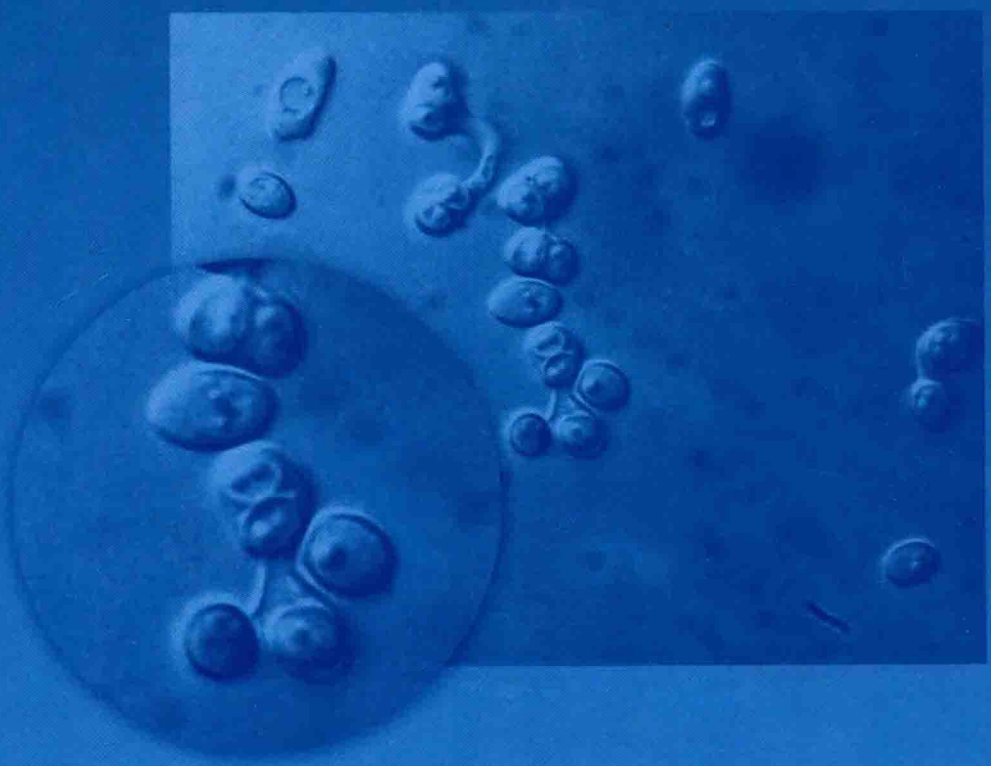
HANDBOOK OF FOOD SPOILAGE YEASTS

SECOND EDITION



TIBOR DEÁK

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Preface

Yeasts are undoubtedly the most important group of microorganisms exploited for commercial purposes. Yeasts that bring about the leavening of bread and the fermentation of wine and beer are essential parts of everyday life. In addition to playing a crucial role in the production of fermented foods and beverages, yeasts are also the source of a wide range of valuable products and useful ingredients made by the various branches of biotechnology. Their benefits to humans, however, are counterbalanced to some degree by the detrimental role they play in the spoilage of processed and stored foods.

Yeasts are capable of growing in a wide range of foods if environmental conditions are favorable. Under such conditions, the growth and metabolic activities of yeasts in foods may result in extensive economic losses to the food industry. To control the spoilage of foods by yeasts, the physicochemical and biological parameters associated with various foods should be adjusted to inactivate or inhibit the growth of yeasts. These parameters are collectively called ecological factors.

Microbial ecology has become a very inspiring concept in food microbiology. Though artificial and man-made, foods can be considered as ecosystems that provide specific niches and habitats for microorganisms whose activities are governed by intrinsic and extrinsic ecological factors. By understanding these factors and the implicit properties of food-borne microorganisms, both the beneficial and harmful activities of bacteria, molds, and yeasts can be controlled. Preservation of foods and beverages can be based on the same ecological principles that are used in the exploitation of yeasts, and govern, in general, the activity, growth, survival, and death of microorganisms. A more thorough understanding of these ecological factors is becoming increasingly important to avoid spoilage risks. In recent years, these risks have increased because of new product formulations, novel, non-thermal preservation methods, and milder processing and preservation introduced to meet consumer demands.

The bulk of this book focuses on the microbial ecology of yeasts. In characterizing food-borne yeasts, the effects of physical, chemical, and biological factors on the physiological properties of yeasts are summarized. The metabolic and enzymic activities of yeasts are directly responsible for unwanted changes in sensory properties and for loss of storage quality of foods. Strategies for food preservation are based on ecological principles, with goals of prohibiting growth or killing spoilage microorganisms. Some gross ecological parameters render certain foods particularly vulnerable to yeast spoilage. An overview of the yeasts present in major types of food and beverages is the second main feature of this book, which has been maintained and further elaborated in the second edition.

In the decade since the first edition, however, there has been a great increase in knowledge about yeasts, which has forced changes in many ways in this book. The biodiversity of yeasts has developed as a new disciplinee, resulting in the description of novel species in various habitats. New insights have been gained into the understanding of the physiological and genetic backgrounds of stress responses of yeasts to ecological factors applied in processing and preservation. The great progress in molecular biology has revolutionized the taxonomy and phylogeny of yeasts. Consequently, many changes in names have come about, confusing many uninitiated in the subject. Considerable progress has been made in the detection and identification of yeasts, resulting in more reliable recognition of spoilage agents. In the professional field, new strategies have emerged for the production of more natural, more convenient products. The industrial production of food and beverages has been

changed by the introduction of novel and improved processing, packaging, and storing technologies, mostly based on a combination of ecological factors. In an effort to follow all these developments, this book is more than an update of the first edition.

This second edition of the *Handbook of Food Spoilage Yeasts* barely contains an unchanged paragraph from the first edition. This is a new book rather than a revised and updated edition. The scope and content of the handbook have been extended and restructured. Chapter 1 gives a concise summary of the morphological and phenotypic characteristics of yeasts, illustrated with photographs. Chapter 2 on classification has been completely revised to follow the continuous development and changes in the taxonomy of yeasts. It is, nevertheless, a restrained treatment, focusing on groups of foodborne yeasts. "Ecology" (Chapter 3) is one of the main lines followed throughout the book; it outlines the most important ecological factors encountered in foods, supplemented by new sections on biofilms and interactions. Chapter 4 gives a brief but concise overview of the metabolic activities of yeasts, also pointing out the regulation of processes. Chapter 5 deals with the growth, life cycle, and death of yeast cells, also touching upon on kinetics and predictive modeling, in addition to stress responses. This edition includes a separate chapter (Chapter 6) on preservative treatments used to inhibit and inactivate yeasts, including both the traditional treatments (heating, freezing, drying, and chemical preservation), and the new and alternative methods such as irradiation, high pressure, pulsed electric fields and others, as well as novel combinations. Chapter 7, which makes up one-third of the total volume of the book, is a comprehensive coverage of the biodiversity and ecology of yeasts in various food types and commodities. The emphasis is on spoilage aspects; however, the beneficial role and application of yeasts are also explored. The thoroughly revised Chapter 8 on methods of enumeration and detection provides new insights into conventional methods and novel rapid and automated techniques. In line with the phylogenetic classification, Chapter 9 on identification focuses on the molecular techniques of identification, pointing also to recent and possible future developments of these methods. The traditional identification procedures based on phenotypic characters are also summarized, and the simplified method developed by the author is found in the Appendices. The number of species discussed has been increased by 20%, and an outline of the most important foodborne yeasts is also provided. Chapter 10 is a new addition, an outlook on the industrial application of yeasts, both on food fermentation and their exploitation in the broader field of biotechnology. The discussion of industrial strain developments inevitably draws on the field of genomics. In addition to the new and revised text, the second edition includes 30 new tables and 40 new figures. A total of more than 2000 references are cited. While most of the reports in the first edition are retained, more than half of the references are from recent literature of the past 10 years.

It is hoped that the book will serve as a practical guide to understanding the ecological factors governing the activities of yeasts in foods and beverages. Knowledge of the underlying ecological principles, the sources, and routes of spoilage can be recognized, quality assurance programs planned, and control measurements implemented. By the same token, food and beverage processing technologies can be improved, and both the preservation and fermentation of products can be executed in a more effective way. The text will be useful for advanced study, and the comprehensive repository of relevant literature included may provide helpful reference for research. Last but not least, this book can be used as a teaching aid in academia.

This book would not have been possible without the foundation of the first edition made jointly by the present author and Professor Larry R. Beuchat. Over the years, our collaboration has remained continuous, and Larry Beuchat's encouragement to compile this new edition is sincerely acknowledged. The author also wishes to express his thanks to Dr. Gábor Péter for critical appraisal of the manuscript and for providing the photographs in Chapter 1. The author is greatly indebted to those who granted permission to use or adapt illustrations from published works.

Tibor Deák

About the Author

Tibor Deák, Ph.D., D.Sc., is Professor Emeritus in the Department of Microbiology and Biotechnology, Faculty of Food Science, of the Corvinus University, Budapest, Hungary.

Dr. Deák received his B.Sc. degree in biology and chemistry from the University of Szeged in 1957, and his M.Sc. degree in microbiology from the Eötvös University of Budapest in 1963. He received his Ph.D. and D.Sc. degrees in biological sciences in 1970 and 1989, respectively, from the Biology Section of the Hungarian Academy of Sciences, Budapest. After gaining experience at the Budapest Canning Co. and the Research Institute for Canning Industry, he was appointed assistant professor in microbiology at the University of Horticulture and Food Science in 1967. He became associate professor in 1970 and full professor in 1980. He was the head of the department from 1970 to 1996, and served two terms as dean of the faculty of food science and technology (1986–1991) and one term as the rector of the university (1993–1996).

Dr. Deák has served as president of the Hungarian Scientific Society for Food Industry. He is a board member of numerous scientific societies including the International Committee for Food Microbiology and Hygiene, the International Committee for Yeast, the International Committee for Food Mycology, and the Hungarian Society of Microbiology, and member of the World Federation of Culture Collection, European Culture Collection Organization, and the American Society of Microbiology.

He has been granted postdoctoral research fellowships by the Hungarian Academy of Sciences, the British Council, FAO-UNO, and has twice been Senior Fulbright Scholar and visiting research professor affiliated with the Department of Food Science and Technology of the University of Georgia. His awards include the Sigmund Award for Food Science and the Manninger Award for Food Microbiology. He has twice received the Magister Optimus Teaching Award. He is a Fellow of the American Academy of Microbiology, a Distinguished Fellow of the Kansas State University, Manhattan, and an appointed External Examiner of the Free State University, Bloemfontein, South Africa.

Dr. Deák is author or co-author of more than 330 research papers and 24 books and chapters, as well as 15 textbooks and manuals. His continuing research interests include the microbial ecology of foods, biodiversity of yeasts in agrofood-ecosystems, yeasts as spoilage agents in foods and beverages, and yeast detection and identification.

List of Abbreviations

Abbreviations for genera of most common foodborne yeasts (used only for binomial species names)

Bret.	*Brettanomyces*
C.	*Candida*
Citerom.	*Citeromyces*
Clsp.	*Clavispora*
Cry.	*Cryptococcus*
Cysto.	*Cystofilobasidium*
Db.	*Debaryomyces*
Dek.	*Dekkera*
F'ella	*Filobasidiella*
Filob.	*Filobasidium*
Gal.	*Galactomyces*
Geo.	*Geotrichum*
Guehom.	*Guehomyces*
Hsp.	*Hanseniaspora*
Hyphop.	*Hyphopichia*
Iss.	*Issatchenkia*
Kazach.	*Kazachstania*
Klc.	*Kloeckera*
Klu.	*Kluyveromyces*
Leucosp.	*Leucosporidium*
Lodd.	*Lodderomyces*
Met.	*Metschnikowia*
P.	*Pichia*
Rho.	*Rhodotorula*
Rhosp.	*Rhodosporidium*
S.	*Saccharomyces*
S'codes	*Saccharomycodes*
S'copsis	*Saccharomycopsis*
Schizo.	*Schizosaccharomyces*
Schwan.	*Schwanniomyces*
Spb.	*Sporobolomyces*
Sporid.	*Sporidiobolus*
Trichomon.	*Trichomonascus*
Trisp.	*Trichosporon*
Tsp.	*Torulaspora*
Ya.	*Yarrowia*
Zygo.	*Zygosaccharomyces*
Zygotsp.	*Zygotorulaspora*

Other Abbreviations

5.8S, 18S, 26S	rDNA in ribosomal subunits
am.	Anamorph
bp	Basepair
cfu	Colony-forming units
ITS	Internal transcribed spacer
kb	Kilobase
LSU	Large subunit ribosome
Mb	Megabase
mtDNA	Mitochondrium DNA
PCR	Polymerase chain reaction
rDNA	Ribosomal DNA
rRNA	Ribosomal RNA
SSU	Small subunit ribosome
syn.	Synonym
tel.	Teleomorph

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