# SOURDOUGH INNOVATIONS

NOVEL USES OF METABOLITES, ENZYMES, AND MICROBIOTA FROM SOURDOUGH PROCESSING

EDITED BY MARCO GARCIA-VAQUERO JOÃO MIGUEL F. ROCHA



## Sourdough Innovations

Novel Uses of Metabolites, Enzymes, and Microbiota from Sourdough Processing

> Edited by Marco Garcia-Vaquero and João Miguel F. Rocha



CRC Press is an imprint of the Taylor & Francis Group, an **informa** business First edition published 2024 by CRC Press 6000 Broken Sound Parkway NW, Suite 300, Boca Raton, FL 33487-2742

and by CRC Press 4 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

CRC Press is an imprint of Taylor & Francis Group, LLC

© 2024 selection and editorial matter, Marco Garcia-Vaquero and João Miguel F. Rocha; individual chapters, the contributors

Reasonable efforts have been made to publish reliable data and information, but the author and publisher cannot assume responsibility for the validity of all materials or the consequences of their use. The authors and publishers have attempted to trace the copyright holders of all material reproduced in this publication and apologize to copyright holders if permission to publish in this form has not been obtained. If any copyright material has not been acknowledged please write and let us know so we may rectify in any future reprint.

Except as permitted under U.S. Copyright Law, no part of this book may be reprinted, reproduced, transmitted, or utilized in any form by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying, microfilming, and recording, or in any information storage or retrieval system, without written permission from the publishers.

For permission to photocopy or use material electronically from this work, access www.copyright.com or contact the Copyright Clearance Center, Inc. (CCC), 222 Rosewood Drive, Danvers, MA 01923, 978-750-8400. For works that are not available on CCC please contact mpkbookspermissions@tandf.co.uk

Trademark notice: Product or corporate names may be trademarks or registered trademarks and are used only for identification and explanation without intent to infringe.

#### Library of Congress Cataloging-in-Publication Data

Names: Garcia-Vaquero, Marco, editor. | Rocha, João Miguel, editor. Title: Sourdough innovations : novel uses of metabolites, enzymes, and microbiota from sourdough processing / edited by Marco Garcia-Vaquero, João Miguel Rocha.

Description: First edition. | Boca Raton : CRC Press, 2023. | Includes bibliographical references and index. | Summary: "Sourdough fermentation is a widely used to produce and preserve bread, while increasing the health benefits due to the activity of several microorganisms. This book provides an exploration of health beneficial compounds through the downstream processing of sourdough from cereals, microbiota and enzymes"-- Provided by publisher.

Identifiers: LCCN 2022060710 (print) | LCCN 2022060711 (ebook) | ISBN 9780367674977 (hbk) | ISBN 9780367692599 (pbk) | ISBN 9781003141143 (ebk)

Subjects: LCSH: Yeast. | Bioactive compounds. | Sourdough starter--Health aspects. | Dough. | Functional foods. | Food--Microbiology. | Food industry and trade--By-products.

Classification: LCC TP580 .S68 2023 (print) | LCC TP580 (ebook) | DDC 664/.08--dc23/eng/20230427

LC record available at https://lccn.loc.gov/2022060710

LC ebook record available at https://lccn.loc.gov/2022060711

ISBN: 978-0-367-67497-7 (hbk) ISBN: 978-0-367-69259-9 (pbk) ISBN: 978-1-003-14114-3 (ebk)

DOI: 10.1201/9781003141143

Typeset in Times by Deanta Global Publishing Services, Chennai, India

## Contents

Preface	ix
About the Editors	
Contributors	XV

#### SECTION I Cereal and Non-cereal Sourdough Metabolites

Chapter 1	Sourdough Fermentation as a Way to Improve Health Benefits and the Sensory Properties of Bakery Products
	Sedef Nehir El, Yesim Elmaci, Sibel Karakaya, and Alexandrina Sirbu
Chapter 2	Cereals and Cereal Sourdoughs as a Source of Functional and Bioactive Compounds
	Monica Trif, Claudia Terezia Socol, Sneh Punia Bangar, and Alexandru Vasile Rusu
Chapter 3	Non-cereal and Legume Based Sourdough Metabolites
	Maria Aspri, Nikolina Čukelj Mustač, and Dimitrios Tsaltas
Chapter 4	Innovative Technologies to Extract High-Value Compounds
	Anca C. Farcas, Sonia A. Socaci, Dubravka Novotni, and Marco Garcia-Vaquero

### SECTION II Enzymes from Sourdough Cultures

Chapter 5	Introduction to Sourdough Enzymology 117
	Bogdan Păcularu-Burada, Marina Pihurov,
	Mihaela Cotârleț, Elena Enachi, and Gabriela-Elena Bahrim

Chapter 6	Major Classes of Sourdough Enzymes 14	17
	Maria Aspri and Dimitrios Tsaltas	
Chapter 7	Discovery, Characterization, and Databases of Enzymes from Sourdough	51
Chapter 8	Enzyme Production from Sourdough	<del>)</del> 9
Chapter 9	Biotechnological Applications of Sourdough Lactic Acid Bacteria: A Source for Vitamins Fortification and Exopolysaccharides Improvement	31
	Pasquale Russo, Kenza Zarour, María Goretti Llamas-Arriba, Norhane Besrour-Aouam, Vittorio Capozzi, Nicola De Simone, Paloma López, and Giuseppe Spano	

### SECTION III Innovative Applications of Sourdough Microbiota

Chapter 10	Sourdough as a Source of Technological, Antimicrobial, and Probiotic Microorganisms
	Vera Fraberger, Görkem Özülkü, Penka Petrova, Knežević Nada, Kaloyan Petrov, Domig Konrad Johann, and João Miguel F. Rocha
Chapter 11	Isolation, Technological Functionalization, and Immobilization Techniques Applied to Cereals and Cereal-Based Products and Sourdough Microorganisms
	Zlatina A. Genisheva, Pedro Ferreira-Santos, and José A. Teixeira
Chapter 12	Sourdough Microorganisms in Food Applications
	Mensure Elvan and Sebnem Harsa

#### Contents

Chapter 13	Production of Nutraceuticals or Functional Foods Using Sourdough Microorganisms	. 369
	Armin Mirzapour-Kouhdasht, Samaneh Shaghaghian, and Marco Garcia-Vaquero	
Chapter 14	Applications of Sourdough in Animal Feed	. 391
	Kristina Kljak, Miona Belović, Marija Duvnjak, Vanja Jurišić, and Miloš Radosavljević	
Index		. 435