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J.-M. Mérillon · K.G. Ramawat

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Halina Maria Ekiert  
Kishan Gopal Ramawat  
Jaya Arora *Editors*

# Plant Antioxidants and Health

 Springer

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# Reference Series in Phytochemistry

## Series Editors

Jean-Michel Mérillon, Faculty of Pharmaceutical Sciences, Institute of Vine and Wine Sciences, University of Bordeaux, Villenave d'Ornon, France

Kishan Gopal Ramawat, Department of Botany, Mohanlal Sukhadia University, Udaipur, India

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Halina Maria Ekiert • Kishan Gopal Ramawat •  
Jaya Arora  
Editors

# Plant Antioxidants and Health

With 144 Figures and 63 Tables

 Springer

*Editors*

Halina Maria Ekiert  
Department of Pharmaceutical Botany  
Jagiellonian University, Medical College  
Kraków, Poland

Kishan Gopal Ramawat  
Department of Botany  
Mohanlal Sukhadia University  
Udaipur, India

Jaya Arora  
Department of Botany  
Mohanlal Sukhadia University  
Udaipur, India

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## Preface

Antioxidants are small molecules, such as tocopherol, ascorbate, selenite, and many more, which occur naturally in fruits, vegetables, and beverages and possess a unique chemical activity that quenches the reactive oxygen species (ROS). ROS can be very harmful for human system as it damages macromolecules and cell components by oxidation reaction. Daily intake of natural antioxidants prevents the occurrence of many cardiovascular, heart, and neurological diseases and extends the life span. Polyphenols and carotenoids are some major bioactive molecule groups which are obtained from plants and play significant role as antioxidants. Currently, various research groups are actively working on various cellular models to evaluate the antioxidant capacity of bioactive molecules and their role in prevention of various ailments. Examples of such compounds are epigallocatechin gallate, a catechin-based flavonoid in green tea leaves, curcuminoids from turmeric, cinnamon extract, and resveratrol from red grapes. In the present COVID-19 pandemic, natural dietary sources rich in antioxidants, such as polyphenols and carotenoids, have been clinically proven to reduce oxidative stress and inflammation, which play important role in progression of COVID-19 severity. Therefore, this is a timely compilation of information as one book. This book aims to provide a comprehensive account of sources of antioxidants, their beneficial activity, mechanism of action of these antioxidants, and their involvement in prevention of various diseases and improvement of general health (anti-aging effect). The chapters are written by well-recognized group leaders working in this field. The book is divided into four parts: I “Antioxidant Resources,” II “Utilization of Antioxidants,” III “Antioxidants and Health,” and IV “Screening, Preservation, and Determination Methods for Antioxidants,” spread over 29 chapters. The additional attraction of book is the detailed part which gives insights of many analytical methodologies involving diverse instrumental techniques that are being developed for the separation, identification, and quantification of antioxidant compounds with detailed description of certain advanced methods of extraction, such as microwave-, ultrasound-, enzyme-assisted, and supercritical fluid extraction. Microencapsulation methods for food antioxidants and various methods to measure antioxidant activities can be beneficial literature for budding researchers in this field. Besides dietary supplements, the antioxidants play key role in [industrial chemicals](#) added during synthesis of [synthetic rubber](#), [plastics](#), and fuels to prevent oxidation, or as [preservatives](#) in food and [cosmetics](#).

This aspect is covered in the book by emphasizing role of antioxidants in edible and non-edible active packaging films. The book will be useful for academicians, biotechnologists, researcher, and medical [practitioners](#) as well as industries involved in manufacturing of antioxidants-rich dietary supplements. The editors are thankful to all the contributors for their cooperation and patience during the process of publication. The editors are also grateful to the editorial team at Springer, Sylvia Blago, and Johanna Klute for their continued professional expertise and support during book production.

Kraków, Poland  
Udaipur, India  
Udaipur, India

Professor H. M. Ekiert  
Professor K. G. Ramawat  
Dr. Jaya Arora

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## About the Editors



**Professor Halina Maria Ekiert** is Head of Chair and Department of Pharmaceutical Botany in the Pharmaceutical Faculty, Medical College, Jagiellonian University, Kraków (Poland), since 2015. Her scientific career was associated first with the Pharmaceutical Faculty at Medical Academy in Kraków (Poland) and after reorganization (since 1993) with the Pharmaceutical Faculty at Medical College of Jagiellonian University. In the years 1999–2014, she was acting Head of Chair and Department of Pharmaceutical Botany. The areas of her scientific interests are associated mainly with pharmaceutical sciences with strong background in plant biotechnology, phytochemistry, analysis of natural products, and biological activity of plant secondary metabolites. Her biotechnological interests include medicinal and/or cosmetic plant *in vitro* cultures, endogenic production of bioactive plant secondary metabolites, and biotransformations of exogenic substrates in *in vitro* cultures. Coumarins, phenolic acids, flavonoids, schisandra lignans, phenylpropanoid glycosides, iridoids, catechins, glucosinolates, and arbutin are the special objects of her interest. Throughout her career, Prof. Ekiert received postdoctoral internships at German universities (Bonn – 1993, Würzburg – 1998, and Marburg am Lahn – 2000, two trainings). The trainings in Bonn and in Marburg were supported by DAAD – German Academic Exchange Service. Her scientific achievements include more than 130 published articles with total number of citation of approximately 1480 and H-index of 24 (according to Web of Science), a few book chapters (published by Springer, Science Publisher, and Studium Press), and the role of co-editor and/or editor at Springer

Nature and also guest-editor with the MDPI journal – *Molecules*.

Prof. Ekiert has collaborated with Würzburg University, and she currently collaborates with Technical University of Braunschweig (Germany), the University of Messina (Sicily, Italy), and the University of Split (Croatia). She is academic teacher with extensive and broad experience in pharmaceutical botany, plant biotechnology, and phytochemistry. She has guided PhD students and candidates for habilitation in the field of plant biotechnology.



**Prof. Dr. Kishan Gopal Ramawat** is a former professor and head of the Botany Department, M.L. Sukhadia University, Udaipur, India, and has longstanding research experience. He received his PhD in plant biotechnology in 1978 from the University of Jodhpur, India, and afterwards joined the university as a faculty member. In 1991 he moved to the M.L. Sukhadia University in Udaipur as associate professor and became professor in 2001. He served as the head of the Department of Botany (2001–2004, 2010–2012); was in charge of the Department of Biotechnology (2003–2004); was a member of the task force on medicinal and aromatic plants in the Department of Biotechnology, Government of India, New Delhi (2002–2005); and coordinated UGC-DRS and DST-FIST program (2002–2012).

Prof. Ramawat completed his postdoctoral studies at the University of Tours, France, from 1983 to 1985, and later returned to Tours as visiting professor (1991). He also visited the University of Bordeaux 2, France, several times as visiting professor (1995, 1999, 2003, 2006, 2010), and in 2005, he went to Poland in an academic exchange program (2005). Through these visits in France, Prof. Ramawat and Prof. Mérillon established a strong connection, which has resulted in productive collaborations and several book and reference work publications.

Prof. Ramawat has published more than 170 well-cited peer reviewed papers and articles, and edited several books and reference works on topics such as the biotechnology of medicinal plants, secondary metabolites, bioactive molecules, herbal drugs, and other

topics. His research was funded by several funding agencies. In his research group, Prof. Ramawat has supervised doctoral thesis of 25 students. He is an active member of several academic bodies, associations, and editorial boards of journals.



**Dr. Jaya Arora**, assistant professor, Department of Botany, Mohanlal Sukhadia University, Udaipur, has been teaching botany since 2012. She obtained her MSc and PhD in botany, with specialization in plant tissue culture and secondary metabolite production, from Mohanlal Sukhadia University. She was awarded the Maharana Fateh Singh Award in 2000 for meritorious performance during her matriculation and the Gargi Award and Scholarship for matriculation by the Government of Rajasthan, India, 2000. Dr. Arora joined the Council of Scientific & Industrial Research (CSIR) NET–JRF in 2008. She has been working the past 14 years on production of useful metabolites from medicinal plants using biotechnological methods and published 25 papers in journals of repute. This work is funded by various funding agencies such as UGC, CSIR, and RUSA, MHRD. Currently, she is supervising five PhD students. Dr. Arora has co-authored one comprehensive textbook for UG students entitled *Molecular Biology and Plant Biotechnology* and co-edited one international reference book entitled *Medicinal Plants: Domestication, Biotechnology and Regional Importance*, published by Springer International Publishing.

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## Contributors

**Marcelo Angeles-Valencia** Laboratorio de Medicina de Conservación, Escuela Superior de Medicina, Instituto Politécnico Nacional, Mexico City, Mexico

**Resat Apak** Department of Chemistry, Faculty of Engineering, Istanbul University-Cerrahpasa, Avcilar, Istanbul, Turkey

Turkish Academy of Sciences (TUBA), Cankaya, Ankara, Turkey

**Fatemeh Asadi-Samani** Student Research Committee, Shahrekord University of Medical Sciences, Shahrekord, Iran

**Hossein Asadi-Samani** Student Research Committee, Shahid Beheshti University of Medical Sciences, Tehran, Iran

**Majid Asadi-Samani** Cellular and Molecular Research Center, Basic Health Sciences Institute, Shahrekord University of Medical Sciences, Shahrekord, Iran

Cancer Research Center, Shahrekord University of Medical Sciences, Shahrekord, Iran

**Asli Neslihan Avan** Department of Chemistry, Faculty of Engineering, Istanbul University-Cerrahpasa, Avcilar, Istanbul, Turkey

**Karine Pires Barsalobra** Departamento de Ciências Farmacêuticas, Universidade Federal de São Paulo, Diadema, São Paulo, Brazil

**Erick L. Bastos** Departamento de Química Fundamental, Instituto de Química, Universidade de São Paulo, São Paulo, SP, Brazil

**Esra Capanoglu** Department of Food Engineering, Faculty of Chemical and Metallurgical Engineering, Istanbul Technical University, Maslak, Istanbul, Turkey

**M. Carpena** Nutrition and Bromatology Group, Analytical and Food Chemistry Department, Faculty of Food Science and Technology, University of Vigo, Ourense, Spain

**Gianluca Caruso** Department of Agricultural Sciences, University of Naples Federico II, Naples, Italy

**Félix Carvalho** UCIBIO, REQUIMTE, Laboratory of Toxicology, Department of Biological Sciences, Faculty of Pharmacy, University of Porto, Porto, Portugal

**Runu Chakraborty** Department of Food Technology and Biochemical Engineering, Jadavpur University, Kolkata, West Bengal, India

**F. Chamorro** Nutrition and Bromatology Group, Analytical and Food Chemistry Department, Faculty of Food Science and Technology, University of Vigo, Ourense, Spain

**Indranil Chatterjee** Department of Surgical Oncology, Saroj Gupta Cancer Centre and Research Institute, Thakurpukur, Kolkata, West Bengal, India

**R. F. Chavan** Department of Chemical Technology, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, Maharashtra, India

**N. Collazo** Nutrition and Bromatology Group, Analytical and Food Chemistry Department, Faculty of Food Science and Technology, University of Vigo, Ourense, Spain

**Shefali Dahiya** Sri Venkateswara College, University of Delhi, New Delhi, India

**Mamali Das** Department of Biotechnology, Alagappa University [Science Campus], Karaikudi, India

**Sourav Das** School of Pharmacy, The Neotia University, Sarisha, West Bengal, India

**Marcondes Viana da Silva** Department of Exact and Natural Sciences (DCEN), State University of Southwest Bahia (UESB), Itapetinga, Brazil

**Sema Demirci Cekic** Department of Chemistry, Faculty of Engineering, Istanbul University-Cerrahpasa, Avcilar, Istanbul, Turkey

**Halina Maria Ekiert** Department of Pharmaceutical Botany, Jagiellonian University, Medical College, Kraków, Poland

**Eduarda Fernandes** LAQV, REQUIMTE, Laboratory of Applied Chemistry, Department of Chemical Sciences, Faculty of Pharmacy, University of Porto, Porto, Portugal

**Agata Fijalkowska** Faculty of Pharmacy, Department of Pharmaceutical Botany, Jagiellonian University Medical College, Kraków, Poland

**Marisa Freitas** LAQV, REQUIMTE, Laboratory of Applied Chemistry, Department of Chemical Sciences, Faculty of Pharmacy, University of Porto, Porto, Portugal

**Cláudia Maria Furlan** Departamento de Botânica, Instituto de Biociências, Universidade de São Paulo, São Paulo, Brazil

**Leticia Hernández Galán** Zentrela Inc., Hamilton, ON, Canada

**Ren-You Gan** Research Center for Plants and Human Health, Institute of Urban Agriculture, Chinese Academy of Agricultural Sciences, Chengdu, China

**P. Garcia-Oliveira** Nutrition and Bromatology Group, Analytical and Food Chemistry Department, Faculty of Food Science and Technology, University of Vigo, Ourense, Spain

Centro de Investigação de Montanha (CIMO), Instituto Politécnico de Bragança, Campus de Santa Apolonia, Bragança, Portugal

**Esra Gençdağ** Department of Food Engineering, Faculty of Engineering, Aydın Adnan Menderes University, Aydın, Turkey

**Nadezhda Golubkina** Laboratory Analytical Department, Federal Scientific Center of Vegetable Production, Moscow, Russia

**Ahmet Görgüç** Department of Food Engineering, Faculty of Engineering, Aydın Adnan Menderes University, Aydın, Turkey

**Maria Tereza Grombone-Guaratini** Núcleo de Pesquisa em Ecologia, Instituto de Botânica -SMA/SP, São Paulo, Brazil

**Büşra Gültekin Subaşı** Department of Food Engineering, Faculty of Chemical and Metallurgical Engineering, Istanbul Technical University, Istanbul, Turkey

Cumhuriyet University, Hafik Kamer Ornek MYO, Sivas, Turkey

**Amit Gupta** Department of Biotechnology, Graphic Era (Deemed to be) University, Dehradun, India

**Karolina Jafarnik** Department of Pharmaceutical Botany, Jagiellonian University, Medical College, Kraków, Poland

**Vaishnavi S. Jambhorkar** Department of Chemical Technology, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, Maharashtra, India

**A. Jarboui** Nutrition and Bromatology Group, Analytical and Food Chemistry Department, Faculty of Food Science and Technology, University of Vigo, Ourense, Spain

**Najmeh Kaffash Farkhad** Immunology Research Center, Mashhad University of Medical Science, Mashhad, Iran

Student Research Committee, Mashhad University of Medical Sciences, Mashhad, Iran

**Diganta Kalita** Department of Research and Development, VDF FutureCeuticals, Inc., Momence, IL, USA

**Senem Kamiloglu** Science and Technology Application and Research Center (BITUAM), Bursa Uludag University, Gorukle, Bursa, Turkey

**Viktor Kharchenko** Laboratory of Selection and Seed Production of Green, Spice and Flower Crops, Federal Scientific Center of Vegetable Production, Moscow, Russia

**Marta Klimek-Szczykutowicz** Department of Pharmaceutical Botany, Jagiellonian University, Medical College, Kraków, Poland



**Aditi Kothari Chhajer** Department of Botany, Sri Venkateswara College, University of Delhi, New Delhi, India

**Paweł Kubica** Department of Pharmaceutical Botany, Jagiellonian University, Medical College, Kraków, Poland

**Kanishka Kumar** Sri Venkateswara College, University of Delhi, New Delhi, India

**Inga Kwiecień** Department of Pharmaceutical Botany, Jagiellonian University, Medical College, Kraków, Poland

**Vânia R. Leite e Silva** Departamento de Ciências Farmacêuticas, Universidade Federal de São Paulo, Diadema, São Paulo, Brazil

**Bang-Yan Li** Guangdong Provincial Key Laboratory of Food, Nutrition and Health, Department of Nutrition, School of Public Health, Sun Yat-Sen University, Guangzhou, China

**Hang-Yu Li** Guangdong Provincial Key Laboratory of Food, Nutrition and Health, Department of Nutrition, School of Public Health, Sun Yat-Sen University, Guangzhou, China

**Hua-Bin Li** Guangdong Provincial Key Laboratory of Food, Nutrition and Health, Department of Nutrition, School of Public Health, Sun Yat-Sen University, Guangzhou, China

**Patricia Santos Lopes** Departamento de Ciências Farmacêuticas, Universidade Federal de São Paulo, Diadema, São Paulo, Brazil

**Mariana Lucas** LAQV, REQUIMTE, Laboratory of Applied Chemistry, Department of Chemical Sciences, Faculty of Pharmacy, University of Porto, Porto, Portugal

**Min Luo** Guangdong Provincial Key Laboratory of Food, Nutrition and Health, Department of Nutrition, School of Public Health, Sun Yat-Sen University, Guangzhou, China

**Eduardo O. Madrigal-Santillán** Laboratorio de Medicina de Conservación, Escuela Superior de Medicina, Instituto Politécnico Nacional, Mexico City, Mexico

**Sandra T. Martín del Campo** School of Science and Engineering, Tecnológico de Monterrey, Querétaro, Qro, Mexico

**Neeti Mehla** Department of Botany, Sri Venkateswara College, University of Delhi, New Delhi, India

**Siti Syairah Mohd Mutalip** Faculty of Pharmacy, Universiti Teknologi MARA (UiTM) Selangor Branch, Puncak Alam Campus, Selangor, Malaysia

**Vanshika Mohindroo** Sri Venkateswara College, University of Delhi, New Delhi, India

**Ángel Morales-González** Escuela Superior de Cómputo, Instituto Politécnico Nacional, Mexico City, Mexico

**José Antonio Morales-González** Laboratorio de Medicina de Conservación, Escuela Superior de Medicina, Instituto Politécnico Nacional, Mexico City, Mexico

**Mauricio Morales-Martínez** Licenciatura en Nutrición, Universidad Intercontinental, Mexico City, Mexico

**Paulo Roberto H. Moreno** Departamento de Química Fundamental, Instituto de Química, Universidade de São Paulo, São Paulo, Brazil

**Bożena Muszyńska** Faculty of Pharmacy, Department of Pharmaceutical Botany, Jagiellonian University Medical College, Kraków, Poland

**Boris Nemzer** Department of Research and Development, VDF FutureCeuticals, Inc., Momence, IL, USA

Department of Food Science and Human Nutrition, University of Illinois at Urbana-Champaign, Urbana, IL, USA

**Dariusz Nowak** Department of Clinical Physiology, Medical University of Lodz, Lodz, Poland

**Michał Nowak** Radiation Protection, University Hospital No 2, Medical University of Lodz, Lodz, Poland

**Piotr Nowak** Department of Nephrology, Hypertension, and Kidney Transplantation, Medical University of Lodz, Lodz, Poland

**Vassiliki Oreopoulou** School of Chemical Engineering, Laboratory of Food Chemistry and Technology, National Technical University of Athens, Athens, Greece

**Kasi Pandima Devi** Department of Biotechnology, Alagappa University [Science Campus], Karaikudi, India

**A. G. Pereira** Nutrition and Bromatology Group, Analytical and Food Chemistry Department, Faculty of Food Science and Technology, University of Vigo, Ourense, Spain

Centro de Investigação de Montanha (CIMO), Instituto Politécnico de Bragança, Campus de Santa Apolonia, Bragança, Portugal

**Danuta Plichta** Department of Experimental Dermatology and Cosmetology, Jagiellonian University Medical College, Krakow, Poland

**Jacqueline Portillo-Reyes** Laboratorio de Medicina de Conservación, Escuela Superior de Medicina, Instituto Politécnico Nacional, Mexico City, Mexico

**M. A. Prieto** Nutrition and Bromatology Group, Analytical and Food Chemistry Department, Faculty of Food Science and Technology, University of Vigo, Ourense, Spain

Centro de Investigação de Montanha (CIMO), Instituto Politécnico de Bragança, Campus de Santa Apolonia, Bragança, Portugal

**Krystyna Pyrzyńska** Department of Chemistry, University of Warsaw, Warsaw, Poland

**Daniela Ribeiro** LAQV, REQUIMTE, Laboratory of Applied Chemistry, Department of Chemical Sciences, Faculty of Pharmacy, University of Porto, Porto, Portugal

**Jéssica Souza Ribeiro** Center for Science and Technology in Energy and Sustainability (CETENS), Federal University of Recôncavo of Bahia (UFRB), Feira de Santana, Brazil

**Anirban Roy** Department of Food Technology and Biochemical Engineering, Jadavpur University, Kolkata, West Bengal, India

**Sukanta Roy** School of Pharmacy, The Neotia University, Sarisha, West Bengal, India

**Bhagwan K. Sakhale** Department of Chemical Technology, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, Maharashtra, India

Food Technology Division University Department of Chemical Technology (UDCT), Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, Maharashtra, India

**Eli Mireya Sandoval-Gallegos** Centro de Investigación Interdisciplinario, Área Académica de Nutrición, Instituto de Ciencias de la Salud, Universidad Autónoma del Estado de Hidalgo, Pachuca, Mexico

**Aniket P. Sarkate** Department of Chemical Technology, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, Maharashtra, India

**Willibald Schliemann** Leibniz Institute of Plant Biochemistry, Department of Secondary Metabolism, Halle (Saale), Germany

**Aleksandra Sentkowska** Heavy Ion Laboratory, University of Warsaw, Warsaw, Poland

**Mustafa Sevindik** Bahçe Vocational School, Department of Food Processing, Osmaniye Korkut Ata University, Osmaniye, Turkey

**Ashfaq Ahmad Shah** Department of Life Sciences (Microbiology), Graphic Era (Deemed to be) University, Dehradun, India

**Ao Shang** Guangdong Provincial Key Laboratory of Food, Nutrition and Health, Department of Nutrition, School of Public Health, Sun Yat-Sen University, Guangzhou, China

**Larissa Kauly Rosa Silva** Federal University of Western Bahia (UFOB), Barreiras, Brazil

**J. Simal-Gandara** Nutrition and Bromatology Group, Analytical and Food Chemistry Department, Faculty of Food Science and Technology, University of Vigo, Ourense, Spain

**A. Soria-Lopez** Nutrition and Bromatology Group, Analytical and Food Chemistry Department, Faculty of Food Science and Technology, University of Vigo, Ourense, Spain

**Marvin Antonio Soriano-Ursúa** Academia de Fisiología Humana, Escuela Superior de Medicina, Instituto Politécnico Nacional, Mexico City, Mexico

**Keyser Sozgen Baskan** Department of Chemistry, Faculty of Engineering, Istanbul University-Cerrahpasa, Avcilar, Istanbul, Turkey

**Radoslaw Spiewak** Department of Experimental Dermatology and Cosmetology, Jagiellonian University, Medical College, Krakow, Poland

**Katarzyna Sulowska-Ziaja** Faculty of Pharmacy, Department of Pharmaceutical Botany, Jagiellonian University Medical College, Kraków, Poland

**Agnieszka Szopa** Department of Pharmaceutical Botany, Jagiellonian University, Medical College, Kraków, Poland

**Theofania Tsironi** Department of Food Science and Human Nutrition, Laboratory of Food Process Engineering, Agricultural University of Athens, Athens, Greece

**Seda Uzunboy** Department of Chemistry, Faculty of Engineering, Istanbul University-Cerrahpasa, Avcilar, Istanbul, Turkey

**Beyza Vahapoglu** Department of Food Engineering, Faculty of Chemical and Metallurgical Engineering, Istanbul Technical University, Maslak, Istanbul, Turkey

**Nancy Vargas-Mendoza** Laboratorio de Medicina de Conservación, Escuela Superior de Medicina, Instituto Politécnico Nacional, Mexico City, Mexico

**Rosa Vazquez-Garcia** School of Science and Engineering, Tecnológico de Monterrey, Querétaro, Qro, Mexico

**Ewa Widy-Tyszkiewicz** Department of Experimental and Clinical Pharmacology, Centre for Preclinical Research and Technology CePT, Medical University of Warsaw, Warsaw, Poland

**Fatih Mehmet Yilmaz** Department of Food Engineering, Faculty of Engineering, Aydın Adnan Menderes University, Aydın, Turkey

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**Part I**

**Antioxidant Resources**



# Natural Food Antioxidants

# 1

Aniket P. Sarkate, Vaishnavi S. Jambhorkar, and Bhagwan K. Sakhale

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## Abstract

Due to increasing awareness about various effects of antioxidants, it has become an essential part to understand and thoroughly study the various antioxidants and their biological effect on day to day lifestyle. Oxidative stress being major

A. P. Sarkate · V. S. Jambhorkar  
Department of Chemical Technology, Dr. Babasaheb Ambedkar Marathwada University,  
Aurangabad, Maharashtra, India

B. K. Sakhale (✉)  
Department of Chemical Technology, Dr. Babasaheb Ambedkar Marathwada University,  
Aurangabad, Maharashtra, India

Food Technology Division University Department of Chemical Technology (UDCT),  
Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, Maharashtra, India