



biomedicine AND
PHARMACOTHERAPY

Biomedicine & Pharmacotherapy Editorial Board

Editor-in-Chief

Danyelle Townsend

Analytical Redox Biochemistry Center Department of Drug Discovery and Pharmaceutical Sciences, Medical University of South Carolina Charleston, South Carolina, United States

Ethics Editor

Kenneth Tew

Medical University of South Carolina - College of Nursing, Charleston, South Carolina, United States

Executive Editors

Andre Luis Branco de Barros

Federal University of Minas Gerais, Belo Horizonte, Brazil

Swapnil Desale

Biocon Ltd, India

Jason D. Gardner

Louisiana State University Health Sciences Center, New Orleans, Louisiana, United States

Xiao-Jie Lu

Nanjing Medical University, Nanjing, China

Francesco Maione

University of Naples Federico II Department of Pharmacy, Napoli, Italy

Eduardo N. Maldonado

Medical University of South Carolina, Charleston, South Carolina, United States

Associate Editors

Marcela de Moura Garcia Bini Dutra

Federal University of Minas Gerais, Belo Horizonte, Brazil

Renata Salgado Fernandes

Faculty of Pharmacy, Department of Pharmaceutical Products Federal University of Minas Gerais (UFMG), Belo Horizonte, Minas Gerais, Brazil

David Kurtz

Medical University of South Carolina Department of Cell and Molecular Pharmacology and Experimental Therapeutics, Charleston, South Carolina, USA

Tassanee Lerksuthirat

Mahidol University Faculty of Medicine Ramathibodi Hospital Research Center, Bangkok, Thailand

Assistant Editors

Kwang-Hyun Baek

CHA University, Department of Biomedical Science, Seongnam, Korea, Republic of

Arnab Banerjee

Department of Pharmacology & Nutritional Sciences, College of Medicine, University of Kentucky, Lexington, KY 40536, United States of America

Maria Barnes

Des Moines University, Des Moines, Iowa, United States

Jessica Bradley

University of the Incarnate Word, San Antonio, Texas, United States

Susan Burke

Baton Rouge, Louisiana, United States of America

Diana Cruz-Topete

Louisiana State University Health Sciences Center Shreveport, Shreveport, Louisiana, United States

Izabella Thais Da Silva

Federal University of Minas Gerais, Belo Horizonte, Brazil

Carmen De Miguel

The University of Alabama at Birmingham, Birmingham, Alabama, United States

Diana Fang

Napoli, Italy

Daniel Cristian Ferreira Soares

Federal University of Itajubá, ITAJUBA, Brazil

Rodrigo Franco Cruz

University of Nebraska-Lincoln School of Veterinary Medicine and Biomedical Sciences, Lincoln, Nebraska, United States

Asif J Iqbal

University of Birmingham Institute of Cardiovascular Sciences, Birmingham, United Kingdom

Alejandra Krüger

National University of the Center of the Province of Buenos Aires Faculty of Veterinary Sciences, Tandil, Argentina

Pellegrino Lippiello

University of Naples Federico II Department of Pharmacy, Napoli, Italy

Editorial Board

Mary-Ann Bjornsti

University of Alabama at Birmingham, Birmingham, Alabama, United States

Angelo Carpi

University of Pisa, Pisa, Italy

Yanhong Gu

Nanjing Medical University, Nanjing, China

Zhiheng He

Hebrew University of Jerusalem, Jerusalem, Israel

Hieronim Jakubowski

Rutgers New Jersey Medical School, Newark, New Jersey, United States

Founding Editors

Georges Mathé †

Haim Tapiero †

Kenneth Tew

Medical University of South Carolina - College of Nursing, Charleston, South Carolina, United States

Xiaoqian Wang

Nanjing Tech University, Nanjing, China

Zhiwei Ye

Medical University of South Carolina Department of Cell and Molecular Pharmacology and Experimental Therapeutics, Charleston, South Carolina, United States

Jie Zhang

Medical University of South Carolina Department of Cell and Molecular Pharmacology and Experimental Therapeutics, Charleston, South Carolina, United States

Stefany Primeaux

Louisiana State University Health Sciences Center, New Orleans, Louisiana, United States

Federica Raucci

University of Naples Federico II, Napoli, Italy

Chonticha Saisawang

Mahidol University, Salaya, Thailand

Monica Valentovic

Marshall University, Huntington, West Virginia, United States of America

Jacqueline Womersley

Stellenbosch University, Stellenbosch, South Africa

Zhongmin Lu

Salk Institute for Biological Studies Molecular Neurobiology Laboratory, San Diego, California, United States

Yonggang Ma

University of Mississippi Medical Center, Jackson, Mississippi, United States

Pedro Martín

Institute of Immunological and Physiopathological Studies (IIFP UNLP-CONICET), La Plata, Argentina

Nelli Mnatsakanyan

New Haven, Connecticut, United States of America

Marialuisa Piccolo

University of Naples Federico II Department of Pharmacy, Napoli, Italy

Maria Queralt-Martín

Universitat Jaume I, Physics Department, Laboratory of Molecular Biophysics, Castellon, Spain

Anella Saviano

University of Naples Federico II, Napoli, Italy

Marek Schwendt

University of Florida, Gainesville, Florida, United States

Liz Simon Peter

Louisiana State University Health Sciences Center, New Orleans, Louisiana, United States

Frank T. Spradley

University of Mississippi Medical Center, Jackson, Mississippi, United States

Simone de Vasconcelos Generoso

Federal University of Minas Gerais, Belo Horizonte, Brazil

Clara Ventura

La Plata, Argentina

Jianqiang Xu

School of Life and Pharmaceutical Sciences Dalian University of Technology Panjin-124221, Liaoning, China

Xinping Yue

Louisiana State University Health Sciences Center, New Orleans, Louisiana, United States

John Lazo

University of Virginia School of Medicine, Charlottesville, Virginia, United States

Andrea Nicolini

University of Pisa, Pisa, Italy

Gary O. Rankin, PhD

Marshall University Department of Biomedical Sciences, Huntington, West Virginia, United States

Yongqian Shu

Nanjing Medical University, Nanjing, China



[Submit your article](#)

[Guide for authors](#)

Menu



Search in this journal

Volume 161

May 2023

[< Previous vol/issue](#)

[Next vol/issue >](#)

Receive an update when the latest issues in this journal are published

[Set up journal alerts](#)

Open access

Editorial Board

Article 114604

[View PDF](#)

Review Articles

Review article [Open access](#)

A review of the effect of exosomes from different cells on liver fibrosis

Xiaojie Hu, Qinglin Ge, Yunting Zhang, Bowen Li, ... Yan Huang

Article 114415

[View PDF](#) [Article preview](#)

Review article [Open access](#)

Role of sirtuins in metabolic disease-related renal injury

Huan-Huan Chen, Yi-Xiao Zhang, Jia-Le Lv, Yu-Yang Liu, ... Yu-Hong Zhao

Article 114417

[View PDF](#) [Article preview](#)

Review article [Open access](#)

The emerging role of PPAR-alpha in breast cancer

Zhiwen Qian, Lingyan Chen, Jiayu Liu, Ying Jiang, Yan Zhang

Article 114420



[View PDF](#) [Article preview](#)

Review article [Open access](#)

FEEDBACK

Natural sources, biological effects, and pharmacological properties of cynaroside



Abdelhakim Bouyahya, Douae Taha, Taoufiq Benali, Gokhan Zengin, ... Narjis Sahib
Article 114337

 [View PDF](#) Article preview 

Review article [Open access](#)

GABAergic signaling as a potential therapeutic target in cancers

Yihui Yang, Liwen Ren, Wan Li, Yizhi Zhang, ... Jinhua Wang
Article 114410

 [View PDF](#) Article preview 

Review article [Open access](#)

Emerging role of macrophages in non-infectious diseases: An update



Hassan Yousaf, Malik Ihsan Ullah Khan, Iftikhar Ali, Muhammad Usman Munir, Ka Yiu Lee
Article 114426

 [View PDF](#) Article preview 

Review article [Open access](#)

The impact of oncolytic adenoviral therapy on the therapeutic efficacy of PD-1/PD-L1 blockade



Sajad Najafi, Jamal Majidpoor, Keywan Mortezaee
Article 114436

 [View PDF](#) Article preview 

Review article [Open access](#)

Emerging role of inositol monophosphatase in cancer

Qian Chen, Liangfang Shen, Shan Li
Article 114442

 [View PDF](#) Article preview 

Review article [Open access](#)

A mechanistic updated overview on lycopene as potential anticancer agent


Gulay Ozkan, Deniz Günel-Köroğlu, Ayse Karadag, Esra Capanoglu, ... William C. Cho
Article 114428

 [View PDF](#) Article preview 

Review article [Open access](#)

miR-33b in human cancer: Mechanistic and clinical perspectives



Wenlong Zhang, Bincan Jiang, Hecheng Zhu, Ailan Cheng, ... Yirui Kuang
Article 114432

 [View PDF](#) Article preview 

Review article [Open access](#)

A comprehensive review of key factors affecting the efficacy of antibody drug conjugate

Anupama Samantasinghar, Naina Pullarkat Sunildutt, Faheem Ahmed, Afaq Manzoor Soomro, ... Kyung Hyun Choi
Article 114408

 [View PDF](#) Article preview 

Review article [Open access](#)

Application of aptamer-drug delivery system in the therapy of breast cancer

Rui Fan, Xufeng Tao, Xiaohan Zhai, Yanna Zhu, ... Linlin Lv

Article 114444



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

Gut microbiota dysbiosis in AKI to CKD transition

GR Saranya, Pragasam Viswanathan

Article 114447



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

The importance of hsa-miR-28 in human malignancies

Seyede Fatemeh Hosseini, Setareh Javanshir-giv, Hanieh Soleimani, Homa Mollaei, ... Zohreh Rezaei

Article 114453



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

Friend or foe? The dual role of triptolide in the liver, kidney, and heart

Shiyuan Jiang, Feng Wan, Hui Lian, Zhihao Lu, ... Jian Li

Article 114470



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

Advances in the role and mechanism of miRNA in inflammatory pain

Xiaoyu Zhang, Lin Zhu, Xuezhen Wang, Lei Xia, Yanan Zhang

Article 114463



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

Exploring the potential impact of probiotic use on drug metabolism and efficacy

Carmen Purdel, Anca Ungurianu, Ines Adam-Dima, Denisa Margină

Article 114468



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

Strategy and application of manipulating DCs chemotaxis in disease treatment and vaccine design

Yichao Lu, Jian You

Article 114457



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

Current progress of mesenchymal stem cell membrane-camouflaged nanoparticles for targeted therapy

Lianlian Fan, Anhui Wei, Zihui Gao, Xupeng Mu

Article 114451



[View PDF](#)



[Article preview](#)

Review article [Open access](#)

The macrophage polarization in inflammatory dermatosis and its potential drug candidates

Qingru Sun, Shiyu Hu, Zhaohuan Lou, Jianli Gao

Article 114469



 [View PDF](#) Article preview 

Review article [Open access](#)

Matrix metalloproteinases induce extracellular matrix degradation through various pathways to alleviate hepatic fibrosis

Liang Shan, Fengling Wang, Dandan Zhai, Xiangyun Meng, ... Xiongwen Lv

Article 114472



 [View PDF](#) Article preview 

Review article [Open access](#)

Maresin1 can be a potential therapeutic target for nerve injury

Xichen Wang, Benson O.A. Botchway, Yong Zhang, Min Huang, Xuehong Liu

Article 114466



 [View PDF](#) Article preview 

Review article [Open access](#)

The role of lipotoxicity in kidney disease: From molecular mechanisms to therapeutic prospects

Linan Ren, Haiying Cui, Yao Wang, Feng Ju, ... Guixia Wang

Article 114465

 [View PDF](#) Article preview 

Review article [Open access](#)

Investigating regulated signaling pathways in therapeutic targeting of non-small cell lung carcinoma

Manzar Alam, Gulam Mustafa Hasan, Sayed M. Eldin, Mohd Adnan, ... Md. Imtaiyaz Hassan

Article 114452


 [View PDF](#) Article preview 

Review article [Open access](#)

Therapeutic potential of natural molecules against Alzheimer's disease *via* SIRT1 modulation

Mingming Zhang, Zhiyin Tang

Article 114474



 [View PDF](#) Article preview 

Review article [Open access](#)

Autophagy in cancer resistance to paclitaxel: Development of combination strategies

Jan Škubník, Vladimíra Svobodová Pavlíčková, Tomáš Ruml, Silvie Rimpelová

Article 114458


 [View PDF](#) Article preview 

Review article [Open access](#)

The pathophysiology of Post SSRI Sexual Dysfunction – Lessons from a case study

Samantha Klaas, Jessica Barbut Siva, Maarten Bak, Mark Govers, Rudy Schreiber

Article 114166

 [View PDF](#) Article preview 

Review article [Open access](#)

New insights into the non-enzymatic function of HDAC6

Yuanzai Zhu, Mengkai Feng, Bo Wang, Yichao Zheng, ... Ya Gao

Article 114438



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

Gastric immune homeostasis imbalance: An important factor in the development of gastric mucosal diseases

Shuhui Liu, Zilin Deng, Jiaying Zhu, Zhiyuan Ma, ... Xuemei Liu

Article 114338



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

T helper 17 (Th17) cell responses to the gut microbiota in human diseases

Chao-Yue Sun, Na Yang, Zuo-Liang Zheng, Dong Liu, Qi-Lin Xu

Article 114483



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

The emerging diagnostic and therapeutic roles of small nucleolar RNAs in lung diseases

Xiaoying Liu, Md Khadem Ali, Lan Zhao, Kamal Dua, Yuqiang Mao

Article 114519



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

Hydrogen sulfide and its donors for the treatment of cerebral ischaemia-reperfusion injury: A comprehensive review

Yiwei Huang, Moussa Omorou, Meng Gao, Chenxi Mu, ... Hui Xu

Article 114506



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

Quercetin activates the Sestrin2/AMPK/SIRT1 axis to improve amyotrophic lateral sclerosis

Tian Jin, Yong Zhang, Benson O.A. Botchway, Min Huang, ... Xuehong Liu

Article 114515



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

Non-coding RNAs in radiotherapy resistance: Roles and therapeutic implications in gastrointestinal cancer

Kaiyue Xu, Huimin Guo, Anliang Xia, Zhangding Wang, ... Qiang Wang

Article 114485



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

Immunogenic cell death inducer peptides: A new approach for cancer therapy, current status and future perspectives

Hamid Aria, Marzieh Rezaei

Article 114503



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

The mechanistic basis for the effects of electroacupuncture on neuropathic pain within the central nervous system

Mengmeng Zhou, Qingxiang Zhang, Mingzhu Huo, Huijun Song, ... Di Zhang

Article 114516



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

New insights about the PDGF/PDGFR signaling pathway as a promising target to develop cancer therapeutic strategies

Pratibha Pandey, Fahad Khan, Tarun Kumar Upadhyay, Moon Seungjoon, ... Bonglee Kim

Article 114491



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

Dual-drug codelivery nanosystems: An emerging approach for overcoming cancer multidrug resistance

Jianing Gong, Taoran Shi, Jinfeng Liu, Zerong Pei, ... Feng Qiu

Article 114505



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

Update on the sources, pharmacokinetics, pharmacological action, and clinical application of anisodamine

Yuan Zhang, Jiayu Zou, Feng Wan, Fu Peng, Cheng Peng

Article 114522



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

Overview of blood-brain barrier dysfunction in methamphetamine abuse

Lu Pang, Yun Wang

Article 114478



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

The role of metabolic reprogramming of tumor-associated macrophages in shaping the immunosuppressive tumor microenvironment

Lunxu Li, Yu Tian

Article 114504



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

Natural flavonoids alleviate glioblastoma multiforme by regulating long non-coding RNA

Xian Liu, Xinyu Xiao, Xue Han, Lan Yao, Wei Lan

Article 114477



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

Managing metabolic diseases: The roles and therapeutic prospects of herb-derived polysaccharides

Xinmei Xu, Lijie Wang, Kun Zhang, Yi Zhang, Gang Fan

Article 114538



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

Metabolic reprogramming and interventions in endometrial carcinoma

Jiajia Li, Hongmei Yang, Lingyi Zhang, Songling Zhang, Yun Dai

Article 114526



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

Novel insight on GRP/GRPR axis in diseases

Hao-lu Sun, Qiu-ying Ma, He-ge Bian, Xiao-ming Meng, Juan Jin

Article 114497



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

Role of emodin in atherosclerosis and other cardiovascular diseases: Pharmacological effects, mechanisms, and potential therapeutic target as a phytochemical

Xinyue Wang, Shengjie Yang, Yujuan Li, Xiao Jin, ... Min Wu

Article 114539



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

The potential roles of ATF family in the treatment of Alzheimer's disease

Ting Yang, Yuhong Zhang, Lixuan Chen, Elizabeth Rosalind Thomas, ... Xiang Li

Article 114544



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

Stachydrine, a potential drug for the treatment of cardiovascular system and central nervous system diseases

Li Liao, Yan Tang, Bo Li, Jing Tang, ... Xiaochun Zhang

Article 114489



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

Metaflammation in glucolipid metabolic disorders: Pathogenesis and treatment

Pingjie Xiong, Fan Zhang, Fang Liu, Jiayu Zhao, ... Jiao Guo

Article 114545



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

Targeting Hippo pathway: A novel strategy for *Helicobacter pylori*-induced gastric cancer treatment

Yunyun Liu, Bingkai Zhang, Yimin Zhou, Yuanxin Xing, ... Duanrui Liu

Article 114549



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

Towards dual function of autophagy in breast cancer: A potent regulator of tumor progression and therapy response

Mehrdad Hashemi, Mahshid Deldar Abad Paskeh, Sima Orouei, Pegah Abbasi, ... Kiavash Hushmandi

Article 114546



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

The role of high mobility group box 1 in neuroinflammatory related diseases

Jialu Mo, Jiao Hu, Xianglin Cheng

Article 114541



[View PDF](#)

[Article preview](#)

Review article [Open access](#)

Autophagy orchestrates resistance in hepatocellular carcinoma cells

Homeyra Seydi, Kosar Nouri, Niloufar Rezaei, Atena Tamimi, ... Massoud Vosough

Article 114487



[View PDF](#)

[Article preview](#)

Original Articles

Research article [Open access](#)

In silico evaluation of geroprotective phytochemicals as potential sirtuin 1 interactors

Alessandro Medoro, Tassadaq Hussain Jafar, Sawan Ali, Truong Tan Trung, ... Sergio Davinelli

Article 114425



[View PDF](#)

[Article preview](#)

Research article [Open access](#)

Herba Origani alleviated DSS-induced ulcerative colitis in mice through remodeling gut microbiota to regulate bile acid and short-chain fatty acid metabolisms

Zuoting Yu, Dinggang Li, Hongxiang Sun

Article 114409



[View PDF](#)

[Article preview](#)

Research article [Open access](#)

HIF-1 α inhibitor YC-1 suppresses triple-negative breast cancer growth and angiogenesis by targeting PlGF/VEGFR1-induced macrophage polarization

Yan Li, Meng-Zhao Zhang, Shu-Jing Zhang, Xin Sun, ... Ji-Chang Wang

Article 114423



[View PDF](#)

[Article preview](#)

Research article [Open access](#)

Immune recovery among Romanian HIV/AIDS patients receiving darunavir/ritonavir or darunavir/cobicistat regimens in cART management: A three-year study

Ruxandra-Cristina Marin, Simona Gabriela Bungau, Delia Mirela Tit, Paul Andrei Negru, ... Radu Dumitru Moleriu

Article 114427



[View PDF](#)

[Article preview](#)

Research article [Open access](#)

Piceatannol-3'-O- β -D-glucopyranoside attenuates colistin-induced neurotoxicity by suppressing oxidative stress via the NRF2/HO-1 pathway

Liguang Xiong, Debiao Xiang, Fang Yuan, Huan Tong, ... Xin Li

Article 114419



[View PDF](#)



[Article preview](#)

Research article [Open access](#)

Fe-MnO₂ nanosheets loading dihydroartemisinin for ferroptosis and immunotherapy

Dandan Huang, Dafen Xu, Wenxin Chen, Ruimei Wu, ... Xuewen Wang


Article 114431

 [View PDF](#) Article preview 

Research article [Open access](#)

Rapid screening and *in vivo* target occupancy quantitative evaluation of xanthine oxidase inhibitors based on drug-target binding kinetics research strategy: A case study of *Chrysanthemum morifolium* Ramat.

Xueyan Li, Wenning Yang, Hongjiao Chen, Fulu Pan, ... Guopeng Wang
Article 114379

 [View PDF](#) Article preview 

Research article [Open access](#)

Pharmacological targeting of MTHFD2 suppresses NSCLC *via* the regulation of ILK signaling pathway


Feng Zhou, Ziyi Yuan, Yuyan Gong, Luyao Li, ... Xiaoying Huang
Article 114412

 [View PDF](#) Article preview 

Research article [Open access](#)

Moringa oleifera leaf attenuate osteoporosis in ovariectomized rats by modulating gut microbiota composition and MAPK signaling pathway

Xue-Hong Hu, Xiu-Yan Yang, Juan Lian, Yang Chen, ... Guang-Jian Jiang
Article 114434

 [View PDF](#) Article preview 

Research article [Open access](#)

Niclosamide causes lysosome-dependent cell death in endometrial cancer cells and tumors.



Rajani Rai, Debasish Kumar Dey, Doris Mangiaracina Benbrook, Vishal Chandra
Article 114422

 [View PDF](#) Article preview 

Research article [Open access](#)

Limosilactobacillus reuteri ameliorates preeclampsia in mice via improving gut dysbiosis and endothelial dysfunction


Bingyu Li, Yiya Shi, Wen Qiu, Qi Lin, ... Dongxin Zhang
Article 114429

 [View PDF](#) Article preview 

Research article [Open access](#)

PGK1 modulates balance between pro- and anti-inflammatory cytokines by interacting with ITI-H4


Hong-Beom Park, Bum-Chae Choi, Kwang-Hyun Baek
Article 114437

 [View PDF](#) Article preview 

Research article [Open access](#)

Preventive effect of empagliflozin and ezetimibe on hepatic steatosis in adults and murine models



Dong Yun Kim, Kyu Sik Chung, Jun Yong Park, Heon Yung Gee
Article 114445

 [View PDF](#) Article preview 

Research article [Open access](#)

Environmental exposure to cadmium in breast cancer – association with the Warburg effect and sensitivity to tamoxifen


Kateryna Tarhonska, Beata Janasik, Joanna Roszak, Kornelia Kowalczyk, ... Ewa Jablonska
Article 114435

 [View PDF](#) Article preview 

Research article *Open access*

Engeletin mediates antiarrhythmic effects in mice with isoproterenol-induced cardiac remodeling


Zhao Fang, Zhebo Liu, Bo Tao, Xuejun Jiang
Article 114439

 [View PDF](#) Article preview 

Research article *Open access*

Decreased medial prefrontal cortex activity related to impaired novel object preference task performance following GALR2 and Y1R agonists intranasal infusion


Estela Díaz-Sánchez, Alexander López-Salas, Marina Mirchandani-Duque, Jose Erik Alvarez-Contino, ... Manuel Narváez
Article 114433

 [View PDF](#) Article preview 

Research article *Open access*

Epigallocatechin-3-gallate (EGCG) based metal-polyphenol nanoformulations alleviates chondrocytes inflammation by modulating synovial macrophages polarization


Hong Wei, Jun Qin, Quanxin Huang, Zhiqiang Jin, ... Zainen Qin
Article 114366

 [View PDF](#) Article preview 

Research article *Open access*

Itraconazole inhibits endothelial cell migration by disrupting inositol pyrophosphate-dependent focal adhesion dynamics and cytoskeletal remodeling

Ji Qi, Weiwei Cheng, Zhe Gao, Yuanyuan Chen, ... Chenglai Fu
Article 114449

 [View PDF](#) Article preview 

Research article *Open access*

Limonin mitigates cardiometabolic complications in rats with metabolic syndrome through regulation of the IRS-1/GLUT4 signalling pathway

Putcharawipa Maneesai, Banyaphon Jan-o, Anuson Poasakate, Siwayu Rattanakanokchai, ... Poungrat Pakdeechote
Article 114448

 [View PDF](#) Article preview 

Research article *Open access*

Macrophage inflammatory protein-1 β as a novel therapeutic target for renal protection in diabetic kidney disease

Ting-Ting Chang, Szu-Yuan Li, Liang-Yu Lin, Ching Chen, Jaw-Wen Chen
Article 114450

 [View PDF](#) Article preview 

Research article *Open access*

Targeted EpCAM-binding for the development of potent and effective anticancer proteins

Zhao Liu, Chen Zhang, Beiming Cui, Yijie Wang, ... Chun Loong Ho
Article 114443

 [View PDF](#) Article preview 

Research article [Open access](#)

S-allylmercaptocysteine promotes anti-tumor immunity by suppressing PD-L1 expression

Jianxiong Zhao, Yueyue Sun, Peng Gao, Zhongxi Zhao, Guangwei Wei

Article 114446



[View PDF](#)

[Article preview](#)

Research article [Open access](#)

Comparison of the effects of ketoprofen and ketoprofen lysine salt on the Wistar rats' nervous system, kidneys and liver after ethyl alcohol intoxication

Joanna Kuczyńska, Barbara Nieradko-Iwanicka

Article 114456



[View PDF](#)

[Article preview](#)

Research article [Open access](#)

Identification of MAP Kinase Kinase 3 as a protein target of myricetin in non-small cell lung cancer cells

Ling Gu, Zhihui Li, Xiongfei Zhang, Meijuan Chen, Xu Zhang

Article 114460



[View PDF](#)

[Article preview](#)

Research article [Open access](#)

Combined and independent effects of OCT1 and CYP2D6 on the cellular disposition of drugs

Lukas Gebauer, Christof Dücker, Ole Jensen, Jürgen Brockmöller

Article 114454



[View PDF](#)

[Article preview](#)

Research article [Open access](#)

The protective effect of cannabinoids against colorectal cancer cachexia through modulation of inflammation and immune responses

Shang-Kok Ng, Dai-Jung Chung, Li-Chun Chang, Cong-Kai Luo, ... Tzu-Tang Wei

Article 114467



[View PDF](#)

[Article preview](#)

Research article [Open access](#)

Immunoregulatory effects of *Tetragium hemsleyanum* polysaccharide via TLR4-mediated NF- κ B and MAPK signaling pathways in Raw264.7 macrophages

Jiayuan Wu, Juanfen Mo, Wei Xiang, Xiaowen Shi, ... Li Zheng

Article 114471



[View PDF](#)

[Article preview](#)

Research article [Open access](#)

Diosmin mitigates dexamethasone-induced osteoporosis in vivo: Role of Runx2, RANKL/OPG, and oxidative stress

El-Shaimaa A. Arafa, Noran O. Elgendy, Mai A. Elhemely, Eglal A. Abdelaleem, Wafaa R. Mohamed

Article 114461



[View PDF](#)

[Article preview](#)

Research article [Open access](#)

Magnolol improves Alzheimer's disease-like pathologies and cognitive decline by promoting autophagy through activation of the AMPK/mTOR/ULK1 pathway

Xuechu Wang, Jianping Jia

Article 114473

 [View PDF](#) Article preview 

Research article [Open access](#)

Withania somnifera influences MDMA-induced hyperthermic, cognitive, neurotoxic and neuroinflammatory effects in mice

Giulia Costa, Marcello Serra, Riccardo Maccioni, Maria Antonietta Casu, ... Micaela Morelli

Article 114475

 [View PDF](#) Article preview 

Research article [Open access](#)

A second-generation artificial intelligence-based therapeutic regimen improves diuretic resistance in heart failure: Results of a feasibility open-labeled clinical trial

Ram Gelman, Noa Hurvitz, Rima Nesserat, Yotam Kolben, ... Yaron Ilan

Article 114334

 [View PDF](#) Article preview 

Research article [Open access](#)

Depletion of gut microbiota resistance in 5xFAD mice enhances the therapeutic effect of mesenchymal stem cell-derived exosomes

Xuejia Hou, Hongyu Jiang, Te Liu, Jun Yan, ... Jinlan Jiang

Article 114455

 [View PDF](#) Article preview 

Research article [Open access](#)

Melatonin protects retinal integrity through mediated immune homeostasis in the sodium iodate-induced mouse model of age-related macular degeneration

Li-Cheng Ku, Meei-Ling Sheu, He-Hsiung Cheng, Chun-Yi Lee, ... De-Wei Lai

Article 114476

 [View PDF](#) Article preview 

Research article [Open access](#)

Discovery of drug targets and therapeutic agents based on drug repositioning to treat lung adenocarcinoma

Occam Kelly Graves, Woonghee Kim, Mehmet Özcan, Sajda Ashraf, ... Xiangyu Li

Article 114486

 [View PDF](#) Article preview 

Research article [Open access](#)

Amelioration of lipopeptide biosurfactants for enhanced antibacterial and biocompatibility through molecular antioxidant property by methoxy and carboxyl moieties

Khushbu Kumari, Himadri Tanaya Behera, Priyadarshini Pratikshya Nayak, Adrija Sinha, ... Vishakha Raina

Article 114493

 [View PDF](#) Article preview 

Research article [Open access](#)

Ovatodiolide inhibits SARS-CoV-2 replication and ameliorates pulmonary fibrosis through suppression of the TGF- β /T β Rs signaling pathway

Wei-Chung Chiou, Guan-Jhong Huang, Tein-Yao Chang, Tzu-Lan Hsia, ... Cheng Huang

Article 114481

 [View PDF](#) Article preview 

Research article [Open access](#)

Interruption of TRPC6-NFATC1 signaling inhibits NADPH oxidase 4 and VSMCs phenotypic switch in intracranial aneurysm


Zheng-Hao Sun, Fei Liu, Liang-Liang Kong, Peng-Min Ji, ... Wei-Zu Li
Article 114480

 [View PDF](#) [Article preview](#) 

Research article [Open access](#)

Exogenous hydrogen sulfide (H₂S) exerts therapeutic potential in triple-negative breast cancer by affecting cell cycle and DNA replication pathway



Xiaoyue Cui, Rui Liu, Lian Duan, Qiaoling Zhang, ... Aijie Zhang
Article 114488

 [View PDF](#) [Article preview](#) 

Research article [Open access](#)

Machine learning for genetic prediction of chemotherapy toxicity in cervical cancer

Lu Guo, Wei Wang, Xiaodong Xie, Shuihua Wang, Yudong Zhang
Article 114518

 [View PDF](#) [Article preview](#) 

Research article [Open access](#)

Shouhui Tongbian Capsules induce regression of inflammation to improve intestinal barrier in mice with constipation by targeted binding to Prkaa1: With no obvious toxicity

Chenghong Sun, Yongkang Zhang, Mingfei Liu, Zhong Liu, ... Guimin Zhang
Article 114495

 [View PDF](#) [Article preview](#) 

Research article [Open access](#)

Effects of platelet-rich plasma glue placement at the prostatectomy site on erectile function restoration and cavernous nerve preservation in a nerve-sparing prostatectomy rat model

Chun-Hou Liao, Chi-Jen Chang, Kuo-Chiang Chen, Chellappan Praveen Rajneesh, ... Yi-No Wu
Article 114499

 [View PDF](#) [Article preview](#) 

Research article [Open access](#)

Phylloidalin improves hippocampal long-term potentiation in 5XFAD mice

Eunbi Cho, Se Jin Jeon, Jieun Jeon, Jee Hyun Yi, ... Dong Hyun Kim
Article 114511

 [View PDF](#) [Article preview](#) 

Research article [Open access](#)

Platelet lysate promotes hair growth: In vitro and in vivo mechanism and randomized, controlled trial

Qing Guan, Ze-hong Guo, Da-mao Dai, Zhe-xiang Fan, ... Qian Qu
Article 114517

 [View PDF](#) [Article preview](#) 

Research article [Open access](#)

Fully human monoclonal antibody targeting activated ADAM10 on colorectal cancer cells

Nayanendu Saha, Du-San Baek, Rachelle P. Mendoza, Dorothea Robev, ... Dimitar B. Nikolov
Article 114494

 [View PDF](#) [Article preview](#) 

Research article [Open access](#)

Piceatannol induces regulatory T cells and modulates the inflammatory response and adipogenesis

Ahmed Rakib, Mousumi Mandal, Anaum Showkat, Sonia Kiran, ... Udai P. Singh

Article 114514



[View PDF](#)

Article preview [v](#)

Research article [Open access](#)

Gleditsia sinensis Lam. aqueous extract attenuates nasal inflammation in allergic rhinitis by inhibiting MUC5AC production through suppression of the STAT3/STAT6 pathway

Myung-A Jung, Hyun-Kyung Song, Kyuhyung Jo, Ami Lee, ... Taesoo Kim

Article 114482



[View PDF](#)

Article preview [v](#)

[⏪ Previous vol/issue](#)

[Next vol/issue ⏩](#)

ISSN: 0753-3322

Copyright © 2023 Elsevier Masson SAS. All rights reserved



Copyright © 2023 Elsevier B.V. or its licensors or contributors.
ScienceDirect® is a registered trademark of Elsevier B.V.

RELX™



Natural sources, biological effects, and pharmacological properties of cynaroside

Abdelhakim Bouyahya^{a,*}, Douae Taha^b, Taoufiq Benali^c, Gokhan Zengin^d, Nasreddine El Omari^e, Naoufal El Hachlafi^f, Asaad Khalid^{g,h}, Ashraf N. Abdallaⁱ, Chrismawan Ardianto^j, Ching Siang Tan^{k,*}, Long Chiau Ming^{j,l,m}, Narjis Sahibⁿ

^a Laboratory of Human Pathologies Biology, Department of Biology, Faculty of Sciences, Mohammed V University in Rabat, Morocco

^b Laboratory of Spectroscopy, Molecular Modelling Materials, Nanomaterials Water and Environment–CERNE2D, Faculty of Sciences, Mohammed V University in Rabat, Morocco

^c Environment and Health Team, Polydisciplinary Faculty of Safi, Cadi Ayyad University, Marrakesh-Safi 46030, Morocco

^d Department of Biology, Science Faculty, Selcuk University, Konya 42250, Turkey

^e Laboratory of Histology, Embryology and Cytogenetic, Faculty of Medicine and Pharmacy, Mohammed V. University in Rabat, B.P. 6203, Rabat 10000, Morocco

^f Microbial Biotechnology and Bioactive Molecules Laboratory, Sciences and Technologies Faculty, Sidi Mohamed Ben Abdellah University, Fez B.P. 2626, Morocco

^g 7 Substance Abuse and Toxicology Research Center, Jazan University, Jazan 45142, Saudi Arabia

^h Medicinal and Aromatic Plants and Traditional Medicine Research Institute, National Center for Research, P.O. Box 2404, Khartoum, Sudan

ⁱ Department of Pharmacology and Toxicology, College of Pharmacy, Umm Al-Qura University, Makkah 21955, Saudi Arabia

^j Department of Pharmacy Practice, Faculty of Pharmacy, Universitas Airlangga, Surabaya 60115, Indonesia

^k School of Pharmacy, KPJ Healthcare University College, 71800 Nilai, Malaysia

^l PAPRSB Institute of Health Sciences, Universiti Brunei Darussalam, Gadong, Brunei Darussalam

^m School of Medical and Life Sciences, Sunway University, Sunway City 47500, Malaysia

ⁿ Laboratoire d'Amélioration des Productions Agricoles, Biotechnologie et Environnement (LAPABE), Faculté des Sciences, Mohammed Premier University, Oujda 60000, Morocco

ARTICLE INFO

Keywords:

Cancer cell
Diabetes
Infectious disease
Biological properties
Anticancer
Bioactive compound

ABSTRACT

Cynaroside is a flavonoid, isolated from several species belonging to the Apiaceae, Poaceae, Lamiaceae, Solanaceae, Zingiberaceae, Compositae and other families and it can be extracted from seeds, roots, stems, leaves, barks, flowers, fruits, aerial parts, and the whole plant of these species. This paper discloses the current state of knowledge on the biological/pharmacological effects and mode of action to better understand the numerous health benefits of cynaroside. Several research works revealed that cynaroside could have beneficial effects on various human pathologies. Indeed, this flavonoid exerts antibacterial, antifungal, antileishmanial, antioxidant, hepatoprotective, antidiabetic, anti-inflammatory, and anticancer effects. Additionally, cynaroside exhibits its anticancer effects by blocking MET/AKT/mTOR axis by decreasing the phosphorylation level of AKT, mTOR, and P70S6K. For antibacterial activity, cynaroside reduces biofilm development of *Pseudomonas aeruginosa* and *Staphylococcus aureus*. Moreover, the incidence of mutations leading to ciprofloxacin resistance in *Salmonella typhimurium* was reduced after the treatment with cynaroside. In addition, cynaroside inhibited the production of reactive oxygen species (ROS), which reduced the damage to mitochondrial membrane potential caused by hydrogen peroxide (H₂O₂). It also enhanced the expression of the anti-apoptotic protein Bcl-2 and lowered that of the pro-apoptotic protein Bax. Cynaroside abrogated the up-regulation of c-Jun N-terminal kinase (JNK) and p53 protein expression triggered by H₂O₂. All these findings suggest that cynaroside could be used to prevent certain human diseases.

* Corresponding author.

E-mail addresses: bouyahya@um5r.ac.ma (A. Bouyahya), douae.taha02@gmail.com (D. Taha), benali.taoufiq@gmail.com (T. Benali), gokhanzengin@selcuk.edu.tr (G. Zengin), nasrelomari@gmail.com (N. El Omari), naoufal.elhachlafi@usmba.ac.ma (N. El Hachlafi), akahmed@jazanu.edu.sa (A. Khalid), anabdrabo@uqu.edu.sa (A.N. Abdalla), chrismawan-a@ff.unair.ac.id (C. Ardianto), tcsiang@kpjuc.edu.my (C.S. Tan), longchiauming@gmail.com (L.C. Ming), n.sahib@ump.ac.ma (N. Sahib).

<https://doi.org/10.1016/j.bioph.2023.114337>

Received 18 November 2022; Received in revised form 19 January 2023; Accepted 27 January 2023

Available online 20 February 2023

0753-3322/© 2023 The Authors. Published by Elsevier Masson SAS. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

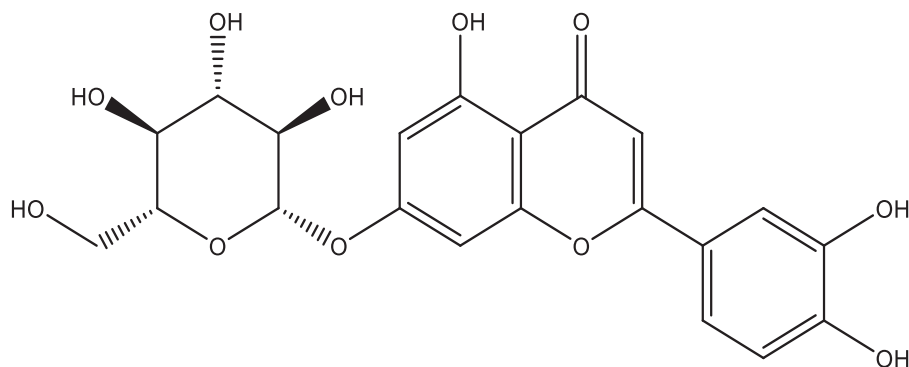


Fig. 1. Chemical structure of Cynaroside.

1. Introduction

Since antiquity, natural products have been used to prevent and treat pathologies of human health systems. The importance of these herbal products in human society has increased due to: i) low toxicity, ii) easy availability, and iii) fewer adverse effects than chemically synthesized drugs [1]. Several studies have demonstrated the bioactivity of plant extracts rich in polyphenols, flavonols, flavonoids, saponins, and carotenes [2–10]. This prompted researchers to isolate and identify the molecule responsible for the biological activities of plant extracts; thus several compounds such as morin, carvone, chalcones, chrysoeriol, grifolin, pinosylvin, quercetin, and others are tested for their biological properties, the results of which have shown that these molecules exert antioxidant, anti-free radical, anticancer, anti-inflammatory, antimicrobial, anti-arthritic, antidiabetic, neuroprotective, cardioprotective, hepatoprotective, and nephroprotective effects [11–24]. Currently, a large number of drugs based on natural compounds are available in the market such as morphine, cannabidiol, and taxal extracted from *Papaver somniferum*, *Cannabis sativa*, *Salix* spp., and *Taxus brevifolia* plants, respectively [25–28].

Cynaroside is a flavonoid compound widely found in plants belonging to the families Apiaceae, Poaceae, Lamiaceae, Solanaceae, Zingiberaceae, Compositae, and others. It has been described to have important pharmacological activities, including antibacterial [29–39], antifungal [30,32,33,36,38–40], antileishmanial [41], [31], antioxidant [35,42–48], hepatoprotective [49], [50], antidiabetic [46,51–53], anti-inflammatory [54–60], and anticancer effects [38], [61–64]. Moreover, cynaroside exhibits its anticancer effects by modulating various cell signaling pathways. Ji et al. [62] demonstrated that this flavonoid decreases the level of phosphorylation of AKT, mTOR, and P70S6K which causes a blockage of the MET/AKT/mTOR axis [62]. Regarding the antibacterial effect, cynaroside reduced biofilm development of *P. aeruginosa* and *Staphylococcus aureus* and increased the incidence of mutations leading to ciprofloxacin resistance in *Salmonella typhimurium* [38].

Despite the richness of the literature by research works, which have valorized the different biological activities of this molecule, to the best of our knowledge, no critical review has been performed to provide suggestions for potential future clinical trials of this bioactive compound. This paper aims to provide a comprehensive review of the natural reservoirs, chemistry, and pharmacological activities of cynaroside.

2. Source of cynaroside

Merremia tridentata (L.) stem and root extracts revealed that cynaroside is the major compound of this plant collected in Vietnam [51], as well as of *Cuminum cyminum* L. collected in China [65] and *Olea europaea* collected in Pakistan [66]. Cynaroside is the major compound of leaf extract of *Anthriscus sylvestris* (L.) Hoffm. harvested in Korea [67], the extract of *Vernonia amygdalina* collected in Vietnam [68], the extract of

Prunus pseudocerasus harvested in China [69], *Cymbopogon citratus* Stapf leaf extract harvested in Portugal [70], *Thymus migricus* leaf extract harvested in Turkey [71], *Cantharanthus roseus* and *Bryophyllum pinnatum* extracts collected in Nigeria [72], the extract of *Stachys lavandulifolia* Vahl. aerial parts from Iran [73], the extract of *Salvia tesquicola* and *Salvia verticillata* collected in regions of Russia [74], and *Bischofia javanica* leaf extract from Bangladesh [75]. It was found in leaf extracts of *Mentha piperita* and *Mentha longifolia* collected in regions of Saudi Arabia [42].

Cynaroside richness has also been recorded in other plant extracts, including *Capsicum annuum* seeds from Netherlands [76], aerial parts of *Launaea capitata* from Egypt [77], aerial parts of *Salvia dracocephaloides* Boiss. collected in Iran [78], *Canarium patentinervium* Miq. leaves and barks from Malaysia [79], *Ipinia blepharocalyx* K. seeds from Vietnam [80], the extracts of *Chrysanthemum morifolium* collected in Korea [81], and the leaves and the flowers of *M. longifolia* (L.) from Hungary [82,83].

Other extracts have also been characterized by the dominance of this component, such as those of the leaves and flowers of *Acantholippia salsoloides* from Portugal [84], the leaves of *Capsicum Cultivars* from Germany [85], of *Lavandula stoechas* collected in Greece [86], *Lonicera japonica* flos [87] and *Elsholtzia bodinieri* [55] from China, *Aronia melanocarpa* and *Aronia arbutifolia*, leaves and fruits of *Aronia prunifolia* collected in Poland [88], *Angelica keiskei* [63], *Salvia plebeia* R. Br. [89], and *Lonicera japonica* Thunb. [90,91] collected in Korea.

Indeed, cynaroside is the main compound of many plant extracts, such as the extracts of the aerial parts of *Bidens cernua* L. collected in Poland [40], the extract of *Lagotis integrifolia* (Willd.) Schischk from Mongolia [92], also of *Centaurea borysthena* and *Centaurea daghestanica* from Poland [93], *Artocarpus incisa* L. leaves from Vietnam [61], and *Gentianaella azurea* leaves and flowers collected in Russia [94].

This has also been observed with extracts of aerial parts of *Bidens tripartita* from Turkey [46], *B. tripartita* flowers from Poland [95,96], *C. citratus* leaves from Portugal [97], *L. japonica* Thunb. flowers from China [98], *L. japonica* flowers from China [99], extracts of *A. sylvestris* from Romania [100], *Carthamus tinctorius* L. flowers from Russia [101], *Tilia rubra* subsp. *Caucasica* leaves from Iran [102], *Centaurea scoparia* aerial parts from Egypt [103], and *A. sylvestris* (L.) aerial parts from Slovakia [38].

Furthermore, cynaroside is one of the major compounds of *Polygonum orientale* collected in China [104,105], *Veronica longifolia* L. stems from Ukraine [106], *Dracocephalum palmatum* Stephan extracts [107], *Sophora flavescens* Soland. aerial parts from Russia [108], *S. plebeia* leaves from Korea [109], *Agrimonia eupatoria* L. from Russia [110], as well as *Scutellaria immaculata* and *Scutellaria ramosissima* aerial parts and roots from Uzbekistan [32].

Cynaroside was isolated from *Salvia limbata* aerial part extracts from Iran [111], *Ixeris dentata* roots from Korea [112], *Sonneratia caseolaris* from Japan [113], *Melissa officinalis* L. from Turkey [114], aerial parts of *Halenia corniculata* L., *Pyrola rotundifolia* L., and *Pyrola incarnate* from Mongolia [57], *A. Keiskei* aerial parts from Korea [50], and *Thermopsis*

Table 1
Source of cynaroside

Plants Families	Countries	Parts used	References
<i>Merremia tridentata</i> (L.) Convolvulaceae	Vietnam	Stems and roots	[51]
<i>Cuminum cyminum</i> L. Apiaceae	China	Not reported	[65]
<i>Olea europaea</i> Oleaceae	Pakistan	Not reported	[66]
<i>Vernonia amygdalina</i> Asteraceae	Vietnam	Not reported	[68]
<i>Anthriscus sylvestris</i> (L.) Hoffm. Apiaceae	Korea	Leaves	[67]
<i>Prunus pseudocerasus</i> Rosaceae	China	Not reported	[69]
<i>Cymbopogon citratus</i> Stapf. Poaceae	Portugal	Leaves	[70]
<i>Thymus migricus</i> Lamiaceae	Turkey	Leaves	[71]
<i>Cantharanthus roseus</i> Crassulaceae	Nigeria	Not reported	[72]
<i>Bryophyllum pinnatum</i> Crassulaceae			
<i>Stachys lavandulifolia</i> Vahl. Lamiaceae	Iran	Aerial parts	[73]-
<i>Salvia tesquicola</i> Lamiaceae	Russia	Aerial parts (leaves and stems)	[74]
<i>Salvia verticillata</i> Lamiaceae			
<i>Bischofia javanica</i> Euphorbiaceae	Bangladesh	Leaves	[75]
<i>Mentha piperita</i> Lamiaceae	Saudi Arabia	Leaves	[132]
<i>Mentha longifolia</i> Lamiaceae			
<i>Capsicum annuum</i> Solanaceae	Netherlands	Seeds	[76]
<i>Launaea capitata</i> Asteraceae	Egypt	Aerial parts	[77]
<i>Salvia dracocephaloides</i> Boiss. Lamiaceae	Iran	Aerial parts	[78]
<i>Canarium patentinervium</i> Miq. Burseraceae	Malaysia	Leaves and barks	[79]
<i>Alpinia blepharocalyx</i> K. Zingiberaceae	Vietnam	Seeds	[80]
<i>Chrysanthemum morifolium</i> Asteraceae	Korea	Not reported	[81]
<i>Scutellaria baicalensis</i> Labiatae			
<i>Mentha longifolia</i> (L.) Lamiaceae	Hungary	Leaves and flowers	[82,83]
<i>Acantholippia salsoloides</i> Verbenaceae	Portugal	Leaves and flowers	[84]
<i>Capsicum Cultivars</i> Solanaceae	Germany	Leaves	[85]
<i>Lavandula stoechas</i> Lamiaceae	Greece	Not reported	[86]
<i>Lonicera japonica flos</i> Caprifoliaceae	China	Not reported	[87]
<i>Elsholtzia bodinieri</i> Lamiaceae	China	Not reported	[55]
<i>Aronia melanocarpa</i> Rosaceae	Poland	Leaves and fruits	[88]
<i>Aronia arbutifolia</i> Rosaceae			
<i>Aronia prunifolia</i> Rosaceae			
<i>Angelica keiskei</i> Apiaceae	Korea	Not reported	[90]
<i>Salvia plebeia</i> R. Br. Lamiaceae	Korea	Aerial parts	[89]
<i>Lonicera japonica</i> Thunb. Caprifoliaceae	Korea	Not reported	[90,91]

Table 1 (continued)

Plants Families	Countries	Parts used	References
<i>Lagotis integrifolia</i> (Willd.) Schischk Scrophulariaceae	Mongolia	Not reported	[92]
<i>Centaurea borysthena</i> Asteraceae	Poland	Not reported	[93]
<i>Centaurea daghestanica</i> Asteraceae			
<i>Bidens cernua</i> L. Asteraceae	Poland	Aerial parts	[40]
<i>Artocarpus incisa</i> L. Moraceae	Vietnam	Leaves	[61]
<i>Gentianella azurea</i> Gentianaceae	Russia	Leaves and flowers	[94]
<i>Bidens tripartita</i> Asteraceae	Turkey Poland	Aerial parts Flowers	[46] [96]
<i>Bidens tripartitus</i> Asteraceae	Poland	Not reported	[95]
<i>Cymbopogon citratus</i> Poaceae	Portugal	Leaves	[97]
<i>Lonicera japonica</i> Thunb. Caprifoliaceae	China	Flowers	[98]
<i>Lonicera japonica</i> Caprifoliaceae	China	Flowers	[99]
<i>Anthriscus sylvestris</i> Apiaceae	Romania	Not reported	[100]
<i>Carthamus tinctorius</i> L. Asteraceae	Russia	Flowers	[101]
<i>Tilia rubra</i> subsp. <i>Caucasica</i> Tiliaceae	Iran	Leaves	[102]
<i>Centaurea scoparia</i> Asteraceae	Egypt	Aerial parts	[133]
<i>Anthriscus sylvestris</i> (L.) Apiaceae	Slovakia	Aerial parts	[38]
<i>Polygonum orientale</i> Polygonaceae	China	Not reported	[104,105]
<i>Veronica longifolia</i> L. Scrophulariaceae	Ukraine	Stems	[106]
<i>Dracocephalum palmatum</i> Stephan. Lamiaceae	Not reported	Not reported	[108]
<i>Sophora flavescens</i> Soland. Fabaceae	Russia	Aerial parts	[107]
<i>Salvia plebeia</i> Labiatae	Korea	Leaves	[109]
<i>Agrimonia eupatoria</i> L. Rosaceae	Russia	Not reported	[110]
<i>Scutellaria immaculata</i> Lamiaceae	Uzbekistan	Aerial parts and roots	[32]
<i>Scutellaria ramosissima</i> Lamiaceae			
<i>Salvia limbata</i> Lamiaceae	Iran	Aerial parts	[111]
<i>Ixeris dentata</i> Asteraceae	Korea	Roots	[112]
<i>Sonneratia caseolaris</i> Sonneratiaceae	Japan	Not reported	[113]
<i>Melissa officinalis</i> L. Labiatae	Turkey	Not reported	[114]
<i>Halenia corniculata</i> L. Gentianaceae	Mongolia	Aerial parts	[57]
<i>Pyrola rotundifolia</i> L. Ericaceae			
<i>Pyrola incarnate</i> Ericaceae			
<i>Angelica Keiskei</i> Apiaceae	Korea	Aerial parts	[50]
<i>Thermopsis altherniflora</i> Fabaceae	Uzbekistan	Not reported	[115]
<i>Cynara scolymus</i> L. Asteraceae	Portugal Vietnam Not reported Egypt Bulgaria Italy	Not reported Leaves Leaves Not reported Leaves and seeds	[116] [61] [117] [118] [119] [120]

(continued on next page)

Table 1 (continued)

Plants Families	Countries	Parts used	References
		Leaves, outer bracts, heads, and stems	
	Brazil	Leaves	[121]
	Germany		[122]
	United States		[123]
	Austria		[124]
	Germany	Not reported	[125]
	Egypt	Seeds	[126]
	Italy	Whole plants	[127]
<i>Digitalis ciliata</i> Plantaginaceae	Not reported	Leaves	[128]
<i>Symphandra pendula</i> Campanulaceae	Not reported	Leaves and flowers	[129]
<i>Phlomis tuberosa</i> (L.) Labiatae	Russia	Leaves and fruits	[130]

altherniflora from Uzbekistan [115],

Cynaroside is the major compound of *Cynara scolymus* L. extracts from many parts of plants and regions such as Portugal [116], plant leaves from Vietnam [61], [117], and Egypt [118], plant leaves and seeds from Bulgaria [119], leaves, outer bracts, flower heads, and stems from Italy [120], *C. Scolymus* L. leaves from Brazil [121], plant leaves from Germany [122], [125], United States [123], and Austria [124], as well as seeds from a plant collected in Egypt [126], and the whole plant with various parts collected in Italy [127].

Cynaroside has also been recorded in other plant extracts, *Digitalis ciliata* leaves [128], *Symphandra pendula* Leaves and flowers [129], and *Phlomis tuberosa* (L.) leaves and fruits from Russia [130].

We can conclude that this molecule is chemotype although most of the plants with cynaroside as main constituent correspond to the Asteraceae/Compositae family [46,61,68,77,81,95,96,101,103,112,116–127,131], the Lamiaceae family [32,55,71,73,74,78,82,83,89,108,111,132] and Apiaceae family [38,50,65,67,90,100].

Cynaroside (Fig. 1) is a flavone widely present in plants (Table 1). It is called by various names (Luteolin-7-O-glucoside, Luteoloid, Cinaroside).

3. Extraction, identification, and isolation process of cynaroside

As shown in Table 2, several research groups have isolated and purified cynaroside from a variety of medicinal plants.

Spectroscopic techniques such as UPLC-Q-TOF-MS, and elemental analysis have been used to elucidate the structure of cynaroside isolated and purified from *C. cynimum* L. extract [65], and also from *T. migricus* leaves obtained by the methods of maceration [71], HPLC-PDA-ESI/MSn and ¹H NMR of *Cymbopogon citratus* Stapf. [70] were been used to elucidate this molecule from *Stachys lavandulifolia* Vahl. with ¹H NMR, ¹³C NMR, and UV spectral analysis [73], *M. piperita* and *M. longifolia* used HPLC-DAD [132], *C. annuum* seed extract [77].

It was by-product from *S. dracocephaloides* Boiss. obtained with the maceration method using ¹H and ¹³C NMR [78], *A. blepharocalyx* K. using MS, IR, and NMR analysis [80], *M. longifolia* (L.) leaves and flowers obtained with soxhlet, maceration, and ultrasonic using the HPLC-DAD method [82], *C. morifolium* and *Scutellaria baicalensis* using LC-MS/MS [81], *A. salsoloides* using Ion-trap mass spectrometry with flame ionization detection via gas chromatography [84] *C. Cultivars* [85], *L. stoechas* [86], *L. japonica* flos [87], leaves and fruits of *A. melanocarpa*, *A. arbutifolia*, and *A. prunifolia* using HPLC-DAD [88].

Cynaroside eluted from *E. bodinieri* by HPLC, ESI-MS, and NMR [55], *S. plebeia* R. Br. [89], *L. integrifolia* (Willd.) Schischk obtained with soxhlet method using MS, ¹H, ¹³C, HSQC, HMBC, and ¹H-1 H COSY NMR [92], *C. Scolymus* L. [116,117,120,123,124,126] *C. citratus* [97], *G. azurea* [94], *B. tripartita* [46], from leaves of *T. rubra* subsp. *Caucasica*

obtained by maceration using UV, ¹H NMR, and ¹³C NMR [102], flowers of *C. tinctorius* L. [101], and *L. japonica* [99]. The complete interpretation of ¹D and ²D NMR, UV, IR, and mass spectroscopy allowed the identification of cynaroside in *C. scoparia* aerial part extracts obtained by maceration [103], *A. sylvestris* (L.) [38], *P. orientale* [104,105], *D. palmatum* Stephan. [107], *S. flavescens* Soland. using ¹H and ¹³C NMR [108], aerial parts and roots of *S. immaculata* and *S. ramosissima* [32], *S. limbata* [111], from *B. tripartita* L. flowers obtained by maceration using HPLC analysis [96], *H. corniculata* L., *P. rotundifolia* L., *P. incarnate* [57], and *D. ciliata* [128], from leaves and fruits of *P. tuberosa* (L.) using IR spectrum [130].

4. Biological properties

4.1. Antibacterial activity

Several investigations have tested the antimicrobial effects of cynaroside in their various solvent forms, including acetone, ethanol, methanol, hexane, and ethyl acetate from a wide range of plant species [29–39]. As summarized in Table 3, from the literature, the antibacterial potential of cynaroside (effective against both Gram-positive and Gram-negative bacteria) was detailed according to the plants of origin, antibacterial assay, tested strains, and the main results. Indeed, Žemlička et al. [38] extracted cynaroside from the aerial parts of wild chervil, *A. sylvestris* (L.) Hoffm. The results of antibacterial activity test against *S. aureus*, *Staphylococcus epidermidis*, *Streptococcus pyogenes*, *Bacillus cereus*, *Escherichia coli*, *Serratia marcescens*, *Proteus* sp., *S. typhimurium*, and *P. aeruginosa* showed inhibition effect only on *S. marcescens* and *S. typhimurium*. Additionally, the cynaroside suppresses the increased incidence of mutations leading to ciprofloxacin resistance in *S. typhimurium* and promotes biofilm development of *P. aeruginosa* and *S. aureus*. Zhu et al. [39] used the dried leaves of *C. scolymus* extracted with 75% ethanol. Cynaroside's antimicrobial properties were tested using the diffusion technique at a concentration of 10.0 mg/mL of the extract, and it was shown to have an antibacterial effect on all bacteria tested. Indeed, *Bacillus subtilis*, *S. aureus*, *Agrobacterium tumefaciens*, *Micrococcus luteus*, *E. coli*, *S. typhimurium*, and *P. aeruginosa* were sensitive to cynaroside with MIC values of 100, 50, 200, 200, 200, 200, and 100 µg/mL, respectively.

In contrast, the Akroum et al. [29] studied the antibacterial activity of cynaroside isolated from *M. longifolia* methanolic and ethanolic extracts against certain clinical bacteria. The ethanolic extract was more active than the methanolic extract. However, it showed no growth inhibition against *E. coli* and *P. aeruginosa*. While the minimal inhibitory concentrations (MICs) for the strains tested using the ethanolic extracted were 0.070, 0.095, and 0.050 mg/mL for *S. aureus*, *B. cereus*, and *B. subtilis*, respectively. *In vitro*, the study of Mamadalieva et al. [32] demonstrate that the cynaroside from *S. immaculata* and *S. ramosissima* exerts antibacterial effectiveness against various types of bacteria tested including *E. coli* ATCC 25922, *P. aeruginosa* ATCC 27853, *Staphylococcus pyogenes* ATCC 12344, Methicillin-resistant *Staphylococcus aureus* (MRSA), and *S. aureus* NTCC 10442 with equal MIC values of 0.5 mM. Confirmed by the study of Xiong et al. [37], the antibacterial activity of cynaroside isolated from *L. japonica* leaves was demonstrated against *S. aureus* and *E. coli*. Indeed, the diameters of inhibition zone against *E. coli* and *S. aureus* are 22.9 ± 0.2 mm and 27.4 ± 0.4 mm, respectively. In fact, the cynaroside was the most common constituent in half of the samples EE in the extract of *Chimonanthus salicifolius* S. Y. Hu. [36] improving the sensitivity of bacteria such as *E. coli* (MIC=2.8 µg/mL), *S. aureus* (MIC=317.5 µg/mL), and *B. subtilis* (MIC=1250 µg/mL). Cynaroside purified from the ethanol extract of *Youngia japonica* was also isolated by Ooi et al. [33] and studied for its antibacterial effect against *Vibrio cholera*, *Vibrio parahaemolyticus*, *B. cereus*, *S. aureus*, *P. aeruginosa*, and *S. typhimurium*. The results showed that this molecule inhibits strain growth with an inhibition zone diameter of 0.7 and 0.8 mm against *V. cholera* and *V. parahaemolyticus*, respectively, while

Table 2
Extraction, identification, and isolation process of cynaroside.

Plants Families	Parts used	Extraction methods	Extraction and isolation parameters	Identification and isolation methods	References
<i>Cuminum cyminum</i> L. Apiaceae	Not reported	Not reported	Not reported	UPLC-Q-TOF-MS	[65]
<i>Thymus migricus</i> Lamiaceae	Leaves	Maceration	Plants were extracted using both water and methanol <i>Thymus migricus</i> water extract is prepared by combining 20 g of the powdered air-dried leaves of the plant with 200 mL of distilled water For 12 h, it was filtered and stirred at room temperature A lyophilizer was used to lyophilize the filtrate at 5 mmHg and 50 °C 20 g of air-dried <i>Thymus migricus</i> leaves were ground into a powder and combined with 200 mL of methanol to create <i>Thymus migricus</i> methanol extract For 12 h, it was stirred at room temperature before being filtered Rotary evaporators were used to evaporate the filtrate (Heidolph 94200)	LC-MS/MS	[71]
<i>Cymbopogon citratus</i> Stapf. Poaceae	Leaves	Infusion	Not reported	HPLC-PDA-ESI/MSn and ¹ H NMR	[70]
<i>Stachys lavandulifolia</i> Vahl. Lamiaceae	Aerial parts	Maceration	At room temperature, 0.5 kg of shade-dried and ground plant aerial parts were macerated in methanol-water (7:3) (38 L each) The concentrated hydroalcoholic extract was diluted with water and then liquid-liquid fractionated using chloroform and n-butanol The fractions were then dried at 45 °C in a low-pressure rotary evaporator	¹ H NMR, ¹³ C NMR, and UV spectral analysis	[73]-
<i>Mentha piperita</i> Lamiaceae	Leaves	Not reported	Not reported	HPLC-DAD	[132]
<i>Mentha longifolia</i> Lamiaceae					
<i>Capsicum annuum</i> Solanaceae	Seeds	Not reported	Not reported	HPLC	[76]
<i>Launaea capitata</i> Asteraceae	Aerial parts	Maceration	Air-dried aerial portions of <i>Launaea capitata</i> ground to a fine powder The sample (500 g) was transferred to a suitable container and soaked using pure methanol and the eluate was concentrated <i>in vacuo</i> to obtain 18.37 g of the crude extract Using the gradient elution method, thin layer chromatography (TLC), and high performance liquid chromatography (HPLC), the residue was separated on a silica gel column After loading the extract (4.0 g) onto a silica gel chromatography column (2.5 × 60 cm), it was eluted with methylene chloride followed by a linear gradient of methylene chloride and methanol to 100% MeOH	¹ H and ¹³ C NMR	[77]
<i>Salvia dracocephaloides</i> Boiss. Lamiaceae	Aerial parts	Maceration	We used the maceration technique to extract powder from 300 g of air-dried <i>Salvia dracocephaloides</i> aerial parts in three and a half liters of methanol water (8:2) The crude extract (71.68 g) was divided into water (1 L) and organic solvents (31 L) in order of increasing polarity; n-hexane, chloroform, ethyl acetate, and n-butanol The solvent was then evaporated using a rotary evaporator The organic layers were condensed while the residual water portion was frozen at – 20 °C	¹ H and ¹³ C NMR	[78]
<i>Alpinia blepharocalyx</i> K. Zingiberaceae	Seeds	Maceration	At room temperature, 9.0 kg were macerated with methanol (3 × 20 L) to extract the desired substance A crude methanol extract was obtained by evaporating the solvent extract at low pressure between 40 and 50 °C (950 g) Hexane, ethyl acetate, and butanol were then used in a liquid-liquid extraction technique to separate the crude methanol extract Three crudes were produced when the solvent was	MS, IR, and NMR	[80]

(continued on next page)

Table 2 (continued)

Plants Families	Parts used	Extraction methods	Extraction and isolation parameters	Identification and isolation methods	References
<i>Mentha longifolia</i> (L.) Lamiaceae	Leaves and flowers	Soxhlet, maceration, and ultrasonic	recovered at low pressure: crude hexane (20 g), crude ethyl acetate (345 g), crude butanol (189 g), and crude water (126 g) The ethyl acetate crude was isolated by silica gel column chromatography (CC) with hexane/ethylacetate step gradient system (100/1 – 0/1, v/v) to yield eight fractions Compound 1 was obtained by further separating the eluted hexane/acetone (10/1, v/v) eluted fraction (9.8 g) by CC and purifying it by preparative HPLC (12 mg) Six subfractions were obtained from the initial fraction (43 g) by CC eluting with a hexane/ethyl acetate solvent mixture of 15/1 Methanol, a 7:3 ethanol and water combination, and water were used as solvents Metabolites were separated chromatographically using an ACQUITY UPLC® BEH C18 column (2.1 150 mm, 1.7 m) with water (mobile phase A) and acetonitrile with 0.1% formic acid (mobile phase B) at 40 °C Holding for 0.5 min the starting gradient composition of 95% A/5% B, increasing to 80% B in 10 min, decreasing to 0% A in 10.01 min, and holding for 1.90 min	HPLC-DAD method	[82]
<i>Chrysanthemum morifolium</i> Compositae	No reported	Decoction	Not reported	LC-MS/MS	[81]
<i>Scutellaria baicalensis</i> Labiatae					
<i>Acantholippia salsoides</i> Verbenaceae	Leaves and flowers	Infusion	Not reported	Ion-trap mass spectrometry with flame ionization detection via gas chromatography	[84]
<i>Capsicum Cultivars</i> Solanaceae	Leaves	Not reported	Not reported	HPLC-MS	[85]
<i>Lavandula stoechas</i> Lamiaceae	Not reported	Not reported	Not reported	HPLC/ESI-MS	[86]
<i>Lonicera japonica flos</i> Caprifoliaceae	Not reported	Not reported	Not reported	HPLC	[87]
<i>Aronia melanocarpa</i> Rosaceae	Leaves and fruits	Not reported	Air dried sample sizes (0.5 g) were taken from stems and leaves harvested at the end of three separate 4-week growth cycles A modified HPLC-DAD technique was used to estimate the levels of the polyphenols under investigation These are the test conditions: Mobile phase: A-methanol: 0.5% acetic acid (1:4 v/v); B-methanol (gradient program); flow rate: 1 mL min ⁻¹ ; injection volume: 10 l; detection wavelength: 254 nm; analytical column: Purospher RP-18e; 4 mm 250 mm 5 mL; Merck)	HPLC-DAD	[88]
<i>Aronia arbutifolia</i> Rosaceae					
<i>Aronia prunifolia</i> Rosaceae					
<i>Elsholtzia bodinieri</i> Lamiaceae	Not reported	Not reported	Not reported	HPLC, ESI-MS, and NMR	[55]
<i>Salvia plebeia</i> R. Br. Lamiaceae	Aerial parts	Maceration	Powder (1.0 g) was suspended in extract solvents (methanol: water: formic acid, 50:45:5, v/v/v for flavonoids and methanol: water: formic acid, 80:15:5, v/v/v for phenolic acids) containing the internal standard, and the mixture was extracted for 5 min at 200 rpm on an orbital shaker The mixture was centrifuged at 4 °C for 10 min at 3000 rpm Each supernatant was filtered using a 0.2 µm polyvinylidene fluoride (PVDF) syringe filter (Whatman, Kent, England), and then 0.5 mL of phenolic extract was mixed with 4.5 mL of water to make 5 mL of a phenolic-containing crude extract Finally, the phenolic concentration was separated from the crude extract using the solid phase extraction technique using a Sep-pak C18 cartridge (Waters Co., Milford, MA, USA) Sep-pak cartridges were conditioned with 2 mL of water, then activated with 2 mL of methanol After the flavonoid extract was diluted, it was placed into a cartridge and washed with 2 cc of	UPLC-DAD-QTOF/MS	[89]

(continued on next page)

Table 2 (continued)

Plants Families	Parts used	Extraction methods	Extraction and isolation parameters	Identification and isolation methods	References
<i>Lagotis integrifolia</i> (Willd.) Schischk Scrophulariaceae	Not reported	Soxhlet	water to eliminate contaminants. We next used 3 mL of methanol to elute the cartridge and recover the whole phenolic mixture Dried and powdered plant material (600 g) was extracted six times with 1 L 70% EtOH using the Soxhlet equipment, and the combined extract was concentrated under decreased pressure The residue was first suspended in H ₂ O, then split into four 0.5 L volumes of hexane, chloroform, ethyl acetate, and butanol The ethyl acetate extract (6.4 g) was subjected to chromatography on silica gel and eluted with chloroform/methanol (100:1→1:1) Fractions containing similar content was combined and concentrated The E-1 compound was isolated with 10 mg yield	MS, ¹ H, ¹³ C, HSQC, HMBC, and ¹ H-1 H COSY NMR	[92]
<i>Cynara scolymus</i> L. Asteraceae	Leaves	Decoction Ultrasonic	Not reported The leaves of a frozen artichoke were pulverized using a mortar and a pestle and some liquid nitrogen Following 30 min in an ultrasonic bath, the powder (20 mg) was homogenized with 4 mL 60% MeOH containing 10 g/mL umbelliferone (as internal standard) The extracts were then filtered through a 22 mL Millipore filter after being vortexed and centrifuged at 10,000 g for 10 min to get rid of any remaining plant debris	RP-HPLC-DAD UHPLC-PDA-MS	[116] [117]
	Leaves, outer bracts, heads, and stems	Maceration	Not reported	HPLC-DAD and HPLC-MS	[120]
	Leaves	Infusion	Two extractions of 300 g of dried Green Globe artichoke heads each in 2000 mL of 70% methanol were performed Under vacuum, the extract was concentrated until dry, and then the residue was mixed with water (300 mL) and chloroform (3 × 300 mL) to be separated The water layer was then extracted thrice using ethyl acetate (3 × 300 mL) and n-butanol (3 300 mL) in that order	MS and NMR ¹ H NMR and ¹³ C NMR	[123]
	Leaves	Ultrasonic	The 80 mg of dried extract used in the quantification tests was dissolved in 2.00 mL of methanol solution containing 15% (v/v) water using a sonicator for 5 min Before injection, each solution was filtered through 0.45 μm cellulose acetate membrane filters (Sartorius, Göttingen, Germany)	HPLCMS and by 1D and ² D NMR	[124]
<i>Cymbopogon citratus</i> Poaceae	Seeds	Not reported	Not reported	Ultra-voilet absorption spectra	[126]
	Leaves	Infusion	150 mL of boiling water were added to 5 g of dried leaves were ground into a powder and then steeped in boiling water for 15 min The polyphenol-rich fractions follow	HPLC-PDA-ESI/MSn	[97]
<i>Gentianella azurea</i> Gentianaceae	Leaves and flowers	Maceration	Air-dried, ground herb of <i>Gentianella azurea</i> (sample GaH3; 1.7 kg) was extracted with 70% EtOH (60 °C, ×3), and the combined extracts were partitioned with CHCl ₃ (Ga-F1, 108.3 g), EtOAc (Ga-F2, 159.8 g), and n-BuOH (Ga-F3, 283.9 g), respectively	HPLC	[94]
<i>Bidens tripartita</i> Asteraceae	Aerial parts	Maceration	For the LC-MS and HPLC analyses, we employed chromatographic grade double-distilled water, analytical grade trifluoroacetic acid, and HPLC grade methanol and acetonitrile	LC-MS and HPLC analysis	[46]
<i>Tilia rubra</i> subsp. <i>Caucasica</i> Tiliaceae	Leaves	Maceration	Macerating powdered, shade-dried leaves (170 g) in a solution of 80% methanol in water (5 × 1 L) yielded a complete hydroalcoholic extract After defatting the whole extract using sufficient amounts of petroleum ether and chloroform, it was concentrated using a rotary evaporator at 45 °C	UV, ¹ H NMR, and ¹³ C NMR	[102]
<i>Carthamus tinctorius</i> L. Asteraceae	Flowers	Infusion	The August 2013 harvest of 100 g of air-dried safflower flowers was subjected to three extractions with 70% EtOH: the first two took place at room temperature for 24 h each, while the third was conducted in a boiling water bath for 30 min	¹ H NMR-, UV-spectroscopy, and mass spectrometry	[101]

(continued on next page)

Table 2 (continued)

Plants Families	Parts used	Extraction methods	Extraction and isolation parameters	Identification and isolation methods	References
<i>Lonicera japonica</i> Caprifoliaceae	Flowers	Soxhlet and ultrasonic	<p>Evaporating the water-alcoholic extract under vacuum reduced the volume to 50 mL, which was then combined with 30 g of silica gel L 40/100 and dried</p> <p>A powdered version of a chloroform solution (dried extract with silica gel), applied to a silica gel layer (5 cm in height and 8 cm in diameter) CHCl₃ and CHCl₃-EtOH mixtures of varying concentrations were used to elute the chromatographic column (99:1; 98:2; 97:3; 95:5; 93:7; 90:10; 85:15; 80:20; 70:30, 60:40, 50:50) TLC analysis was used to track progress in 100-mL increments (Sorbfil PTLC-AF-A-UV, solvent systems CHCl₃-EtOH, 9:1; CHCl₃-EtOH-H₂O, 26:16:3; and n-butanol-glacial acetic acid-water, 4:1:2)</p> <p>Precipitate from compound 1 that had fallen into one of the mixed fractions was collected, and then the compound was crystallized from EtOH water</p> <p>1 g of dried plant material was rehydrated in fifty milliliters of 70% (v/v) ethanol over the course of 24 h</p> <p>The sample was then transferred to a clean polyethylene bag</p> <p>After bringing the extracts to room temperature, they were centrifuged at 2000 rpm for 5 min, and the resulting supernatants were combined and kept at 4 °C for later HPLC analysis</p>	HPLC-DAD	[99]
<i>Centaurea scoparia</i> Asteraceae	Aerial parts	Maceration	<p>At room temperature, 5 kg of dried, powdered <i>Centaurea scoparia</i> leaves and stems were extracted four times (10 L each) with 70% EtOH</p> <p>The combined extracts' solvent was evaporated under reduced pressure at a temperature no higher than 40 °C until dry, yielding a crude residue of 275 g</p> <p>This was then partitioned three times with one liter each of hexane, ethyl acetate, and n-butanol to produce 70 g of hexane, 50 g of ethyl acetate, and 30 g of n-butanol (75 g)</p> <p>A column (150 × 4 cm) packed with 600 g of polyamide 6 S was used to fractionate the ethyl acetate extract</p> <p>The elution gradient began with water and progressed through a series of progressively less polar H₂O/EtOH solutions (10: 0, 9: 1, 8: 2, 7: 3, 6: 4, 5: 5, 4: 6, 3: 7, 2: 8, 1: 9, and 0: 10)</p>	1D and ² D NMR, UV, IR, and mass spectroscopy	[103]
<i>Anthriscus sylvestris</i> (L.) Apiaceae	Aerial parts	Not reported	Not reported	The use of ¹ H, ¹³ C, attached proton test (APT), heteronuclear single quantum correlation (HSQC), and heteronuclear multiple bond correlation (HMBC) NMR spectroscopy, as well as EPR spectroscopy	[38]
<i>Polygonum orientale</i> Polygonaceae	Not reported	Not reported Infusion	<p>Not reported</p> <p>Extraction solutions were mixed, filtered, concentrated under decreased pressure, and ethanol was precipitated from dried <i>Polygonum orientale</i> that had been refluxed with boiling water (3 times, 1:10, w/v) for 1 h</p> <p>Precipitate was discarded after ethanol was extracted at low pressure</p> <p>Four times, residue was dissolved in water and extracted with n-butanol (2:1, v/v) to get an extract with a concentration of 1 g/mL</p> <p>After removing the nbutanol at a lower pressure, the residue was dissolved in 80% ethanol, put onto a polyamide column, and then eluted with the same solvent</p> <p>The <i>Polygonum orientale</i> extract was obtained by drying the plant under low pressure</p>	UPLC-ESI-MS/MS UPLC-MS/MS	[134] [104]
<i>Dracocephalum palmatum</i> Stephan. Lamiaceae	No reported	Not reported	<p>A 60% EtOH extract of the <i>Dracocephalum palmatum</i> plant was partitioned with CHCl₃, EtOAc, and n-BuOH to obtain three fractions, which were separated by CC (gel permeation, normal phase silica gel (NP-SiO₂) and reverse phase silica gel (RP-SiO₂), XAD, polyamide chromatography), preparative (prep)</p>	HPLC-UV	[107]

(continued on next page)

Table 2 (continued)

Plants Families	Parts used	Extraction methods	Extraction and isolation parameters	Identification and isolation methods	References
<i>Sophora flavescens</i> Soland. Fabaceae	Aerial parts	Infusion	Subterranean component (raw material no. Tsh0702) Five times in a boiling water bath, the powdered raw material (400 g) was extracted with 70% EtOH (1:15) Liquid-phase extraction with C ₆ H ₁₄ , CHCl ₃ , and EtAc was performed on the water residual after the alcohol fraction had been concentrated there Hexane (at 5.28 g, 1.32% of the air-dried raw material mass), chloroform (at 26.24 g, 6.56%), ethylacetate (at 5.92 g, 1.48%), and water (at 117.68 g, 29.42%) were the resulting fractions After separating the chloroform fraction (20 g) using CC on SiO ₂ (3 40 cm) in a hexan EtAc (100: 0 60: 40) gradient system, the resultant fractions were rechromatographed on Sephadex LH20 (2 × 50 cm) in a CHCl ₃ EtOH (100: 0 85: 15) system, and preparative TLC was performed (solvent systems 1 and 2)	¹ H and ¹³ C NMR	[108]
<i>Scutellaria immaculata</i> Lamiaceae <i>Scutellaria ramosissima</i> Lamiaceae	Aerial parts and roots	Maceration	The final concentration of all samples was 20 mg per 1 mL of methanol Rheodyne injectors were used with the HPLC system (Merck-Hitachi L-6200A) (20 mL loop) A 5 mm RP-C18e LichroCART 250–4 column was used for separation (Merck, Darmstadt, Germany). A) HPLC grade water from VWR (Fontenay-Sous-Bois, France) containing 0.5% formic acid (Merck (Darmstadt, Germany)), and B) acetonitrile made up the mobile phase (J. T. Backer, Deventer, Holland) For the methanol and chloroform fractions, the gradient program ran from 0% to 50% B in 50 min, and then to 100% in 5 min; for the water fraction, the program ran from 0% to 25% B in 50 min, and then to 100% in 5 min	LC-MS	[32]
<i>Salvia limbata</i> Lamiaceae	Aerial parts	Maceration	<i>Salvia limbata</i> (836 g) dried aerial parts were chopped into pieces and extracted with ethyl acetate and methanol at room temperature Hexane: acOEt (19:1, 9:1, 1:1, 0:1) was used in silica gel CC on the ethyl acetate extract (38.4 g) to produce nine fractions (A–I) After passing 1 g of fraction G through silica gel CC in a 1:1 hexane: acOEt mixture, we obtained five different fractions (G1–G5) After submitting fraction G5 to sephadex LH20 CC using methanol as the eluent, we were able to isolate pure component 1. (235 g) Pure compounds 2, 3, 4, and 5 were obtained by passing Fraction H through sephadex LH20 CC twice using AcOEt: MeOH (1: 4) as eluent (5.5 mg)	¹ H- and ¹³ C NMR	[111]
<i>Bidens tripartita</i> L. Asteraceae	Flowers	Maceration	2 g of dried, powdered plant material was extracted using petrol (5 × 50 mL) and chloroform (5 × 50 mL) in that order Second, 6 × 50 mL of 70% methanol was added to the plant remains and heated at a reflux for 2 h After evaporating the mixed extracts until dry, they were redissolved in 20 mL of 40% methanol containing 0.5% ortho-phosphoric acid An aliquot (20 L) was injected onto the HPLC column after a 5 mL sample of the solution was filtered via a Chromafil O-45/25 (PTFE 25 mm, 0.45 m, Macherey-Nagel, Germany)	HPLC analysis	[96]
<i>Halenia corniculata</i> L. Gentianaceae <i>Pyrola rotundifolia</i> L. Ericaceae <i>Pyrola incarnate</i> Ericaceae	Aerial parts	Not reported	All flavonoids were isolated from the ethylacetate fraction of the related plants according to the general procedure for the isolation of phenolic compounds from plant origins The purification of isolated compounds was done by CC and crystallization from methanol or ethanol following the determination of purity by TLC on pre-coated Silicagel 60 F 254 aluminium sheets gradually spraying with 1% of methanol diphenylboric acid-β-ethylamino ester (NP) and 5% of ethanol poly	¹³ C NMR	[57]
<i>Digitalis ciliata</i> Plantaginaceae	Leaves	Not reported	Not reported	NMR and mass spectroscopy	[128]

(continued on next page)

Table 2 (continued)

Plants Families	Parts used	Extraction methods	Extraction and isolation parameters	Identification and isolation methods	References
<i>Phlomis tuberosa</i> (L.) Labiatae	Leaves and fruits	Not reported	Not reported	IR spectrum	[130]

no inhibition was exerted against *B. cereus*, *S. aureus*, *P. aeruginosa*, and *S. typhimurium*. The *Echium arenarium* plant was also used as a plant source for cynaroside extraction. Kefi et al. [31] studied *in vitro* its antibacterial activity against *Listeria monocytogenes* (ATCC 19115), MRSA ATCC 2592, *Salmonella*, *E. coli*, *S. aureus* (ATCC 29212), *B. cereus* (ATCC 14579), *P. aeruginosa* (ATCC 27853), *E. coli* (ATCC 35214), and *Klebsiella pneumoniae* (CIP 104727). The MIC of *E. arenarium* cynaroside extract were 1000 µg/mL for *L. monocytogene*; 62 µg/mL for both MRSA; 125 µg/mL for *S. aureus*, 500 µg/mL for both *Enterococcus faecalis* and *B. cereus* MIC= 500 ug/mL, while it was above 1000 µg/mL for *P. aeruginosa*, *E. coli*, and *K. pneumoniae*.

Salawu et al. [34] examined the antibacterial effects of *V. amygdalina* phenolic extracts. The phenolic compound was characterized by reversed phase HPLC/DAD/MS. Luteolin, luteolin 7-*O*-glucoside (cynaroside), and luteolin 7-*O*-glucuronide were the most important chemicals found in *V. amygdalina*, with the latter being the most abundant flavonoid. The powdered sample was extracted with ethanol-water (7/3) and filtered. Additionally, *B. cereus*, *E. coli*, *Salmonella* spp., *P. aeruginosa*, *Staphylococcus aeruginosa*, *Shigella* spp., *Enterobacter*, *Clostridium sporogenes*, *B. subtilis*, and *Proteus vulgaris* were used to test the antimicrobial properties of the extracts using the agar-well diffusion technique. Results indicate that, except *S. aureus* and *Shigella* spp, the three different concentrations tested (10 mg/mL; 25 mg/mL and 50 mg/mL) of cynaroside are active against the rest of strains tested.

4.2. Antileishmanial activity

Tabrez et al. [41] evaluated the antileishmanial properties of a purchased cynaroside through test-tube experiments. The 50% inhibitory concentration (IC₅₀) value of cynaroside against leishmanial cells *in vitro* was 49.49 ± 3.515 M, and this activity decreased with time. Associated with miltefosine, even at a dose of 20 M, it severely blocked parasite development. Kefi et al. [31] investigated the *in vitro* antileishmanial activity of *E. arenarium*. The ethyl acetate extract yielded the highest concentration of cynaroside (288 60.56 g/mg), making it the most abundant constituent in the organic extracts. Two species of Leishmania, *Leishmania infantum* and *Leishmania major*, were used to test the extract. The MTT (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl tetrazolium bromide) assay was used to determine parasite vitality. The active extract showed action against *L. infantum* (IC₅₀ = 8.66 ± 0.24 g/mL) and *L. major* (IC₅₀ = 10.7 ± 0.59 g/mL). It also showed a strong anti-mastigote action against both *L. major* (IC₅₀ = 22.48 ± 0.14 g/mL) and *L. infantum* (IC₅₀ = 18.59 ± 0.09 g/mL).

4.3. Antifungal activity

The antifungal activity of cynaroside against many fungi was reported in several works [30,32,33,36,38–40]. Table summarizes all studies that have evaluated the antifungal activity of cynaroside, including its origin, type of assay, tested strains, and key results.

The antifungal efficacy of the extracts will be evaluated. Indeed, concerning *B. tripartita* herbs, Tomczykowa et al. [40] subjected the plant to three different extraction methods, including those using water, methanol/water, acetone/water, and methanol. The dominant flavonoid in *B. tripartita* herb was cynaroside. *Candida albicans* ATCC 10231, *C. parapsilosis* ATCC 22019, *Aspergillus fumigatus*, and *A. terreus* were the organisms challenged in this experiment. The tested organisms used in this study were *C. albicans* ATCC 10231, *C. parapsilosis* ATCC 22019, *A. fumigatus*, and *A. terreus*. Fungies were tested by the disc diffusion test

and broth microdilution method. Therefore, for each fungi tested, different results were recorded according to the three concentrations of the extract: *C. albicans* [MIC > 100 mg/mL (Water extract); I. Z. Φ = 0 mm (Water extract); MIC > 100 mg/mL (Methanol/Water extract); I. Z. Φ = 0 mm (Methanol/Water extract); MIC > 100 mg/mL (Acetone/Water extract); I. Z. Φ = 0 mm (Acetone/Water extract)], *C. parapsilosis* [MIC > 100 mg/mL (Water extract); I. Z. Φ = 0 mm (Water extract); MIC > 100 mg/mL (Methanol/Water extract); I. Z. Φ = 0 mm (Methanol/Water extract); MIC > 100 mg/mL (Acetone/Water extract); I. Z. Φ = 0 mm (Acetone/Water extract)], *A. fumigatus* [MIC > 100 mg/mL; (Water extract); I. Z. Φ = 0 mm (Water extract); MIC > 100 mg/mL; (Methanol/Water extract); I. Z. Φ = 0 mm (Methanol/Water extract); MIC > 100 mg/mL; (Acetone/Water extract); I. Z. Φ = 0 mm (Acetone/Water extract)], *A. terreus* [MIC > 100 mg/mL; (Water extract); I. Z. Φ = 0 mm (Water extract); MIC > 100 mg/mL; (Methanol/Water extract); I. Z. Φ = 0 mm (Methanol/Water extract); MIC > 100 mg/mL (Acetone/Water extract); I. Z. Φ = 0 mm (Acetone/Water extract)].

Žemlička et al. [38] extracted cynaroside from the aerial parts of wild chervil, *A. sylvestris* (L.) Hoffm by acetone and ethyl acetate, and then used in disc diffusion (5 mm) assay was saturated with 20 µg/disc on *Saccharomyces cerevisiae*, *C. albicans*, *Alternaria alternata*, *Aspergillus niger*, *Penicillium purpurogenum*, *Rhizopus oryzae*, *Trichophyton interdigitale*, *Rhodotorula glutinis*, which showed an effect only on *R. glutinis* with an inhibition zone of 12 mm without any inhibition for the rest of the fungi. Zhu et al. [39] used the dried leaves of *C. scolymus* extracted with 75% ethanol. The antifungal potency of cynaroside was investigated by disc (6.0 mm in diameter) using the diffusion method impregnated with 25 µL of the extract at a concentration of 10.0 mg/mL then placed on the inoculated plates. Cynaroside showed antifungal activity against *B. subtilis* (MIC= 100 µg/mL), *S. aureus* (MIC = 50 µg/mL), *A. tumefaciens* (MIC = 200 µg/mL), *M. luteus* (MIC = 200 µg/mL), *E. coli* (MIC = 200 µg/mL), *S. typhimurium* (MIC = 200 µg/mL), and *P. aeruginosa* (MIC = 100 µg/mL). Additionally, Mamadaliyeva et al. [32] studied the antimicrobial activity of cynaroside from *S. immaculata* and *S. ramosissima*, the antifungal activity was evaluated *in vitro* by diffusion and microdilution methods. The standard strains were *C. albicans* and *Candida glabrata*, without any activity on both fungi. Chiruvella et al. [30] used *Soymida febrifuga* (roxb.) A. Juss. root callus extracted with hexane, ethyl acetate, and methanol hexane. These extracts were used separately to extract cynaroside. The disc diffusion method was used to evaluate *A. fumigatus*, *A. niger*, *Alternaria alternate* at two cynaroside concentrations (200 and 400 µg/disc). The results showed that *A. fumigatus* present IZ (200 µg/disc) = 10.2 ± 0.15 and IZ (400 µg/disc) = 17.5 ± 0.42, *A. niger* IZ (200 µg/disc) = 11.7 ± 0.38 and IZ (400 µg/disc) = 14.6 ± 0.13, and *A. alternate* IZ (200 µg/disc) = 15.2 ± 0.83 IZ (400 µg/disc) = 18.2 ± 0.67. Wang et al. [36] prepared ethanol extracts from *Chimonanthus salicifolius* S.Y. Hu. leaves by ethanol gradient elution and evaluated them by high-performance liquid chromatography-diode array detector (HPLC-DAD). Antifungal activity was determined using the broth microdilution technique against several fungal strains, namely *S. cerevisiae* (CICC 1340), *S. cerevisiae* (CICC 1540), *Penicillium digitatum* (AS3.5752), *A. niger*, and *Cephalosporium Fiagans*. Half of the EE samples tested positive for cynaroside. The results showed for each strain tested promising results; *S. cerevisiae* (CICC 1340) (MIC = 156 µg/mL and MBC = 317.5 µg/mL), *S. cerevisiae* (CICC 1540) (MIC = 156 µg/mL and MBC = 317.5 µg/mL), *P. digitatum* (AS3.5752) (MIC = 156 µg/mL and MBC = 156 µg/mL), and *A. niger* (MIC = 156 µg/mL and MBC = 1250 µg/mL).

Table 3
Antibacterial activity.

Origins	Methods used	Strains tested	Key results	References
<i>Bidens tripartita</i> Fresh herb	Disc diffusion method Broth microdilution method	<i>Bacillus subtilis</i> <i>Micrococcus luteus</i> <i>Staphylococcus aureus</i> <i>Escherichia coli</i> <i>Escherichia coli</i> (B-lactamase+) <i>Klebsiella pneumonia</i> <i>Pseudomonas aeruginosa</i>	MIC = 3.1 mg/mL; (Water extract) Inhibition zone (I. Z.) Φ = 15 mm; (Water extract) MIC = 3.1 mg/mL; (Methanol/Water extract) I. Z. Φ = 15 mm (Methanol/Water extract) MIC = 3.1 mg/mL; (Acetone/Water extract) I. Z. Φ = 16 mm; (Acetone/Water extract) MIC = 3.1 mg/mL; (Water extract) I. Z. Φ = 16 mm; (Water extract) MIC = 6.2 mg/mL; (Methanol/Water extract) I. Z. Φ = 14 mm (Methanol/Water extract) MIC = 1.5 mg/mL; (Acetone/Water extract) I. Z. Φ = 16 mm; (Acetone/Water extract) MIC = 1.5 mg/mL; (Water extract) I. Z. Φ = 17 mm; (Water extract) MIC = 3.1 mg/mL; (Methanol/Water extract) I. Z. Φ = 12 mm; (Methanol/Water extract) MIC = 3.1 mg/mL; (Acetone/Water extract) I. Z. Φ = 13 mm; (Acetone/Water extract) MIC = 12.5 mg/mL; (Water extract) I. Z. Φ = 9 mm; (Water extract) MIC = 12.5 mg/mL; (Methanol/Water extract) I. Z. Φ = 8 mm; (Methanol/Water extract) MIC = 6.2 mg/mL; (Acetone/Water extract) I. Z. Φ = 10 mm; (Acetone/Water extract) MIC = 12.5 mg/mL; (Water extract) I. Z. Φ = 7 mm; (Water extract) MIC = 25 mg/mL; (Methanol/Water extract) I. Z. Φ = 10 mm; (Methanol/Water extract) MIC = 25 mg/mL; (Acetone/Water extract) I. Z. Φ = 8 mm; (Acetone/Water extract) MIC = 50 mg/mL; (Water extract) I. Z. Φ = 6 mm; (Water extract) MIC = 25 mg/mL; (Methanol/Water extract) I. Z. Φ = 8 mm; (Methanol/Water extract) MIC = 12.5 mg/mL; (Acetone/Water extract) I. Z. Φ = 7 mm; (Acetone/Water extract) MIC = 50 mg/mL; (Water extract) I. Z. Φ = 7 mm; (Water extract) MIC > 100 mg/mL; (Methanol/Water extract) I. Z. Φ = 6 mm; (Methanol/Water extract) MIC > 100 mg/mL; (Acetone/Water extract) I. Z. Φ = 0 mm; (Acetone/Water extract) I. Z. Φ = 12 mm	[40]
<i>Anthriscus sylvestris</i> (L.) Hoffm	Disc diffusion method	<i>Escherichia coli</i> <i>Proteus</i> sp. <i>Salmonella typhimurium</i> <i>Pseudomonas aeruginosa</i>	Reduced the biofilm development of <i>Pseudomonas aeruginosa</i> and <i>Staphylococcus aureus</i> and increased the incidence of mutations leading to ciprofloxacin resistance in <i>Salmonella typhimurium</i>	[38]
<i>Cynara scolymus</i> L.) leaves	Disc diffusion method	<i>Bacillus subtilis</i> <i>Staphylococcus aureus</i> <i>Agrobacterium tumefaciens</i> <i>Micrococcus luteus</i> <i>Escherichia coli</i> <i>Salmonella typhimurium</i> <i>Pseudomona aeruginosa</i>	MIC = 100 μ g/mL MIC = 50 μ g/mL MIC = 200 μ g/mL MIC = 200 μ g/mL MIC = 200 μ g/mL MIC = 200 μ g/mL MIC = 100 μ g/mL	[39]
<i>Mentha longifolia</i>	Agar diffusion method	<i>Escherichia coli</i> <i>Staphylococcus aureus</i> <i>Bacillus cereus</i> <i>Pseudomonas aeruginosa</i> <i>Bacillus subtilis</i>	- MIC = 0.070 mg/mL MIC = 0.095 mg/mL - MIC = 0.050 mg/mL	[29]
<i>Scutellaria immaculata</i> <i>Scutellaria ramosissima</i>	Diffusion method and microdilution method	<i>Staphylococcus aureus</i> <i>Streptococcus pyogenes</i> <i>Escherichia coli</i> <i>Pseudomonas aeruginosa</i>	MIC = 0 I. Z. Φ = 0.5 mm MMC > 0.5 MIC = 0 I. Z. Φ = 0.5 mm MMC > 0.5 MIC = 0 I. Z. Φ = 0.5 mm MMC > 0.5 MIC = 0	[32]

(continued on next page)

Table 3 (continued)

Origins	Methods used	Strains tested	Key results	References
<i>Soymida febrifug</i> Callus cultures	Disc diffusion	<i>Klebsiella pneumonia</i> <i>Salmonella typhimurium</i> <i>Proteus vulgaris</i> <i>Pseudomonas aeruginosa</i> <i>Bacillus subtilis</i> <i>Escherichia coli</i> <i>Staphylococcus aureus</i>	I. Z. Φ = 0.5 mm MMC > 0.5	[30]
			I. Z. Φ (200 μ g/disc) = 10.0 \pm 0.16 mm	
			I. Z. Φ (400 μ g/disc) = 12.5 \pm 0.67 mm	
			I. Z. Φ (200 μ g/disc) = 10.5 \pm 0.50 mm	
			I. Z. Φ (400 μ g/disc) = 14.3 \pm 0.00 mm	
			I. Z. Φ (200 μ g/disc) = 11.1 \pm 0.36 mm	
			I. Z. Φ (400 μ g/disc) = 13.0 \pm 0.25 mm	
			I. Z. Φ (200 μ g/disc) = no inhibition	
			I. Z. Φ (400 μ g/disc) = 11.3 \pm 0.37 mm	
			I. Z. Φ (200 μ g/disc) = 10.4 \pm 0.70 mm	
			I. Z. Φ (400 μ g/disc) = 11.6 \pm 0.34 mm	
			I. Z. Φ (200 μ g/disc) = 11.6 \pm 0.34 mm	
			I. Z. Φ (400 μ g/disc) = 11.0 \pm 0.43 mm	
			I. Z. Φ (200 μ g/disc) = no inhibition	
I. Z. Φ (400 μ g/disc) = 10.4 \pm 0.52 mm				
<i>Lonicera japonica</i> Thunb.	Disk diffusion assay	<i>Escherichia coli</i> <i>Staphylococcus aureus</i>	I. Z. Φ = 22.9 \pm 0.2 mm	[37]
			I. Z. Φ = 27.4 \pm 0.4 mm	
<i>Chimonanthus salicifolius</i> S. Y.Hu. leaves	Broth microdilution method	<i>Escherichia coli</i> <i>Staphylococcus aureus</i> <i>Bacillus subtilis</i>	MIC = 2.8 μ g/mL	[36]
			MBC > 2500 μ g/mL	
			MIC = 317.5 μ g/mL	
			MBC > 2500 μ g/mL	
<i>Youngia japonica</i>	Disk diffusion assay	<i>Vibrio cholera</i> and <i>Vibrio parahaemolyticus</i>	I. Z. Φ = 0.7 cm	[33]
			I. Z. Φ = 0.8 cm	
<i>Echium arenarium</i>	Disk diffusion assay	<i>Listeria monocytogenes</i> <i>Staphylococcus aureus</i> Methicillin-resistant <i>Staphylococcus aureus</i> <i>Enterococcus faecalis</i> <i>Bacillus cereus</i> <i>Pseudomonas aeruginosa</i> <i>Escherichia coli</i> <i>Klebsiella pneumonia</i>	MIC = 1000 μ g/mL	[31]
			MIC = 62 μ g/mL	
			MIC = 62 μ g/mL	
			MIC = 125 μ g/mL	
			MIC = 500 μ g/mL	
			MIC = 500 μ g/mL	
			MIC > 1000 μ g/mL	
			MIC > 1000 μ g/mL	
			MIC > 1000 μ g/mL	
			MIC > 1000 μ g/mL	
<i>Veronica amygdalina</i>	Agar-well diffusion method	<i>Staphylococcus aureus</i> <i>Bacillus cereus</i> <i>Shigella</i> spp.	No inhibition (at 10 mg/mL)	[34]
			I. Z. Φ = 0.69 mm (at 25 mg/mL)	
			I. Z. Φ = 1.21 mm (at 50 mL/mL)	
			I. Z. Φ = 0.4 mm (at 10 mg/mL)	
			I. Z. Φ = 0.81 mm (at 25 mg/mL)	
			I. Z. Φ = 1.32 mm (at 50 mL/mL)	
			No inhibition (at 10 mg/mL)	
I. Z. Φ = 0.52 mm (at 25 mg/mL)				
			I. Z. Φ = 0.82 mm (at 50 mL/mL)	

Ooi et al. [33] examined the ethanolic extract of *Y. japonica* with a disc diffusion assay. This extract was then used to isolate and characterize three anti-fungal agents (3,4-dicafeoylquinic acid, 3,5-dicafeoylquinic acid, and luteolin-7-O-glucoside). The diameter of the inhibition zone induced by cynaroside's antifungal action against *B. cereus* was only 0.7 cm. Tables 4–6.

4.3.1. Antioxidant activity

Cynaroside has been investigated for its antioxidant effect by several studies [35,42–48]. Its protective activity against H₂O₂-induced apoptosis in H9c2 cardiomyoblasts will be demonstrated, Xiao et al. [47] examined the antioxidant effect of cynaroside on oxidative damage in cardiac myocytes. Cynaroside pretreatment for 4 h was applied to H9c2 cells, with addition of H₂O₂ (150 mM) for 6 h. Therefore, pretreatment with cynaroside showed promising results. Superoxide dismutase, glutathione peroxidase, and catalase are all endogenous antioxidant enzymes that act energetically to prevent ROS production in the cell. Cynaroside inhibited ROS production, which in turn reduced the damage to mitochondrial membrane potential caused by hydrogen peroxide. It also enhanced the expression of the anti-apoptotic protein Bcl-2 and lowered that of pro-apoptotic protein Bax. Cynaroside suppressed the upregulation of c-Jun N-terminal kinase (JNK) and p53 protein expression triggered by H₂O₂. Cynaroside was detected by Elansary et al. [42] when examining the polyphenol profiles of methanolic leaf extracts

of *M. piperita* and *M. longifolia*. In addition, antioxidant activity was explored using β -carotene bleaching, FRAP (ferric reducing antioxidant power), and DPPH (2,2-Diphenyl-1-picrylhydrazyl) assays. Chromatographic analyses revealed an amount of cynaroside (162.8 mg/100 g DW) in *M. piperita* leaves. The IC₅₀ values were 6.9 \pm 0.1 μ g/mL, 8.2 \pm 0.1 mM TEAC/g Extract, and 6.3 \pm 0.1 μ g/mL for β -carotene bleaching, FRAP, and DPPH assays, respectively.

To demonstrate the antioxidant activity of cynaroside in protecting ARPE-19 cells against H₂O₂-induced oxidative stress, Yu et al. [48] used cynaroside (100 μ L) which was added to ARPE-19 cells cultured in CO₂ with the positive control NAC. Intracellular ROS generation was measured, followed by intracellular activities of bicinchoninic acid-binding proteins (CAT, SOD, GSH, and MDA) detection and Western blot analysis. Very low concentrations of cynaroside (500 vs. 100 μ M) revealed substantial antioxidant and anti-apoptotic effects. Cynaroside protected ARPE19 cells from apoptosis through down-regulation of caspase-3 protein activation, which was controlled by upstream proteins; Bcl2 and Bax. Cynaroside effectively inhibited oxidative stress-induced apoptosis in ARPE19 cells through the regulation of related enzymes activation and protein expression. Cynaroside was shown to increase antioxidant and antiapoptotic capacity of ARPE19 cells via increased pAkt expression. Kim et al. [43] isolated and characterized the antioxidant compounds from the aerial parts of *A. keiskei*, the cynaroside was extracted with boiling water, the extracted

Table 4 (continued)

Origins	Methods Used	Strains tested	Key results	References
			active I. Z. Φ = not active MMC = not active	
<i>Soyimida febrifug</i> cultures	Disc diffusion method	<i>Aspergillus fumigatus</i> <i>Aspergillus niger</i> <i>Alternaria alternata</i>	I. Z. Φ (200 μ g/disc) = 10.2 \pm 0.15 mm I. Z. Φ (400 μ g/disc) = 17.5 \pm 0.42 mm I. Z. Φ (200 μ g/disc) = 11.7 \pm 0.38 mm I. Z. Φ (400 μ g/disc) = 14.6 \pm 0.13 mm I. Z. Φ (200 μ g/disc) = 15.2 \pm 0.83 mm I. Z. Φ (400 μ g/disc) = 18.2 \pm 0.67 mm	[30]
<i>Chimonanthus salicifolius</i> S. Y.Hu. leaves	Broth microdilution method	<i>Saccharomyces cerevisiae</i> (CICC 1340) <i>Saccharomyces cerevisiae</i> (CICC 1540) <i>Penicillium digitatum</i> (AS3.5752) <i>Aspergillus niger</i> <i>Cephalckiscus Fiagens</i>	MIC = 156 μ g/mL MBC = 317.5 μ g/mL MIC = 156 μ g/mL MBC = 317.5 μ g/mL MIC = 156 μ g/mL MBC = 1250 μ g/mL	[36]
<i>Youngia japonica</i>	Disk diffusion assay	<i>Bacillus cereus</i>	I. Z. Φ = 0.7 cm	[33]

solution was partitioned with ethyl acetate, and the free radical scavenging activity showed 2.2 DPPH radical trapped per 1.0 mol of α -tocopherol. In other trials, Ma et al. [45] evaluated the antioxidant activity of cynaroside by scavenging the stable DPPH free radicals. Cynaroside was isolated from the methanolic extract from *Lophatherum gracile* leaves. The authors recorded a value of 0.43 μ M and also using the DPPH assay, Liu et al. [44] tested cynaroside extracted from *L. japonica* (IC₅₀ = 0.334 g/L). In the same context of DPPH assay, Orhan et al. [46] investigated *Bidens tripartite* to extract cynaroside with 80% ethanol extract and then with ethyl acetate to obtain a sub-extract, with

a cynaroside level 10.87%, the inhibition percentage was 62.86 \pm .80% at 2 mg/mL of ethyl acetate extract. Testing *Salvia multicaulis* antioxidant capability Shojaeifard et al. [35] extracted cynaroside using methanol extract. Both the DPPH and FRAP assays were used to evaluate cynaroside activity. Therefore, the IC₅₀ values were 2.42 μ g/mL and 3.30 mg eq. FeSO₄/1 g of plant extract for both tests, respectively.

4.4. Hepatoprotective effect

Park et al. [50] administered bromobenzene to rats to promote hepatic lipid peroxidation, and they examined the influence of cynaroside on hepatic lipid peroxide and the activities of free radical producing and scavenging enzymes. Additionally, methanol was used to isolate cynaroside from *A. keiskei*. Cynaroside (50 or 100 mg/kg) was administered intraperitoneally once daily to four groups of rats for one week; subsequently, the last two days of week 4, bromobenzene was injected. Lipid peroxidation was evaluated by measuring the amount of thiobarbituric acid reactive material in the liver after it was cleaned, minced, and centrifuged twice. Through spectrophotometric analysis, the rate of trans-stilbene oxide production was used to measure epoxide hydrolase activity. The findings demonstrate that cynaroside attenuates bromobenzene-induced hepatic lipid peroxidation by increasing epoxide hydrolase activity. Ethyl acetate extract from *Phillyrea latifolia* (L.) showed luteolin 7-O-glucoside to be the main extracted component [49]. A total of 24 6-week-old male Wistar albino rats were divided into four groups of six; (1) a control group fed standard pellets, (2) a group fed a high-energy diet for 15 weeks, (3) a group fed a standard pellet diet for 10 weeks, a group fed the aqueous extract of *P. latifolia* leaves for 5 weeks, and (4) a group fed a high-energy diet for 10 weeks which continued to receive aqueous extract of *P. latifolia*. At the end of the 15th week, haematoxylin-eosin (HE) staining was used to perform histological analyses on liver tissue samples. The structural integrity of liver tissue and leukocyte infiltration were both enhanced after treatment with *P. latifolia* aqueous extract. The high energy diet group had decreases in blood glucose, leptin, total cholesterol, and LDL after receiving *P. latifolia*.

4.5. Antidiabetic activity

Van et al. [51] investigated the flavonoid-rich fraction of *Merremia tridentate* dissolved in 100 mL of the methanol:water (1: 1) mixture.

Cynaroside showed the highest level with a percentage of 4.375% in the stem-ethanol extract and 58.430% in the flavonoid rich fraction. The test was performed on healthy adult Swiss albino mice. The animals were fasted overnight and then given an intraperitoneal injection of 200 mg/kg of alloxan dissolved in sterile water. After 72 h, blood glucose levels were tested and mice with levels above 250 mg/dL were maintained for further testing. Diabetic mice treated with a flavonoid-rich fraction (25, 50, and 75 mg/kg) had enhanced glycogen phosphorylase activity and reduced glycogen synthase activity. Compared to pretreatment levels, these enzymes returned to near normal levels. The flavonoid-rich fraction had an IC₅₀ value for the α -glucosidase enzyme of 0.24 mg/mL. The flavonoid-rich fraction inhibited α -amylase with an IC₅₀ of 1.72 mg/mL.

Orhan et al. [46] selected *B. tripartite* to extract the cynaroside with 80% ethanol extract and then with ethyl acetate to obtain a sub-extract. The cynaroside level was 10.87%. Diabetes was induced by streptozotocin (STZ, 60 mg/kg, intraperitoneally), and male Wistar Albino rats were used for glucose oxydase technique for blood level assessment and oral tolerance test. The ethanol extract and ethyl acetate sub-extract of *B. tripartite* were orally administered to diabetic rats for seven consecutive days to measure blood glucose levels, and *in vitro* experiments included α -amylase and α -glucosidase inhibitory activities assays were performed. The results showed a decrease in blood glucose levels of 11.5–25.8% in normoglycaemic and glucose-loaded rats, compared to healthy control rats, in a dose-dependent manner. In another study using

Table 5
Antioxidant activity of Cynaroside.

Origins	Extraction methods	Experimental approaches	Key results	References
Purchased	-	Hoechst 33342 staining Double fluorescence staining (Phosphatidylserine) Total intracellular reactive oxygen species (ROS) detection Mitochondrial transmembrane potential Fluorometric Assay to analyse the labeled cells with JC-1 Western blot analysis	Pretreatment with cynaroside significantly increased the endogenous anti-oxidative activity of superoxide dismutase, glutathione peroxidase, and catalase, and reduced ROS production inside the cell Reduced loss of mitochondrial membrane potential induced by H ₂ O ₂ Increased Bcl-2 expression while decreasing Bax expression, and thus prevented cell apoptosis Inhibited c-Jun N-terminal kinase (JNK) induced by oxidative stress and P53 protein production	[47]
<i>Mentha piperita</i> <i>Mentha longifolia</i> Leaf extracts	Methanol extract	Evaluation of β -carotene bleaching Ferric reducing antioxidant power (FRAP) test Evaluation with 2,2-Diphenyl-1-picrylhydrazyl (2,2-DPPH)	β -carotene bleaching assay; IC ₅₀ = 6.9 ± 0.1 μ g/mL FRAP assay; IC ₅₀ = 8.2 ± 0.1 mM TEAC/g Extract DPPH; IC ₅₀ = 6.3 ± 0.1 μ g/mL	[42]
Purchased	-	ROS level detection Bicinchoninic acid protein assay Intracellular activities (CAT, SOD, GSH, and MDA) detection Western blot analysis	After being pretreated with cynaroside, H ₂ O ₂ -treated ARPE-19 cells exhibited a dramatic increase in ROS Apoptosis of ARPE-19 cells generated by oxidative stress was successfully suppressed through modulation of associated enzyme activity and protein expression Inhibited the upstream proteins Bcl-2 and Bax from activating caspase-3, which protected ARPE-19 cells from apoptosis Increased the expression of pAkt, which increased the antioxidant and antiapoptotic capacity of ARPE19 cells	[48]
<i>Lophatherum gracile</i>	Methanol extract	DPPH scavenging	IC ₅₀ = 0.43 ± 0.00 μ M	[45]
<i>Angelica keiskei</i>	Boiling water and Ethyl acetate methanol extract	DPPH radical scavenging	2,2-DPPH radical trapped per 1.0 mol of α -tocopherol	[43]
<i>Lonicera japonica</i>	Ethyl acetate sub-extract	DPPH radical scavenging activity assay	IC ₅₀ = 0.334 g/L	[44]
<i>Bidens tripartita</i>	Ethyl acetate sub-extract	DPPH assay	62.86 ± 80% at 2 mg/mL of ethyl acetate extract	[46]
<i>Salvia multicaulis</i> Vahl	80% methanol	Detection of Reduced Phosphorus in Halothane FRAP test, or ferric reducing antioxidant power	IC ₅₀ = 2.42 μ g/mL 3.30 mg eq. FeSO ₄ / 1 g plant extract	[35]

STZ-induced diabetic rats, the euglycemic index of *B. tripartita* ethanol extract ranged from 14.0% to 32.7%. The ethanol extract of *B. tripartite* (500 mg/kg) significantly lowered blood glucose levels from 24.3% to 32.7%, with moderate inhibitory activity against α -glucosidase. The ethyl acetate sub-extract exhibited the highest inhibitory activity against α -glucosidase (64.56% at 2 mg/mL ethyl acetate), while the ethanol extract was inactive against the enzyme α -amylase and its sub-extracts.

Wei et al. [52] carried out a test on STZ-induced diabetic mice. They were fasted for 12 h before oral administration of *Stigma Maydis* powder extracted with 75% ethanol. The amount of cynaroside administered was equivalent to 24.5 mg/kg. Blood samples were collected before and after oral administration and then centrifuged. A non-compartmental analysis of plasma concentration. Kim et al. [53] tested the inhibition of α -glucosidase and α -amylase by luteolin 7-O-glucoside extracted from *Salix gracilistyla*, the compound was resolved in dimethylsulfoxide (5 mg/mL) and used as a test solution. The α -glucosidase and porcine pancreatic α -amylase inhibitory assays were carried out by the chromogenic method. Inhibitory activity was expressed as the relative absorbance difference. The results were: α -glucosidase IC₅₀ > 50 μ g/mL and α -amylase IC₅₀ > 100 μ g/mL. In order to assess the hypoglycemic activity of cynaroside from *C. citratus* by α -glucosidase inhibition, Borges et al. [70] used the oil-free infusion prepared from the dried leaves of *C. citratus*, the chemical composition was evaluated by HPLC-PDA-ESI/MSn, and the flavonoid showed an IC₅₀ value of 21.01 μ M for the α -glucosidase inhibition test (*in vivo*).

4.6. Anti-inflammatory activities of Cynaroside

As a natural molecule, cynaroside was investigated by numerous scientists for its anti-inflammatory effects (Table 7). Szekalska and

colleagues reported that 10% of cynaroside isolated from *B. tripartita* aerial parts suppress the release of some anti-inflammatory mediators. Besides, this bioactive molecule (2 and 20 mg) reduced the oxazolone-induced ear swelling in male C57BL6/cmdb outbred mice. Histopathological examination revealed a marked reduction in inflammation of the paw skin and ear tissue in the animal model. These findings suggest that topical use of cynaroside expressively decreases T cells, mast cells and histiocytes in mouse skin with inflammation [54]. Another study examined the anti-inflammatory effect of cynaroside extracted from *E. bodinieri* (*in vitro* and *in vivo*). Cynaroside was found to regress nitrite oxide (NO) and ROS levels in lipopolysaccharide (LPS)-stimulated RAW264.7 cells and considerably reduced inflammation in the mouse model [55]. Similarly, Lee et al. [135] analyzed the protective effect of this substance on human periodontal ligament (hPDL) cells against lipopolysaccharide-induced damage and inflammation. NO and prostaglandin E₂ (PGE₂) were measured to assess the inflammatory response. Therefore, cynaroside inhibited the expression of inducible nitric oxide synthase (iNOS), a key nitric oxide-generating enzyme, and cyclooxygenase-2 (COX-2) which is implicated in the inflammatory response. Some cytokines implicated in chronic inflammation were also repressed, namely tumor necrosis factor- α (TNF- α) and interleukin-6 (IL-6), in LPS-stimulated hPDL and RAW264.7 cells, without any cytotoxicity. Additionally, cynaroside significantly inhibited the expression of matrix metalloproteinase 3 and prevented nuclear factor κ B (NF- κ B) p65 subunit translocation to the cell nucleus. This bioactive compound exerts these effects through inhibition of I κ B- α phosphorylation and degradation [135]. Moreover, another experiment revealed that cynaroside stimulates macrophage phenotypic transition from pro-inflammatory M1 to anti-inflammatory M2, and reduces inflammatory liver damage associated with sepsis. The mechanism of action

Table 6
Antidiabetic activity of Cynaroside.

Origins	Models used	Experimental approaches	Key results	References
<i>Merremia tridentate</i>	Alloxan-induced diabetic mice	Mice were fasted overnight and then received an intraperitoneal injection of 200 mg/kg of alloxan dissolved in sterile water. Blood glucose levels were monitored in mice for a total of 72 h	The flavonoid-rich fraction (58.430%) had the highest cynaroside concentration. In diabetic mice, treatment with a flavonoid-rich fraction (25, 50, and 75 mg/kg) stimulated glycogen phosphorylase activity while decreasing glycogen synthase activity. IC ₅₀ = 0.24 mg/mL against the enzyme α-glucosidase. IC ₅₀ = 1.72 mg/mL against α-amylase enzyme.	[51]
<i>Bidens tripartita</i>	Ethanol extract Ethyl acetate sub-extract	<i>In vitro</i> enzyme inhibitory assay by glucose oxidase method. STZ-induced diabetic rats. <i>In vitro</i> α-amylase and α-glucosidase inhibitory activities.	Reduced blood sugar levels by 11.5–25.8%. Reduced blood glucose levels by 14.0–32.7% in STZ-induced diabetic rats. Induced a statistically significant antidiabetic effect of the extract at 500 mg/kg (24.3–32.7%).	[46]
<i>Maydis stigma</i>	Methanol And 0.1% formic acid water	STZ-induced diabetic rats	Cynaroside could have a potential role in in type 2 diabetes. Mice diabetes group showed better absorption for cynaroside than normal group. The area under the curve was (AUC _{0-t}) = 3072 ± 675.7 ugh/L, AUC _{0-∞} = 3074 ± 676.2 ugh/l; Mean residence time (MRT) = 4.53 ± 0.15 h. Terminal half-life (T _{1/2}) = 3.26 ± 0.22 h.	[52]

Table 6 (continued)

Origins	Models used	Experimental approaches	Key results	References
			Time to maximum concentration (T _{max}) = 1.25 ± 0.27 h. Maximum concentration (C _{max}) = 769.3 ± 111.2 ug/L and clearance (CL _{z/F}) = 8.323 ± 1.966 (L/Kg/h).	
<i>Salix gracilistyla</i>	Not mentioned	<i>In vivo</i> α-glucosidase inhibitory assay. Porcine pancreatic α-amylase.	IC ₅₀ > 50 µg/mL. IC ₅₀ > 100 µg/mL.	[53]
<i>Cymbopogon citratus</i> Stapf.	Oil-free infusion	<i>In vivo</i> α-glucosidase inhibition assay.	IC ₅₀ = 21.01 µM.	[70]

was explained by the fact that cynaroside inhibits the binding of pyruvate kinase M2 (PKM2), a potential target for controlling the inflammatory response, to hypoxia-inducible factor-1α (HIF-1α) which is considered an essential regulator of transcription. This is due to prevention of PKM2 translocation to the nucleus and suppression of PKM2 phosphorylation [56,135]. Furthermore, Odontuya et al. [57] estimated the ability of cynaroside derived from luteolin to inhibit enzymes responsible for the synthesis of thromboxane B2 (TXB2) and leukotriene B4 (LTB4) involved in the pain and inflammatory response. The phenolic compound was found to possess a moderate inhibitory effect on both enzyme synthesis pathways. This activity was dose dependent and the inhibition values ranged from 0% to 42.23% and 21.68–57.68% for TXB2 and LTB4, respectively. More interestingly, Feng et al. [58] studied the protective effect of cynaroside against sepsis and its mechanism on cecal ligation puncture (CLP) and sham surgery in mouse model. At concentrations of 5 and 10 mg/kg, cynaroside has been observed to regulate serum levels of inflammatory factors, including IL-1β and TNF-α. Thus, some tissue damage markers such as creatinine, creatine kinase-MB and lactate dehydrogenase were significantly decreased at the serum level compared with the sepsis mice. It was also observed that the biomarker of pro-inflammatory macrophage M1 phenotype (iNOS+) was suppressed and the anti-inflammatory M2 polarization (CD206+) was promoted in injured organs of septic mice. Mechanistic research has established that cynaroside inhibits LPS-induced polarization of macrophage into M1 phenotype, which can be highly blocked by Nrf2 inhibitor, and expected that Nrf2 and its downstream (Heme oxygenase-1 (HO-1)) was adjusted in injured organs after treatment with cynaroside. Another work was carried out by Lee et al. in order to determine the chondroprotective effect of cynaroside as well as its mechanism of action by measuring the protein levels of catabolic and anabolic factors. The results of this work revealed that cynaroside inhibits the expression of catabolic factors (nitrite, iNOS, ROS, PGE₂, Cox-2, MMP-1, MMP-3, and MMP-13), and regresses the degradation of anabolic factors (type II collagen and aggrecan). This substance has also been reported to limit the phosphorylation of MAPKs and NF-κB into the nucleus, playing a central role in inflammation [59]. Other important studies have specified that cynaroside extremely inhibits the phosphorylation of IκB kinase (IKK)β, an enzyme complex involved in the propagation of the cellular response to inflammation, via the NF-κB signaling pathway. It has also been cited that this molecule inhibits the activation of the inflammasome and the secretion of

Table 7
Anti-inflammatory activities of cynaroside.

Origins	Doses	Study types	Methods used	Key results	References
<i>Bidens tripartita</i>	2 – 20 mg	<i>In vivo</i>	Carrageenan-induced mouse paw oedema inflammation model	Reduced T cells, mast cells and histiocytes in mouse skin with inflammation or atopic dermatitis	[54]
<i>Elsholtzia bodinieri</i>	5–300 µg/mL	<i>In vitro</i> and <i>in vivo</i>	NO and ROS production in LPS-stimulated RAW264.7 cells xylene-induced auricular swelling mice model	Inhibited NO and ROS production in LPS-stimulated RAW264.7 cells Reduced inflammation in the mouse model	[55]
Purchased	5–20 µM	<i>In vitro</i>	Measurement of NO and prostaglandin E ₂ (PGE ₂)	Inhibited iNOS, COX-2, TNF-α, and IL-6 production in LPS-stimulated hPDL and RAW264.7 cells	[135]
Purchased	5 mg/kg	<i>In vivo</i>	Analysis of pyruvate kinase activity of PKM2	Prevented macrophage polarization into pro-inflammatory phenotype and relief of cecal ligation and puncture-induced liver injury by targeting PKM2/HIF-1α axis	[56]
<i>Oxalis corniculata</i>	25–100 µg/mL	<i>in vitro</i>	Thromboxane B2 and leukotriene B4 scavenging activity	Inhibited 42.23% of TXB2 and 57.68% of LTB4	[57]
<i>Lonicera</i> spp. (honeysuckle)	5–10 mg/kg	<i>in vivo</i> and <i>in vitro</i> models	Sepsis mouse model by cecal ligation and puncture (CLP) surgery in mice C57BL/6 mice Serum cytokine measurement and hematoxylin-eosin (HE) staining	Improved systematic inflammation and multi-organ injury dependent on Nrf2/HO-1 pathway in septic mice	[58]
<i>Anthriscus sylvestris</i>	160 µM	<i>In vitro</i> and <i>in vivo</i>	Measurement of nitrite, PGE ₂ , type II collagen, aggrecan, and ROS production Measurement of iNOS, Cox-2, MMP-1, MMP-3, MMP-13, ADAMTS-4, MAPKs, and the NF-κB p65 subunit	Inhibited IL-1β-induced inflammatory factors (NO, ROS, PGE ₂ , iNOS, Cox-2, and TNF-α) and cartilage-degrading enzymes (MMP-1, MMP-3, MMP-13, and ADAMTS-4) Protected type II collagen and aggrecan from degradation by IL-1β treatment	[59]

Table 8
Anticancer activities of cynaroside.

Origins	Doses	Cell lines/ Animal models	Key results	References
Purchased	0, 25, 50, 75, and 100 µM	Gastric cancer cell lines (HGC27, MKN45, and SGC7901)	Reduced gastric cancer cell self-renewal ability Inhibited tumorigenesis ability <i>in vivo</i> Inhibited the activation of the MET/AKT/mTOR axis	[62]
<i>Lonicera japonica</i>	10, 20, 40, and 80 µM 10 mg/kg, i.p., once daily for 3 days	Human kidney proximal tubule cell (HK-2 cells) Male BALB/c mice	Reduced cell death, DNA fragmentation, apoptosis and mitochondrial dysfunction Decreased nephrotoxicity <i>in vivo</i>	[63]
<i>Lonicera japonica</i>	80 µM	HK-2 cells	Ameliorated doxorubicin-induced necrosis in HK-2 cells	[64]

inflammatory factors, and it that is able to reduce retinal damage after exposure to blue light by inhibiting the nuclear translocation of NF-κB and activating autophagy [60], [130].

4.7. Anticancer activities of cynaroside

Some scientific reports have shown that cynaroside has important anticancer properties on different tumor cell lines (Table 8) [61]. Ji et al. [62] investigated the antitumor effect of cynaroside using many assays to assess cell viability and proliferation and to perceive cell cycle and apoptosis (MTT assay, BrdU staining, plate colony formation, flow cytometry, and western blotting). Data obtained in this work showed that cynaroside induces cell cycle arrest at S phase and inhibits proliferation migration and invasion of gastric cancer cells. This substance was also able to activate the apoptosis and suppress the tumorigenic capacity of gastric cancer cells *in vivo* and *in vitro*. Mechanistic analysis has established that cynaroside can block an intracellular signaling pathway, MET/AKT/mTOR axis, having a pivotal role in cell cycle control [62]. Nho and colleagues investigated the effect of cynaroside on

the caspase-3/MST-1 signaling pathway in cisplatin-induced nephrotoxicity using a human proximal tubule cell line (HK-2 cells). On the other hand, they tested the protective effect of this compound on cisplatin-induced nephrotoxicity in male BALB/c mice. The results indicated that 10 µM cynaroside regresses cisplatin-induced apoptosis and suppresses mitochondrial dysfunction and caspase-3 activation. Cynaroside treatment decreased caspase-3/MST-1 pathway upregulation in HK-2 cells. Additionally, 10 mg/kg cynaroside, i.p., once daily for 3 days, reduced renal dysfunction, tubular damage, and neutrophilia induced by cisplatin injection in mice. These results showed that this compound can attenuate cisplatin-induced side effects [63]. The same research team evaluated the protective effect of cynaroside against doxorubicin-induced necrosis in HK-2 cells. They revealed that pre-treatment with 80 µM cynaroside attenuates DNA fragmentation, caspase-3 activity, and mitochondrial hyperactivation induced by 10 µM doxorubicin in HK-2 cells [64]. It was also found that cynaroside isolated from *A. sylvestris* exerts a significant antimutagenic effect against two carcinogenic and mutagenic food additives; 2-nitrofluorene (2NF) and 3-(5-nitro-2-furyl)acrylic acid (NFAA) [38].

5. Conclusion and perspectives

Here, we report the natural sources and biological properties of cynaroside. It has been revealed that this bioactive compound is synthesized by different natural sources, including medicinal plants. With its particular chemical structure, cynaroside exhibits stochastic pharmacological actions such as anti-inflammatory, anti-microbial, and anti-cancer activities. *In vitro* investigations highlighted certain cellular and molecular mechanisms of this molecule. However, further mechanistic investigations should be carried out eventually to determine precisely its different mechanisms with all the versatile stochasticity. Moreover, other investigations concerning pharmacokinetic and toxicological studies should also be carried out to determine the absorption, availability, and metabolism of cynaroside, as well as to validate its safety.

Funding

The authors would like to thank the Deanship of Scientific Research at Umm Al-Qura University for supporting this work by Grant Code: (22UQU4331128DSR18).

CRediT authorship contribution statement

Conceptualization, A.B, L.C.M., C.A., C.S.T.; methodology, A.B., S. B., G.Z., C.A., N.E.O. and N.E.H.; software, A.B.; validation, A.B., D.T., T. B., Y.B., A.K.; A.N.A.; formal analysis, A.B.; investigation, C.A., N.S. and A.B.; resources, S.B., A.K.; A.N.A.; data curation, N.S.; writing – original draft preparation, D.T., T.B., L.C.M., A.B. and N.E.H.; writing – review and editing, C.A., A.B., N.E.O. and C.S.T.; visualization, A.B., N.E.O.; supervision, A.B. and L.C.M.; project administration, A.B. All authors have read and agreed to the published version of the manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No new data were created or analyzed in this study. Data sharing is not applicable to this article.

Acknowledgments

The authors would like to thank the Deanship of Scientific Research at Umm Al-Qura University for supporting this work by Grant Code: (22UQU4331128DSR77).

References

- [1] S.A. Rajput, C. Zhang, Y. Feng, X.T. Wei, M.M. Khalil, I.R. Rajput, D.M. Baloch, A. Shaikat, N. Rajput, H. Qamar, Proanthocyanidins Alleviates AflatoxinB1-Induced Oxidative Stress and Apoptosis through Mitochondrial Pathway in the Bursa of Fabricius of Broilers, *Toxins* 11 (2019) 157.
- [2] K.M. Anusmtha, M. Aruna, J.T. Job, A. Narayanankutty, P.B. Benil, R. Rajagopal, A. Alfarhan, D. Barcelo, Phytochemical Analysis, Antioxidant, Anti-Inflammatory, Anti-Genotoxic, and Anticancer Activities of Different Ocimum Plant Extracts Prepared by Ultrasound-Assisted Method, *Physiol. Mol. Plant Pathol.* 117 (2022), 101746.
- [3] Z. Barmoudeh, M.T. Ardakani, A.H. Doustimotlagh, H. Bardania, Evaluation of the Antioxidant and Anticancer Activities of Hydroalcoholic Extracts of Thymus Daenensis Celak and Stachys Ptilifera Benth, *J. Toxicol.* (2022) 2022.
- [4] T. Benali, K. Habbadi, A. Bouyahya, A. Khabbach, I. Marmouzi, T. Aanniz, H. Chtibi, H.N. Mrabti, E.H. Achbani, K. Hammani, Phytochemical Analysis and Study of Antioxidant, Anticandidal, and Antibacterial Activities of Teucrium Polium Subsp. Polium and Micromeria Graeca (Lamiaceae) Essential Oils from Northern Morocco, *Evid. -Based Complement. Altern. Med.* (2021) 2021.
- [5] T. Benali, K. Habbadi, A. Khabbach, I. Marmouzi, G. Zengin, A. Bouyahya, I. Chamkhi, H. Chtibi, T. Aanniz, E.H. Achbani, GC-MS Analysis, Antioxidant and Antimicrobial Activities of Achillea odorata Subsp. Pectinata and Ruta Montana Essential Oils and Their Potential Use as Food Preservatives, *Foods* 9 (2020) 668.
- [6] M.R. Kachmar, A.P. Oliveira, P. Valentão, A. Gil-IZquierdo, R. Dominguez-Perles, A. Ouahbi, El Badaoui, K.; Andrade, P.B.; Ferreres, F. HPLC-DAD-ESI/MSn Phenolic Profile and in Vitro Biological Potential of Centaurea erythraea Rafn Aqueous Extract, *Food Chem.* 278 (2019) 424–433.
- [7] H.N. Mrabti, A. Bouyahya, A. Ed-Dra, M.R. Kachmar, N.N. Mrabti, T. Benali, M. A. Shariati, A. Ouahbi, L. Doudach, M.E.A. Faouzi, Polyphenolic Profile and Biological Properties of Arbutus unedo Root Extracts, in: *European Journal of Integrative Medicine*, 42, 2021, 101266.
- [8] A. Nieto-Maldonado, S. Bustos-Guadarrama, H. Espinoza-Gomez, L.Z. Flores-López, K. Ramirez-Acosta, G. Alonso-Núñez, R.D. Cadena-Nava, Green Synthesis of Copper Nanoparticles Using Different Plant Extracts and Their Antibacterial Activity, *J. Environ. Chem. Eng.* 10 (2022), 107130.
- [9] M. Oves, M.A. Rauf, M. Aslam, H.A. Qari, H. Sonbol, I. Ahmad, G.S. Zaman, M. Saeed, Green Synthesis of Silver Nanoparticles by Conocarpus Lancifolius Plant Extract and Their Antimicrobial and Anticancer Activities, *Saudi J. Biol. Sci.* 29 (2022) 460–471.
- [10] E. Souri, G. Amin, H. Farsam, H. Jalalizadeh, S. Barez, Screening of Thirteen Medicinal Plant Extracts for Antioxidant Activity, *Iran. J. Pharm. Res.* 7 (2022) 149–154.
- [11] S. Aboulghras, N. Sahib, S. Bakrim, T. Benali, S. Charfi, F.-E. Guaouguaou, N. E. Omari, M. Gallo, D. Montesano, G. Zengin, Health Benefits and Pharmacological Aspects of Chrysoeriol, *Pharmaceuticals* 15 (2022) 973.
- [12] K.K. Aggarwal, S.P.S. Khanuja, A. Ahmad, Santha Kumar, T.R.; Gupta, V.K.; Kumar, S. Antimicrobial Activity Profiles of the Two Enantiomers of Limonene and Carvone Isolated from the Oils of Mentha spicata and Anethum Sowa, *Flavour Fragr. J.* 17 (2002) 59–63.

- [13] S. Bakrim, H. Machate, T. Benali, N. Sahib, I. Jaouadi, N.E. Omari, S. Aboulghras, S.P. Bangar, J.M. Lorenzo, G. Zengin, Natural Sources and Pharmacological Properties of Pinosylvin, *Plants* 11 (2022) 1541.
- [14] N.A. Elkanti, H. Hrichi, R.A. Aolayan, W. Derafa, F.M. Zahou, R.B. Bakr, Synthesis of Chalcones Derivatives and Their Biological Activities: A Review, *ACS Omega* (2022).
- [15] M. Friedman, P.R. Henika, R.E. Mandrell, Bactericidal Activities of Plant Essential Oils and Some of Their Isolated Constituents against Campylobacter Jejuni, Escherichia coli, Listeria Monocytogenes, and Salmonella Enterica, *J. Food Prot.* 65 (2002) 1545–1560.
- [16] H. Hwang-Bo, W.S. Lee, A. Nagappan, H.J. Kim, R. Panchanathan, C. Park, S.-H. Chang, N.D. Kim, S.-H. Leem, Y.-C. Chang, Morin Enhances Auranofin Anticancer Activity by Up-Regulation of DR4 and DR5 and Modulation of Bcl-2 through Reactive Oxygen Species Generation in Hep3B Human Hepatocellular Carcinoma Cells, *Phytother. Res.* 33 (2019) 1384–1393.
- [17] A.K. Jangid, H. Agrawal, N. Gupta, P. Jain, U.C. Yadav, D. Pooja, H. Kulhari, Amorphous Nano Morin Outperforms Native Molecule in Anticancer Activity and Oral Bioavailability, *Drug Dev. Ind. Pharm.* 46 (2020) 1123–1132.
- [18] N. Karaca, B. Demirci, F. Demirci, Evaluation of Lavandula stoechas L. Subsp. Stoechas L., Mentha spicata L. Subsp. Spicata L. Essential Oils and Their Main Components against Sinusitis Pathogens, *Z. für Naturforsch. C.* 73 (2018) 353–360.
- [19] E. Króllicka, K. Kieć-Kononowicz, D. Łazewska, Chalcones as Potential Ligands for the Treatment of Parkinson's Disease, *Pharmaceuticals* 15 (2022) 847.
- [20] R. Naigre, P. Kalck, C. Roques, I. Roux, G. Michel, Comparison of Antimicrobial Properties of Monoterpenes and Their Carbonylated Products, *Planta Med.* 62 (1996) 275–277.
- [21] A. Rauf, M. Akram, H. Anwar, M. Daniyal, N. Munir, S. Bawazeer, S. Bawazeer, M. Rebezov, A. Bouyahya, M.A. Shariati, Therapeutic Potential of Herbal Medicine for the Management of Hyperlipidemia: Latest Updates, *Environ. Sci. Pollut. Res.* (2022) 1–21.
- [22] B. Salehi, D. Mnayer, B. Özçelik, G. Altin, K.N. Kasapoğlu, C. Daskaya-Dikmen, M. Sharifi-Rad, Z. Selamoglu, K. Acharya, S. Sen, Plants of the Genus Lavandula: From Farm to Pharmacy, *Nat. Prod. Commun.* 13 (2018), 1934578X1801301037.
- [23] E. Schmidt, L. Jirovetz, G. Buchbauer, Z. Denkova, A. Stoyanova, I. Murgov, M. Geissler, Antimicrobial Testings and Gas Chromatographic Analyses of Aroma Chemicals, *J. Essent. oil Bear. Plants* 8 (2005) 99–106.
- [24] I. Trendafilova, J. Mihály, D. Momekova, R. Chimshirova, H. Lazarova, G. Momekov, M. Popova, Antioxidant Activity and Modified Release Profiles of Morin and Hesperetin Flavonoids Loaded in Mg-or Ag-Modified SBA-16 Carriers, *Mater. Today Commun.* 24 (2020), 101198.
- [25] M. D'hooghe, B. Willekens, V. Delvaux, M. D'haeseleer, D. Guillaume, G. Laureys, G. Nagels, P. Vanderdonck, Van Pesch, V.; Popescu, V. Sativex®(Nabiximols) Cannabinoid Oromucosal Spray in Patients with Resistant Multiple Sclerosis Spasticity: The Belgian Experience, *BMC Neurol.* 21 (2021) 1–9.
- [26] J.W.-H. Li, J.C. Vederas, Drug Discovery and Natural Products: End of an Era or an Endless Frontier? *Science* 325 (2009) 161–165.
- [27] I. Urits, K. Gress, K. Charipova, K. Habib, D. Lee, C. Lee, J.W. Jung, H. Kassem, E. Cornett, A. Paladini, Use of Cannabidiol (CBD) for the Treatment of Chronic Pain, *Best. Pract. Res. Clin. Anaesthesiol.* 34 (2020) 463–477.
- [28] L. Zhu, L. Chen, Progress in Research on Paclitaxel and Tumor Immunotherapy, *Cell. Mol. Biol. Lett.* 24 (2019) 1–11.
- [29] S. Akroum, D. Bendjedou, D. Satta, K. Lalaoui, Antibacterial Activity and Acute Toxicity Effect of Flavonoids Extracted from Mentha Longifolia, *Am. -Eurasia J. Sci. Res.* 4 (2009) 93–96.
- [30] K.K. Chiruvella, A. Mohammed, G. Dampuri, R.G. Ghanta, S.C. Raghavan, Phytochemical and Antimicrobial Studies of Methyl Angelensate and Luteolin-7-O-Glucoside Isolated from Callus Cultures of Soyimida Febrifuga, *Int. J. Biomed. Sci.: IJBS* 3 (2007) 269.
- [31] S. Kefi, R. Essid, K. Mkadmini, A. Kefi, F.M. Haddada, O. Tabbene, F. Limam, Phytochemical Investigation and Biological Activities of Echium Arenarium (Guss) Extracts, *Microb. Pathog.* 118 (2018) 202–210.
- [32] N.Z. Mamadalieva, F. Herrmann, M.Z. El-Readi, A. Tahrani, R. Hamoud, D. R. Egamberdieva, S.S. Azimova, M. Wink, Flavonoids in Scutellaria Immaculata and S. Ramosissima (Lamiaceae) and Their Biological Activity, *J. Pharm. Pharmacol.* 63 (2011) 1346–1357.
- [33] L.S. Ooi, H. Wang, Z. He, V.E. Ooi, Antiviral Activities of Purified Compounds from Youngia japonica (L.) DC (Asteraceae, Compositae), *J. Ethnopharmacol.* 106 (2006) 187–191.
- [34] Salawu, S.O.; Ogundare, A.O.; Ola-Salawu, B.B.; Akindahunsi, A.A. Antimicrobial Activities of Phenolic Containing Extracts of Some Tropical Vegetables. 2011.
- [35] Z. Shojaeifard, B. Hemmateenejad, A.R. Jassbi, Chemometrics-Based LC-UV-ESIMS Analyses of 50 Salvia Species for Detecting Their Antioxidant Constituents, *J. Pharm. Biomed. Anal.* 193 (2021), 113745.
- [36] N. Wang, H. Chen, L. Xiong, X. Liu, X. Li, Q. An, X. Ye, W. Wang, Phytochemical Profile of Ethanolic Extracts of Chimonanthus Salicifolius SY Hu. Leaves and Its Antimicrobial and Antibiotic-Mediating Activity, *Ind. Crops Prod.* 125 (2018) 328–334.
- [37] J. Xiong, S. Li, W. Wang, Y. Hong, K. Tang, Q. Luo, Screening and Identification of the Antibacterial Bioactive Compounds from Lonicera japonica Thunb. Leaves, *Food Chem.* 138 (2013) 327–333.
- [38] L. Žemlička, P. Fodran, V. Lukeš, A. Vagánek, M. Slovákova, A. Staško, T. Dubaj, T. Liptaj, M. Karabín, L. Bírošová, Physicochemical and Biological Properties of Luteolin-7-O-β-d-Glucoside (Cynaroside) Isolated from Anthriscus sylvestris (L.) Hoffm, *Mon. für Chem. -Chem. Mon.* 145 (2014) 1307–1318.

- [39] X. Zhu, H. Zhang, R. Lo, Phenolic Compounds from the Leaf Extract of Artichoke (*Cynara scolymus* L.) and Their Antimicrobial Activities, *J. Agric. Food Chem.* 52 (2004) 7272–7278.
- [40] M. Tomczykowa, M. Tomczyk, P. Jakoniuk, E. Tryniszewska, Antimicrobial and Antifungal Activities of the Extracts and Essential Oils of *Bidens tripartita*, *Folia Histochem. Et. Cytobiol.* 46 (2008) 389–393.
- [41] S. Tabrez, F. Rahman, R. Ali, A.S. Alouffi, S.K. Akand, B.M. Alshehri, F. A. Alshammari, A. Alam, M.A. Alaidarous, S. Banawas, Cynaroside Inhibits *Leishmania* Donovanii UDP-Galactopyranose Mutase and Induces Reactive Oxygen Species to Exert Antileishmanial Response, *Biosci. Rep.* (2021) 41.
- [42] H.O. Elansary, A. Szopa, P. Kubica, H. Ekiert, M. Klimek-Szczykutowicz, D.O. El-Ansary, E.A. Mahmoud, Polyphenol Profile and Antimicrobial and Cytotoxic Activities of Natural Mentha's Piperita and Mentha Longifolia Populations in Northern Saudi Arabia, *Processes* 8 (2020) 479.
- [43] S.-J. Kim, J.-Y. Cho, J.-H. Wee, M.-Y. Jang, C. Kim, Y.-S. Rim, S.-C. Shin, S.-J. Ma, J.-H. Moon, K.-H. Park, Isolation and Characterization of Antioxidative Compounds from the Aerial Parts of *Angelica Keiskei*, *Food Sci. Biotechnol.* 14 (2005) 58–63.
- [44] H. Liu, S. Zhu, Q. Liu, Y. Zhang, Spectrum–Effect Relationship Study between HPLC Fingerprints and Antioxidant of Honeysuckle Extract, *Biomed. Chromatogr.* 33 (2019), e4583.
- [45] N.-H. Ma, J. Guo, S.-H. Xu Chen, X.-R. Yuan, T. Zhang, Y. Ding, Antioxidant and Compositional HPLC Analysis of Three Common Bamboo Leaves, *Molecules* 25 (2020) 409.
- [46] N. Orhan, Ü.G. İçöz, L. Altun, M. Aslan, Anti-Hyperglycaemic and Antioxidant Effects of *Bidens tripartita* and Quantitative Analysis on Its Active Principles, *Iran. J. Basic Med. Sci.* 19 (2016) 1114.
- [47] X. Sun, G. Sun, M. Wang, J. Xiao, X. Sun, Protective Effects of Cynaroside against H2O2-Induced Apoptosis in H9c2 Cardiomyoblasts, *J. Cell. Biochem.* 112 (2011) 2019–2029.
- [48] H. Yu, J. Li, X. Hu, J. Feng, H. Wang, F. Xiong, Protective Effects of Cynaroside on Oxidative Stress in Retinal Pigment Epithelial Cells, *J. Biochem. Mol. Toxicol.* 33 (2019), e22352.
- [49] S. Yazici-Tutunis, E. Gurel-Gurevin, S. Ustunova, C. Demirci-Tansel, F. Mericli, Possible Effects of *Phillyrea Latifolia* on Weight Loss in Rats Fed a High-Energy Diet, *Pharm. Biol.* 54 (2016) 1991–1997.
- [50] J.C. Park, J.G. Park, H.J. Kim, J.M. Htur, J.H. Lee, N.J. Sung, S.K. Chung, J. W. Choi, Effects of Extract from *Angelica Keiskei* and Its Component, Cynaroside, on the Hepatic Bromobenzene-Metabolizing Enzyme System in Rats, *Phytother. Res.* 16 (2002) 24–27.
- [51] L.V. Van, E.C. Pham, C.V. Nguyen, N.T.N. Duong, T.V. Le Thi, T.N. Truong, In Vitro and in Vivo Antidiabetic Activity, Isolation of Flavonoids, and in Silico Molecular Docking of Stem Extract of *Merremia Tridentata* (L.), *Biomed. Pharmacother.* 146 (2022), 112611.
- [52] B.-B. Wei, Z.-X. Chen, M.-Y. Liu, M.-J. Wei, Development of a UPLC-MS/MS Method for Simultaneous Determination of Six Flavonoids in Rat Plasma after Administration of *Maydis Stigma* Extract and Its Application to a Comparative Pharmacokinetic Study in Normal and Diabetic Rats, *Molecules* 22 (2017) 1267.
- [53] J.-S. Kim, C.-S. Kwon, K.H. Son, Inhibition of Alpha-Glucosidase and Amylase by Luteolin, a Flavonoid, *Biosci., Biotechnol., Biochem.* 64 (2000) 2458–2461.
- [54] M. Szezkalska, K. Sosnowska, M. Tomczykowa, K. Winnicka, I. Kasacka, M. Tomczyk, In Vivo Anti-Inflammatory and Anti-Allergic Activities of Cynaroside Evaluated by Using Hydrogel Formulations, *Biomed. Pharmacother.* 121 (2020), 109681.
- [55] Y. Zou, M. Zhang, T. Zhang, J. Wu, J. Wang, K. Liu, N. Zhan, Antioxidant and Anti-Inflammatory Activities of Cynaroside from *Elsholtzia Bodinieri*, *Nat. Prod. Commun.* 13 (2018), 1934578X1801301122.
- [56] L. Pei, Y. Le, H. Chen, J. Feng, Z. Liu, J. Zhu, C. Wang, L. Chen, X. Dou, D. Lu, Cynaroside Prevents Macrophage Polarization into Pro-Inflammatory Phenotype and Alleviates Cecal Ligation and Puncture-Induced Liver Injury by Targeting PKM2/HIF-1 α Axis, *Fitoterapia* 152 (2021), 104922.
- [57] Odontuya, G.; Hoult, J.R.S.; Houghton, P.J. Structure-activity Relationship for Antiinflammatory Effect of Luteolin and Its Derived Glycosides. *Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives* 2005, 19, 782–786.
- [58] J. Feng, Z. Liu, H. Chen, M. Zhang, X. Ma, Q. Han, D. Lu, C. Wang, Protective Effect of Cynaroside on Sepsis-Induced Multiple Organ Injury through Nrf2/HO-1-Dependent Macrophage Polarization, *Eur. J. Pharmacol.* 911 (2021), 174522.
- [59] S.A. Lee, B.-R. Park, S.-M. Moon, J.H. Hong, D.K. Kim, C.S. Kim, Chondroprotective Effect of Cynaroside in IL-1 β -Induced Primary Rat Chondrocytes and Organ Explants via NF-KB and MAPK Signaling Inhibition, *Oxid. Med. Cell. Longev.* 2020 (2020).
- [60] W. Wei, H. Ping, J. XiaoMing, Anti-Inflammatory and Antioxidant Effects of Luteolin and Its Flavone Glycosides, *Shipin Kexue/Food Sci.* 41 (2020) 208–215.
- [61] B.T. Phuong Thuy, N.T. Ai Nhung, T. Duong, P.Van Trung, N.M. Quang, H.T. Kim Dung, P. Tat, Van Prediction of Anticancer Activities of Cynaroside and Quercetin in Leaf of Plants *Cynara scolymus* L and *Artocarpus Incisa* L Using Structure–Activity Relationship, *Cogent Chem.* 2 (2016) 1212452.
- [62] J. Ji, Z. Wang, W. Sun, Z. Li, H. Cai, E. Zhao, H. Cui, Effects of Cynaroside on Cell Proliferation, Apoptosis, Migration and Invasion Through the MET/AKT/MTOR Axis in Gastric Cancer, *Int. J. Mol. Sci.* 22 (2021) 12125.
- [63] J.-H. Nho, H.-K. Jung, M.-J. Lee, J.-H. Jang, M.-O. Sim, D.-E. Jeong, H.-W. Cho, J.-C. Kim, Beneficial Effects of Cynaroside on Cisplatin-Induced Kidney Injury in Vitro and in Vivo, *Toxicol. Res.* 34 (2018) 133–141.
- [64] J.H. Nho, H.K. Jung, M.J. Lee, J.H. Jang, M.O. Sim, J.K. Jung, D.E. Jung, B.K. An, H.W. Cho, Inhibitory Effect of Cynaroside Isolated from *Lonicera Japonica* Thunb on Doxorubicin-Induced Necrosis in Human Renal Proximal Tubular HK-2 Cells. *Korean, J. Med. Crop Sci.* 25 (2017) 322–327.
- [65] Sa, R.; Daouf, A.; Sa, C. Identification of Chemical Constituents in Rat Serum and Brain Tissue of Cumin (*Cuminum cyminum* L.) Aqueous Extract by UPLC-Q-TOF-MS. *Cuminum cyminum* 2022.
- [66] R. Saif, G. Ali, K. Ashfaq, S. Zia, A.R. Qureshi, Computational Prediction of Oleauropea Compounds as Inhibitor of Main-Peptidase of SARS-CoV2, *Adv. Life Sci.* 8 (2021) 133–136.
- [67] Hong, J.H.; Lee, M.J.; Jo, Y.I.; Moon, S.M.; Lee, S.A.; Kim, C.S. Analytical Method Validation of Cynaroside in Domestic *Anthriscus sylvestris* (L.) Hoffm. Leaves Extract for Standardization as a Functional Ingredient Using RP-HPLC. 2021.
- [68] T.X.T. Nguyen, D.L. Dang, V.Q. Ngo, T.C. Trinh, Q.N. Trinh, T.D. Do, T.T. T. Thanh, Anti-Inflammatory Activity of a New Compound from *Vernonia Amygdalina*, *Nat. Prod. Res.* 35 (2021) 5160–5165.
- [69] Y. Dong, C. Chen, C. Zhang, L. Zhang, Y. Zhang, Y. Li, Z. Dong, Stigmasterol Inhibits the Progression of Lung Cancer by Regulating Retinoic Acid-Related Orphan Receptor C, *Histol. Histopathol.* (2021), 18388–18388.
- [70] P.H. Borges, S. Pedreiro, S.J. Baptista, C.F. Geraldes, M.T. Batista, M.M. Silva, A. Figueirinha, Inhibition of α -Glucosidase by Flavonoids of *Cymbopogon citratus* (DC) Stapf, *J. Ethnopharmacol.* 280 (2021), 114470.
- [71] A. Aras, F. Türkan, U. Yildiko, M.N. Atalar, Ö. Kılıç, M.H. Alma, E. Bursal, Biochemical Constituent, Enzyme Inhibitory Activity, and Molecular Docking Analysis of an Endemic Plant Species, *Thymus Migricus*, *Chem. Pap.* 75 (2021) 1133–1146.
- [72] O.Y. Adeniran, D.S. Metibemu, E.O. Akinsiku, O.A. Akinloye, R.N. Ugbaja, A. J. Akamo, A.O. Metibemu, A.O. Olusola, I.O. Omotuyi, Homo Sapien Bcr-Abl-Interacting Scaffolds from *Bryophyllum Pinnatum* and *Cantharanthus Roseus*: Computational Studies. *NISEB, Journal* (2021) 19.
- [73] A. Akbari-Avhangar, M.-R. Delnavazi, Flavone Glycosides from the Aerial Parts of *Stachys Lavandulifolia* Vahl, *Pharm. Sci.* 26 (2020) 198–202.
- [74] E. Bimenyindavvi, O.A. Timofeeva, Phenolics and Ascorbic Contents in Two Sage (*Salvia* Sps. I) Species, *J. Exp. Biol. Agric. Sci.* 8 (2020) S286–S291.
- [75] M.R. Chowdhury, K.H. Chowdhury, N.B. Hanif, M.A. Sayeed, J. Mouah, I. Mahmud, A.M. Kamal, M.N.U. Chy, M. Adnan, An Integrated Exploration of Pharmacological Potencies of *Bischofia javanica* (Blume) Leaves through Experimental and Computational Modeling, *Heliyon* 6 (2020), e04895.
- [76] J. Ellenberger, N. Siefen, P. Krefting, Schulze Lutum, J.-B.; Pfarr, D.; Rimmel, M.; Schröder, L.; Röhlen-Schmittgen, S. Effect of UV Radiation and Salt Stress on the Accumulation of Economically Relevant Secondary Metabolites in Bell Pepper Plants, *Agronomy* 10 (2020) 142.
- [77] F. Emad, A.K. Khalafalah, M.A. El Sayed, A.-E.H. Mohamed, M. Stadler, S. E. Helaly, Three New Polyacetylene Glycosides (PAGs) from the Aerial Part of *Launaea Capitata* (Asteraceae) with anti-biofilm activity against *Staphylococcus aureus*, *Fitoterapia* 143 (2020), 104548.
- [78] S.H. Ghoran, O. Firuzi, A.R. Jassbi, Phytoconstituents from the Aerial Parts of *Salvia Dracocephaloidea* Boiss. and Their Biological Activities, *J. Environ. Treat. Tech.* 8 (2020) 1274–1278.
- [79] R. Mogana, A. Adhikari, M.N. Tzar, R. Ramliza, C. Wiart, Antibacterial Activities of the Extracts, Fractions and Isolated Compounds from *Canarium Patentinervium* Miq. against Bacterial Clinical Isolates, *BMC Comp. Med. Therapies* 20 (2020) 1–11.
- [80] N.-T. Nguyen, T.-H. Nguyen, T.-H. Tran, T.-H.M. Thi, N.-T.N. Thi, X.-H. Tang, V.-H. Ha, G.-B. Tran, D.-T. Tran, Chemical constituents from the seeds of *Alpinia Blerpharocalyx* K. Schum in Vietnam and their bioactives, *Pharmacophore* (2020) 11.
- [81] M.G. Suh, H.-S. Choi, K. Cho, S.S. Park, W.J. Kim, H.J. Suh, H. Kim, Anti-Inflammatory Action of Herbal Medicine Comprised of *Scutellaria Baicalensis* and *Chrysanthemum morifolium*, *Biosci., Biotechnol., Biochem.* 84 (2020) 1799–1809.
- [82] K. Patonay, O. Szabó-Hudák, H. Szalontai, M. Jánószky, E. Kónya, É. Németh, Extraction and Identification of Major Polyphenol Constituents of Northern Hungarian Horsemint (*Mentha Longifolia* L.(L.)), *Acta Biol. Plant. Agriensis* 8 (2020) 53–68.
- [83] Patonay, K.; Szalontai, H.; Jánószky, M.; Lovas, M.; Pénezsné, E. Main Phenolic Constituents of *Mentha Longifolia* (L.) L. Samples from Northern Hungary–Extractability, Variability and Contribution to Some in Vitro Antioxidant Properties of the Plant. 2019.
- [84] L. Celaya, C. Vitorro, L.R. Silva, *Acantholippia Salsoloides*: Phytochemical Composition and Biological Potential of a Thujonic Population, *Nat. Prod. Commun.* 14 (2019), 1934578X19858542.
- [85] F. Genzel, M.D. Dicke, L.V. Junker-Frohn, A. Neuwohner, B. Thiele, A. Putz, B. Usadel, A. Wormit, A. Wiese-Klinkenberg, Impact of Moderate Cold and Salt Stress on the Accumulation of Antioxidant Flavonoids in the Leaves of Two Capsicum Cultivars, *J. Agric. Food Chem.* 69 (2021) 6431–6443.
- [86] I.K. Karabagias, V.K. Karabagias, K.A. Riganakos, Physico-Chemical Parameters, Phenolic Profile, in Vitro Antioxidant Activity and Volatile Compounds of *Ladastacho* (*Lavandula stoechas*) from the Region of Saidona, *Antioxidants* 8 (2019) 80.
- [87] H. Liu, S. Zhu, Q. Liu, Y. Zhang, Spectrum–Effect Relationship Study between HPLC Fingerprints and Antioxidant of Honeysuckle Extract, *Biomed. Chromatogr.* 33 (2019), e4583.
- [88] A. Szopa, A. Starzec, H. Ekiert, The Importance of Monochromatic Lights in the Production of Phenolic Acids and Flavonoids in Shoot Cultures of *Aronia melanocarpa*, *Aronia arbutifolia* and *Aronia's Prunifolia*, *J. Photochem. Photobiol. B: Biol.* 179 (2018) 91–97.

- [89] S.-H. Lee, H.-W. Kim, M.-K. Lee, Y.-J. Kim, G. Asamenew, Y.-S. Cha, J.-B. Kim, Phenolic Profiling and Quantitative Determination of Common Sage (*Salvia Plebeia* R. Br.) by UPLC-DAD-QTOF/MS, *Eur. Food Res. Technol.* 244 (2018) 1637–1646.
- [90] J.-H. Nho, H.-K. Jung, M.-J. Lee, J.-H. Jang, M.-O. Sim, D.-E. Jeong, H.-W. Cho, J.-C. Kim, Beneficial Effects of Cynaroside on Cisplatin-Induced Kidney Injury in Vitro and in Vivo, *Toxicol. Res.* 34 (2018) 133–141.
- [91] J.H. Nho, H.K. Jung, M.J. Lee, J.H. Jang, M.O. Sim, J.K. Jung, D.E. Jung, B.K. An, H.W. Cho, Inhibitory Effect of Cynaroside Isolated from *Lonicera Japonica* Thunb on Doxorubicin-Induced Necrosis in Human Renal Proximal Tubular HK-2 Cells, *Korean J. Med. Crop Sci.* 25 (2017) 322–327.
- [92] E. Chuluunbaatar, P. Sodnomtseren, C. Chimedtseren, G. Batsuren, B. Dulamjav, Isolation of Two Flavonoids and Mannitol from *Lagotis Integrifolia* (Willd.) Schischk (Scrophulariaceae), *Central Asian J. Med. Sci.* 3 (2017) 167–172.
- [93] A. Korga, A. Józefczyk, G. Zgórk, M. Homa, M. Ostrowska, F. Burdan, J. Dudka, Evaluation of the Phytochemical Composition and Protective Activities of Methanolic Extracts of *Centaurea Borysthena* and *Centaurea Daghestanica* (Lipsky) Wagenitz on Cardiomyocytes Treated with Doxorubicin, *Food Nutr. Res.* 61 (2017) 1344077, <https://doi.org/10.1080/16546628.2017.1344077>.
- [94] D.N. Olennikov, N.K. Chirikova, C. Vennos, Chemical Composition, Antioxidant and Anticholinesterase Activities of *Gentianaella Azurea* from Russian Federation, *Nat. Prod. Commun.* 12 (2017), 1934578X1701200115.
- [95] R. Dobrucka, Synthesis and Structural Characteristic of Platinum Nanoparticles Using Herbal *Bidens Tripartita* Extract, *J. Inorg. Organomet. Polym. Mater.* 26 (2016) 219–225.
- [96] M. Wolniak, M. Tomczykowa, M. Tomczyk, J. Gudej, I. Wawer, Antioxidant Activity of Extracts and Flavonoids from *Bidens tripartita*, *Acta Pol. Pharm.* 64 (2007) 441–447.
- [97] G. Costa, J.P. Ferreira, C. Vitorino, M.E. Pina, J.J. Sousa, I.V. Figueiredo, M. T. Batista, Polyphenols from *Cymbopogon citratus* Leaves as Topical Anti-Inflammatory Agents, *J. Ethnopharmacol.* 178 (2016) 222–228.
- [98] L. Lei, Y. Bin, Z. Wenxue, R. Guangyue, D. Xu, K. Xinyan, Degradation Kinetics of Functional Components of Honeysuckle Flowers during Controlled-Atmosphere Heat Pump Drying, *Int. J. Agric. Biol. Eng.* 9 (2016) 159–168.
- [99] H.U. Wen, G.U.O. Ting, W.-J. Jiang, D. Guang-Li, C. Da-Wei, Y. Shi-Lin, L.I. He-Ran, Effects of Ultrahigh Pressure Extraction on Yield and Antioxidant Activity of Chlorogenic Acid and Cynaroside Extracted from Flower Buds of *Lonicera japonica*, *Chin. J. Nat. Med.* 13 (2015) 445–453.
- [100] O.T. Olaru, G.M. Nițulescu, A. Orțan, C.E. Dinu-Pirvu, Ethnomedicinal, Phytochemical and Pharmacological Profile of *Anthriscus sylvestris* as an Alternative Source for Anticancer Lignans, *Molecules* 20 (2015) 15003–15022.
- [101] V.A. Saffloroside Kurkin, A New Flavonoid from Flowers of *Carthamus tinctorius* L., *J. Pharmacogn. Phytochem.* (2015) 4.
- [102] M.R. Delnavazi, M. Shahabi, N. Yassa, Flavonoids Leaves Iran. Linden; *Tilia Rubra* Subsp. *Caucasica*, *Res. J. Pharmacogn.* 2 (2015) 17–22.
- [103] Ahmed, S.A.; Kamel, E.M. Cytotoxic Activities of Flavonoids from *Centaurea Scoparia*, *The Scientific world journal* 2014, 2014.
- [104] Y. Huang, H. Chen, F. He, Z.-R. Zhang, L. Zheng, Y. Liu, Y.-Y. Lan, S.-G. Liao, Y.-J. Li, Y.-L. Wang, Simultaneous Determination of Human Plasma Protein Binding of Bioactive Flavonoids in Polygonum Orientale by Equilibrium Dialysis Combined with UPLC-MS/MS, *J. Pharm. Anal.* 3 (2013) 376–381.
- [105] Y. Huang, P. Zhang, F. He, L. Zheng, Y. Wang, J. Wu, Simultaneous Determination of Four Bioactive Flavonoids from Polygonum Orientale L. in Dog Plasma by UPLC-ESI-MS/MS and Application of the Technique to Pharmacokinetic Studies, *J. Chromatogr. B* 957 (2014) 96–104.
- [106] Osmachko, A.P.; Kovaleva, A.M.; Ochkur, O.V.; Sydora, N.V. Morphological, Anatomical and Phytochemical Research of *Veronica longifolia* L. Herb. 2013.
- [107] D.N. Olennikov, N.K. Chirikova, Z.M. Okhlopova, I.S. Zulfugarov, Chemical Composition and Antioxidant Activity of *Tánara Ótó* (*Dracocephalum Palmatum* Stephan), a Medicinal Plant Used by the North-Yakutian Nomads, *Molecules* 18 (2013) 14105–14121.
- [108] D.N. Olennikov, L.M. Tankhaeva, N.A. Pankrushina, D.V. Sandanov, Phenolic Compounds of *Sophora flavescens* Soland. of Russian Origin, *Russ. J. Bioorg. Chem.* 39 (2013) 755–760.
- [109] A. Nugroho, M.-H. Kim, J. Choi, N.-I. Baek, H.-J. Park, In Vivo Sedative and Gastroprotective Activities of *Salvia Plebeia* Extract and Its Composition of Polyphenols, *Arch. Pharmacol. Res.* 35 (2012) 1403–1411.
- [110] A.V. Kurkina, A Method for the Assay of Total Flavonoids in Common Agrimony Herb, *Pharm. Chem. J.* 45 (2011) 43–46.
- [111] A.R. Gohari, S. Saeidnia, K. Mollazadeh, N. Yassa, M. Malmir, A.R. Shahverdi, Isolation of a New Quinic Acid Derivative and Its Antibacterial Modulating Activity, *Daru: Journal of Faculty of Pharmacy, Tehran Univ. Med. Sci.* 18 (2010) 69.
- [112] K.-S. Lee, G.-H. Kim, H.-H. Kim, E.-S. Kim, H.-M. Park, M.-J. Oh, Quality Characteristics of Tea Thermally Processed from Dried *Ilex Dentata* Root, *Korean J. Food Preserv.* 15 (2008) 524–531.
- [113] S.K. Sadhu, F. Ahmed, T. Ohtsuki, M. Ishibashi, Flavonoids from *Sonneratia Caseolaris*, *J. Nat. Med.* 60 (2006) 264–265.
- [114] S. Bolkent, R. Yanardag, O. Karabulut-Bulan, B. Yesilyaprak, Protective Role of *Melissa officinalis* L. Extract on Liver of Hyperlipidemic Rats: A Morphological and Biochemical Study, *J. Ethnopharmacol.* 99 (2005) 391–398.
- [115] Z.A. Khushbaktova, S.K. Faizieva, V.N. Syrov, M.P. Yuldashev, E.K. Batirov, A. U. Mamatkhanov, Isolation, Chemical Analysis, and Study of the Hypolipidemic Activity of the Total Flavonoid Extract from *Thermopsis Althernaiflora*, *Pharm. Chem. J.* 35 (2001) 155–158.
- [116] P. Marques, J. Marto, L.M. Gonçalves, R. Pacheco, M. Fitas, P. Pinto, M.L. M. Serralheiro, H. Ribeiro, *Cynara scolymus* L.: A Promising Mediterranean Extract for Topical Anti-Aging Prevention, *Ind. Crops Prod.* 109 (2017) 699–706.
- [117] A.S. El Senousy, M.A. Farag, D.A. Al-Mahdy, L.A. Wessjohann, Developmental Changes in Leaf Phenolics Composition from Three Artichoke Cvs. (*Cynara scolymus*) as Determined via UHPLC-MS and Chemometrics, *Phytochemistry* 108 (2014) 67–76.
- [118] M.I. Nassar, T.K. Mohamed, A.I. Elshamy, S.A. El-Toumy, A.M.A. Lateef, A.-R. H. Farrag, Chemical Constituents and Anti-Ulcerogenic Potential of the Scales of *Cynara scolymus* (Artichoke) Heads, *J. Sci. Food Agric.* 93 (2013) 2494–2501.
- [119] E. Georgieva, Y. Karamalakova, G. Nikolova, B. Grigorov, D. Pavlov, V. Gadjeva, A. Zheleva, Radical Scavenging Capacity of Seeds and Leaves Ethanol Extracts of *Cynara scolymus* L.—A Comparative Study, *Biotechnol. Equip.* 26 (2012) 151–155.
- [120] A. Romani, P. Pinelli, C. Cantini, A. Cimato, D. Heimler, Characterization of *Violetto Di Toscana*, a Typical Italian Variety of Artichoke (*Cynara scolymus* L.), *Food Chem.* 95 (2006) 221–225.
- [121] F. Emendörfer, F. Emendörfer, F. Bellato, V.F. Noldin, V. Cechinel-Filho, R. A. Yunes, Delle Monache, F.; Cardozo, A.M. Antispasmodic Activity of Fractions and Cynaropicrin from *Cynara scolymus* on Guinea-Pig Ileum, *Biol. Pharm. Bull.* 28 (2005) 902–904.
- [122] H. Li, N. Xia, I. Brausch, Y. Yao, U. Förstermann, Flavonoids from Artichoke (*Cynara scolymus* L.) up-Regulate Endothelial-Type Nitric-Oxide Synthase Gene Expression in Human Endothelial Cells, *J. Pharmacol. Exp. Ther.* 310 (2004) 926–932.
- [123] M. Wang, J.E. Simon, I.F. Aviles, K. He, Q.-Y. Zheng, Y. Tadmor, Analysis of Antioxidative Phenolic Compounds in Artichoke (*Cynara scolymus* L.), *J. Agric. Food Chem.* 51 (2003) 601–608.
- [124] M. Häusler, M. Ganzer, G. Abel, M. Popp, H. Stuppner, Determination of Caffeoylquinic Acids and Flavonoids in *Cynara scolymus* L. by High Performance Liquid Chromatography, *Chromatographia* 56 (2002) 407–411.
- [125] Nüßlein, B.; Kreis, W. Purification and Characterization of a Cynaroside 7-O- β -d-Glucosidase from *Cynarae Scolymi Folium*. In Proceedings of the IV International Congress on Artichoke 681; 2000; pp. 413–420.
- [126] F.M. Hammouda, Seif El-Nasr, M.M. Shahat, A.A. Flavonoids Of *Cynara scolymus* L. Cultivated in Egypt, *Plant Foods Hum. Nutr.* 44 (1993) 163–169.
- [127] V. Lattanzio, I. Morone, Variations of the Orthodiphenol Content Of *Cynara scolymus* L. during the Plant Growing Seasons, *Experientia* 35 (1979) 993–994.
- [128] L.N. Gvazava, Cynaroside from the Leaves Of *Digitalis Ciliata*, *Chem. Nat. Compd.* 12 (1976) 737–738.
- [129] S.F. Dzhumyrko, Flavonoids of Plants of the Genus *Symphandra*, *Chem. Nat. Compd.* 11 (1975), 537–537.
- [130] N.K. Vavilova, É. Gella, Homoorientin from *Phlomis tuberosa*, *Chem. Nat. Compd.* 9 (1973), 282–282.
- [131] M. Tomczykowa, M. Tomczyk, K. Leszczyrska, D. Kalemba, Flavonoids and Essential Oil of *Bidens cernua* of Polish Origin and in Vitro Antimicrobial Activity of the Oil, *Res. Nat. Prod.* 11 (2017) 468–473.
- [132] H.O. Elansary, A. Szopa, P. Kubica, H. Ekiert, M. Klimek-Szczykutowicz, D.O. El-Ansary, E.A. Mahmoud, Polyphenol Profile and Antimicrobial and Cytotoxic Activities of Natural *Mentha*, *Piperita* and *Mentha Longifolia* Populations in Northern Saudi Arabia, *Processes* 8 (2020) 479.
- [133] Z.S. Ahmed, S.S. Abozed, M.S. Negm, Nutritional Value and Sensory Profile of Gluten-Free Tiger Nut Enriched Biscuit, *World J. Dairy Food Sci.* 9 (2014) 127–134.
- [134] H.-C. Huang, D. Tang, K. Xu, Z.-F. Jiang, Curcumin Attenuates Amyloid- β -Induced Tau Hyperphosphorylation in Human Neuroblastoma SH-SY5Y Cells Involving PTEN/Akt/GSK-3 β Signaling Pathway, *J. Recept. Signal Transduct.* 34 (2014) 26–37.
- [135] S.A. Lee, B.-R. Park, S.-M. Moon, S.H. Shin, J.-S. Kim, D.K. Kim, C.S. Kim, Cynaroside Protects Human Periodontal Ligament Cells from Lipopolysaccharide-Induced Damage and Inflammation through Suppression of NF-KB Activation, *Arch. Oral. Biol.* 120 (2020), 104944.



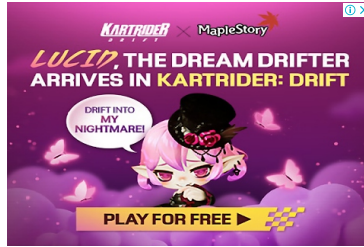
Enter Journal Title, ISSN or Publisher Name

also developed by scimago:  SCIMAGO INSTITUTIONS RANKINGS

SJR

Scimago Journal & Country Rank


- Home
- Journal Rankings
- Country Rankings
- Viz Tools
- Help
- About Us




Biomedicine and Pharmacotherapy

COUNTRY

France

 Universities and research institutions in France

 Media Ranking in France

PUBLISHER

Elsevier
Masson
s.r.l.

H-INDEX

10
9



SUBJECT AREA AND CATEGORY

Medicine
Medicine (miscellaneous)

Pharmacology, Toxicology and Pharmaceutics
Pharmacology

PUBLICATION TYPE

Journals

ISSN

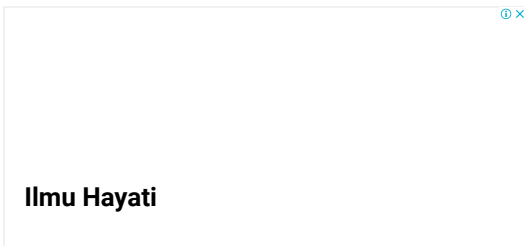
07533322

COVERAGE

1982-2021


INFORMATION

- [Homepage](#)
- [How to publish in this journal](#)
- [Contact](#)



SCOPE

Biomedicine & Pharmacotherapy is a multidisciplinary journal which publishes full-length, original research reports, reviews, and preliminary communications or letters to the editor which fall within the general scope of clinical and basic medicine and pharmacology. The general fields of interest will include Cancer, Nutraceuticals, Neurodegenerative, Cardiac and Infectious Diseases. Special emphasis will be placed on studies of specific topics such as molecular mechanisms, gene regulation in normal and pathologic cells as well as susceptibility in response to oncogenic agents. Effects of drugs on preclinical and clinical pharmacology and the role of bacteria, viruses and parasites in animals and humans. Brief reports of meetings, symposia and conferences will also be considered for publication as well as brief listings of scientific meetings or academic courses of interest to the readers

 Join the conversation about this journal

Submit paper for publication

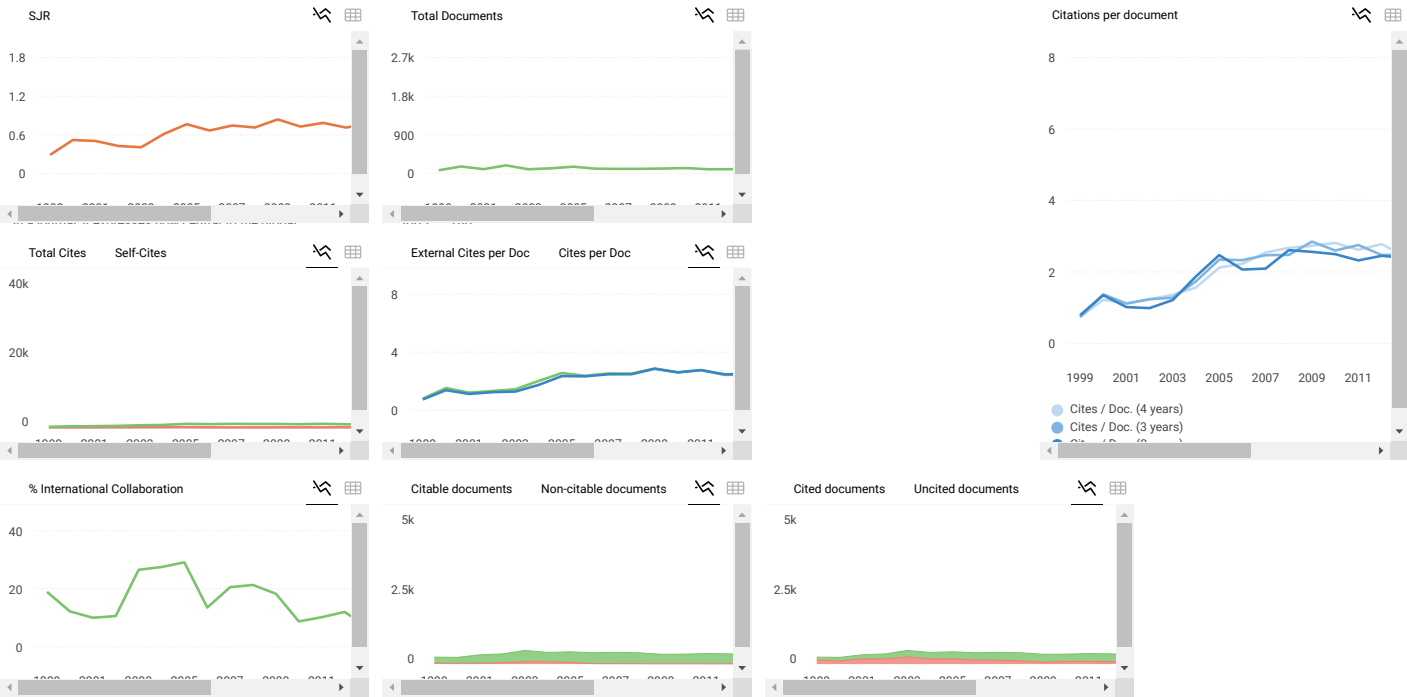
Submit paper publication

How to Publish Paper, free cost publication, ugc care journal policy follow

FIND SIMILAR JOURNALS ?

options ⋮

<p>1 Life Sciences USA</p> <p>85% similarity</p>	<p>2 American Journal of Translational Research USA</p> <p>81% similarity</p>	<p>3 Bioscience Reports GBR</p> <p>80% similarity</p>	<p>4 Molecular Medicine Reports GRC</p> <p>80% similarity</p>	<p>5 International Journal of Molecular Medicine GRC</p> <p>79% similarity</p>
--	---	---	---	--



Biomedicine and Pharmacotherapy

Q1
Medicine (miscellaneous)
best quartile

SJR 2021
1.19

powered by scimagojr.com

Show this widget in your own website

Just copy the code below and paste within your html code:

`<a href="https://www.scimag`

SCImago Graphica

Explore, visually communicate and make sense of data with our **new data visualization tool**.

