

Edited by Suraini Abd-Aziz, Misri Gozan,
Mohamad Faizal Ibrahim, and Lai-Yee Phang

Chemical Substitutes from Agricultural and Industrial By-Products

Bioconversion, Bioprocessing, and Biorefining



Chemical Substitutes from Agricultural and Industrial By-Products

Chemical Substitutes from Agricultural and Industrial By-Products

Bioconversion, Bioprocessing, and Biorefining

Edited by Suraini Abd-Aziz, Misri Gozan, Mohamad Faizal Ibrahim, and Lai-Yee Phang

WILEY-VCH

The Editors

Prof Ts Dr Suraini Abd-Aziz
Universiti Putra Malaysia
Faculty of Biotechnology &
Biomolecular Sciences
43400 Serdang, Selangor
Malaysia

Prof Dr-Ing Misri Gozan
Universitas Indonesia
Faculty of Engineering
16424 Depok
Indonesia

Associate Prof Ts Dr Mohamad Faizal Ibrahim
Universiti Putra Malaysia
Faculty of Biotechnology &
Biomolecular Sciences
43400 Serdang, Selangor
Malaysia

Associate Prof Ts Dr Lai-Yee Phang
Universiti Putra Malaysia
Faculty of Biotechnology &
Biomolecular Sciences
43400 Serdang, Selangor
Malaysia

Cover Image: © ARTFULLY
PHOTOGRAPHER/Shutterstock

■ All books published by **WILEY-VCH** are carefully produced. Nevertheless, authors, editors, and publisher do not warrant the information contained in these books, including this book, to be free of errors. Readers are advised to keep in mind that statements, data, illustrations, procedural details or other items may inadvertently be inaccurate.

Library of Congress Card No.: applied for

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library.

Bibliographic information published by the Deutsche Nationalbibliothek
The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available on the Internet at <<http://dnb.d-nb.de>>.

© 2024 WILEY-VCH GmbH, Boschstr. 12,
69469 Weinheim, Germany

All rights reserved (including those of translation into other languages). No part of this book may be reproduced in any form – by photoprinting, microfilm, or any other means – nor transmitted or translated into a machine language without written permission from the publishers. Registered names, trademarks, etc. used in this book, even when not specifically marked as such, are not to be considered unprotected by law.

Print ISBN: 978-3-527-35186-2
ePDF ISBN: 978-3-527-84112-7
ePub ISBN: 978-3-527-84113-4
oBook ISBN: 978-3-527-84114-1

Typesetting Straive, Chennai, India

Contents

Preface xv

About the Editors xvii

- 1 A Glance on Biorefinery of Chemical Substitutes from Agriculture and Industrial By-products 1**
Suraini Abd-Aziz, Misri Gozan, Mohamad F. Ibrahim, Lai-Yee Phang, and Mohd A. Jenol
 - 1.1 Introduction 1
 - 1.2 Analysis of Feedstocks for Composition and Potential for Chemical Substitutes 3
 - 1.2.1 Different Types of Agricultural Wastes and Associated Risks 4
 - 1.2.2 Waste Utilization Routes 5
 - 1.2.2.1 Fertilizer Application 5
 - 1.2.2.2 Fibers for Textile Industry 5
 - 1.2.2.3 Mushroom Cultivation 6
 - 1.2.2.4 Organic Acids 7
 - 1.2.2.5 Industrial Enzymes 7
 - 1.2.3 Industrial By-products 8
 - 1.2.3.1 Agriculture, Horticulture, and Landscaping 8
 - 1.2.3.2 Use as Raw Material or Additive of New Products 8
 - 1.3 Potential Application of Chemical Substitute Extracted from Selected Agricultural Wastes and Industrial By-products 9
 - 1.4 Conclusions 13
 - References 13
- 2 Antioxidants from Agricultural Wastes and their Potential Applications 19**
Mohd A. Jenol, Yazmin Hussin, Pei H. Chu, Suraini Abd-Aziz, and Noorjahan B. Alitheen
 - 2.1 Introduction to Antioxidants and their Usages 19
 - 2.2 Sources of Antioxidants 21
 - 2.3 Alternative Antioxidants Sources from Agricultural Wastes 22
 - 2.4 Extraction of Antioxidants from Selected Agricultural Waste 22

- 2.4.1 Maceration 23
- 2.4.2 Pressurized Liquid Extraction 26
- 2.4.3 Microwave-assisted Extraction 27
- 2.4.4 Ultrasounds-assisted Extraction 28
- 2.4.5 Supercritical Fluid Extraction 29
- 2.5 Potential Applications of Antioxidants Extracted from Selected Agricultural Wastes 30
 - 2.5.1 Food 30
 - 2.5.2 Cosmetics 32
 - 2.5.3 Therapeutics 33
- 2.6 Future Direction of Antioxidants from Agriculture Wastes 34
- 2.7 Conclusions 35
- References 35

3 Lemongrass Oleoresin in Food Flavoring 39

Madiyah Md Salleh, Shankar Ramanathan, and Rohaya Mohd Noor

- 3.1 Introduction 39
- 3.2 Types of Lemongrass and Their Components 40
- 3.3 Potential Chemical Substitutes from Lemongrass 42
 - 3.3.1 Essential Oil 42
 - 3.3.2 Phytoconstituents 43
 - 3.3.3 Oleoresins 43
- 3.4 Characteristics and Properties of Oleoresin 44
- 3.5 Lemongrass Oleoresin Composition and Function 44
- 3.6 Extraction Technique of Lemongrass Oleoresin 46
 - 3.6.1 Chemical Extraction 46
 - 3.6.2 Steam Distillation 49
 - 3.6.3 Pressurized Liquid Extraction (PLE) 50
- 3.7 Application of Lemongrass Oleoresin as Food Flavoring 51
- 3.8 Oleoresin Prospect 53
- 3.9 Conclusions 53
- References 54

4 Nanocarbon Material and Chemicals from Seaweed for Energy Storage Components 59

Tirto Prakoso, Hary Devianto, Heri Rustamaji, Praswasti PDK Wulan, and Misri Gozan

- 4.1 Introduction 59
- 4.2 Source of Seaweed 62
 - 4.2.1 Red Seaweed 62
 - 4.2.2 Brown Seaweed 62
 - 4.2.3 Green Seaweed 63
- 4.3 Potential Material Substitute from Seaweed 64

4.3.1	Activated Carbon from Seaweed	64
4.3.2	Graphene from Seaweed	66
4.4	Utilization of Seaweed-based Material for Energy Storage Component	76
4.4.1	Seaweed-derived Carbon Material for Supercapacitor Component	76
4.4.2	Seaweed-derived Chemical Materials for Battery Component	79
4.5	Future Prospects and Challenges	82
4.6	Conclusions	83
	References	83
5	Spent Mushroom Substrate as Alternative Source for the Production of Chemical Substitutes	87
	<i>Vikineswary Sabaratnam, Chia Wei Phan, Hariprasath Lakshmanan, and Jegadeesh Raman</i>	
5.1	Introduction	87
5.2	Spent Mushroom Substrate (SMS) as Source of Bulk Enzymes	90
5.2.1	Enzymes Extracted from SMS for Bioremediation	91
5.2.2	Enzymes Extracted from SMS for Green Fuel Feedstock Production: Case Study	92
5.3	Various Challenges and Future Prospects in the Use of SMS	94
5.3.1	Challenges in the Use of Enzymes in SMS	94
5.3.2	Future Prospects for Use of SMS for Production of Green Chemicals	95
5.4	Conclusions	97
	References	98
6	Essential Oil from Pineapple Wastes	103
	<i>Mohamad F. Ibrahim, Nurshazana Mohamad, Mariam J. M. Fairus, Mohd A. Jenol, and Suraini Abd-Aziz</i>	
6.1	Introduction	103
6.2	Pineapple Wastes	104
6.3	Pineapple Essential Oil	105
6.4	Extraction of Essential Oils	106
6.4.1	Distillation	106
6.4.1.1	Hydro-distillation	107
6.4.1.2	Soxhlet Extraction	107
6.4.2	Enzyme-assisted Extraction	109
6.4.3	Supercritical Fluid Extraction	109
6.5	Extracted Essential Oil Compounds	112
6.5.1	Essential Oils and Hydrosols	114
6.5.2	Applications of Essential Oils and Hydrosols	114
6.5.3	Market Analysis of Essential Oils and Hydrosols	116
6.6	Conclusions	117
	References	118