

**THE CHEMICAL ANALYSIS
OF FOODS**

THE CHEMICAL ANALYSIS OF FOODS

by
H. E. COX, Ph.D., D.Sc.
and
DAVID PEARSON, M.Sc.



1962

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The Chemical Analysis of Foods

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PREFACE TO THE FIRST AMERICAN EDITION

The sudden death of the eminent Public Analyst, Dr. H. E. Cox, in 1951 came as a shock to all who were connected with food analysis. Long before this, "Cox" meant to members of the profession a standard work to which to refer for advice on analytical methods and interpretation. Also his tables of analytical data based on long experience have been widely used and quoted throughout the English speaking countries ever since the first edition was published. Although it was considered advisable to make various changes to bring this new edition up-to-date, an attempt has been made to retain Dr. Cox's style, which has been described as "readable and to the point."

The first American edition corresponds to the fifth British edition with the modification that instead of a summary of food legislation in England and Wales, the Requirements for food of the United States Food, Drug, and Cosmetic Act are given in Chapter 1. As the body of the text was retained in its original form the reference to British food legislation could not be eliminated from special sections. The users of this book should refer to Chapter 1 for American requirements whenever necessary. Three new basic chapters have been inserted at the beginning of this edition.

Many of the general methods such as those which are available for the determination of moisture, protein, fat, etc., have been brought together in Chapter 2. Similarly, the methods which may be employed for the detection and determination of trace elements, preservatives, colouring matters, etc., have been incorporated in Chapter 3, instead of being included in various parts of the book with specific foods. The titles of Chapters 4-14 are very similar to Chapters 1-11 in the previous edition, but much of the material has been re-written and many foods have been added to those previously covered, *e.g.*, mincemeat, numerous herbs and spices, ice-cream, table jellies. Also entirely new sections on butter confectionery, iodised salt, saccharin tablets and soups have been included in the "Miscellaneous" Chapter 15.

With the tremendous advances being made in the subject, it is now more difficult than ever to decide what is not to be included in a fairly small volume of this type. Also, it is well known that food analysts differ considerably in their choice of methods and any book on the subject therefore is liable to reflect to a greater or lesser extent the personal choice of the author. In this volume the aim has been to bring the material more in line with current practice in the average food laboratory, which is equipped for dealing with routine work. At the same time, a large number of references are quoted, which should enable the reader to seek out further information as to alternative methods which are available. In this connection, it may be noted that most of the recently introduced methods are included in the reviews which appear periodically in the U.S. journal "Analytical Chemistry."

As previously, the matter contained in most sections is largely based on the work carried out by Public Analysts. With many materials, a suggestion is made as to the type of tests which are called for in routine work, and an indication is also given of other methods which may be performed when a more searching examination is necessary. One difference from the previous edition, however, is that in many instances mention is made of other methods which are likely to be used in the food industry for control purposes. Similarly, although the standardised methods of the Analytical Methods Committee of the Society for Analytical Chemistry (formerly the Society of Public Analysts) are given major prominence, those published by the British Standards Institution (which appear to be increasingly used in industry) are also included where appropriate. Such additions should, it is hoped, make the book more useful to a wider section of readers.

It is obviously impossible to thank all of one's past and present colleagues, and others one has met, who have helped in different ways with the preparation of a book of this type. The author feels, however, that this opportunity should not be allowed to pass without according special thanks to Mr. R. G. Minor, F.R.I.C., F.P.S. (Deputy Public Analyst and Lecturer-in-Charge of the Food and Drugs Section at Chelsea College of Science and Technology), whose experience, encouragement and good humour at all times have been invaluable. Special thanks are also due to another "Chelsea" colleague, Mr. E. C. Apling, B.Sc., A.R.I.C. (Chief Chemist, D. W. Kent-Jones and A. J. Amos), for first-rate assistance, particularly during proof reading, and to Mr. E. C. Tubb, B.A., B.Sc. (Chief Chemist, Tate and Lyle Ltd.), for supplying much useful information relating to the composition and properties of cane and beet sugar. Also the author would like to thank the numerous official Associations, Societies and other organisations who readily gave permission to use published information, among whom are the following:

American Association of Cereal Chemists, Minnesota, U.S.A.
 Association of Official Agricultural Chemists, Washington, U.S.A.
 Association of Public Analysts, London.
 British Pharmacopoeia Commission (General Medical Council),
 London.
 Canada Department of Agriculture, Summerland, B.C.
 C.S.I.R.O. (Division of Food Preservation), Homebush, N.S.W.
 Her Majesty's Stationery Office, London.
 National Bureau of Standards, U.S.A.
 Society for Analytical Chemistry, London.
 Society of Chemical Industry, London.

Finally, the new author would like to repeat a statement made by Dr. Cox in the preface to the first edition, that he "will be grateful to anyone directing his attention to errors, which are sure to have crept in, so that they may be eliminated."

D. PEARSON.

National College of Food Technology,
 St. George's Avenue,
 Weybridge, Surrey.

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LIST OF ABBREVIATIONS

- A.M.C. — Analytical Methods Committee (of the Society of Public Analysts, or the Society for Analytical Chemistry).
- A.O.A.C. — Official Methods of the Association of Official Agricultural Chemists, U.S.A.
- J.A.O.A.C. — Journal of the A.O.A.C. (see above).
- A.P.A. — Association of Public Analysts, London.
- B.P. — British Pharmacopoeia.
- B.P.C. — British Pharmaceutical Codex.
- B.S. — British Standard (of the British Standards Institution).
- B.S.I. — British Standards Institution, London.
- F.C. — Full Cream.
- f.f. — Fat-free material.
- F.M.F. — Food Manufacturers' Federation, London
- F.S.C. — Food Standards Committee.
- G.M.S. — Glyceryl monostearate.
- max. — maximum.
- min. — minimum.
- M.O.F. — Ministry of Food.
- M.O.H. — Ministry of Health.
- M.R.C. — Medical Research Council.
- M.S.N.F. — Milk-solids-not-fat.
- N.F.M.S. — Non-fatty milk solids.
- N.F.S. — Non-fatty solids.
- p.p.m. — parts per million.
- P.S. — Proof Spirit.
- R.I. — Refractive index.
- S.A.C. — Society for Analytical Chemistry, London.
- S.I. — Statutory Instrument.
- S.N.F. — Solids-not-fat.
- S.P.A. — Society of Public Analysts, London.
- S.R. & O. — Statutory Rule and Order.
- T.M.S. — Total milk solids.
- U.S.F.D.A. — Food and Drug Administration of the United States.

Chapter 1

REQUIREMENTS FOR FOOD OF THE UNITED STATES FOOD, DRUG, AND COSMETIC ACT

Section 201 (f) of the Federal Food, Drug, and Cosmetic Act defines food as follows:

The term "food" means (1) articles used for food or drink for man or other animals, (2) chewing gum, and (3) articles used for components of any such article.

PRINCIPAL REQUIREMENTS OF FOOD LAW

Below is a synopsis of the principal requirements of the act relating to foods, in nonlegal language. The symbols in parentheses are the pertinent sections of the statute itself.

Health Safeguards

A food is illegal if it contains a natural or added deleterious substance which may render it injurious to health or unsafe (402 (a) (1) and (2)).

The act authorizes placing a limit on the amount in a food of an added deleterious substance that cannot be avoided in the manufacture of the food (406; 402 (a) (2)).

Raw agricultural products containing residues of pesticides not authorized by, or in excess of, a tolerance established by regulation are illegal (408).

A food is illegal if it is prepared, packed, or held under insanitary conditions whereby it may be rendered injurious to health (402 (a) (4)).

Food containers must be free from any poisonous or deleterious substance which may cause the contents to be injurious to health (402 (a) (6)).

Coal-tar colors contained in food must come from batches certified by the Food and Drug Administration as being harmless (402 (c); 406).

Confectionery, including candy, must not contain any alcohol except alcohol not in excess of 0.5 percent derived solely from the use of flavoring extracts, and must not contain a nonnutritive substance (talc, for example) except harmless color, flavor, or not over 0.4 percent resinous glaze (402 (d)).

Sanitary Safeguards

A food is illegal if it is filthy, putrid, or decomposed (402 (a) (3)).

A food is illegal if it is prepared, packed, or held under insanitary conditions whereby it may have become contaminated with filth (402 (a) (4)).

A food is illegal if it is the product of a diseased animal or one that has died otherwise than by slaughter (402 (a) (5)).

Prohibited Deceptions

Food labels or labeling (circulars, etc.) must not be false or misleading in any particular (403 (a)). In determining whether labeling is misleading, consideration is given not only to the representations made or suggested, but also to the extent to which there is a failure of the labeling to reveal material facts. Half truths are not enough (201 (n)).

Damage or inferiority in a food must not be concealed in any manner (402 (b) (3)). Example: A diluted fruit juice artificially colored to resemble the undiluted juice.

No substance may be added to a food to increase its bulk or weight or make it appear of greater value than it is (402 (b) (4)). Example: In the artificially colored diluted fruit juice, the added water increases its bulk or weight and the added color makes it appear to be fruit juice which is better and of greater value.

A food must not be sold under the name of another food (403 (b)). Example: Canned bonito fish represented by label or otherwise as tuna fish.

A substance which is recognized as being a valuable constituent of a food must not be omitted or abstracted in whole or in part, nor may any substance be substituted for the food in whole or in part (402 (b) (1) and (2)). Example: An article labeled or represented as "milk" or "whole milk" from which part of the valuable constituent butterfat has been skimmed, since skimmed milk is substituted for milk or whole milk.

Food containers must not be so made, formed, or filled as to be misleading (403 (d)). Example: A closed package filled to less than its capacity.

Required Label Statements

Required label information must not only be conspicuously displayed, but it must be in terms that the ordinary consumer is likely to read and understand under ordinary conditions of purchase and use (403 (f)). To insure this, the required statements should appear in prominent positions on the principal display panels of labels.

If the label of a food bears representations in a foreign language, the label must bear all of the required statements in the foreign language, as well as in English. (Note—The Tariff Act of 1930 requires

all imported articles to be marked with the English name of the country of origin.)

The following statements must appear on the label in the English language:

1. If the food is packaged, the name and address of either the manufacturer, or the packer, or the distributor, and an accurate statement of the amount of food in the package (403 (e)).
 - a. If the food is not manufactured by the person or company whose name appears on the label, the name must be qualified by "Manufactured for," "Distributed by," or similar expression.
 - b. The statement of quantity of the contents must express the quantity of food in the package, exclusive of wrappers. The statement shall be expressed in the terms of weight, measure, numerical count, or a combination of numerical count and weight or measure, which are generally used by consumers to express quantity of such food and which give accurate information as to the quantity thereof. But if no such general consumer usage exists, the statement shall be in terms of liquid measure if the food is liquid; or in terms of weight if the food is solid, semisolid, viscous, or a mixture of solid and liquid; or it may be in terms of dry measure if the food is a fresh fruit, fresh vegetable, or other dry commodity. A statement of weight must be in terms of the avoirdupois pound and ounce. A statement of liquid measure must be in terms of the United States gallon of 231 cubic inches and subdivisions thereof (quarts, pints, and fluid ounces). The statement must be in terms of the largest unit of measure, such as "1 pound" not "16 ounces," and "1 pint" not "16 fluid ounces."
2. The common or usual name of the food and the common or usual name of each ingredient, except foods for which identity standards have been promulgated, which must make label declarations of ingredients in accordance with the prescriptions of the standards (403 (h) and (i); 401). The word "ingredients" does not refer to the chemical composition, but means the individual food components of a mixed food. The ingredients should be listed in the order of their predominance in the food.
3. The labeling of foods intended for special dietary uses must bear certain prescribed additional information concerning their vitamin, mineral, and other dietary properties which is necessary to inform purchasers fully as to their value for such uses. Regulations that have been issued under this section prescribe the specific additional mandatory label information (403 (j)).
4. Foods must bear labeling stating the presence of any artificial flavoring, artificial coloring (except butter, cheese, or ice cream), or chemical preservative (403 (k)).
5. Imitations must be labeled as such (403 (c)).

Standards for Foods

The act authorizes promulgation of definitions and standards of identity, standards of quality, and standards of fill of container for foods (401). A food which is represented as or purports to be a food for which a standard of identity has been promulgated must comply with the specifications of the standard in every respect (403 (g)). If a food for which a standard of quality or fill of container has been promulgated falls below such standard, it must bear label statements specified in the standard showing it to be substandard in quality or in fill of container (403 (h)). Standards for foods are discussed more fully elsewhere in this publication.

SANITATION AND FILTH

The Food, Drug, and Cosmetic Act is often referred to by the public as the "Pure Food and Drug Act," thus emphasizing one of its basic purposes—the protection of the consuming public from articles that may be deleterious, that are unclean or decomposed, or have been exposed to insanitary conditions that may contaminate the article with filth or may render it injurious to health.

In determining whether or not conditions surrounding preparation, packing, and storage of foods are insanitary, it is necessary to evaluate the possibilities of contamination both with foreign matter that may be harmless but disgusting and with elements which involve danger to health. In its sanitary provisions, the Food, Drug, and Cosmetic Act goes further than to prohibit commerce in products that are carriers of causative agents of disease. It prohibits the distribution and sale of foods which may contain repulsive or offensive matter classed as filth regardless of whether such objectionable substances can be detected by laboratory procedures or are very likely to be present because of the conditions under which the goods were prepared and handled.

However, there is nothing highly technical in the concept of sanitation applied in the enforcement of the act. Ability to conform to standards of production that will result in a clean product does require a careful study of sources and routes of contamination. It is expected, of course, that establishments in which foods are prepared will be properly constructed, lighted, and ventilated, and that employees will be properly attired. Conditions which give rise to denial of entry to importations into this country because a product is filthy or has been produced under insanitary conditions go far deeper than that. Such contaminating elements as rat and mouse hairs and excreta, whole insects, insect parts and excreta, maggots, larvae, and parasitic worms, pollution from the excrement of man and animals, as well as other extraneous material which, because of their repulsiveness would not

knowingly be eaten or used, constitute filth. The presence of such filth renders foods adulterated, whether or not harm to health can be shown. Insanitary conditions which permit the contamination by rodents, such as rats and mice, infestation by insects, and pollution from human and animal wastes, are those with which the act is primarily concerned.

The maintenance of sanitary conditions requires extermination and exclusion of rodents, inspection and sorting of raw materials to eliminate the insect-infested and decomposed portions, fumigation, quick handling and proper storage to prevent insect development or contamination, the use of clean equipment, control of possible sources of sewage pollution, and supervision of the conduct of those who prepare foods so that acts of misconduct may not defile the products they handle. Fumigation of commodities already infested with insects will not result in a legal product since dead insects or evidence of past insect activity are objectionable. Fumigation should be employed where necessary, to *prevent* infestation.

Many food materials imported into this country are intended for further manufacture into finished foods. This fact in no way relieves such imported raw materials from these requirements of cleanliness and freedom from deleterious impurities. It must be remembered also that articles of foods that are free from contamination at the time they leave foreign shores sometimes become contaminated en route and must be detained. This emphasizes the importance of insisting upon proper storage conditions in vessels, railroad cars, or other conveyances. Many detentions have been made of shipments of foods that may have become contaminated, insect-infested, moldy, or otherwise illegal during the journey from the country of origin. While the foreign exporter may be wholly blameless, the law requires action against illegal merchandise no matter where it may have become illegal. Foreign exporters should pack their products for shipment so as to protect them against contamination en route, and should urge transportation agencies to protect the merchandise by maintaining sanitary conditions and segregating food from other cargo which might contaminate it. For example, vessels transporting green coffee in burlap bags have also carried ore concentrates and poisonous insecticides. Improper cargo handling or disasters at sea have resulted in large lots of coffee becoming seriously contaminated, with detentions required.

TOLERANCES FOR FILTH

Innumerable inquiries are received by the Food and Drug Administration as to permitted variations from complete cleanliness or soundness in foods. The act does not authorize "tolerances" for filth or decomposition in foods. It states that a food is adulterated if it con-

sists *in whole or in part* of a filthy, putrid, or decomposed substance. It is obvious that tolerances cannot be recognized, from the additional fact that the mere production of a food under insanitary conditions which may contaminate it with unclean foreign matter renders such food adulterated under the law.

This does not mean that a food is necessarily condemned because of the presence of foreign matter in amounts below the irreducible minimum after all precautions humanly possible have been taken to prevent contamination. In some instances the Food and Drug Administration has informally advised importers of the basis upon which actions are taken against foods which may have been subjected to attack by insect pests or subjected to deterioration due to climatic conditions. As commercial practices improve or an insect infestation is brought under control, the basis of action may be lowered. This should not be a hardship on those who prepare the foods in foreign countries, because whatever may be the basis upon which actions are taken at the United States ports on filth and decomposition, it represents only what the careful producer or manufacturer can meet.

FOOD STANDARDS

Section 401 of the Food, Drug, and Cosmetic Act provides:

Whenever in the judgment of the Secretary such action will promote honesty and fair dealing in the interest of consumers, he shall promulgate regulations fixing and establishing for any food, under its common or usual name so far as practicable, a reasonable definition and standard of identity, a reasonable standard of quality, and/or reasonable standards of fill of container: *Provided*, That no definition and standard of identity and no standard of quality shall be established for fresh or dried fruits, fresh or dried vegetables, or butter, except that definitions and standards of identity may be established for avocados, cantaloupes, citrus fruits, and melons.

It should be borne in mind that these are standards of identity (what the particular food is), of quality (whether above or below standard), and fill of container (how full the package must be). These standards contemplate in every case that the food is properly prepared from clean, sound materials. They do not relate to factors such as deleterious impurities, filth, and decomposition.

The standards of quality established under the Food, Drug, and Cosmetic Act must not be confused with "standards for grades" that are established from time to time by the United States Department of Agriculture. Under the Food, Drug, and Cosmetic Act one minimum standard of quality is established for each food standardized. A food that falls below the minimum standard established must bear a special substandard label reading, for example, "Below Standard in Quality. Good Food—Not High Grade" in a prescribed size and style of type.

The United States Department of Agriculture grades which have been established are usually designated "Grade A" or "Fancy," "Grade B" or "Choice," or "Grade C" or "Standard." These grade designations are not required by the Food, Drug, and Cosmetic Act to be stated on the labels, but if they are stated, the product must comply with the specifications for the declared grade.

The various foods for which standards of identity, quality, or fill of container have been promulgated under the Food, Drug, and Cosmetic Act are listed in the Appendix.

The standards govern labeling and composition and should be consulted for detailed specifications. All standards are published in the Federal Register of the United States. The promulgation of food standards is a continuous task and standards for additional foods will be prescribed in the future. Except in emergencies, 90 days must elapse between the date of promulgation and the date on which standards go into effect.

In addition to the standards authorized to be promulgated under the act, the Act of Congress of March 4, 1923, provides a definition for butter which is quoted under Dairy Products.

SPICES, SPICE SEEDS, AND HERBS

This group represents food materials that are subject to the depositions of various animal and insect pests from which they must be protected. They may also become moldy or otherwise decomposed unless properly prepared and stored. In any discussion of methods of preparing and storing foods intended for human consumption, emphasis must be placed on the principle of "clean" food, not "cleaned" food. This is particularly true with spices. One of the most serious consequences of failure to protect spices is contamination with excreta from rats, mice, birds, chickens, or other animals. Imported spices have been found to contain excreta not only of these animals, but of bats, goats, and camels. Insects, larvae, weevils, moths, mites, beetles, flies, etc., and their excreta constitute another problem.

Emphasis should be placed on harvesting, storing, handling, packing, and shipping under conditions which will *prevent* contamination; that means keeping rats, mice, goats, and other animals away from the food product. Besides shortening the time of exposure in the fields, or in drying or curing spaces which are often in the open, all the necessary preventive measures should be taken to keep animals from walking over or having access to the food material. Separate enclosures may be necessary; places under trees or other perches where birds might roost should be avoided. Barns, sheds, cribs, warehouses, and other storage spaces should be made rodentproof. Experience in the United States has indicated that only by such meas-

ures as metal flashing around baseboards, use of concrete floors and foundations, screening of openings and windows, elimination of false ceilings or spaces between inner and outer walls, and of rat and mice harborages of all sorts inside and outside of buildings, can rats and mice be effectively kept away from these products. Where it is not feasible to rodentproof the entire building, for example, a barn on the farm, it might be possible to rodentproof a section or room where the foodstuff is being held.

The same basic principle of prevention of contamination applies in the case of insects. Gauze netting spread over foods drying in the open may be necessary to keep insects away. Screening of windows and doors will help to keep insects out of storage or packing places. Careful cleaning and fumigation of premises and equipment before a new crop is put into a storage space may save it from contamination by insects that are left over and have been multiplying unmolested since the old crop was removed. The use of infested second-hand bags is another common source of trouble.

While insecticides and fumigants have their function (for example, in preparing a storage space for the reception of spices or other foods, and in preventing the development of infestation in a lot), a product which is already infested is not made acceptable for food by fumigation because the insects are no less objectionable just because they may have been killed by the fumigation.

Many insecticides and fumigants are poisonous or deleterious substances, and if they contaminate food, the food becomes adulterated and subject to action under the requirements of the act. While most of the fumigants are volatile, they may, nevertheless, result in contamination of the food with deleterious residues.

In some cases spices may be used for drug purposes and they then become subject to the drug provisions of the act discussed in Part II. Those spices or spice oils which are listed in the United States Pharmacopeia or the National Formulary are subject to the standards set forth in these compendia when used for drug purposes. Spice products should be sold under their correct names; for example, in the United States the spice known to consumers as sage is *Salvia officinalis* L. Other related sages should be labeled to show they are not this variety. Spice products, when offered for importation, should be reasonably free from foreign matter, such as pebbles, dirt, stems, wood chaff, or other extraneous substance peculiar to each type of product.

No standards of identity for food spice products have been promulgated under the Food, Drug, and Cosmetic Act. Solely as an advisory guide as to IDENTITY of food spice products, the Food and Drug Administration uses the following definitions:

- SPICES. Aromatic vegetable substances used for the seasoning of food. They are true to name, and from them no portion of any volatile oil or other flavoring principle has been removed.
- ALLSPICE, PIMENTO. The dried, nearly ripe fruit of *Pimenta officinalis* Lindl.
- ANISE, ANISEED. The dried fruit of *Pimpinella anisum* L.
- BAY LEAVES. The dried leaves of *Laurus nobilis* L.
- CAPERS. The flower buds of *Capparis spinosa* L.
- CARAWAY, CARAWAY SEED. The dried fruit of *Carum carvi* L.
- CARDAMON. The dried, nearly ripe fruit of *Elettaria cardamomum* Maton.
- CARDAMON SEED. The dried seed of cardamom.
- CINNAMON. The dried bark of cultivated varieties of *Cinnamomum zeylanicum* Nees or of *C. cassia* (L.) Blume, from which the outer layers may or may not have been removed.
- CEYLON CINNAMON. The dried inner bark of cultivated varieties of *Cinnamomum zeylanicum* Nees.
- SAIGON CINNAMON, CASSIA. The dried bark of cultivated varieties of *Cinnamomum cassia* (L.) Blume.
- CLOVES. The dried flower buds of *Caryophyllus aromaticus* L.
- CORIANDER SEED. The dried fruit of *Coriandrum sativum* L.
- CUMIN SEED. The dried fruit of *Cuminum cyminum* L.
- GINGER. The washed and dried, or decorated and dried, rhizome of *Zingiber officinale* Roscoe.
- MACE. The dried arillus of *Myristica fragrans* Houtt.
- MACASSAR MACE, PAPUA MACE. The dried arillus of *Myristica argentea* Warb.
- MARJORAM, LEAF MARJORAM. The dried leaves, with or without a small proportion of the flowering tops, of *Marjorana hortensis* Moench.
- NUTMEG. The dried seed of *Myristica fragrans* Houtt, deprived of its testa, with or without a thin coating of lime (CaO).
- MACASSAR NUTMEG, PAPUA NUTMEG, MALE NUTMEG, LONG NUTMEG. The dried seed of *Myristica argentea* Warb, deprived of its testa.
- PAPRIKA. The dried, ripe fruit of *Capsicum annum* L.
- BLACK PEPPER. The dried, immature berry of *Piper nigrum* L.
- WHITE PEPPER. The dried mature berry of *Piper nigrum* L. from which the outer coating or the outer and inner coatings have been removed.
- SAFFRON. The dried stigma of *Crocus sativus* L.
- SAGE. The dried leaf of *Salvia officinalis* L.
- TARRAGON. The dried leaves and flowering tops of *Artemisia dracunculus* L.
- THYME. The dried leaves and flowering tops of *Thymus vulgaris* L.

CANNED FRUITS AND VEGETABLES

Canned Fruits

Standards of identity, quality, and fill of container have been promulgated under section 401 of the act for a number of canned fruits. The specific standards should be consulted by anyone intending to ship canned fruits to the United States. (Definitions and Standards for Foods, part 27).

The standards of quality are minimum standards. If a canned fruit falls below the minimum standard of quality prescribed for it, the label must bear a substandard statement in the manner and form prescribed in the standard. Labels on canned fruits which meet the minimum

quality standards, and on canned fruits for which no standards of quality have been promulgated, need not make reference to quality, but if they do, the product must correspond to the usual understanding of the labeled grade. Particular care must be taken not to use the terms "Fancy" or "Grade A" on products that do not meet the established understanding of these terms in the United States.

Fill-of-container standards have been promulgated for only a few specified canned fruits, but in packing any other canned fruit the container must be well filled with fruit with only enough packing medium added to fill the interstices, otherwise the container may be deceptive and the product prohibited by the act. In judging the finished product, due allowance is made for natural shrinkage in processing.

Canned fruits for which identity and quality standards have not yet been promulgated are sometimes imported. Fruit used for canning should be mature and should be sound, that is, free from insect infestation, moldiness, or other form of decomposition. In some growing areas blueberries are infested with larvae; such fruit must be discarded when selecting fruit for canning or other food use.

Pitted and stuffed olives found to contain pits and parts of pits were the basis of a notice issued to dealers, importers, and shippers of pitted and stuffed olives. The notice read in part:

While a complete elimination of pit fragments may not be possible in all cases, certainly consumers do not expect to encounter them in so-called pitted olives, to the extent to which they now occur. Shipments of stuffed or so-called pitted olives showing an appreciable percentage of olives containing pits or fragments of pits must be regarded as in violation of the Food and Drugs Act.

Packers and dealers in these commodities are hereby requested to give immediate attention to the correction of this condition in order to obviate that action which otherwise must be taken by the Administration under both the import and domestic provisions of the Act. Opinions have been expressed by dealers to the effect that pitted olives should not contain at the most in excess of 1 percent of olives showing pits or fragments of pits. While this is not announced as a tentative tolerance, immediate attention should be given to eliminating pits and fragments of pits to the extent that it is reasonably feasible. Importers should take up this matter promptly with their contacts abroad, with a view to ensuring that shipments actually are "pitted" rather than "partially pitted." This condition has been found to be more prevalent in the so-called Queen olives than in the smaller, or Manzanilla olives, possibly due to the fact that the pit of the larger olive appears to adhere more closely to the flesh of the olive. In not a few of the lots of the larger olives examined, the percentage of olives containing fragments has been found to be surprisingly high.

Canned Vegetables

Canned vegetable products must be prepared from sound, wholesome raw materials free from decomposition. It has been necessary on occasions to deny entry of canned pimientos and other vegetable products because they had been prepared from sour, fermented raw materials. The definitions and standards of identity which have been

promulgated under the act for a wide variety of canned vegetables provide that "the food is sealed in a container and so processed by heat as to prevent spoilage." The importance of adequate heat processing of canned vegetables, particularly the nonacid types, is emphasized by the danger that spoilage may be caused by *Clostridium botulinum*, the organism responsible for a highly fatal type of food poisoning. It has sometimes been necessary to detain or deny entry to shipments of canned vegetables, canned mushrooms, canned pimientos, and other canned food products because of spoilage resulting from under-processing or occasionally from the use of defective containers.

Cans of food which have become swells or otherwise abnormal should be destroyed.

Standards of quality have been promulgated for several vegetables. The detailed requirements of the standards, should be consulted before making import shipments. For each canned vegetable there is one minimum standard of quality established. If the product falls below this minimum quality standard when judged by the criteria laid down in the standard, its label must show the required substandard statement in the manner and form prescribed.

If a fill-of-container standard has not been promulgated for a canned vegetable, the container must nevertheless be well filled with the vegetable, with only enough packing medium to fill the interstices. In the case of canned tomatoes, no excess water is needed or permitted by the fill-of-container standard.

Canned Tomato Paste, Puree, Juice, and Catsup

Shippers of tomato products (Tomato juice, catsup, puree, and paste) should note the standards of identity for these items in Definitions and Standards for Foods, part 53. Particular attention is called to the salt-free tomato solids requirements for puree and paste, and to the fact that neither artificial color nor preservatives are permitted in any of these products. Tomato juice is unconcentrated; tomato puree must contain not less than 8.37 and tomato paste not less than 25 percent salt-free tomato solids.

These tomato products are occasionally contaminated with rot because of failure to remove decayed tomatoes from the raw material entering the cannery. Flies and worms are also filth contaminants of tomato products. The preparation of a clean tomato product requires proper washing, sorting, and trimming of the tomatoes and frequent cleaning of the cannery equipment, such as tables, utensils, vats, and pipelines.

In judging whether tomato products have been properly prepared to eliminate rot and decay, the Food and Drug Administration uses the Howard mold-count test, and refuses admission to import shipments and takes action against domestic shipments if mold filaments

are present in more than 40 percent of the microscopic fields in the case of puree, paste, catsup, or sauce or more than 20 percent in the case of tomato juice. Methods of testing tomato products are given in the Methods of Analysis of the Association of Official Agricultural Chemists.

DRIED FRUITS AND VEGETABLES

Much, if not all, that has been said about prevention of contamination of spices is applicable to other perishable foods such as dried fruits and vegetables which are subject to attack by insects, other animals, or to deterioration resulting in moldiness or other forms of decomposition.

Dried Figs

Dried figs, both domestic and foreign, are subject to insect infestation during their growth and during storage where improper storage conditions exist. They are also at times subject to conditions which may result in development of mold which must be guarded against. The domestic industry and to a large extent foreign producers have made great progress in recent years in elimination of conditions responsible for contamination or deterioration of figs. Some importations, however, are encountered which bear evidence of failure of producers to eliminate objectionable conditions and these must necessarily be refused admission. Figs are classed as objectionable if upon examination they show internal or external insect excreta or internal or external evidence of larvae, dead or alive. Figs are classed as objectionable also if they show internal or external evidence of mold or of a webby condition or of sourness or fermentation.

In order to insure a suitable product for importation, the attacks of the fig moth or similar pests should be guarded against as much as possible, as well as those conditions tending to produce mold growth or fermentation. If the figs are found to be so affected to some extent upon harvesting, they should be thoroughly sorted to remove objectionable figs before packing or shipping is undertaken. To insure against infestation or deterioration between the time of harvest and exportation to this country, the movement from the farms or orchards to the packing houses and thence to vessels should be prompt. Storage of figs before shipment should be for as short a time as possible and should be under sanitary conditions so as to prevent infestation.

Dried Dates

Dried dates constitute another important article of import commerce as well as domestic commerce, and again both domestic and foreign producers are confronted with problems involving infesta-

tion and deterioration. As in the case of figs, importations of dates are examined for evidence of insect infestation or moldiness and decomposition, or other objectionable conditions.

Dried Orange Peel

Importations of dried orange peel are occasionally encountered which must be denied entry because of extensive insect infestation and moldiness. Any orange peels which are to be dried or otherwise prepared for subsequent use in any food product must be scrupulously guarded against contamination.

Dried Mushrooms

Inclusion in wild mushrooms of poisonous species is a matter of concern and steps should be taken to insure that only edible species are offered for entry into the United States. The most common bar to entry of mushrooms, especially the wild dried product, is infestation with flies and maggots, since mushrooms sometimes are attacked by maggots during the course of their growth. If infestation is heavy in certain areas and removal of the insects is difficult, the elimination of mushrooms from these areas for importation into this country may be necessary. Infestation may possibly occur in some seasons and not in others. Experience in the examination of importations of dried mushrooms has shown a wide divergence in the condition of different importations from the standpoint of infestation, and it appears that infestation either may not be universal throughout mushroom-growing areas, or it may be sporadic.

It has been necessary also to deny entry to mushrooms for such other causes as evidence of storage under insanitary conditions resulting in contamination by rats or mice or storage insects, and even in some cases by mites in large numbers. After having satisfied himself that he has eliminated field-infested mushrooms from his stock ready for drying, the mushroom producer should then concern himself with the problem of carrying out his drying and storage under conditions which will keep his product clean and free from infestation or from contamination by mice, rats, or other animals.

FRESH FRUITS

Apples and other fruits bearing excessive residues from insecticide sprays or dusts are classed as adulterated under the Federal law. See paragraph entitled "Pesticidal Residues on Raw Agricultural Products."

Pineapples showing or likely to show the internal condition known as "brown heart" or "black heart," should not be offered for entry into the United States. All of the factors causing this condition have not been established but it can be stated that time, and storage and shipping temperatures are important factors.

Blueberries and huckleberries sometimes contain small larvae which render them unfit for food. Fruit from infested areas should be avoided. Fresh blueberries should be held and transported under conditions which will prevent deterioration and decomposition evidenced by mold or other indications of unfitness.

PESTICIDAL RESIDUES ON RAW AGRICULTURAL PRODUCTS

Raw agricultural products include unprocessed fruits and vegetables, grains, meat, and poultry. Products of this kind containing residues of poisonous or deleterious pesticides are in violation of the Federal Food, Drug, and Cosmetic Act unless a tolerance has been established for the particular pesticide on the specific food, and the residue does not exceed the established tolerance. In some instances, a zero tolerance may be established for a pesticide, which means that no residue is permitted on the food as it is marketed.

Tolerances for pesticidal residues on many raw agricultural commodities have been established under the law. Additional tolerances will be established as the facts warrant such action. Firms considering offering for entry into the United States raw agricultural commodities which may contain pesticidal residues should write to the Food and Drug Administration, U. S. Department of Health, Education, and Welfare, Washington 25, D. C., for current information concerning the status of tolerances for residues on raw agricultural products.

FRUIT JAMS (PRESERVES), JELLIES, FRUIT BUTTERS, MARMALADES

Standards of identity have been promulgated for jams, jellies, and fruit butters, copies of which will be sent by the Food and Drug Administration upon request. These standards should be consulted before manufacturing these foods for importation. The standards for jams and jellies require that there be in the batch not less than 45 parts by weight of fruit (or fruit juice in the case of jelly) to each 55 parts by weight of sugar or other optional sweetening ingredient. Only sufficient pectin may be added to jams and jellies to compensate for deficiency, if any, of the natural pectin content of the particular fruit. The standards also require a certain degree of concentration. In the case of jellies the finished product must be concentrated to not less than 65 percent soluble solids. In the case of jams (preserves) the finished jam should have not less than 65 percent soluble solids if made from certain specified fruits. With other designated fruits the batch must be concentrated to 68 percent soluble solids. Importations of a product complying with the standard for pineapple preserve except that it was somewhat less concentrated have been refused admission on

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LOGARITHMS

LOGARITHMS

											Proportional parts.								
	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
10	0000	0043	0086	0128	0170	0212	0253	0294	0334	0374	4	8	12	17	21	25	29	33	37
11	0414	0453	0492	0531	0569	0607	0645	0682	0719	0755	4	8	11	15	19	23	26	30	34
12	0792	0828	0864	0899	0934	0969	1004	1038	1072	1106	3	7	10	14	17	21	24	28	31
13	1139	1173	1206	1239	1271	1303	1335	1367	1399	1430	3	6	10	13	16	19	23	26	29
14	1461	1492	1523	1553	1584	1614	1644	1673	1703	1732	3	6	9	12	15	18	21	24	27
15	1761	1790	1818	1847	1875	1903	1931	1959	1987	2014	3	6	8	11	14	17	20	22	25
16	2041	2068	2095	2122	2148	2175	2201	2227	2253	2279	3	5	8	11	13	16	18	21	24
17	2304	2330	2355	2380	2405	2430	2455	2480	2504	2529	2	5	7	10	12	15	17	20	22
18	2553	2577	2601	2625	2648	2672	2695	2718	2742	2765	2	5	7	9	12	14	16	19	21
19	2788	2810	2833	2856	2878	2900	2923	2945	2967	2989	2	4	7	9	11	13	16	18	20
20	3010	3032	3054	3075	3096	3118	3139	3160	3181	3201	2	4	6	8	11	13	15	17	19
21	3222	3243	3263	3284	3304	3324	3345	3365	3385	3404	2	4	6	8	10	12	14	16	18
22	3424	3444	3464	3483	3502	3522	3541	3560	3579	3598	2	4	6	8	10	12	14	15	17
23	3617	3636	3655	3674	3692	3711	3729	3747	3766	3784	2	4	6	7	9	11	13	15	17
24	3802	3820	3838	3856	3874	3892	3909	3927	3945	3962	2	4	5	7	9	11	12	14	16
25	3979	3997	4014	4031	4048	4065	4082	4099	4116	4133	2	3	5	7	9	10	12	14	15
26	4150	4166	4183	4200	4216	4232	4249	4265	4281	4298	2	3	5	7	8	10	11	13	15
27	4314	4330	4346	4362	4378	4393	4409	4425	4440	4456	2	3	5	6	8	9	11	13	14
28	4472	4487	4502	4518	4533	4548	4564	4579	4594	4609	2	3	5	6	8	9	11	12	14
29	4624	4639	4654	4669	4683	4698	4713	4728	4742	4757	1	3	4	6	7	9	10	12	13
30	4771	4786	4800	4814	4829	4843	4857	4871	4886	4900	1	3	4	6	7	9	10	11	13
31	4914	4928	4942	4955	4969	4983	4997	5011	5024	5038	1	3	4	6	7	8	10	11	12
32	5051	5065	5079	5092	5105	5119	5132	5145	5159	5172	1	3	4	5	7	8	9	11	12
33	5185	5198	5211	5224	5237	5250	5263	5276	5289	5302	1	3	4	5	6	8	9	10	12
34	5315	5328	5340	5353	5366	5378	5391	5403	5416	5428	1	3	4	5	6	8	9	10	11
35	5441	5453	5465	5478	5490	5502	5514	5527	5539	5551	1	2	4	5	6	7	9	10	11
36	5563	5575	5587	5599	5611	5623	5635	5647	5658	5670	1	2	4	5	6	7	8	10	11
37	5682	5694	5705	5717	5729	5740	5752	5763	5775	5786	1	2	3	5	6	7	8	9	10
38	5798	5809	5821	5832	5843	5855	5866	5877	5888	5899	1	2	3	5	6	7	8	9	10
39	5911	5922	5933	5944	5955	5966	5977	5988	5999	6010	1	2	3	4	5	7	8	9	10
40	6021	6031	6042	6053	6064	6075	6085	6096	6107	6117	1	2	3	4	5	6	8	9	10
41	6128	6138	6149	6160	6170	6180	6191	6201	6212	6222	1	2	3	4	5	6	7	8	9
42	6232	6243	6253	6263	6274	6284	6294	6304	6314	6325	1	2	3	4	5	6	7	8	9
43	6335	6345	6355	6365	6375	6385	6395	6405	6415	6425	1	2	3	4	5	6	7	8	9
44	6435	6444	6454	6464	6474	6484	6493	6503	6513	6522	1	2	3	4	5	6	7	8	9
45	6532	6542	6551	6561	6571	6580	6590	6599	6609	6618	1	2	3	4	5	6	7	8	9
46	6628	6637	6646	6656	6665	6675	6684	6693	6702	6712	1	2	3	4	5	6	7	7	8
47	6721	6730	6739	6749	6758	6767	6776	6785	6794	6803	1	2	3	4	5	5	6	7	8
48	6812	6821	6830	6839	6848	6857	6866	6875	6884	6893	1	2	3	4	4	5	6	7	8
49	6902	6911	6920	6928	6937	6946	6955	6964	6972	6981	1	2	3	4	4	5	6	7	8
50	6990	6998	7007	7016	7024	7033	7042	7050	7059	7067	1	2	3	3	4	5	6	7	8
51	7076	7084	7093	7101	7110	7118	7126	7135	7143	7152	1	2	3	3	4	5	6	7	8
52	7160	7168	7177	7185	7193	7202	7210	7218	7226	7235	1	2	2	3	4	5	6	7	7
53	7243	7251	7259	7267	7275	7284	7292	7300	7308	7316	1	2	2	3	4	5	6	6	7
54	7324	7332	7340	7348	7356	7364	7372	7380	7388	7396	1	2	2	3	4	5	6	6	7
	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9

LOGARITHMS

											Proportional parts.								
	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
55	7404	7412	7419	7427	7435	7443	7451	7459	7466	7474	I	2	2	3	4	5	5	6	7
56	7482	7490	7497	7505	7513	7520	7528	7536	7543	7551	I	2	2	3	4	5	5	6	7
57	7559	7566	7574	7582	7589	7597	7604	7612	7619	7627	I	2	2	3	4	5	5	6	7
58	7634	7642	7649	7657	7664	7672	7679	7686	7694	7701	I	1	2	3	4	4	5	6	7
59	7709	7716	7723	7731	7738	7745	7752	7760	7767	7774	I	1	2	3	4	4	5	6	7
60	7782	7789	7796	7803	7810	7818	7825	7832	7839	7846	I	1	2	3	4	4	5	6	6
61	7853	7860	7868	7875	7882	7889	7896	7903	7910	7917	I	1	2	3	4	4	5	6	6
62	7924	7931	7938	7945	7952	7959	7966	7973	7980	7987	I	1	2	3	3	4	5	6	6
63	7993	8000	8007	8014	8021	8028	8035	8041	8048	8055	I	1	2	3	3	4	5	5	6
64	8062	8069	8075	8082	8089	8096	8102	8109	8116	8122	I	1	2	3	3	4	5	5	6
65	8129	8136	8142	8149	8156	8162	8169	8176	8182	8189	I	1	2	3	3	4	5	5	6
66	8195	8202	8209	8215	8222	8228	8235	8241	8248	8254	I	1	2	3	3	4	5	5	6
67	8261	8267	8274	8280	8287	8293	8299	8306	8312	8319	I	1	2	3	3	4	5	5	6
68	8325	8331	8338	8344	8351	8357	8363	8370	8376	8382	I	1	2	3	3	4	4	5	6
69	8388	8395	8401	8407	8414	8420	8426	8432	8439	8445	I	1	2	2	3	4	4	5	6
70	8451	8457	8463	8470	8476	8482	8488	8494	8500	8506	I	1	2	2	3	4	4	5	6
71	8513	8519	8525	8531	8537	8543	8549	8555	8561	8567	I	1	2	2	3	4	4	5	5
72	8573	8579	8585	8591	8597	8603	8609	8615	8621	8627	I	1	2	2	3	4	4	5	5
73	8633	8639	8645	8651	8657	8663	8669	8675	8681	8686	I	1	2	2	3	4	4	5	5
74	8692	8698	8704	8710	8716	8722	8727	8733	8739	8745	I	1	2	2	3	4	4	5	5
75	8751	8756	8762	8768	8774	8779	8785	8791	8797	8802	I	1	2	2	3	3	4	5	5
76	8808	8814	8820	8825	8831	8837	8842	8848	8854	8859	I	1	2	2	3	3	4	5	5
77	8865	8871	8876	8882	8887	8893	8899	8904	8910	8915	I	1	2	2	3	3	4	4	5
78	8921	8927	8932	8938	8943	8949	8954	8960	8965	8971	I	1	2	2	3	3	4	4	5
79	8976	8982	8987	8993	8998	9004	9009	9015	9020	9025	I	1	2	2	3	3	4	4	5
80	9031	9036	9042	9047	9053	9058	9063	9069	9074	9079	I	1	2	2	3	3	4	4	5
81	9085	9090	9096	9101	9106	9112	9117	9122	9128	9133	I	1	2	2	3	3	4	4	5
82	9138	9143	9149	9154	9159	9165	9170	9175	9180	9186	I	1	2	2	3	3	4	4	5
83	9191	9196	9201	9206	9212	9217	9222	9227	9232	9238	I	1	2	2	3	3	4	4	5
84	9243	9248	9253	9258	9263	9269	9274	9279	9284	9289	I	1	2	2	3	3	4	4	5
85	9294	9299	9304	9309	9315	9320	9325	9330	9335	9340	I	1	2	2	3	3	4	4	5
86	9345	9350	9355	9360	9365	9370	9375	9380	9385	9390	I	1	2	2	3	3	4	4	5
87	9395	9400	9405	9410	9415	9420	9425	9430	9435	9440	O	I	1	2	2	3	3	4	4
88	9445	9450	9455	9460	9465	9469	9474	9479	9484	9489	O	I	1	2	2	3	3	4	4
89	9494	9499	9504	9509	9513	9518	9523	9528	9533	9538	O	I	1	2	2	3	3	4	4
90	9542	9547	9552	9557	9562	9566	9571	9576	9581	9586	O	I	1	2	2	3	3	4	4
91	9590	9595	9600	9605	9609	9614	9619	9624	9628	9633	O	I	1	2	2	3	3	4	4
92	9638	9643	9647	9652	9657	9661	9666	9671	9675	9680	O	I	1	2	2	3	3	4	4
93	9685	9689	9694	9699	9703	9708	9713	9717	9722	9727	O	I	1	2	2	3	3	4	4
94	9731	9736	9741	9745	9750	9754	9759	9763	9768	9773	O	I	1	2	2	3	3	4	4
95	9777	9782	9786	9791	9795	9800	9805	9809	9814	9818	O	I	1	2	2	3	3	4	4
96	9823	9827	9832	9836	9841	9845	9850	9854	9859	9863	O	I	1	2	2	3	3	4	4
97	9868	9872	9877	9881	9886	9890	9894	9899	9903	9908	O	I	1	2	2	3	3	4	4
98	9912	9917	9921	9926	9930	9934	9939	9943	9948	9952	O	I	1	2	2	3	3	4	4
99	9956	9961	9965	9969	9974	9978	9983	9987	9991	9996	O	I	1	2	2	3	3	4	4

