ENCYCLOPEDIA OF COMMON NATURAL INGREDIENTS

USED IN FOOD, DRUGS, AND COSMETICS

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Foreword

By some peculiar irony, the rapid technological advances made by the chemical industry since World War II have worked to obscure the solid basic knowledge the industry once had of some of its natural building blocks, the botanicals that were (and still are) the prime ingredients in so many drugs, cosmetics, flavors, industrial reodorants, and so on. The recently trained chemist, pharmacologist, or food flavorist (or for that matter, the person involved in sales, marketing, or purchasing of these materials) in all likelihood has missed the fact that these materials have considerable historical significance, that they still have application in so diverse a list of products, and even what specific role they play in familiar products. After all, these older, possibly no-longer-glamorous natural substances may seem unsophisticated and awkward to handle to those trained in the glories of what might be called synthetic chemistry—the molecular juggling of carbons, hydrocarbons, acids, and alcohols to evolve pristine crystals and powders.

Many of the veteran bench chemists with experience in natural materials have retired or passed on to their ultimate reward (hopefully, a golf cart or a fishing boat in some warmer clime), so the time is coming when there will be less use of such fascinating ingredients as bloodroot, horehound, or ylang ylang oil. The veteran chemists used these materials to make cough remedies or perfume oils before there were synthetics, and when they are gone, the individual little pockets of knowledge have been in danger of dying out. They appreciated that these unique materials provide special product attributes, in the same way that classic spices do for a good chef. Then too, much of the chemical and biological information has been buried in foreign scientific literature, thus making it unavailable to the average technologist.

Dr. A. Y. Leung has been observing this widening information gap for several years, perceiving that one logical way to bridge it was to put together a compendium of materials of natural origin. He has gone about the task with logic and a sense of order, selecting the cardinal facts without deluging the reader or peruser of the book with a veritable mountain of biological data. As befits the only reference book that covers foods, drugs, and cosmetics aspects of common natural ingredients, Dr. Leung has identified each entry according to biological name, its alternative or slang description, a general description of the plant from which it is derived, chemical composition, pharmacological or biological activity, and uses and commercial preparations. And for those needing more information, he has included a comprehensive list of references.

Such handy organization of material makes this book especially useful to the working chemist or technologist, to the purchasing director, to the person in sales or product development or marketing, for in one fell swoop he or she is given clear, comprehensive information with no unnecessary embellishment. Exotica become less exotic, the strange becomes more familiar.

Because of the ongoing work of the Cosmetic Ingredient Review and the Research Institute for Fragrance Materials, it's a safe bet that in the not-so-distant future there will be a demand for a second edition of this monumental work. These efforts will produce much information about the toxicity or safety of these materials, information that will give better clues as to whether it may be opportune or diplomatic or safe from a regulatory standpoint to persist in using a material that

may be allergenic or sensitizing. Also, Dr. Leung has tried to emphasize the quality of commercial preparations, with an eye toward the purchasers and end users who will ultimately find the volume so useful.

Anyone with a sense of romance will cherish the names of these materials, and anyone with an appreciation for order and thorough documentation will regard this book as useful and to-the-point.

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Foreword

The publication of *Encyclopedia of Common Natural Ingredients Used in Food, Drugs, and Cosmetics* is a welcome addition to the libraries of those of us interested in natural products. The reasons for publishing this unique encyclopedia are aptly dealt with by the author in the Preface, and the principal audience has been identified as practicing technologists in the food, drug, and cosmetic industries and their purchasing agents and marketers. But, as well, it should prove to be an important reference for teaching and research in economic botany, food technology, natural products chemistry, and pharmacognosy, for it brings together information about a variety of substances which, for various reasons, are not included in recent compendia dealing with one or another of these disciplines. Yet, as the author points out, these are materials which find significant usage in our society.

Dr. Albert Y. Leung's education as a pharmacist and pharmacognocist, coupled with his extensive experience in natural products industries, provide him with a unique background that accounts for his successful synthesis of this information into a practical compendium. The material is accurately and succinctly presented, the individual monographs are selectively supplemented with a current bibliography that allows for further reading on a particular product, and the selection of products included has been skillful.

Dr. Leung is to be commended for his efforts in bringing us this most worthy publication.

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Preface

About 500 natural ingredients are currently used in commercial food, drug, and cosmetic products. These do not include antibiotics, vitamins, and many other natural substances that constitute prescription drugs nor medicinal herbs that are not readily available in commerce. Some of these ingredients are pure chemicals isolated from natural sources while others are extracts of botanicals. Our daily food, drug, and cosmetic items often contain these ingredients. Many of the substances used in foods are also used in drugs and cosmetics, where higher concentrations are involved.

Three major reasons have prompted me to compile this encyclopedia. First, no reference books are presently available that specifically and simultaneously deal with commonly used natural ingredients in processed foods, over-the-counter drugs, and cosmetics. Since many natural flavor ingredients and food additives are also drug and cosmetic ingredients when used in higher concentrations, there has been an acute need for a compact reference book that provides condensed and accurate information on these substances, saving the reader much time and effort that otherwise would have to be spent in consulting various handbooks and journals.

Second, most of the currently available technical reference books in the English language on food, drug, or cosmetic ingredients contain limited and out-of-date information regarding naturally derived substances. Many formerly official botanical drugs that are no longer official in the *United States Pharmacopoeia* (U.S.P. XIX) or the *National Formulary* (N.F. XIV) are still widely used in nonprescription pharmaceutical preparations and in food products. Yet they are largely neglected or ignored by editors or authors of readily available handbooks. Presumably, when a botanical drug is deleted from a currently official compendium, there should no longer be any interest in it. Nothing is further from the truth. Formerly official drugs such as arnica, chamomile, rhubarb, valerian, white pine, and witch hazel are still widely used today in foods, drugs, and cosmetics; so are many plants that have never been admitted as official drugs, examples of which are alfalfa herb, annatto seed, chicory root, fenugreek seed, ginseng root, and rose hips. There is still ongoing, active research on many of these natural products, particularly outside the United States. Since these botanicals are very much a part of our culture and daily life, information on them should be readily available. This encyclopedia is intended to furnish correct, up-to-date information on these materials.

Third, there is a general information gap regarding natural products between technologists of the botanical industry and those of the food, drug, and cosmetic industries, between members of the academic and research communities and those in industry, as well as between the consumer and the industry concerned. Information readily available to one group is often not available to the others. One of the objectives of this book is to try to bridge this gap by supplying information that would make different groups more aware of the practices and happenings outside of their own circle regarding the use of natural ingredients.

In this encyclopedia, each natural product is presented in alphabetical order according to its most common name, with each natural ingredient being cross-referenced with its scientific name (Latin binomial) in the Index. As a natural ingredient often has several common names (synonyms), the reader is advised to use the Index if an ingredient cannot be found in the text under a particular synonym. Data on about 310 natural ingredients are furnished. Information included in each item includes plant or other sources,

habitats, parts used or derived from, method of preparation, brief physical description, chemical composition, pharmacology or biological activities, common commercially available forms in the United States and their qualities, uses, and regulatory status, whenever applicable.

Data on chemical compositions of natural ingredients are constantly increasing as analytical techniques keep improving. Often an ingredient contains hundreds of chemical constituents, yet only a few (occasionally arbitrarily selected) are listed in this encyclopedia. For further information on other compounds the reader is referred to the original references cited. Incidentally, the absence of a particular compound in a natural ingredient does not necessarily mean that it is actually absent; it may simply mean that nobody has analyzed for it in this particular ingredient. On the other hand, its reported presence in a natural ingredient means only that someone has investigated it in this particular ingredient using a particular analytical technique for whatever reason. Also, the mere presence of a toxic chemical in a natural ingredient does not necessarily make this ingredient toxic. Its concentration and biological availability should be taken into account when the toxicity of the ingredient is considered.

The data on pharmacology or biological activities (be they favorable or unfavorable) reported in this book should be viewed with caution as often they were single reports or reports from a single laboratory or research group that have not been substantiated by other studies. Furthermore, it should be kept in mind that results from animal studies are not necessarily applicable to humans. Purity of the test materials (which is often not sufficiently stressed) should also be taken into account when evaluating such data.

Uses are categorized into four major areas: (1) pharmaceutical and/or cosmetic, (2) food, (3) folk medicine, and (4) others. Pharmaceutical and cosmetic uses refer to current uses in commercially available products mainly in the United States. No attempt has been made to identify the function of each ingredient in a product, as often there are over a dozen botanical components present in a single preparation, making it an impossible task. The same situation applies to the food area where the majority (200–250) of the ingredients used in food products are broadly identified only as flavor ingredients. The specific function and use level of a particular ingredient in a flavor formulation are often proprietary information, which is seldom publicly available. Consequently, food uses are reported in this encyclopedia by food categories, as in the report on "Average Maximum Use Levels" published by the Flavor and Extracts Manufacturers' Association of the United States (FEMA). Only in cases where the functions of the ingredients have become widely known in the trade or otherwise in open literature (e.g., fenugreek extract as a major flavoring agent in artificial maple syrup, yucca extracts as foaming agents in rootbeer, and absinthium as a flavor ingredient in vermouths, etc.) are they specifically mentioned in this book. Sometimes an ingredient is reported used in various types of food products yet federal regulations have approved its use in only one particular type of product. This appears to be a typical case of information dissemination lag. Under folk medicinal uses are listed only those traditional uses that are reported in reliable sources available to me, primarily in the English, German, and Chinese languages; they are by no means complete and they should not be regarded as endorsement of such uses. They are included in this volume because of their popular interest. Under the fourth category ("others") are listed potential or unusual uses that do not fall in above categories.

Use levels in foods reported in this encyclopedia are based on the FEMA report; a manufacturer may foreseeably use an ingredient in an amount five times the average maximum use and still be considered within good manufacturing practice. Use levels reported for cosmetics are based on values reported in the Monographs on "Fragrance Raw Materials" prepared by Opdyke of The

Research Institute for Fragrance Materials, Inc. and published in *Food and Cosmetic Toxicology.*

Under regulatory status, GRAS means generally recognized as safe as sanctioned by the Food and Drug Administration (FDA); an ingredient described as having been approved for food use is not necessarily GRAS. For more precise and up-to-date information, the reader is referred to §182 and its appropriate sections under Title 21 of the *Code of Federal Regulations* (formerly §121.101), to §172.510 (formerly §121.1163), and to other appropriate sections, to the FDA, and to the latest notices and rulings published in the *Federal Register.*

A glossary of terminology commonly used in the botanical industry is found in the Introduction. Since the primary purpose of this encyclopedia is to serve as a practical reference guide for practicing technologists in the food, drug, and cosmetic industries and their purchasing agents and marketers, theoretical considerations and basic principles in the fields concerned are omitted. For these topics, the reader is referred to standard texts on these subjects such as BALSAM AND SAGARIN, FURIA, HARBORNE, LEWIS AND ELVIN-LEWIS, REMINGTON, and TYLER, listed in the General References.

In the General References are listed textbooks and handbooks from which general and sometimes specific information was obtained. They are identified in the text by the names of the authors in small capital letters, and if there are more than two authors, by the name of the first author. If an author has more than one book, it is identified by a number such as 1 or 2 immediately following the author's name (e.g., BAILEY 2); the number refers to the order of appearance of this author's books in the list.

The number or numbers following a major Chinese reference with a hyphen (e.g., KIANGSU-2581 or KIANGSU-429 and 431) refer to the pages where the sources of information were obtained; the page numbers are provided since the index to this handbook was not yet available.

Specific references are cited under References immediately following each entry, numbered according to their order of citation in the text.

It is hoped that this encyclopedia will serve as a handy and useful reference to technical and nontechnical members of the food, drug, and cosmetic industries, to teachers and students of corresponding sciences and related fields, and to the general public who want to know more about natural ingredients.

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Glen Rock, New Jersey
January 1980

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I have spent two years and thousands of working hours of intensive efforts in compiling this encyclopedia. A book of this scope could not have been written without the assistance or participation of others. I am indebted to all who have been part of my heritage and background and to those who have contributed to my scientific training, especially to the University of Michigan and to the Lilly Endowment Foundation.

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During the research and preparation of the manuscript I used the facilities of numerous libraries. I wish to express my appreciation to these libraries and their librarians, including in alphabetical order: College of Medicine and Dentistry of New Jersey (CMDNJ) Library; the Fair Lawn Public Library; Glen Rock Public Library; Montclair College Library; National Library of Medicine; New York Public Library and its branches; Ramapo College Library; Ridgewood Public Library; Rutgers University Libraries; and William Paterson College Library. Special thanks are due my local library, the Glen Rock Public Library, for obtaining copies of numerous patents.

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drafts. Furthermore, during these two years, she maintained a household as normal as possible for our two young daughters, who at times for days on end could say only brief hellos to their father. In this regard I wish also to thank my older daughter, Amy, for her patience and understanding and for her occasional care of Camille during that period.

A.Y.L.

Contents

Introduction

People have been using natural products since the dawn of human history. Only during the last century, however, have we started to know something about the chemistry of some of these products. With our increasing knowledge of chemistry and related sciences, we have begun to duplicate some of the natural chemicals and at the same time made modifications in these compounds or sometimes produced completely new ones. Consequently, since the advent of the Synthetic Era several decades ago, many natural drugs have been replaced by synthetic ones; natural flavors and fragrances have been duplicated or simulated by manufactured chemicals. However the number of natural products used in drugs is still sizable, comprising almost half of all prescriptions written. And this number has not changed appreciably for the last two decades, especially with reference to botanicals.[1] At least 250 plants or their extracts are currently used in commercial food products broadly classified as flavoring ingredients. (FEMA). The present trend points to an increasing interest in the use of natural products, particularly in foods and cosmetics.

To define a natural product is not a straightforward task; for, strictly speaking, everything is derived from nature. Nevertheless by natural products it is generally meant that products are not made by chemical synthesis. Theoretically a natural chemical is the same as its synthetic counterpart in every respect. However it must be pointed out that unless this chemical is absolutely pure (which it seldom is) it would contain different impurities, depending on its sources. The impurities present in a naturally derived food, drug, or cosmetic ingredient are bound to be different from those of its synthetic counterpart, and if there is more than one way to synthesize this compound, then the impurities would be different from one synthetic process to another. The relative toxicities or merits of these small differences have not been determined. If an impurity, whether it is in a natural or synthetic chemical, has unusually high latent biological activity, a minute quantity of it present in a chemical would produce physiological effects besides those elicited by the pure chemical itself; these effects may not be immediately apparent. Most if not all of existing standards for food, drug, and cosmetic ingredients do not have provisions for pinpointing small amounts of impurities, as it is impractical to set absolute purity standards for these ingredients. Consequently in practice most of these materials are permitted to have a range of error built into their purity assays. This range of error can be due either to the assay methods themselves or to actual impurities present in the chemical. In some cases, as analytical methodology advances, this range has become progressively narrower. However before this range becomes negligible, one should not equate a naturally derived chemical with its synthetic counterpart, and their sources should be indicated, as is the case with certain flavor chemicals.

There are several definitions of a natural product. In the case of flavoring substances, some definitions of a natural product (flavor) limit the product to be one obtained from natural sources by physical processes only. Other definitions allow hydrolysis and fermentation as permissible processes. For all practical purposes in this book, a natural product is defined as a product that is derived from plant, animal, or microbial sources, primarily through physical processing, sometimes facilitated by simple chemical reactions such as acidification, basification, ion exchange, hydrolysis, and salt formation as well as microbial fermentation. These chemical reactions do not drastically alter the chemical structure of the natural product to be isolated.

Ingredients used in foods, drugs, and cosmetics can be divided into two main categories, namely, active and inactive. Active ingredients can be considered as those that supply energy to the body or serve as its nu-

trients (foods and some food additives), or cause physiological changes in or on the body (drugs and cosmetics) when taken internally or applied externally. Inactive ingredients are substances which, based on prevalent data, do not exert physiological actions when ingested or applied to the body. Their primary function is to facilitate the ultimate intake or utilization of the active ingredients. Among food products, basic foodstuffs such as flour, starch, and milk are not included in this book although they are considered active ingredients. Only food additives are considered. However in drug and cosmetic products, both active and inactive substances are included.

Food additives are a large group of substances that are added to foods either directly or indirectly during the growing, storage, or processing of foods for one or more of the following purposes[2]:

1. Improve or maintain nutritional value
2. Enhance quality.
3. Reduce wastage.
4. Enhance consumer acceptability.
5. Improve keeping quality.
6. Make the food more readily available.
7. Facilitate preparation of the food.

There are about 2500 food additives currently used by the food industry. Out of this number perhaps 12 to 15% are natural products. Many of these food additives are also drugs when used in larger quantities. Some of these are also used in cosmetics. The total number of the more commonly used natural food, drug, and cosmetic ingredients in this encyclopedia is about 310.

In spite of the fact that plants have been used for therapeutic purposes for millennia, only a relatively few plants or plant derivatives are currently officially recognized in the United States as effective drugs. This is largely due to the difficulties encountered in plant drug research and the limitations of scientific methodology employed. Quite often, premature publicity on unconfirmed research data has tainted the reputation of many botanical drugs. Since many drug plants have rather complicated chemical compositions and analytical technology has not been adequate in determining their identities and qualities once extracts are made from them, adulteration, sophistication, or substitution has been common. This has led to inconsistencies in drug potency, and many natural drugs have probably been removed from officially recognized status as a result. Many natural drugs formerly recognized by the *United States Pharmacopoeia* (U.S.P.) and *National Formulary* (N.F.) are no longer official in these compendia; yet many of these continue to be used in pharmaceutical preparations.

Some of the food, drug, and cosmetic ingredients are pure chemicals isolated from plants, animals or microbes. However most are in the form of extracts, oleoresins, fixed oils, and volatile oils, among others. The following is a glossary of the most commonly encountered terms used in the botanical industry.

GLOSSARY

ABSOLUTES. Absolutes are entirely alcohol-soluble extracts prepared by alcohol extraction of ***concrètes*** or related fat-soluble or waxy materials, alcohol-insoluble substances being removed before evaporation of the solvent.

ALKALOIDS. Alkaloids can be broadly defined as natural amines (nitrogen-containing compounds) which have pharmacological properties and which are generally of plant origin. They are widely distributed throughout the plant kingdom. They usually exhibit basic properties, though there are exceptions. Most alkaloids are insoluble or only slightly soluble in water, but their salts are water soluble. Many naturally derived drugs are alkaloids; well-known examples are morphine, codeine, cocaine, caffeine, nicotine, emetine, atropine, and quinine.

BALSAMS. By conventional definition, balsams are mixtures of ***resins*** that contain relatively

large amounts of cinnamic or benzoic acid or their esters. Typical balsams are balsam Peru, balsam Tolu, styrax, and benzoin. Canada balsam, Oregon balsam, and copaiba balsam are not true balsams since they do not contain benzoic or cinnamic acid or their esters. Balsams are insoluble in water but soluble in alcohol.

CONCRETES. Concrètes are water-insoluble but hydrocarbon-soluble extracts prepared from natural materials by using hydrocarbon-type solvents. They are primarily used in perfumery and in the preparation of ***absolutes***.

DECOCTIONS. Decoctions are dilute aqueous ***extracts*** prepared by boiling the botanicals with water for a specific period of time, followed by straining or filtering. These are normally not commercially available in the United States.

DRY EXTRACTS. Dry extracts are the same as ***powdered extracts.*** This term is used mainly in Great Britain and in Commonwealth countries.

ELIXIRS. According to the U.S.P. definition, elixirs are clear, sweetened, hydroalcoholic liquids intended for oral use. They contain flavoring substances and, in the case of medicated elixirs, active medicinal agents. Their primary solvents are alcohol and water, with glycerin, sorbitol, and syrup sometimes used as additional solvents and/or sweetening agents. They are prepared by simple solution or admixture of the several ingredients.

ENZYMES. Enzymes are proteins produced by living organisms which can bring about specific changes in other compounds (called substrates). Enzymes are also called organic catalysts; they are not consumed in the reactions they catalyze but are regenerated at the end of such reactions. The most commonly used enzymes in the food and drug industries are ***proteases,*** amylases, ***lipases,*** and pectinases.

ESSENTIAL OILS. Essential oils are also known as volatile oils, ethereal oils, or essences. When exposed to the air they evaporate at room temperature. They are usually complex mixtures of a wide variety of organic compounds (e.g., hydrocarbons, alcohols, ketones, phenols, acids, ethers, aldehydes, esters, oxides, sulfur compounds, etc.). They generally represent the odoriferous principles of the plants from which they are obtained. Most of these compounds are derived from isoprene and are terpenes at different stages of oxidation. Essential oils are generally isolated by distillation (most commonly steam distillation), solvent extraction, or expression. Clove, cinnamon, and peppermint oils are obtained by steam distillation, while bergamot and lemon oils and sweet and bitter orange oils are obtained by expression.

EXTRACTS. Extracts are generally but not necessarily concentrated forms of natural substances obtained by treating crude materials containing these substances with a solvent and then removing the solvent completely or partially from the preparations. Most commonly used extracts are ***fluid-extracts*** (***liquid extracts***), ***solid extracts, powdered extracts*** (***dry extracts***), ***tinctures,*** and ***native extracts.***

FATS. Fats are glycerol esters (glycerides) of ***fatty acids.*** They are semisolids or solids at room temperature and are generally produced from botanicals by expression and from animal materials by extraction or rendering.

FATTY ACIDS. Fatty acids are carboxylic acids obtained from natural sources, mostly from ***fats.*** They can be both saturated and unsaturated. Examples of saturated fatty acids are palmitic and stearic acids; unsaturated ones are oleic, linoleic, and linolenic acids.

FIXATIVES. Fixatives are materials, usually high boiling and of high molecular weight, that retard the evaporation of the more volatile components in perfume formulations.

FIXED (FATTY) OILS. Fixed oils are chemically the same as ***fats.*** They differ only physically from fats in that they are generally liquids at room temperature.

FLUIDEXTRACTS. These ***extracts*** are commonly hydroalcoholic solutions with ***strengths*** of 1:1. The alcohol content varies with each

product. Fluidextracts are prepared either from ***native extracts*** or ***solid extracts*** by adjusting to the prescribed strength with alcohol and water or by direct extraction of the botanicals with alcohol-water mixtures as directed in the official compendia. The latter method usually produces more desirable products due to the fewer steps involved in processing. Fluidextracts are also known as ***liquid extracts.***

GLYCOSIDES. Glycosides are sugar-containing compounds which on hydrolysis yield one or more sugars. They contain two components in their molecules, glycone and aglycone. The glycone is the sugar component, which can be glucose, rhamnose, xylose, arabinose, or other sugars. When the glycone is glucose, the glycoside is commonly known as a glucoside. The aglycone is the nonsugar component of the glycoside; it can be any type of compound such as sterols, triterpenes, anthraquinones, hydroquinones, tannins, carotenoids, and anthocyanidins. They are a very important group of natural products, are widely present in plants, and constitute major classes of drugs. Well-known drug examples are digitalis glycosides, sennosides, cascarosides, ginseng glycosides, rutin, and arbutin. Glycoside-containing materials that are used in foods include grape skin color (anthocyanins), red beet color (betanin), soapbark, fenugreek, alfalfa (saponins), and licorice (glycyrrhizin).

GRANULAR EXTRACTS. Granular extracts are produced in the same way as ***powdered extracts.*** They are also of the same potency as powdered extracts. The only difference between them is that granular extracts have larger particle sizes.

GUMS. Gums are hydrocolloids. They are polysaccharides of high molecular weight and can be dissolved or dispersed in water to form a viscous colloidal solution. The most commonly used natural gums are seaweed extracts (agar, algin, carrageenan, furcellaran), tree exudates (acacia, ghatti, karaya, tragacanth), tree extracts (larch gum), seed gums (guar, locust bean, quince seed) and microbial gums (dextran, xanthan).

GUM RESINS. Gum resins are ***resins*** occurring admixed with ***gums.*** They usually also contain small amounts of ***volatile oils*** and sometimes are also called ***oleogum resins.*** Common examples are myrrh, gamboge, asafetida, galbanum, and olibanum.

INFUSIONS. Infusions are sometimes the same as ***decoctions.*** They are generally dilute aqueous ***extracts*** containing the water-soluble ingredients of the botanicals. They are prepared by extracting the botanicals with boiling water. The resulting extracts are not concentrated further. Because of the dilute and aqueous nature of infusions and decoctions, they are very susceptible to microbial deterioration. Infusions are not normally available commercially in the United States.

LIPASES. Lipases are lipolytic ***enzymes*** that hydrolyze ***fats*** or ***fixed oils*** into their glycerol and ***fatty acid*** components. They are chiefly used in the dairy industry as flavor producers or modifiers and in medicine as digestive aids.

LIPIDS. Lipids are fatty materials that are soluble in fat solvents (ether, chloroform, alcohol, etc.). They include ***fatty acids, fats, waxes, fixed oils,*** steroids, lecithins, and fat-soluble vitamins (vitamins A, D, and K).

LIQUID EXTRACTS. Liquid extracts are British equivalents of ***fluidextracts.*** They are used in Great Britain and the Commonwealth countries.

MENSTRUUMS. Menstruums (or menstrua) are solvents used for extraction, for example, alcohol, acetone, and water.

NATIVE EXTRACTS. In the commercial manufacture of extracts, a botanical is first extracted with an appropriate solvent such as denatured alcohol, alcohol, methanol, water, or mixtures of these solvents. The extract is then concentrated under reduced pressure at low temperatures until all solvent is removed. The viscous, semisolid concentrated ***extract*** at this state is called a native extract by some manufacturers. The native extracts are usually of high potency from which ***solid, fluid,*** and ***powdered extracts*** of various ***strengths*** can be prepared by diluting with suitable diluents. If the botanical has ***resins*** and ***volatile oils*** as

its active principles and the solvent used is a fat solvent, the resulting native extract is equivalent to a prepared ***oleoresin.***

OLEOGUM RESINS. See gum resin.

OLEORESINS. Oleoresins are mixtures of mostly ***resins*** and ***volatile oils.*** They either occur naturally or are prepared by solvent extraction of botanicals. Prepared oleoresins are made by extracting the oily and resinous materials from botanicals with fat solvents (hexane, acetone, ether, alcohol). The solvent is then removed under vacuum, leaving behind a viscous, semisolid extract which is an oleoresin. Examples of prepared oleoresins are paprika, ginger, and capsicum (see also ***native extract***). Examples of natural oleoresins are gum turpentine, Oregon balsam, and Canada balsam.

POWDERED EXTRACTS. Powdered extracts are prepared from ***native extracts*** by diluting the native extracts to the specified ***strengths*** with appropriate diluents (lactose, dextrose, sucrose, starch, etc.) and/or anticaking agents (calcium phosphate, magnesium carbonate, magnesium oxide, etc.), followed by drying, usually under vacuum, to yield dry solids. These are then ground into fine powders to form powdered extracts or into coarse granules to produce ***granular extracts.***

PROTEASES. Proteases, or proteinases, are proteolytic ***enzymes*** which act on proteins by attacking specific peptide linkages in the proteins and hydrolyzing them. Depending on their specific applications, commonly used proteases can be of plant, animal, or microbial origin. They find uses in tenderizing meat, modifying dough in baking, chillproofing beer, cheese making, in wound debridement, as digestive aids, in relieving inflammation, bruises, and blood clots, as well as in other industries (leather, textile, dry cleaning, waste control). Examples of widely used plant proteases are bromelain, ficin, and papain; common animal proteases are pepsin and rennin. Proteases are usually divided into two types. Endopeptidases break up internal peptide bonds of the protein chain, producing peptides. Exopeptidases, on the other hand, cleave terminal peptide linkages, producing amino acids. Most commercial proteases are mixtures of different protease fractions and usually have both endopeptidase and exopeptidase activities. Commercial proteases come in many different grades which vary widely in proteolytic strengths. Few published studies on proteases, particularly commercial plant proteases, specify activity of enzymes used, and hence results are generally quantitatively irreproducible.

RESINS. Resins are natural products that either occur naturally as plant exudates or are prepared by alcohol extraction of botanicals that contain resinous principles. Naturally occurring resins are solids or semisolids at room temperature. They are soluble in alcohol and alkali solutions but are insoluble in water. They are usually noncrystalline, transparent or translucent, and soften or melt on heating. Chemically they are complex oxidation products of terpenes. They rarely occur in nature without being mixed with ***gums*** and/or ***volatile oils,*** forming ***gum resins, oleoresins,*** and ***oleogum resins.*** Hence in commerce the term "resins" is often used to include all above resinous materials. During preparation of a resin, the alcoholic extract is poured into an excess of water or acidified water and the precipitated resin is collected, washed, and dried. Typical examples of prepared resins are podophyllum and jalap resins. A prepared resin may also be derived from a natural oleoresin by removing the volatile oil by heat or from a natural gum resin by extracting its resin with alcohol followed by removal of the solvent. Resins prepared by alcohol extraction of natural resinous materials are sometimes referred to as resinoids. Resinoids may be considered as purified forms of certain resins; they are usually prepared from resins by extraction with hydrocarbons.

SAPONINS. Saponins are ***glycosides*** generally with sterols or triterpenes as their aglycones, although there are exceptions. They have the ability of forming foams when their aqueous solutions are shaken. The aglycone portions are called sapogenins. Many saponins are hemolytic. However their foam-forming prop-