# ALTERNATIVE SWEETENERS

## SECOND EDITION REVISED AND EXPANDED

edited by
Lyn O'Brien Nabors
Robert C. Gelardi

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*Calorie Control Council*
*Atlanta, Georgia*

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# Preface

Alternative sweeteners continue to be a fascinating area of food technology. Food and beverage companies, food technologists and other scientists, and regulators spend considerable effort following sweetener developments. They cannot afford to do otherwise, considering the impact sucrose alternatives are having on low-calorie food production—one of the fastest-growing segments of the food industry.

With a variety of approved sweeteners, manufacturers are able to use the most appropriate sweetener or combination of sweeteners for a given product—the multiple sweetener approach. And recent additional sweetener approvals are making the multiple sweetener approach a reality. An individual sweetener's limitations can be compensated for by combining sweeteners. Product and taste options can be broadened. Additionally, many sweeteners when used in combination have a synergistic effect.

A sweetener by any name is not necessarily just a sweetener. Speciality sweeteners have important properties other than sweetness. For example, some (e.g., isomalt) are being used effectively for bulk in combination with high intensity sweeteners. Others can be used in speciality products designed to inhibit dental caries.

A very significant area for food technologists in the future will be the interaction and combination of alternative sweeteners with low-calorie ingredients such as bulking agents and fat replacers. By using the multiple ingredient approach—combining bulking agents (one or more), fat

substitutes, and sweeteners—opportunities for future product development will be limitless.

This book presents the latest information on a wide variety of alternative sweeteners. All chapters have been updated from our first edition and chapters have been added on sweeteners barely mentioned just five years ago. Although there are many additions, there is only one deletion. Developers of thaumatin have found that it cannot be used as an intense sweetener in reduced calorie foods. Since it is more properly a flavor enhancer and palatability improver, thaumatin is not included in this edition. We have once again made a concerted effort to provide the reader with comprehensive, updated information on a wide variety of alternative sweeteners. Substantial reference material is included for those wishing to pursue the topic further.

Lyn O'Brien Nabors
Robert C. Gelardi

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# I
# INTENSE SWEETENERS

# Contents

# 1

# Alternative Sweeteners: An Overview

**Lyn O'Brien Nabors and Robert C. Gelardi** *Calorie Control Council, Atlanta, Georgia*

Low-calorie and light foods and beverages comprise one of the fastest growing segments of the food and beverage industry. A 1989 low-calorie and dieting consumer survey conducted in the United States found that a majority of adult Americans consume low-calorie products. Since 1986, the number of adult Americans using these products increased from 45% to 51%, or from 78 to 93 million. This is more than double the 42 million consumers using these products in 1978. The 1989 data also show for the first time that a majority of low-calorie consumers, about 60%, are not on a diet but are using low-calorie products as part of an overall healthy lifestyle (1).

A study conducted in 1988 in Great Britain found that over half of the British population consume intense sweeteners regularly. The study data also indicate that individuals are using these products as part of their regular food consumption and not primarily for weight loss or in special dietary regimens (2).

## THE MULTIPLE SWEETENER APPROACH

For nearly a century, low-calorie products were almost entirely dependent on saccharin, the oldest intense sweetener. Now with additional sweeteners available, a multiple sweetener approach can be used. Availability of a variety of sweeteners is important because no sweetener, including sucrose, is perfect for all uses. With several available, each sweetener can be used in the applications for which it is best suited.

Manufacturers also can overcome limitations of individual sweeteners by using them in blends.

Cyclamate and saccharin historically provided sweetness in a number of popular products. Their use in combination was the first practical application of the multiple sweetener approach. The primary advantage of this sweetener blend was that saccharin boosts the sweetening power of cyclamate, while cyclamate masks the aftertaste that some people associate with saccharin. Also, the two sweeteners when combined have a synergistic effect—that is, the sweetness of the combination is greater than the sum of the individual parts. This is true for most sweetener blends. Combinations of other sweeteners, such as (1) aspartame and saccharin and (2) acesulfame-K, aspartame, and saccharin, are being utilized.

Now with the advent of fat substitutes and low-calorie bulking agents, not only a multiple sweetener approach but a multiple ingredient approach is being utilized to provide additional low-calorie product choices. Some specialty sweeteners, for example, many polyols, provide bulk as well as sweetness and combine well with the intense sweeteners. Polydextrose also can provide the bulk needed in many low-calorie products.

Not only is there evidence that humans have an innate desire for sweets (3), but research also indicates that the obese or those who were once obese may have a greater taste preference for fatty liquids mixed with sugar (4). Thus, fat substitution will be increasingly important in the development of new low-calorie products.

## RELATIVE SWEETNESS

Sweetness is subjective and dependent upon a number of factors. The concentration of the sweetener, the temperature at which the product is consumed, pH, the other ingredients in the product, and the sensitivity of the taster are all important. Sucrose is the usual standard. Evaluation of the sweetness of a given substance in relation to sucrose is made on a weight basis. Table 1 provides an approximation of the relative sweetness of many of the alternatives to sucrose discussed in this volume.

## THE IDEAL SWEETENER

Alternative sweeteners are used to (1) provide and expand food and beverage choices to control caloric, carbohydrate, or specific sugar intake; (2) assist in weight maintenance or reduction; (3) aid in the manage-

**Table 1** Relative Sweetness of Alternatives to Sucrose

| Alternative sweetener | Approximate sweetness (sucrose = 1) |
|---|---|
| Acesulfame-K | 200 |
| Alitame | 2000 |
| Aspartame | 180 |
| Crystalline fructose | 1.2–1.7 |
| Cyclamate | 30 |
| Dihydrochalcones | 300–2000 |
| Glycyrrhizin | 50–100 |
| Hernandulcin | 1000 |
| High fructose corn syrup, 55% | 1 |
| High fructose corn syrup, 90% | 1+ |
| Isomalt | 0.45–0.64 |
| Isomaltulose | 0.48 |
| L-Sugars | 1 |
| Lactitol | 0.4 |
| Maltitol and hydrogenated starch hydrolysates | 0.7–0.9 |
| Mannitol | 0.7 |
| Monellin | 1500–2000 |
| Saccharin | 300 |
| Sorbitol | 0.54–0.7 |
| Stevioside | 300 |
| Sucralose | 600 |
| Thaumatin | 2000–3000 |
| Xylitol | 1 |

ment of diabetes; (4) assist in the control of dental caries; (5) enhance the usability of pharmaceutical and cosmetics; (6) provide sweetness when sugar is not available; and (7) assist the cost-effective use of limited resources.

The ideal sweetener does not exist. Even sucrose does not fulfill all sweetening needs. Alternative sweeteners are superior to sucrose in some products (e.g., pharmaceuticals and chewing gums).

The ideal sweetener should be at least as sweet as sucrose, colorless, odorless, and noncariogenic. It should have a clean, pleasant, untainted taste with immediate onset and without lingering. The more a sweetener tastes and functions like sucrose, the greater its facility for use in foods and beverages. A sweetener must be compatible with a wide range of food ingredients as sweetness is but one component of complex flavor systems.