared, and their structural and morphological chematistics were investigated. The XRD pattern revealed that Mg-doped ZnO NPs have weak crystallinity **[...] Read more.**
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Open Access Review 16 pages, 1326 KiB **(/1424-8247/17/1/112/pdf?version=1705140406)**

Microbiome and Prostate Cancer: Emerging Diagnostic and Therapeutic Opportunities (/1424-8247/17/1/112)

by **Sung Jin Kim (https://sciprofiles.com/profile/3284523?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)**,
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Pharmaceuticals **2024**, *17*(1), 112; **https://doi.org/10.3390/ph17010112 (https://doi.org/10.3390/ph17010112)** - 13 Jan 2024

Abstract This review systematically addresses the correlation between the microbiome and prostate cancer and explores its diagnostic and therapeutic implications. Recent research has indicated an association between the urinary and gut microbiome composition and prostate cancer incidence and progression. Specifically, the urinary microbiome is **[...] Read more.**
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Open Access Article 11 pages, 631 KiB **(/1424-8247/17/1/111/pdf?version=1705138645)**

Ocular and Plasma Pharmacokinetics of Enavogliflozin Ophthalmic Solution in Preclinical Species (/1424-8247/17/1/111)

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Pharmaceuticals **2024**, *17*(1), 111; **https://doi.org/10.3390/ph17010111 (https://doi.org/10.3390/ph17010111)** - 13 Jan 2024

Abstract An enavogliflozin ophthalmic solution (DWRX2008) is being developed to treat diabetic retinopathy and macular edema. This study evaluated the ocular distribution and plasma pharmacokinetics (PKs) of enavogliflozin in animal species. A sample of [^{14}C] enavogliflozin was ocularly administered to two rabbits **[...] Read more.**
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Open Access Article 22 pages, 2461 KiB **(/1424-8247/17/1/110/pdf?version=1705137222)**

Can Pharmacological Conditioning as an Add-On Treatment Optimize Standard Pharmacological Treatment in Patients with Recent-Onset Rheumatoid Arthritis? A Proof-of-Principle Randomized Clinical Trial (/1424-8247/17/1/110)

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Pharmaceuticals **2024**, *17*(1), 110; **https://doi.org/10.3390/ph17010110 (https://doi.org/10.3390/ph17010110)** - 13 Jan 2024

Abstract Medication regimens using conditioning via variable reinforcement have shown similar or improved therapeutic effects as full pharmacological treatment, but evidence in patient populations is scarce. This proof-of-principle double-blind randomized clinical trial examined whether treatment effects in recent-onset rheumatoid arthritis (RA) can be optimized **[...] Read more.**
(This article belongs to the Special Issue **Rheumatic Diseases: Pathophysiology, Targeted Therapy, Focus on Vascular and Pulmonary Manifestations 2023 (/journal/**

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Open Access Review 22 pages, 7188 KiB (/1424-8247/17/1/109/pdf?version=1705133692)

Interleukins in Platelet Biology: Unraveling the Complex Regulatory Network (/1424-8247/17/1/109)

by Miao Huang (https://sciprofiles.com/profile/3338910?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Long Wang (https://sciprofiles.com/profile/1723343?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Qianhui Zhang (https://sciprofiles.com/profile/author/VFlkbHA1Tko2VHhFcThiRHdsbHBOajZqaGpoV2pmbkdNbUFZTUxCZEJDUT0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Ling Zhou (https://sciprofiles.com/profile/author/N1ppUjg1dGx1TDhQOUtXeWhudmpFNEhzalFxNFpvZWthQzU2a21tUEpMaz0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Rui Liao (https://sciprofiles.com/profile/author/QWdLMStnamZpY2NZVGYveExGNVg0L0NIcFl1Y0pLODVJRlBYcHJNNkRTST0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Anguo Wu (https://sciprofiles.com/profile/430407?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Xinle Wang (https://sciprofiles.com/profile/author/anJ6Y3NQUCtpbXRRL2pmaVlUSmJsdz09?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Jiesi Luo (https://sciprofiles.com/profile/1238767?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Feihong Huang (https://sciprofiles.com/profile/author/a29LeDlHeXN1aXU3TEZ4L3g1dmtjSk1RSVRnSFoxZlNGSk9DK2JONWthdz0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Wenjun Zou (https://sciprofiles.com/profile/2615636?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name) and Jianming Wu (https://sciprofiles.com/profile/71307?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)

Pharmaceuticals **2024**, *17*(1), 109; https://doi.org/10.3390/ph17010109 (https://doi.org/10.3390/ph17010109) - 13 Jan 2024

Abstract Interleukins, a diverse family of cytokines produced by various cells, play crucial roles in immune responses, immunoregulation, and a wide range of physiological and pathological processes. In the context of megakaryopoiesis, thrombopoiesis, and platelet function, interleukins have emerged as key regulators, exerting significant [...] Read more.

(This article belongs to the Special Issue Inflammatory Cytokines as New Therapeutic Targets (/journal/pharmaceuticals/special_issues/V18KNT37HL))

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Canthin-6-One Inhibits Developmental and Tumour-Associated Angiogenesis in Zebrafish (/1424-8247/17/1/108)

by Mei Fong Ng (https://sciprofiles.com/profile/2105262?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Juliana Da Silva Viana (https://sciprofiles.com/profile/author/SWZCbjJJSlBBaVAvVlh2TUJWZm1ERkp0cU1weEU2TTVYQzZ0VDJONE1Wb082dkFiN0E5Y1lNM1VTRG5kTnNFKw==?utm_source=mdpi.com&utm_medium=, Pei Jean Tan (https://sciprofiles.com/profile/author/UnNsWThXOEVDWGI0ZmwwWGk4d1BhOXNqSFNiL01adWtXOGVDcjdCRkl4dz0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Denver D. Britto (https://sciprofiles.com/profile/author/NlVlbVphSjVYcXNuMFM1UUJLU3hsKzh4UXRyY21wWnJlbWkvS3FBby8xST0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Sy Bing Choi (https://sciprofiles.com/profile/author/aERsd3pvbnNZWTZCQTFpYUpTQUVpblBLbUdLYWY2a2pFY2Q5c1dFcnZkbz0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Sakurako Kobayashi (https://sciprofiles.com/profile/author/TDJOWGtKTWNMTGczbUw1TUp3a1gvbVllWElDbEg1Z3BRZ0p2cWtxRm95UT0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_nam, Norazwana Samat (https://sciprofiles.com/profile/author/eEFIMGw2cHZ0NDlUb0Z3TThmckN4V0F5T1VUKzhzdXQ2eXd3cG8zRVZ3Zz0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Dedrick Soon Seng Song (https://sciprofiles.com/profile/author/UElWMVlCZDJPV0VCaEZMeUo0RVd2L3ZTQTFJeW5Nb1pKNHhtcEdod3dSZz0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_, Satoshi Ogawa (https://sciprofiles.com/profile/847155?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Ishwar S. Parhar (https://sciprofiles.com/profile/3335910?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Jonathan W. Astin (https://sciprofiles.com/profile/1160957?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Benjamin M. Hogan (https://sciprofiles.com/profile/author/M0ZQaTlveXc3QkM0djk5RCsrdGNOV0Q1ekh3OEp0NXpQR0xxaUJ5T3JUbz0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Vyomesh Patel (https://sciprofiles.com/profile/author/eEVBelV3TGJZcDZEeIJKNnluNDNob21XbWhadndOYTNzOGpmaUpJcjRxRT0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name) and Kazuhide S. Okuda (https://sciprofiles.com/profile/810504?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)

Pharmaceuticals **2024**, *17*(1), 108; https://doi.org/10.3390/ph17010108 (https://doi.org/10.3390/ph17010108) - 12 Jan 2024

Abstract Tumour-associated angiogenesis play key roles in tumour growth and cancer metastasis. Consequently, several anti-angiogenic drugs such as sunitinib and axitinib have been approved for use as anti-cancer therapies. However, the majority of these drugs target the vascular endothelial growth factor A (VEGFA)/VEGF receptor [...] Read more.

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Open Access Article 20 pages, 4248 KiB (/1424-8247/17/1/107/pdf?version=1705049179)

Chrysin Directing an Enhanced Solubility through the Formation of a Supramolecular Cyclodextrin–Calixarene Drug Delivery System: A Potential Strategy in Antifibrotic Diabetes Therapeutics (/1424-8247/17/1/107)

by Anca Hermenean (https://sciprofiles.com/profile/26486?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Eleftheria Dossi (https://sciprofiles.com/profile/3285245?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Alex Hamilton (https://sciprofiles.com/profile/author/MGVGRHREbGZUa3Q1L21vbkNGZnh2L29ObWNoY21CdUl3aWc4Szkzd3Jiaz0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Maria Consiglia Trotta (https://sciprofiles.com/profile/1904337?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Marina Russo (https://sciprofiles.com/profile/2690083?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Caterina Claudia Lepre (https://sciprofiles.com/profile/author/NkkwdWQxdWs1cjB1RnFnWEN2VngrWWtraXBmbTZrV1ZMcWluVkVkdHNsUT0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_n, Csilla Sajtos (https://sciprofiles.com/profile/3372676?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Ágnes Rusznyák (https://sciprofiles.com/profile/1053510?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Judit Váradi (https://sciprofiles.com/profile/219530?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Ildikó Bácskay (https://sciprofiles.com/profile/115535?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), István Budai (https://sciprofiles.com/profile/1151650?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Michele D'Amico (https://sciprofiles.com/profile/291314?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name) and Ferenc Fenyvesi (https://sciprofiles.com/profile/121282?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)

Pharmaceuticals **2024**, *17*(1), 107; https://doi.org/10.3390/ph17010107 (https://doi.org/10.3390/ph17010107) - 12 Jan 2024

Abstract Calixarene 0118 (OTX008) and chrysin (CHR) are promising molecules for the treatment of fibrosis and diabetes complications but require an effective delivery system to overcome their low solubility and bioavailability. Sulfobutylated β-cyclodextrin (SBECD) was evaluated for its ability to increase the solubility of [...] Read more.

(This article belongs to the Special Issue Cyclodextrin-Based Drug Delivery System and Its Pharmaceutical and Biomedical Application 2024 (/journal/pharmaceuticals/special_issues/15K64B2F1Y))

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Open Access Article 14 pages, 252 KiB (/1424-8247/17/1/106/pdf?version=1705044433)

Improving Drug Safety in Pediatric and Young Adult Patients with Hemato-Oncological Diseases: A Prospective Study of Active Pharmacovigilance (/1424-8247/17/1/106)

by
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Pharmaceuticals **2024**, *17*(1), 106; https://doi.org/10.3390/ph17010106 (https://doi.org/10.3390/ph17010106) - 12 Jan 2024

Abstract The acquisition of relevant pediatric clinical safety data is essential to ensure tolerable drug therapies. Comparing the real number of Adverse Drug Reaction (ADR) reports in clinical practice with the literature, the idea of ADR underreporting emerges. An active pharmacovigilance observational prospective study [...] Read more.
(This article belongs to the Special Issue Pharmacology of Pediatric Medicines (/journal/pharmaceuticals/special_issues/Pediatric_Medicines))

Open Access Editorial 8 pages, 262 KiB (/1424-8247/17/1/105/pdf?version=1705030568)

Aptamers' Potential to Fill Therapeutic and Diagnostic Gaps (/1424-8247/17/1/105)

by Alfredo Berzal-Herranz (https://sciprofiles.com/profile/19235?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name) and
Cristina Romero-López (https://sciprofiles.com/profile/180902?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)
Pharmaceuticals **2024**, *17*(1), 105; https://doi.org/10.3390/ph17010105 (https://doi.org/10.3390/ph17010105) - 12 Jan 2024

Abstract More than 30 years ago, in 1990, three independent research groups published several papers demonstrating that genetics could be performed in vitro in the absence of living organisms or cells [...] Full article (/1424-8247/17/1/105)
(This article belongs to the Special Issue Potential of the Aptamers to Fill Therapeutic and Diagnostic Gaps (/journal/pharmaceuticals/special_issues/pharm_aptamers))

Open Access Article 19 pages, 19277 KiB (/1424-8247/17/1/99/pdf?version=1704962335)

Liuwei Dihuang Pills Enhance Osteogenic Differentiation in MC3T3-E1 Cells through the Activation of the Wnt/β-Catenin Signaling Pathway (/1424-8247/17/1/99)

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Pharmaceuticals **2024**, *17*(1), 99; https://doi.org/10.3390/ph17010099 (https://doi.org/10.3390/ph17010099) - 11 Jan 2024

Abstract Objective: The therapeutic efficacy and molecular mechanisms of traditional Chinese medicines (TCMs), such as Liuwei Dihuang pills (LWDH pills), in treating osteoporosis (OP) remain an area of active research and interest in modern medicine. This study investigated the mechanistic underpinnings of LWDH pills [...] Read more.
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Open Access Article 19 pages, 3273 KiB (/1424-8247/17/1/98/pdf?version=1704953141)

The Study on Timolol and Its Potential Phototoxicity Using Chemical, In Silico and In Vitro Methods (/1424-8247/17/1/98)

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Pharmaceuticals **2024**, *17*(1), 98; https://doi.org/10.3390/ph17010098 (https://doi.org/10.3390/ph17010098) - 11 Jan 2024

Abstract Timolol (TIM) is a non-selective ß-adrenergic receptor antagonist used orally for the treatment of hypertension and heart attacks, and topically for treating glaucoma; lately, it has also been used in some specific dermatological problems. In the present study, its photodegradation and potential risk [...] Read more.
(This article belongs to the Special Issue Advances in Drug Analysis and Drug Development (/journal/pharmaceuticals/special_issues/1OF90ZP65X))

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Open Access Editorial 2 pages, 153 KiB (/1424-8247/17/1/97/pdf?version=1704949472)

Immune Diseases: Challenges, Hopes and Recent Achievements (/1424-8247/17/1/97)

by François Dufrasne (https://sciprofiles.com/profile/121564?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)

Pharmaceuticals **2024**, *17*(1), 97; https://doi.org/10.3390/ph17010097 (https://doi.org/10.3390/ph17010097) - 11 Jan 2024

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Abstract Although they have been greatly described for about 50 years, we have gained a much greater understanding of immune diseases since the beginning of this millennium [...] **Full article (/1424-8247/17/1/97)**

(This article belongs to the Special Issue **Drug Candidates for the Treatment of Immune Disease 2023 (/journal/pharmaceuticals/special_issues/YL49G89Y51)**)

Open Access Review 50 pages, 11795 KiB (/1424-8247/17/1/104/pdf?version=1705053114)

Recent Advances in Pyrimidine-Based Drugs (/1424-8247/17/1/104)

by Baskar Nammalwar (https://sciprofiles.com/profile/3288930?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name) and Richard A. Bunce (https://sciprofiles.com/profile/63392?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)

Pharmaceuticals **2024**, *17*(1), 104; https://doi.org/10.3390/ph17010104 (https://doi.org/10.3390/ph17010104) - 11 Jan 2024

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Abstract Pyrimidines have become an increasingly important core structure in many drug molecules over the past 60 years. This article surveys recent areas in which pyrimidines have had a major impact in drug discovery therapeutics, including anti-infectives, anticancer, immunology, immuno-oncology, neurological disorders, chronic pain, [...] **Read more.**

(This article belongs to the Special Issue **Heterocyclic Compounds in Medicinal Chemistry (/journal/pharmaceuticals/special_issues/GC66SFS95K)**)

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Open Access Article 40 pages, 8102 KiB (/1424-8247/17/1/103/pdf?version=1704983393)

Comprehensive Tools of Alkaloid/Volatile Compounds–Metabolomics and DNA Profiles: Bioassay-Role-Guided Differentiation Process of Six *Annona* sp. Grown in Egypt as Anticancer Therapy (/1424-8247/17/1/103)

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Pharmaceuticals **2024**, *17*(1), 103; https://doi.org/10.3390/ph17010103 (https://doi.org/10.3390/ph17010103) - 11 Jan 2024

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Abstract Trees of the *Annona* species that grow in the tropics and subtropics contain compounds that are highly valuable for pharmacological research and medication development and have anticancer, antioxidant, and migratory properties. Metabolomics was used to functionally characterize natural products and to distinguish differences **[...] Read more.**
(This article belongs to the Special Issue **Bioactive Compounds and Their Optimized Structural Derivatives of Natural Products (/journal/pharmaceuticals/special_issues/I9D0U8C792)**)

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Open Access Article 15 pages, 16823 KiB (/1424-8247/17/1/102/pdf?version=1704975578)

An Integrated Computational and Experimental Approach to Formulate Tamanu Oil Bigels as Anti-Scarring Agent (/1424-8247/17/1/102)

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Pharmaceuticals **2024**, *17*(1), 102; **https://doi.org/10.3390/ph17010102 (https://doi.org/10.3390/ph17010102)** - 11 Jan 2024

Abstract Tamanu oil has traditionally been used to treat various skin problems. The oil has wound-healing and skin-regenerating capabilities and encourages the growth of new skin cells, all of which are helpful for fading scars and hyperpigmentation, as well as promoting an all-around glow. **[...] Read more.**
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Open Access Article 12 pages, 1072 KiB (/1424-8247/17/1/101/pdf?version=1704962943)

Safety and Efficacy of Selective Internal Radionuclide Therapy with ^{90}Y Glass Microspheres in Patients with Progressive Hepatocellular Carcinoma after the Failure of Repeated Transarterial Chemoembolization (/1424-8247/17/1/101)

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Pharmaceuticals **2024**, *17*(1), 101; **https://doi.org/10.3390/ph17010101 (https://doi.org/10.3390/ph17010101)** - 11 Jan 2024

Abstract Transarterial chemoembolization (TACE) is currently the standard of care in patients with unresectable hepatocellular carcinoma (HCC), and selective internal radionuclide therapy (SIRT) with ^{90}Y microspheres is mainly used as an alternative modality in patients considered poor candidates for TACE. Treatment with sorafenib **[...] Read more.**
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From PROTAC to TPD: Advances and Opportunities in Targeted Protein Degradation (/1424-8247/17/1/100)

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Pharmaceuticals **2024**, *17*(1), 100; **https://doi.org/10.3390/ph17010100 (https://doi.org/10.3390/ph17010100)** - 11 Jan 2024

Abstract PROTAC is a rapidly developing engineering technology for targeted protein degradation using the ubiquitin–proteasome system, which has promising applications for inflammatory diseases, neurodegenerative diseases, and malignant tumors. This paper gives a brief overview of the development and design principles of PROTAC, with a **[...] Read more.**
(This article belongs to the Section **Pharmacology (/journal/pharmaceuticals/sections/pharm-pharmacology)**)

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Open Access Article 26 pages, 7325 KiB (/1424-8247/17/1/96/pdf?version=1704961958)

Fabrication of Nanocrystals for Enhanced Distribution of a Fatty Acid Synthase Inhibitor (Orlistat) as a Promising Method to Relieve Solid Ehrlich Carcinoma-Induced Hepatic Damage in Mice (/1424-8247/17/1/96)

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Pharmaceuticals **2024**, *17*(1), 96; https://doi.org/10.3390/ph17010096 (https://doi.org/10.3390/ph17010096) - 10 Jan 2024

Abstract Background: Orlistat (ORL) is an effective irreversible inhibitor of the lipase enzyme, and it possesses anticancer effects and limited aqueous solubility. This study was designed to improve the aqueous solubility, oral absorption, and tissue distribution of ORL via the formulation of nanocrystals (NCs). [...] Read more.
(This article belongs to the Special Issue Recent Progress of Nanomedicine and Targeted Drug Delivery for Cancer Treatment 2.0 (/journal/pharmaceuticals/special_issues/894Y393QL6))

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Logistic Regression Is Non-Inferior to the Response Surface Model in Patient Response Prediction of Video-Assisted Thoracoscopic Surgery (/1424-8247/17/1/95)

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Pharmaceuticals **2024**, *17*(1), 95; https://doi.org/10.3390/ph17010095 (https://doi.org/10.3390/ph17010095) - 10 Jan 2024

Abstract Response surface models (RSMs) are a new trend in modern anesthesia. RSMs have demonstrated significant applicability in the field of anesthesia. However, the comparative analysis between RSMs and logistic regression (LR) in different surgeries remains relatively limited in the current literature. We hypothesized [...] Read more.
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Open Access Article 16 pages, 4513 KiB (/1424-8247/17/1/94/pdf?version=1704878230)

Improvement of the Thermal Stability and Aqueous Solubility of Three Matrine Salts Assembled by the Similar Structure Salt Formers (/1424-8247/17/1/94)

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Pharmaceuticals **2024**, *17*(1), 94; https://doi.org/10.3390/ph17010094 (https://doi.org/10.3390/ph17010094) - 10 Jan 2024

Abstract Matrine (MAT), a natural Chinese herbal medicine, has a unique advantage in the treatment of various chronic diseases. However, its low melting point, low bioavailability, and high dosage restrict its subsequent development into new drugs. In this study, three kinds of MAT salts, [...] Read more.
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Open Access Article 15 pages, 18328 KiB (/1424-8247/17/1/93/pdf?version=1704879279)

Mesenchymal Stem Cell-Derived Exosomes Ameliorate Doxorubicin-Induced Cardiotoxicity (/1424-8247/17/1/93)

by Sawdah A. Ali (https://sciprofiles.com/profile/3324213?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name) and
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Pharmaceuticals **2024**, *17*(1), 93; https://doi.org/10.3390/ph17010093 (https://doi.org/10.3390/ph17010093) - 10 Jan 2024

Abstract Doxorubicin (DOX) is an incessantly used chemotherapeutic drug that can cause detrimental dose-dependent effects such as cardiotoxicity and congestive heart failure. Hence, there is a need to discover innovative therapeutic approaches to counteract DOX-induced cardiotoxicity (DIC). MSC-Exos have shown to reduce apoptosis and [...] Read more.
(This article belongs to the Special Issue Cancer Drugs Treatment and Toxicity 2023 (/journal/pharmaceuticals/special_issues/676TJN75KC))

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Open Access Opinion 11 pages, 1338 KiB (/1424-8247/17/1/92/pdf?version=1704875245)

Chemical Adjustment of Fibrinolysis (/1424-8247/17/1/92)

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Pharmaceuticals **2024**, *17*(1), 92; https://doi.org/10.3390/ph17010092 (https://doi.org/10.3390/ph17010092) - 10 Jan 2024

Abstract Fibrinolysis is the process of the fibrin–platelet clot dissolution initiated after bleeding has been stopped. It is regulated by a cascade of proteolytic enzymes with plasmin at its core. In pathological cases, the balance of normal clot formation and dissolution is replaced by [...] Read more.
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The Immune-Stimulating and Anti-Diabetic Effects of *Allium hookeri* Leaves Grown in a Plant Factory with Artificial Lights in Immunosuppressed Obese C57BL/6 Mice (/1424-8247/17/1/91)

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Pharmaceuticals **2024**, *17*(1), 91; https://doi.org/10.3390/ph17010091 (https://doi.org/10.3390/ph17010091) - 09 Jan 2024

Abstract We investigated the immune-stimulating and anti-diabetic effects of *Allium hookeri* leaves grown in a plant factory with artificial lights. The immunomodulatory effects of *A. hookeri* leaves' ethanol extracts were evaluated with immune-related hematological factors in blood, the proliferation of splenocytes, NK cell activity, [...] Read more.
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Drug-Induced Anaphylaxis: National Database Analysis (/1424-8247/17/1/90)

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Pharmaceuticals **2024**, *17*(1), 90; https://doi.org/10.3390/ph17010090 (https://doi.org/10.3390/ph17010090) - 09 Jan 2024

Abstract (1) Background: National health system databases represent an important source of information about the epidemiology of adverse drug reactions including drug-induced allergy and anaphylaxis. Analysis of such databases may enhance the knowledge of healthcare professionals regarding the problem of drug-induced anaphylaxis. (2) Methods: [...] Read more.
(This article belongs to the Special Issue Therapeutic Drug Monitoring and Adverse Drug Reactions (/journal/pharmaceuticals/special_issues/Q4B8E1FM23))

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Biochanin A Inhibits the Growth and Biofilm of *Candida* Species (/1424-8247/17/1/89)

by Monika Janeczko (https://sciprofiles.com/profile/3305705?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name) and
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Pharmaceuticals **2024**, *17*(1), 89; https://doi.org/10.3390/ph17010089 (https://doi.org/10.3390/ph17010089) - 09 Jan 2024

Abstract The aim of this study was to investigate the antifungal activity of biochanin A (BCA) against planktonic growth and biofilms of six *Candida* species, including *C. albicans*, *C. parapsilosis*, *C. glabrata*, *C. tropicalis*, *C. auris*, and *C. krusei* **[...] Read more.**
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Towards a New Generation of Hormone Therapies: Design, Synthesis and Biological Evaluation of Novel 1,2,3-Triazoles as Estrogen-Positive Breast Cancer Therapeutics and Non-Steroidal Aromatase Inhibitors (/1424-8247/17/1/88)

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Pharmaceuticals **2024**, *17*(1), 88; https://doi.org/10.3390/ph17010088 (https://doi.org/10.3390/ph17010088) - 09 Jan 2024

Abstract Aromatase inhibitors (AIs) show promising features as drugs to treat estrogen-responsive breast cancer as they block aromatase activity, the key enzyme in estrogen synthesis. The current AIs approved by the Food and Drug Administration for breast cancer treatment present severe adverse effects. For **[...] Read more.**
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An ADAM10 Exosite Inhibitor Is Efficacious in an In Vivo Collagen-Induced Arthritis Model (/1424-8247/17/1/87)

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Pharmaceuticals **2024**, *17*(1), 87; https://doi.org/10.3390/ph17010087 (https://doi.org/10.3390/ph17010087) - 09 Jan 2024

Abstract Rheumatoid arthritis is a systemic autoimmune inflammatory disease that affects millions of people worldwide. There are multiple disease-modifying anti-rheumatic drugs available; however, many patients do not respond to any treatment. A disintegrin and metalloproteinase 10 has been suggested as a potential new target **[...] Read more.**
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Total Synthesis and Anti-Inflammatory Evaluation of Osajin, Scandenone and Analogues (/1424-8247/17/1/86)

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Pharmaceuticals **2024**, *17*(1), 86; https://doi.org/10.3390/ph17010086 (https://doi.org/10.3390/ph17010086) - 09 Jan 2024

Abstract In this study, the total synthesis of osajin, scandenone and their analogues have been accomplished. The key synthetic steps include aldol/intramolecular iodoetherification/elimination sequence reactions and a Suzuki coupling reaction to assemble the tricyclic core, chemoselective propargylation and Claisen rearrangement reactions to obtain natural **[...] Read more.**
(This article belongs to the Special Issue **Design, Synthesis and Biological Evaluation with Potential Anti-inflammatory Activity (/journal/pharmaceuticals/special_issues/E3ZL8ZIM5M)**)

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Involvement of the Expression of G Protein-Coupled Receptors in Schizophrenia (/1424-8247/17/1/85)

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Pharmaceuticals **2024**, *17*(1), 85; https://doi.org/10.3390/ph17010085 (https://doi.org/10.3390/ph17010085) - 09 Jan 2024

Abstract The expression of GPCRs has been associated with schizophrenia, and their expression may induce morphological changes in brain regions responsible for schizophrenia and disease-specific behavioral changes. The articles included in this review were selected using keywords and databases of scientific research websites. The [...] Read more.
(This article belongs to the Special Issue Recent Advances in Drug Discovery and Evaluation for the Treatment of Affective Disorders and Schizophrenia (/journal/pharmaceuticals/special_issues/4E9F06KC0U))

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Open Access Review 24 pages, 1475 KiB (/1424-8247/17/1/84/pdf?version=1704792347)

Berries vs. Disease: Revenge of the Phytochemicals (/1424-8247/17/1/84)

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Pharmaceuticals **2024**, *17*(1), 84; https://doi.org/10.3390/ph17010084 (https://doi.org/10.3390/ph17010084) - 09 Jan 2024

Abstract Secondary metabolites and phytochemicals in plant-based diets are known to possess properties that inhibit the development of several diseases including a variety of cancers of the aerodigestive tract. Berries are currently of high interest to researchers due to their high dietary source of [...] Read more.
(This article belongs to the Special Issue Naturally-Occurring Dietary Compounds for Cancer Prevention and Therapy (/journal/pharmaceuticals/special_issues/80I809T6B8))

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Open Access Article 15 pages, 2211 KiB (/1424-8247/17/1/83/pdf?version=1704784087)

The Designed Pore-Forming Antimicrobial Peptide C14R Combines Excellent Activity against the Major Opportunistic Human Pathogen *Pseudomonas aeruginosa* with Low Cytotoxicity (/1424-8247/17/1/83)

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Pharmaceuticals **2024**, *17*(1), 83; https://doi.org/10.3390/ph17010083 (https://doi.org/10.3390/ph17010083) - 09 Jan 2024

Abstract The diminishing portfolio of mankind's available antibiotics urges science to develop novel potent drugs. Here, we present a peptide fitting the typical blueprint of amphipathic and membrane-active antimicrobial peptides, denominated C14R. This 2 kDa peptide consists of 16 amino acid residues, with seven [...] Read more.
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Open Access Article 11 pages, 1067 KiB (/1424-8247/17/1/82/pdf?version=1706178259)

Lansoprazole Ameliorates Isoniazid-Induced Liver Injury (/1424-8247/17/1/82)

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Pharmaceuticals **2024**, *17*(1), 82; https://doi.org/10.3390/ph17010082 (https://doi.org/10.3390/ph17010082) - 08 Jan 2024

Abstract Isoniazid is a first-line drug in antitubercular therapy. Isoniazid is one of the most commonly used drugs that can cause liver injury or acute liver failure, leading to death or emergency liver transplantation. Therapeutic approaches for the prevention of isoniazid-induced liver injury are [...] Read more.
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Open Access Article 21 pages, 5588 KiB (/1424-8247/17/1/81/pdf?version=1705374803)

1,2,4-Triazole-Tethered Indolinones as New Cancer-Fighting Small Molecules Targeting VEGFR-2: Synthesis, Biological Evaluations and Molecular Docking (/1424-8247/17/1/81)

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Pharmaceuticals **2024**, *17*(1), 81; https://doi.org/10.3390/ph17010081 (https://doi.org/10.3390/ph17010081) - 08 Jan 2024

Abstract Targeting the VEGFR-2 signaling pathway is an inveterate approach toward combating pancreatic and hepatocellular cancers. Based on Sunitinib, the FDA-approved VEGFR-2 inhibitor, novel indolin-2-one-triazole hybrids were designed and synthesized as anti-hepatocellular and anti-pancreatic cancer agents with VEGFR-2 inhibitory activity. All the targeted compounds **[...] Read more.**

(This article belongs to the Special Issue **The Role of Molecular Docking in the Design of Targeted Therapeutic Entities and Nanomaterials (/journal/pharmaceuticals/special_issues/572083346P)**)

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Identification of Antagonistic Action of Pyrrolizidine Alkaloids in Muscarinic Acetylcholine Receptor M1 by Computational Target Prediction Analysis (/1424-8247/17/1/80)

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Pharmaceuticals **2024**, *17*(1), 80; https://doi.org/10.3390/ph17010080 (https://doi.org/10.3390/ph17010080) - 08 Jan 2024

Abstract Pyrrolizidine alkaloids (PAs) are one of the largest distributed classes of toxins in nature. They have a wide range of toxicity, such as hepatotoxicity, pulmonary toxicity, neuronal toxicity, and carcinogenesis. Yet, biological targets responsible for these effects are not well addressed. Using methods **[...] Read more.**

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Open Access Article 13 pages, 6863 KiB (/1424-8247/17/1/79/pdf?version=1704709149)

Cytocidal Effect of Irradiation on Gastric Cancer Cells Infected with a Recombinant Mammalian Orthoreovirus Expressing a Membrane-Targeted KillerRed (/1424-8247/17/1/79)

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Pharmaceuticals **2024**, *17*(1), 79; https://doi.org/10.3390/ph17010079 (https://doi.org/10.3390/ph17010079) - 08 Jan 2024

Abstract The outcomes of unresectable gastric cancer (GC) are unfavorable even with chemotherapy; therefore, a new treatment modality is required. The combination of an oncolytic virus and photodynamic therapy can be one of the promising modalities to overcome this. Mammalian orthoreovirus (MRV) is an **[...] Read more.**

(This article belongs to the Special Issue **Oncolytic Viruses: New Cancer Immunotherapy Drugs (/journal/pharmaceuticals/special_issues/OGG8G1O1AY)**)

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Open Access Article 14 pages, 1823 KiB (/1424-8247/17/1/78/pdf?version=1704703664)

Medication Dosage Impact on Mortality in Old-Age Individuals with Schizophrenia: A National Cohort Study (/1424-8247/17/1/78)

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Pharmaceuticals **2024**, *17*(1), 78; https://doi.org/10.3390/ph17010078 (https://doi.org/10.3390/ph17010078) - 08 Jan 2024

Abstract As the prevalence of old-age individuals with schizophrenia (OAS) increases in a society undergoing demographic aging, the exploration of medication choices becomes increasingly crucial. Due to the current scarcity of literature on OAS, this study seeks to examine how the utilization and cumulative **[...] Read more.**

(This article belongs to the Special Issue **Recent Advances in Drug Discovery and Evaluation for the Treatment of Affective Disorders and Schizophrenia (/journal/pharmaceuticals/special_issues/4E9F06KC0U)**)

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Topical Delivery of Tofacitinib in Dermatology: The Promise of a Novel Therapeutic Class Using Biodegradable Dendritic Polyglycerol Sulfates (/1424-8247/17/1/77)

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Pharmaceuticals **2024**, *17*(1), 77; https://doi.org/10.3390/ph17010077 (https://doi.org/10.3390/ph17010077) - 08 Jan 2024

Abstract Inflammatory skin diseases, such as psoriasis, atopic dermatitis, and alopecia areata, occur when the regulatory tolerance of the innate immune system is disrupted, resulting in the activation of the Janus kinase-signal transducer and activator of transcription (JAK-STAT) inflammatory signaling pathway by interleukin 6 [...] Read more.
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Alpha-Emitting Radionuclides: Current Status and Future Perspectives (/1424-8247/17/1/76)

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Pharmaceuticals **2024**, *17*(1), 76; https://doi.org/10.3390/ph17010076 (https://doi.org/10.3390/ph17010076) - 08 Jan 2024

Abstract The use of radionuclides for targeted endoradiotherapy is a rapidly growing field in oncology. In particular, the focus on the biological effects of different radiation qualities is an important factor in understanding and implementing new therapies. Together with the combined approach of imaging [...] Read more.
(This article belongs to the Special Issue Therapeutic Radionuclides in Nuclear Medicine (/journal/pharmaceuticals/special_issues/M8TAS21VQU))

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A Novel Combined Dry Powder Inhaler Comprising Nanosized Ketoprofen-Embedded Mannitol-Coated Microparticles for Pulmonary Inflammations: Development, In Vitro–In Silico Characterization, and Cell Line Evaluation (/1424-8247/17/1/75)

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Pharmaceuticals **2024**, *17*(1), 75; https://doi.org/10.3390/ph17010075 (https://doi.org/10.3390/ph17010075) - 07 Jan 2024

Abstract Pulmonary inflammations such as chronic obstructive pulmonary disease and cystic fibrosis are widespread and can be fatal, especially when they are characterized by abnormal mucus accumulation. Inhaled corticosteroids are commonly used for lung inflammations despite their considerable side effects. By utilizing particle engineering [...] Read more.
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The Bi-(AID-1-T) G-Quadruplex Has a Janus Effect on Primary and Recurrent Gliomas: Anti-Proliferation and Pro-Migration (/1424-8247/17/1/74)

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Pharmaceuticals **2024**, *17*(1), 74; https://doi.org/10.3390/ph17010074 (https://doi.org/10.3390/ph17010074) - 07 Jan 2024

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Abstract High-grade gliomas are considered an incurable disease. Despite all the various therapy options available, patient survival remains low, and the tumor usually returns. Tumor resistance to conventional therapy and stimulation of the migratory activity of surviving cells are the main factors that lead [...] Read more.

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Open Access Article 17 pages, 5445 KiB (/1424-8247/17/1/73/pdf?version=1704680648)

Assessing Nasal Epithelial Dynamics: Impact of the Natural Nasal Cycle on Intranasal Spray Deposition (/1424-8247/17/1/73)

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Pharmaceuticals **2024**, *17*(1), 73; https://doi.org/10.3390/ph17010073 (https://doi.org/10.3390/ph17010073) - 06 Jan 2024

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Abstract This study investigated the intricate dynamics of intranasal spray deposition within nasal models, considering variations in head orientation and stages of the nasal cycle. Employing controlled delivery conditions, we compared the deposition patterns of saline nasal sprays in models representing congestion (N1), normal [...] Read more.

(This article belongs to the Special Issue Advances in Pharmaceutical Sciences: In Honor of Dr. Jean Jacques Vanden Eynde (JJ) (/journal/pharmaceuticals/special_issues/VN5JPSXZW9))

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A Preliminary Study on Hepatoprotective, Hypolipidemic and Aortic Morphometric Effects of Omega-3-Rich Fish Oil in Hypercholesterolemic Mice (/1424-8247/17/1/72)

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Pharmaceuticals **2024**, *17*(1), 72; https://doi.org/10.3390/ph17010072 (https://doi.org/10.3390/ph17010072) - 06 Jan 2024

Viewed by 604

Abstract This study aims to evaluate the hepatoprotective, hypolipidemic and aortic morphometric effects of fish oil rich in omega-3 in hypercholesterolemic BALB/c mice. This is an experimental model that included 16 male BALB/c mice (*Mus musculus*) divided into three groups (G1 (standard [...] Read more.

(This article belongs to the Section Medicinal Chemistry (/journal/pharmaceuticals/sections/pharm_medicinal_chemistry))

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Open Access Brief Report 9 pages, 791 KiB (/1424-8247/17/1/71/pdf?version=1704350495)

Using Nutraceuticals to Help Manage Traumatic Spinal Cord Injury (/1424-8247/17/1/71)

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Pharmaceuticals **2024**, *17*(1), 71; https://doi.org/10.3390/ph17010071 (https://doi.org/10.3390/ph17010071) - 04 Jan 2024

Abstract Traumatic spinal cord injury (TSCI) is a significant public health challenge that has an adverse impact on functional independence, quality of life, and life expectancy. Management of people's chronic conditions is a key aspect of contemporary medical practice. Our study was an open [...] Read more.

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Open Access Article 14 pages, 2458 KiB (/1424-8247/17/1/70/pdf?version=1704339003)

Researching New Drug Combinations with Senolytic Activity Using Senescent Human Lung Fibroblasts MRC-5 Cell Line (/1424-8247/17/1/70)

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Pharmaceuticals **2024**, *17*(1), 70; https://doi.org/10.3390/ph17010070 (https://doi.org/10.3390/ph17010070) - 04 Jan 2024

Abstract Therapeutically targeting senescent cells seems to be an interesting perspective in treating chronic lung diseases, which are often associated with human aging. The combination of the drug dasatinib and the polyphenol quercetin is used in clinical trials as a senolytic, and the first [...] Read more.

(This article belongs to the Special Issue Targeting Apoptosis as a Strategy for Developing New Drugs (/journal/pharmaceuticals/special_issues/7R94ZW8W79))

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Open Access Article 11 pages, 561 KiB (/1424-8247/17/1/69/pdf?version=1704276888)

Use of Exposure Data to Establish Causality in Drug–Adverse Event Relationships: An Example with Desvenlafaxine (/1424-8247/17/1/69)

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Pharmaceuticals **2024**, *17*(1), 69; https://doi.org/10.3390/ph17010069 (https://doi.org/10.3390/ph17010069) - 03 Jan 2024

Abstract Causality algorithms help establish relationships between drug use and adverse event (AE) occurrence. High drug exposure leads to a higher likelihood of an AE being classified as an adverse drug reaction (ADR). However, there is a knowledge gap regarding what concentrations are predictive [...] Read more.

(This article belongs to the Special Issue Sex Differences in Pharmaceutical Practice (/journal/pharmaceuticals/special_issues/F63P58TAQE))

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Open Access Article 19 pages, 2777 KiB (/1424-8247/17/1/68/pdf?version=1704333524)

Antibacterial Action of Protein Fraction Isolated from *Rapana venosa* Hemolymph against *Escherichia coli* NBIMCC 8785 (/1424-8247/17/1/68)

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Pharmaceuticals **2024**, *17*(1), 68; https://doi.org/10.3390/ph17010068 (https://doi.org/10.3390/ph17010068) - 03 Jan 2024

Abstract Natural products and especially those from marine organisms are being intensively explored as an alternative to synthetic antibiotics. However, the exact mechanisms of their action are not yet well understood. The molecular masses of components in the hemolymph fraction with MW 50–100 kDa [...] Read more.

(This article belongs to the Special Issue Pharmaceutical Functions of Natural Compounds Derived from Molluscs and Arthropods (/journal/pharmaceuticals/special_issues/706V954144))

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Open Access Article 22 pages, 6994 KiB (/1424-8247/17/1/67/pdf?version=1704170277)

Examining the Antioxidant and Superoxide Radical Scavenging Activity of Anise, (*Pimpinella anisum* L. Seeds), Esculetin, and 4-Methyl-Esculetin Using X-ray Diffraction, Hydrodynamic Voltammetry and DFT Methods (/1424-8247/17/1/67)

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Pharmaceuticals **2024**, *17*(1), 67; https://doi.org/10.3390/ph17010067 (https://doi.org/10.3390/ph17010067) - 31 Dec 2023

Abstract *Pimpinella anisum* L., or anise, is a plant that, besides its nutritional value, has been used in traditional medical practices and described in many cultures in the Mediterranean region. A possible reason for anise's therapeutic value is that it contains coumarins, which are **[...] Read more.**
(This article belongs to the Special Issue **Natural Coumarins as Lead Compounds and Their Synthetic Analogues with Biological Activities (/journal/pharmaceuticals/special_issues/95T87NB5A0)**)

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Open Access Article 23 pages, 8044 KiB (/1424-8247/17/1/66/pdf?version=1703930258)

Consumption of Policosanol (Raydel®) Improves Hepatic, Renal, and Reproductive Functions in Zebrafish: In Vivo Comparison Study among Cuban, Chinese, and American Policosanol (/1424-8247/17/1/66)

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Pharmaceuticals **2024**, *17*(1), 66; **https://doi.org/10.3390/ph17010066 (https://doi.org/10.3390/ph17010066)** - 30 Dec 2023

Abstract The current study compared three policosanols from Cuba (sugarcane, Raydel®, policosanol (1), China (rice bran, Shaanxi, policosanol (2), and the USA (sugarcane, Lesstanol®, policosanol (3) in the treatment of dyslipidemia and protection of the liver, ovary, and testis in **[...] Read more.**
(This article belongs to the Special Issue **Bioactive Substances, Oxidative Stress, and Inflammation (/journal/pharmaceuticals/special_issues/90CI66403U)**)

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A Narrative Review: Analysis of Supplemental Parenteral Nutrition in Adults at the End of Life (/1424-8247/17/1/65)

by **Francisco Rivas García (https://sciprofiles.com/profile/2935749?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)**,
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Pharmaceuticals **2024**, *17*(1), 65; **https://doi.org/10.3390/ph17010065 (https://doi.org/10.3390/ph17010065)** - 30 Dec 2023

Abstract "End of life" is a stage defined by the existence of an irreversible prognosis that ends with a person's death. One of the aspects of interest regarding end of life focuses on parenteral nutrition, which is usually administered in order to avoid malnutrition **[...] Read more.**
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Eugenol-Rich Essential Oil from *Pimenta dioica*: In Vitro and In Vivo Potentialities against *Leishmania amazonensis* (/1424-8247/17/1/64)

by **Lianet Monzote (https://sciprofiles.com/profile/429964?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)**,
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Pharmaceuticals **2024**, *17*(1), 64; **https://doi.org/10.3390/ph17010064 (https://doi.org/10.3390/ph17010064)** - 29 Dec 2023

Abstract *Pimenta dioica* L. is one the most recognized species with diverse biological activities. In this study, in vitro activity and in vivo efficacy of essential oil from *P. dioica* (EO-Pd) was evaluated. The main compound was also included in the animal studies and **[...] Read more.**
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Paclitaxel and Therapeutic Drug Monitoring with Microsampling in Clinical Practice (/1424-8247/17/1/63)

by Mirjana Radovanovic (https://sciprofiles.com/profile/2743421?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Peter Galettis (https://sciprofiles.com/profile/2792880?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Alex Flynn (https://sciprofiles.com/profile/author/anozOExMbEVkdE13RzRmWER3Q0djdkxCc3lQRXFLUkpVcmxZY0NzelF2QT0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Jennifer H. Martin (https://sciprofiles.com/profile/2478378?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name) and Jennifer J. Schneider (https://sciprofiles.com/profile/200631?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)

Pharmaceuticals **2024**, *17*(1), 63; https://doi.org/10.3390/ph17010063 (https://doi.org/10.3390/ph17010063) - 29 Dec 2023

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Abstract Paclitaxel is an anticancer agent efficacious in various tumors. There is large interindividual variability in drug plasma concentrations resulting in a wide variability in observed toxicity in patients. Studies have shown the time the concentration of paclitaxel exceeds 0.05 μM is a predictive **[...] Read more.**

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Assessment of Some Unsymmetrical Porphyrins as Promising Molecules for Photodynamic Therapy of Cutaneous Disorders (/1424-8247/17/1/62)

by Andreea Mihaela Burloiu (https://sciprofiles.com/profile/1868622?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Gina Manda (https://sciprofiles.com/profile/97420?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Dumitru Lupuliasa (https://sciprofiles.com/profile/1952748?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Radu Petre Socoteanu (https://sciprofiles.com/profile/121602?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Dragos Paul Mihai (https://sciprofiles.com/profile/327862?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Ionela Victoria Neagoe (https://sciprofiles.com/profile/author/TElqTUNiclRBNlJlYkNwOHFQUHh0YWs0cDJtWkNNU1BhVklHeVlrYzE1MD0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Laurentiu-Iliuta Anghelache (https://sciprofiles.com/profile/3332687?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Mihaela Surcel (https://sciprofiles.com/profile/author/MUdDcXpZbGpmY3NldENiRFBhejRLTVZ3YzZoU2VqeFFsbXAraEE5NXB3cz0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Mihai Anastasescu (https://sciprofiles.com/profile/439795?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Laura Olariu (https://sciprofiles.com/profile/author/d3VGU00xVmlDRit2cnR6UXJCZmxZaHNobHpYZDVFNk5ySERVMU5POEFFMD0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Cerasela Elena Gîrd (https://sciprofiles.com/profile/1059565?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Stefania Felicia Barbuceanu (https://sciprofiles.com/profile/2049162?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Luis Filipe Vieira Ferreira (https://sciprofiles.com/profile/262450?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name) and Rica Boscencu (https://sciprofiles.com/profile/8796?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)

Pharmaceuticals **2024**, *17*(1), 62; https://doi.org/10.3390/ph17010062 (https://doi.org/10.3390/ph17010062) - 29 Dec 2023

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Abstract In order to select for further development novel photosensitizers for photodynamic therapy in cutaneous disorders, three unsymmetrical porphyrins, namely 5-(4-hydroxy-3-methoxyphenyl)-10,15,20-tris-(4-acetoxy-3-methoxyphenyl) porphyrin (P2.2), 5-(2-hydroxy-5-methoxyphenyl)-10,15,20-tris-(4-carboxymethylphenyl) porphyrin (P3.2), and 5-(2,4-dihydroxyphenyl)-10,15,20-tris-(4-acetoxy-3-methoxyphenyl) porphyrin (P4.2), along with their fully symmetrical counterparts 5,10,15,20-tetrakis-(4-acetoxy-3-methoxyphenyl) porphyrin (P2.1) and 5,10,15,20-tetrakis-(4-carboxymethylphenyl) porphyrin (P3.1) were **[...] Read more.**

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Antipsychotics and Mortality in Adult and Geriatric Patients with Schizophrenia (/1424-8247/17/1/61)

by Ling-Ling Yeh (https://sciprofiles.com/profile/1111953?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Wei-Chen Lee (https://sciprofiles.com/profile/author/bC9UYStTWjUwaEl3aUhWNTRyODhHbHVSS1E1eDVuM3Y3MUp1NlFCNjl2az0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name), Kuei-Hong Kuo (https://sciprofiles.com/profile/1728974?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name) and Yi-Ju Pan (https://sciprofiles.com/profile/604194?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)

Pharmaceuticals **2024**, *17*(1), 61; https://doi.org/10.3390/ph17010061 (https://doi.org/10.3390/ph17010061) - 29 Dec 2023

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Abstract Patients with schizophrenia have a high mortality risk, and the role of antipsychotic medications remains inconclusive. In an aging society, older patients with schizophrenia warrant increased attention. This study investigated the association of antipsychotic medication dosages with mortality in patients with schizophrenia by **[...] Read more.**

(This article belongs to the Special Issue **Drug Analysis and Therapeutic Drug Monitoring (/journal/pharmaceuticals/special_issues/1D3UA8YN65)**)

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Open Access Article 12 pages, 2240 KiB (/1424-8247/17/1/60/pdf?version=1703845507)

In Silico Screening of Multi-Domain Targeted Inhibitors for PTK6: A Strategy Integrating Drug Repurposing and Consensus Docking (/1424-8247/17/1/60)

by Yujing Zhou (https://sciprofiles.com/profile/author/bVl1K203aWN1RVRNaXd1eEovMHlDZGRndU5SQm9PWDkvWkszK01xd0gyZz0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name) and Ming Wah Wong (https://sciprofiles.com/profile/117655?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)

Pharmaceuticals **2024**, *17*(1), 60; https://doi.org/10.3390/ph17010060 (https://doi.org/10.3390/ph17010060) - 29 Dec 2023

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Abstract Protein tyrosine kinase 6 (PTK6), also known as breast tumor kinase (BRK), serves as a non-receptor intracellular tyrosine kinase within the Src kinases family. Structurally resembling other Src kinases, PTK6 possesses an Src homology 3 (SH3) domain, an Src homology 2 (SH2) domain, **[...] Read more.**

(This article belongs to the Special Issue **Computer-Aided Drug Design and Drug Discovery (/journal/pharmaceuticals/special_issues/CDY0D8W0CQ)**)

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Open Access Editorial 5 pages, 187 KiB (/1424-8247/17/1/59/pdf?version=1703834177)

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Special Issue “Drug Treatments for Inflammatory Bowel Diseases” (/1424-8247/17/1/59)

by Anderson Luiz-Ferreira (https://sciprofiles.com/profile/28166?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name) and
Carmine Stolfi (https://sciprofiles.com/profile/27928?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)

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Pharmaceuticals **2024**, *17*(1), 59; https://doi.org/10.3390/ph17010059 (https://doi.org/10.3390/ph17010059) - 29 Dec 2023

Abstract Inflammatory bowel diseases (IBD), including Crohn’s disease (CD) and ulcerative colitis (UC), are chronic idiopathic, relapsing and remitting inflammatory diseases that affect the gastrointestinal tract, causing significant morbidity and loss of quality of life in affected individuals [...] Full article (/1424-8247/17/1/59)

(This article belongs to the Special Issue Drug Treatments for Inflammatory Bowel Diseases (/journal/pharmaceuticals/special_issues/drug_colitis))

Open Access Article 17 pages, 6093 KiB (/1424-8247/17/1/58/pdf?version=1703832900)

The Discovery of Novel Agents against *Staphylococcus aureus* by Targeting Sortase A: A Combination of Virtual Screening and Experimental Validation (/1424-8247/17/1/58)

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Xu Liu (https://sciprofiles.com/profile/author/T0kxNGNCRWdOc2VWMGNpcldkUG4vYU9rdjhTcGhDMlZUd3crQ1hHNk9jbz0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)
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Qiang Wang (https://sciprofiles.com/profile/2368639?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)

Pharmaceuticals **2024**, *17*(1), 58; https://doi.org/10.3390/ph17010058 (https://doi.org/10.3390/ph17010058) - 29 Dec 2023

Abstract *Staphylococcus aureus (S. aureus)*, commonly known as “superbugs”, is a highly pathogenic bacterium that poses a serious threat to human health. There is an urgent need to replace traditional antibiotics with novel drugs to combat *S. aureus*. Sortase A (SrtA) is [...] Read more.

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Correction: Volkova et al. Cyclodextrin’s Effect on Permeability and Partition of Nortriptyline Hydrochloride. *Pharmaceuticals* 2023, *16*, 1022 (/1424-8247/17/1/57)

by Tatyana Volkova (https://sciprofiles.com/profile/2455523?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name),
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and
German Perlovich (https://sciprofiles.com/profile/1598173?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)

Pharmaceuticals **2024**, *17*(1), 57; https://doi.org/10.3390/ph17010057 (https://doi.org/10.3390/ph17010057) - 29 Dec 2023

Abstract In the original publication [...] Full article (/1424-8247/17/1/57)

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The Tandem of Liquid Chromatography and Network Pharmacology for the Chemical Profiling of Pule’an Tablets and the Prediction of Mechanism of Action in Treating Prostatitis (/1424-8247/17/1/56)

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Pharmaceuticals **2024**, *17*(1), 56; https://doi.org/10.3390/ph17010056 (https://doi.org/10.3390/ph17010056) - 28 Dec 2023

Abstract Prostatitis, a prevalent urinary tract disorder in males, has a complex etiology that leads to severe clinical discomfort. Pule’an Tablets, a classic single-component formulation primarily based on rapeseed pollen, have been clinically proven to have a beneficial therapeutic effect on both prostatitis and [...] Read more.

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Comparative Studies on the Photoreactivity, Efficacy, and Safety of Depigmenting Agents (/1424-8247/17/1/55)

by
Sandra Mota (https://sciprofiles.com/profile/author/L3RlTlExcFR2SllxNDJRSTNDd0tSWFVnL0o3RU5STlo2cGdvTTNxMlAwdz0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)
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Pharmaceuticals **2024**, *17*(1), 55; https://doi.org/10.3390/ph17010055 (https://doi.org/10.3390/ph17010055) - 28 Dec 2023

Abstract Depigmenting products are increasingly used to counteract skin hyperpigmentation and related psychosocial issues. This study aimed to compare different depigmenting agents—4-butylresorcinol; bakuchiol; tranexamic acid; ascorbyl glucoside; α-arbutin; and ascorbic acid—for photoreactivity; tyrosinase inhibition; and safety. Photoreactivity was assessed using the Reactive Oxygen Species [...] Read more.

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Open Access Review 42 pages, 2077 KiB (/1424-8247/17/1/54/pdf?version=1703761584)

Triterpenes Drug Delivery Systems, a Modern Approach for Arthritis Targeted Therapy (/1424-8247/17/1/54)

by **Célia Faustino (https://sciprofiles.com/profile/715488?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)**, **Noélia Duarte (https://sciprofiles.com/profile/739227?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)** and **Lídia Pinheiro (https://sciprofiles.com/profile/903786?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)**
Pharmaceuticals **2024**, *17*(1), 54; **https://doi.org/10.3390/ph17010054 (https://doi.org/10.3390/ph17010054)** - 28 Dec 2023
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Abstract Arthritis is a major cause of disability. Currently available anti-arthritic drugs, such as disease-modifying anti-rheumatic drugs (DMARDs), have serious side-effects associated with long-term use. Triterpenoids are natural products with known anti-inflammatory properties, and many have revealed efficiency against arthritis both in vitro and **[...] Read more.**
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The Use of Population Pharmacokinetics to Extrapolate Food Effects from Human Adults and Beagle Dogs to the Pediatric Population Illustrated with Paracetamol as a Test Case (/1424-8247/17/1/53)

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Pharmaceuticals **2024**, *17*(1), 53; **https://doi.org/10.3390/ph17010053 (https://doi.org/10.3390/ph17010053)** - 28 Dec 2023
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Abstract To date, food–drug interactions in the pediatric population remain understudied. The current food effect studies are mostly performed in adults and do not mimic the real-life situation in the pediatric population. Since the potential benefits of food effect studies performed in pediatrics should **[...] Read more.**
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The Effective Synthesis of New Benzoquinoline Derivatives as Small Molecules with Anticancer Activity (/1424-8247/17/1/52)

by **Gheorghita Zbancioc (https://sciprofiles.com/profile/478244?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)**, **Ionel I. Mangalagiu (https://sciprofiles.com/profile/10160?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)** and **Costel Moldoveanu (https://sciprofiles.com/profile/1414533?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)**
Pharmaceuticals **2024**, *17*(1), 52; **https://doi.org/10.3390/ph17010052 (https://doi.org/10.3390/ph17010052)** - 28 Dec 2023
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Abstract In this study, some novel benzo[*c*]quinoline derivatives were synthesized, their structural characteristics were described, and their in vitro anticancer efficacy was investigated. The synthesis involves an initial quaternization of the nitrogen atom from benzo[*c*]quinoline and then a [3+2] dipolar **[...] Read more.**
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Surgical Primary Tumor Resection Reduces Accumulation of $CD11b^+$ Myeloid Cells in the Lungs Augmenting the Efficacy of an Intranasal Cancer Vaccination against Secondary Lung Metastasis (/1424-8247/17/1/51)

by **Michael Donkor (https://sciprofiles.com/profile/2300839?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)**, **Jamie Y. Choe (https://sciprofiles.com/profile/2734782?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)**, **Danielle Marie Reid (https://sciprofiles.com/profile/2745871?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)**, **Hope K. Fiadjoe (https://sciprofiles.com/profile/3333286?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)**, **Byron Quinn (https://sciprofiles.com/profile/author/K3d5S1lmTUROTHFoSVA2SnZ1WmxyUUV1SC9QSHhyUkwxcVNEaDhVV0tyVT0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)**, **Amalendu Ranjan (https://sciprofiles.com/profile/1217964?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)**, **Mark Pulse (https://sciprofiles.com/profile/author/NWR3MGYzS1RjeG56VXVPd3JCZ2pDM0RlRXRDOVVYNnAxbXpvMVd4U2E5UT0=?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)**, **Pankaj Chaudhary (https://sciprofiles.com/profile/1344249?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)**, **Riyaz Basha (https://sciprofiles.com/profile/98246?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)** and **Harlan P. Jones (https://sciprofiles.com/profile/185212?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)**
Pharmaceuticals **2024**, *17*(1), 51; **https://doi.org/10.3390/ph17010051 (https://doi.org/10.3390/ph17010051)** - 28 Dec 2023
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Abstract A hallmark of effective cancer treatment is the prevention of tumor reoccurrence and metastasis to distal organs, which are responsible for most cancer deaths. However, primary tumor resection is expected to be curative as most solid tumors have been shown both experimentally and **[...] Read more.**
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A Ru(II)-Strained Complex with 2,9-Diphenyl-1,10-phenanthroline Ligand Induces Selective Photoactivatable Chemotherapeutic Activity on Human Alveolar Carcinoma Cells via Apoptosis (/1424-8247/17/1/50)

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Pharmaceuticals **2024**, *17*(1), 50; https://doi.org/10.3390/ph17010050 (https://doi.org/10.3390/ph17010050) - 28 Dec 2023
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Abstract [Ru(bipy)$_2$(dpphen)]Cl$_2$ (where bipy = 2,2′-bipyridine and dpphen = 2,9-diphenyl-1,10-phenanthroline) (complex **1**) is a sterically strained compound that exhibits promising in vitro photocytotoxicity on an array of cell lines. Since lung adenocarcinoma cancer remains the most common lung cancer and **[...] Read more.**
(This article belongs to the Special Issue **The 20th Anniversary of *Pharmaceuticals*—Metal-Based Drugs for Cancer Treatment, Antibacterial and Antiviral Applications (/journal/pharmaceuticals/special_issues/70A4B37AYW)**)

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Open Access Editorial 4 pages, 161 KiB (/1424-8247/17/1/49/pdf?version=1703736517)

Special Issue: "Molecular Imaging in Oncology: Radiopharmaceuticals for PET and SPECT 2022" (/1424-8247/17/1/49)

by Junbo Zhang (https://sciprofiles.com/profile/150552?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)
Pharmaceuticals **2024**, *17*(1), 49; https://doi.org/10.3390/ph17010049 (https://doi.org/10.3390/ph17010049) - 28 Dec 2023
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Abstract Molecular imaging is partly defined as in vivo imaging of biological or biochemical processes using various markers [...] **Full article (/1424-8247/17/1/49)**
(This article belongs to the Special Issue **Molecular Imaging in Oncology: Radiopharmaceuticals for PET and SPECT 2022 (/journal/pharmaceuticals/special_issues/Imaging_Oncology_Radiopharmaceuticals)**)

Open Access Article 14 pages, 3502 KiB (/1424-8247/17/1/48/pdf?version=1703727121)

Radiosynthesis Standardization and Preclinical Assessment of the [^{68}Ga]Ga-DOTA-Ubiquicidin$_{29-41}$: A Translational Study Targeting Differential Diagnosis of Infectious Processes (/1424-8247/17/1/48)

by Ana Cláudia Camargo Miranda (https://sciprofiles.com/profile/1525822?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name),
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Pharmaceuticals **2024**, *17*(1), 48; https://doi.org/10.3390/ph17010048 (https://doi.org/10.3390/ph17010048) - 28 Dec 2023
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Abstract Human bacterial infections significantly contribute to the increase in healthcare-related burdens. This scenario drives the study of novel techniques for the early and precise diagnosis of infectious processes. Some alternatives include Nuclear Medicine- and Molecular Imaging-based strategies. However, radiopharmaceuticals that are available for **[...] Read more.**
(This article belongs to the Special Issue **Gallium 68 Radiochemistry and Labelling Strategies (/journal/pharmaceuticals/special_issues/A9D6KF3N9G)**)

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Open Access Article 14 pages, 3923 KiB (/1424-8247/17/1/47/pdf?version=1703729493)

Protective Effect of Monoterpene Isoespintanol in a Rat Model of Prediabetes Induced by Fructose (/1424-8247/17/1/47)

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Pharmaceuticals **2024**, *17*(1), 47; https://doi.org/10.3390/ph17010047 (https://doi.org/10.3390/ph17010047) - 28 Dec 2023
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Abstract A high-fructose diet (HFD) induces murine alterations like those recorded in human prediabetes. Protective effects of isoespintanol (monoterpene isolated from Oxandra cf. xylopioides) on changes induced by HFD were evaluated. Animals were maintained for 21 days with a standard diet (C), 10% fructose **[...] Read more.**
(This article belongs to the Special Issue **Drug Candidates for the Treatment of Metabolic Syndrome (/journal/pharmaceuticals/special_issues/39XL716389)**)

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Open Access Article 19 pages, 5486 KiB (/1424-8247/17/1/46/pdf?version=1703683700)

***N*-(coumarin-3-yl)cinnamamide Promotes Immunomodulatory, Neuroprotective, and Lung Function-Preserving Effects during Severe Malaria (/1424-8247/17/1/46)**

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Pharmaceuticals **2024**, *17*(1), 46; https://doi.org/10.3390/ph17010046 (https://doi.org/10.3390/ph17010046) - 27 Dec 2023

Abstract *Plasmodium berghei* ANKA (PbA) infection in mice resembles several aspects of severe malaria in humans, such as cerebral malaria and acute respiratory distress syndrome. Herein, the effects of *N*-(coumarin-3-yl)cinnamamide (M220) against severe experimental malaria have been investigated. Treatment with M220 proved to **[...] Read more.**
(This article belongs to the Special Issue **The 20th Anniversary of Pharmaceuticals—New Insights in Medicinal Chemistry of Nitrogen-Containing Compounds (/journal/pharmaceuticals/special_issues/C99K2RPOFE)**)

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First In Vivo Applicational Data of Foam-Based Intrathoracic Chemotherapy (FBiTC) in a Swine Model (/1424-8247/17/1/45)

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Pharmaceuticals **2024**, *17*(1), 45; https://doi.org/10.3390/ph17010045 (https://doi.org/10.3390/ph17010045) - 27 Dec 2023

Abstract Background: For decades, both intraperitoneal and pleural chemotherapy (IPC) have been delivered as a liquid solution. Recent studies suggest that foam carriers outperform liquid carriers for locoregional chemotherapy. For the first time, this study aims to evaluate the feasibility, safety, and characteristics of **[...] Read more.**
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Gallium-68-Labeled KISS1-54 Peptide for Mapping KISS1 Receptor via PET: Initial Evaluation in Human Tumor Cell Lines and in Tumor-Bearing Mice (/1424-8247/17/1/44)

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Pharmaceuticals **2024**, *17*(1), 44; https://doi.org/10.3390/ph17010044 (https://doi.org/10.3390/ph17010044) - 27 Dec 2023

Abstract Kisspeptins (KPs, KISS1) and their receptor (KISS1R) play a pivotal role as metastasis suppressor for many cancers. Low or lost KP expression is associated with higher tumor grade, increased metastatic potential, and poor prognosis. Therefore, KP expression has prognostic relevance and correlates with **[...] Read more.**
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Isoliquiritigenin Inhibits the Growth of Colorectal Cancer Cells through the ESR2/PI3K/AKT Signalling Pathway (/1424-8247/17/1/43)

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Pharmaceuticals **2024**, *17*(1), 43; https://doi.org/10.3390/ph17010043 (https://doi.org/10.3390/ph17010043) - 27 Dec 2023

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Abstract Colorectal cancer (CRC) is one of the most common malignancies. Isoliquiritigenin (ISL), a flavonoid phytoestrogen, has shown anti-tumour activities against various cancers. However, its anti-CRC mechanism has not been clarified. In this study, the potential molecular mechanism of ISL against CRC was investigated **[...] Read more.**

(This article belongs to the Special Issue **Bioactive Compounds from Plants and Foods with Pharmaceutical Interest 2023 (/journal/pharmaceuticals/special_issues/K69060516X)**)

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Potency and Powder X-ray Diffraction (PXRD) Evaluation of Levothyroxine Sodium Tablets under Ambient, Accelerated, and Stressed Conditions (/1424-8247/17/1/42)

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Pharmaceuticals **2024**, *17*(1), 42; https://doi.org/10.3390/ph17010042 (https://doi.org/10.3390/ph17010042) - 27 Dec 2023

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Abstract Levothyroxine tablets, although highly prescribed in the United States, have been one of the most frequently recalled products. Because of the importance of the medication, several efforts have been put in place by the United States Food and Drug Administration (US FDA) to **[...] Read more.**

(This article belongs to the Special Issue **Polymorphs, Salts, Cocrystals and Cationic Lipid Nanoparticle Complexes in Drug Delivery (/journal/pharmaceuticals/special_issues/5U2Z2H897B)**)

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Open Access Review 17 pages, 4955 KiB (/1424-8247/17/1/41/pdf?version=1703744555)

Molecular Marvels: Small Molecules Paving the Way for Enhanced Gene Therapy (/1424-8247/17/1/41)

by Sebastian Hasselbeck (https://sciprofiles.com/profile/3304108?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name) and
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Pharmaceuticals **2024**, *17*(1), 41; https://doi.org/10.3390/ph17010041 (https://doi.org/10.3390/ph17010041) - 27 Dec 2023

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Abstract In the rapidly evolving landscape of genetic engineering, the advent of CRISPR-Cas technologies has catalyzed a paradigm shift, empowering scientists to manipulate the genetic code with unprecedented accuracy and efficiency. Despite the remarkable capabilities inherent to CRISPR-Cas systems, recent advancements have witnessed the **[...] Read more.**

(This article belongs to the Special Issue **The 20th Anniversary of Pharmaceuticals—Emerging Trends in Biopharmaceuticals (/journal/pharmaceuticals/special_issues/Y15QW0HH30)**)

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Juniperus oxycedrus L. ssp. Essential Oil Microneedles: A Promising Antimicrobial and Wound Healing Activity (/1424-8247/17/1/40)

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Pharmaceuticals **2024**, *17*(1), 40; https://doi.org/10.3390/ph17010040 (https://doi.org/10.3390/ph17010040) - 27 Dec 2023

Abstract The use of essential oil (EO) in treating infected wounds is still challenging. A lot of effort has been made to make such an application more convenient. Recently, microneedles (MNDs) have been considered as a smart dermal delivery system to overcome the poor [...] Read more.

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Pharmacological Advances for Treatment in Hypertension (/1424-8247/17/1/39)

by Arquimedes Gasparotto Junior (https://sciprofiles.com/profile/815286?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)
Pharmaceuticals **2024**, *17*(1), 39; https://doi.org/10.3390/ph17010039 (https://doi.org/10.3390/ph17010039) - 27 Dec 2023

Abstract Hypertension plays a significant role in the development of cardiovascular disease and renal diseases, which can heighten the likelihood of experiencing related conditions like myocardial infarction, stroke, and heart failure [...] Full article (/1424-8247/17/1/39)
(This article belongs to the Special Issue Pharmacological Advances for Treatment in Hypertension (/journal/pharmaceuticals/special_issues/pharm_Hypertension))

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Active Compounds of *Panax ginseng* in the Improvement of Alzheimer's Disease and Application of Spatial Metabolomics (/1424-8247/17/1/38)

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Pharmaceuticals **2024**, *17*(1), 38; https://doi.org/10.3390/ph17010038 (https://doi.org/10.3390/ph17010038) - 26 Dec 2023

Abstract *Panax ginseng* C.A. Meyer (*P. ginseng*) is one of the more common traditional Chinese medicines (TCMs). It contains numerous chemical components and exhibits a range of pharmacological effects. An enormous burden is placed on people's health and life by Alzheimer's disease [...] Read more.
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An In Silico Investigation of the Molecular Interactions between Volatile Anesthetics and Actin (/1424-8247/17/1/37)

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Pharmaceuticals **2024**, *17*(1), 37; https://doi.org/10.3390/ph17010037 (https://doi.org/10.3390/ph17010037) - 26 Dec 2023

Abstract Volatile anesthetics (VAs) are medicinal chemistry compounds commonly used to enable surgical procedures for patients who undergo painful treatments and can be partially or fully sedated, remaining in an unconscious state during the operation. The specific molecular mechanism of anesthesia is still an [...] Read more.
(This article belongs to the Section Pharmacology (/journal/pharmaceuticals/sections/pharm-pharmacology))

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Advancements and Perspectives in Polysaccharide-Based Nanoparticles for Theranostic Nanomedicine (/1424-8247/17/1/36)

by Jingdi Chen (https://sciprofiles.com/profile/1831333?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)
Pharmaceuticals **2024**, *17*(1), 36; https://doi.org/10.3390/ph17010036 (https://doi.org/10.3390/ph17010036) - 26 Dec 2023

Abstract It is with great enthusiasm [...] Full article (/1424-8247/17/1/36)
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Synthesis and Antiviral Activity of Novel β-D-N4-Hydroxycytidine Ester Prodrugs as Potential Compounds for the Treatment of SARS-CoV-2 and Other Human Coronaviruses (/1424-8247/17/1/35)

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Pharmaceuticals **2024**, *17*(1), 35; https://doi.org/10.3390/ph17010035 (https://doi.org/10.3390/ph17010035) - 26 Dec 2023
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Abstract The spread of COVID-19 infection continues due to the emergence of multiple transmissible and immune-evasive variants of the SARS-CoV-2 virus. Although various vaccines have been developed and several drugs have been approved for the treatment of COVID-19, the development of new drugs to [...] Read more.
(This article belongs to the Special Issue Small Molecules Targeting Viral Polymerases (/journal/pharmaceuticals/special_issues/molecule_viral_polymerases))

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Open Access Review 17 pages, 679 KiB (/1424-8247/17/1/34/pdf?version=1703638803)

Photodynamic Action of Curcumin and Methylene Blue against Bacteria and SARS-CoV-2—A Review (/1424-8247/17/1/34)

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Pharmaceuticals **2024**, *17*(1), 34; https://doi.org/10.3390/ph17010034 (https://doi.org/10.3390/ph17010034) - 25 Dec 2023
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Abstract Coronavirus disease 19 (COVID-19) has occurred for more than four years, and the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) causing COVID-19 is a strain of coronavirus, which presents high rates of morbidity around the world. Up to the present date, there are [...] Read more.
(This article belongs to the Special Issue Photodynamic Therapy 2023 (/journal/pharmaceuticals/special_issues/9943PV4D1H))

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Open Access Article 25 pages, 4607 KiB (/1424-8247/17/1/33/pdf?version=1703504027)

HIV-1 Transcription Inhibition Using Small RNA-Binding Molecules (/1424-8247/17/1/33)

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Pharmaceuticals **2024**, *17*(1), 33; https://doi.org/10.3390/ph17010033 (https://doi.org/10.3390/ph17010033) - 25 Dec 2023
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Abstract The HIV-1 transactivator protein Tat interacts with the transactivation response element (TAR) at the three-nucleotide UCU bulge to facilitate the recruitment of transcription elongation factor-b (P-TEFb) and induce the transcription of the integrated proviral genome. Therefore, the Tat–TAR interaction, unique to the virus, [...] Read more.
(This article belongs to the Special Issue HIV and Viral Hepatitis: Prevention, Treatment and Coinfection (/journal/pharmaceuticals/special_issues/P8STP8KXC3))

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Synthesis and Biological Evaluation of Chalconesulfonamides: En Route to Proapoptotic Agents with Antiestrogenic Potency (/1424-8247/17/1/32)

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Pharmaceuticals **2024**, *17*(1), 32; https://doi.org/10.3390/ph17010032 (https://doi.org/10.3390/ph17010032) - 25 Dec 2023
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Abstract Breast and other estrogen receptor α-positive cancers tend to develop resistance to existing drugs. Chalcone derivatives possess anticancer activity based on their ability to form covalent bonds with targets acting as Michael acceptors. This study aimed to evaluate the anticancer properties of a [...] Read more.
(This article belongs to the Special Issue Recent Developments of Chalcones and Their Derivatives in Medicinal Chemistry (/journal/pharmaceuticals/special_issues/4482WUCK0P))

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Illuminating Dersimelagon: A Novel Agent in the Treatment of Erythropoietic Protoporphyria and X-Linked Protoporphyria (/1424-8247/17/1/31)

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Pharmaceuticals **2024**, *17*(1), 31; https://doi.org/10.3390/ph17010031 (https://doi.org/10.3390/ph17010031) - 25 Dec 2023
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Abstract Erythropoietic protoporphyria (EPP) is a genetic disorder stemming from reduced ferrochelatase expression, the final enzyme in the pathway of heme biosynthesis. A closely related condition, X-linked protoporphyria (XLP), bears similar clinical features although it arises from the heightened activity of δ-aminolevulinic acid synthase **[...] Read more.**

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New 2,4-bis[(substituted-aminomethyl)phenyl]phenylquinazoline and 2,4-bis[(substituted-aminomethyl)phenyl]phenylquinoline Derivatives: Synthesis and Biological Evaluation as Novel Anticancer Agents by Targeting G-Quadruplex (/1424-8247/17/1/30)

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Abstract The syntheses of novel 2,4-bis[(substituted-aminomethyl)phenyl]phenylquinazolines **12** and 2,4-bis[(substituted-aminomethyl)phenyl]phenylquinolines **13** are reported here in six steps starting from various halogeno-quinazoline-2,4-(1*H*,3*H*)-diones or substituted anilines. The antiproliferative activities of the products were determined in vitro against a panel of breast (MCF-7 and **[...] Read more.**
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Open Access Review 21 pages, 2750 KiB (/1424-8247/17/1/29/pdf?version=1703491185)

Novel Opioids in the Setting of Acute Postoperative Pain: A Narrative Review (/1424-8247/17/1/29)

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Pharmaceuticals **2024**, *17*(1), 29; https://doi.org/10.3390/ph17010029 (https://doi.org/10.3390/ph17010029) - 25 Dec 2023
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Abstract Although traditional opioids such as morphine and oxycodone are commonly used in the management of acute postoperative pain, novel opioids may play a role as alternatives that provide potent pain relief while minimizing adverse effects. In this review, we discuss the mechanisms of **[...] Read more.**
(This article belongs to the Special Issue **New Endogenous Opioid Peptides and Peptidomimetics with Potential Biological Importance (/journal/pharmaceuticals/special_issues/7TM3M9K3GU)**)

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Open Access Article 12 pages, 594 KiB (/1424-8247/17/1/28/pdf?version=1703408853)

Efficacy of Perampanel in Refractory and Super-Refractory Status Epilepticus with Suspected Inflammatory Etiology: A Case Series (/1424-8247/17/1/28)

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Pharmaceuticals **2024**, *17*(1), 28; https://doi.org/10.3390/ph17010028 (https://doi.org/10.3390/ph17010028) - 24 Dec 2023

Abstract (1) Background: Increasing evidence supports the anti-inflammatory and neuroprotective role of perampanel (PER), mediated by decreased expression of pro-inflammatory cytokines and by interference with apoptosis processes. Therefore, the use of PER to treat status epilepticus (SE) with suspected inflammatory etiology is appealing and **[...] Read more.**
(This article belongs to the Special Issue **Targeted Therapies for Epilepsy (/journal/pharmaceuticals/special_issues/8V28RDW9HA)**)

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Open Access Article 11 pages, 2411 KiB (/1424-8247/17/1/27/pdf?version=1703406147)

A Pharmacodynamic Study of Aminoglycosides against Pathogenic *E. coli* through Monte Carlo Simulation (/1424-8247/17/1/27)

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Pharmaceuticals **2024**, *17*(1), 27; https://doi.org/10.3390/ph17010027 (https://doi.org/10.3390/ph17010027) - 24 Dec 2023

Abstract This research focuses on combating the increasing problem of antimicrobial resistance, especially in *Escherichia coli* (*E. coli*), by assessing the efficacy of aminoglycosides. The study specifically addresses the challenge of developing new therapeutic approaches by integrating experimental data with mathematical modeling **[...] Read more.**
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Open Access Article 14 pages, 3903 KiB (/1424-8247/17/1/26/pdf?version=1703323220)

Nuclear Cross-Section of Proton-Induced Reactions on Enriched ^{48}Ti Targets for the Production of Theranostic ^{47}Sc Radionuclide, ^{46c}Sc, ^{44m}Sc, ^{44g}Sc, ^{43}Sc, and ^{48}V (/1424-8247/17/1/26)

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Pharmaceuticals **2024**, *17*(1), 26; https://doi.org/10.3390/ph17010026 (https://doi.org/10.3390/ph17010026) - 23 Dec 2023

Abstract The cross-sections of the ^{48}Ti(p,x)^{47}Sc, ^{46c}Sc, ^{44m}Sc, ^{44g}Sc, ^{43}Sc, and ^{48}V nuclear reactions were measured from 18 to 70 MeV, with particular attention to ^{47}Sc production. Enriched ^{48}Ti powder was deposited on an **[...] Read more.**
(This article belongs to the Special Issue **New Trends in Applications and Production of Metal Radionuclides for Nuclear Medicine (/journal/pharmaceuticals/special_issues/M0H0807H2Y)**)

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Radiopharmaceuticals for Treatment of Adrenocortical Carcinoma (/1424-8247/17/1/25)

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Pharmaceuticals **2024**, *17*(1), 25; https://doi.org/10.3390/ph17010025 (https://doi.org/10.3390/ph17010025) - 23 Dec 2023

Abstract Adrenocortical carcinoma (ACC) represents a rare tumor entity with limited treatment options and usually rapid tumor progression in case of metastatic disease. As further treatment options are needed and ACC metastases are sensitive to external beam radiation, novel theranostic approaches could complement established **[...] Read more.**
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Open Access Article 13 pages, 2960 KiB (/1424-8247/17/1/24/pdf?version=1703499821)

Anthocyanin Oligomers Induce Apoptosis and Autophagy by Inhibiting the mTOR Signaling Pathway in Human Breast Cancer Cells (/1424-8247/17/1/24)

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Pharmaceuticals **2024**, *17*(1), 24; https://doi.org/10.3390/ph17010024 (https://doi.org/10.3390/ph17010024) - 22 Dec 2023

Abstract Anthocyanin oligomers (AOs) are phytochemicals synthesized by fermenting anthocyanins extracted from grape skins and are more biologically active than monomeric anthocyanins. In this study, we evaluate the effects of an AO on triple-negative MDA-MB-231 and HER2-overexpressing SK-BR-3 breast cancer cells. The cell viability **[...] Read more.**

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Cytocompatibility, Antimicrobial and Antioxidant Activity of a Mucoadhesive Biopolymeric Hydrogel Embedding Selenium Nanoparticles Phytosynthesized by Sea Buckthorn Leaf Extract (/1424-8247/17/1/23)

by **Naomi Tritean (https://sciprofiles.com/profile/3025214?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name)**,
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Pharmaceuticals **2024**, *17*(1), 23; **https://doi.org/10.3390/ph17010023 (https://doi.org/10.3390/ph17010023)** - 22 Dec 2023

Abstract Phytosynthesized selenium nanoparticles (SeNPs) are less toxic than the inorganic salts of selenium and show high antioxidant and antibacterial activity. Chitosan prevents microbial biofilm formation and can also determine microbial biofilm dispersal. Never-dried bacterial nanocellulose (NDBNC) is an efficient carrier of bioactive compounds **[...] Read more.**

(This article belongs to the Special Issue **Hydrogels for Pharmaceutical and Biomedical Applications 2024 (/journal/pharmaceuticals/special_issues/4DT23T6TLI)**)

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Computer-Aided Drug Design and Drug Discovery: A Prospective Analysis (/1424-8247/17/1/22)

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Pharmaceuticals **2024**, *17*(1), 22; **https://doi.org/10.3390/ph17010022 (https://doi.org/10.3390/ph17010022)** - 22 Dec 2023

Abstract In the dynamic landscape of drug discovery, Computer-Aided Drug Design (CADD) emerges as a transformative force, bridging the realms of biology and technology. This paper overviews CADDs historical evolution, categorization into structure-based and ligand-based approaches, and its crucial role in rationalizing and expediting **[...] Read more.**

(This article belongs to the Special Issue **Computer-Aided Drug Design and Drug Discovery (/journal/pharmaceuticals/special_issues/CDY0D8W0CQ)**)

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Open Access Article 13 pages, 1449 KiB **(/1424-8247/17/1/21/pdf?version=1703238618)**

Therapeutic Drug Monitoring and Pharmacogenetic Testing as Guides to Psychotropic Drug Dose Adjustment: An Observational Study (/1424-8247/17/1/21)

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Pharmaceuticals **2024**, *17*(1), 21; **https://doi.org/10.3390/ph17010021 (https://doi.org/10.3390/ph17010021)** - 22 Dec 2023

Abstract To avoid the failures in therapy with psychotropic drugs, treatments can be personalized by applying the results of therapeutic drug monitoring and pharmacogenetic testing. The objective of the present single-center observational study was to describe the changes in psychotropic drug management prompted by **[...] Read more.**

(This article belongs to the Special Issue **Drug Analysis and Therapeutic Drug Monitoring (/journal/pharmaceuticals/special_issues/1D3UA8YN65)**)

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Open Access Article 17 pages, 2700 KiB **(/1424-8247/17/1/20/pdf?version=1703237315)**

Antiarthritic and Anti-Inflammatory Properties of *Cannabis sativa* Essential Oil in an Animal Model (/1424-8247/17/1/20)

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Pharmaceuticals **2024**, *17*(1), 20; https://doi.org/10.3390/ph17010020 (https://doi.org/10.3390/ph17010020) - 22 Dec 2023

Abstract Arthritis and inflammatory conditions require effective therapies, but conventional drugs have side effects. This study explored *Cannabis sativa* L. essential oil (CSEO) as a safer alternative. A chemical characterization of EO conducted via GC/MS showed the presence of sesquiterpene hydrocarbons (67.63%), oxygenated sesquiterpenes **[...] Read more.**

(This article belongs to the Special Issue **Chromatographic and Mass Spectrometry Techniques to Detect Secondary Metabolites from Natural Products of Pharmacological Interest (/journal/pharmaceuticals/special_issues/A397B5XU5G)**)

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Open Access Article 18 pages, 2070 KiB (/1424-8247/17/1/19/pdf?version=1703227299)

Tween 80-Based Self-Assembled Mixed Micelles Boost Valsartan Transdermal Delivery (/1424-8247/17/1/19)

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Pharmaceuticals **2024**, *17*(1), 19; https://doi.org/10.3390/ph17010019 (https://doi.org/10.3390/ph17010019) - 22 Dec 2023

Abstract Valsartan (Val) is an important antihypertensive medication with poor absorption and low oral bioavailability. These constraints are due to its poor solubility and dissolution rate. The purpose of this study was to optimize a mixed micelle system for the transdermal delivery of Val **[...] Read more.**

(This article belongs to the Special Issue **Self-Assembled Nanoparticles: An Emerging Delivery Platform for Drugs (/journal/pharmaceuticals/special_issues/U199Y8X3JE)**)

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Open Access Article 20 pages, 5618 KiB (/1424-8247/17/1/18/pdf?version=1703252704)

Computational Molecular Docking and Simulation-Based Assessment of Anti-Inflammatory Properties of *Nyctanthes arbor-tristis Linn* Phytochemicals (/1424-8247/17/1/18)

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Pharmaceuticals **2024**, *17*(1), 18; https://doi.org/10.3390/ph17010018 (https://doi.org/10.3390/ph17010018) - 22 Dec 2023

Abstract The leaves, flowers, seeds, and bark of the *Nyctanthes arbor-tristis Linn* plant have been pharmacologically evaluated to signify the medicinal importance traditionally described for various ailments. We evaluated the anti-inflammatory potentials of 26 natural compounds using AutoDock 4.2 and Molecular Dynamics (MDS) performed **[...] Read more.**

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Open Access Article 16 pages, 1998 KiB (/1424-8247/17/1/17/pdf?version=1703154460)

Nanoemulsion Improves the Anti-Inflammatory Effect of Intraperitoneal and Oral Administration of Carvacryl Acetate (/1424-8247/17/1/17)

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Pharmaceuticals **2024**, *17*(1), 17; https://doi.org/10.3390/ph17010017 (https://doi.org/10.3390/ph17010017) - 21 Dec 2023

Abstract Carvacryl acetate (CA) is a monoterpene obtained from carvacrol, which exhibits anti-inflammatory activity. However, its low solubility in aqueous media limits its application and bioavailability. Herein, we aimed to develop a carvacryl acetate nanoemulsion (CANE) and assess its anti-inflammatory potential in preclinical trials. **[...] Read more.**

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Open Access Review 16 pages, 354 KiB (/1424-8247/17/1/16/pdf?version=1703152813)

Ketamine, an Old–New Drug: Uses and Abuses (/1424-8247/17/1/16)

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Pharmaceuticals **2024**, *17*(1), 16; https://doi.org/10.3390/ph17010016 (https://doi.org/10.3390/ph17010016) - 21 Dec 2023

Abstract Ketamine as an old–new drug has a variety of clinical implications. In the last 30 years, ketamine has become popular for acute use in humans. Ketamine in standard doses is principally utilized for the induction and maintenance of surgical procedures. Besides its use [...] Read more.

(This article belongs to the Special Issue Ketamine and Ketamine Metabolite Pharmacology (/journal/pharmaceuticals/special_issues/1T3F4T552X))

Open Access Article 20 pages, 5634 KiB (/1424-8247/17/1/15/pdf?version=1703147806)

A New Approach for Preparing Stable High-Concentration Peptide Nanoparticle Formulations (/1424-8247/17/1/15)

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Pharmaceuticals **2024**, *17*(1), 15; https://doi.org/10.3390/ph17010015 (https://doi.org/10.3390/ph17010015) - 21 Dec 2023

Abstract The subcutaneous administration of therapeutic peptides would provide significant benefits to patients. However, subcutaneous injections are limited in dosing volume, potentially resulting in high peptide concentrations that can incur significant challenges with solubility limitations, high viscosity, and stability liabilities. Herein, we report on [...] Read more.

(This article belongs to the Special Issue Strategies for Improving Peptide Stability and Delivery (/journal/pharmaceuticals/special_issues/56CA1ST7N2))

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Open Access Systematic Review 13 pages, 1177 KiB (/1424-8247/17/1/14/pdf?version=1703159515)

Risk of Melanoma and Non-Melanoma Skin Cancer in Patients with Psoriasis and Psoriatic Arthritis Treated with Targeted Therapies: A Systematic Review and Meta-Analysis (/1424-8247/17/1/14)

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Pharmaceuticals **2024**, *17*(1), 14; https://doi.org/10.3390/ph17010014 (https://doi.org/10.3390/ph17010014) - 21 Dec 2023

Abstract Targeted therapies represent major advancements in the treatment of chronic skin conditions such as psoriasis. While previous studies have shown an increased risk of melanoma and non-melanoma skin cancer (NMSC) in patients receiving TNF-α inhibitors, the risks associated with newer biologics (IL-12/23 inhibitors, [...] Read more.

(This article belongs to the Special Issue Combining Immunotherapy and Targeted Therapies in Cancer Treatment (/journal/pharmaceuticals/special_issues/9Y9M5DO1H4))

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Open Access Article 11 pages, 2043 KiB (/1424-8247/17/1/13/pdf?version=1703145546)

Exploring Enzymatic Hydrolysis of Urine Samples for Investigation of Drugs Associated with Drug-Facilitated Sexual Assault (/1424-8247/17/1/13)

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Pharmaceuticals **2024**, *17*(1), 13; https://doi.org/10.3390/ph17010013 (registering DOI) - 21 Dec 2023

Abstract Analyzing urine is common in drug-facilitated sexual assault cases if the analysis of blood is not optimal. The efficient enzymatic pretreatment of urine is important for cleaving glucuronides and improving the detection of the parent drug. The aim was to investigate the efficiency [...] Read more.

(This article belongs to the Section Pharmacology (/journal/pharmaceuticals/sections/pharm-pharmacology))

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Open Access Review 14 pages, 1752 KiB **(/1424-8247/17/1/12/pdf?version=1703145258)**

Repurposing Therapeutic Drugs Complexed to Vanadium in Cancer (/1424-8247/17/1/12)

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Pharmaceuticals **2024**, *17*(1), 12; https://doi.org/10.3390/ph17010012 (registering DOI) - 21 Dec 2023

Abstract Repurposing drugs by uncovering new indications for approved drugs accelerates the process of establishing new treatments and reduces the high costs of drug discovery and development. Metal complexes with clinically approved drugs allow further opportunities in cancer therapy—many vanadium compounds have previously shown **[...] Read more.**
(This article belongs to the Special Issue **Recent Advances and Future Approaches in Preventive and Therapeutic Effects of Vanadium Complexes (/journal/pharmaceuticals/special_issues/BBDF9D5FNM)**)

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Open Access Systematic Review 25 pages, 2015 KiB **(/1424-8247/17/1/11/pdf?version=1703138093)**

Anti-Inflammatory Activity of Pequi Oil (*Caryocar brasiliense*): A Systematic Review (/1424-8247/17/1/11)

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Pharmaceuticals **2024**, *17*(1), 11; https://doi.org/10.3390/ph17010011 (registering DOI) - 21 Dec 2023

Abstract Disorders in the inflammatory process underlie the pathogenesis of numerous diseases. The utilization of natural products as anti-inflammatory agents is a well-established approach in both traditional medicine and scientific research, with studies consistently demonstrating their efficacy in managing inflammatory conditions. Pequi oil, derived **[...] Read more.**
(This article belongs to the Section **Natural Products (/journal/pharmaceuticals/sections/natural_products)**)

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Open Access Article 12 pages, 2227 KiB **(/1424-8247/17/1/10/pdf?version=1703231625)**

Trace Metal Impurities Effects on the Formation of [^{64}Cu]Cu-diacetyl-bis(*N*^{4}-methylthiosemicarbazone) ([^{64}Cu]Cu-ATSM) (/1424-8247/17/1/10)

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Pharmaceuticals **2024**, *17*(1), 10; https://doi.org/10.3390/ph17010010 (registering DOI) - 21 Dec 2023

Abstract [^{64}Cu]Cu-diacetyl-bis(*N*^{4}-methylthiosemicarbazone) ([^{64}Cu]Cu-ATSM) is a radioactive hypoxia-targeting therapeutic agent being investigated in clinical trials for malignant brain tumors. For the quality management of [^{64}Cu]Cu-ATSM, understanding trace metal impurities' effects on the chelate formation of ^{64} **[...] Read more.**
(This article belongs to the Special Issue **Copper Radiopharmaceuticals for Theranostic Applications (/journal/pharmaceuticals/special_issues/QDCI781UMX)**)

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Open Access Article 19 pages, 4736 KiB **(/1424-8247/17/1/9/pdf?version=1703128990)**

CP-673451, a Selective Platelet-Derived Growth Factor Receptor Tyrosine Kinase Inhibitor, Induces Apoptosis in *Opisthorchis viverrini*-Associated Cholangiocarcinoma via Nrf2 Suppression and Enhanced ROS (/1424-8247/17/1/9)

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Pharmaceuticals **2024**, *17*(1), 9; https://doi.org/10.3390/ph17010009 (https://doi.org/10.3390/ph17010009) - 20 Dec 2023

Abstract Platelet-derived growth factors (PDGFs) and PDGF receptors (PDGFRs) play essential roles in promoting cholangiocarcinoma (CCA) cell survival by mediating paracrine crosstalk between tumor and cancer-associated fibroblasts (CAFs), indicating the potential of PDGFR as a target for CCA treatment. Clinical trials evaluating PDGFR inhibitors **[...] Read more.**
(This article belongs to the Special Issue **Cancer Drugs Treatment and Toxicity 2023 (/journal/pharmaceuticals/special_issues/676TJN75KC)**)

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Open Access Article 13 pages, 2617 KiB (/1424-8247/17/1/8/pdf?version=1703085310)

Identification of a New Integration Site and Study on Site-Specific Integration in CHO-K1 Cells (/1424-8247/17/1/8)

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Pharmaceuticals **2024**, *17*(1), 8; https://doi.org/10.3390/ph17010008 (https://doi.org/10.3390/ph17010008) - 20 Dec 2023

Abstract Site-specific integration is an important approach used to address the problem of unstable cell lines in industry. In this study, we observed a reduction in the gene copy number and antibody production in a CHOK1 cell line BA03 capable of high antibody expression. **[...] Read more.**
(This article belongs to the Section **Biopharmaceuticals (/journal/pharmaceuticals/sections/biopharmaceuticals)**)

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Open Access Review 32 pages, 845 KiB (/1424-8247/17/1/7/pdf?version=1703664528)

A Mechanistic Review on How Berberine Use Combats Diabetes and Related Complications: Molecular, Cellular, and Metabolic Effects (/1424-8247/17/1/7)

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Pharmaceuticals **2024**, *17*(1), 7; https://doi.org/10.3390/ph17010007 (https://doi.org/10.3390/ph17010007) - 20 Dec 2023

Abstract Berberine (BBR) is an isoquinoline alkaloid that can be extracted from herbs such as Coptis, Phellodendron, and Berberis. BBR has been widely used as a folk medicine to treat various disorders. It is a multi-target drug with multiple mechanisms. Studies have shown that **[...] Read more.**
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Open Access Article 13 pages, 5061 KiB (/1424-8247/17/1/6/pdf?version=1703069796)

***Sinomenium acutum* Modulates Platelet Aggregation and Thrombus Formation by Regulating the Glycoprotein VI-Mediated Signalosome in Mice (/1424-8247/17/1/6)**

by Yeon-Ji Kim (https://sciprofiles.com/profile/3133814?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name),
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Pharmaceuticals **2024**, *17*(1), 6; https://doi.org/10.3390/ph17010006 (https://doi.org/10.3390/ph17010006) - 20 Dec 2023

Abstract *Sinomenium acutum* (SA) has long been used as a traditional medicine in China, Japan, and Korea to treat a wide range of diseases. It has been traditionally used to ameliorate inflammation and improve blood circulation. However, its role in platelet activation has not **[...] Read more.**
(This article belongs to the Section **Natural Products (/journal/pharmaceuticals/sections/natural_products)**)

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Open Access Article 30 pages, 10378 KiB (/1424-8247/17/1/5/pdf?version=1703066212)

Dual Role of Vitamin C-Encapsulated Liposomal Berberine in Effective Colon Anticancer Immunotherapy (/1424-8247/17/1/5)

by Martyna Mianowska (https://sciprofiles.com/profile/3111550?utm_source=mdpi.com&utm_medium=website&utm_campaign=avatar_name),
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Pharmaceuticals **2024**, *17*(1), 5; https://doi.org/10.3390/ph17010005 (https://doi.org/10.3390/ph17010005) - 20 Dec 2023

Abstract The aim of the study was to achieve effective colon anticancer immunotherapy using the alkaloid berberine. In the presented paper we attempt to develop a formulation of berberine loaded into liposomal carriers using the vitamin C gradient method, characterized by efficient drug encapsulation, **[...] Read more.**
(This article belongs to the Special Issue **Combining Immunotherapy and Targeted Therapies in Cancer Treatment (/journal/pharmaceuticals/special_issues/9Y9M5DO1H4)**)

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Open Access Review 18 pages, 945 KiB (/1424-8247/17/1/4/pdf?version=1703061423)

Emerging Pharmaceutical Therapies to Address the Inadequacy of a Gluten-Free Diet for Celiac Disease (/1424-8247/17/1/4)

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Pharmaceuticals **2024**, *17*(1), 4; https://doi.org/10.3390/ph17010004 (https://doi.org/10.3390/ph17010004) - 20 Dec 2023

Abstract Celiac disease (CeD) is a chronic autoimmune disorder triggered by the ingestion of gluten, affecting around 1% of the global population. It is a multifactorial disease involving both genetics and environmental factors. Nowadays, the only available treatment for CeD is a life-long gluten-free **[...] Read more.**
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Open Access Article 19 pages, 1225 KiB (/1424-8247/17/1/3/pdf?version=1703225534)

Effects of COVID-19 on the Liver and Mortality in Patients with SARS-CoV-2 Pneumonia Caused by Delta and Non-Delta Variants: An Analysis in a Single Centre (/1424-8247/17/1/3)

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Pharmaceuticals **2024**, *17*(1), 3; https://doi.org/10.3390/ph17010003 (https://doi.org/10.3390/ph17010003) - 19 Dec 2023

Abstract The aim of this study was to ascertain patient characteristics, outcomes, and liver injuries in patients infected with different SARS-CoV-2 variants. Data from consecutive adult patients with severe/critical COVID-19 admitted to our hospital during the peak month of the Delta wave were compared **[...] Read more.**
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Postoperative Nausea and Vomiting following Endoscopic Sinus Surgery under the Guidance of Adequacy of Anesthesia or Pupillometry with Intravenous Propofol/Remifentanil (/1424-8247/17/1/2)

by
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Pharmaceuticals **2024**, *17*(1), 2; https://doi.org/10.3390/ph17010002 (https://doi.org/10.3390/ph17010002) - 19 Dec 2023

Abstract Postoperative nausea and vomiting (PONV) constitutes an adverse event after endoscopic sinus surgery (ESS) under general anesthesia (GA) with intravenous opioids, such as remifentanil (RMF). Monitoring the nociception/antinociception balance using the surgical pleth index (SPI) or pupillary dilatation reflex (PRD) helps guide intravenous **[...] Read more.**
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Open Access Article 12 pages, 633 KiB (/1424-8247/17/1/1/pdf?version=1702971389)

Inhalation of *Pelargonium graveolens* Essential Oil Alleviates Pain and Related Anxiety and Stress in Patients with Lumbar Spinal Stenosis and Moderate to Severe Pain (/1424-8247/17/1/1)

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Pharmaceuticals **2024**, *17*(1), 1; https://doi.org/10.3390/ph17010001 (https://doi.org/10.3390/ph17010001) - 19 Dec 2023

Abstract Pain in lumbar spinal stenosis (LSS) patients is closely associated with psychological factors, including anxiety, stress, and depression, and is a critical determinant of

pharmaceuticals

Review

Moringa oleifera: A Review of the Pharmacology, Chemical Constituents, and Application for Dental Health

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Abstract: *Moringa oleifera* L., commonly known as Kelor in Indonesia and miracle tree in English, has a rich history of utilization for medicinal, nutritional, and water treatment purposes dating back to ancient times. The plant is renowned for its abundance of vitamins, minerals, and various chemical constituents, making it a valuable resource. Among its notable pharmacological properties are its effectiveness as an anti-diabetic, anti-diarrheal, anti-helmintic, anti-leishmanial, anti-fungal, anti-bacterial, anti-allergic, anti-cancer, anti-inflammatory, and anti-oxidant agent. In this comprehensive review, we delve into the extensive pharmacological applications and phytochemical constituents of *M. oleifera* and its application in dental health.

Keywords: *Moringa oleifera*; pharmacological use; phytochemical constituent

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1. Introduction

Moringa oleifera L. comes from the Moringaeceae family and is commonly known as Kelor in Indonesia, Sahajan in India, and Horseradish tree or Drumstick tree in English. It is also described as a miracle tree due to its nutritional value, diverse functions, and medicinal properties. *M. oleifera* can grow up to 12 m in tropical and subtropical environments. Although it is native to South Asia, the cultivation itself has already spread to the Middle East, Africa, Asia, and other areas. Traditionally, *M. oleifera* has been used in medicine, skincare, breastmilk production, and even food. Almost all parts of *M. oleifera* can be useful. Nowadays, *M. oleifera* is also used for water purification, animal feed, as a bio-stimulant, bio-pesticide, and biomass as biodiesel production in industrial and agricultural processes [1–6]. Table 1 describes the traditional usage of *M. oleifera*.

Table 1. Traditional usage of *M. oleifera*.

Part of Plant	Usage	References
Seed	Skincare, haircare, fertilizer, cure for eye disease, fever, snake bite, headache, bladder, ulcer, gastritis, gout, stimulant, antispasmodic, stomachache, anemia, joint pain, hypertension, water purification.	[2–4]
Leaf	Wound healing, snake bites, stimulation, breast milk production, diarrhea, animal feed, constipation, bronchitis, glandular swelling, rheumatism, influenza, food, malaria, arthritis.	[2–6]
Root	Anticoagulation, wound healing, laxative, diuretic, toothache, cold, sores, asthma, bronchitis, epilepsy, urinary discharge, laxative, antiparalytic, cardiac tonic.	[3–5]
Pod (Fruit)	Diabetic, antipyretic, asthma, spleen, skin tumor, joint pain.	[4,5]
Flower	Stimulant, tonic, cholagogue, cold, inflammation, muscle disease, tumor, cholera.	[4,5]
Bark (Stem)	Heart compilation, fever, eye disease, digestive disorder, animal feed, headache, hypoglycemia, toothache.	[4–6]

As a food and stimulant, *M. oleifera* is known to have an abundance of nutritional value and is comparatively easy to cultivate because of its rapid growth and good adaptability to climate change. Thus, in poor countries, *M. oleifera* is used as a source of proteins, calories, minerals, and vitamins. It has been reported that dry leaves of *M. oleifera* contain more calories, protein, carbohydrate, fiber, vitamin B, calcium, magnesium, phosphorus, potassium, copper, and iron than fresh leaves. Meanwhile, fresh leaves contain more vitamin C and E. Between the leaf, seed, and pod of *M. oleifera*, proteins, vitamin E, and magnesium have been found to be more abundant in the seed [7–9].

Due to many its traditional usages, research has been conducted to prove its ability as medicine. It is reported to have pharmacological properties such as anti-diabetic, anti-diarrheal, anti-helmintic, anti-leishmanial, anti-fungi, anti-bacterial, anti-allergic, anti-cancer, anti-inflammatory, and anti-oxidant. Hastuty and Nitia reported the efficiency of *M. oleifera* leaf extract to raise hemoglobin levels in young girls. They showed a value of 10.83 g/dL before treatment, while after treatment with *M. oleifera*, the hemoglobin levels increased to 12.72 g/dL [10]. Yuliastuti and Kurnia also reported the effect of *M. oleifera* on hemoglobin levels in anemic pregnant women. The result showed a significant difference, where before treatment, the respondents showed hemoglobin levels about 10.2 g/dL, and after treatment these increased to 10.8 g/dL ($p = 0.003 < 0.05$) [11].

Dental health has been a concern for researchers to this day. The various infections that can occur in the teeth cause a decline in health. Dental infections occur due to the growth of various kinds of microbes in the dental and oral area. Among these are odontogenic infections and periradicular periodontitis that occur in the root canal system caused by anaerobic bacteria such as *Porphyromonas gingivalis*, *Enteroccus faecalis*, and *Candida albicans* [12–14]. *E. faecalis* is reported to infect root canals up to 30–80% [15]. In addition, based on polymerase chain reaction (PCR) analysis, the bacteria *Tannerella forysthia*, *Treponema denticola*, *Dialister pneumosintes*, and *Prevotella tannerae* were also reported to infect root canals with high prevalence [16]. These infections occur due to biofilm formation by microbes on the tooth area [17]. The use of antibiotics is a very useful treatment due to their effectiveness, low cost, and compatibility. However, resistance to antibiotic agents by microbes has been identified. Gram-negative bacteria have been reported to be resistant to beta-lactam antibiotics due to an enzyme that can open the ring in the beta-lactam structure, thus inactivating the action of the drug [18].

Therefore, natural product drug discovery research is of particular interest to researchers as a natural antibacterial agent. The main parameters in determining antibacterial activity are the inhibition zone value, minimum inhibition concentration (MIC) as a reference for the minimum concentration that can inhibit bacterial growth, and minimum bactericidal concentration (MBC) as a reference for the minimum concentration needed to kill a microorganism [19]. Based on the bioactivity and phytochemicals contained in *M. oleifera*, this plant has become one of the natural sources for dental disease treatment. *M. oleifera* seed extract was reported to provide MIC and antibiofilm values against *P. gingivalis* of 12.5 mg/mL and 6.25 mg/mL, respectively [20]. *M. oleifera* nanosuspension can inhibit *Aggregatibacteri actinomycetemcomitans*, *P. gingivalis*, *Prevotella intermedia*, *Fusobacterium nucleatum* with an MIC and MBC of 25% and 12.5%, respectively [21]. Based on this description, this review will explain the bioactivity contained in *M. oleifera* and describe the role of the plant for dental health and the chemical components contained therein.

2. Phytochemical Constituent

The pharmacological effects of *M. oleifera* are influenced by its phytochemical components. Previous studies have reported that there are several groups of compounds that are unique to each part of *M. oleifera*. The flowers are known to contain flavonoids, alkaloids, sucrose, and amino acids such as kaempferitrin, isoquercitrin, and rhamnetin. Furthermore, the stem contains alkaloid compounds such as moringinine and moringin, octacosanoic acid, β-sitosterol, and 4-hydroxymellein. The seed contains high contents of 4-(α-l-rhamnosyloxy) phenylacetonitrile, benzylglucosinolate, 4-(α-l-rhamnosyloxy) benzylisothiocyanate, *O*-ethyl-4-

(α-l-rhamnosyloxy) benzyl, and 4-(α-l-rhamnopyranosyloxy)-benzylglucosinolate carbamate, while the fruit contains cytokines. In addition, the whole pods were specific for *O*-[2′-hydroxy-3′-(2′′-heptenyloxy)]-propyl undecanoate, methyl-p-hydroxybenzoate, thiocarbamates, isothiocyanate, nitrile, and *O*-ethyl-4-[(α-l-rhamnosyloxy)-benzyl] carbamate [22]. The seeds of *M. oleifera* contain total flavonoids 144.07 mg/kg, total polyphenols 145.16 mg/100 g, and proanthocyanidines 140.49 mg/kg. In addition, the oil of *M. oleifera* contains 18.24 mg rutin equivalent/g (total flavonoids), 37.94 mg ascorbic acid equivalent/g (total antioxidant capacity), and 40.17 mg GA equivalent/g (total phenols). Based on this description, the following are some of the structures of phytochemical components contained in *M. oleifera* [23].

2.1. Phenolic

Niazirin (**1**) was obtained through an ethanol and butanol extraction of the seeds and leaves of *M. oleifera*. It was reported to inhibit α-glucosidase inhibitor with an IC_{50} value of 382.2 μM. [24–28]. Caffeoylquinic acid (**2**), 4-*O*-caffeoylquinic acid (**3**), 4-*O*-(3′-*O*-α-D-glucopyranosyl)-caffeoylquinic acid (**4**), 4-*O*-(4′-*O*-α-D-glucopyranosyl)-caffeoylquinic acid (**5**), 4-*O*-β-D-glucopyranoside benzoic acid (**6**), 5-*O*-caffeoylquinic acid (**7**), benzaldehyde 4-*O*-α-L-rhamnopyranoside (**8**), chlorogenic acid (**9**), methyl caffeoylquinate (**10**), methyl 4-caffeoylquinate (**11**), and 3,4-dihydroxybenzoic acid (**12**) could be obtained through an ethyl acetate and butanol extraction of *M. oleifera* leaves. The structures of the compounds are shown in Figure 1 [24–28].

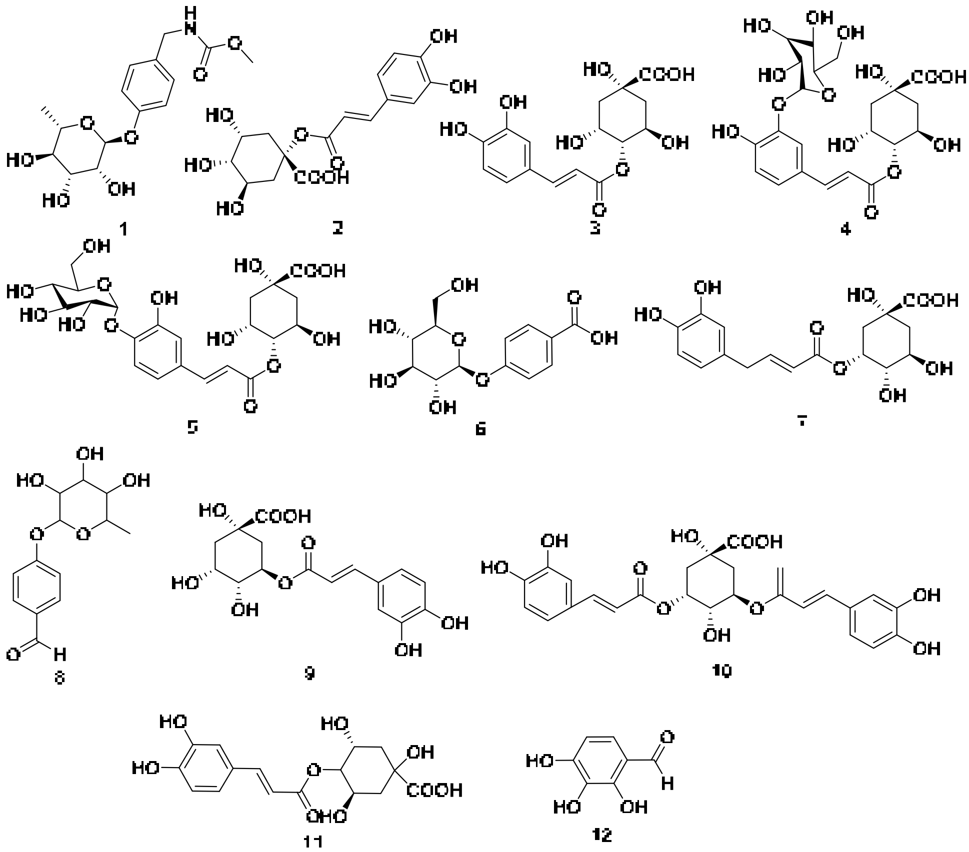


Figure 1. Phenolic compounds in ethanol and butanol extracts of seeds and leaves of *M. oleifera*.

Other phenolic compounds that could be isolated from various parts of *M. oleifera* were caffeic acid (**13**), gallic acid (**14**), *p*-coumaric (**15**), and vanillin (**16**). Cryptochlorogenic acid (**17**) also could be obtained from *M. oleifera*, and it was also reported to have anticancer activity against MCF-7 with an IC_{50} value of 20.8 M. The structures are shown in Figure 2 [28–30].

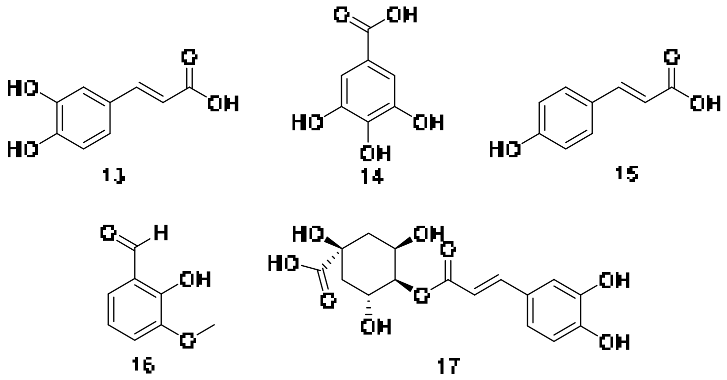


Figure 2. Phenolic compounds of other parts of *M. oleifera*.

2.2. Glucosinolate

Glucosinolate compounds, as shown in Figure 3, could be isolated from the ethanol extracts of seeds of *M. oleifera*. These include the following compounds: 4-(3′-O-acetyl-α-L-rhamnosyloxy) benzyl isothiocyanate (**18**), 4-(α-L-rhamnopyranosyloxy)-benzylglucosinolate (**19**), 4-(α-L-rhamnosyl) benzyl ethyl ester (**20**), moringaside C (**21**), moringaside D (**22**), moringaside E (**23**), moringaside F (**24**), moringaside G (**25**), moringin (**26**), niazimicin (**27**), and glucomoringin (**28**). Furthermore, compound **23** exhibited α-glucosidase inhibitory activity with an IC_{50} value of 382.8 μM, meanwhile compound **26** had a reported an anti-adipogenic effect and an anticancer activity against HeLa cells with an IC_{50} value of 9.2 μg/mL. Meanwhile, compound **28** exhibited anti-allergic properties with IC_{50} values towards β-hexosaminidase and histamine releases of 10.43 and 27.22 μM, respectively. It is also reported to has antiviral properties against H1N1 with an IC_{50} value of 0.98 μg/mL [13,15,26,30–37].

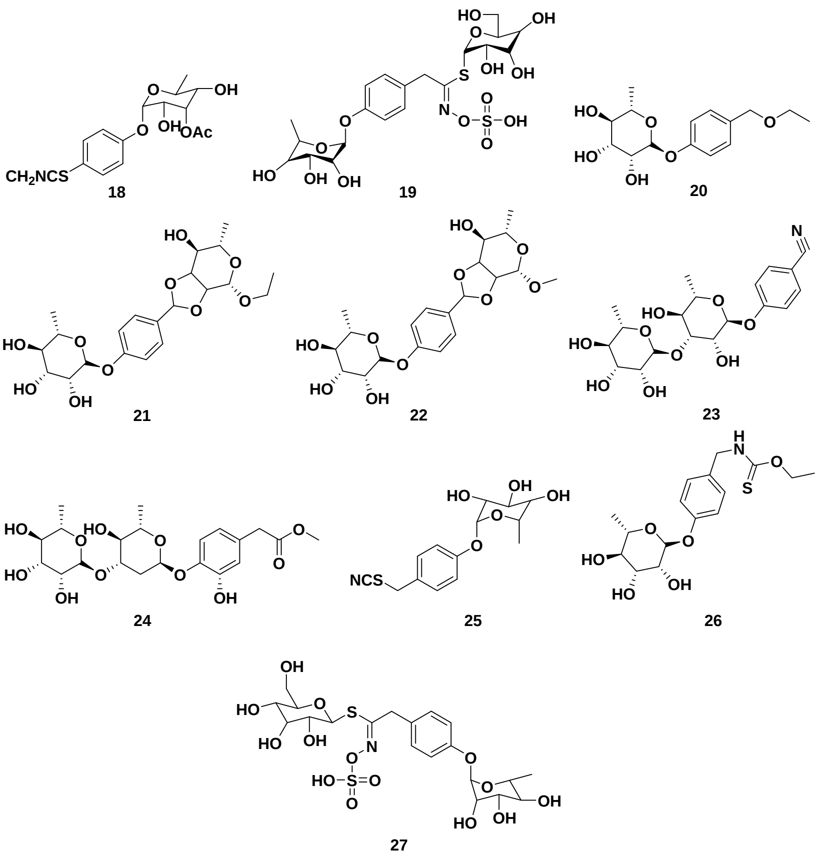


Figure 3. Glucosinolate compounds of seed ethanol extract of *M. oleifera*.

Other glucosinolates found in *M. oleifera* were 4-(4′-O-acetyl-α-L-rhamnosyloxy) benzyl isothiocyanate (**29**), benzyl glucosinolate (**30**), 4-[(2′-*O*-acetyl-α-L-rhamnosyloxy) benzyl] isothiocyanate (**31**), 4-[(3′-*O*-acetyl-α-L-rhamnosyloxy) benzyl] isothiocyanate (**32**), niazinin (**33**), and niazinin B (**34**). Furthermore, compound **31** and **32** exhibited NO inhibitory activity with IC_{50} values of 1.67 and 2.66 μM, respectively, meanwhile compound **33** exhibited antileishmanial properties with an IC_{50} value of 5.25 mM. The structures are shown in Figure 4 [24,38–41].

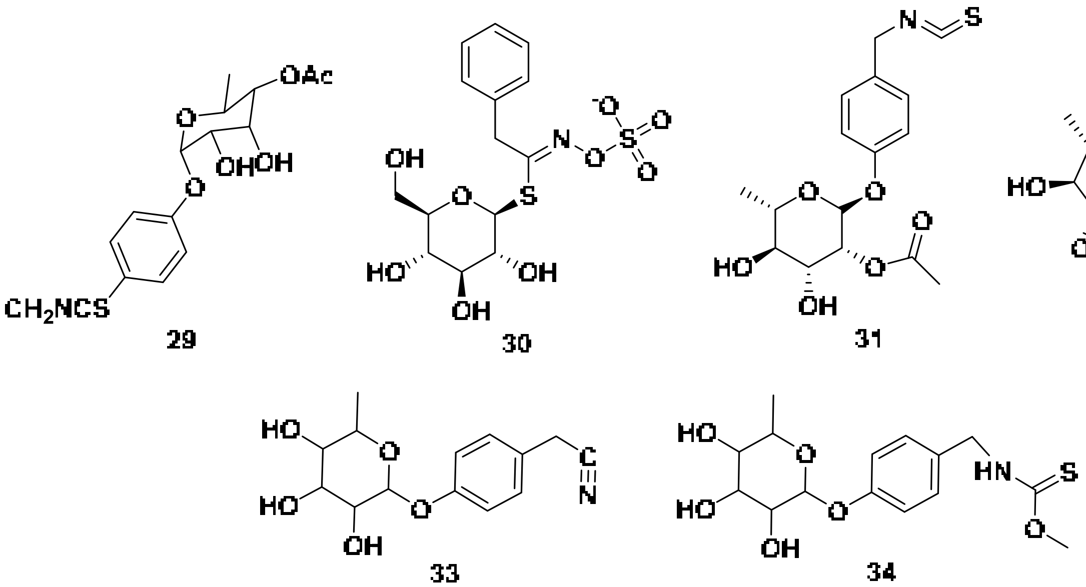


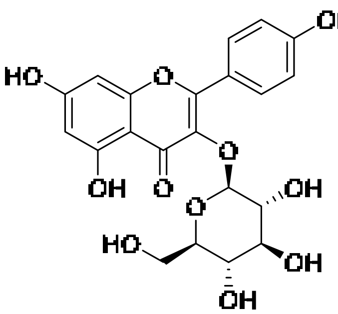
Figure 4. Glucosinolate compounds of other parts of *M. oleifera*.

2.3. Flavonoid

The leaves, barks, and seeds of *M. oleifera* contained various flavonoid compounds, as shown in Figure 5. The flavonoids reported were astragalin (**35**), isoquercitrin (**36**), kaempferol (**37**), kaempferol 3-*O*-glucoside (**38**), kaempferol acetyl glycoside (**39**), kaempferol-3-*O*-(6″-malonyl-glucoside) (**40**), quercetin (**41**), quercetin 3-*O*-β-D-glucopyranoside (**42**), quercetin-3-acetyl-glucoside (**43**), quercetin-3-*O*-(6″-malonyl-glucoside) (**44**), quercetin-3-*O*-β-D-(6″-*O*-3-hydroxy-3-methylglutaryl)-glucoside (**45**), rutin (**46**), vitexin (**47**), and 3,5,6-trihydroxy-2-(2,3,4,5,6-pentahydroxyphenyl)-4*H*chromen*n*-4-one (**48**). Those compounds could be obtained through extraction with methanol, ethanol, butanol, and ethyl acetate. Compounds **35**, **36**, and **46** were reported to inhibit CYP3A4 and CYP2D6, with IC_{50} values of 69.5 and 90 μM for compound **35**, whereas compounds **36** and **46** were reported to be CYP3AP inhibitors with IC_{50} values of 65.5 and 60 μM, respectively.

Compounds **37**, **41**, and **48** were reported to have anti-allergic properties by inhibiting β-hexosaminidase and histamine release, with IC_{50} values of 29.39 and 46.94 μM, respectively, for compound **37**. Compound **41** exhibited IC_{50} values of 19.07 and 7.77 μM, respectively. Compound **48** showed IC_{50} values of 17.70 and 44.87 μM, respectively. Furthermore, compound **46** also inhibited α-glucosidase and pancreatic lipase with IC_{50} values of 40 and 35 μg/mL, respectively. Compound **47** also exhibited antiviral properties against virus H1N1 with an IC_{50} value of 3.42 μg/mL [13,24–27,33,39,42–46].

Apigenin (**49**), kaempferol-3-*O*-[methyl-(*S*)-3-hydroxy-3-methylglutaroyl(1→6)]-β-d-glucopyranoside (**50**), and multiflorin-B (**51**) also could be obtained from *M. oleifera* ethanol extracts [42,47,48].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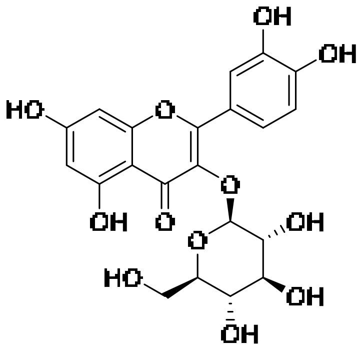
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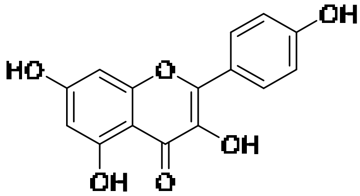
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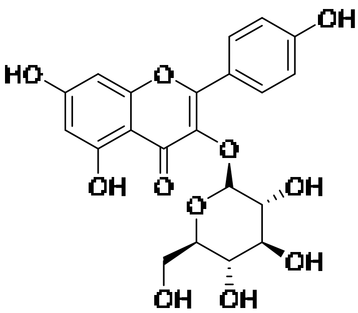

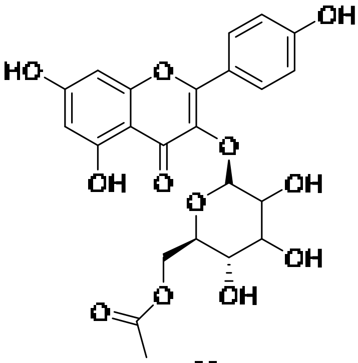
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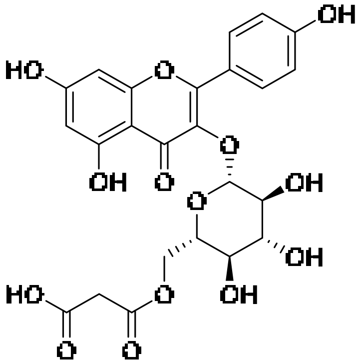
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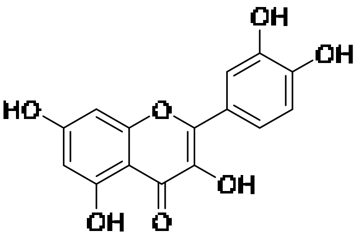
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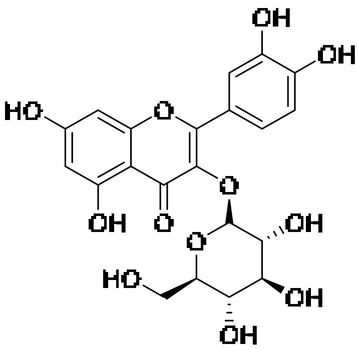
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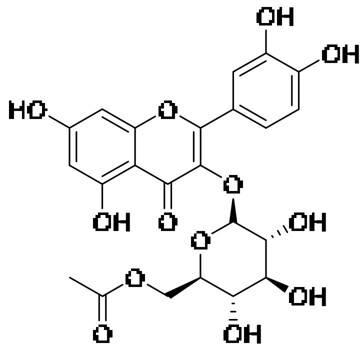
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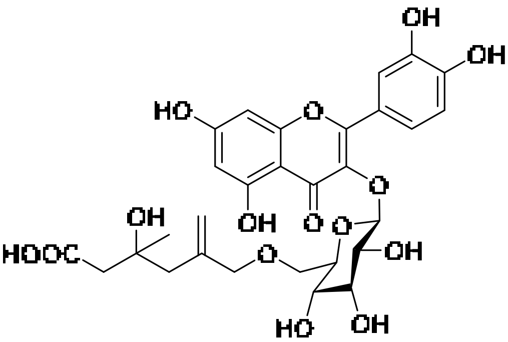
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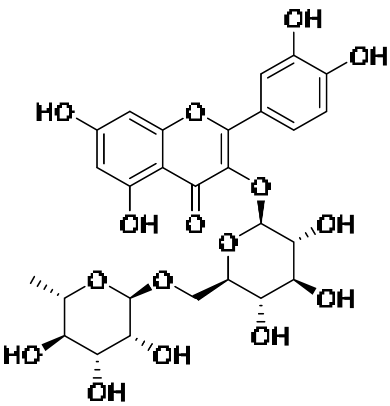
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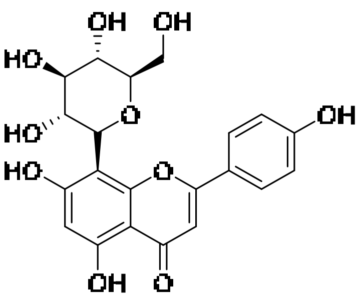
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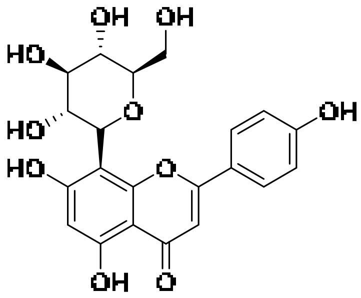
Figure 5. *Cont*.



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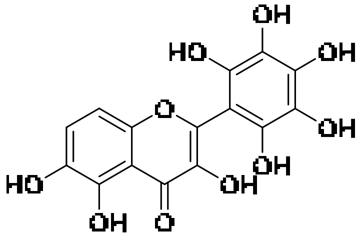

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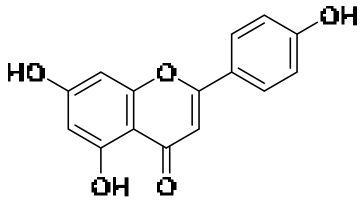

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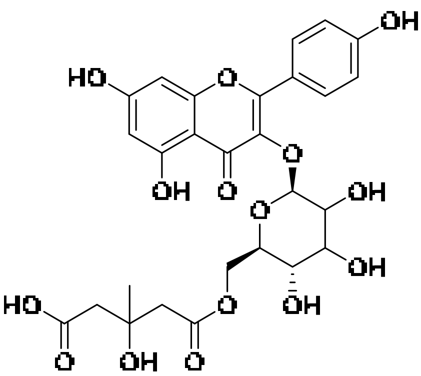

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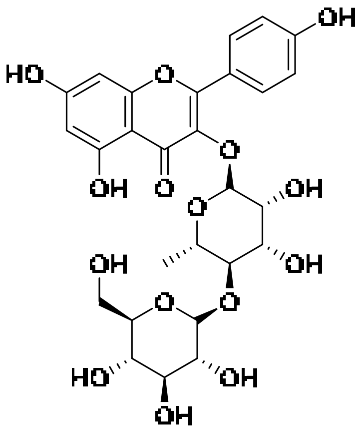

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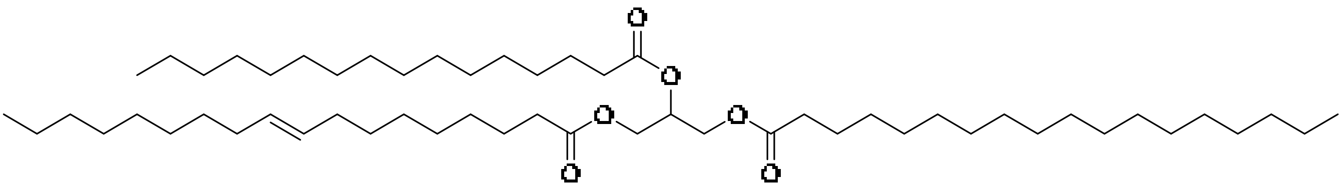
Figure 5. Flavonoid compounds of leaves, barks, and seeds of *M. oleifera*.

2.4. Fatty Acid

Figure 6 shows the structure of fatty acid compounds from the ethanol, methanol, and ethyl acetate extracts of leaves, seeds, and flowers of *M. oleifera*. The compounds are glycerol-1-(9-octadecanoate) (**52**), heneicosanoic acid (**53**), monoacetyl glycerol (**54**), monacosa*n*-15-one (**55**), octacosanol (**56**), oleic acid (**57**), 3,4-methyleneazelaic acid (**58**), and triolein acid (**59**). Compound **57** exhibited anti-allergic properties by inhibiting β-hexosaminidase and histamine release, with IC_{50} values of 53.76 and 56.05 μM, respectively [40,42,49–53].



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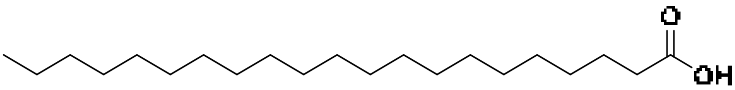

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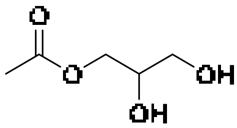

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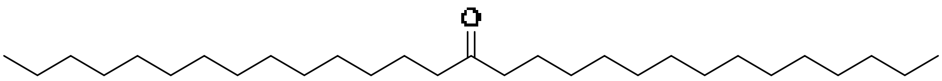

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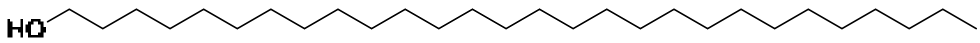
Figure 6. *Cont.*



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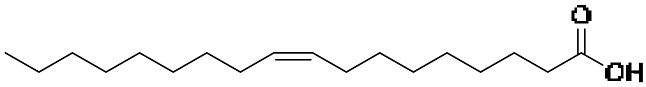

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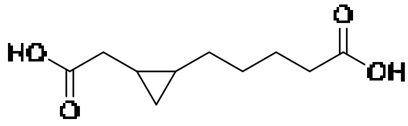

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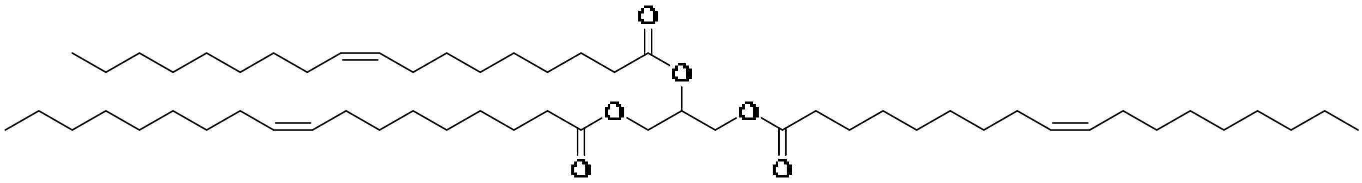

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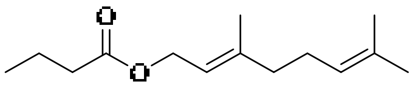
Figure 6. Fatty acid compounds of leaves, seeds, and flowers of ethanol, methanol, and ethyl acetate extracts of *M. oleifera*.

2.5. Ester

Ethyl geranyl acetate (**60**), ethyl-(*E*)-undec-6-enoate (**61**), methyl heptanoate (**62**), methyl-4-(α-L-rhamnopyranosyloxy) benzyl carbamate (**63**), *O*-ethyl-4-(α-l-rhamnosyloxy)benzyl carbamate (**64**), and 2-formyl-5-methyl-1*H*-pyrrol-1-ylbutanoic acid (**65**) were ester groups isolated from leaves, flowers, and seeds of ethanol, methanol, and *n*-hexane *M. oleifera* extracts. The structures are shown in Figure 7. Compound **61** exhibited anti-allergic properties by inhibiting β-hexosaminidase and histamine release with IC_{50} values of 82.68 and 82.07 μM, respectively [42,49,50,53–55].



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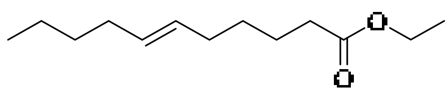

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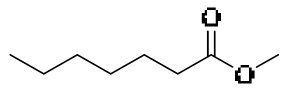

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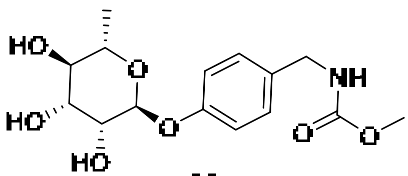

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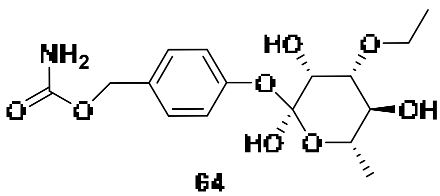

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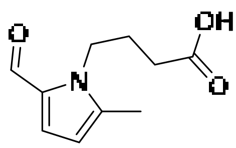

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Figure 7. Ester compounds of leaves, flowers, and seeds of ethanol, methanol, and *n*-hexane extracts of *M. oleifera*.

2.6. Alkaloid

The roots, seeds, and leaves of *M. oleifera* contain alkaloids, as shown in Figure 8. Some of them could be obtained from butanol extraction. The alkaloids contained in *M. oleifera* include the following: marumoside A (**66**), marumoside B (**67**), aurantiamide acetate (**68**), hostine D (**69**), methyl 4-(α-L-rhamnopyranosyloxy) benzylcarbamate (**70**), pyrrolemorine A (**71**), pyrrolemorine B (**72**), pyrrolemorine C (**73**), pyrrolemorine D (**74**), pyrrolemorine E (**75**), pyrrolemorine F (**76**), pyrrolemorine G (**77**), pyrrolemarumine (**78**), tangutorid E (**79**), and tangutorid F (**80**). Compounds **71** and **75** demonstrated notable neuroprotective effects. At a concentration of 0.1 μM, they effectively mitigated PC12 cell damage caused by oxygen glucose deprivation and concurrently reduced the expression of NF-kB [42,47,56,57].

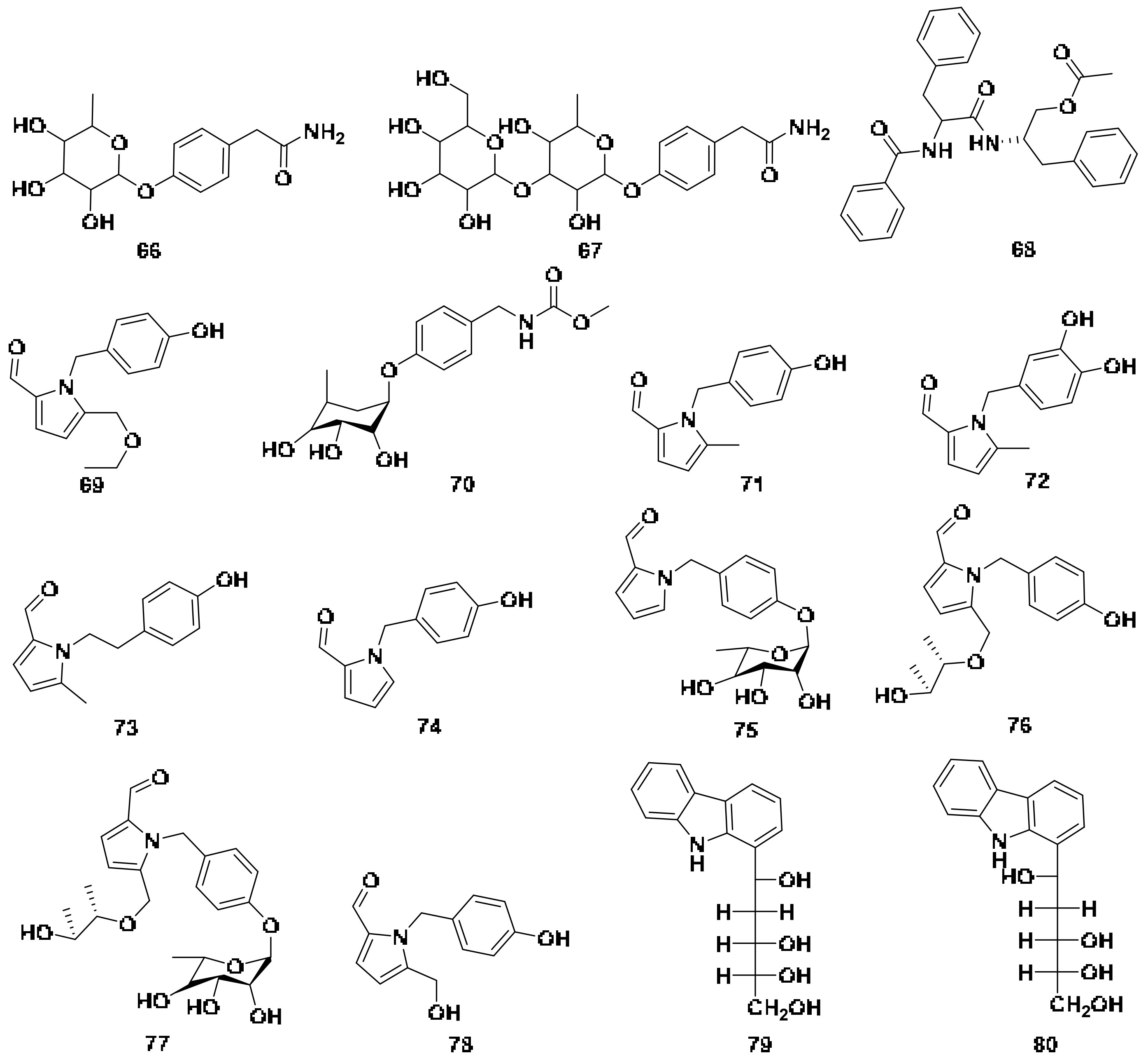


Figure 8. Alkaloid compounds of roots, seeds, and leaves of *M. oleifera*.

2.7. Sterol

All parts of *M. oleifera* contain sterol compounds, as shown in Figure 9. The compounds could be isolated from methanol, ethanol, ethyl acetate, and acetone extracts. The following are sterols isolated from various parts of *M. oleifera*: β-sitosterone (**81**), stigmasterol (**82**), β-sitosterol-3-O-glucoside (**83**), β-sitosteryl oleate (**84**), and 24-methylene-9,19-cyclolanostan-3-ol (**85**). Compounds **82** and **83** exhibited anti-allergic properties by inhibiting β-hexosaminidase and histamine release with IC_{50} values of 75.92 and 38.27 μM, respectively, for compound **82**; meanwhile, compound **83** only inhibited β-hexosaminidase release with an IC_{50} value of 24.93 μM. Moreover, compound **82** exhibited anti-inflammatory characteristics by inhibiting caspase 1 and NF-kB. It also exhibited anti-adipogenic properties by reducing the S and G2/M phases, inhibiting ROS, and enhancing glucose uptake [13,31,37,58–61].

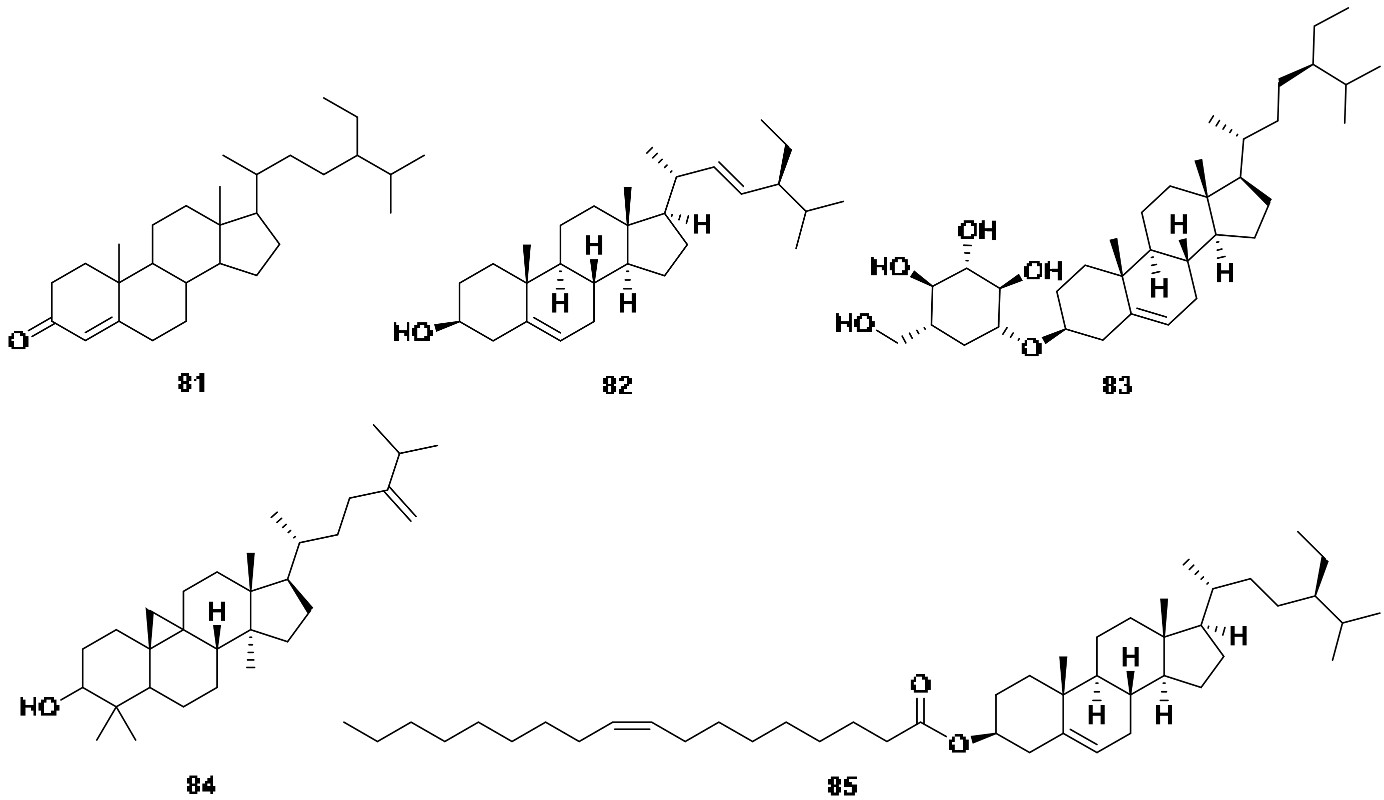


Figure 9. Sterol compounds of *M. oleifera*.

2.8. Terpene

(*S*) Linalyl-β-D-glucoside (**86**), (S) linalyl-β-primeveroside (**87**), lupeol (**88**), tuberonic acid (**89**), γ-diosphenol (**90**), and 2,2,4,4-tetramethyl-6-(1-oxobutyl)-1,3,5-cyclohexanetrione (**91**) were terpenes isolated from *M. oleifera*. Compound **88** exhibited anti-adipogenic properties by reducing the S and G2/M phases, inhibiting ROS, and enhancing glucose uptake. The structure of the compounds is shown in Figure 10 [52,54,62].

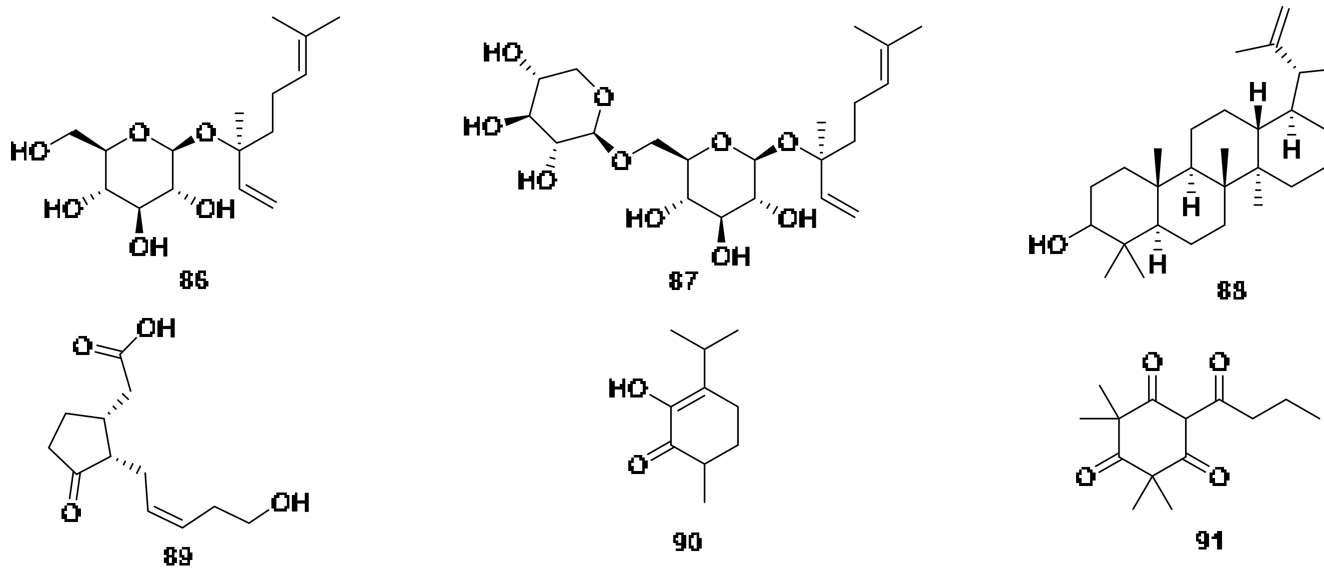


Figure 10. Terpene compounds of *M. oleifera*.

2.9. Other Compounds

The leaf extract of *M. oleifera* contained 4-hydroxyphenylacetonitrile (**92**), lutein (**93**), adenosine (**94**), uridine (**95**), 3-pyridinecarboxamide (**96**), 5-hydroxymethyl-2-furaldehyde

(**97**), 5-hydroxymethyl-2-furancarboxylic acid (**98**), *bis*-isothiocyanatomethyl benzene (**99**), and pyropheophorbide-a (**100**). Compound **92** exhibited activity to induce the secretion of insulin. Other compounds isolated from *M. oleifera* were L-tryptophan (**101**), benzyl β-D-glucopyranoside (**102**), benzyl-β-primeveroside (**103**), (+)-pinoresinol-4-O-β-D-glucopyranoside (**104**), isolariciresinol-3a-O-β-D-glucopyranoside (**105**), lariciresinol-9-O-β-D-glucopyranoside (**106**), fluoropyrazine (**107**), (10-hydroxy-1,3-dimethylchrysen-3-yl)-5-hydroxypentan-1-one (**108**), hexademethylated 3β,11β-dihydroxyfriedelane (**109**), 6,7-dipropanone-5-hydroxyphenyl-3-methylphenanthrene-1-carboxylic acid (**110**), (2*R*)-2-phenylmethoxybutane-1,4-diol (**111**), (2*S*)-2-phenylmethoxybutane-1,4-diol (**112**), 2-hexenyl-β-D-glucopyranoside (**113**), omoringone (**114**), 1,3-dibenzyl urea (**115**), 1-hydroxy-3-phenylpropa*n*-2-yl benzoate (**116**), 1-octadecene (**117**), 2,3,4-trihydroxybenzaldehyde (**118**), 3,4-dihydroxy benzonitrile (**119**), 3,7,11,15-tetramethyl-2-hexadece*n*-1-ol (**120**), 3-hydroxy-β-ionone (**121**), *N*-benzyl *S*-ethyl thioformate (**122**), benzyl benzylcarbamate (**123**), methyl-4-hydroxybenzoate (**124**), and pyrrolezanthine (**125**). The structures of these compounds are shown in Figure 11.

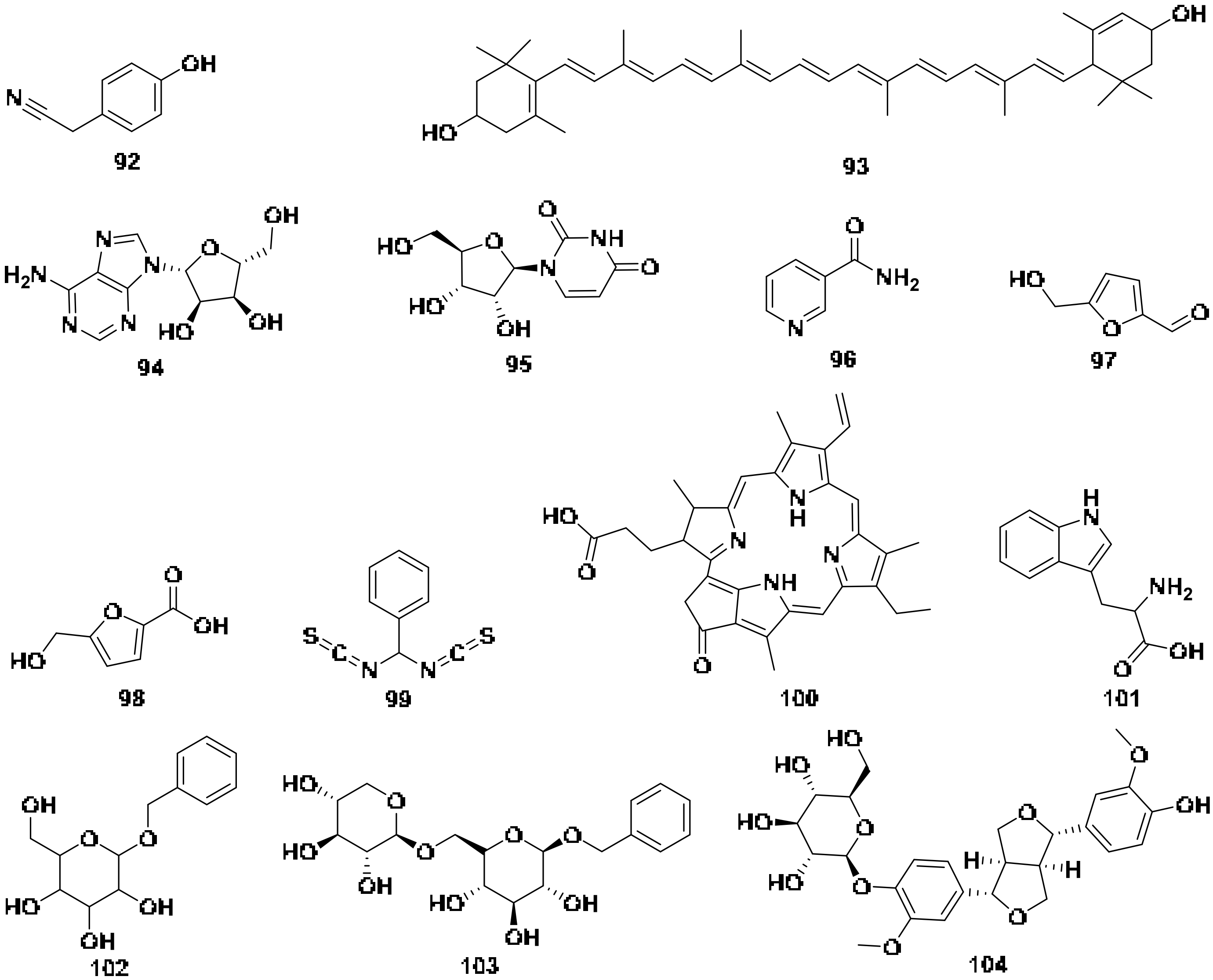
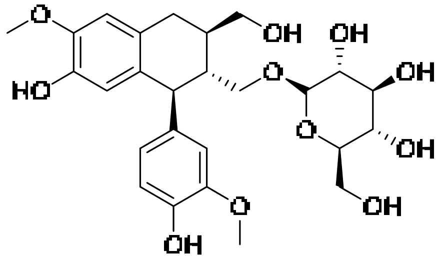


Figure 11. *Cont.*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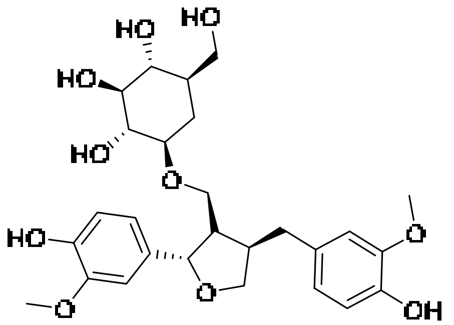
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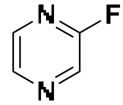
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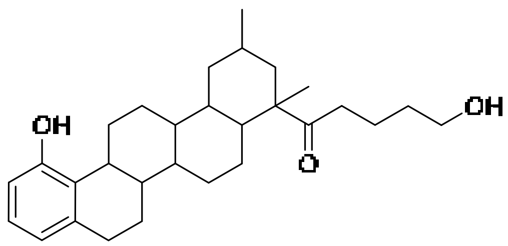
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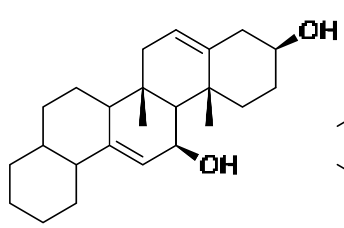
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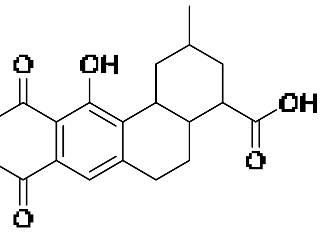
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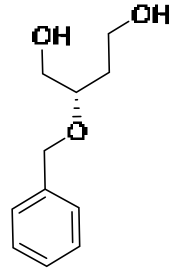
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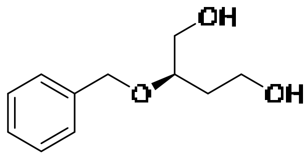
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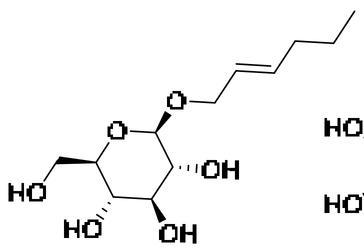
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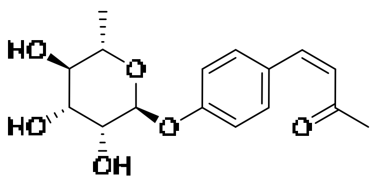
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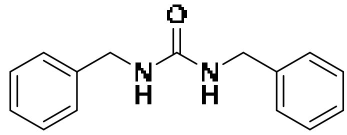
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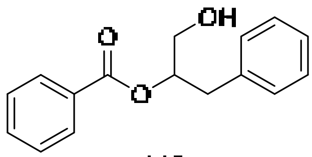
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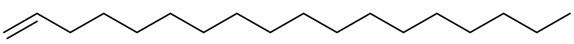
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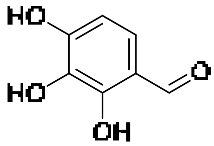
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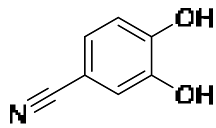
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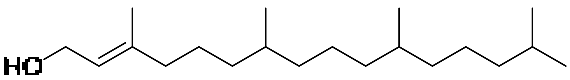
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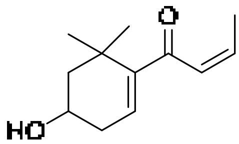
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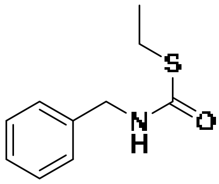
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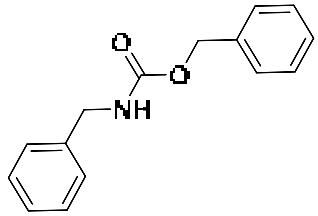
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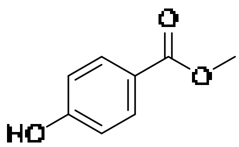
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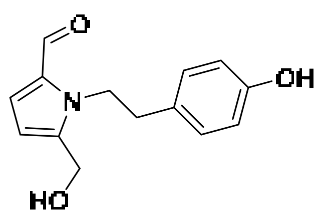
125

Figure 11. The structures of compounds of leaf extract of *M. oleifera*.

Compound **104** displayed a potent inhibition of CYP3A4, with an IC_{50} value of 41.5 µg/mL, while compound **105** exhibited CYP3A4 inhibition with an IC_{50} value of 100 µg/mL. Compound **107** also demonstrated CYP3A4 inhibitory activity, with an IC_{50} value of 72.5 µg/mL. In addition to their enzyme inhibitory effects, compounds **109** and **110** showcased strong antioxidant properties, as indicated by DPPH IC_{50} values of 0.475 and 0.671 mg/mL, respectively. Furthermore, compound **122** exhibited significant antibacterial activity, with MIC values of 32 µg/mL against pathogens such as *S. dysenteriae*, *S. boydii*, and *S. aureus* [13,25,30,37,41,43,51,58,63–69].

3. Pharmacological Properties

3.1. Anti-Hemorrhage

Anti-hemorrhage properties in medicine are used to prevent excessive bleeding due to injury or surgery. Excessive bleeding could lead to death. Adeyemi et al. investigated the anti-hemorrhage properties of *M. oleifera* extracts. The experiment was studied by utilizing the venom of *Echis ocellatus*. The result reported that the ethanol extract of *M. oleifera* showed the highest effectiveness in neutralizing hemorrhage, with a dose of 800 mg/kg for 2 mL of 0.22 mg/kg venom. They also investigated the incubation factor and demonstrated its enhanced potency when pre-incubated with venom from *E. ocellatus* [43].

3.2. Anti-Allergic

Allergy is a condition where the immune system in the body mistakenly identifies substances as harmful and triggers reactions that affect various parts of the body. The development of anti-allergy medicine has been evolving to improve treatment and understand allergy mechanisms. Rani et al. evaluated the effectiveness of the anti-allergic properties of the leaves, pods, and seeds of *M. oleifera*. The extracts were macerated with ethanol at 80% and yielded nine compounds from the isolation. The study showed that the extracts of *M. oleifera* could inhibit the early and late phases of allergic reactions. In particular, the leaf extracts could better suppress the release of β-hexosaminidase (IC_{50} 7.17 µg/mL), IL-4 (IC_{50} 2.32 µg/mL), and TNF-α (IC_{50} 1.2 µg/mL) compared to ketotifen fumarate as a positive control. *M. oleifera* seed extract could inhibit histamine release better compared to other extracts and the positive control, with an IC_{50} value of 5.97 µg/mL. Further study showed that compared to other isolated compounds, glucomoringin (**28**) had a better inhibition against beta-hexosaminidase in the early phase and TNF-α release in the late phase (IC_{50} 10.43 µg/mL); meanwhile, quercetin (**41**) had a better inhibition against histamine release (IC_{50} 7.77 µg/mL). In the last allergic phase, β-sitosterol-3-*O*-glucoside (**83**) showed a better inhibition against IL-4 release compared to other isolated compounds, with an IC_{50} value of 7.33 µg/mL [50].

3.3. Antimicrobial

Antimicrobial properties of compounds always gain interest due to their crucial role in preventing infectious diseases. In an era where microorganisms keep evolving and show resistance to antimicrobial agents, the development of natural antimicrobial agents has become urgent. Various parts of *M. oleifera* extracts with antibacterial activity were studied against *E. coli* and *S. aureus* using the agar well diffusion method. The study showed that the 80% methanol extract of leaves, pulp, and seed had the best inhibition against *E. coli*. The 70 and 80% methanol extract of flowers showed the same value against *S. aureus*, and the aqueous pulp extract showed a better result against *S. aureus* compared to other extracts [70]. Abadallah and Ali studied the comparison of aqueous and ethanol extracts of *M. oleifera* against several bacteria. The MIC value and zone inhibition of the ethanol extract showed better results compared to the aqueous extract. *Shigella* spp. was the most susceptible to both extracts [71]. The extracts of *M. oleifera* showed potential for antibacterial and anti-fungal properties, as shown in Table 2.

Table 2. Antimicrobial activity of *M. oleifera* against (A) Gram negative bacteria, (B) Gram positive bacteria, and (C) fungi.

M. oleifera	Microorganism	Inhibition Zone (mm)	MIC (mg/mL)	MBC (mg/mL)	References
(A) Gram Negative Bacteria					
Stem methanol extract	*Vibrio cholerae*	-	2.50	-	[72]
	Vibrio mimicus	-	1.25	-	
Leaves ethanol extract	*V. cholerae*	-	0.08	-	[72]
	V. mimicus	-	5	-	
Pods ethanol extract	*V. cholerae*	-	0.31	-	[72]
	V. mimicus	-	2.5	-	
Flower chloroform extract	*V. cholerae*	-	0.63	-	[72]
	V. mimicus	-	1.25	-	
Ethanol extract	*Proteus mirabilis*	-	3.75 µg/mL	-	[55]
	Fusarium sp.	12	-	-	
Methanol extract	*Burkholderia cepacian*	19	-	-	[55]
	Yersinia enterocolitica	19	-	-	
Aqueous extract	*Proteus vulgaris*	15	-	-	[55]
	Escherichia coli	15	-	-	
	Yersinia enterocolitica	15	-	-	
	Serratia rubidaea	15	-	-	
	Salmonella pollum	15	-	-	
	Pullarum sp.	5	-	-	
	P. mirabilis	-	3.75 µg/mL	-	
Root powder extract	*E. coli*	-	87%	-	[73]
Nanoparticles loaded to extract	*Aspergillus niger*	55	-	-	[74]
Ethanol extract	*Aeromonas cavie*	23.8	-	-	[75]
	Vibrio parahaelomyticus	21.9	-	-	
Aqueous extract	*Aeromonas cavie*	22.3	-	-	[75]
	V. parahaelomyticus	20.7	-	-	
Methanol pod extract	*P. aeruginosa*	22	-	-	[76]
Acetone extract	*E. coli*	-	5	5	[77]
	Enterobacter cloacae	-	5	5	
	P. vulgaris	-	5	5	
Leaf ethanol extract	*E. coli*	18.3	-	-	[78]
Leaf methanol extract	*E. coli*	19	-	-	[78]
Leaf aqueous extract	*E. coli*	14	-	-	[78]
Aqueous extract	*E. coli*	18.25	25	-	[79]
Ethanol extract		27.75	390 µg/mL	-	
Aqueous extract	*Klebsiella pneumoniae*	21.75	50	-	[79]
Ethanol extract		28.5	780 µg/mL	-	
Aqueous extract	*Citrobacter* sp.	20.65	50	-	[79]
Ethanol extract		19.5	390 µg/mL	-	
Aqueous extract	*P. vulgaris*	14.75	25	-	[79]
Ethanol extract		24.75	780 µg/mL	-	
Aqueous extract	*P. aeruginosa*	17.5	25	-	[79]
Ethanol extract		22.25	780 µg/mL	-	
Aqueous extract	*Staphylococcus aureus*	20	-	-	[79]
Methanol extract		24	-	-	
Aqueous extract	*E. coli*	18	-	-	[80]
Methanol extract		16	-	-	
Methanol extract	*Klebsiella* spp.	25	-	-	[81]
Ethanol extract	*Enterococcus faecalis*	27.5	10% (*w*/*v*)	-	[82]
Ethanol extract	*Salmonella typhi*	8	8	8.5	[83]
Chloroform extract	*Shigella dysenteriae*	-	1500 µg/mL	2000 µg/mL	[31]
Ethanol seed extract	*E. coli*	16	100	-	[25]
	Shigella flexneri	15	100	-	
(B) Gram Positive Bacteria					
Methanol extract	*Aspergillus flavus*	12	-	-	[55]
Nanoparticles loaded to extract	*A. flavus*	55	-	-	[74]
Ethanol extract	*S. aureus*	23.3	-	-	[75]
	Enterococcus aureus	19.4	-	-	
Aqueous extract	*S. aureus*	25.4	-	-	[75]
	E. aureus	17.8	-	-	
Acetone extract	*S. aureus*	-	5	5	[77]
	Micrococcus kristinae	-	0.5	1	
Leaf ethanol extract	*Bacillus subtilis*	19	-	-	[78]
	S. aureus	21.3	-	-	
Leaf methanol extract	*B. subtilis*	22	-	-	[78]
	S. aureus	23.6	-	-	
Leaf aqueous extract	*B. subtilis*	12	-	-	[78]
	S. aureus	18	-	-	
Aqueous extract	*Corynebacterium pseudotuberculosis*	22.5	25	-	[79]
Ethanol extract		25.65	390 µg/mL	-	
Aqueous extract	*Corynebacterium ulcerans*	25.5	25	-	[79]
Ethanol extract		30.5	390 µg/mL	-	

Table 2. *Cont.*

M. oleifera	Microorganism	Inhibition Zone (mm)	MIC (mg/mL)	MBC (mg/mL)	References
Aqueous extract Ethanol extract	*S. aureus*	14.75 26.75	50 390 μg/mL	- -	[79]
Aqueous extract Methanol extract	*B. subtilis*	23 23	- -	- -	[80]
Ethanol extract	*Staphylococcus epidermidis*	12	-	-	[80]
Ethanol extract	*S. aureus*	19.5	10% (*w*/*v*)		[82]
(C) Fungi					
Aqueous extract	*Candica albicans*	5	-	-	[55]
Ethanol extract	*C. albicans*	-	718.33 μg/mL	-	[74]
Nanoparticles loaded to extract	*C.albicans*	75	-	-	[74]
Methanol pod extract	*Colletotrichum* sp.	14	-	-	[76]
Ethanol extract Aqueous extract	*C.albicans*	1.87 cm 1.87 cm	- -	- -	[63]
Ethyl acetate extract	*Microsporum gypseum* *Rhizopus stolonifer*	9.67 8.67	1.56 6.25	- -	[26]
Methanol extract	*R. stolonifer*	9.66	1.56	-	[26]

Note: - (not tested).

The antiviral activities of *M. oleifera* extracts against several viruses are shown in Table 3.

Table 3. Antiviral activity of *M. oleifera* against several viruses.

M. oleifera	Viral	IC_{50} (μg/mL)	CC_{50} (μg/mL)	EC_{50} (μg/mL)	References
Leaf extract	SARS-CoV-2 "NRC-03-nhCoV"	52.79	111.54	-	[27]
Crude ethanol extract	SARS-CoV-2	12.29	7277	-	[28]
Seed extract	IAVs	-	-	1.27	[29]
Seed extract	H1N1	0.26	-	-	[84]
Aqueous extract	HSV-1 HSV-2	43.2% 21.4%	- -	- -	[30]
Leaf ethanol extract	H9	-	100	-	[33]
Methanol extract	HSV-1F VU-09	- -	724.5 -	74.8 79.6	[34]
Aqueous leaf extract	AqMOL ACV	- -	697.8 >30	721.8 0.48	[35]

Note: - (not tested).

3.4. Anthelminthic

Parasitic worm infections can infect various parts of the body, which could lead to health issues for the host. This could lead to the economic loss of livestock. To prevent these losses, the development of anthelmintic medicine has gained interest due to parasitic worm that affect not only affect livestock but also human health. Utilizing earthworms 3–5 cm in length and 0.1–0.2 cm in width, Nilani et al. evaluated the anthelminthic properties of the seed oil *M. oleifera*. The seed oil was divided into two concentrations, 25 and 50 mg/mL, they exhibit anthelminthic properties, with paralysis times of 21 and 16 min respectively while the death time 30 and 24 min, respectively. The study also reported that oleic acid (**57**) at a concentration of 25 mg/mL contained in seed oil showed a paralysis time 23 min and a death time 33 min [36].

3.5. Antihypertensive

Hypertension is a cardiovascular disease that causes sustained blood pressure levels. It could lead to health complications, including heart disease, kidney, and stroke. Randriamboajonvy et al. utilizing spontaneous hypertensive rats (SHR) as experiment model to demonstrate the effect of *M. oleifera* seed oil. The result showed a significant reduction in nocturnal heart rate without a change in diurnal heart rate after ten days of treatment. The use of seed oil in SHR increased the capacity of the left ventricle during diastole, which was substantially lower in SHR rats as in comparison with WKY (control) rats. Ejection fraction, a measure of systolic ventricular function, was substantially reduced in both SHR groups (control and seed oil-treated) in comparison with to WKY rats. This suggests that seed oil treatment did not have a positive effect on systolic ventricular function in SHR. The increased isovolumic relaxation time, indicative of diastolic function impairment in SHR, was completely reversed by seed oil treatment. *M. oleifera* seed oil treatment also led to a reduction in cardiomyocyte size in SHR seed oil-treated hearts compared to those in SHR control hearts. Furthermore, the study explored the potential involvement of peroxisome proliferator-activated receptor (PPAR) signaling pathways in seed oil's protective effect against cardiac fibrosis in SHR. The expression of PPARα and PPARδ in cardiac tissue was assessed, revealing increased staining in the left ventricle of SHR seed oil-treated rats compared to SHR controls. These findings collectively suggest a beneficial impact of *M. oleifera* seed oil on cardiac structure and function in SHR, accompanied by an upregulation of PPAR-α and δ signaling pathways [37].

Acuram et al. studied the antihypertensive properties of methanol and ethyl acetate extracts related to inhibition of angiotensin converting enzyme (ACE), furthermore, blood pressure was also investigated. The hypertension was induced in mice with N^{ω}-nitro-L-arginine methyl ester (L-name). The result demonstrated that compared to methanol extract, ethyl acetate showed more significant inhibition of ACE and lowering blood pressure on the last day [85].

3.6. Antileishmanial

Infection from the genus Leishmanial affecting health issues in tropical and subtropical regions such as Asia, Africa, America, and Mediterranean. This infection is transmitted from sandflies to humans. Kaur et al. studied the anti-leishmanial properties of *M. oleifera* extract against promastigotes of *Leishmania donavani*. The roots were extracted with 70% ethanol and the leaves were extracted with methanol. The roots ethanolic extract and the leaves' methanolic extract exhibited moderate inhibitory activity, with IC_{50} values of 83.0 and 47.5 μg/mL, respectively. Upon fractionation, the methanolic extract of leaves showed enhanced antileishmanial activity, particularly in its ethyl acetate fraction, which displayed increased potency with an IC_{50} value of 27.5 mg/mL. Niazin was isolated from ethyl acetate fraction gave antileishmanial properties with IC_{50} value of 5.25 mM [41].

3.7. Wound Healing

Tofiq et al. macerated the leaves of *M. oleifera* with 70% ethanol. The experiment was conducted in 7 groups and observed wound healing properties. The result demonstrated that ointment with 10% concentration of extract formulation showed a better effect, representing less scarring, brighter skin, and more regenerated hair follicles compared to gentamicin ointment. Ramadhany et al. made *M. oleifera* leaves extract by soxhlet with ethanol. The extract was made into 4 and 15% gel and investigated their wound healing properties on gingival wounds. The study analyzes the neutrophils, fibroblasts, angiogenesis, and epithelial thickness for seven days. It resulted in 15% *M. oleifera* gel extract having a better effect in reducing neutrophils, increasing the number fibroblasts and angiogenesis. However, 4% *M. oleifera* gel extract was better at increasing epithelial thickness [86].

3.8. Antioxidant

Antioxidant properties are used to decrease oxidative stress, which could lead to damaging tissues. Antioxidants function as electron donors to free radicals and neutralize them. Thus, made antioxidant properties become one of most researched topics. Antioxidant activities of *M. oleifera* by several bio-assay methods are shown in Table 4.

Table 4. Antioxidant activity of *M. oleifera* by several bio-assay methods.

M. oleifera	Bio-Assay	IC_{50}	EC_{50} (mg/mL)	References
Roots extract	Xanthine oxidase	16 µL	-	[44]
Leaf extract		30 µL	-	
Stem bark extract		38 µL	-	
Roots extract	2-deoxyguanosine	40 µL	-	[44]
Leaf extract		58 µL	-	
Stem bark extract		72 µL	-	
n-Butanol extract	DPPH	92.62%	0.07	[45]
Ethyl acetate extract		90.27%	0.08	
Petroleum ether extract		-	0.35	
Aqueous extract		-	0.44	
n-Butanol extract	ABTS	99.46%	0.01	[45]
Ethyl acetate extract		97.49%	0.04	
Crude extract		77.82%	-	
Petroleum ether extract	ABTS	-	0.18	[45]
Aqueous extract		-	0.29	
n-Butanol extract	Hydroxy radical-scavenging	94.46%	-	[45]
Ethyl acetate extract		80.68%	-	
Leaf extract	DPPH	1.87 mg/mL	-	[46]
Leaf extract	FRAP	0.99 mM Fe^{2+}/g	-	[46]
Root extract	ABTS	1.24 mg/mL	-	[46]
Ethyl acetate extract	DPPH	526.7 µMol	-	[87]
Acetone extract		435.7 µMol	-	
Ethanol extract	DPPH	0.44 mg/mL	-	[88]
Ethanol extract	Hydroxy peroxide free radical scavenging	0.54 mg/mL	-	[88]
Ethanol extract	FRAP	0.25 mg/mL	-	[88]
Ethyl acetate extract	DPPH	71.9 µg/mL	-	[89]
Ethyl acetate extract	ABTS	54.79 µg/mL	-	[89]

Note: - (not tested).

3.9. Anti-diarrheal

Misra et al. evaluated the anti-diarrheal potential of *M. oleifera*. Leaves of *M. oleifera* were extracted with petroleum ether and then subjected to ethanol for seven days. The animal models were divided into six groups, as control and as doses of extract, and castor oil was used to induce diarrhea. The study showed that the ethanol extract successfully acted as an anti-diarrheal within 52 min, with an extract dose 150 mg/kg, and showed total stools of 0.130 mg [90].

3.10. Hepatoprotective

Pari and Kumar conducted an evaluation of the hepatoprotective properties of an ethanol extract obtained from *Moringa oleifera* leaves in rats with liver damage caused by anti-tubercular medications such as isoniazid (INH), rifampicin (RMP), and pyrazinamide (PZA). This extract had considerable protective effects when administered orally, as indicated by its impact on numerous parameters. This included the serum levels of glutamic pyruvic transaminase (alanine aminotransferase), glutamic oxaloacetic transaminase (aspartate aminotransferase), bilirubin, and alkaline phosphatase, as well as the levels of lipids and lipid peroxidation in the liver [91].

Khalid et al. assessed the potential protective effects of *M. oleifera* leaf powder and a 70% ethanol extract of *M. oleifera* leaves in alleviating liver and kidney dysfunction induced by polycystic ovary syndrome (PCOS) in female albino mice. PCOS was induced by administering intramuscular injections of testosterone enanthate at a dose of 1.0 mg/100 g body weight for a duration of thirty-five days. The study conducted assessments of renal function (RFT), liver function (LFT), and the oxidative stress biomarker malondialdehyde (MDA) in the serum at intervals of 0, 7, and 14 days. The mice that received treatments of *M. oleifera* exhibited significant reductions in the levels of alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), total bilirubin, urea, and creatinine compared to the PCOS-induced controls. Conversely, there was a notable increase in the levels of total protein, albumin, globulin, and the albumin/globulin (A/G) ratio. Furthermore, oxidative stress levels exhibited significant reductions in response to treatments, exposure duration, and their combined effect. The findings of this study suggest that both *Moringa oleifera* leaf powder and extract have the potential to reduce oxidative stress and improve renal and hepatic activity in female albino mice with PCOS-induced dysfunction [58].

3.11. Anti-Inflammatory

Inflammation is a recognized physiological reaction that serves to safeguard the body against infections and promote the healing of tissue injuries. However, persistent or chronic inflammation can potentially support the growth of various disorders and diseases associated with inflammation. Sulaiman et al. assessed the anti-inflammatory potential of an *M. oleifera* aqueous extract. The assay was conducted by carrageenan-induced paw edema. The extract was made at different doses and showed inhibitory effects in a dose-dependent manner. At dose 100 mg/kg, after five hours, the inhibition showed a value of 50%. The suggested anti-inflammatory mechanism was the extract which contained flavonoids with an inhibitory action against NF-k [64].

Fard et al. studied the anti-inflammatory potential of an *M. oleifera* extract on macrophages stimulated with lipopolysaccharide (LPS) in RAW264.7 macrophages. The anti-inflammatory properties of ethanol extracts derived from *M. oleifera*'s bioactive leaves were assessed by examining their ability to inhibit nitric oxide (NO) production using the Griess reaction and to modulate the expression of pro-inflammatory mediators in macrophages. The ethanol leaf extract exhibited a significant inhibition of various inflammatory markers, including NO production, as well as prostaglandin E2, TNF-α, IL-6, and IL-1β secretion. Concurrently, the bioactive extract dose-dependently stimulated the production of IL-10. Furthermore, the ethanol extract effectively suppressed the protein expression of inflammatory markers such as inducible NO synthase, cyclooxygenase-2, and NF-kB p65, also in a dose-dependent manner [65].

Previously, Xu et al. investigated the antioxidant properties of *M. oleifera*, and also investigated its anti-inflammatory properties. The study was conducted by determining the NO production of RAW264.7 macrophages. The study revealed that the leaf extract gave a lower NO production, at 100 μg/mL, while the seed extract presented higher NO production. It concluded that the leaf extract had better anti-inflammatory properties compared to the seed extract [46].

An ethyl acetate fraction of *M. oleifera* was assessed to have anti-inflammatory potential against LPS-induced macrophages. The study showed that macrophages which were treated with the ethyl acetate fraction exhibited a reduction in the production of pro-inflammatory mediators. This reduction was observed between the mRNA and protein levels. The study findings indicated that the fraction downregulated the mRNA expression of various inflammatory markers, including IL-1, IL-6, TNF-α, PTGS2, NF-kB P50, and RelA. Furthermore, the fraction effectively inhibited the expression of inflammatory mediators such as IL-6, TNF-α, and cyclooxygenase-2. Notably, the fraction effects included the inhibition of IkB-α phosphorylation and the ability to decrease the expression of nuclear factor NF-kB p65, thereby impeding its nuclear translocation [52].

3.12. Anti-Diabetic

One of the traditional usages of *M. oleifera* was as a diabetic medicine. Gupta et al., and Al-Malki and El Rabey studied the proper effects of *M. oleifera* as an anti-diabetic medicine. Pod and seed powders of *M. oleifera* were used in various doses. The animal model used was a streptozotocin-induced diabetic male rat. The parameters used were the determination of IL-6, immunoglobulin A, immunoglobulin G, fasting blood sugar, glycosylated hemoglobin, albumin, potassium, sodium, creatinine, and uric acid. Both studies showed that *M. oleifera* extracts could restore the abnormalities to a slightly normal level; however, a higher dose was suspected to be more effective. The water consumption of all subject groups also returned to normal after treatment [59,60].

Previously, Hamed et al. examined the antioxidant properties of *M. oleifera* leaf extracts. Furthermore, they also investigated the anti-diabetic activity of purified flavonoids from crude extracts by determining their α-glucosidase inhibitory effects. The results showed that purified flavonoids inhibited α-glucosidase by 54.41% at 100 µg/mL and 99.01% at 800 µg/mL in an uncompetitive manner [48]. Chen et al. reported that the ethanol leaf extracts of *M. oleifera* could be used as anti-diabetic medicine. They investigated the activity by determining the α-glucosidase value. The study showed an IC_{50} value of 123 µg/mL [61].

3.13. Anticancer

Jung evaluated the anticancer properties of *M. oleifera* leaf extracts against A549 human lung cancer cells. The evaluation was conducted by MTT assay, and the changes and apoptotic effects were observed. The observation revealed that *M. oleifera* extract treatment resulted in a dose-dependent downregulation of caspase-3 and an upregulation of cleaved caspase-3, indicating an induction of apoptosis. There was a significant dose-dependent downregulation of Akt, p-IkB, NF-kB, p-Erk, β-catenin, and cyclin D1, all of which play roles in cell survival and proliferation. Treatment with soluble *M. oleifera* extracts for 48 h resulted in a significantly reduced release of reactive oxygen species (ROS) in comparison to the untreated control group. This implies a decrease in oxidative stress. In summary, the study concluded that MOL treatment induced apoptosis, inhibited the growth of tumor cells, and reduced the levels of internal reactive oxygen species (ROS) in human lung cancer cells. These outcomes emphasize the potential of *M. oleifera* leaf extracts as a promising candidate for further research and development in the context of lung cancer therapy [66]. The anticancer activities of *M. oleifera* against several cancer cell types are shown in Table 5.

Table 5. Anticancer activity of *M. oleifera* against several cancer cell types.

M. oleifera	Bio-Assay	IC_{50} (µg/mL)	Other Values	References
Seed essential oil	HeLa HepG2 MCF-7 CACO-2 L929	442.8 751.9 226.1 1000 1000	23.9% 34.93% 40.48% 50.28% 42.99%	[67,68]
Aqueous extract	HeLa	70	70 µg/mL	[67,68]
Aqueous extract	A375	-	36.40%	[69]
Aqueous extract	Bcl-2	-	0.68 to 0.53-fold	[69]
Aqueous extract	Bax	- -	2.62-fold increase at the m-RNA level; 1.85-fold increase at the protein level	[69]
Aqueous extract	MOE activation of Caspase-3/7	-	Increase 1.75-fold	[69]
Aqueous extract	MOE activation of Caspase-9	-	Increase 1.42-fold	[69]
Aqueous extract	MCF-7 HTC116 AsPC-1	100 125 240	- - -	[92]
Leaf extract	Urethane-induced lung cancer in rats	-	Induced in glutathione 3.8 mg/g, superoxide dismutase 900.6 U/g, and malondialdehyde 172 nmol/g	[93]
Leaf extract	Urethane-induced lung cancer in rats	-	Increase 50% EGFR-mRNA, 10.8% improvements of mucin level and the presence of PCNA-positive cells in lung	[93]
CO_2 root extract	MCF-7	-	Spanning 100 to 500 µg/mL	[94]
n-Hexane extract Chloroform extract Ethyl acetate extract Methanol extract	Hep-2	180.6 190.2 40.2 170.1	- - - -	[95]
Crude extract	HCT116	9.5 (24 h) 5.04 (48 h)	-	[96]
Crude extract	CYP3A4	52.50	-	[54]

Table 5. *Cont.*

M. oleifera	Bio-Assay	IC_{50} (µg/mL)	Other Values	References
Chloroform extract	MCF-7	6.25		
Dicholoromethane extract	MCF-7	5	1.87-fold increase in p53 expression, 1.47-fold increase in Bax expression 1.05-fold increase in cytochrome C levels, 2.21-fold increase in caspase 8 expression	[97]
Ethyl acetate extract	MDA-MB-231	233.5	Increase 44.2% of late apoptotic cells; increased level of cleaved caspase 3 protein, Bax mRNA, and p53 mRNA; decreased anti-apoptotic Bcl-2 protein	[98]

Note: - (not tested).

Based on the data attained by Do et al., as shown in Table 3, this study demonstrated that *M. oleifera* extract induced apoptosis in A375 cells, as evidenced by chromatin condensation and the externalization of phosphatidylserine (PS), which are characteristic features of apoptotic cell death. The apoptosis process was initiated by the activation of caspase-9 and caspase-3/7, the cleavage of PARP, and the translocation of apoptosis-inducing factor into the nucleus. These findings provide insights into the apoptotic mechanisms triggered by *M. oleifera* extract in A375 cells [69]. Meanwhile, Pappas et al. assessed the gene expression of *M. oleifera* aqueous wild and cultivated leaf extracts against human pancreas cancer cells AsPC-1, MCF-7, and HCT-116 colon cancer cells. The aqueous extract exerted its effects by down-regulating p53 expression in all tested cell lines and by dow*n*-regulating c-myc in AsPC-1 cells. Additionally, specific marker genes associated with each cell line, such as BRCA-1 in MCF-7, mta-1 in AsPC-1, and Ki-67 in HTC116 cells, were dow*n*-regulated. Furthermore, the survivin (BIRC5) gene, an inhibitor of apoptosis, was dow*n*-regulated in all three cell lines, suggesting a shared target mechanism of Moringa constituents across these cell lines [92].

Kumar et al. discovered that an extract of *M. oleifera* leaves demonstrated effective inhibition of Dalton lymphoma (DL) cell proliferation. This inhibition was characterized by alterations in mitochondrial membrane potential (ΔΨm) and noticeable changes in overall cell morphology. Notably, DL cells treated with the extract experienced cell cycle arrest at the G2/M phase and a significant upregulation in the expression of p53 and p21. Furthermore, the treatment resulted in increased levels of pro-apoptotic markers, including Bax, Cytochrome-c (Cyt-c), and caspase-3, while reducing the expression levels of the anti-apoptotic Bcl-2 protein. These changes strongly suggest the induction of apoptosis in DL cells. Mechanistically, the anticancer efficacy of *M. oleifera* extract was attributed to the inactivation of the MEK/ERK-mediated pathway in DL cells. Additionally, it is noteworthy that the inhibition of DL growth by MOML was accompanied by apoptosis induction and improvements in hematological parameters in DL-induced mice [99].

4. Utilization of *M. oleifera* in Dental Health

Research on several bacteria that are pathogenic to dental health has been carried out, such as *Streptococcus mutans*, *Enterococcus faecalis*, *Staphylacoccus aureus*, and others. Table 6 shows some data on the antibacterial activity of *M. oleifera* against oral pathogenic bacteria.

Jwa evaluated the aqueous and ethanol extracts of *M. oleifera* against *S. mutans,* which were found in the cariogenic biofilm of dental caries. Both extracts reduced the bacteria's growth at concentrations of 25 and 6.25 µg/mL, respectively. At the same concentration, heated ethanol extract exhibited inhibitory activity better than non-heated extracts. This study showed that the ethanol extract was more effective than the aqueous extract against *S. mutans* [109]. Soraya et al. investigated the anti-bacterial properties of *M. oleifera* gel in inhibiting the growth of *S. mutans,* which were involved in the pathogenesis of dental caries. After 48 h, it was observed that the 12.5% concentration exhibited the highest effectiveness in reducing *S. mutans* growth. Within 24 h, the 6.25 and 3.125% concentrations displayed remarkable capabilities in suppressing *S. mutans* growth. Notably, the 6.25%

concentration showed superior efficacy in reducing the formation of *S. mutans* biofilms. The application of *M. oleifera* gel extract created conditions in which *S. mutans*, a commensal bacterium, struggled to form a biofilm, with inhibition levels surpassing 70%. This was evidenced by the absence of substantial biofilm development. It is worth mentioning that at all tested concentrations, *M. oleifera* exhibited a toxic effect on *S. mutans* cells. The ethanol extract gel of *M. oleifera* demonstrated the ability to curtail both the growth and biofilm formation of *S. mutans* on tooth surfaces while concurrently exerting toxicity on *S. mutans* cells, potentially due to the presence of anti-bacterial compounds [110]. The anti-bacterial properties of herbal toothpaste, formulated with *M. oleifera* root essential oil, were assessed against bacteria commonly associated with tooth plaque, namely *S. mutans* and *S. aureus*. The Muller Hinton agar well diffusion method was used for this evaluation The findings of this study demonstrated that *S. mutans* exhibited susceptibility to the herbal toothpaste, as indicated by a significant inhibition zone measuring 31 mm [111].

Table 6. Antibacterial activity of *M. oleifera* to some oral pathogenic bacteria.

M. oleifera	Microorganism	Inhibition Zone (mm)	MIC (µg/mL)	MBC	References
Ethanol extract	*P. aeruginosa*	21.21	458	-	[100]
Ethanol extract	*S. aureus*	20.55	>1	-	[101]
Aqueous extract	*S. aureus*	12	58.75 mg/mL	-	[100]
Methanol extract	*E. faecalis*	44.83	-	-	[102]
Leaves ethanolic extract	*S. aureus* *S. mutans*	19.25 13	-	-	[103]
Roots ethanolic extract	*S. aureus* *S. mutans*	9.25 10.50	-	-	[103]
Seed ethanolic extract	*S. aureus* *S. mutans*	3.25 4.75	-	-	[103]
Bark ethyl acetate extract	*S. aureus*	16.33	-	-	[104]
Root bark methanolic extract	*S. aureus*	19	12.5 mg/mL	-	[105]
Leaf extract	*S. mutans* biofilm	0.20/(OD 520 nm)	-	-	[106]
Diethyl ether, *n*-Hexane, and Ethyl acetate extract	*S. aureus*	-	15.6	-	[107]
Diethyl ether extract	*E. faecalis*	-	15.6	-	[107]
extract	*S. aureus*	-	15.6	-	[107]
Leaf extract	*E. faecalis*	11.89 (at 100 µg/mL)	-	-	[108]
Leaf extract	*E. faecalis*	35.5 (at 24 h) 48.83 (at 48 h)	75	-	[102]

Note: - (not tested).

Alharbi et al. examined the antimicrobial efficacy of *M. oleifera* leaf extract, octenidine dihydrochloride (OCT), sodium hypochlorite (NaOCl), and their combinations as an intracanal irrigant against *E. faecalis*. Decoronation and root canal preparation were performed on single-rooted mandibular premolars. After autoclaving, each root specimen was inoculated with *E. faecalis* and incubated at 37 °C for 48 h. Subsequently, based on the irrigation solution used, the specimens were split into six groups: 2.5% NaOCl (Group 1), 0.1% OCT (Group 2), *M. oleifera* leaf extract (Group 3), a combination of *M. oleifera* extract and 1.25% NaOCl (Group 4), a combination of *M. oleifera* extract and OCT (Group 5), and normal saline (Group 6). Both *M. oleifera* extract and 0.1% OCT demonstrated antibacterial effects against *E. faecalis* comparable to 2.5% NaOCl and could be considered as potential root canal irrigants. Furthermore, combination groups exhibited superior anti-microbial activity compared to individual irrigants [112].

Rochyani investigated the inhibitory potential of *M. oleifera* leaf extract on the biofilm formation of *E. faecalis* bacteria. The experiment was divided into several groups, including a negative control group (CMC solvent 0.1%), a positive control group (ChKM), and four test groups extracts of 20, 40, 60, and 80%, respectively. The results indicate that the *M. oleifera* leaf extract demonstrates a significant inhibitory effect on the biofilm formation of *E. faecalis* bacteria. Notably, the inhibitory effect observed in the 80% extract was found to be substantially greater than that achieved by the positive control group using ChKM [113].

Shanmugapriya et al. investigated the antimicrobial effects of *M. oleifera* extracts on pooled plaque collected from orthodontic patients. To achieve this, *M. oleifera* extracts were prepared through maceration. Subgingival plaque samples were collected, and the microorganisms present were cultured under anaerobic conditions. The microorganisms were subsequently subjected to treatment with the extracts, and their MIC and MBC were determined. Additionally, the cytotoxic effects of the extracts were assessed using a brine shrimp assay. The results of the study revealed that the 5% aqueous extract of *M. oleifera* exhibited a dose-dependent antimicrobial activity against oral anaerobic organisms. Notably, this anti-microbial effect became more pronounced with longer exposure times of the treated samples. Furthermore, in the cytotoxicity assay, the aqueous extract showed superior performance in lower concentrations in comparison to the ethanol extract. This was evident from the higher number of live nauplii observed in the aqueous extract group, indicating its lower cytotoxicity [114].

Sopandani et al. evaluated the antibacterial efficacy of *M. oleifera* extract at various concentrations (25, 50, 75, and 100%) when used as an irrigation solution against *E. faecalis* within the root canal ex vivo. Quantitative polymerase chain reaction (qPCR) was employed to assess the population of *E. faecalis* within the root canal following treatment with *M. oleifera* extract. The results indicated that *M. oleifera* extract solutions at concentrations of 75 and 100% exhibited comparable effectiveness to a 5.25% sodium hypochlorite (NaOCl) solution as a positive control [114].

Rieuwpassa et al. assessed the effectiveness of *M. oleifera* leaf extract in modulating the anti-inflammatory cytokine IL-1 of the bacteria *Porphyromonas gingivalis*, a key contributor to chronic periodontitis. The study revealed a significant variation in IL-1 levels across different observation days. Administration of the extract led to a reduction in pro-inflammatory cytokine IL-1 levels, as evident from the observations on days D0, D1, D3, D5, and D7 in the experimental Wistar rats induced with *Porphyromonas gingivalis* bacteria [115].

Kumar et al. evaluated the antibacterial effectiveness of a 5% *M. oleifera* mouthwash enhanced with silver nanoparticles against oral aerobic microorganisms. The mouthwash was prepared by utilizing a 5% *M. oleifera* aqueous extract for the synthesis of silver nanoparticles. The characterization of the mouthwash was performed through scanning electron microscopy analysis and energy dispersive X-ray analysis. To assess its anti-bacterial properties, the mouthwash was tested against *S. mutans*, *S. aureus*, *E. faecalis*, and *C. albicans* using the agar well diffusion assay. The results indicated that the 5% *Moringa oleifera*-silver nanoparticle mouthwash exhibited a pronounced effect on *S. aureus* and a comparable impact on *S. mutans* [114].

5. Conclusions

M. oleifera has a variety of pharmacological effects, such as anti-hemorrhage, anti-allergic, antimicrobial, anthelmintic, antihypertensive, antileukemia, antioxidant, anti-diabetic, hepatoprotection, anti-inflammatory, and anticancer effects. This plant is effective against dental infections. Antimicrobial research against microbes that cause dental infections has been carried out on the leaves of *M. oleifera* both in aqueous and ethanol extracts. This plant is reported to be active in vitro to inhibit several oral bacteria such as *E. faecalis*, *S. mutans*, *P. gingivalis*, *S. aureus*, and *C. albicans*, and has been tested ex vivo. The chemical components contained in *M. oleifera* are phenolics, glucosinolates, flavonoids, fatty acids, esters, alkaloids, sterols, terpenes, and several other compounds. Based on the pharmacological effects and chemical components contained in *M. oleifera*, this plant has the potential to be further developed to produce an antibacterial agent product, especially for dental health. The search for bioactive compounds in *M. oleifera* that have a major role as antibacterials in oral pathogens can be carried out through isolation. Furthermore, both extracts and isolated compounds from *M. oleifera* can be further traced for their activity through in vitro, in vivo, and clinical trials.

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Moringa oleifera: A Review of the Pharmacology, Chemical Constituents, and Application for Dental Health

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pharmaceuticals

Review

Moringa oleifera: A Review of the Pharmacology, Chemical Constituents, and Application for Dental Health

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Abstract: *Moringa oleifera* L., commonly known as Kelor in Indonesia and miracle tree in English, has a rich history of utilization for medicinal, nutritional, and water treatment purposes dating back to ancient times. The plant is renowned for its abundance of vitamins, minerals, and various chemical constituents, making it a valuable resource. Among its notable pharmacological properties are its effectiveness as an anti-diabetic, anti-diarrheal, anti-helmintic, anti-leishmanial, anti-fungal, anti-bacterial, anti-allergic, anti-cancer, anti-inflammatory, and anti-oxidant agent. In this comprehensive review, we delve into the extensive pharmacological applications and phytochemical constituents of *M. oleifera* and its application in dental health.

Keywords: *Moringa oleifera*; pharmacological use; phytochemical constituent

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1. Introduction

Moringa oleifera L. comes from the Moringaeceae family and is commonly known as Kelor in Indonesia, Sahajan in India, and Horseradish tree or Drumstick tree in English. It is also described as a miracle tree due to its nutritional value, diverse functions, and medicinal properties. *M. oleifera* can grow up to 12 m in tropical and subtropical environments. Although it is native to South Asia, the cultivation itself has already spread to the Middle East, Africa, Asia, and other areas. Traditionally, *M. oleifera* has been used in medicine, skincare, breastmilk production, and even food. Almost all parts of *M. oleifera* can be useful. Nowadays, *M. oleifera* is also used for water purification, animal feed, as a bio-stimulant, bio-pesticide, and biomass as biodiesel production in industrial and agricultural processes [1–6]. Table 1 describes the traditional usage of *M. oleifera*.

Table 1. Traditional usage of *M. oleifera*.

Part of Plant	Usage	References
Seed	Skincare, haircare, fertilizer, cure for eye disease, fever, snake bite, headache, bladder, ulcer, gastritis, gout, stimulant, antispasmodic, stomachache, anemia, joint pain, hypertension, water purification.	[2–4]
Leaf	Wound healing, snake bites, stimulation, breast milk production, diarrhea, animal feed, constipation, bronchitis, glandular swelling, rheumatism, influenza, food, malaria, arthritis.	[2–6]
Root	Anticoagulation, wound healing, laxative, diuretic, toothache, cold, sores, asthma, bronchitis, epilepsy, urinary discharge, laxative, antiparalytic, cardiac tonic.	[3–5]
Pod (Fruit)	Diabetic, antipyretic, asthma, spleen, skin tumor, joint pain.	[4,5]
Flower	Stimulant, tonic, cholagogue, cold, inflammation, muscle disease, tumor, cholera.	[4,5]
Bark (Stem)	Heart compilation, fever, eye disease, digestive disorder, animal feed, headache, hypoglycemia, toothache.	[4–6]

As a food and stimulant, *M. oleifera* is known to have an abundance of nutritional value and is comparatively easy to cultivate because of its rapid growth and good adaptability to climate change. Thus, in poor countries, *M. oleifera* is used as a source of proteins, calories, minerals, and vitamins. It has been reported that dry leaves of *M. oleifera* contain more calories, protein, carbohydrate, fiber, vitamin B, calcium, magnesium, phosphorus, potassium, copper, and iron than fresh leaves. Meanwhile, fresh leaves contain more vitamin C and E. Between the leaf, seed, and pod of *M. oleifera*, proteins, vitamin E, and magnesium have been found to be more abundant in the seed [7–9].

Due to many its traditional usages, research has been conducted to prove its ability as medicine. It is reported to have pharmacological properties such as anti-diabetic, anti-diarrheal, anti-helmintic, anti-leishmanial, anti-fungi, anti-bacterial, anti-allergic, anti-cancer, anti-inflammatory, and anti-oxidant. Hastuty and Nitia reported the efficiency of *M. oleifera* leaf extract to raise hemoglobin levels in young girls. They showed a value of 10.83 g/dL before treatment, while after treatment with *M. oleifera,* the hemoglobin levels increased to 12.72 g/dL [10]. Yuliastuti and Kurnia also reported the effect of *M. oleifera* on hemoglobin levels in anemic pregnant women. The result showed a significant difference, where before treatment, the respondents showed hemoglobin levels about 10.2 g/dL, and after treatment these increased to 10.8 g/dL ($p = 0.003 < 0.05$) [11].

Dental health has been a concern for researchers to this day. The various infections that can occur in the teeth cause a decline in health. Dental infections occur due to the growth of various kinds of microbes in the dental and oral area. Among these are odontogenic infections and periradicular periodontitis that occur in the root canal system caused by anaerobic bacteria such as *Porphyromonas gingivalis*, *Enteroccus faecalis*, and *Candida albicans* [12–14]. *E. faecalis* is reported to infect root canals up to 30–80% [15]. In addition, based on polymerase chain reaction (PCR) analysis, the bacteria *Tannerella forysthia*, *Treponema denticola*, *Dialister pneumosintes*, and *Prevotella tannerae* were also reported to infect root canals with high prevalence [16]. These infections occur due to biofilm formation by microbes on the tooth area [17]. The use of antibiotics is a very useful treatment due to their effectiveness, low cost, and compatibility. However, resistance to antibiotic agents by microbes has been identified. Gram-negative bacteria have been reported to be resistant to beta-lactam antibiotics due to an enzyme that can open the ring in the beta-lactam structure, thus inactivating the action of the drug [18].

Therefore, natural product drug discovery research is of particular interest to researchers as a natural antibacterial agent. The main parameters in determining antibacterial activity are the inhibition zone value, minimum inhibition concentration (MIC) as a reference for the minimum concentration that can inhibit bacterial growth, and minimum bactericidal concentration (MBC) as a reference for the minimum concentration needed to kill a microorganism [19]. Based on the bioactivity and phytochemicals contained in *M. oleifera*, this plant has become one of the natural sources for dental disease treatment. *M. oleifera* seed extract was reported to provide MIC and antibiofilm values against *P. gingivalis* of 12.5 mg/mL and 6.25 mg/mL, respectively [20]. *M. oleifera* nanosuspension can inhibit *Aggregatibacteri actinomycetemcomitans*, *P. gingivalis*, *Prevotella intermedia*, *Fusobacterium nucleatum* with an MIC and MBC of 25% and 12.5%, respectively [21]. Based on this description, this review will explain the bioactivity contained in *M. oleifera* and describe the role of the plant for dental health and the chemical components contained therein.

2. Phytochemical Constituent

The pharmacological effects of *M. oleifera* are influenced by its phytochemical components. Previous studies have reported that there are several groups of compounds that are unique to each part of *M. oleifera*. The flowers are known to contain flavonoids, alkaloids, sucrose, and amino acids such as kaempferitrin, isoquercitrin, and rhamnetin. Furthermore, the stem contains alkaloid compounds such as moringinine and moringin, octacosanoic acid, β-sitosterol, and 4-hydroxymellein. The seed contains high contents of 4-(α-l-rhamnosyloxy) phenylacetonitrile, benzylglucosinolate, 4-(α-l-rhamnosyloxy) benzylisothiocyanate, *O*-ethyl-4-

(α-l-rhamnosyloxy) benzyl, and 4-(α-l-rhamnopyranosyloxy)-benzylglucosinolate carbamate, while the fruit contains cytokines. In addition, the whole pods were specific for *O*-[2′-hydroxy-3′-(2′′-heptenyloxy)]-propyl undecanoate, methyl-p-hydroxybenzoate, thiocarbamates, isothiocyanate, nitrile, and *O*-ethyl-4-[(α-l-rhamnosyloxy)-benzyl] carbamate [22]. The seeds of *M. oleifera* contain total flavonoids 144.07 mg/kg, total polyphenols 145.16 mg/100 g, and proanthocyanidines 140.49 mg/kg. In addition, the oil of *M. oleifera* contains 18.24 mg rutin equivalent/g (total flavonoids), 37.94 mg ascorbic acid equivalent/g (total antioxidant capacity), and 40.17 mg GA equivalent/g (total phenols). Based on this description, the following are some of the structures of phytochemical components contained in *M. oleifera* [23].

2.1. Phenolic

Niazirin (**1**) was obtained through an ethanol and butanol extraction of the seeds and leaves of *M. oleifera*. It was reported to inhibit α-glucosidase inhibitor with an IC_{50} value of 382.2 µM. [24–28]. Caffeoylquinic acid (**2**), 4-*O*-caffeoylquinic acid (**3**), 4-*O*-(3′-*O*-α-D-glucopyranosyl)-caffeoylquinic acid (**4**), 4-*O*-(4′-*O*-α-D-glucopyranosyl)-caffeoylquinic acid (**5**), 4-*O*-β-D-glucopyranoside benzoic acid (**6**), 5-*O*-caffeoylquinic acid (**7**), benzaldehyde 4-*O*-α-L-rhamnopyranoside (**8**), chlorogenic acid (**9**), methyl caffeoylquinate (**10**), methyl 4-caffeoylquinate (**11**), and 3,4-dihydroxybenzoic acid (**12**) could be obtained through an ethyl acetate and butanol extraction of *M. oleifera* leaves. The structures of the compounds are shown in Figure 1 [24–28].

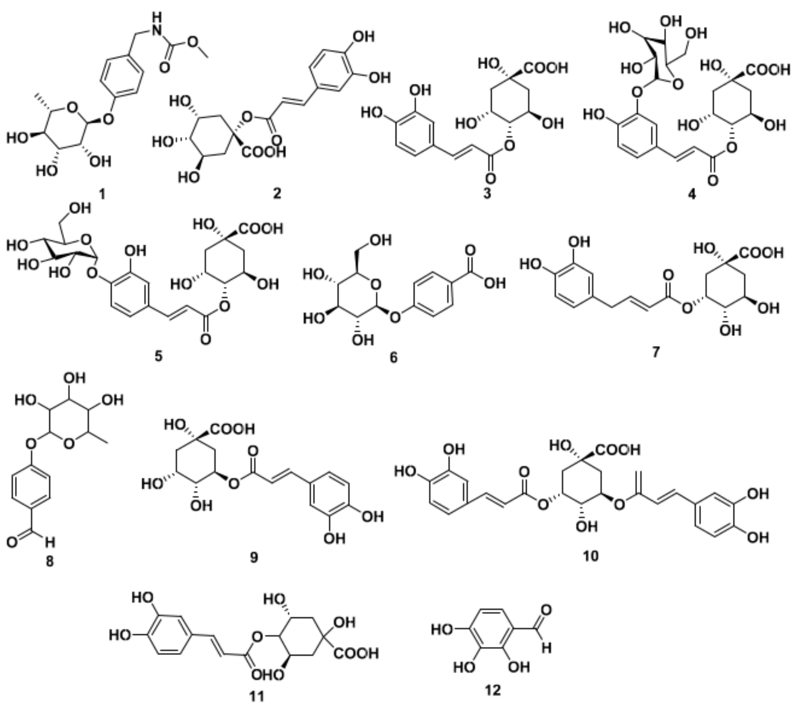


Figure 1. Phenolic compounds in ethanol and butanol extracts of seeds and leaves of *M. oleifera*.

Other phenolic compounds that could be isolated from various parts of *M. oleifera* were caffeic acid (**13**), gallic acid (**14**), *p*-coumaric (**15**), and vanillin (**16**). Cryptochlorogenic acid (**17**) also could be obtained from *M. oleifera*, and it was also reported to have anticancer activity against MCF-7 with an IC_{50} value of 20.8 M. The structures are shown in Figure 2 [28–30].

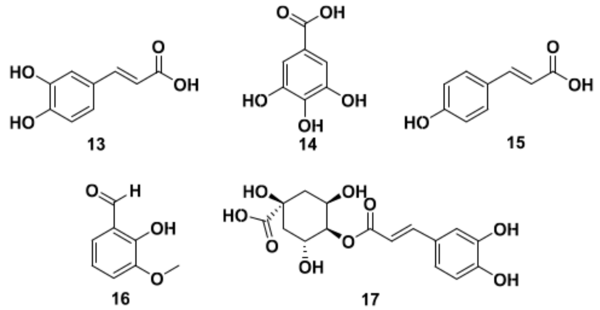


Figure 2. Phenolic compounds of other parts of *M. oleifera*.

2.2. Glucosinolate

Glucosinolate compounds, as shown in Figure 3, could be isolated from the ethanol extracts of seeds of *M. oleifera*. These include the following compounds: 4-(3′-O-acetyl-α-L-rhamnosyloxy) benzyl isothiocyanate (**18**), 4-(α-L-rhamnopyranosyloxy)-benzylglucosinolate (**19**), 4-(α-L-rhamnosyl) benzyl ethyl ester (**20**), moringaside C (**21**), moringaside D (**22**), moringaside E (**23**), moringaside F (**24**), moringaside G (**25**), moringin (**26**), niazimicin (**27**), and glucomoringin (**28**). Furthermore, compound **23** exhibited α-glucosidase inhibitory activity with an IC_{50} value of 382.8 μM, meanwhile compound **26** had a reported an anti-adipogenic effect and an anticancer activity against HeLa cells with an IC_{50} value of 9.2 μg/mL. Meanwhile, compound **28** exhibited anti-allergic properties with IC_{50} values towards β-hexosaminidase and histamine releases of 10.43 and 27.22 μM, respectively. It is also reported to has antiviral properties against H1N1 with an IC_{50} value of 0.98 μg/mL [13,15,26,30–37].

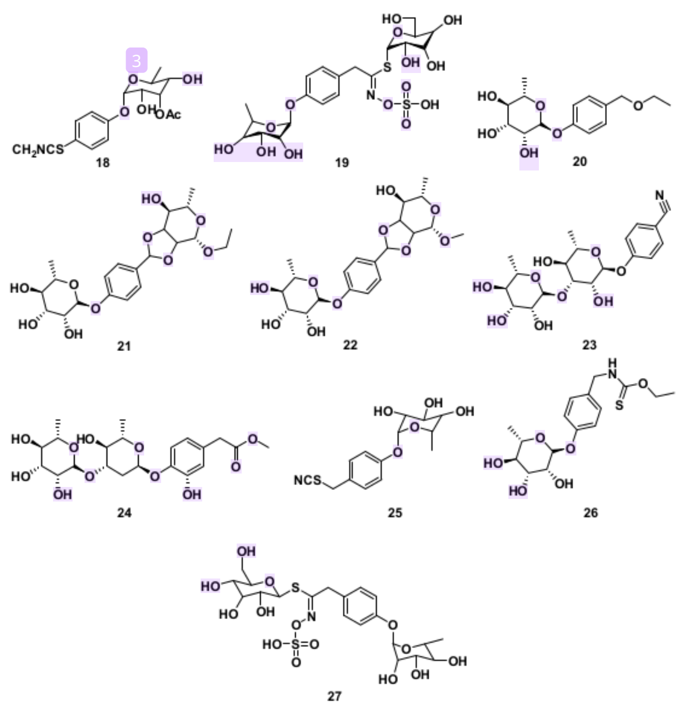


Figure 3. Glucosinolate compounds of seed ethanol extract of *M. oleifera*.

Other glucosinolates found in *M. oleifera* were 4-(4′-O-acetyl-α-L-rhamnosyloxy) benzyl isothiocyanate (**29**), benzyl glucosinolate (**30**), 4-[(2′-*O*-acetyl-α-L-rhamnosyloxy) benzyl] isothiocyanate (**31**), 4-[(3′-*O*-acetyl-α-L-rhamnosyloxy) benzyl] isothiocyanate (**32**), niazinin (**33**), and niazinin B (**34**). Furthermore, compound **31** and **32** exhibited NO inhibitory activity with IC_{50} values of 1.67 and 2.66 μM, respectively, meanwhile compound **33** exhibited antileishmanial properties with an IC_{50} value of 5.25 mM. The structures are shown in Figure 4 [24,38–41].

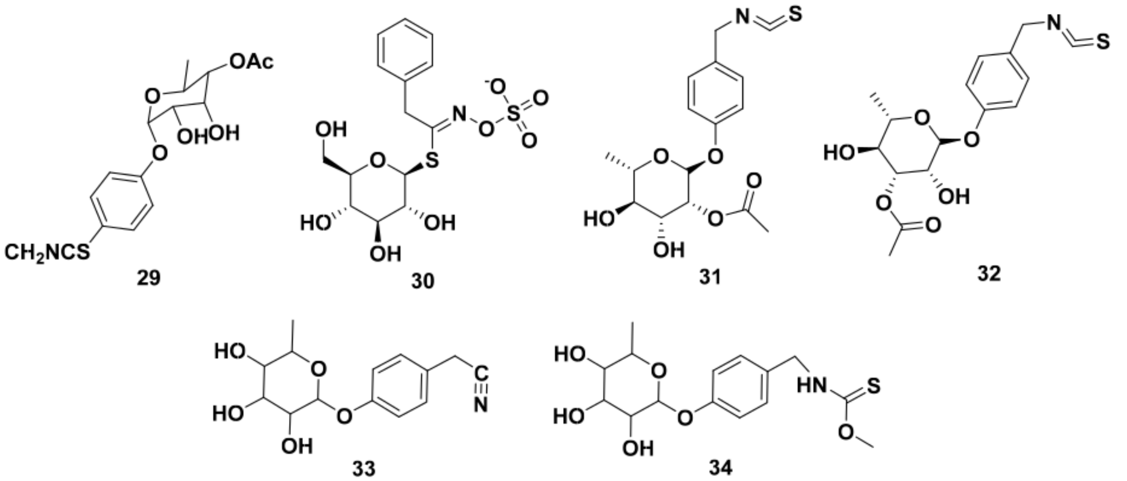


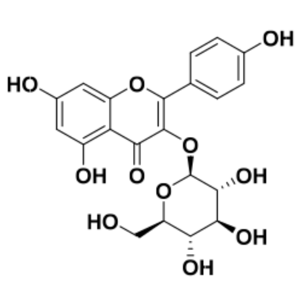
Figure 4. Glucosinolate compounds of other parts of *M. oleifera*.

2.3. Flavonoid

The leaves, barks, and seeds of *M. oleifera* contained various flavonoid compounds, as shown in Figure 5. The flavonoids reported were astragalin (**35**), isoquercitrin (**36**), kaempferol (**37**), kaempferol 3-*O*-glucoside (**38**), kaempferol acetyl glycoside (**39**), kaempferol-3-*O*-(6″-malonyl-glucoside) (**40**), quercetin (**41**), quercetin 3-*O*-β-D-glucopyranoside (**42**), quercetin-3-acetyl-glucoside (**43**), quercetin-3-*O*-(6″-malonyl-glucoside) (**44**), quercetin-3-*O*-β-D-(6″-*O*-3-hydroxy-3-methylglutaryl)-glucoside (**45**), rutin (**46**), vitexin (**47**), and 3,5,6-trihydroxy-2-(2,3,4,5,6-pentahydroxyphenyl)-4*H*chromen*n*-4-one (**48**). Those compounds could be obtained through extraction with methanol, ethanol, butanol, and ethyl acetate. Compounds **35**, **36**, and **46** were reported to inhibit CYP3A4 and CYP2D6, with IC_{50} values of 69.5 and 90 μM for compound **35**, whereas compounds **36** and **46** were reported to be CYP3AP inhibitors with IC_{50} values of 65.5 and 60 μM, respectively.

Compounds **37**, **41**, and **48** were reported to have anti-allergic properties by inhibiting β-hexosaminidase and histamine release, with IC_{50} values of 29.39 and 46.94 μM, respectively, for compound **37**. Compound **41** exhibited IC_{50} values of 19.07 and 7.77 μM, respectively. Compound **48** showed IC_{50} values of 17.70 and 44.87 μM, respectively. Furthermore, compound **46** also inhibited α-glucosidase and pancreatic lipase with IC_{50} values of 40 and 35 μg/mL, respectively. Compound **47** also exhibited antiviral properties against virus H1N1 with an IC_{50} value of 3.42 μg/mL [13,24–27,33,39,42–46].

Apigenin (**49**), kaempferol-3-*O*-[methyl-(*S*)-3-hydroxy-3-methylglutaroyl(1→6)]-β-d-glucopyranoside (**50**), and multiflorin-B (**51**) also could be obtained from *M. oleifera* ethanol extracts [42,47,48].



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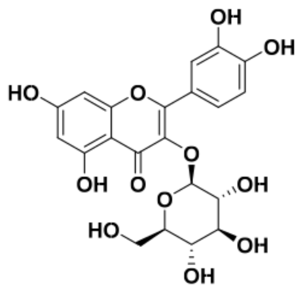

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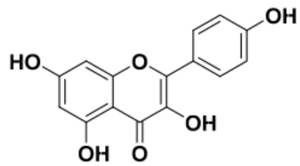

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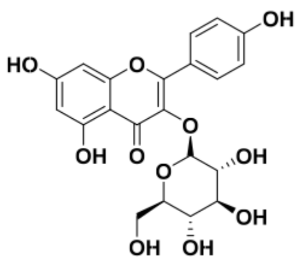

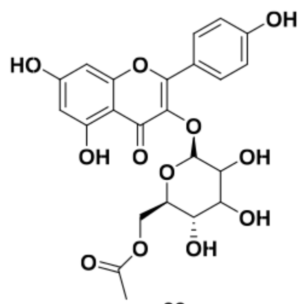

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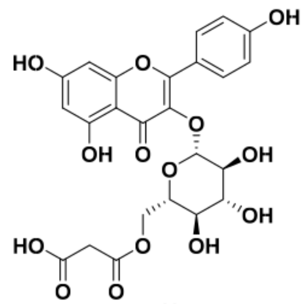

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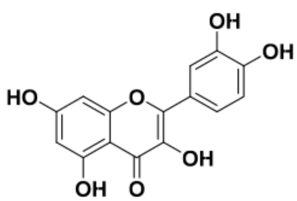

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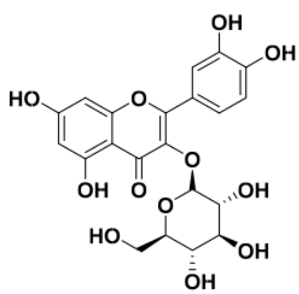

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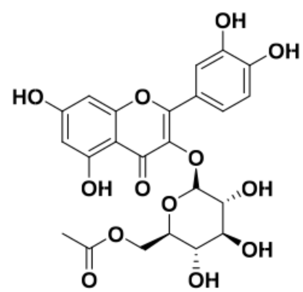

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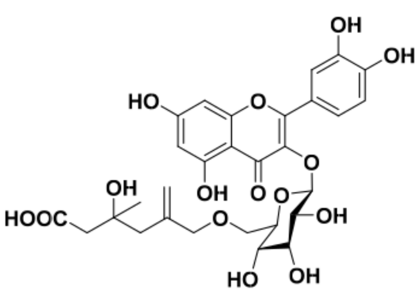

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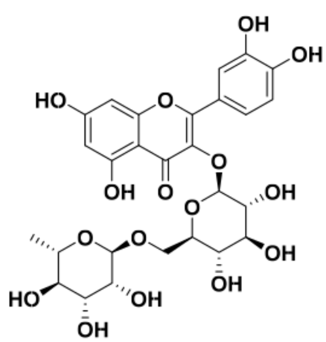

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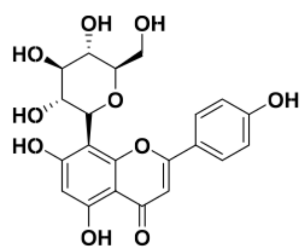

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Figure 5. *Cont.*

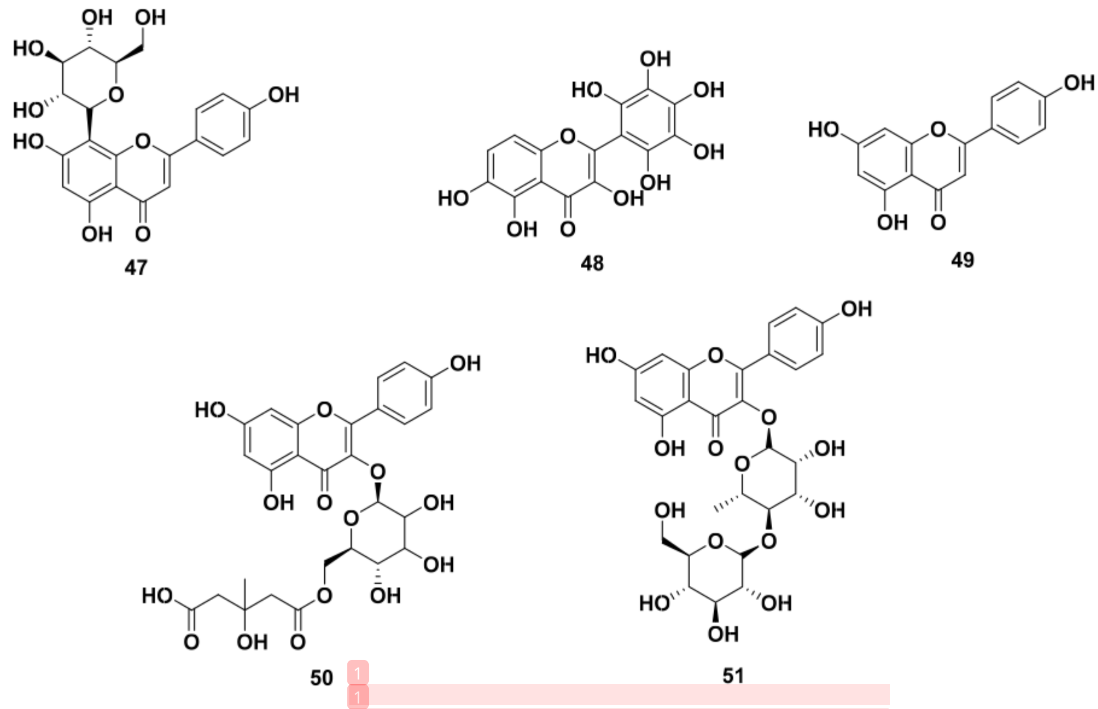


Figure 5. Flavonoid compounds of leaves, barks, and seeds of *M. oleifera*.

2.4. Fatty Acid

Figure 6 shows the structure of fatty acid compounds from the ethanol, methanol, and ethyl acetate extracts of leaves, seeds, and flowers of *M. oleifera*. The compounds are glycerol-1-(9-octadecanoate) (**52**), heneicosanoic acid (**53**), monoacetyl glycerol (**54**), monacosa*n*-15-one (**55**), octacosanol (**56**), oleic acid (**57**), 3,4-methyleneazelaic acid (**58**), and triolein acid (**59**). Compound **57** exhibited anti-allergic properties by inhibiting β-hexosaminidase and histamine release, with IC_{50} values of 53.76 and 56.05 μM, respectively [40,42,49–53].

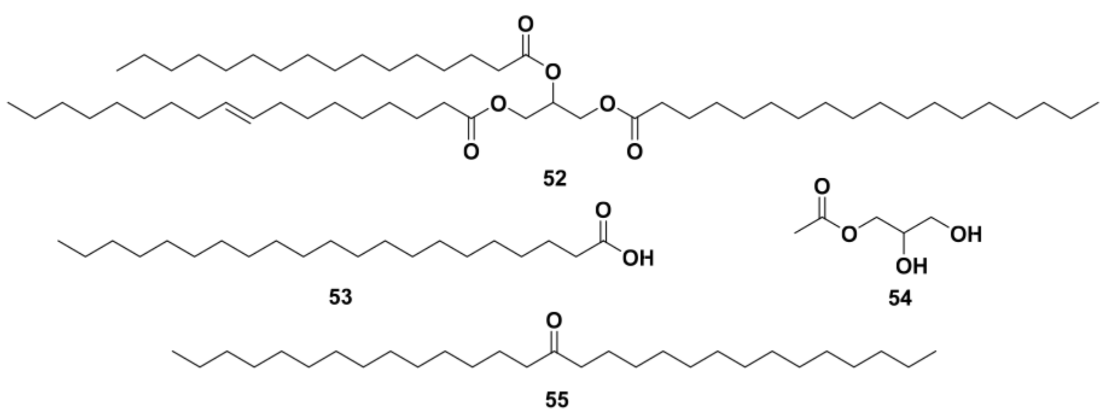


Figure 6. *Cont*.

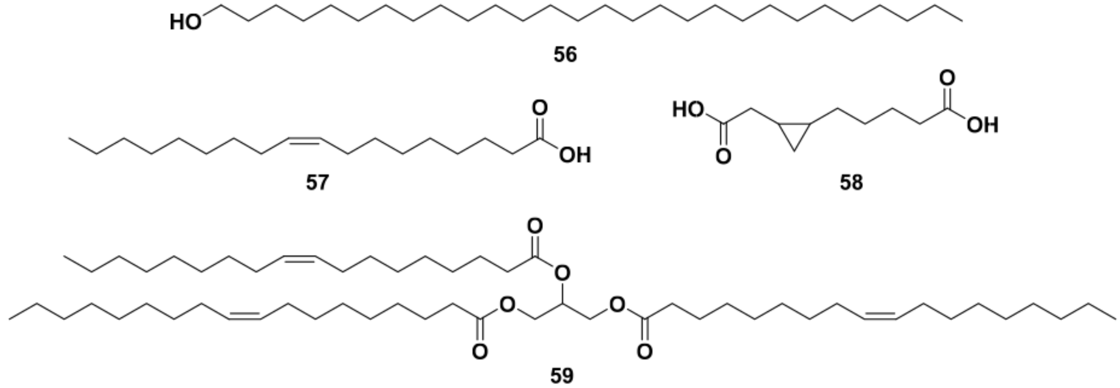


Figure 6. Fatty acid compounds of leaves, seeds, and flowers of ethanol, methanol, and ethyl acetate extracts of *M. oleifera*.

2.5. Ester

Ethyl geranyl acetate (**60**), ethyl-(*E*)-undec-6-enoate (**61**), methyl heptanoate (**62**), methyl-4-(α-L-rhamnopyranosyloxy) benzyl carbamate (**63**), *O*-ethyl-4-(α-l-rhamnosyloxy)benzyl carbamate (**64**), and 2-formyl-5-methyl-1*H*-pyrrol-1-ylbutanoic acid (**65**) were ester groups isolated from leaves, flowers, and seeds of ethanol, methanol, and *n*-hexane *M. oleifera* extracts. The structures are shown in Figure 7. Compound **61** exhibited anti-allergic properties by inhibiting β-hexosaminidase and histamine release with IC_{50} values of 82.68 and 82.07 μM, respectively [42,49,50,53–55].

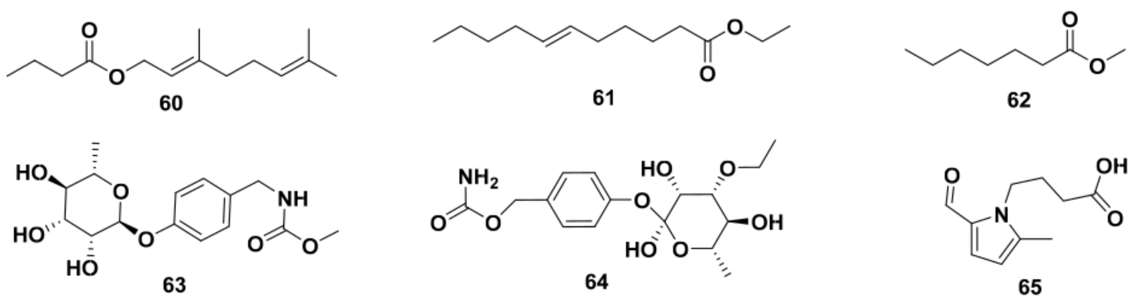


Figure 7. Ester compounds of leaves, flowers, and seeds of ethanol, methanol, and *n*-hexane extracts of *M. oleifera*.

2.6. Alkaloid

The roots, seeds, and leaves of *M. oleifera* contain alkaloids, as shown in Figure 8. Some of them could be obtained from butanol extraction. The alkaloids contained in *M. oleifera* include the following: marumoside A (**66**), marumoside B (**67**), aurantiamide acetate (**68**), hostine D (**69**), methyl 4-(α-L-rhamnopyranosyloxy) benzylcarbamate (**70**), pyrrolemorine A (**71**), pyrrolemorine B (**72**), pyrrolemorine C (**73**), pyrrolemorine D (**74**), pyrrolemorine E (**75**), pyrrolemorine F (**76**), pyrrolemorine G (**77**), pyrrolemarumine (**78**), tangutorid E (**79**), and tangutorid F (**80**). Compounds **71** and **75** demonstrated notable neuroprotective effects. At a concentration of 0.1 μM, they effectively mitigated PC12 cell damage caused by oxygen glucose deprivation and concurrently reduced the expression of NF-kB [42,47,56,57].

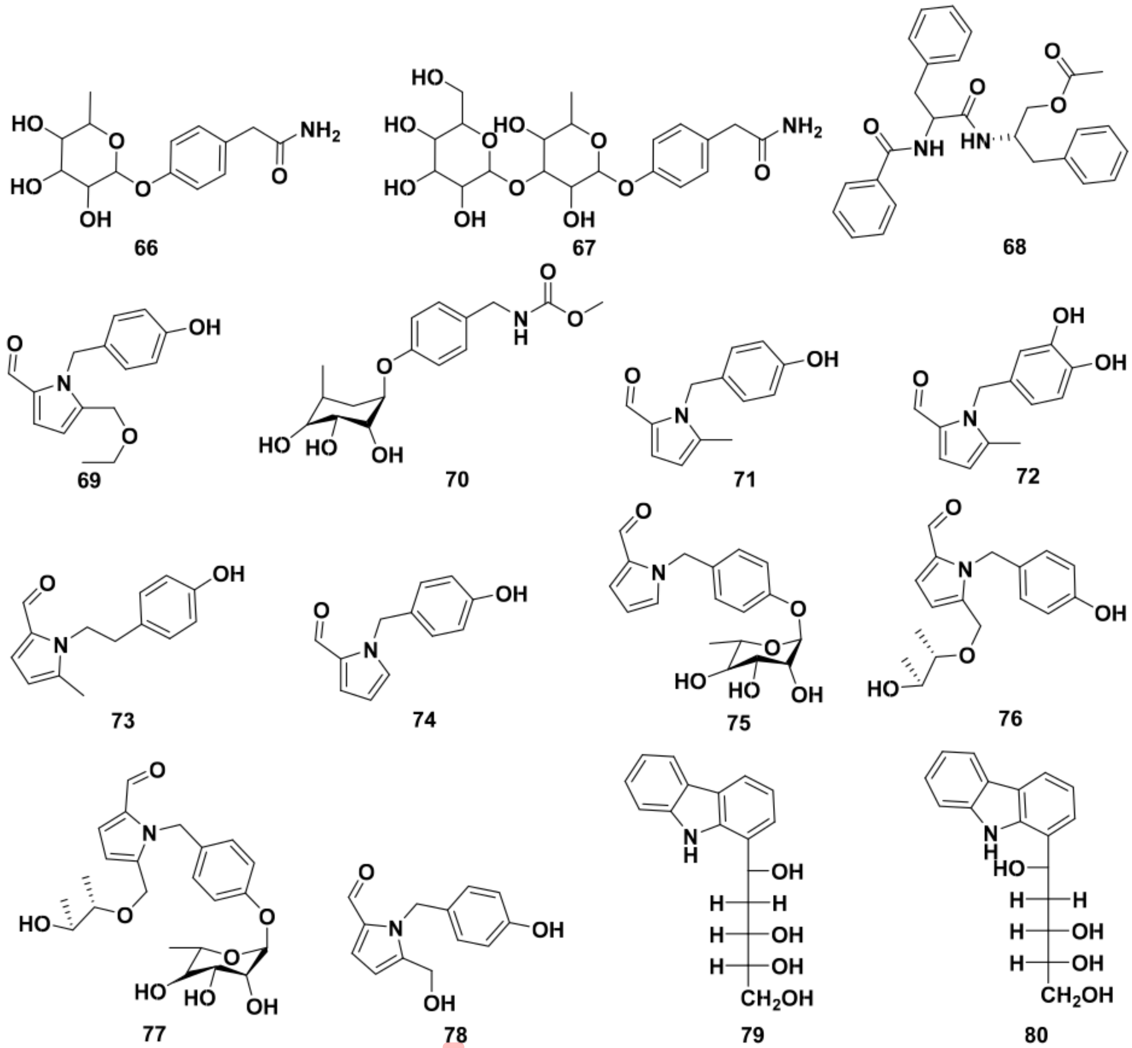


Figure 8. Alkaloid compounds of roots, seeds, and leaves of *M. oleifera*.

2.7. Sterol

All parts of *M. oleifera* contain sterol compounds, as shown in Figure 9. The compounds could be isolated from methanol, ethanol, ethyl acetate, and acetone extracts. The following are sterols isolated from various parts of *M. oleifera*: β-sitosterone (**81**), stigmasterol (**82**), β-sitosterol-3-O-glucoside (**83**), β-sitosteryl oleate (**84**), and 24-methylene-9,19-cyclolanostan-3-ol (**85**). Compounds **82** and **83** exhibited anti-allergic properties by inhibiting β-hexosaminidase and histamine release with IC_{50} values of 75.92 and 38.27 μM, respectively, for compound **82**; meanwhile, compound **83** only inhibited β-hexosaminidase release with an IC_{50} value of 24.93 μM. Moreover, compound **82** exhibited anti-inflammatory characteristics by inhibiting caspase 1 and NF-kB. It also exhibited anti-adipogenic properties by reducing the S and G2/M phases, inhibiting ROS, and enhancing glucose uptake [13,31,37,58–61].

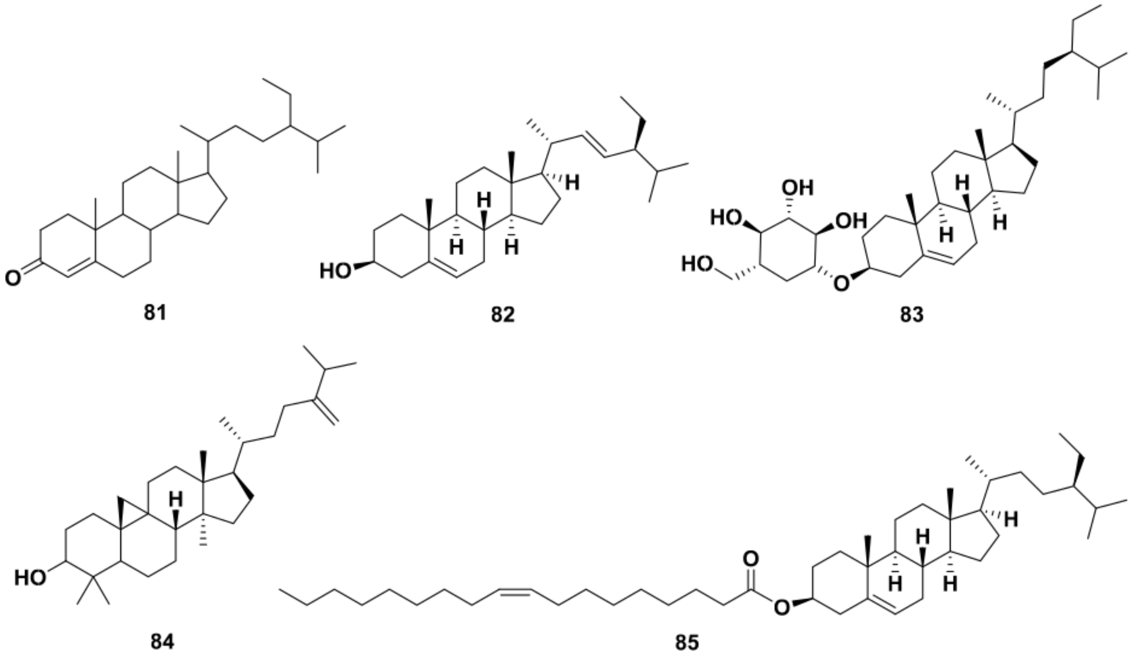


Figure 9. Sterol compounds of *M. oleifera*.

2.8. Terpene

(*S*) Linalyl-β-D-glucoside (**86**), (S) linalyl-β-primeveroside (**87**), lupeol (**88**), tuberonic acid (**89**), γ-diosphenol (**90**), and 2,2,4,4-tetramethyl-6-(1-oxobutyl)-1,3,5-cyclohexanetrione (**91**) were terpenes isolated from *M. oleifera*. Compound **88** exhibited anti-adipogenic properties by reducing the S and G2/M phases, inhibiting ROS, and enhancing glucose uptake. The structure of the compounds is shown in Figure 10 [52,54,62].

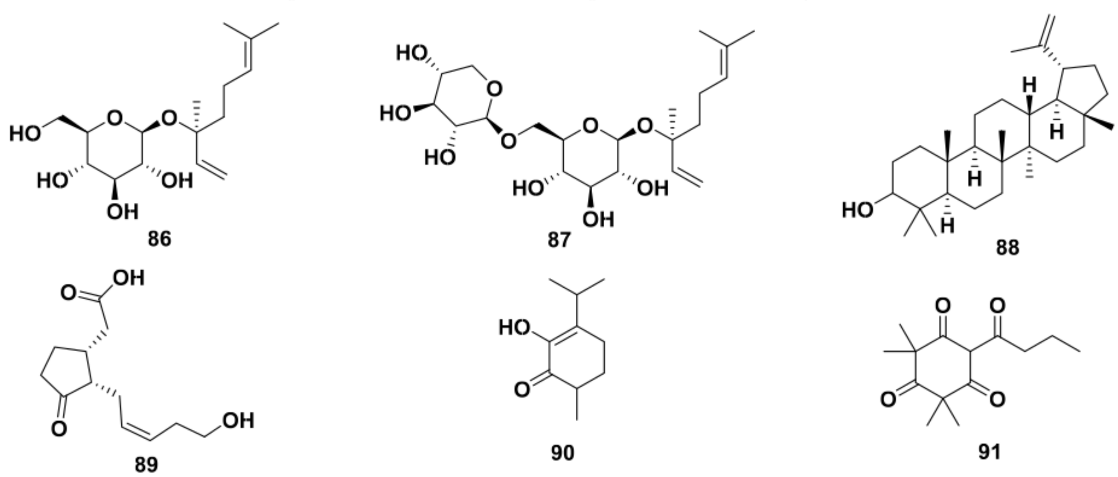
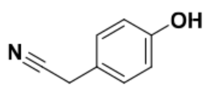


Figure 10. Terpene compounds of *M. oleifera*.

2.9. Other Compounds

The leaf extract of *M. oleifera* contained 4-hydroxyphenylacetonitrile (**92**), lutein (**93**), adenosine (**94**), uridine (**95**), 3-pyridinecarboxamide (**96**), 5-hydroxymethyl-2-furaldehyde

(**97**), 5-hydroxymethyl-2-furancarboxylic acid (**98**), *bis*-isothiocyanatomethyl benzene (**99**), and pyropheophorbide-a (**100**). Compound **92** exhibited activity to induce the secretion of insulin. Other compounds isolated from *M. oleifera* were L-tryptophan (**101**), benzyl β-D-glucopyranoside (**102**), benzyl-β-primeveroside (**103**), (+)-pinoresinol-4-O-β-D-glucopyranoside (**104**), isolariciresinol-3a-O-β-D-glucopyranoside (**105**), lariciresinol-9-O-β-D-glucopyranoside (**106**), fluoropyrazine (**107**), (10-hydroxy-1,3-dimethylchrysen-3-yl)-5-hydroxypentan-1-one (**108**), hexademethylated 3β,11β-dihydroxyfriedelane (**109**), 6,7-dipropanone-5-hydroxyphenyl-3-methylphenanthrene-1-carboxylic acid (**110**), (2*R*)-2-phenylmethoxybutane-1,4-diol (**111**), (2*S*)-2-phenylmethoxybutane-1,4-diol (**112**), 2-hexenyl-β-D-glucopyranoside (**113**), omoringone (**114**), 1,3-dibenzyl urea (**115**), 1-hydroxy-3-phenylpropa*n*-2-yl benzoate (**116**), 1-octadecene (**117**), 2,3,4-trihydroxybenzaldehyde (**118**), 3,4-dihydroxy benzonitrile (**119**), 3,7,11,15-tetramethyl-2-hexadece*n*-1-ol (**120**), 3-hydroxy-β-ionone (**121**), *N*-benzyl *S*-ethyl thioformate (**122**), benzyl benzylcarbamate (**123**), methyl-4-hydroxybenzoate (**124**), and pyrrolezanthine (**125**). The structures of these compounds are shown in Figure 11.



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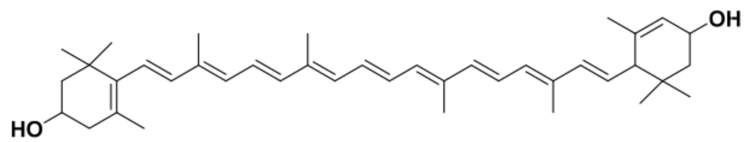

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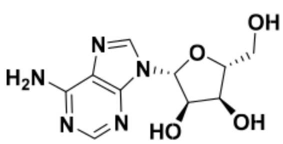

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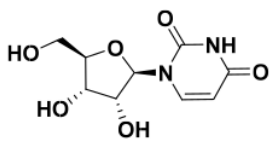

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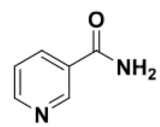

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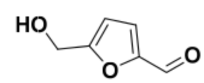

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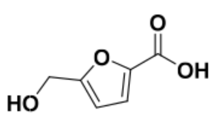

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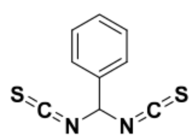

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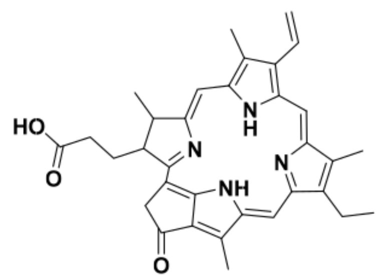

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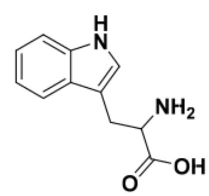

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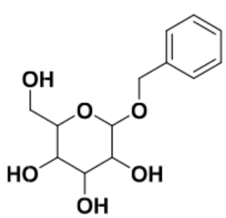

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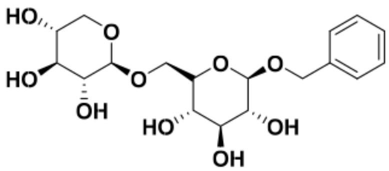

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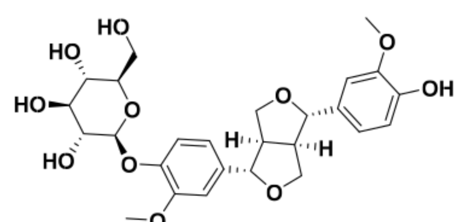

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Figure 11. *Cont.*

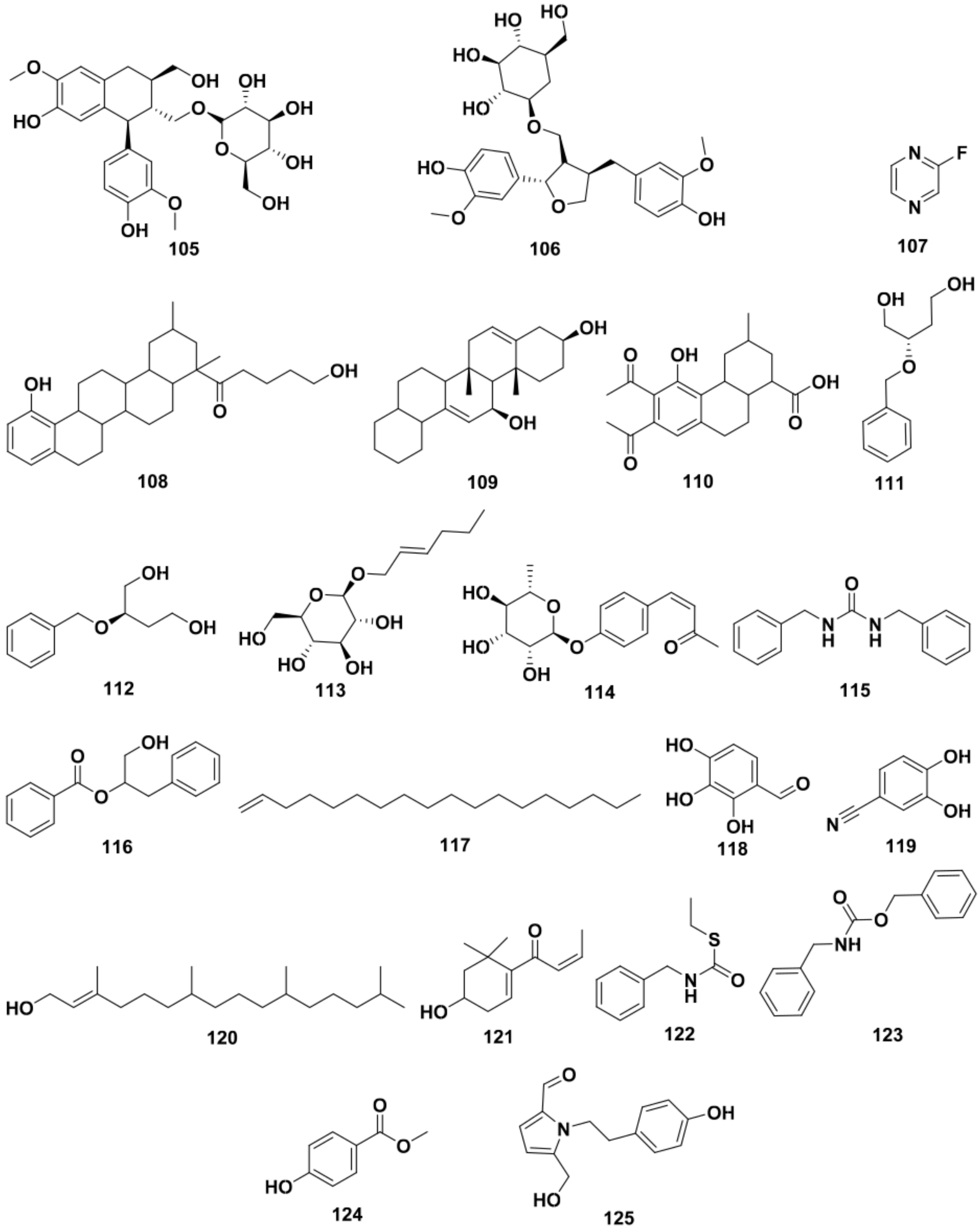

Figure 11. The structures of compounds of leaf extract of *M. oleifera*.

Compound **104** displayed a potent inhibition of CYP3A4, with an IC_{50} value of 41.5 μg/mL, while compound **105** exhibited CYP3A4 inhibition with an IC_{50} value of 100 μg/mL. Compound **107** also demonstrated CYP3A4 inhibitory activity, with an IC_{50} value of 72.5 μg/mL. In addition to their enzyme inhibitory effects, compounds **109** and **110** showcased strong antioxidant properties, as indicated by DPPH IC_{50} values of 0.475 and 0.671 mg/mL, respectively. Furthermore, compound **122** exhibited significant antibacterial activity, with MIC values of 32 μg/mL against pathogens such as *S. dysenteriae*, *S. boydii*, and *S. aureus* [13,25,30,37,41,43,51,58,63–69].

3. Pharmacological Properties

3.1. Anti-Hemorrhage

Anti-hemorrhage properties in medicine are used to prevent excessive bleeding due to injury or surgery. Excessive bleeding could lead to death. Adeyemi et al. investigated the anti-hemorrhage properties of *M. oleifera* extracts. The experiment was studied by utilizing the venom of *Echis ocellatus*. The result reported that the ethanol extract of *M. oleifera* showed the highest effectiveness in neutralizing hemorrhage, with a dose of 800 mg/kg for 2 mL of 0.22 mg/kg venom. They also investigated the incubation factor and demonstrated its enhanced potency when pre-incubated with venom from *E. ocellatus* [43].

3.2. Anti-Allergic

Allergy is a condition where the immune system in the body mistakenly identifies substances as harmful and triggers reactions that affect various parts of the body. The development of anti-allergy medicine has been evolving to improve treatment and understand allergy mechanisms. Rani et al. evaluated the effectiveness of the anti-allergic properties of the leaves, pods, and seeds of *M. oleifera*. The extracts were macerated with ethanol at 80% and yielded nine compounds from the isolation. The study showed that the extracts of *M. oleifera* could inhibit the early and late phases of allergic reactions. In particular, the leaf extracts could better suppress the release of β-hexosaminidase (IC_{50} 7.17 μg/mL), IL-4 (IC_{50} 2.32 μg/mL), and TNF-α (IC_{50} 1.2 μg/mL) compared to ketotifen fumarate as a positive control. *M. oleifera* seed extract could inhibit histamine release better compared to other extracts and the positive control, with an IC_{50} value of 5.97 μg/mL. Further study showed that compared to other isolated compounds, glucomoringin (**28**) had a better inhibition against beta-hexosaminidase in the early phase and TNF-α release in the late phase (IC_{50} 10.43 μg/mL); meanwhile, quercetin (**41**) had a better inhibition against histamine release (IC_{50} 7.77 μg/mL). In the last allergic phase, β-sitosterol-3-*O*-glucoside (**83**) showed a better inhibition against IL-4 release compared to other isolated compounds, with an IC_{50} value of 7.33 μg/mL [50].

3.3. Antimicrobial

Antimicrobial properties of compounds always gain interest due to their crucial role in preventing infectious diseases. In an era where microorganisms keep evolving and show resistance to antimicrobial agents, the development of natural antimicrobial agents has become urgent. Various parts of *M. oleifera* extracts with antibacterial activity were studied against *E. coli* and *S. aureus* using the agar well diffusion method. The study showed that the 80% methanol extract of leaves, pulp, and seed had the best inhibition against *E. coli*. The 70 and 80% methanol extract of flowers showed the same value against *S. aureus*, and the aqueous pulp extract showed a better result against *S. aureus* compared to other extracts [70]. Abadallah and Ali studied the comparison of aqueous and ethanol extracts of *M. oleifera* against several bacteria. The MIC value and zone inhibition of the ethanol extract showed better results compared to the aqueous extract. *Shigella* spp. was the most susceptible to both extracts [71]. The extracts of *M. oleifera* showed potential for antibacterial and anti-fungal properties, as shown in Table 2.

Table 2. Antimicrobial activity of *M. oleifera* against (A) Gram negative bacteria, (B) Gram positive bacteria, and (C) fungi.

M. oleifera	Microorganism	Inhibition Zone (mm)	MIC (mg/mL)	MBC (mg/mL)	References
(A) Gram Negative Bacteria					
Stem methanol extract	*Vibrio cholerae*	-	2.50	-	[72]
	Vibrio mimicus	-	1.25	-	
Leaves ethanol extract	*V. cholerae*	-	0.08	-	[72]
	V. mimicus	-	5	-	
Pods ethanol extract	*V. cholerae*	-	0.31	-	[72]
	V. mimicus	-	2.5	-	
Flower chloroform extract	*V. cholerae*	-	0.63	-	[72]
	V. mimicus	-	1.25	-	
Ethanol extract	*Proteus mirabilis*	-	3.75 μg/mL	-	[55]
	Fusarium sp.	12	-	-	
Methanol extract	*Burkholderia cepacian*	19	-	-	[55]
	Yersinia enterocolitica	19	-	-	
Aqueous extract	*Proteus vulgaris*	15	-	-	[55]
	Escherichia coli	15	-	-	
	Yersinia enterocolitica	15	-	-	
	Serratia rubidaea	15	-	-	
	Salmonella pollum	15	-	-	
	Pullarum sp.	5	-	-	
	P. mirabilis	-	3.75 μg/mL	-	
Root powder extract	*E. coli*	-	87%	-	[73]
Nanoparticles loaded to extract	*Aspergillus niger*	55	-	-	[74]
Ethanol extract	*Aeromonas cavie*	23.8	-	-	[75]
	Vibrio parahaelomyticus	21.9	-	-	
Aqueous extract	*Aeromonas cavie*	22.3	-	-	[75]
	V. parahaelomyticus	20.7	-	-	
Methanol pod extract	*P. aeruginosa*	22	-	-	[76]
Acetone extract	*E. coli*	-	5	5	[77]
	Enterobacter cloacae	-	5	5	
	P. vulgaris	-	5	5	
Leaf ethanol extract	*E. coli*	18.3	-	-	[78]
Leaf methanol extract	*E. coli*	19	-	-	[78]
Leaf aqueous extract	*E. coli*	14	-	-	[78]
Aqueous extract	*E. coli*	18.25	25	-	[79]
Ethanol extract		27.75	390 μg/mL	-	
Aqueous extract	*Klebsiella pneumoniae*	21.75	50	-	[79]
Ethanol extract		28.5	780 μg/mL	-	
Aqueous extract	*Citrobacter* sp.	20.65	50	-	[79]
Ethanol extract		19.5	390 μg/mL	-	
Aqueous extract	*P. vulgaris*	14.75	25	-	[79]
Ethanol extract		24.75	780 μg/mL	-	
Aqueous extract	*P. aeruginosa*	17.5	25	-	[79]
Ethanol extract		22.25	780 μg/mL	-	
Aqueous extract	*Staphylococcus aureus*	20	-	-	[79]
Methanol extract		24	-	-	
Aqueous extract	*E. coli*	18	-	-	[80]
Methanol extract		16	-	-	
Methanol extract	*Klebsiella* spp.	25	-	-	[81]
Ethanol extract	*Enterococcus faecalis*	27.5	10% (*w*/*v*)	-	[82]
Ethanol extract	*Salmonella typhi*	8	8	8.5	[83]
Chloroform extract	*Shigella dysenteriae*	-	1500 μg/mL	2000 μg/mL	[31]
Ethanol seed extract	*E. coli*	16	100	-	[25]
	Shigella flexneri	15	100	-	
(B) Gram Positive Bacteria					
Methanol extract	*Aspergillus flavus*	12	-	-	[55]
Nanoparticles loaded to extract	*A. flavus*	55	-	-	[74]
Ethanol extract	*S. aureus*	23.3	-	-	[75]
	Enterococcus aureus	19.4	-	-	
Aqueous extract	*S. aureus*	25.4	-	-	[75]
	E. aureus	17.8	-	-	
Acetone extract	*S. aureus*	-	5	5	[77]
	Micrococcus kristinae	-	0.5	1	
Leaf ethanol extract	*Bacillus subtilis*	19	-	-	[78]
	S. aureus	21.3	-	-	
Leaf methanol extract	*B. subtilis*	22	-	-	[78]
	S. aureus	23.6	-	-	
Leaf aqueous extract	*B. subtilis*	12	-	-	[78]
	S. aureus	18	-	-	
Aqueous extract	*Corynebacterium pseudotuberculosis*	22.5	25	-	[79]
Ethanol extract		25.65	390 μg/mL	-	
Aqueous extract	*Corynebacterium ulcerans*	25.5	25	-	[79]
Ethanol extract		30.5	390 μg/mL	-	

Table 2. *Cont.*

M. oleifera	Microorganism	Inhibition Zone (mm)	MIC (mg/mL)	MBC (mg/mL)	References
Aqueous extract Ethanol extract	*S. aureus*	14.75 26.75	50 390 µg/mL	- -	[79]
Aqueous extract Methanol extract	*B. subtilis*	23 23	- -	- -	[80]
Ethanol extract	*Staphylococcus epidermidis*	12	-	-	[80]
Ethanol extract	*S. aureus*	19.5	10% (*w*/*v*)		[82]
(C) Fungi					
Aqueous extract	*Candica albicans*	5	-	-	[55]
Ethanol extract	*C. albicans*	-	718.33 µg/mL	-	[74]
Nanoparticles loaded to extract	*C.albicans*	75	-	-	[74]
Methanol pod extract	*Colletotrichum* sp.	14	-	-	[76]
Ethanol extract Aqueous extract	*C.albicans*	1.87 cm 1.87 cm	- -	- -	[63]
Ethyl acetate extract	*Microsporum gypseum* *Rhizopus stolonifer*	9.67 8.67	1.56 6.25	- -	[26]
Methanol extract	*R. stolonifer*	9.66	1.56	-	[26]

Note: - (not tested).

The antiviral activities of *M. oleifera* extracts against several viruses are shown in Table 3.

Table 3. Antiviral activity of *M. oleifera* against several viruses.

M. oleifera	Viral	IC_{50} (µg/mL)	CC_{50} (µg/mL)	EC_{50} (µg/mL)	References
Leaf extract	SARS-CoV-2 "NRC-03-nhCoV"	52.79	111.54	-	[27]
Crude ethanol extract	SARS-CoV-2	12.29	7277	-	[28]
Seed extract	IAVs	-	-	1.27	[29]
Seed extract	H1N1	0.26	-	-	[84]
Aqueous extract	HSV-1 HSV-2	43.2% 21.4%	- -	- -	[30]
Leaf ethanol extract	H9	-	100	-	[33]
Methanol extract	HSV-1F VU-09	- -	724.5 -	74.8 79.6	[34]
Aqueous leaf extract	AqMOL ACV	- -	697.8 >30	721.8 0.48	[35]

Note: - (not tested).

3.4. Anthelminthic

Parasitic worm infections can infect various parts of the body, which could lead to health issues for the host. This could lead to the economic loss of livestock. To prevent these losses, the development of anthelmintic medicine has gained interest due to parasitic worm that affect not only affect livestock but also human health. Utilizing earthworms 3–5 cm in length and 0.1–0.2 cm in width, Nilani et al. evaluated the anthelminthic properties of the seed oil *M. oleifera*. The seed oil was divided into two concentrations, 25 and 50 mg/mL, they exhibit anthelminthic properties, with paralysis times of 21 and 16 min respectively while the death time 30 and 24 min, respectively. The study also reported that oleic acid (**57**) at a concentration of 25 mg/mL contained in seed oil showed a paralysis time 23 min and a death time 33 min [36].

3.5. Antihypertensive

Hypertension is a cardiovascular disease that causes sustained blood pressure levels. It could lead to health complications, including heart disease, kidney, and stroke. Randriamboajonvy et al. utilizing spontaneous hypertensive rats (SHR) as experiment model to demonstrate the effect of *M. oleifera* seed oil. The result showed a significant reduction in nocturnal heart rate without a change in diurnal heart rate after ten days of treatment. The use of seed oil in SHR increased the capacity of the left ventricle during diastole, which was substantially lower in SHR rats as in comparison with WKY (control) rats. Ejection fraction, a measure of systolic ventricular function, was substantially reduced in both SHR groups (control and seed oil-treated) in comparison with to WKY rats. This suggests that seed oil treatment did not have a positive effect on systolic ventricular function in SHR. The increased isovolumic relaxation time, indicative of diastolic function impairment in SHR, was completely reversed by seed oil treatment. *M. oleifera* seed oil treatment also led to a reduction in cardiomyocyte size in SHR seed oil-treated hearts compared to those in SHR control hearts. Furthermore, the study explored the potential involvement of peroxisome proliferator-activated receptor (PPAR) signaling pathways in seed oil's protective effect against cardiac fibrosis in SHR. The expression of PPARα and PPARδ in cardiac tissue was assessed, revealing increased staining in the left ventricle of SHR seed oil-treated rats compared to SHR controls. These findings collectively suggest a beneficial impact of *M. oleifera* seed oil on cardiac structure and function in SHR, accompanied by an upregulation of PPAR-α and δ signaling pathways [37].

Acuram et al. studied the antihypertensive properties of methanol and ethyl acetate extracts related to inhibition of angiotensin converting enzyme (ACE), furthermore, blood pressure was also investigated. The hypertension was induced in mice with N^{ω}-nitro-L-arginine methyl ester (L-name). The result demonstrated that compared to methanol extract, ethyl acetate showed more significant inhibition of ACE and lowering blood pressure on the last day [85].

3.6. Antileishmanial

Infection from the genus Leishmanial affecting health issues in tropical and subtropical regions such as Asia, Africa, America, and Mediterranean. This infection is transmitted from sandflies to humans. Kaur et al. studied the anti-leishmanial properties of *M. oleifera* extract against promastigotes of *Leishmania donavani*. The roots were extracted with 70% ethanol and the leaves were extracted with methanol. The roots ethanolic extract and the leaves' methanolic extract exhibited moderate inhibitory activity, with IC_{50} values of 83.0 and 47.5 μg/mL, respectively. Upon fractionation, the methanolic extract of leaves showed enhanced antileishmanial activity, particularly in its ethyl acetate fraction, which displayed increased potency with an IC_{50} value of 27.5 mg/mL. Niazin was isolated from ethyl acetate fraction gave antileishmanial properties with IC_{50} value of 5.25 mM [41].

3.7. Wound Healing

Tofiq et al. macerated the leaves of *M. oleifera* with 70% ethanol. The experiment was conducted in 7 groups and observed wound healing properties. The result demonstrated that ointment with 10% concentration of extract formulation showed a better effect, representing less scarring, brighter skin, and more regenerated hair follicles compared to gentamicin ointment. Ramadhany et al. made *M. oleifera* leaves extract by soxhlet with ethanol. The extract was made into 4 and 15% gel and investigated their wound healing properties on gingival wounds. The study analyzes the neutrophils, fibroblasts, angiogenesis, and epithelial thickness for seven days. It resulted in 15% *M. oleifera* gel extract having a better effect in reducing neutrophils, increasing the number fibroblasts and angiogenesis. However, 4% *M. oleifera* gel extract was better at increasing epithelial thickness [86].

3.8. Antioxidant

Antioxidant properties are used to decrease oxidative stress, which could lead to damaging tissues. Antioxidants function as electron donors to free radicals and neutralize them. Thus, made antioxidant properties become one of most researched topics. Antioxidant activities of *M. oleifera* by several bio-assay methods are shown in Table 4.

Table 4. Antioxidant activity of *M. oleifera* by several bio-assay methods.

M. oleifera	Bio-Assay	IC_{50}	EC_{50} (mg/mL)	References
Roots extract		16 µL	-	
Leaf extract	Xanthine oxidase	30 µL	-	[44]
Stem bark extract		38 µL	-	
Roots extract		40 µL	-	
Leaf extract	2-deoxyguanosine	58 µL	-	[44]
Stem bark extract		72 µL	-	
n-Butanol extract		92.62%	0.07	
Ethyl acetate extract	DPPH	90.27%	0.08	[45]
Petroleum ether extract		-	0.35	
Aqueous extract		-	0.44	
n-Butanol extract		99.46%	0.01	
Ethyl acetate extract	ABTS	97.49%	0.04	[45]
Crude extract		77.82%	-	
Petroleum ether extract	ABTS	-	0.18	[45]
Aqueous extract		-	0.29	
n-Butanol extract	Hydroxy radical-scavenging	94.46%	-	[45]
Ethyl acetate extract		80.68%	-	
Leaf extract	DPPH	1.87 mg/mL	-	[46]
Leaf extract	FRAP	0.99 mM Fe^{2+}/g	-	[46]
Root extract	ABTS	1.24 mg/mL	-	[46]
Ethyl acetate extract	DPPH	526.7 µMol	-	[87]
Acetone extract		435.7 µMol	-	
Ethanol extract	DPPH	0.44 mg/mL	-	[88]
Ethanol extract	Hydroxy peroxide free radical scavenging	0.54 mg/mL	-	[88]
Ethanol extract	FRAP	0.25 mg/mL	-	[88]
Ethyl acetate extract	DPPH	71.9 µg/mL	-	[89]
Ethyl acetate extract	ABTS	54.79 µg/mL	-	[89]

Note: - (not tested).

3.9. Anti-diarrheal

Misra et al. evaluated the anti-diarrheal potential of *M. oleifera*. Leaves of *M. oleifera* were extracted with petroleum ether and then subjected to ethanol for seven days. The animal models were divided into six groups, as control and as doses of extract, and castor oil was used to induce diarrhea. The study showed that the ethanol extract successfully acted as an anti-diarrheal within 52 min, with an extract dose 150 mg/kg, and showed total stools of 0.130 mg [90].

3.10. Hepatoprotective

Pari and Kumar conducted an evaluation of the hepatoprotective properties of an ethanol extract obtained from *Moringa oleifera* leaves in rats with liver damage caused by anti-tubercular medications such as isoniazid (INH), rifampicin (RMP), and pyrazinamide (PZA). This extract had considerable protective effects when administered orally, as indicated by its impact on numerous parameters. This included the serum levels of glutamic pyruvic transaminase (alanine aminotransferase), glutamic oxaloacetic transaminase (aspartate aminotransferase), bilirubin, and alkaline phosphatase, as well as the levels of lipids and lipid peroxidation in the liver [91].

Khalid et al. assessed the potential protective effects of *M. oleifera* leaf powder and a 70% ethanol extract of *M. oleifera* leaves in alleviating liver and kidney dysfunction induced by polycystic ovary syndrome (PCOS) in female albino mice. PCOS was induced by administering intramuscular injections of testosterone enanthate at a dose of 1.0 mg/100 g body weight for a duration of thirty-five days. The study conducted assessments of renal function (RFT), liver function (LFT), and the oxidative stress biomarker malondialdehyde (MDA) in the serum at intervals of 0, 7, and 14 days. The mice that received treatments of *M. oleifera* exhibited significant reductions in the levels of alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), total bilirubin, urea, and creatinine compared to the PCOS-induced controls. Conversely, there was a notable increase in the levels of total protein, albumin, globulin, and the albumin/globulin (A/G) ratio. Furthermore, oxidative stress levels exhibited significant reductions in response to treatments, exposure duration, and their combined effect. The findings of this study suggest that both *Moringa oleifera* leaf powder and extract have the potential to reduce oxidative stress and improve renal and hepatic activity in female albino mice with PCOS-induced dysfunction [58].

3.11. Anti-Inflammatory

Inflammation is a recognized physiological reaction that serves to safeguard the body against infections and promote the healing of tissue injuries. However, persistent or chronic inflammation can potentially support the growth of various disorders and diseases associated with inflammation. Sulaiman et al. assessed the anti-inflammatory potential of an *M. oleifera* aqueous extract. The assay was conducted by carrageenan-induced paw edema. The extract was made at different doses and showed inhibitory effects in a dose-dependent manner. At dose 100 mg/kg, after five hours, the inhibition showed a value of 50%. The suggested anti-inflammatory mechanism was the extract which contained flavonoids with an inhibitory action against NF-k [64].

Fard et al. studied the anti-inflammatory potential of an *M. oleifera* extract on macrophages stimulated with lipopolysaccharide (LPS) in RAW264.7 macrophages. The anti-inflammatory properties of ethanol extracts derived from *M. oleifera*'s bioactive leaves were assessed by examining their ability to inhibit nitric oxide (NO) production using the Griess reaction and to modulate the expression of pro-inflammatory mediators in macrophages. The ethanol leaf extract exhibited a significant inhibition of various inflammatory markers, including NO production, as well as prostaglandin E2, TNF-α, IL-6, and IL-1β secretion. Concurrently, the bioactive extract dose-dependently stimulated the production of IL-10. Furthermore, the ethanol extract effectively suppressed the protein expression of inflammatory markers such as inducible NO synthase, cyclooxygenase-2, and NF-kB p65, also in a dose-dependent manner [65].

Previously, Xu et al. investigated the antioxidant properties of *M. oleifera*, and also investigated its anti-inflammatory properties. The study was conducted by determining the NO production of RAW264.7 macrophages. The study revealed that the leaf extract gave a lower NO production, at 100 µg/mL, while the seed extract presented higher NO production. It concluded that the leaf extract had better anti-inflammatory properties compared to the seed extract [46].

An ethyl acetate fraction of *M. oleifera* was assessed to have anti-inflammatory potential against LPS-induced macrophages. The study showed that macrophages which were treated with the ethyl acetate fraction exhibited a reduction in the production of pro-inflammatory mediators. This reduction was observed between the mRNA and protein levels. The study findings indicated that the fraction downregulated the mRNA expression of various inflammatory markers, including IL-1, IL-6, TNF-α, PTGS2, NF-kB P50, and RelA. Furthermore, the fraction effectively inhibited the expression of inflammatory mediators such as IL-6, TNF-α, and cyclooxygenase-2. Notably, the fraction effects included the inhibition of IkB-α phosphorylation and the ability to decrease the expression of nuclear factor NF-kB p65, thereby impeding its nuclear translocation [52].

3.12. Anti-Diabetic

One of the traditional usages of *M. oleifera* was as a diabetic medicine. Gupta et al., and Al-Malki and El Rabey studied the proper effects of *M. oleifera* as an anti-diabetic medicine. Pod and seed powders of *M. oleifera* were used in various doses. The animal model used was a streptozotocin-induced diabetic male rat. The parameters used were the determination of IL-6, immunoglobulin A, immunoglobulin G, fasting blood sugar, glycosylated hemoglobin, albumin, potassium, sodium, creatinine, and uric acid. Both studies showed that *M. oleifera* extracts could restore the abnormalities to a slightly normal level; however, a higher dose was suspected to be more effective. The water consumption of all subject groups also returned to normal after treatment [59,60].

Previously, Hamed et al. examined the antioxidant properties of *M. oleifera* leaf extracts. Furthermore, they also investigated the anti-diabetic activity of purified flavonoids from crude extracts by determining their α-glucosidase inhibitory effects. The results showed that purified flavonoids inhibited α-glucosidase by 54.41% at 100 μg/mL and 99.01% at 800 μg/mL in an uncompetitive manner [48]. Chen et al. reported that the ethanol leaf extracts of *M. oleifera* could be used as anti-diabetic medicine. They investigated the activity by determining the α-glucosidase value. The study showed an IC_{50} value of 123 μg/mL [61].

3.13. Anticancer

Jung evaluated the anticancer properties of *M. oleifera* leaf extracts against A549 human lung cancer cells. The evaluation was conducted by MTT assay, and the changes and apoptotic effects were observed. The observation revealed that *M. oleifera* extract treatment resulted in a dose-dependent downregulation of caspase-3 and an upregulation of cleaved caspase-3, indicating an induction of apoptosis. There was a significant dose-dependent downregulation of Akt, p-IkB, NF-kB, p-Erk, β-catenin, and cyclin D1, all of which play roles in cell survival and proliferation. Treatment with soluble *M. oleifera* extracts for 48 h resulted in a significantly reduced release of reactive oxygen species (ROS) in comparison to the untreated control group. This implies a decrease in oxidative stress. In summary, the study concluded that MOL treatment induced apoptosis, inhibited the growth of tumor cells, and reduced the levels of internal reactive oxygen species (ROS) in human lung cancer cells. These outcomes emphasize the potential of *M. oleifera* leaf extracts as a promising candidate for further research and development in the context of lung cancer therapy [66]. The anticancer activities of *M. oleifera* against several cancer cell types are shown in Table 5.

Table 5. Anticancer activity of *M. oleifera* against several cancer cell types.

M. oleifera	Bio-Assay	IC_{50} (μg/mL)	Other Values	References
Seed essential oil	HeLa	442.8	23.9%	[67,68]
	HepG2	751.9	34.93%	
	MCF-7	226.1	40.48%	
	CACO-2	1000	50.28%	
	L929	1000	42.99%	
Aqueous extract	HeLa	70	70 μg/mL	[67,68]
Aqueous extract	A375	-	36.40%	[69]
Aqueous extract	Bcl-2	-	0.68 to 0.53-fold	[69]
Aqueous extract	Bax	- -	2.62-fold increase at the m-RNA level; 1.85-fold increase at the protein level	[69]
Aqueous extract	MOE activation of Caspase-3/7	-	Increase 1.75-fold	[69]
Aqueous extract	MOE activation of Caspase-9	-	Increase 1.42-fold	[69]
Aqueous extract	MCF-7	100	-	[92]
	HTC116	125	-	
	AsPC-1	240	-	
Leaf extract	Urethane-induced lung cancer in rats	-	Induced in glutathione 3.8 mg/g, superoxide dismutase 900.6 U/g, and malondialdehyde 172 nmol/g	[93]
Leaf extract	Urethane-induced lung cancer in rats	-	Increase 50% EGFR-mRNA, 10.8% improvements of mucin level and the presence of PCNA-positive cells in lung	[93]
CO_2 root extract	MCF-7	-	Spanning 100 to 500 μg/mL	[94]
n-Hexane extract	Hep-2	180.6	-	[95]
Chloroform extract		190.2	-	
Ethyl acetate extract		40.2	-	
Methanol extract		170.1	-	
Crude extract	HCT116	9.5 (24 h) 5.04 (48 h)	-	[96]
Crude extract	CYP3A4	52.50	-	[54]

Table 5. *Cont.*

M. oleifera	Bio-Assay	IC_{50} (µg/mL)	Other Values	References
Chloroform extract	MCF-7	6.25		
Dicholoromethane extract	MCF-7	5	1.87-fold increase in p53 expression, 1.47-fold increase in Bax expression 1.05-fold increase in cytochrome C levels, 2.21-fold increase in caspase 8 expression	[97]
Ethyl acetate extract	MDA-MB-231	233.5	Increase 44.2% of late apoptotic cells; increased level of cleaved caspase 3 protein, Bax mRNA, and p53 mRNA; decreased anti-apoptotic Bcl-2 protein	[98]

Note: - (not tested).

Based on the data attained by Do et al., as shown in Table 3, this study demonstrated that *M. oleifera* extract induced apoptosis in A375 cells, as evidenced by chromatin condensation and the externalization of phosphatidylserine (PS), which are characteristic features of apoptotic cell death. The apoptosis process was initiated by the activation of caspase-9 and caspase-3/7, the cleavage of PARP, and the translocation of apoptosis-inducing factor into the nucleus. These findings provide insights into the apoptotic mechanisms triggered by *M. oleifera* extract in A375 cells [69]. Meanwhile, Pappas et al. assessed the gene expression of *M. oleifera* aqueous wild and cultivated leaf extracts against human pancreas cancer cells AsPC-1, MCF-7, and HCT-116 colon cancer cells. The aqueous extract exerted its effects by down-regulating p53 expression in all tested cell lines and by dow*n*-regulating c-myc in AsPC-1 cells. Additionally, specific marker genes associated with each cell line, such as BRCA-1 in MCF-7, mta-1 in AsPC-1, and Ki-67 in HTC116 cells, were dow*n*-regulated. Furthermore, the survivin (BIRC5) gene, an inhibitor of apoptosis, was dow*n*-regulated in all three cell lines, suggesting a shared target mechanism of Moringa constituents across these cell lines [92].

Kumar et al. discovered that an extract of *M. oleifera* leaves demonstrated effective inhibition of Dalton lymphoma (DL) cell proliferation. This inhibition was characterized by alterations in mitochondrial membrane potential ($\Delta\Psi m$) and noticeable changes in overall cell morphology. Notably, DL cells treated with the extract experienced cell cycle arrest at the G2/M phase and a significant upregulation in the expression of p53 and p21. Furthermore, the treatment resulted in increased levels of pro-apoptotic markers, including Bax, Cytochrome-c (Cyt-c), and caspase-3, while reducing the expression levels of the anti-apoptotic Bcl-2 protein. These changes strongly suggest the induction of apoptosis in DL cells. Mechanistically, the anticancer efficacy of *M. oleifera* extract was attributed to the inactivation of the MEK/ERK-mediated pathway in DL cells. Additionally, it is noteworthy that the inhibition of DL growth by MOML was accompanied by apoptosis induction and improvements in hematological parameters in DL-induced mice [99].

4. Utilization of *M. oleifera* in Dental Health

Research on several bacteria that are pathogenic to dental health has been carried out, such as *Streptococcus mutans*, *Enterococcus faecalis*, *Staphylacoccus aureus*, and others. Table 6 shows some data on the antibacterial activity of *M. oleifera* against oral pathogenic bacteria.

Table 6. Antibacterial activity of *M. oleifera* to some oral pathogenic bacteria.

M. oleifera	Microorganism	Inhibition Zone (mm)	MIC (µg/mL)	MBC	References
Ethanol extract	*P. aeruginosa*	21.21	458	-	[100]
Ethanol extract	*S. aureus*	20.55	>1	-	[101]
Aqueous extract	*S. aureus*	12	58.75 mg/mL	-	[100]
Methanol extract	*E. faecalis*	44.83	-	-	[102]

Table 6. *Cont.*

M. oleifera	Microorganism	Inhibition Zone (mm)	MIC (µg/mL)	MBC	References
Leaves ethanolic extract	*S. aureus* *S. mutans*	19.25 13	-	-	[103]
Roots ethanolic extract	*S. aureus* *S. mutans*	9.25 10.50	-	-	[103]
Seed ethanolic extract	*S. aureus* *S. mutans*	3.25 4.75	-	-	[103]
Bark ethyl acetate extract	*S. aureus*	16.33	-	-	[104]
Root bark methanolic extract	*S. aureus*	19	12.5 mg/mL	-	[105]
Leaf extract	*S. mutans* biofilm	0.20/(OD 520 nm)	-	-	[106]
Diethyl ether, *n*-Hexane, and Ethyl acetate extract	*S. aureus*	-	15.6	-	[107]
Diethyl ether extract	*E. faecalis*	-	15.6	-	[107]
extract	*S. aureus*	-	15.6	-	[107]
Leaf extract	*E. faecalis*	11.89 (at 100 µg/mL)	-	-	[108]
Leaf extract	*E. faecalis*	35.5 (at 24 h) 48.83 (at 48 h)	75	-	[102]

Note: - (not tested).

Jwa evaluated the aqueous and ethanol extracts of *M. oleifera* against *S. mutans*, which were found in the cariogenic biofilm of dental caries. Both extracts reduced the bacteria's growth at concentrations of 25 and 6.25 µg/mL, respectively. At the same concentration, heated ethanol extract exhibited inhibitory activity better than non-heated extracts. This study showed that the ethanol extract was more effective than the aqueous extract against *S. mutans* [109]. Soraya et al. investigated the anti-bacterial properties of *M. oleifera* gel in inhibiting the growth of *S. mutans*, which were involved in the pathogenesis of dental caries. After 48 h, it was observed that the 12.5% concentration exhibited the highest effectiveness in reducing *S. mutans* growth. Within 24 h, the 6.25 and 3.125% concentrations displayed remarkable capabilities in suppressing *S. mutans* growth. Notably, the 6.25% concentration showed superior efficacy in reducing the formation of *S. mutans* biofilms. The application of *M. oleifera* gel extract created conditions in which *S. mutans*, a commensal bacterium, struggled to form a biofilm, with inhibition levels surpassing 70%. This was evidenced by the absence of substantial biofilm development. It is worth mentioning that at all tested concentrations, *M. oleifera* exhibited a toxic effect on *S. mutans* cells. The ethanol extract gel of *M. oleifera* demonstrated the ability to curtail both the growth and biofilm formation of *S. mutans* on tooth surfaces while concurrently exerting toxicity on *S. mutans* cells, potentially due to the presence of anti-bacterial compounds [110]. The anti-bacterial properties of herbal toothpaste, formulated with *M. oleifera* root essential oil, were assessed against bacteria commonly associated with tooth plaque, namely *S. mutans* and *S. aureus*. The Muller Hinton agar well diffusion method was used for this evaluation The findings of this study demonstrated that *S. mutans* exhibited susceptibility to the herbal toothpaste, as indicated by a significant inhibition zone measuring 31 mm [111].

Alharbi et al. examined the antimicrobial efficacy of *M. oleifera* leaf extract, octenidine dihydrochloride (OCT), sodium hypochlorite (NaOCl), and their combinations as an intracanal irrigant against *E. faecalis*. Decoronation and root canal preparation were performed on single-rooted mandibular premolars. After autoclaving, each root specimen was inoculated with *E. faecalis* and incubated at 37 °C for 48 h. Subsequently, based on the irrigation solution used, the specimens were split into six groups: 2.5% NaOCl (Group 1), 0.1% OCT (Group 2), *M. oleifera* leaf extract (Group 3), a combination of *M. oleifera* extract and 1.25% NaOCl (Group 4), a combination of *M. oleifera* extract and OCT (Group 5), and normal saline (Group 6). Both *M. oleifera* extract and 0.1% OCT demonstrated antibacterial effects against *E. faecalis* comparable to 2.5% NaOCl and could be considered as potential root canal irrigants. Furthermore, combination groups exhibited superior anti-microbial activity compared to individual irrigants [112].

Rochyani investigated the inhibitory potential of *M. oleifera* leaf extract on the biofilm formation of *E. faecalis* bacteria. The experiment was divided into several groups, including a negative control group (CMC solvent 0.1%), a positive control group (ChKM), and four test groups extracts of 20, 40, 60, and 80%, respectively. The results indicate that the *M. oleifera* leaf extract demonstrates a significant inhibitory effect on the biofilm formation of *E. faecalis* bacteria. Notably, the inhibitory effect observed in the 80% extract was found to be substantially greater than that achieved by the positive control group using ChKM [113].

Shanmugapriya et al. investigated the antimicrobial effects of *M. oleifera* extracts on pooled plaque collected from orthodontic patients. To achieve this, *M. oleifera* extracts were prepared through maceration. Subgingival plaque samples were collected, and the microorganisms present were cultured under anaerobic conditions. The microorganisms were subsequently subjected to treatment with the extracts, and their MIC and MBC were determined. Additionally, the cytotoxic effects of the extracts were assessed using a brine shrimp assay. The results of the study revealed that the 5% aqueous extract of *M. oleifera* exhibited a dose-dependent antimicrobial activity against oral anaerobic organisms. Notably, this anti-microbial effect became more pronounced with longer exposure times of the treated samples. Furthermore, in the cytotoxicity assay, the aqueous extract showed superior performance in lower concentrations in comparison to the ethanol extract. This was evident from the higher number of live nauplii observed in the aqueous extract group, indicating its lower cytotoxicity [114].

Sopandani et al. evaluated the antibacterial efficacy of *M. oleifera* extract at various concentrations (25, 50, 75, and 100%) when used as an irrigation solution against *E. faecalis* within the root canal ex vivo. Quantitative polymerase chain reaction (qPCR) was employed to assess the population of *E. faecalis* within the root canal following treatment with *M. oleifera* extract. The results indicated that *M. oleifera* extract solutions at concentrations of 75 and 100% exhibited comparable effectiveness to a 5.25% sodium hypochlorite (NaOCl) solution as a positive control [114].

Rieuwpassa et al. assessed the effectiveness of *M. oleifera* leaf extract in modulating the anti-inflammatory cytokine IL-1 of the bacteria *Porphyromonas gingivalis*, a key contributor to chronic periodontitis. The study revealed a significant variation in IL-1 levels across different observation days. Administration of the extract led to a reduction in pro-inflammatory cytokine IL-1 levels, as evident from the observations on days D0, D1, D3, D5, and D7 in the experimental Wistar rats induced with *Porphyromonas gingivalis* bacteria [115].

Kumar et al. evaluated the antibacterial effectiveness of a 5% *M. oleifera* mouthwash enhanced with silver nanoparticles against oral aerobic microorganisms. The mouthwash was prepared by utilizing a 5% *M. oleifera* aqueous extract for the synthesis of silver nanoparticles. The characterization of the mouthwash was performed through scanning electron microscopy analysis and energy dispersive X-ray analysis. To assess its anti-bacterial properties, the mouthwash was tested against *S. mutans*, *S. aureus*, *E. faecalis*, and *C. albicans* using the agar well diffusion assay. The results indicated that the 5% *Moringa oleifera*-silver nanoparticle mouthwash exhibited a pronounced effect on *S. aureus* and a comparable impact on *S. mutans* [114].

5. Conclusions

M. oleifera has a variety of pharmacological effects, such as anti-hemorrhage, anti-allergic, antimicrobial, anthelmintic, antihypertensive, antileukemia, antioxidant, anti-diabetic, hepatoprotection, anti-inflammatory, and anticancer effects. This plant is effective against dental infections. Antimicrobial research against microbes that cause dental infections has been carried out on the leaves of *M. oleifera* both in aqueous and ethanol extracts. This plant is reported to be active in vitro to inhibit several oral bacteria such as

E. faecalis, *S. mutans*, *P. gingivalis*, *S. aureus*, and *C. albicans*, and has been tested ex vivo. The chemical components contained in *M. oleifera* are phenolics, glucosinolates, flavonoids, fatty acids, esters, alkaloids, sterols, terpenes, and several other compounds. Based on the pharmacological effects and chemical components contained in *M. oleifera*, this plant has the potential to be further developed to produce an antibacterial agent product, especially for dental health. The search for bioactive compounds in *M. oleifera* that have a major role as antibacterials in oral pathogens can be carried out through isolation. Furthermore, both extracts and isolated compounds from *M. oleifera* can be further traced for their activity through in vitro, in vivo, and clinical trials.

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