国外优秀食品科学与工程专业教材

食品加工原理

（影印版）

Dennis R. Heldman

Richard W. Hartel

Principles of Food Processing

中国轻工业出版社

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PREFACE

The approach to teaching the concepts of food processing to the undergraduate food science major has evolved over the past 40 years. In most undergraduate food science curricula, food processing has been taught on a commodity basis. In many programs, several courses dealt with processing with emphasis on a different commodity, such as fruits and vegetables, dairy products, meat products, and eggs. In most situations, the emphasis was on the unique characteristics of the commodity and very little emphasis on the common elements associated with processing of the different commodities. Quite often the undergraduate student was allowed to select one or two courses from those offered in order to satisfy the minimum standards suggested by the Institute of Food Technologists.

The current IFT minimum standards suggest that the undergraduate food science major be required to complete at least one food processing course. The description of this course is as follows:

> One course with lecture and laboratory which covers general characteristics of raw food materials, principles of food preservation, processing factors that influence quality, packaging, water and waste management, and sanitation. Prerequisites: general chemistry, physics, and general microbiology.

This textbook, *Principles of Food Processing,* has been developed to respond directly to the topics identified in the proposed food processing course de-

scription. Although sufficient flexibility may not exist in all programs, the ideal positioning of this type of food processing course is after the student has taken food chemistry, food microbiology, and food engineering, and prior to the capstone course.

The approach followed in this textbook is on descriptive components of unit operations used in the processing of food. The text material contains both descriptive information and quantitative evaluations of the individual processes. The descriptive information provides the student with background on the process and the impact of the process on food product quality. A quantitative approach assists the student in understanding the ability of the process to achieve the desired result, as well as the consequences of improper operation of the process. The text contains references to different food commodities to ensure that the student gains an appreciation of the relationships between the commodity and the process.

The early chapters of *Principles of Food Processing* deal with more traditional operations used to accomplish preservation. After an introduction to establish a broad base for information to follow in the text, the second chapter presents the general concepts associated with thermal processing. The third and fourth chapters deal with specific food preservation processes, including pasteurization, blanching, and commercial sterilization. Two chapters in the text deal with processes using the reduction of temperature to achieve food preservation. A chapter describes the role of refrigeration temperatures to preserve food and extend shelf-life. A separate chapter is devoted to the use of subfreezing temperatures to preserve foods and extend shelf-life. Both chapters discuss the influence of storage temperatures on shelf-life and product quality.

The reduction of water content in a food product is a separate concept in food preservation. Some processes concentrate the product solids in a nearly equal mass of water. These processes are referred to as concentration. The removal of water beyond that achieved by concentration is referred to as dehydration. Dehydration processes result in very-low-moisture products and shelf-stable products for extended periods of time at ambient temperatures. *Principles of Food Processing* contains a chapter devoted to extrusion: a relatively new process leading to shelf-stable food products. The final chapter of the text deals with other separation processes. Although these types of operations may not achieve preservation independently, separation is an essential part of several other preservation processes.

It is important to acknowledge the direction provided by previous textbooks on food processing. *Physical Principles of Food Preservation* by Karel, Fennema, and Lund provided the early structure for teaching food processing with emphasis on process. More recently, *Food Processing Technology* by Fellows has provided similar structure, but with emphasis

on a much larger number of individual processes. *Principles of Food Processing* has similarities with these previous textbooks but places even greater emphasis on the description of the process, a quantitative understanding of the process design, and the unique emphasis of the process on product quality.

The authors are pleased to have this opportunity to participate in the education of undergraduate food science majors. The information in the textbook is presented in a manner that will encourage the student to begin the integration of previous knowledge in the areas of chemistry, microbiology, and physics into the study of processes utilized to preserve food products. This initial step in integration provides excellent background for the additional integration expected when the students complete the requirements in a capstone course. The increased emphasis on integration in both the food processing course and the capstone course will improve the ability of the student majoring in food science to understand and appreciate the importance of food chemistry, food microbiology, and food engineering as they influence the quality assurance, sensory evaluation, and product development leading to high-quality and nutritious food products.

Many individuals have contributed to the successful completion of this textbook in either a direct or indirect manner. Both authors have had an opportunity to interact with students and faculty colleagues during the development of the information and materials appearing in the text. These interactions have been extremely important in the development of the approach followed in the presentation of the various topics. The authors take this opportunity to express their appreciation to everyone who has assisted in making this textbook possible.

Dennis R. Heldman
Richard W. Hartel

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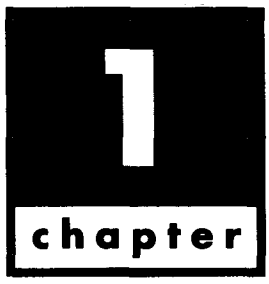

INTRODUCTION

The processing of food can be defined in many different ways. A review of many traditional books dealing with the subject of food processing indicates that the definition is closely related to the product or commodity being processed. Many of the traditional definitions stress the relationship of food processing to the preservation of food, and this dimension still represents the single most important reason for processing. A simple definition of food processing is the conversion of raw materials or ingredients into a consumer food product. A more complete definition is found in Connor (1988), where "commercial food processing" is defined as that branch of manufacturing that starts with raw animal, vegetable, or marine materials and transforms them into intermediate foodstuffs or edible products through the application of labor, machinery, energy, and scientific knowledge. This more complex definition clearly indicates the beginning and end points for the food industry, as well as the inputs required to achieve the desired result.

THE FOOD PROCESSING INDUSTRY

There are many ways to describe the food processing industry, as is evident from the definitions. According to Connor (1988), the food processing industries are among the largest of 20 industry groups within the manufacturing sector of the U.S. economy. In 1985, the value of shipments from the food

processing industry was close to $302 billion. Other sources suggest that this number exceeded $400 billion by 1995. These statistics indicate that food processing is nearly double the size of petroleum refining and 3 times the magnitude of the paper industry. The food processing industry employs in excess of 1.5 million or slightly less than 10% of all employees in the entire manufacturing sector. Finally, the magnitude of value added by food processing was $104 billion in 1985. This statistic indicates that food processing is among the industries with the largest magnitude of "value added" when compared to other industries associated with manufacturing.

The food processing industry is a rapidly growing industry. Connor (1988) indicates that the value of shipments increased by a factor of 4 between 1963 and 1985. These significant increases in value of shipments occurred with a slight decrease in employment over the same time period. Obviously, the value-added component of the product value increased consistently, with an overall increase of 7.4% between 1963 and 1985. During this time period, the percentage of disposable income for food by consumers in the United States decreased from 23.6% in 1963 to 18% in 1985.

A description or scope of the food processing industry is nearly as complex as the definition. Many references utilize the most significant raw material in the consumer product as a reference industry. In other references, the more common reference will be to supermarket or grocery product categories. A common reference used to describe the food industry is the standard industrial classification (SIC) manual where, in 1972, 47 food processing industries were compiled and published in a census of manufacturers. The food and kindred products group includes establishments involved in manufacturing or processing of foods and beverages for human consumption, as well as certain related products such as manufactured ice, chewing gum, vegetable and animal fats and oils, and prepared feeds for animals and fowl. The major categories under food and kindred products include meat products, dairy products, canned and preserved fruits and vegetables, grain mill products, bakery products, sugar and confectionery products, fats and oils, beverages, and miscellaneous food preparations and kindred products.

The common element in all sectors of the food processing industry is conversion of raw material into a product of higher value. In some situations, processing is a one-step conversion of raw material to a consumer product. These types of situations are becoming more rare, with the number of conversion steps increasing. In fact, it is far more common to find an entire industry sector devoted to conversion of raw materials into a widely used ingredient. In a similar manner, entire industrial sectors are devoted to the processing steps required to convert an ingredient into a final consumer product. Much of this complexity is associated with the increasing

sophistication of the consumer and the responsiveness of marketing segments of the industry to consumer expectations. Although the efforts associated with using processing steps to respond to consumer interests have been increasing, the common element maintained throughout is that of establishing and maintaining the safety of the product at the point when it reaches the final consumer.

HISTORY OF FOOD PROCESSING

The following will be a brief review of the history of food processing, with particular emphasis on the role of establishing and maintaining microbial safety in foods, as well as the desire to establish and maintain economic shelf-life for foods.

Some of the earliest forms of food processing resulted in dry food products. These references to various types of commodities date to very early times and the use of thermal energy from the sun to evaporate water from the product and establish a stable and safe dry product. It appears that the first reference to using heated air to achieve food drying occurred in France around 1795.

The history of chilled and/or refrigerated foods dates to very early times as well. The first references are to the use of natural ice used to preserve food products for extended periods of time. A patent for use of a commercial refrigeration process for fish was registered in 1842. The use of refrigeration to reduce the temperature of food below the point of ice crystallization was developed by Birdseye in the 1920s.

The use of high temperature to produce safe food products dates to the 1790s in France. Napoleon Bonaparte offered a prize to scientists to develop preserved foods for the armies of France. This offer lead to the research of Nicholas Appert and the commercial sterilization of foods. In the 1860s, Louis Pasteur, working with beer and wine, developed the process of pasteurization.

All developments in food processing have similar and common origins. One common aspect was that of achieving and maintaining microbial safety in the product. It was quite evident throughout history that foods without some form of preservation could create illness after consumption. Considerable time elapsed after these observations before an association with the microbial quality of the product was established. The second common factor associated with the history of food processing is the interest in extending the shelf-life of the product. In most situations, there is a desire on the part of the consumer to have an opportunity to acquire many of the seasonal commodities on a year-round basis. Over time, it has become evident that extended shelf-life is not possible without modifications to some of the product attributes.