



**HANDBOOK
OF
FOOD
ADDITIVES**

SECOND EDITION





HANDBOOK OF FOOD ADDITIVES

SECOND EDITION

EDITOR

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Preface to the Second Edition

Since publication of the first edition of the *Handbook of Food Additives* in late 1968, the food industry has undergone significant changes with respect to additives (ingredients) utilized. Restraints imposed by the FDA based on new safety findings by government and industry, as well as deep consumer concern about the ingredients in foods, has reshaped the entire additives issue. Certainly, the food industry is still within the grips of change, and our current efforts can only highlight some of these. For example, the entire issue of non-nutritive sweeteners has plunged the industry into a state of flux. Cyclamates are now banned . . . saccharin is currently under fire . . . a few new candidates are under development but still quite distant from being sanctioned for use in foods. Under these conditions, we chose to reissue the chapter on nonnutritive sweeteners as originally written by Dr. Salant, since much of the information on saccharin is still useful. Should conditions change to a more stable nature, however, this chapter will be revamped to reflect new data. The reader should note that cyclamates have been deleted from Part II of the current edition.

Additional important changes reflected in the current edition include the following: (1) the lowering of use levels of brominated vegetable oil (BVO) as a clouding agent, (2) possible restrictive action against FD&C Red No. 2, (3) FDA's proposed ban of diethyl pyrocarbonate, and (4) the general revocation by FDA of letters to industry affirming the GRAS status of many functional and supplementary ingredients. But, this seemingly negative side of the ledger has been to some extent offset by the positive nature of additions to the ingredient armament, which the reader will find adequately reflected in the updated chapters and Part II. For example, FEMA has deemed GRAS about 125 new flavor ingredients . . . a new certified food color (FD&C Red No. 40) has been added to the approved list, the first in nearly four decades . . . approval has been obtained for synthetic sources of fatty acids, new emulsifiers, xanthan gum as a new hydrocolloid, and many, many more.

Most of the chapters have been revamped to include new data or uses; reference citations have been checked as carefully as possible. An entirely new chapter, titled Phosphates in Food Processing, has been added. On this point, I wish to thank Dr. Ellinger for contributing what the reader should find to be one of the most comprehensive reviews available on the subject.

Finally, I would like to assure readers that we shall do our utmost to keep abreast of rapid changes and to present these in subsequent editions of the handbook.

Hartsdale, New York
November 1972

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Introduction to Food Additives

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Introduction

"Where a man can live, there he can also live well." (From *Meditation* of Marcus Aurelius, 108 B.C.). To extend this philosophy to all people of the world is an acceptable goal of our time. Attempts to do this better, more efficiently, or more economically explain the variety of activities of mankind that have resulted in changes of his environment, purposefully or otherwise. Food additives include the most useful, most well tested, most justified, best controlled, most discussed, most legalized, and least maligned of the materials that man adds to his environment in Quixotic maneuvers to keep nutritional supplies ahead of the population explosion. As people are brought closer together in work, play, and social activities, there is a greater emphasis on personal appearance, cleanliness, and health. Food additives, toiletries (4 billion dollars sales annually), and drugs (about 4 billion dollars sales for nonprescription drugs annually) are the purposeful chemicals used to provide increased health and productive life for our megalopolophilic civilization. It

should be noted that these purposeful chemicals are in a distinctly different category from the waste products of civilization, which provide the bulk of our pollution problem.

Accepting the fact that man is changing his environment at an ever accelerating rate, we are led to the question of what protection we have against this change. Protective factors that counteract the chemicals in our environment include physical, chemical, biological, and social activities. It is worthwhile to outline these forces that are balanced against the changing environment before presenting a detailed consideration of food additives.

The physical factors of placement and dilution offer limited protection against our changing environment. A small amount of waste pumped into a stream may be harmful to biota of that stream, while the dilution of that material when the stream runs into a river may be great enough to have negligible influence on the river biota. Chemical action may cause material to precipitate and become inactive, or it may degrade the material so that its effective life in the environment may be shortened. Biological processes often speed this action. Biological dilution is also important. It is frightening to learn that there are 20 tons of DDT in the tissues of the people of the United States. This fact seems much less amenable to study than does this same information stated as: the average American has 0.1 grams of DDT in his tissues.

Many other biological factors provide protection against change. The feel, taste, and odor of foods are coupled to rejection by spitting, gagging, or regurgitation. Compounds may be modified by hydrochloric acid in the stomach, alkaline salts of the bile, and enzymes of the alimentary tract. Diarrhea and diuresis decrease body contact for certain compounds. A variety of detoxication mechanisms are well known, and some drugs elicit enzyme induction to provide our tissues with specific metabolic pathways for degrading such compounds. Although evolution is a biological factor to help species adapt to a changing environment, man's manipulation may be changing the environment too fast for slowly reproducing mammals to use this protective factor.

Society is the last protective factor. Research, knowledge, and wisdom should provide a basis for action appropriate to the time and country in order to tranquilize social unrest. This can be capped by laws and judicial action to provide the protective factor that is society itself. Man's ability to change his environment evokes the responsibility on him to regulate this action carefully for the ultimate perpetuation of society and mankind. Evolution goes in one direction; we are committed either to use the fruits of science wisely or to allow our society to disintegrate.

This brief introduction sketches the background and philosophy needed to place the one category of purposeful chemicals—food additives—in proper perspective.

Food

Diverse Views

Some materials, as the pentose sugars, are absorbed into the cells of the human body by diffusion; other compounds, as glucose, require the cell to expend energy for adsorption against a concentration gradient by "active

transport." Sometimes the material taken into the cell cannot be utilized. However, in all cases the material taken in must have some effect on the cell and therefore must be considered under the general term *food*. Such a view considers the needs and reactions of the total organism.

Both the philosophic and the cellular views suggest that all material taken into a cell or organism, whether useful, nonutilized, or harmful, should be considered food. Food is all the solids, liquids and gases which are taken into the cell or organisms by any route. This general definition is broader than is desirable for the present purpose. Therefore, the concept will be narrowed by removing three categories of food. Metabolic food is that material synthesized by certain cells and utilized by other cells within the body. One example is the utilization of skin-synthesized vitamin D by other tissues which cannot make it. A less definitive example is the synthesis of material by intestinal microorganisms followed by its adsorption. Although the material is actually produced outside the body, "intestinal synthesis" is not usually separated from tissue synthesis for the first approximation of nutritional consideration. The second category is unintentional food. This includes waste material which inadvertently passes from one cell to another, inactive and noxious gases from the air, and materials other than water and oxygen which are absorbed through the skin. At birth, a baby is transferred from unintentional food, its mother's blood, to intentional food, its mother's milk. The third category is water.

Intentional food is the solid, liquid and gaseous material purposefully taken into the body. In this sense soil is food for the earthworm. Although oxygen is sometimes considered an essential nutrient, oxygen and air may be omitted from the present discussion. Water will also be deleted because it complicates our considerations. Water is often considered in a different institutional department and by different laws than food. However, beverages should be retained in the category. The solids may be simplified by omitting those which are not purposely taken as food. This deletes toothpaste, snuff, mouth washes (including fluoridated ones which actually are good), drugs and lipstick. Chewing gum and chewing tobacco are in a questionable status. Intravenous feeding and antifertility pills are out; vitamin and mineral pills and candy are in. The subcategory remaining includes purposeful food: material ingested for nourishment. This subcategory constitutes a small, manageable portion of the total food concept which corresponds reasonably well with dictionary definitions: Food is "nutritive material absorbed or taken into the body of an organism which serves for the purpose of growth, work or repair and for the maintenance of the vital processes." This would preclude most food additives. Food is "nutriment in solid form, as opposed to *drink*, which may also contain more or less nourishing material." Food is "anything that nourishes, develops, or sustains."¹ In modern concepts, the proof of the pudding is in the subsequent metabolic effects. The FAO/WHO Codex Alimentarius Commission defined food at their November 1966 meeting: "*Food* means any substance, whether processed, semi-processed or raw, which is intended for human consumption, and includes drink, chewing gum and any substance which has been used in the manufacture, preparations, or treatment of 'food,' but does not include cosmetics or tobacco or substances used only as drugs." This definition is broad enough to include food additives.

Food Standards

Food for commercial use is strictly regulated by enforcement of state and federal laws. Exact specifications of each item of concern by commerce and law provide the only equitable means of solving problems. Therefore definitions of foods become a matter of national and international concern and may involve problems of great economic, social, moral, medical, legal and/or political importance. A definitive reference on food standards and definitions in the United States was prepared by Gunderson, Gunderson and Ferguson.² Food standards establish an authority for the quantity, weight, value, or quality of specific food items. The standards are concerned with *identity*, *quality* and *fill of container* to promote honesty and fair dealing in the interest of consumers.

Congressional action provides direct standards for butter (1923) and nonfat dry milk (1956). Filled milk is specifically prohibited by a congressional act of 1923. The Agricultural Marketing Act and the Poultry Products Inspection Act provided extension and improvement of standards on both voluntary and mandatory basis. The Food and Drug Administration provides many food definitions and standards of identity. These categories include foods for special dietary uses, pesticide chemicals in or on raw agricultural commodities, and food additives. The Public Health Service has defined a few foods and is concerned with safety to health, primarily by protection from harmful microorganisms. This agency provides drinking water standards, microbiological standards for foods, radiation protection, miscellaneous food standards, and an ordinance and code regulating eating and drinking establishments.

Hundreds of foods are regulated by the Department of Agriculture. The meat inspection activity of this department is one of the oldest food standard and protection activities of the U.S. government. Although other departments have federal standards on fish and shellfish, the Bureau of Commercial Fisheries of the Department of Interior has this prime responsibility under the Fish and Wildlife Act of 1956. The Treasury Department provides standards for wine, beer, tobacco, bottled cocktails and whiskey. The Department of Defense provides food standards which emphasize packaging and storage requirements. Kosher foods and a variety of other foods are regulated by the Federal Trade Commission. The Veterans' Administration takes most of its standards from other federal agencies. The General Services Administration is responsible for publication of food standards in the Federal Register and in the Code of Federal Regulations and the provisions of standards for food which is to be purchased by more than one branch of the government. Coffee and instant coffee standards are provided only by the General Services Administration.

Over 50 countries are working on international food standards as a joint FAO/WHO Codex Alimentarius Commission.³ Development and acceptance of the Codex, an international food standard, should encourage more free movement of foods from country to country and help developing countries promote adequate legislation, provide consumer protection, and encourage acceptance of their exports. Formal acceptance of a Codex standard by any government would obligate that country to the minimum standards for imported and exported foods. The development of the Codex is expected to be a major factor

in future trade which is of great importance to any country with substantial exports or imports. In general the Codex standards may be expected to be somewhat lower than standards already accepted by the United States. In such cases, appropriate labeling would be necessary to clearly indicate that a given food meets Codex standards but not those of the country. The Codex Alimentarius progress was reviewed by Koenig.⁴

Formula Foods

New foods appear on the market with increasing frequency. We are tantalized by ready availability of dehydrated strawberries in cereals, instant mashed potatoes, preseasoned foods in heat resistant plastic, partially-baked rolls and pastry, prepared milk formula in disposable bottles, prepared ingredients for foreign foods, mixed drinks, frozen TV dinners, and a variety of dietetic foods: low calorie, dietetic, salt-restricted, and hypo-allergenic. Supermarkets stock thousands of items never found in the country store of yesteryear. Among those 6-8000 items available are hidden artificial or formulated foods. Synthetic foods, i.e., protein from crude oil and edible carbohydrates from cellulose, are not included here.⁵ *Formula food* is the term more pertinently applied to the production of new foods from previously accepted materials. Examples such as artificial whipped cream, frozen "ice cream" and margarine from improved processing suggest the wealth of possibilities. The ingredients of these foods must have been accepted by food standard codes; then a manufacturer may use them to prepare a food which has not previously existed. The Department of Agriculture has formula standards for margarine, chopped ham, corned beef hash, soy protein concentrate, calcium reduced dried skim milk and smoke flavorings. Manufacture and labeling are liable to periodic scrutiny by government officials; the main problem is getting customer acceptance. Archer Daniels Midland has started to use vegetable proteins to produce several new foods.⁶ The total of new foods introduced (many of them are new formulations) is 5000 per year; most are short-lived.⁷

Food Supplements

* Food supplements are sometimes considered with items such as alcohol, soft drinks, gum and candy. Beverages (alcoholic and non-alcoholic) and candy should be classed as foods since they have nutritive value. Chewing tobacco is a food supplement in some countries. Since many food supplements are specific nutrients, they are sometimes excluded from the strict definition of food additives. A separate category for things such as iron salts, vitamin D, wheat germ meal, or poppy seed seems unwarranted. Therefore materials sometimes listed as food supplements will be considered either as components of formula foods or as food additives where they fit nicely according to their uses.

Food Additives

Definitions

As was true with food, the broadest definition must be reduced considerably before a definition acceptable to our purpose is provided. Thus, anything added to food is not necessarily a food additive. "A *food additive* is a substance

or mixture of substances, other than a basic food stuff, which is present in food as a result of any aspect of production, processing, storage or packaging. The term does not include chance contaminants.”⁸ Inclusion of the second sentence in this definition changes it from a definition with public health as its prime concern to one which is more concerned with regulation. The second sentence makes it a definition of intentional food additives and purposefully omits incidental, unintentional or contaminating material. This ignores pesticides, packaging materials, fertilizers, promotants and material which may inadvertently but consistently become a part of a food. Therefore, the broad meaning without the second sentence is a more acceptable definition. Fortunately, the Food Protection Committee of the National Research Council accepted incidental additives within its domain.⁹ These two views of what constitutes a food additive are the scientists’ view; the legal-legislative view is more restrictive.

The Food Additives Amendment to the Federal Food, Drug and Cosmetic Act of 1958 contains this definition: “The term food additive means any substance the intended use of which results or may reasonably be expected to result, directly or indirectly, in its becoming a component or otherwise affecting the characteristics of any food (including any substance intended for use in producing, manufacturing, packing, processing, preparing, treating, packaging, transporting, or holding food; and including any source of radiation intended for any such use), if such substance is not generally recognized, among experts qualified by scientific training and experience to evaluate its safety, as having been adequately shown through scientific procedures (or, in the case of a substance used in food prior to January 1, 1958, through either scientific procedures or experience based on common use in food) to be safe under the condition of its intended use; except that such a term does not include—

1. a pesticide chemical in or on a raw agricultural commodity; or
2. a pesticide chemical to the extent that it is intended for use or is used in the production, storage, or transportation of any raw agricultural commodity; or
3. a color additive; or
4. any substance used in accordance with a sanction or approval granted prior to the enactment of this paragraph pursuant to this act, the Poultry Products Inspection Act (21 U.S.C. 451 and the following) or the Meat Inspection Act of March 4, 1907 (34 Stat. 1260), as amended and extended (21 U.S.C. 71 and the following).”

This 1958 amendment recognized three classes of intentional food chemicals: 1. those Generally Recognized As Safe which are known appropriately as GRAS; 2. those with prior sanction; and 3. food additives. This definition is much more restrictive than the first two. The GRAS list of several hundred materials includes components in every functional class of intentional food additives. Pesticides on raw agricultural products and color additives are excluded from the legal-government definition because other laws cover them.

Historical View

Man’s first contact with incidental food additives—the materials produced by fire when cooking food—is one of vital concern to us today. Spices and