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Food process modelling

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Preface

Ever since man walked on the face of this earth, he has consumed food to survive, to maintain his body and mind, and later for pleasure too. In the early days, he had to gather his food wherever he found it. Gradually man started to understand how to grow and cultivate his own food, and he gained more and more control over his environment. All this time, man was curious about what he observed and the mechanisms behind it, longing to understand what happened, what happens to himself, to his food and to his environment.

In the current age of highly developed science and technology, the modern aid to analyse, interpret and understand our surrounding world is modelling. Modelling can be regarded as bringing together the concepts developed by product and process experts into a coherent and consistent entity. By subsequently translating such conceptual models into their mathematical equivalents and by implementing these into computer programs, such models can be used for quantitative analyses and, ultimately, for making predictions. Sometimes expert and modeller are united in one person. In that situation, dedicated models will emerge. When they are different people, the model will often include views that are more generic in nature.

Modelling can be conducted on an almost infinite number of levels, reflecting different degrees of real life, ranging from the purely theoretical to the completely empirical. Nowadays modelling is used in almost every discipline by an ever-increasing number of people. Few of these modellers had a dedicated education in this area, and most of them had to learn the trade the hard way, in daily practice by trial and error, without being aware of the pitfalls of this powerful tool.

In this book, we have attempted to bring some order and rules to the jungle of techniques available for modelling the processes and phenomena that play a part

in our daily food. We need to realise that what we taste and perceive in our food and that what we like in our food, is the result both of processes that occur naturally in our food and processes that we apply to it. On top of that, the techniques used for modelling are applied processes as well. The title of this book, *Food Process Modelling*, has, therefore, to be understood in terms of those three types of processes:

- Processes occurring in food
- Processes applied to food
- Processes applied to model food behaviour.

This book is subdivided into five major parts, each covering a selected area from theory or practice, either involving modelling techniques, or involving particular food processes to which the models are applied.

In Part I the principles and procedures of fundamental, deductive approaches of modelling are explained and discussed. The essence of deductive modelling is the conversion of theories and concepts into mathematical and computer formulations, virtually without applying information contained in the measured data. Data are only used to calibrate and validate the developed models.

In Part II the principles and procedures of empirical, inductive approaches of modelling are explained and discussed. The essence of inductive modelling is to extract as much useful information contained in the measured data as possible, without *a priori* knowledge of the processes involved. Data, for this type of modelling, are the only source of information available. Of course, reality is never that black or white, so models are not purely black or white either. In each of the chapters in Parts I and II some combination of the two types of modelling approaches will be found.

In Parts III and IV of this book, practical examples are provided in the area of production, processing and storage of fresh foods. Models discussed range from almost purely deductive to almost purely inductive. Part III covers the agricultural production, from fruits and vegetables to the dairy and meat sectors. Part IV looks at a range of processing technologies.

The last part of the book discusses aspects of quality and safety. It is not dedicated to one product or process, but to the conglomerate of actions the food industry has to take to bring food to consumers. The emphasis lies on quality and safety throughout the entire food chain, from production, through storage, transport and handling to retail, and finally to the consumer's place to maintain his body and mind, and hopefully to be enjoyed as well.

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Contents

Part I

The principles of modelling: fundamental approaches

Introduction

In modern science, all simple problems have been solved by now. What remains are problems that are so complex, one cannot unravel their mysteries by simple experiments and deductions. To tackle these complex problems, we have to decompose them into their constituting processes and each of these processes has to be studied, analysed and modelled separately. As a consequence, experimental research and analysis of resulting data relies more and more on theoretical, fundamental and generic models. These types of models are deduced from views and theories currently available. These deductive models possess the intrinsic opportunity of reusability and parameter transfer. This means that, for the same product, the same model and the same model structure can be used over and over again, in different situations for different problems while keeping the attached parameters and the parameter values actually the same. At the same time, this approach ensures that the models built and applied are firmly rooted into the contemporary views and theories of chemistry, biochemistry, physics and physiology as applied in agriculture.

So, it is a logical choice to start this book on food process modelling with an overview of the fundamental techniques of modelling.

In Chapter 1 an overview is given of the powers and pitfalls of deductive modelling based on three examples of processes frequently encountered in our food systems. This chapter describes the problems one encounters in making models useful for practical application, in terms of generic modelling and parameter estimation and parameter transfer.

Chapter 2 devotes its attention to the difficulties and rules of decomposing problems into their constituting processes. In the realm of artificial intelligence,