SOURCE BOOK OF FLAVORS

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Source Book of Flavors

To Henry Heath

This book would not exist without
his initial monumental effort

Preface

Flavor is unquestionably one of the most important attributes of the food we eat. Man does not eat simply to live but even more so lives to eat. Take away the pleasure of food and life becomes relatively mundane.

There now is a substantial body of literature dealing with food flavor. The "golden years" of flavor research in the United States were the 1960s and 70s. Numerous academic and government institutions had strong flavor programs and money was readily available for flavor research. In the 1980s and 90s, research funding has become difficult to obtain, particularly in an esthetic area such as food flavor. The number of research groups focusing on food flavor has declined in the United States. Fortunately, the European and Asian counterparts have not experienced decreased funding for flavor research and, thus, the very strong research centers in food flavor have continued to prosper and be productive.

Literature focusing on food flavor has been published in numerous trade and scientific journals as well as a limited number of books and symposia proceedings. This literature has focused largely on academic issues, as most of the published research has been conducted in academic settings. The industry has been, and continues to be, an extremely secretive one—reluctant to disclose anything that might be of value to a competitor. Thus, little information about the activities of the flavor industry itself is available to the public.

The goal of the original *Source Book of Flavors*, written by Henry Heath, was to bring together in one volume as much of the worldwide data and facts and as many flavor-related subjects (e.g., food colors) as was possible. Henry Heath added a wealth of personal information on how the industry accomplishes its various activities, which had never been published in any other literature. It has been the intent of this author to update and build upon the original work of Henry Heath. Some chapters of this text draw very heavily upon Henry Heath's original text; others reflect changing aspects of the flavor area and have been substantially rewritten. Additional authors were called upon to contribute chapters to the new *Source Book of Flavors*—to expand its coverage (e.g., sensory/instrumental correlations and biotechnology) and to update areas that this author could not (e.g., safety and labeling issues).

The classic work, *Food Flavorings*, by Merory (1960), has been deleted from this new *Source Book of Flavors*. The industry,

as well as the materials used in it, has changed greatly over the 30 years since Merory originally published his book. While many of his formulations would yield good flavorings, the industry has surpassed these creations and thus they are not included in this reference book.

Producing a manageable text required a selection from among the literature. However, every subject area has been thoroughly referenced. These references will lead the interested reader to the most current literature for any given subject area. This text is truly a "source" book or "reference" book for the flavor industry.

Every effort was made to ensure that the information presented meets the stated intent. Despite our combined efforts, some errors or omissions may have occurred. The author would appreciate comments on how to improve the text and notice of any errors.

Gary A. Reineccius

Acknowledgments

It would have been truly impossible for this book to have been written without the contributions of numerous individuals and organizations. This author did little other than assemble and present the accomplishments of so many. Clearly, the efforts of the contributing authors must be singled out for special appreciation. The literature searches and general work on the manuscript provided by Mark Risch (University of Minnesota) relieved the author of a substantial burden. Numerous colleagues in the industry responded to my questions in a responsible, open, and timely manner and must be thanked.

The author must again acknowledge the effort of Henry B. Heath. He cannot conceive of ever undertaking the task of writing this book from "scratch," as Henry did. Henry deserves compliments and appreciation.

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Chapter 1

The Flavor Industry

OVERVIEW

The acceptability of almost everything that passes the lips, whether it be food, drink, confectionery, tobacco, medicine or products used for oral hygiene, is dependent to some extent on its flavor. Flavor in food and food flavorings are different terms that have the same end effect. The flavor of a food is created by aromatic chemicals that are biosynthesized during normal metabolic processes in plants and animals, and possibly further modified by cooking or processing. This intrinsic flavor of food represents the complex impact made by these aromatic components on the senses of odor and taste.

Food flavorings, on the other hand, are man-made. They are compounded from natural and/or synthetic aromatic substances, which may or may not be found in nature. The goal is to impart a flavor of choice, to modify a flavor that is already present or to mask some undesirable flavor to increase the acceptability of the end product.

Factors leading to acceptance or rejection of what we eat and drink are many and complex. The ultimate decision depends not only on odor and taste, but also on sight, touch and, possibly, hearing. The extent to which each of these senses is stimulated also affects the pattern of judgment. This is almost impossible to predict because no one sense acts in isolation, but is interdependent on all the others as well as on the sensibility of the consumer.

In all products the raw materials used contribute their own particular chemistry. In the case of food products this determines not only the flavor complex, but also such attributes as color, texture and mouth-feel. In compounding food flavorings, therefore, it is necessary to achieve a high level of compatibility with the intrinsic flavor of the raw materials used. A knowledge of their nature and the chemistry of their constituents is required, as these will influence the ultimate flavor of the end product.

Food has always been the dominant concern of the human race. The body has a constant need for energy and water, but the process of providing these in the form of food and drink involves far more than the mere ingestion of calories and liquid. Most of us derive great pleasure from eating and drinking, assisted by an inherent ability to discriminate between pleasant and unpleasant experiences. We choose to eat and drink what we most enjoy rather than just what is good for us, in spite of a modern emphasis on nutritional needs. When it

comes to food and related consumer products, the initial and continuing success of many products is dependent upon a positive response to product flavor (Chou 1990).

The science and technology of food flavorings requires a knowledge of the chemistry and characteristics, both physical and sensory, of aromatic substances of both natural and synthetic origin. Their individual contribution as flavoring components as well as their safety in use must be established, and a means devised for their quality control and regulation in the best interests of the consumer. Technical education now provides this basic knowledge and also the skill necessary to develop, manufacture and apply food flavorings to the ultimate benefit of the consumer, who is still the final judge of the success or failure of any given product.

History

Although the food industry is rooted deep in history, the flavor industry has developed only over the past 160 years. It sprang from small beginnings in companies that specialized in the processing and marketing of natural botanicals such as the herbs and spices, vanilla beans, vegetables, drugs, the distillation of essential oils and aromatic essences, the isolation of aromatic chemicals from these products and drug extraction (Dorland and Rogers 1977). The primary products of these companies were pharmaceuticals and fragrances; the development of flavorings came much later. Today, these same companies have complex operations offering a whole range of flavorings as a service to the food, beverage, confectionery and related industries. They also sell fragrance compounds for a vast array of applications, including laundry supplies, household cleaners and polishes, advertising purposes (e.g., magazine inserts), air fresheners, toiletries and the cosmetic industry.

It was not until the latter half of the 19th century that chemists began to realize the flavoring possibilities of synthetic aromatic chemicals (Bedoukian 1967). In 1858, vanillin was first crystallized from an alcoholic extract of vanilla beans by Gobley. It was 1872 before Carles established its empirical formula and another two years before Tiemann and Haarman reported its structure; later Reimer confirmed it by synthesizing vanillin from guaiacol. At about the same time, organic chemists were preparing a wide range of highly odorous aromatic chemicals, which were later to be of great value to the flavor industry. Solutions of esters for use as artificial fruit essences were exhibited at a trade fair in London and shortly after were in use in the United States. In 1860, the first book of artificial flavoring formulations was published anonymously in Philadelphia. This was followed in 1916 by a manual for the essence industry by Walter, in which a large number of formulations for artificial flavorings were published. Until the publication of *Food Flavorings: Composition, Manufacture, and Use* (Merory 1968), there was a complete dearth of information on the formulation of imitation flavors—hardly surprising, as most flavor manufacturers treat this information as a secret essential to their competitive position and growth.

The flavor industry developed from its main centers in the United Kingdom and Europe and soon became firmly established in the United States (Pisano 1973). From Europe, essential oils as well as compounded flavors and fragrances were exported overseas as countries were opened up commercially. In the early part of the 20th century, many of the larger flavor houses established their own local manufacturing facilities in order to better serve this growing industry.

Size and Market

In total, the flavor/fragrance industry had worldwide sales in 1987 estimated at about 7 billion dollars (Unger 1989). As can be seen in Table 1-1, fragrance and flavor com-