Frozen Food Science and Technology

Edited by

Judith A. Evans
Food Refrigeration and Process Engineering Research Centre (FRPERC)
University of Bristol, UK

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Contents

Contributors

Mark Berry
Unilever Plc, Sharnbrook
Bedfordshire, United Kingdom

Teresa R.S. Brandão
Escola Superior de Biotecnologia
Universidade Católica Portuguesa
Porto, Portugal

Giovanni Cortella
Department of Energy Technologies
University of Udine
Udine, Italy

Trygve M. Eikevik
Norwegian University of Science
and Technology, Trondheim, Norway

Kostadin Fikiin
Refrigeration Science and Technology
Technical University of Sofia
Bulgaria

John Fletcher
Unilever Plc, Sharnbrook
Bedfordshire, United Kingdom

H. Douglas Goff
Department of Food Science
University of Guelph
Guelph, Ontario, Canada

Elsa M. Gonçalves
Departamento de Tecnologia das
Indústrias Alimentares
Instituto Nacional de Engenharia,
Tecnologia e Inovação
Lisboa, Portugal

Ronan Gormley
Ashtown Food Research Centre
(Teagasc) Ashtown, Dublin
Ireland

Vidar Hardarsson
SINTEF Energy Research
Trondheim, Norway

Anne K.T. Hemmingsen
SINTEF Energy Research
Trondheim, Norway

Steve James
Food Refrigeration and Process
Engineering Research Centre
(FRPERC), Langford
North Somerset, United Kingdom

Onrawee Laguerre
Refrigerating Process Research Unit
Cemagref,
Antony, France

Alain LeBail
ENITIAA (École Nationale
D'Ingénieurs des
Techniques des Industries Agricoles et
Alimentaires), UMR GEPEA,
Nantes, France

Ola M. Magnussen
SINTEF Energy Research
Trondheim, Norway

Peter McClure
Unilever Plc, Sharnbrook
Bedfordshire, United Kingdom

Paul Nesvadba
Rubislaw Consulting Ltd
Angusfield Avenue
Aberdeen, United Kingdom

Tom S. Nordtvedt
SINTEF Energy Research
Trondheim, Norway

Girolamo Panozzo
Construction Technologies Institute – Italian National Research Council (ITC-CNR)
Padova, Italy

Andy Pearson
Star Refrigeration, Glasgow
United Kingdom

Q. Tuan Pham
School of Chemical Sciences and Engineering
University of New South Wales
Sydney, Australia

Cristina L.M. Silva
Escola Superior de Biotecnologia
Universidade Católica Portuguesa
Porto, Portugal

Andy Stapley
Department of Chemical Engineering
Loughborough University
United Kingdom

Joy Wilkinson
Unilever Plc, Sharnbrook
Bedfordshire,
United Kingdom

Noemi E. Zaritzky
CIDCA (Centro de Investigación y Desarrollo en Criotecnología de Alimentos),
Universidad Nacional de La Plata,
La Plata, Argentina

Preface

Freezing is one of the oldest and most commonly used means of food preservation. It has been known to be an extremely effective means of preserving food for extended periods since Paleolithic and Neolithic times, when man used ice and snow to cool food. The cooling effect of salt and ice was first publicly discussed in 1662 by the chemist Robert Boyle, but this technology was certainly known in Spain, Italy and India in the sixteenth century. The manufacture of ice in shallow lakes using radiant 'night cooling' and the preservation of ice and snow in ice houses was a common practice in large country houses in the Victorian times. Ice was a product only for the privileged, and iced desserts were extremely fashionable and a sign of great wealth.

In more temperate climates the preservation of ice and snow was obviously difficult, and it was only with artificial cooling that frozen food became available more widely. In 1755 William Cullen first made ice without any natural form of cooling by vapourising water at low pressure. This was followed by Jacob Perkins in 1834 who made the first ice-making machine operating on ethyl ether. In the following 30 years refrigeration technology developed rapidly, spearheaded by the likes of Joule and Kelvin, and the first patents related to freezing of food were filed. In 1865 the first cold storage warehouse in New York was built which used brine for cooling. In 1868 a ship's cold air machine was used on board the Anchor line's Circassian and Strathlevan ships that transported meat from New York to Glasgow. This was rapidly followed in the 1880s by the transport of meat from Australia and New Zealand to London.

In the late nineteenth century, refrigeration and the freezing of food underwent rapid developments in terms of the freezing processes and the refrigerants used. In 1880 ammonia was first used as a refrigerant and in 1882 the first plate freezer was developed. Although freezing was an extremely important technology, and a vital means of exporting meat for the troops in World War I, it was only after the war that refrigeration machinery underwent massive developments to improve reliability and efficiency.

In 1928 refrigeration was changed forever when Thomas Midgley invented CFCs (Freons). These were hailed as wonder chemicals and were claimed at the time to be efficient and environmentally harmless. Around the same time (1929) Clarence Birdseye began developing frozen meals. His original intention (that another inventor, a Frenchman called Charles Tellier, had in 1869) was to use freezing to dry foods that would have long-term stability and could be reconstituted by the housewife. When this method was found to produce poor quality results, Birdseye reverted to the fast freezing of food. Uniquely, he understood the beneficial impact of fast freezing on the quality of foods that had until that time often been frozen at slow rates.

Developments in freezing and frozen foods technology developed rapidly in the later half of the twentieth century. With changes in consumers' lifestyles the need for convenience food increased and, coupled with the development of low-cost refrigeration technologies, all households could have access to a freezer to store food. At the end of the twentieth century the market for frozen food was increasing at about 10% per year with approximately 25% of refrigerated food being frozen. This growth has since slowed slightly but sales of

certain frozen foods such as fish and seafood are growing. Growth of frozen fish in Russia is reported to be 17% per year (*Cold Chain Experts Newsletter*, January, 2006) and the British Frozen Food federation has recently reported that sales by value increased by 3% in 2005/6 (*Refrigeration and Air Conditioning*, November, 2006).

Successful freezing can now preserve food almost in its original form. This makes it possible to preserve and transport food worldwide. As freezing prevents growth of microbes, frozen food can be stored for long periods; there is no need to use preservatives or additives to extend shelf life. Freezing allows flexibility in manufacture and supply and means that food can be preserved at near its optimum quality for distribution and transportation.

This book describes the current technologies to preserve food and the best practices to ensure production of safe, high-quality frozen food. It also points to some new technologies that are already making waves and are likely to cast an even greater impact on the frozen food industry in the future.

One of the largest upheavals in the refrigeration industry in the last 30 years was caused by the realisation that the chemicals invented by Thomas Midgley are harmful to the environment. The phasing out of CFCs (chlorofluorocarbons) and introducing their replacements – HCFCs (hydrofluorocarbons) – as part of the Montreal and Kyoto protocols, have brought about a paradigm shift in the chemicals used as refrigerants. Many older refrigerants with low ODP (ozone depletion potential) and GWP (global warming potential) have been, or are being, re-evaluated so as to raise their refrigeration potential making use of the modern machinery. For example, the refrigeration technology used on board the first ships, that brought meat to the UK from America and Australasia, was based on the use of air as the refrigerant. This technology, although effective, was based on large and inefficient machinery that could not compete once newer equipment came into the market. With modern compact, efficient turbo-machinery these disadvantages were overcome and air could once again be used as a competitive refrigerant.

As well as addressing these refrigeration issues, the book examines many interesting new freezing technologies such as pressure shift freezing. Although not yet a commercial reality for large-scale production, the possibility of a rapidly frozen product with minimal cell disruption is an exciting prospect for the future.

I hope that you will find that this book provides a comprehensive source of information on freezing and frozen storage of food. Our aim is to provide readers with in-depth knowledge of current and emerging refrigeration technologies and how these technologies can be used to optimise the quality of frozen food. An impressive group of authors, each an expert in their particular field, have contributed to this book. I would like to thank each of them for their help in developing a practical and comprehensive guide to freezing and frozen foods.

Judith Evans