ADVANCES IN ASEPTIC PROCESSING TECHNOLOGIES

Edited by

RAKESH K. SINGH and PHILIP E. NELSON

ELSEVIER APPLIED SCIENCE

ADVANCES IN ASEPTIC PROCESSING TECHNOLOGIES

Edited by

R. K. SINGH

and

P. E. NELSON

Department of Food Science, Purdue University, West Lafayette, Indiana, USA

ELSEVIER APPLIED SCIENCE
LONDON and NEW YORK

ELSEVIER SCIENCE PUBLISHERS LTD
Crown House, Linton Road, Barking, Essex IG11 8JU, England

Sole Distributor in the USA and Canada
ELSEVIER SCIENCE PUBLISHING CO., INC.
655 Avenue of the Americas, New York, NY 10010, USA

WITH 36 TABLES AND 74 ILLUSTRATIONS

British Library Cataloguing in Publication Data

Advances in aseptic processing technologies.
I. Singh, K. II. Nelson, Philipe.
664

ISBN 1-85166-742-3

Library of Congress CIP data applied for

Printed in Great Britain by Galliard (Printers) Ltd, Great Yarmouth

ADVANCES IN ASEPTIC PROCESSING TECHNOLOGIES

Based on papers given at the Second International Conference on Aseptic Processing Technologies, a special Symposium of the Conference of Food Engineering (CoFE), Chicago, Illinois, USA, 11 March 1991.

PREFACE

Aseptic processing, developed in the early 1940's, is a technique by which a commercially sterilized product is filled into a presterilized, container and sealed hermetically in a sterile environment. The continuous thermal sterilization has been favorably used as an economical and efficient means of destroying microorganisms in a variety of foods. Advantages include less damage to the product, shorter processing periods, uniform and improved product quality, reduced energy consumption, utilization of new packaging materials, and ready adaptability to automatic controls.

This technology has been successfully applied to liquid and acid or acidified particulate foods. However, processing of low-acid (pH $>$ 4.6) particulate foods poses new challenges. Therefore, in recent years, there has been a widespread growth of interest and research in the processing of low-acid foods containing particulates. The challenges in this area are to assure microbiological safety and quality of aseptically processed and packaged products. These involve understanding the heat transfer and flow phenomena in continuous heat exchangers, developing techniques to measure and/or predict microbiological lethality at the center of continuously flowing particles, new packaging materials and systems, and reliable methods for in-line package integrity testing. The ultimate challenge, however, is to develop quantitative information on critical control factors so that the processes and systems can be safely used for commercial production and conform to requirements of various regulatory agencies.

The Department of Food Science at Purdue University has played a key role in developing and promoting this technology through education, research and outreach programs. Our annual Aseptic Processing and Packaging Workshop, and two international congresses, are examples of such efforts. The "First International Congress on Aseptic Processing Technologies" was held in March, 1989 in

Indianapolis and focused on the theme: "Innovations in Aseptic Processing of Particulates".

The *Advances in Aseptic Processing Technologies* is primarily based on the presentations made in the "Second International Congress on Aseptic Processing Technologies" which was organized as a special symposium in a *Conference of Food Engineering (CoFE)* held in Chicago, IL on March 11, 1991. The purpose of this congress was to invite internationally recognized researchers and practitioners in the areas of processing, packaging, product quality and regulations to share their expertise with the industry and academia. Their presentations, expanded with one additional contributor are published in this book.

Chapter 1 provides a synopsis of new advances on various elements of an aseptic processing system through an example of "The NORDIC Project." The areas of heat transfer and residence time distribution in continuous heat exchangers are presented in Chapters 2-4. Advances in a relatively new technology, the "Ohmic Heating Process," for aseptic processing of foods are presented in Chapter 5. The advances made in the area of new packaging materials and systems, and techniques for in-line package integrity testing are given in Chapters 6 and 7. Chapter 8 contains an industrial view on assessment of "Market Advantages and Microbiological Risks" for aseptically processed foods. Chapter 9 addresses the microbiological safety including characterization and application of anti-microbial peptides such as bacteriocin fortified aseptically processed products. The quality concerns during aseptic processing and subsequent storage are covered in Chapter 10. Finally, the procedures for establishing an aseptic process for particulate foods are considered in the last chapter (Chapter 11).

Rakesh K. Singh and Philip E. Nelson

LIST OF CONTRIBUTORS

Dilip I. Chandarana
National Food Processors Association, 1401 New York Avenue NW, Washington, DC 20005, USA

Ashim K. Datta
Cornell University, Department of Agricultural Engineering, Riley-Robb Hall, Ithaca, NY 14853, USA

Jairus R. D. David
Gerber Products Company, Microbiology & Thermal Processing Laboratories, 445 State Street, Fremont, MI 49413-0001, USA

A. A. P. deAlwis
University of Cambridge, Department of Chemical Engineering, Pembroke Street, Cambridge, CB2 3RA, UK

John D. Floros
Purdue University, Department of Food Science, 1160 Smith Hall, West Lafayette, IN 47907-1160, USA

Peter J. Fryer
University of Cambridge, Department of Chemical Engineering, Pembroke Street, Cambridge, CB2 3RA, UK

Vivek Gnanasekharan
Purdue University, Department of Food Science, 1160 Smith Hall, West Lafayette, IN 47907-1160, USA

Jun Ho Lee
Purdue University, Department of Food Science, 1160 Smith Hall, West Lafayette, IN 47907-1160, USA

Zhang Li
University of Cambridge, Department of Chemical Engineering, Pembroke Street, Cambridge, CB2 3RA, UK

Peter Muriana
Purdue University, Department of Food Science, 1160 Smith Hall, West Lafayette, IN 47907-1160, USA

J. M. Mwangi
Cornell University, Department of Food Science, Stocking Hall, Ithaca, NY 14853, USA

Thomas Ohlsson
SIK - The Swedish Institute for Food Research, Box 5401, Goteborg, 40229, SWDEN

A. E. Ostermann
PKL Verpackungssysteme GmbH, D-5172 Linnich, GERMANY

S. S. H. Rizvi
Cornell University, Department of Food Science, Stocking Hall, Ithaca, NY 14853, USA

Sudhir K. Sastry
The Ohio State University, Department of Agricultural Engineering, 590 Woody Hayes Drive, Columbus, OH 43210, USA

Steven J. Schwartz
North Carolina State University, Department of Food Science, Box 7624, Raleigh, NC 27695, USA

Rakesh K. Singh
Purdue University, Departments of Food Science and Agricultural Engineering, 1160 Smith Hall, West Lafayette, IN 47907-1160, USA

CONTENTS

THE NORDIC PROJECT ON ASEPTIC PROCESSES

THOMAS OHLSSON
SIK
Box 5401, S-402 29 Gothenburg, Sweden

ABSTRACT

A three year research program on advancing the use of aseptic processing and packaging of foods has recently been completed. The Nordic project "Aseptic Processes" has involved 8 laboratories and has had a budget of more than 2 million US dollars. A group of 34 industry sponsors has participated actively in the project.

The project objective has been to develop knowledge as well as measuring methods for ensuring the safety and quality of complex, high viscosity foods with special emphasis on particle containing foods.

The project has been divided into three subprojects; methods for microbiological control of aseptic products and systems, methods for controlling the processing of particles e.g. RTD, TTD and mechanical integrity and methods for testing the integrity of aseptic packages. These methods will be discussed and their use exemplified. The project has also included a program for extensive information and knowledge transfer.

INTRODUCTION

Aseptic drink products have been a commercial reality in the Nordic countries for more than 10 years. In later years the aseptic processing and packaging in the industry has been extended to include more viscous starch based and dairy products. The industry has shown a large interest in further extending the application area to low-acid, high-viscosity foods containing large particles with good integrity, so that the benefits of lower packaging and processing costs and improved food quality of aseptic processing and packaging can be used also for these value-added food products.

The problems associated with aseptic processing and packaging of foods containing large and delicate particles of dimensions larger than a few millimeters are being addressed in a large R&D product, sponsored by 34 companies throughout the five Nordic countries. In the project eight laboratories in Denmark, Finland, Iceland and Sweden have studied various aspects of aseptic processing and packaging in, and developed methods and technologies that will facilitate the introduction of particle-containing aseptic food products on the market.

The Nordic project "Aseptic Processes" was divided into three different research areas "microbiological testing methods," "methods for evaluating mechanical transport and equipment" and "methods for package control." The project also involved extensive arrangements for transfer of knowledge to the participating industries.

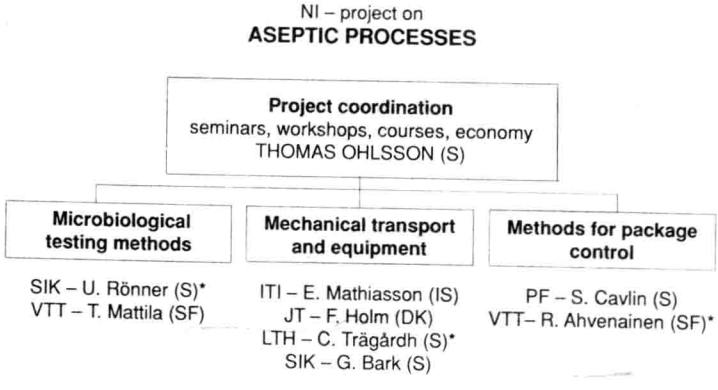

Figure 1. The organizational structure of the project, project leaders and participating laboratories.

The project received financial support from the Nordic industry fund for technological and industrial development in Oslo. The project budget for 1988-1990 has been about 12.5 million SEK or about 2.2 million USD.

MICROBIOLOGICAL PROJECTS

In the microbiology part, the Finnish VTT laboratories and the SIK institute in Sweden have cooperated in the development of methods for controlling the microbiological quality and safety of aseptically processed particulate products. Within the project, rapid microbiological quality control methods such as Bioscreen, DEFT and other methods have been evaluated in comparative tests. Experiments have been done in the SIK aseptic pilot plant. Another part of the studies involved determination of thermal death time kinetics of spores to be used as biological indicators of sterility in particulate products. At VTT in Finland, non-destructive microbiological quality control methods, using headspace indicators placed inside transparent packages have been developed. Finally the two laboratories cooperated in the development of methods for evaluating the efficiency of cleaning and presterilization procedures in aseptic processing and packaging equipment.

MECHANICAL TRANSPORT AND EQUIPMENT PROJECTS

The laboratories have developed various model foods to be used for testing of particle integrity, residence time distribution and time temperature distribution of particle processes. The alginate particle method was used as a model product in these measurements. Both meat and vegetable particles are includeded in a model food soup.

Studies of residence time distribution of particles flowing through processing equipment is another important part. The studies involved both visualization of particle flow and measurements of RTD, as well as modelling of the two-phase flow. Methods for evaluating the time temperature distribution of particles have been developed, using high temperature resistant enzymes.

Methods for evaluating mechanical damage to particulate products transported through the equipment have been tested by the Danish participating laboratory. Finally, methods for visual inspection of the efficiency of various cleaning procedures have been tested.

PACKAGE INTEGRITY CONTROL PROJECTS

Methods for non-destructive testing of package integrity have been reviewed in the project. The Swedish Packaging Research Institute and VTT in Finland have jointly developed and evaluated an electric conductivity measuring method for determining the size of microholes in packages. The possibilities for microorganisms to migrate through microholes of various sizes in packages and how this is correlated to the measured conductivity signal have also been determined.

PROJECT COORDINATION AND KNOWLEDGE TRANSFER

An important aspect of the Nordic work has been the information and knowledge transfer project. The industry reference group has met with the project leaders from the research institutes every sixth months to review the progress of the R&D and discuss plans for the future work. Status reports have been sent out to the industry in connection with these meetings.

At the start of the Nordic project in 1988, an international seminar was held on recent developments in the area of aseptic processing and packaging. A final seminar on the same subjects was arranged in Finland in late January, 1991, in connection with the final industry meeting of the project.

Another part of the information and knowledge transfer has been the workshops arranged in the three areas covered by the Nordic project. A workshop on microbiological quality control and discussions about good manufacturing practice was arranged on Iceland in 1989. A workshop on packaging integrity was held in Stockholm in January, 1990. The third workshop was held in Lund, Sweden, in 1990 on methods for evaluating the processing and packaging of particulate products from a mechanical point of view.

We have also run training courses for the staff of the participating companies in aseptic processing and packaging of particulate food products at the aseptic pilot plant installations at the Danish

Technological Institute in Aarhus and at SIK in Gothenburg, Sweden. Workshops and courses were only open to the participating companies and free of charge.

The results of the R&D work in the Nordic project have first been presented to the participating industries at the reference group meetings. After six months, the reports are also available to the general public in the form of publications, reports, seminar presentations, etc. A list of published papers is available from the author.

FUTURE ACTIVITIES

The Nordic project is now in its final month with final reporting and publishing as the major activity. Discussions are now under way within the project group together with the industry reference group to develop a continuation of the project for another 2-3 years. The methods for evaluating RTD, TTD and mechanical integrity of particles will be further developed. The plans include practical application and evaluation of the developed process measuring methods on various aseptic processing one and two phase flow systems. The SIK computer program for simulating aseptic processing system will be developed to also accomodate two-phase flow aseptic systems. The plans also include continued basic studies of the flow of particles in tubes.

In the area of process hygien, the microbiological status of various food contact surfaces will be evaluated in studies of the adhesion ability of different microorganisms. The effect of various sanitation methods and agents on the micobiological safety of the processing and packaging equipment is planned to be evaluated. In the package integrity project, commercially available non-destructive leakage testing methods are to be compared to the previously developed micro hole measuring method.

The information and knowledge transfer activities are also planned to continue to be an active part of the project. A news letter on aseptic processing and packaging as seen from the Nordic countries is also planned. We plan to arrange workshops for the three project areas and a final news seminar at the end of the project period in 1993.