ESSENTIALS OF THERMAL PROCESSING

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SECOND EDITION

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Preface

Essentials of Thermal Processing is written by two authors with many years' experience of thermal processing practice, one gained in the northern hemisphere and one in the southern hemisphere. This gives the book a unique appeal. It covers all aspects of thermal processing from its beginnings in 1795 with Nicolas Appert through to modern day computer-controlled processing systems and electronic data capture. The intention was to write a book of practical use to students studying food science and technology as well as for their lecturers, individuals in companies, and research centres that have a need to understand thermal processing principles.

In this second edition, we have tried to expand on the information given so that this book is the one stop, single text required to assist with all thermal processing queries. The second edition starts with the history of thermal processing, from the prize-winning invention in the Napoleonic era, and describes many of the developments that resulted in the precise science that we know today. The next chapter covers basic microbiological principles that govern microbial growth and death. Detail about microorganisms of particular interest to thermal processing specialists is given as well as information about solving spoilage problems. The third chapter is dedicated to the hurdles to the growth of microorganisms so that the reader gains a thorough understanding of how to ensure a safe product.

The next chapters take the reader through the different food categories that present their unique challenges for thermal processing. This includes the traditional sector of low acid foods in which the familiar $F_0$3 concept was

derived from heat resistance studies originally undertaken by Esty and Meyer in 1922. Low acid foods are a group of foods that do not contain any preservation hurdles to microorganism growth and rely on the heat process to control microorganism numbers in the food and a hermetically sealed package to prevent recontamination. Chapters 5 and 6 are on acid and acidified foods. The chapters are separated to describe the different principles and the types of thermal processes that are applied. In the acid foods chapter, information is included about other products that can be pasteurized. The last of the chapters that deals with a specific food group is on heat preserved chilled foods, which is one of the most rapidly growing sectors in Europe. This includes the ready meal concept and ready-to-eat meat, fish, and poultry products. Shelf-life requires refrigerated storage and is typically up to 10 days when a very mild process is used or it can be extended beyond this with more severe thermal treatments.

Chapter 8 describes processing methods that can be used for manufacturing heat preserved foods. It is divided into in-pack or in-line systems, often known as retorts and continuous systems. The focus of this chapter is the operating principles of the different designs. The main types of retort are described, for example steam, steam-air, water immersion, raining, and sprayed water, also included are the in-pack continuous retorts such as hydrostatic and reel and spiral cooker–cooler systems. Equipment choice for a continuous or in-line system depends mostly on the food viscosity and whether the flow behaviour is laminar or turbulent.

Thermal processing of foods has a dual purpose, which is to commercially sterilize the product and to cook it to an acceptable level. The chapter on cooking and process optimization addresses the challenges of maximizing a specific quality attribute without damaging the thermal

processing effect on microbial reduction. Examples are given on the different quality parameters appropriate to heat preserved foods and how these can be mathematically analysed with the aim of adjusting processes so that maximum quantities of a nutrient, such as a vitamin, are retained.

Techniques for establishing and validating thermal processes are described in two chapters. Temperature and heat transfer are explained and process calculation methods are discussed. Measurement techniques for in-pack processes include temperature sensors of various types and log reduction methods that can be either microbiological or biochemical. Process calculation techniques are introduced, which allow process conditions to be calculated from the temperature measurements and analysis of deviations to be carried out. Differences in the techniques required for batch (in-pack) and continuous (in-flow) heat processes are described.

Chapter 12 discusses cooling water; almost all types of microorganisms can be found in water, and water is most often the vehicle of transmission for these organisms. Poor quality cooling water or inadequate cooling is arguably the most significant causes of public health issues from canned foods in the last century. Examples of spoilage incidents caused by cooling issues are dealt with in several chapters, and so, this chapter solely describes the different methods of disinfecting cooling water.

Despite the best efforts to control all aspects of a thermal processing operation, all factories will experience process deviations from time to time. Chapter 13 is dedicated to process deviations and describes methods to assess whether a process deviation has made a critical impact on the commercial sterility or safety of a product. Methods to assess a deviation are many and include calculation

methods as well as experimentally recreating the deviation using retort simulators.

Packaging of the product also demanded its own chapter. Understanding packaging options and the way they work together with the product is critical to the success of any food packaging system. The functions of packaging are to contain, protect, preserve, portion, inform, promote, and make foods portable. Packaging options for thermally processed foods are many and include metal (mainly tinplate, but some aluminium), glass, cartons, and specific plastics (laminates and composites). Primary packaging must be able to hold a hermetic seal, withstand the process temperature, provide a physical barrier, withstand the physical stresses during processing, transport, storage, and distribution, and must not react adversely with the food.

Incubation of processed packs is commonplace in the food industry; however, a variety of incubation practices occurs, which suggests that there is no standardized approach. Chapter 15 describes the objectives of incubation together with some recommendations for times and temperatures that different types of microorganism require. It includes suggestions for sample size and methods for interpretation of results.

The penultimate chapter is about the critical control factors (CCP's) involved in thermal processing of food. HACCP (Hazard Analysis Critical Control Point) is a tool to assess hazards and establish control systems that focus on prevention rather than relying mainly on end-product testing. Examples are given of CCPs of relevance to thermal processing.

The final chapter presents a different focus for thermal processing in that it deals with environmental aspects and presents a positive case for thermal processing. As a technology for preserving food, it can be environmentally

beneficial because the goods are stored ambient, thus avoiding the need for refrigeration, and allows agricultural products to be processed close to where they are grown, thus avoiding transportation emissions and forcing crops to grow out of season. An example of a carbon footprint assessment is given in this chapter for a bottled apple juice.

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