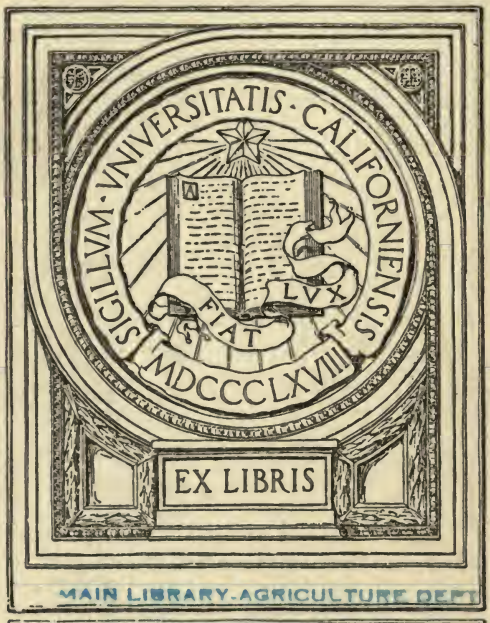

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H. W. WILEY, Chief.

SOME FORMS OF FOOD ADULTERATION

AND

SIMPLE METHODS FOR THEIR DETECTION.

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GENERAL DISCUSSION.

PUBLIC OPINION.

Since the middle of the last century the subject of food adulteration has attracted a constantly increasing amount of attention. In this country very little was done in this line until about 1880. In 1881 the Division of Chemistry began the study of food adulteration, and since then has given a great deal of time to the subject. Since 1898 the origin and place of manufacture of the foods studied by the Bureau have been carefully noted, and special attention has been given to imported foods.

In 1883 the first practicable food-inspection law in the United States was enacted in Massachusetts. Since that time other States have enacted and enforced food laws until at the time of this writing (1906) twenty-five States are seriously attempting to regulate the character and quality of the foods sold in their markets. In three additional States laws relating to the purity of dairy products are enforced, and in several others a beginning has been made.

Food legislation has received much attention abroad and the more highly civilized foreign countries have efficient food laws and enforce them rigidly. The subject of the purity of foods is more widely studied in the United States now than at any previous time. The people as a whole are better informed on the subject than ever before, and there is a constantly increasing demand for definite information. In response to a very large number of inquiries regarding the matter this bulletin has been prepared as a popular statement regarding the nature and extent of food adulteration, and includes simple tests by which the housekeeper or retail dealer may determine some of the more prevalent forms of adulteration practiced.

The demand for information on this subject is now very general and, as is often the case when public interest is deeply aroused, there is an unfortunate tendency toward exaggeration which frequently amounts to sensationalism. Such an attitude is to be deplored, and unless it is checked must sooner or later react unfavorably. It is not unusual to speak of some of our typical foods as poisoned, and of food manufacturers as poisoners. Such characterizations are unfortunate and

untrue. Deleterious substances are doubtless sometimes added to foods. At the same time the word "poison" has a very strong and distinct significance and should not be applied to any of the substances ordinarily added to foods, except in the sense that they are harmful. The word "poisoner" signifies a person who intentionally and deliberately administers an article intended to result fatally, or at least very disastrously to health.

We do not for a moment admit that any manufacturer of foods adds to his products substances which he believes will be injurious to health. There is no reason for attributing such motives to so large and important a class of our citizens, and their business sagacity in other directions precludes the possibility of shortsightedness of so serious a nature. We can not do less than assume that manufacturers who depend for their success upon the reputation of their brands will add nothing which they believe will make their products seriously detrimental to health. It is not to their interest to shorten the lives of their customers nor to impair their appetites. We must assume that they honestly believe the products they employ to be wholesome. Therefore, in judging of the wholesomeness of preservatives and other substances added in the preparation of foods, the subject must be treated in a conservative manner and no criminal or even dishonest motives attributed to those who differ with us on the subject.

"ADULTERATION" DEFINED.

During recent years there has been a tendency to confuse the minds of many by an incorrect use of certain words frequently used in the discussion of foods. It is the policy of some manufacturers to limit the word "adulterated" to foods to which have been added substances of lower value than the foods themselves with the intention of increasing the weight or volume. This limitation is certainly not justified by the English language nor by the facts, and such a restriction of the term is entirely unwarranted. The word "adulterated" properly describes a food to which any noncondimental foreign substance, not properly constituting a portion of the food, has been added. The fact that the added substance may be at times of a greater commercial value than the food itself has no bearing on the question. Conversely, the word "pure" is properly applicable to foods that are unmixed with any foreign substance. It may be wholesome or unwholesome, but this property is not indicated by the word "pure" or "adulterated." This definition is not, of course, complete. According to the laws of many of the States a food is declared to be adulterated under the following conditions:

First, if any substance or substances have been mixed with it, so as to lower or depreciate or injuriously affect its quality, strength, or purity; second, if any inferior or cheaper substance or substances have been substituted wholly or in part for

it; third, if any valuable or necessary constituent or ingredient has been wholly or in part abstracted from it; fourth, if it is an imitation of or is sold under the name of another article; fifth, if it consists wholly or in part of a diseased, decomposed, putrid, infected, tainted, or rotten animal or vegetable substance or article, whether manufactured or not, or, in the case of milk, if it is the product of a diseased animal; sixth, if it is colored, coated, polished, or powdered, whereby damage or inferiority is concealed, or if by any means it is made to appear better or of greater value than it really is; seventh, if it contains any added substance or ingredient which is poisonous or injurious to health: *Provided*, That the provisions of this act shall not apply to mixtures or compounds recognized as ordinary articles or ingredients of articles of food, if each and every package sold or offered for sale bear the name and address of the manufacturer and be distinctly labeled under its own distinctive name and in a manner so as to plainly and correctly show that it is a mixture or compound, and is not in violation with definitions fourth and seventh of this section.

The claim is made by some manufacturers that the addition of a preservative to food does not properly constitute adulteration because the preservatives added are of greater commercial value than the foods themselves. Such a claim, however, seems to be nothing but a play upon words. For instance, benzoate of soda has a greater commercial value, weight for weight, than tomatoes, and the claim has been made that for that reason its addition to tomatoes actually increases the expense of the preparation of tomato catsup. As a matter of fact, however, it permits the tomato pulp to be prepared in large quantities and preserved in barrels in a much less expensive way than can be done without its use. It is evident, therefore, that even though the preservative employed is more expensive than the substance to which it is added, the addition is really made for the purpose of cheapening the product. It is not for this reason that such a substance is properly called an adulterant, however, but because it is an added foreign substance and is neither a food nor a condiment. These definitions can not be emphasized too strongly. Adulterated foods are not necessarily unwholesome foods.

The term "misbranded" is appropriately applied to foods incorrectly described by the label. The word has not the same significance as "adulterated," and yet the two terms may frequently be applied to the same product. For instance, commercial starch is sometimes added to sausage to increase its weight and permit of the use of a larger amount of water or of fatter meat than could otherwise be used. Such a product may properly be deemed adulterated, and at the same time, if the article were properly branded, it might not be open to objection either on the score of unwholesomeness or adulteration. If such an article, however, be sold simply as sausage, the purchaser must naturally assume that no substance has been added to increase the weight of the material without a corresponding increase of nutritive value. The addition of starch to sausage, therefore, is not in itself deleterious to health, but in the absence of a proper declaration is a fraud, because it cheapens the article which the customer supposes he is buying. In

this connection, however, attention should be called to the claim of packers that 1 or 2 per cent of starch should be added to the sausage that is to be boiled, in order to prevent its shrinking when the sausage is cooked.

The following definitions of "adulteration" and "misbranding," as applied to foods, are taken from the food bill now pending in Congress: [a]

SEC. 6. That for the purposes of this act an article shall be deemed to be adulterated—

In the case of food:

First. If any substance has been mixed and packed with it so as to reduce or lower or injuriously affect its quality or strength.

Second. If any substance has been substituted wholly or in part for the article.

Third. If any valuable constituent of the article has been wholly or in part abstracted.

Fourth. If it be mixed, colored, powdered, coated, or stained in a manner whereby damage or inferiority is concealed.

Fifth. If it contain any added poisonous or other added deleterious ingredient which may render such article injurious to health: *Provided*, That when in the preparation of food products for shipment they are preserved by an external application applied in such manner that the preservative is necessarily removed mechanically, or by maceration in water, or otherwise, the provisions of this act shall be construed as applying only when said products are ready for consumption.

Sixth. If it consist in whole or in part of a filthy, decomposed, or putrid animal or vegetable substance, or any portion of an animal unfit for food, whether manufactured or not, or if it is a product of a diseased animal, or one that has died otherwise than by slaughter.

SEC. 7. That the term "misbranded," as used herein, shall apply to all drugs, or articles of food, or articles which enter into the composition of food, the package or label of which shall bear any statement regarding the ingredients or substances contained in such article, which statement shall be false or misleading in any particular, and to any food or drug product which is falsely branded as to the State, Territory, or country in which it is manufactured or produced.

That for the purposes of this act an article shall also be deemed to be misbranded:

In the case of food—

First. If it be an imitation of or offered for sale under the distinctive name of another article.

Second. If it be labeled or branded so as to deceive or mislead the purchaser, or purport to be a foreign product when not so.

Third. If in package form, the quantity of the contents of the package be not plainly and correctly stated in terms of weight or measure, on the outside of the package.

Fourth. If the package containing it or its label shall bear any statement, design, or device regarding the ingredients or the substances contained therein, which statement, design, or device shall be false or misleading in any particular: *Provided*, That an article of food which does not contain any added poisonous or deleterious ingredient shall not be deemed to be adulterated or misbranded in the following cases:

First. In the case of mixtures or compounds which may be now or from time to time hereafter known as articles of food, under their own distinctive names, and not an imitation or offered for sale under the distinctive name of another article, if the

[a] House of Representatives, Fifty-ninth Congress, Report No. 2118, March 7, 1906.

name be accompanied on the same label or brand with a statement of the place where said article has been manufactured or produced.

Second. In the case of articles labeled, branded, or tagged so as to plainly indicate that they are compounds, imitations, or blends: *Provided*, That the term blend as used herein shall be construed to mean a mixture of like substances, not excluding harmless coloring or flavoring ingredients: *And provided further*, That nothing in this act shall be construed as requiring or compelling proprietors or manufacturers of proprietary foods which contain no unwholesome added ingredient to disclose their trade formulas, except in so far as the provisions of this act may require to secure freedom from adulteration or misbranding.

CHEMICAL PRESERVATIVES.

During recent years the practice has sprung up of adding to many articles of foods certain chemical substances which have the property of delaying or preventing fermentation and decay. These substances are commonly known as chemical preservatives. Among them are salicylic, benzoic, and boric acids, and their sodium salts (sodium salicylate, sodium benzoate, and borax), formaldehyde, ammonium fluorid, sulphurous acid, and sulphites.

It is claimed by those who favor the use of chemical preservatives that the action of the latter is similar to that of salt, vinegar, and wood smoke, and that the use of the former is not open to greater objection than that of the latter. In fact, there are not wanting some who claim that the former are less objectionable than the latter. The literature regarding the wholesomeness of the so-called chemical preservatives is not by any means uniform in either approving or disapproving them. It is the opinion of this Bureau that they can not be regarded as entirely wholesome even in the small amounts generally added to foods. The recent investigations conducted by this Bureau, in which twelve men were used as subjects, demonstrated that boric acid is injurious to health.[a] The experiments of the German Imperial Board of Health had the same result, and Germany has prohibited the use of this preservative altogether. It is almost universally conceded that formaldehyde and fluorids are injurious, and the weight of evidence is decidedly adverse to sulphurous acid as a preservative of meat products. The experiments of the Bureau of Chemistry indicate that neither salicylic acid nor benzoic acid is free from injurious effects.

There are now upon the market a large number of brands of commercial preservatives, and there are firms who make a specialty of preparing such preservatives. These substances are usually composed of the chemicals mentioned above. They are frequently sold with the statement that they comply with all pure-food laws, that they are entirely wholesome, and the claim is sometimes made that they are new products, and that their presence in foods can not be detected by

[a] U. S. Dept. Agr., Bureau of Chemistry, Circular No. 15 (digest) and Bul. No. 84, Part I.

the chemist. These statements are all untrue. As stated above, commercial preservatives usually consist of common substances of well-known antiseptic action. Their use is forbidden in many States, and their detection is not a difficult matter.

As a result of these claims many small manufacturers are led unwittingly to violate the food laws of the various States. By using commercial preservatives which they are led to believe are not objectionable they add substances to their foods which they would not knowingly employ. Such instances have repeatedly occurred, and a number of preparations of similar nature are also put up in small packages and sold by agents from house to house for the preparation of what is known as "cold process" preserves. These preparations are sold under the claims mentioned above, and many housekeepers have been led to use them who would not have employed them had they known their true character. Unfortunately, they are sometimes accompanied by directions for the preparation of fruits without any heat whatever, and in such cases the amount of preservatives employed is often far in excess of that which even the advocates of food preservatives advise.

COLORING MATTER.

Some difference of opinion has arisen among hygienists regarding the wholesomeness of the substances frequently employed for coloring foods. European countries have legally recognized the wholesomeness of a considerable number of coal-tar derivatives. In this country a preference is frequently given by the State laws to vegetable colors, although coal-tar derivatives are more commonly employed.

As far as their application to the preparation of foods is concerned, coal-tar colors have been found to be much more satisfactory from a technical standpoint than the pure vegetable colors. They are readily soluble, are cheap in consideration of the amount employed, and withstand the action of light and time much better than the ordinary vegetable colors available for coloring food.

In addition to any influence on digestion and health which the coal-tar colors may have, a certain amount of arsenic is added to them by some methods of preparation. In some colors, however, prepared with a special view to use in foods, arsenic is practically or entirely absent. In this connection it must be borne in mind that the amount of coloring matter necessary to give a food the desired tint is very small, and the danger to health resulting from its use should not be exaggerated. The question of fraud, however, remains, and the use of colors enables the manufacturer to give inferior products the appearance of high-priced goods. Yet again the colors may be used merely to produce an appearance more attractive to the eye and in accordance with popular taste, even though the best materials were employed. Thus, coloring matter may be added to foods for any of the following

reasons: It is sometimes placed in jelly and similar preparations when made only from the more expensive fruits and sugar, to make the color more permanent and enable the product to retain its appearance for a longer time upon the shelves of the grocer. If a considerable portion of the fruit has been replaced by means of apple juice and glucose, the coloring matter is added to simulate the appearance of the fruit that is supposed to be present. In the cheapest grade of jellies, which are made entirely from apple and glucose, and flavored artificially to imitate the product of higher priced fruit, coloring matter is employed to represent the appearance of the product imitated.

In the preparation of tomato catsup the natural coloring matter of the tomato is largely destroyed. This destruction is not so complete if the product is promptly made as when the pulp is stored for a considerable time before it is used, long storage of the pulp bleaching it to some extent. The addition of a little coloring matter, therefore, has been resorted to for the purpose of imitating the color of the product which is made promptly and by the most careful methods. The addition of color, however, is likely to be abused, and this tendency has resulted in placing upon our market tomato catsup of a deep-red color, much more vivid than could possibly be obtained without the use of artificial colors.

In the preparation of cucumber pickles the natural green of the cucumber is somewhat impaired. Some manufacturers have employed copper compounds for the purpose of imparting to the product a greenish tint. This also has been carried to excess, and we sometimes find upon our market pickles of a bright green hue which is not suggestive of any natural food. The same practice obtains in the preparation of canned peas and beans. The great majority of those products imported from Europe are colored with copper, and as a result are of a much brighter color than the same vegetables cooked when gathered freshly from the garden.

In the manufacture of butter it is found that the color varies with the season of the year, the feed of the cow from which the milk is obtained, and within certain limits with the breed of the cow. This results in a variation in the color of butter which manufacturers have attempted to correct by adding a sufficient amount of coloring matter to make the color uniform. This practice has also been carried to excess, and the butter now on our market is colored more deeply than is natural. This color varies in different markets of the country. Fortunately, during recent years, there has been a tendency to decrease the color of the butter, and it is to be hoped that before many years people will demand a product which is prepared without any addition of color whatever.

Coloring matter is sometimes employed for the purpose of simulating the appearance of a more perfect article than that actually used.

For instance, in the preparation of canned tomatoes a product having a certain brightness of color may be obtained if the tomatoes are perfect, fully ripe, and of certain varieties. Often, however, the tomatoes delivered to the canner do not yield a product of the desired color. For this reason some canners make a practice of adding coloring matter to their product, thus giving it an appearance which they say is more acceptable to their customers.

Again, in the case of meat the color disappears after considerable time, the meat losing its bright, fresh color before the process of decay is evident. Therefore, the coloring matter is not usually applied to fresh meat held at low temperature, but to chopped meat, Hamburg steak, and sausage, the addition of coloring matter to this product thus giving it the fictitious appearance of fresh meat.

FORMS OF ADULTERATION OF SPECIFIC FOODS.

In the following pages are given under each class of foods treated the results of the examination of foods in a number of laboratories in the United States. These tables give usually the number of samples of each product examined in the various laboratories and the number found not to comply with the laws of the States in which they were examined. The figures given in these tables, however, must not be understood to represent the percentage of the various classes of foods in the United States that are adulterated, but rather the kinds of adulteration practiced and in a general way whether such forms of adulteration are more or less frequent.

The samples submitted to analysis were not usually representative samples. The inspectors in the various States are trained men, and are always instructed to select especially those samples which they have reason to believe are likely to be adulterated. Brands of foods which they know from previous experience are pure are, therefore, not commonly taken by these inspectors, and products whose purity for any reason they are inclined to suspect are sampled. In the report of each laboratory, therefore, the percentage of adulterated samples is stated, not in terms of the average foods of the State, but in terms of the foods which experienced inspectors have regarded with suspicion.

BAKING POWDERS AND BAKING CHEMICALS.

Baking powders consist of a mixture of bicarbonate of soda with some acid ingredient. When the powders are moistened, these two substances unite and liberate carbon dioxid gas. To prevent the two substances mentioned above uniting prematurely while the baking powder is still in the package, owing to moisture in the atmosphere, starch is usually employed as a filler. Some brands are claimed by the manufacturers to contain no filler, but to consist exclusively of sodium bicarbonate and the acid ingredient employed.

Three substances are used as the acid ingredient of baking powder—cream of tartar, alum (basic aluminum sulphate), and acid phosphate. In some powders a mixture of alum and acid phosphate is employed. Sometimes the amount of filler employed is excessive, and sometimes foreign mineral matter is present. Perhaps the most objectionable form of adulteration of baking powder that has occurred in recent years was the use of a considerable percentage of ground soapstone. The particles of stone were sharp-cornered and decidedly inappropriate for use in the preparation of foods.

The cream of tartar on the market is frequently adulterated with other acid substances, such as alum and acid calcium phosphate. These materials are of a more acid nature than cream of tartar, and permit of the addition of a considerable percentage of inert material which is often employed.

TABLE I.—*Cream of tartar.*

Adulterant.	Extent of adulteration.		Reference.
	No. samples examined.	No. samples adulterated.	
Alum, calcium sulphate, acid calcium phosphate, and starch.	Frequent.		Senate Rept. 516, p. 117, 56th Congress, 2d session.
Do	7	4	Senate Rept. 516, p. 584, 56th Congress, 2d session.
Do	76	24	Rept. Conn. Agr. Expt. Sta., 1900.
Terra alba, acid calcium phosphate	Frequent.		Senate Rept. 516, p. 529, 56th Congress, 2d session.
Acid phosphate of lime, cornstarch, sulphate of lime, alum, etc.	43	9	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1901.
Do	91	19	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1904.
Do	343	5	Rept. Mass. State Bd. Health, 1901.
Do	326	20	Rept. Mass. State Bd. Health, 1902.
Do	317	5	Rept. Mass. State Bd. Health, 1903.
Do	4	4	Rept. Mich. Dairy and Food Comm., 1901.
Do	11	7	Rept. Mich. Dairy and Food Comm., 1904.
Do	20	6	Rept. Minn. Dairy and Food Comm., 1903.
No cream of tartar present	5	2	Rept. N. D. Agr. Expt. Sta., 1902.

BEVERAGES.

ALCOHOLIC.

Wine is sometimes prepared artificially by the fermentation of glucose with the addition of resins, or some fruit juice, and artificially colored. Such products, however, are probably not sold as a beverage to any extent and do not form an important part of our commerce. The cheaper grades of wine are sometimes colored artificially and chemically preserved.

Carbonated wines, prepared by means of dissolving in them carbon dioxid gas under pressure, are sometimes sold as champagne. On the whole, the fraudulent practice most frequently employed with wine is misbranding with regard to its variety and place of manufacture.

Beer is frequently preserved chemically. In the case of whisky and brandy artificial products are often sold under labels which represent

them to be natural products. So-called essences are made on the manufacturing scale and sold commercially for the preparation of beverages intended to represent the various classes of distilled liquors. To these products a small amount of soap is sometimes added to produce a "bead".

NONALCOHOLIC.

Nonalcoholic beverages, such as ginger ale and the various fruit sirups, are frequently preserved with salicylic acid and benzoic acid and colored with coal-tar derivatives. These products may be detected as described on pages 43 to 46. Sirups for soda-water fountains are sometimes altogether artificial and are commonly preserved, colored, and often flavored artificially.

TABLE II.—*Nonalcoholic beverages.*

CARBONATED PRODUCTS.

Adulterant.	Extent of adulteration.		Reference.
	No. samples examined.	No. samples adulterated.	
Artificial flavors and colors	71	43	Rept. Conn. Agr. Expt. Sta., Pt. 3, 1902.
Do	69	26	Rept. Ky. Agr. Expt. Sta., 1902.
Do	36	23	Rept. N. H. State Bd. Health, 1903–4.
Do	36	24	Bull. N. C. State Bd. Agr., 1903.
SIRUPS AND FRUIT JUICES.			
Glucose	120	8	Rept. Conn. Agr. Expt. Sta., 1899.
Preservatives	120	26	Do.
Artificial flavors	120	57	Do.
Do	3	3	Rept. Ohio Dairy and Food Comm., 1897.
Artificial flavors and colors[a]	113	76	Rept. Conn. Agr. Expt. Sta., Pt. 3, 1902.
Do	27	20	Do.
Preservatives (grape juice)	6	2	Rept. Mass. State Bd. Health, 1902.
Do	13	6	Rept. Mass. State Bd. Health, 1903.
Preservatives (grape juice and cider).	3	3	Rept. Ky. Agr. Expt. Sta., 1900.
Preservatives (lime juice)	5	4	Rept. Mass. State Bd. Health, 1902.
MISCELLANEOUS.			
Salicylic acid (cider)	5	3	Rept. Mass. State Bd. Health, 1903.
Salicylic acid (ginger ale)	5	3	Do.

[a] Sirups from soda fountains.

CANNED VEGETABLES.

Canned vegetables constitute a class of products relatively free from adulteration by means of foreign substances. Imported canned peas are commonly colored with copper sulphate. Owing to the enforcement of the imported food law by the Bureau of Chemistry, the presence of copper is now almost universally stated on the labels of these goods. Peas and beans grown and canned in America are rarely colored.

One of the most frequent frauds in this class of products is the preparation of goods which have reached a relatively mature state, and the selling of such products as first grade. Mature peas, for instance, are sometimes soaked for the purpose of softening them, canned, and sold as peas of first quality. Again, peas that are not thoroughly ripe, but so nearly mature as to be relatively hard and white, are sometimes canned as a high grade article.

At the period at which sugar corn is canned the sugar disappears very rapidly after picking and it is customary to add some sugar at the time of canning. During recent years many canning establishments replaced sugar with saccharin, an artificial sweetening material derived from coal tar. A few years ago it was customary to bleach corn for canning by means of sulphites, but this practice has been almost entirely discontinued.

Tomatoes are sometimes colored artificially in order to add to the price of an inferior article.

TABLE III.—*Canned vegetables.*

ASPARAGUS.

Adulterant.	Extent of adulteration.		Reference.
	No. samples examined.	No. samples adulterated.	
Preservatives	9	7	Rept. N. C. State Bd. Agr., 1900.
Do	13	11	Bull. 13, Pt. 8, Div. Chem., U. S. Dept. Agr., 1893.

BEANS (STRING AND LIMA).

Copper (French origin)	7	3	Bull. 13, Pt. 8, Div. Chem., U. S. Dept. Agr., 1893.
Copper (American origin)	20	[a]3	Do.
Copper	Occasional.		
Do	do.		Rept. N. D. Agr. Expt. Sta., 1905.
Preservatives	Rare.		Do.
Saccharin	Frequent.		Do.
Preservatives (French)	7	7	Bull. 13, Pt. 8, Div. Chem., U. S. Dept. Agr., 1893.
Preservatives (American)	20	15	Do.
Do	10	8	N. C. Food Rept., 1900.
Preservatives	15	10	Bull. 13, Pt. 8, Div. Chem., U. S. Dept. Agr., 1893.
Do	8	5	N. C. Food Rept., 1900.

CORN.

Preservatives	41	24	Bull. 13, Pt. 8, Div. Chem., U. S. Dept. Agr., 1893.
Do	6	3	Bull. 165, N. C. Expt. Sta., 1899.
Do	70	32	N. C. Food Rept., 1900.
Sulphites	6	2	Bull. 165, N. C. Expt. Sta., 1899.
Do	41	12	Bull. 13, Pt. 8, Div. Chem., U. S. Dept. Agr., 1893.
Do	70	11	N. C. Food Rept., 1900.
Saccharin	Frequent.		
Do	70	2	N. C. Food Rept., 1900.
Do	Frequent.		Rept. N. D. Agr. Expt. Sta., 1905.
Sulphites	Occasional.		Do.

[a] Contained small amount of copper.

TABLE III.—*Canned vegetables*—Continued.

MUSHROOMS.

Adulterant.	Extent of adulteration.		Reference.
	No. samples examined.	No. samples adulterated.	
Sulphites	Frequent.		Rept. N. D. Agr. Expt. Sta., 1905.

PEAS.

Copper sulphate and soaked goods.	4	2	Rept. Mass. State Bd. Health, 1903.
Copper (French goods)	37	35	Bull. 13, Pt. 8, Div. Chem., U. S. Dept. Agr., 1893.
Copper	98	86	Rept. N. Y. Dairy Comm., 1895.
Do	11	8	Repts. Ohio Dairy and Food Comm., 1895–99.
Copper (American goods)	43	29	Bull. 13, Pt. 8, Div. Chem., U. S. Dept. Agr., 1893.
Copper	Frequent.		Rept. N. D. Agr. Expt. Sta., 1905.
Preservatives	81	15	Bull. 13, Pt. 8, Div. Chem., U. S. Dept. Agr., 1893.
Do	36	29	N. C. Food Rept., 1900.
Aluminum salts	Occasional.		Rept. N. D. Agr. Expt. Sta., 1905.
Borates	do.		do.
Saccharin	Rare.		do.
Not specified	8	5	Rept. Ohio Dairy and Food Comm., 1901.
Do	3	2	Rept. Ohio Dairy and Food Comm., 1902.
Do	7	5	Rept. Ohio Dairy and Food Comm., 1903.

TOMATOES.

Preservatives	55	35	N. C. State Bd. Agr., 1900.
Salicylic acid	10	7	Bull. 13, Pt. 8, Div. Chem., U. S. Dept. Agr., 1893.
Not specified	2	1	Rept. Ohio Dairy and Food Comm., 1903.

CEREAL PRODUCTS.

BREAKFAST FOODS.

During the last few years the number of breakfast foods on the market has been enormously increased, and very many of them are extensively advertised by means of greatly exaggerated statements regarding their nutritive value. Some of these products are simply ground with no other preparation than the removal of the hulls, etc. Others are partially cooked, and still others are "predigested" by means of special treatment.

There appears to be some doubt as to the amount of advantage derived from the treatment to which the partially cooked and predigested foods are subjected. All breakfast foods when thoroughly cooked seem to be equally as digestible as the products placed on the market in a more advanced state of preparation.

The rumors which have been circulated from time to time that arsenic and other poisonous substances are used in breakfast foods have been entirely without foundation. There is no doubt of the wholesomeness of these foods. At the same time, the exaggerated claims made by the manufacturers regarding their superior nutritive qualities are to be deplored.

FLOUR.

There is an impression in some quarters, unfortunately, that flour is adulterated with ground gypsum or other mineral matter. It is also believed by many that alum is used for the purpose of whitening bread. It may be said, however, that these forms of adulteration are not practiced in this country.

Some years ago an effort was made to place on the market a ground stone for the purpose of adulterating flour. This product was extensively advertised by means of circular letters addressed to millers. As far as we have been able to ascertain, however, the product was never used. At one time during recent years the use of Indian corn flour for the adulteration of wheat flour became somewhat prevalent. This practice was entirely stopped by the enforcement of the Federal law relating to mixed flour. At the present time there is probably no product on our market more free from adulteration than wheat flour.

Some adulteration is practiced in special kinds of flour. For instance, much of the so-called gluten flour on the market is not at all what it purports to be. Frequently untreated wheat flour is sold for gluten flour. Buckwheat flour and other special articles of that nature are also frequently adulterated with cheaper cereal products.

TABLE IV.—*Cereal products.*

Adulterant.	Extent of adulteration.		Reference.
	No. samples examined.	No. samples adulterated.	
Coal-tar dyes and other colors (in vermicelli).	10	3	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1901.
Turmeric, foreign colors, etc. (in noodles).	28	24	Do.
Do	22	22	Rept. Conn. Agr. Expt. Sta., 1904.
Not specified (in cereals)	20	1	Rept. Ohio Dairy and Food Comm., 1902.
Wheat flour (in buckwheat flour)	2	1	Rept. Mich. Dairy and Food Comm., 1901.
Do	10	3	Rept. Ohio Dairy and Food Comm., 1900.
Not specified (in flour)	24	2	Rept. Ohio Dairy and Food Comm., 1901.
Do	64	2	Rept. Ohio Dairy and Food Comm., 1902.

COCOA AND CHOCOLATE.

In the preparation of cocoa and chocolate, cocoa beans are roasted, freed from shells, and ground. The resulting product is known as cocoa mass. It contains about 50 per cent of fat (cocoa butter), and is sometimes melted into cakes without any further addition and sold as plain chocolate or bitter chocolate.

For the preparation of sweetened chocolate, cane sugar is added to the cocoa mass and ground at a temperature sufficient to melt the fat. Milk chocolate is prepared by mixing with the cocoa mass dry milk powder (obtained by the evaporation of whole milk) and sugar.

Cocoa is obtained by pressing the cocoa mass while still sufficiently warm to melt the fat so that a portion of it is removed. The fat is

melted into cakes and sold as cocoa butter, while the pressed cakes of cocoa from which a portion of the fat has been extracted are ground up in the preparation of breakfast cocoa.

For the purpose of cheapening cocoa and chocolate, starches of various kinds are ground in with the cocoa mass at the time of the introduction of the sugar or with the cocoa after the expression of the fat. The list of the various starches that have been reported from different sources is given in Table V. It will be noted that with a few exceptions the adulterants reported in this class of products are not injurious to health except in so far as they reduce the nutritive value of the product. At the same time such products as iron oxid, sawdust, sand, and woody shells can not be regarded as wholesome and should not be added to foods.

TABLE V.—*Cocoa and chocolate.*

Adulterated.	Extent of adulteration.		Reference.
	No. samples examined.	No. samples adulterated.	
Cereal	64	9	Bull. 13, Pt. 7, Div. Chem., U. S. Dept. Agr., 1892.
Do	32	1	Unpublished records, Bureau Chem.
Wheat	64	6	Bull. 13, Pt. 7, Div. Chem., U. S. Dept. Agr., 1892.
Do	32	1	Unpublished records, Bureau Chem.
Arrowroot	64	14	Bull. 13, Pt. 7, Div. Chem., U. S. Dept. Agr., 1892.
Do	32	4	Unpublished records, Bureau Chem.
Corn	64	1	Bull. 13, Pt. 7, Div. Chem., 1892.
Rice	64	2	Do.
Potato	64	1	Do.
Excess of cocoa husks	Frequent.		Do.
Do	do.		Unpublished records, Bureau Chem.
Low-grade sugars [a]	29	6	Bull. 13, Pt. 7, Div. Chem., 1892.
In sweet chocolate	18	9	Unpublished records, Bureau Chem.
Wheat flour and maize starch	73	34	Rept. Mass. State Bd. Health, 1901.
Do	45	18	Rept. Mass. State Bd. Health, 1902.
Do	42	20	Rept. Mass. State Bd. Health, 1903.
Do	39	18	Rept. Mich. Dairy and Food Comm., 1904.
Foreign starch	Frequent.		Rept. N. D. Agr. Expt. Sta., 1905.
All adulterants	33	12	Rept. Mass. State Bd. Health, 1900.
Do	64	51	Bull. 13, Pt. 7, Div. Chem., U. S. Dept. Agr., 1892.
Do	32	14	Unpublished records, Bureau Chem.
Wheat, flour, maize starch [b]	40	18	Rept. Conn. Agr. Expt. Sta., 1903.
Bermuda arrowroot starch, wheat flour.[c]	45	19	Rept. Conn. Agr. Expt. Sta., 1902.

[a] In sweet chocolate. [b] In chocolate. [c] In cocoa.

COFFEE AND TEA.

Owing to the enforcement of the Federal tea law, by inspectors stationed at all ports of entry, it is believed that no adulterated tea comes into this country, and it is probably true that the adulteration of this product is not practiced after entry. Formerly it was believed that many other leaves were used as substitutes or adulterants for tea, and a sample may be readily examined for such adulterants by thoroughly wetting and unrolling the leaves and noting their shape.

With regard to coffee, however, while it is believed that only the

pure product is brought into the country, its adulteration after reaching our shores is not uncommon. The attempts that have been made to imitate the coffee bean have not been commercially successful, but the ground coffees sold in the market are frequently adulterated. For this purpose chicory was usually employed, but has since been largely replaced by articles of lower value—ground peas, wheat, beans, barley, etc., now being commonly used. The principal offense in the coffee trade is misbranding as to country of origin. The sale of Brazilian coffee, for example, as Java or Mocha is unfortunately very common.

The artificially molded coffee berries, referred to above, are not on the market, as far as is known, but may be readily distinguished by cutting a cross section of the bean and examining its structure. That of the artificial bean is of a compact, solid, uniform nature, whereas the true coffee has a characteristic structure that can not be imitated. If pure coffee is desired, therefore, the most practical plan is to buy it unground.

TABLE VI.—*Coffee.*

Adulterant.	Extent of adulteration.		Reference.
	No. samples examined.	No. samples adulterated.	
Chicory, ground peas, wheat flour, etc.	50	5	Rept. Conn. Agr. Expt. St ., Pt. 2, 1901.
Do	33	3	Rept. Conn. Agr. Expt. Sta., Pt. 3, 1902.
Do	29	9	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1903.
Do	28	13	Rept. Conn. Agr. Expt. Sta., Pt. 2 1904.
Do	143	10	Rept. Mass. State Bd. Health, 1901.
Do	125	2	Rept. Mass. State Bd. Health, 1902.
Do	106	6	Rept. Mass. State Bd. Health, 1903.
Do	3	1	Rept. Ky. Agr. Expt. Sta., 1900.
Do	8	4	Rept. Mich. Dairy and Food Comm., 1901.
Do	5	4	Bull. N. C. State Bd. Agr., 1902.
Do	3	2	Rept. Ohio Dairy and Food Comm., 1900.
Do	74	36	Rept. Ohio Dairy and Food Comm., 1901.
Do	34	31	Rept. Ohio Dairy and Food Comm., 1902.

CONDIMENTAL SAUCES.

The term "condimental sauces" as here used is intended to apply to catsups, pickles, and miscellaneous sauces. It is not intended to include vinegar or spices, which are considered under other captions (see pp. 33 and 40).

Catsups are very commonly colored and preserved. In the home a single bottle of catsup may be kept open for a considerable time, and a demand has been found for preserved goods in order that the bottle may be kept without deterioration of the contents for some time after it is opened. Again, some manufacturers buy the greater part of the tomatoes used in making catsup within a very short period in the summer. They then prepare the pulp and store it in barrels, preserved with benzoic or salicylic acid to prevent its spoiling. Owing to the demand for catsups free from preservatives, however, some firms are now preparing their goods in small bottles sterilized by heat. These

are found to keep perfectly well before opening, but of course must be used within a reasonable time after they are opened, and be kept in a cool place. An additional expense attends the preparation of goods in this manner, as it is necessary to preserve the pulp by means of sterilization by heat until such time as it is desirable to prepare the catsup.

Pickles are sometimes colored with copper, as in the case of imported peas and beans.

TABLE VII.—*Condimental sauces.*

CATSUPS.

Adulterant.	Extent of adulteration.		Reference.
	No. samples examined.	No. samples adulterated.	
Preservatives	36	35	Rept. N. C. State Bd. Agr., 1900.
Preservatives and artificial coloring.	94	79	Rept. Conn. Agr. Expt. Sta., 1901.
Do	66	66	Rept. Conn. Agr. Expt. Sta., 1904.
Do	53	50	Rept. Ky. Agr. Expt. Sta., 1902.
Do	2	2	Rept. Mass. State Bd. Health, 1902.
Do	23	12	Rept. Minn. Dairy and Food Comm., 1903.
Do	36	5	Rept. N. H. State Bd. Health, 1903–4.
Artificial coloring	12	12	Rept. Minn. Dairy and Food Comm., 1900.
Do	48	31	Rept. Ill. Dairy and Food Comm., 1899–1900.
Do	36	30	Rept. N. C. State Bd. Agr., 1900.
Do	56	8	Bull. 86, Ky. Agr. Expt. Sta., 1900.
Coal tar dyes	22	22	Bull. N. C. State Bd. Agr., 1903.
Do	Frequent.		Rept. N. D. Agr. Expt. Sta., 1905.
Coal tar dyes and preservatives	8	8	Rept. N. D. Agr. Expt. Sta., 1902.
Starch	Frequent.		Rept. N. D. Agr. Expt. Sta., 1905.
Not specified	48	43	Ill. Dairy and Food Rept., 1899–1900.
Do	12	5	Rept. Minn. Dairy and Food Comm., 1900.
Do	56	46	Bull. 86, Ky. Agr. Expt. Sta., 1900.
Do	42	35	Rept. Conn. Agr. Expt. Sta., 1897,
Do	12	4	Rept. Ohio Dairy and Food Comm., 1900.
Do	80	34	Rept. Ohio Dairy and Food Comm., 1901.
Do	42	2	Rept. Ohio Dairy and Food Comm., 1902.
Do	9	9	Rept. Ohio Dairy and Food Comm., 1903.
CHILI SAUCE.			
Preservatives and artificial colors	9	7	Rept. Conn. Agr. Expt. Sta., 1901.
Do	15	15	Rept. Conn. Agr. Expt. Sta., 1904.
PICKLES.			
Preservatives, glucose, copper salts	21	20	Rept. Conn. Agr. Expt. Sta., 1902.
Do	5	5	Rept. Mass. State Bd. Health, 1901.
Not specified	1	1	Rept. Ohio Dairy and Food Comm., 1903.
MISCELLANEOUS.			
Preservatives (in sauces)	3	2	Rept. Conn. Agr. Expt. Sta., 1901
Preservatives (in catsup, etc.)	57	45	Rept. Ky. Agr. Expt. Sta., 1900.

DAIRY PRODUCTS.

BUTTER.

The sale of oleomargarin as butter was formerly very common, but the enforcement of the internal-revenue laws, relative to that subject, by the Treasury Department, and of the State laws,[a] have greatly less-

[a] U. S. Dept. of Agr., Bureau of Chemistry, Bul. 69 Revised, Parts I–VIII, Foods and Food Control.

ened this species of fraud, although, as will be seen on consulting the table on page 25, violations of these laws still occur with considerable frequency.

It is now the custom to treat much of the rancid butter on the market in such a way as to remove the rancidity in the preparation of what is known as "process" or "renovated butter." In the early days of the manufacture of this article it was ordinarily sold as fresh butter. At the present time, however, this product is required to be marked on the wrapper with the words "Renovated Butter," and violations of the law requiring this are relatively infrequent. This law is enforced by the Bureau of Animal Industry of the Department of Agriculture in collaboration with the Treasury Department.[a] The chemical analyses necessary in the enforcement of the law are made in the Bureau of Chemistry.

Butter is sometimes preserved with boric acid, and glucose has sometimes been found as an adulterant. The coloring of butter is usual, and is permitted by the laws of all the States. The principles governing the legislation regarding coloring matter of foods in general have not been ordinarily applied to the coloring of butter. The present tendency, however, seems to be to prepare butter with a lighter tint, and a more natural-looking article can now be found in the market than formerly.

CHEESE.

One of the most frequent methods of adulterating cheese is to prepare it from milk which has been skimmed and to which some other form of fat has been added for the purpose of replacing the fat of the cream removed. Both lard and cotton-seed oil have been used for this purpose. Cheese which has such an addition of foreign fat is known as "filled cheese." Such a product well illustrates a form of adulteration which, although it may not be at all unwholesome, is fraudulent, and if sold as full cream cheese constitutes a form of misbranding. Such a sale is unfair to the buyer, aside from the question of price. If the cheese is desired for melting, as in making a Welsh rarebit, or for other use in cooking, the foreign fat or oil of the filled cheese will separate much more readily than from a genuine cheese, leaving a gummy mass, instead of melting smoothly as a full cream cheese will do.

CREAM.

Cream is frequently preserved artificially. This is illegal in most of the States, but some which prohibit artificial preservatives in milk permit them in cream. How this position is justified does not appear. During recent years preparations known as "thickeners" have been sold to permit dealers to sophisticate their wares. These thickeners

[a] U. S. Dept. of Agr., Bureau of Chemistry, Bul. 69 Revised, Part I, p. 28.

ordinarily consist of gelatin, and sometimes contain boric acid for the purpose of preserving the cream.

Since in the use of cream the dietetic value of fat is taken into consideration, and especially since it is frequently employed in the preparation of modified milk for the use of infants, the sale of a product in which the fat has been largely replaced by gelatin should be condemned in strong terms.

MILK.

The most serious problem connected with food control is the regulation of the milk supply. A considerable portion of the milk consumed is employed as food for infants and invalids. In such cases it frequently forms the entire food consumed by an individual. For that reason, and because of the susceptibility of infants and invalids to interfering substances, it is imperative that the quality of the milk supply be carefully guarded.

The addition of preservatives to milk is particularly to be condemned, partly because of the influences of the preservative itself on the health of infants and invalids by whom the milk may be used as a food, and partly because of the less cleanly methods that may be employed in the preservation of milk when preservatives are used, and of the increased danger in the consumption of such milk.

The most common adulteration practiced with milk is the addition of water or the removal of cream. The management of the dairy and the care of the milk from the time it is received from the cow until it is delivered to the consumer are attended by great difficulties. If the milk is to be kept without chemical preservation, absolute cleanliness and prompt, intelligent care are imperative. This is true at all times and especially in the summer. The milk must be cooled immediately and kept cool until its delivery to the consumer, and then delivery must not be delayed too long. Even after the milk is left at the door of the consumer considerable annoyance is caused by many who do not take their milk promptly and place it in the refrigerator. It is frequently allowed to stand at the door for a considerable time, and then many cases of spoiling for which the consumer is responsible are attributed by him to the dairymen.

In order to avoid these inconveniences the use of preservatives with milk is frequently practiced wherever the enforcement of the food laws is not rigid. In this connection especially the use of commercial preservatives represented to be in conformity with the food laws is of interest (see p. 11).

TABLE VIII.—*Dairy products.*

BUTTER.

Adulterant.	Extent of adulteration.		Reference.
	No. samples examined.	No. samples adulterated.	
Oleomargarin	67	44	Rept. Ohio Dairy and Food Comm., 1899.
Do	173	75	Rept. Mich. Dairy and Food Comm., 1900.
Do	171	167	Rept. N. J. Dairy and Food Comm., 1895.
Do	342	139	Rept. Minn. Dairy and Food Comm., 1901.
Do	Frequent.		Senate Report 516, 1900.
Do	do.		Rept. Conn. Agr. Expt. Sta., 1897.
Do	do.		Rept. N. C. State Bd. of Agr., 1900.
Do		50	Rept. Conn. Agr. Expt. Sta., 1899.
Do	81	56	Rept. Ohio Dairy and Food Comm., 1898.
Do	Frequent.		Rept. Wis. Dairy and Food Comm., 1895–6.
Do	do.		Rept. Ill. Food Comm., 1899–1900.
Do	177	11	Rept. Mass. State Bd. of Health, 1900.
Do	68	44	N. J. Food Rept., 1888.
Do	97	50	Rept. Ohio Dairy and Food Comm., 1888.
Do	1,777	1,033	Rept. Pa. Dept. of Agr., 1900.
Do	227	9	Rept. Mass. State Bd. of Health, 1899.
Process butter	Frequent.		Rept. Ohio Dairy and Food Comm., 1899.
Do	do.		Rept. Mich. Dairy and Food Comm., 1900.
Do	do.		Rept. Minn. Dairy and Food Comm., 1901.
Do	do.		Rept. Ill. Food Comm., 1901.
Do	do.		Rept. Pa. Dept. of Agr., 1900.
Oleomargarin or renovated butter.	35	18	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1901.
Do	41	14	Rept. Conn. Agr. Expt. Sta., Pt. 3, 1902.
Do	147	29	Rept. Ky. Agr. Expt. Sta., 1900.
Do	116	7	Rept. Mass. State Bd. of Health, 1901.
Do	165	41	Rept. Mass. State Bd. of Health, 1902.
Do	142	17	Rept. Mass. State Bd. of Health, 1903.
Do	5	3	Rept. Mich. Dairy and Food Comm., 1901.
Do	4	2	Rept. Mich. Dairy and Food Comm., 1904.
Do	406	268	Rept. Minn. Dairy and Food Comm., 1901.
Do	209	155	Rept. Minn. Dairy and Food Comm., 1903.
Do	2	1	Rept. N. H. State Bd. of Health, 1903–4.
Borax	342	47	Rept. Minn. Dairy and Food Comm., 1900.
Water and foreign fats	121	5	Rept. Ky. Agr. Expt. Sta., 1902.
Not specified	77	38	Rept. Ohio Dairy and Food Comm., 1900.
Do	45	14	Rept. Ohio Dairy and Food Comm., 1901.
Do	43	24	Rept. Ohio Dairy and Food Comm., 1902.
Do	17	10	Rept. Ohio Dairy and Food Comm., 1903.

CHEESE.

Extraction of fat	Frequent.		Rept. Ohio Dairy and Food Comm., 1899.
Do	do.		Rept. Wis. Dairy and Food Comm., 1895.
Do	do.		Rept. Minn. Dairy and Food Comm., 1900.
Cotton-seed oil	do.		Rept. Ohio Dairy and Food Comm., 1895.
Do	do.		Rept. Wis. Dairy and Food Comm., 1895.
Do	do.		Rept. Minn. Dairy and Food Comm., 1900.
Do	do.		Bull. 13, Pt. 1, U. S. Dept. Agr., 1887.
Low in fat content	57	6	Rept. Minn. Dairy and Food Comm., 1901.
Do	106	31	Rept. Minn. Dairy and Food Comm., 1903.
Do	33	4	Bull. N. C. State Bd. of Agr., 1903.
Preservatives	21	7	Rept. Conn. Agr. Expt. Sta., Pt. 3, 1902.
Do	49	1	Rept. Mass. State Bd. of Health, 1901.
Preservatives and skimmed milk	62	26	Rept. Mass. State Bd. of Health, 1903.
Not specified	24	8	Rept. Ohio Dairy and Food Comm., 1904.

CREAM.

Formaldehyde	16	6	Rept. Minn. Dairy and Food Comm., 1900.
Do	4	1	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1903.
Do	9	2	Rept. Mass. State Bd. of Health, 1901.
Do	4	1	Rept. Mass. State Bd. of Health, 1903.
Preservatives	15	1	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1901.
Do	10	2	Rept. Conn. Agr. Expt. Sta., Pt. 3, 1902.
Do	14	14	Rept. Minn. Dairy and Food Comm., 1901.
Borax	Frequent.		Rept. Conn. Agr. Expt. Sta., 1897.
Alum	Rare.		Rept. Minn. Dairy and Food Comm., 1901.
Gelatin	do.		
Boric acid	17	1	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1904.
Not specified	3	3	Rept. Ohio Dairy and Food Comm., 1900.
Do	3	2	Rept. Ohio Dairy and Food Comm., 1903.
Do	25	1	Rept. Ohio Dairy and Food Comm., 1904.
Annatto (Creamore)	2	2	Rept. Ohio Dairy and Food Comm., 1900.

TABLE VIII.—*Dairy products*—Continued.

MILK.

Adulterant.	Extent of adulteration. No. samples examined.	No. samples adulterated.	Reference.
Water or removal of fat	16 per cent.		Rept. San Francisco Bd. of Health, 1897–8.
Do			Rept. N. J. Dairy Comm., 1900.
Do	49.7 per cent.		Rept. Mass. State Bd. of Health, 1893.
Do	49.5 per cent.		Rept. Mass. State Bd. of Health, 1894.
Do	49.8 per cent.		Rept. Mass. State Bd. of Health, 1895.
Do	35 per cent.		Rept. Mass. State Bd. of Health, 1896.
Do	31 per cent.		Rept. Mass. State Bd. of Health, 1897.
Do	do.		Rept. Mass. State Bd. of Health, 1898.
Do	27 per cent.		Rept. Mass. State Bd. of Health, 1899.
Do	28 per cent.		Rept. Mass. State Bd. of Health, 1900.
Do	Frequent.		Rept. Wis. Dairy and Food Comm., 1895–6.
Do	do.		Rept. Mich. Dairy and Food Comm., 1900.
Preservatives	do.		Rept. Milk Inspector, Providence, R. I.
Do	do.		Rept. Pa. Dept. Agr., 1900.
Do	11 per cent.		Rept. Mass. State Bd. of Health, 1899.
Borax	Rare.		Rept. Ohio Dairy and Food Comm., 1899.
Do	do.		Rept. Ohio Dairy and Food Comm., 1895.
Do	do.		Rept. N. J. Dairy and Food Comm., 1895–6.
Do	do.		Rept. Conn. Agr. Expt. Sta., 1897.
Do	do.		Rept. Mass. State Bd. of Health, 1900.
Do	do.		Rept. Pa. Dept. Agr., 1897.
Do	do.		Rept. Mass. State Bd. of Health, 1899.
Formaldehyde	Frequent.		Rept. Mass. State Bd. of Health, 1900.
Carbonate of soda, sodium bicarbonate.	Rare.		Rept. Mass. State Bd. of Health, 1899; Ohio Dairy and Food Comm., 1899.
Ultramarine	do.		Bull. 13, Pt. 1, Div. Chem., U. S. Dept. Agr., 1887.
Coloring matter	do.		Rept. Mass. State Bd. of Health, 1900.
Artificial coloring matter, preservatives, or water.	432	44	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1901.
Do	422	50	Rept. Conn. Agr. Expt. Sta., Pt. 3, 1902.
Do	496	28	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1904.
Do	230	30	Rept. Ky. Agr. Expt. Sta., 1902.
Do	6,109	1,737	Rept. Mass. State Bd. of Health, 1901.
Do	5,870	1,914	Rept. Mass. State Bd. of Health, 1902.
Do	5,793	1,979	Rept. Mass. State Bd. of Health, 1903.
Do	335	56	Rept. Mich. Dairy and Food Comm., 1901.
Do	150	35	Rept. Ky. Agr. Expt. Sta., 1900.
Do	584	52	Rept. Mich. Dairy and Food Comm., 1904.
Do	95	95	Rept. Minn. Dairy and Food Comm., 1901.
Do	371	111	Rept. N. H. State Bd. of Health, 1903–4.
Do	110	22	Rept. Ohio Dairy and Food Comm., 1900.
Do	460	132	Rept. Ohio Dairy and Food Comm., 1901.
Do	777	144	Rept. Ohio Dairy and Food Comm., 1902.
Do	1,199	301	Rept. Ohio Dairy and Food Comm., 1903.
Do	1,429	302	Rept. Ohio Dairy and Food Comm., 1904.
Do. (milk and cream)	172	142	Rept. Minn. Dairy and Food Comm., 1903.
Milk fat deficient[a]	28	4	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1904.
Skimmed milk[a]	23	6	Rept. Mass. State Bd. of Health, 1902.
OLEOMARGARIN.			
Preservatives and artificial coloring matter	18	16	Rept. Ky. Agr. Expt. Sta., 1900.
Do	62	62	Rept. Ky. Agr. Expt. Sta., 1902.
Do	106	105	Rept. Ohio Dairy and Food Comm., 1900.
Do	175	170	Rept. Ohio Dairy and Food Comm., 1901.
Do	303	300	Rept. Ohio Dairy and Food Comm., 1902.
Do	70	3	Rept. Ohio Dairy and Food Comm., 1903.

[a] In samples of condensed milk.

EDIBLE FATS AND OILS.

The substitution for high-priced fats and oils of products of the same class but of lower commercial value is very common. Of special interest in this connection is the sale of cotton-seed oil, peanut oil, and sesame oil for olive oil. Until 1903, when the enforcement of the imported food law was begun by the Bureau of Chemistry, much of

the olive oil imported into the country was adulterated by means of the oils mentioned. This practice has now been practically stopped. At the same time there is no Federal legislation which prevents the importation of these oils separately and their mixture in this country, and to a certain extent this is done. The relative dietetic properties of the various oils have not been carefully studied, and this form of adulteration is therefore to be condemned, not because of its bearing on dietetics, but because of its fraudulent nature.

Lard is often mixed with other fats, such as tallow and cotton-seed oil. Such mixtures are legitimate when sold as compound lard, but that their sale as lard has been practiced to a considerable extent is shown by the following table:

TABLE IX.—*Edible fats and oils.*

LARD.

Adulterant.	Extent of adulteration.		Reference.
	No. samples examined.	No. samples adulterated.	
Cotton-seed oil	Very frequent.		Rept. Ohio Dairy and Food Comm., 1895.
Do	do.		Rept. Conn. Agr. Expt. Sta., 1900.
Do	do.		Rept. N. J. Dairy and Food Comm., 1898.
Do	do.		Rept. Minn. Dairy and Food Comm., 1901.
Do	do.		Bull. 13, Pt. 4, Div. Chem., U. S. Dept. Agr.
Do	do.		Bull. N. C. State Bd. Agr., 1900.
Do	do.		Rept. Conn. Agr. Expt. Sta., 1896.
Do	do.		Rept. Mass. State Bd. of Health, 1900.
Do	22 per cent.		Rept. Mass. State Bd. of Health, 1899.
Beef stearin	Very frequent.		Rept. Ohio Dairy and Food Comm., 1895.
Do	do.		Rept. Conn. Agr. Expt. Sta., 1900.
Do	do.		Rept. Minn. Dairy and Food Comm., 1901.
Do	do.		Bull. 13, Pt. 4, Div. Chem., U. S. Dept. Agr., 1889.
Do	do.		Rept. Conn. Agr. Expt. Sta., 1896.
Cotton-seed oil and beef stearin	171	60	Rept. Conn. Agr. Expt. Sta., Pt. 3, 1902.
Cotton-seed oil	134	67	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1903.
Do	40	11	Rept. Ky. Agr. Expt. Sta., 1900.
Do	14	1	Rept. Ky. Agr. Expt. Sta., 1902.
Do	23	2	Rept. Mass. State Bd. Health, 1901.
Do	5	3	Rept. Mich. Dairy and Food Comm., 1904.
Do	275	73	Rept. Minn. Dairy and Food Comm., 1901.
Do	32	1	Bull. N. C. State Bd. Agr., 1903.
Cotton-seed oil and lard stearin	22	4	Rept. Mass. State Bd. Health, 1902.
Cotton-seed oil and beef stearin	51	30	Rept. Mass. State Bd. Health, 1903.
Cotton-seed oil and tallow	1,175	310	Rept. Minn. Dairy and Food Comm., 1903.
Not specified	36	12	Rept. Ohio Dairy and Food Comm., 1903.

OLIVE OIL.

Cotton-seed oil	Very frequent.		Rept. San Francisco Bd. Health, 1897–8.
Do	do.		Rept. Conn. Agr. Expt. Sta., 1897.
Do	do.		Bull. N. C. Bd. Agr., 1900.
Do	do.		Rept. Mass. State Bd. Health, 1900.
Do	30 per cent.		Rept. Conn. Agr. Expt. Sta., 1900.
Do	Very frequent.		Senate Rept., 561, 1900.
Do	do.		Bull. 129, Cal. Agr. Expt. Sta., 1899.
Do	5	5	Rept. Ohio Dairy and Food Comm., 1895.
Do	Very frequent.		Rept. Bd. Health, Oakland, Cal., 1899.
Cotton-seed oil (California)	15 per cent.		Bull. 77, Bureau Chem., U. S. Dept. Agr., 1903.
Cotton-seed oil (French)	9 per cent.		Do.
Cotton-seed oil (Italian)	10 per cent.		Do.
Peanut oil	21 per cent.		Do.
Other seed oils	Infrequent.		Rept. Conn. Agr. Expt. Sta., 1900.
Corn oil	do.		Rept. Mass. State Bd. Health, 1900.
Sesame oil	Rare.		Rept. Conn. Agr. Expt. Sta., 1897.
Do	do.		Rept. Conn. Agr. Expt. Sta., 1900.
Do	do.		Bull. 77, Bureau Chem., U. S. Dept. Agr., 1903.
Mustard-seed oil	Infrequent.		Rept. San Francisco Bd. Health, 1897.
Poppy-seed oil	do.		Rept. Ohio Dairy and Food Comm., 1899.
Not specified	5	2	Rept. Ohio Dairy and Food Comm., 1901.

The lard sold in tropical and subtropical countries is of a different nature from that sold in cooler places. It is stated by manufacturers that natural lard is too soft a product for marketing in warm weather, and that it can be greatly improved in this respect by the addition of a fat of a firmer nature. For this purpose stearin, that portion of the ordinary fats which melts at the highest temperature, is sometimes employed. Stearin is prepared by heating fat such as beef suet or lard to a temperature sufficient to melt a portion of the product, but insufficient to melt stearin, and then filtering by means of pressure through bags prepared for that purpose. The stearin which is not melted is frequently added to the commercial lard for the purpose of making it more firm than it otherwise would be, as stated above. Less stearin is necessary for this purpose in winter than in summer, and less in cool climates than in hot. A considerable portion is employed for lard used in tropical countries. Beef stearin is sometimes employed for this purpose, although lard stearin is frequently used, especially in the preparation of lard intended for States forbidding the addition of beef fat to lard.

FLAVORING EXTRACTS.

The class of products comprising flavoring extracts is very frequently adulterated. Artificial extracts are commonly sold instead of those prepared from natural sources, and cheaper products than those supposed to be used are often employed. For instance, tonka beans are used instead of vanilla beans in the preparation of supposed vanilla extract, and artificial vanillin, a coal-tar derivative, is very commonly employed in the preparation of the cheapest grade of vanilla extract.

Lemon extract, supposed to be manufactured by dissolving lemon oil in alcohol, may be made from lemon grass. Lemon oil is sometimes treated by distillation with steam, and the nonvolatile portions employed in the preparation of lemon extracts, while the volatile portions containing the terpenes (an essential characteristic of lemon oil) of the oil are sold as lemon oil. Practically the same forms of adulteration are practiced with other classes of flavoring extracts.

Lemon oil is almost insoluble in water, and a fairly strong alcohol is required to obtain it in the strength desired for flavoring purposes. Many manufacturers have unintentionally violated the law by attempting to dissolve lemon oil in alcohol that is not sufficiently strong. They frequently believe that their extract is up to the standard when as a matter of fact only a small portion of the oil they employ is dissolved in the weak alcohol, and the remainder is unintentionally discarded. A lemon extract having but a small amount of alcohol must necessarily have a low percentage of oil of lemon.

TABLE X.—*Flavoring extracts.*

LEMON EXTRACT.

Adulterant.	Extent of adulteration. No. samples examined.	No. samples adulterated.	Reference.
Lemon grass	Frequent.		
Mace, capsicum, etc	do.		
Foreign coloring matter	do.		Rept. Ohio Dairy and Food Comm., 1897.
Do	do.		Rept. Ohio Dairy and Food Comm., 1898.
Do	do.		Rept. Ill. Food Comm., 1899.
Foreign color and insufficient amount lemon oil.	66	[a] 58	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1901.
Do	167	139	Rept. Mass. State Bd. Health, 1901.
Do	16	13	Rept. Mass. State Bd. Health, 1902.
Do	27	19	Rept. Mass. State Bd. Health, 1903.
Do	159	56	Rept. Mich. Dairy and Food Comm., 1904.
Do	4	2	Rept. Minn. Dairy and Food Comm., 1903.
Do	53	34	Rept. N. H. State Bd. Health, 1903–4.
Do	10	7	Rept. N. D. Agr. Expt. Sta., 1902.
Foreign color	Frequent.		Rept. N. D. Agr. Expt. Sta., 1905.
Low in lemon oil	Occasional.		Do.

VANILLA EXTRACT.

Coumarin	Very frequent.		Rept. Ohio Dairy and Food Comm., 1899.
Vanillin	do.		Rept. Ohio Dairy and Food Comm., 1898.
Coumarin	do.		Rept. Mass. State Bd. Health., 1900.
Do	do.		Rept. Ohio Dairy and Food Comm., 1897.
Coumarin and vanillin	do.		Rept. Mich. Dairy and Food Comm., 1900.
Do	26	20	Rept. Ill. Food Comm., 1899.
Do	Very frequent.		Rept. Ohio Dairy and Food Comm., 1895.
Do	62	[b] 47	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1901.
Do	73	54	Rept. Mass. State Bd. Health, 1901.
Do	18	15	Rept. Mass. State Bd. Health, 1902.
Do	25	12	Rept. Mass. State Bd. Health, 1903.
Do	32	21	Rept. N. H. State Bd. Health, 1903–4.
Tonka	Very frequent.		Rept. Mass. State Bd. Health, 1890.
Artificial extract	Frequent.		Rept. N. D. Agr. Expt. Sta., 1905.
Foreign color	do.		Do.
Low-grade extract of coumarin	Rare.		Do.

MISCELLANEOUS.

Coloring matter and artificial flavors (strawberry and raspberry).	19	18	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1901.
Foreign colors, deficiency of oil (orange).	9	6	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1901.
Cane sugar, cornstarch, coumarin (powder).	4	4	Rept. Mich. Dairy and Food Comm., 1904.
Only a trace of ginger oil present (Jamaica ginger).	5	1	Rept. Mass. State Bd. Health, 1903.
Artificial preparations and foreign colors.[c]	49	36	Rept. Mich. Dairy and Food Comm., 1901.
Do	12	12	Rept. Mich. Dairy and Food Comm., 1904.
Do	42	14	Rept. Ohio Dairy and Food Comm., 1901.
Do	68	16	Rept. Ohio Dairy and Food Comm., 1902.

[a] 4 labeled "compounds." [b] 6 labeled "compounds." [c] Kind not specified.

FRUIT PRODUCTS.

The class of goods known as fruit products includes jams, jellies, marmalades, and dried and preserved fruits of every description. Glucose is often used as a substitute for cane sugar, and coloring matter is employed in order that the color of the finished article may stand for a considerable time on the shelves in the light without deterioration. Coloring matter is also used with cheap fruits in the preparation of a

product supposedly made from more expensive products. For instance, jellies are sometimes made of glucose and apple juice, the latter having been prepared from peelings and cores, the by-product of the manufacture of dried apples. These jellies may be flavored and colored to represent the jelly of high-priced fruits, or they may be sold without additional flavor and as a low-priced product. Always, however, when the product of a high-priced fruit is imitated artificial coloring matter is employed.

Apple juice, as mentioned above, and especially the product obtained from peelings and cores, is used extensively with the cheaper grades of jellies where but little fruit is used. With the cheapest grade of goods, starch is often used as a filler and gelatinizing agent.

Preservatives, such as salicylic acid and benzoic acid, are often employed with jellies and jams. Their purpose is twofold: First, to preserve apple juice in barrels until it is desired in the manufacture of the finished product; second, to prevent molding in the finished article which is subjected to much less favorable conditions during transportation on trains and in heated storerooms than is the case of the domestic product, which stands quietly, often in a cool, dark cellar, from the time it is made until it is used.

The exhausted apple residue from the manufacture of jelly is sometimes used for the preparation of jams, giving to the latter the seeds and other insoluble material of the fruit supposed to be present, while the soluble material is frequently made up of glucose. Occasionally foreign seeds are used for this purpose. Glucose, as has been already stated, is commonly used in the cheaper varieties of fruit products, and sometimes, though very rarely, saccharin is employed for sweetening.

TABLE XI.—*Fruit products.*

JAMS.

Adulterant.	Extent of adulteration.		Reference.
	No. samples examined.	No. samples adulterated.	
Glucose	86	68	Bull. 66, Bureau of Chem., U.S. Dept. Agr., 1902.
Do	47	43	Rept. Conn. Agr. Expt. Sta., 1898.
Preservatives	86	41	Bull. 66, Bureau of Chem., U. S. Dept. Agr., 1902.
Do	47	25	Rept. Conn. Agr. Expt. Sta., 1898.
Coloring matter	86	39	Bull. 66, Bureau of Chem., U. S. Dept. Agr., 1902.
Do	47	10	Rept. Conn. Agr. Expt. Sta., 1898.
Apple juice	Frequent.		Bull. 66, Bureau of Chem., U. S. Dept. Agr., 1902.
Saccharin	86	1	Do.
Organic acids	Occasional.		Senate Rept. 516, pp. 22, 23, 1900.
Artificial flavors	do.		Do.
Figs, apple pulp, apple residue, exhausted pulp.	do.		Bull. 66, Bureau of Chem., U. S. Dept. Agr., 1902.
Glucose, preservatives, artificial colors.	28	a26	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1901.

a10 labeled "compounds."

TABLE XI.—*Fruit products*—Continued.

JELLIES.

Adulterant.	Extent of adulteration.		Reference.
	No. samples examined.	No. samples adulterated.	
Glucose	[a]44	26	Bull. 66, Bureau of Chem., U. S. Dept. Agr., 1902.
Do	32	18	Rept. Minn. Dairy and Food Comm., 1900.
Do	64	42	Rept. Conn. Agr. Expt. Sta., 1898.
Preservatives	44	15	Bull. 66, Bureau of Chem., U. S. Dept. Agr., 1902.
Do	64	10	Rept. Conn. Agr. Expt. Sta., 1898.
Coloring matter	44	11	Bull. 66, Bureau of Chem., U. S. Dept. Agr., 1902.
Do	32	14	Rept. Minn. Dairy and Food Comm., 1900.
Do	64	29	Rept. Conn. Agr. Expt. Sta., 1898.
Apple juice	Usual.		Bull. 66, Bureau of Chem., U. S. Dept. Agr., 1902.
Do	13	7	Rept. Ohio Dairy and Food Comm., 1897.
Starch	Occasional.		Bull. 66, Bureau of Chem., U. S. Dept. Agr., 1902.
Saccharin	44	1	Do.
Organic acids	Occasional.		Senate Rept. 516, pp. 22, 23, 1900.
Artificial flavors	16	5	Rept. Ohio Dairy and Food Comm., 1899.
Glucose, starch paste, preservative, artificial colors.	38	[b]28	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1901.

JELLIES AND JAMS.

Glucose, starch paste, preservatives, artificial colors.	23	18	Rept. Ky. Agr. Expt. Sta., 1900.
Do	15	7	Rept. Ky. Agr. Expt. Sta., 1902.
Do	12	11	Rept. Mass. State Bd. Health, 1902.
Do	103	75	Rept. Mass. State Bd. Health, 1903.
Do	15	13	Rept. Mich. Dairy and Food Comm., 1901.
Do	97	71	Rept. Mich. Dairy and Food Comm., 1904.
Do	40	27	Rept. Minn. Dairy and Food Comm., 1901.
Do	280	125	Rept. Minn. Dairy and Food Comm., 1903.
Do	35	35	Bull. N. C. State Bd. Agr., 1902.
Do	33	33	Bull. N. D. Agr. Expt. Sta., 1902.
Do	15	11	Rept. Ohio Dairy and Food Comm., 1900.
Do	21	6	Rept. Ohio Dairy and Food Comm., 1901.
Do	11	4	Rept. Ohio Dairy and Food Comm., 1902.
Preservatives	Frequent.		Rept. N. D. Agr. Expt. Sta., 1905.
Coal-tar dyes	do.		Do.
Saccharin	Rare.		Do.

WHOLE FRUITS.

Glucose	74	13	Bull. 66, Bureau Chem., U. S. Dept. Agr., 1902.
Preservatives	74	10	Do.
Coloring matter	74	10	Do.
Saccharin	74	1	
Coal-tar dyes [c]	6	6	Rept. Conn. Agr. Expt. Sta., Pt. 3, 1902.

[a] 12 labeled "compounds." [b] 10 labeled "compounds." [c] In maraschino cherries.

MEAT PREPARATIONS.

In this class of foods are considered fresh and prepared meat, fish, crabs, oysters, and similar products. The fresh meats on the market are rarely subject to adulteration. Packers depend entirely on cold storage for their preservation, and they are kept at a low temperature, not only in the packing house, but also in refrigerator cars in transit and in cold-storage rooms at their destination until immediately before they go into consumption.

In fresh meats, however, preservatives are sometimes employed by retail dealers who have not efficient refrigerator service or who desire to keep fresh meat for a considerable time on the block. For this purpose powdered preparations of preservatives are employed, and dusted over the meat from time to time.

All varieties of meat that are sold in a finely comminuted state, such as chopped meat, Hamburg steak, and sausage, are likely to have a preservative added in their preparation. By this statement it is not meant that preservatives are added in all cases. Their use, however, simplifies the keeping of such preparations and is not unusual. The preservatives most commonly employed with meat are borax or boric acid and sulphites. Oysters, when kept in bulk after shucking, are also frequently preserved.

It is frequently pointed out by manufacturers that the addition of preservatives does not restore the fresh character of spoiled meat and that they can not be used for this purpose. As has been stated above, however, (p. 14) sometimes meat, especially in a finely comminuted condition, frequently loses its natural fresh color before there is any other evidence of deterioration. This color is restored to a certain extent by the addition of sulphites, and the color is very materially preserved if sulphites are added at the time of the preparation of chopped meat. Moreover, manufacturers of chemical preservatives frequently add a small amount of coal-tar color to preservatives consisting of sulphites intended to be added to meat.

One of the most objectionable forms of adulteration practiced in connection with meat is the sale of the flesh of immature calves. This practice is forbidden in practically all of the States, but the enforcement of such laws has sometimes been found very difficult. Particular difficulty has been experienced in this matter in New York.

TABLE XII.—*Meat preparations.*

MEAT CURED.

Adulterant.	Extent of adulteration.		Reference.
	No. samples examined.	No. samples adulterated.	
Preservatives	Frequent.		Bull. 13, Pt. 10, Bureau Chem., U. S. Dept. Agr., 1902.
Do	11	8	Do.
Do	2,066	511	Rept. Minn. Dairy and Food Comm., 1903.
Borax and decomposed meats	11	5	Rept. Ohio Dairy and Food Comm., 1900.
Borates	Frequent.		Rept. N. D. Agr. Expt. Sta., 1905.
Sulphites	do.		Do.

OYSTERS AND LOBSTER.

Fish, meat, etc. (in lobster)	2	2	Rept. Ohio Dairy and Food Comm., 1900.
Preservatives	18	8	Rept. Mich. Dairy and Food Comm., 1901.
Borax	123	50	Rept. N. H. State Bd. of Health, 1903–4.
Not specified	16	1	Rept. Ohio Dairy and Food Comm., 1901.
Do	11	6	Rept. Ohio Dairy and Food Comm., 1902.

TABLE XII.—*Meat preparations*—Continued.

POTTED MEATS, PÂTÉS, ETC.

Adulterant.	Extent of adulteration.		Reference.
	No. samples examined.	No. samples adulterated.	
Substitution of cheaper varieties of meats.	Frequent.		Bull. 13, Pt. 10, Bureau Chem., U. S. Dept. Agr., 1902.
Do	do.		
Do	do.		
Do	do.		
Preservatives	do.		
Do	do.		Bull. 13, Pt. 10, Bureau Chem., U. S. Dept. Agr., 1902.

SAUSAGE.

Boric acid	19	14	Rept. Conn. Agr. Expt. Sta., 1898.
Do	25	15	Bull. 13, Pt. 10, Bureau Chem., U. S. Dept. Agr., 1902.
Excess of starch	19	10	Rept. Conn. Agr. Expt. Sta., 1898.
Borax	13	12	Rept. N. H. State Bd. of Health, 1903–4.
Not specified	75	51	Rept. Ohio Dairy and Food Comm., 1901.
Do	27	23	Rept. Ohio Dairy and Food Comm., 1902.

MISCELLANEOUS.

Not specified (in ham)	5	5	Rept. Ohio Dairy and Food Comm., 1902.
Not specified (in Hamburger steak)	3	1	Do.
Preservatives (in fresh meat)	Rare.		Bull. 13, Pt. 10, Bureau Chem., U. S. Dept. Agr., 1902.
Preservatives (in soup)	Frequent.		Unpublished results, Bureau of Chemistry.

SPICES.

Spices offer many opportunities for the food adulterator. They are usually sold after being ground, and for that reason are easily imitated. Practically all varieties of ground spices are adulterated by some grinders and in some markets. The products ordinarily used for the purpose of adulterating spices are cereals and cereal products (such as ground wheat and Indian corn), ground shells of cocoanuts, almond shells (sometimes parched), olive pits, and sawdust. The cheaper varieties of spices are sometimes substituted for the more valuable kinds, and stems, husks, etc., may be added. These adulterants are mainly objectionable because of the fraud connected with their use.

Products are made in imitation of the various spices and sold for 3½ or 5 cents a pound to mixers and others who use them in the preparation of low-grade goods, while the products that they imitate are worth from 16 to 60 cents a pound. These articles (enumerated above) have the physical appearance of the spices they are intended to represent, but are entirely without any spice flavor. They are sometimes colored with coal-tar derivatives, or other coloring matter, for the purpose of more nearly simulating the spices they are intended to imitate.

Colors, stems, and cocoanut shells are imported into the United States in considerable quantity for the purpose of adulterating spices. Bombay mace and wild mace are products belonging to the same class of plant products as true mace and bear a general resemblance to it, but they have very little flavoring power, and hence constitute an adulteration when mixed with it.

TABLE XIII.—*Spices.*

ALLSPICE.

Adulterant.	Extent of adulteration.		Reference.
	No. samples examined.	No. samples adulterated.	
Cocoanut shells	21	2	Rept. Conn. Agr. Expt. Sta., 1898.
Do	23	6	Do.
Ground shells	4	3	Rept. Ohio Dairy and Food Comm., 1895.
Clove stems	21	1	Rept. Conn. Agr. Expt. Sta., 1898.
Do	23	5	Rept. Conn. Agr. Expt. Sta., 1897.
Do	10	1	Rept. Mich. Dairy and Food Comm., 1900.
Cloves	23	2	Rept. Conn. Agr. Expt. Sta., 1897.
Nutmeg	10	1	Rept. Mich. Dairy and Food Comm., 1900.
Wheat	23	2	Rept. Conn. Agr. Expt. Sta., 1897.
Wheat product	10	2	Rept. Mich. Dairy and Food Comm., 1900.
Corn meal	10	1	Do.
Woody matter	10	1	Rept. Mich. Dairy and Food Comm., 1900.
All adulterants	10	5	Rept. Mass. State Bd. Health, 1900.
Do	154	3	Do.
Do	23	11	Rept. Conn. Agr. Expt. Sta., 1897.
Do	21	4	Rept. Conn. Agr. Expt. Sta., 1898.
Clove stems, cocoanut shells, wheat, starchy matter.	16	6	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1901.
Do	34	1	Rept. Conn. Agr. Expt. Sta., Pt. 3, 1902.
Do	28	8	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1904.
Do	151	6	Rept. Mass. State Bd. Health, 1901.
Do	146	7	Rept. Mass. State Bd. Health, 1902.
Do	184	9	Rept. Mass. State Bd. Health, 1903.
Do	2	1	Rept. Mich. Dairy and Food Comm., 1901.
Do	3	1	Rept. Mich. Dairy and Food Comm., 1904.
Do	54	4	Rept. Minn. Dairy and Food Comm., 1901.
Do	4	4	Bull. N. C. State Bd. Agr., 1902.

CINNAMON AND CASSIA.

Foreign bark	193	3	Rept. Mass. State Bd. Health, 1900.
Foreign woody material	25	2	Rept. Mich. Dairy and Food Comm., 1900.
Wood and red sandalwood	34	34	Rept. Conn. Agr. Expt. Sta., 1897.
Woody fiber	16	1	Rept. Ohio Dairy and Food Comm., 1895.
Foreign starchy matter	25	10	Rept. Mich. Dairy and Food Comm., 1900.
Wheat	34	3	Rept. Conn. Agr. Expt. Sta., 1897.
Wheat (probably biscuit)	34	1	Do.
Bread or crackers	16	2	Rept. Ohio Dairy and Food Comm., 1895.
Buckwheat	34	1	Rept. Conn. Agr. Expt. Sta., 1897.
Rice flour or hulls	16	3	Rept. Ohio Dairy and Food Comm., 1895.
Ginger	16	2	Rept. Conn. Agr. Expt. Sta., 1898.
Turmeric	16	2	Rept. Ohio Dairy and Food Comm., 1895.
Charcoal	16	1	Do.
Sand	34	3	Rept. Conn. Agr. Expt. Sta., 1897.
Sand in excess	25	4	Rept. Mich. Dairy and Food Comm., 1900.
Gypsum	16	1	Rept. Ohio Dairy and Food Comm., 1895.
All adulterants	34	8	Rept. Conn. Agr. Expt. Sta., 1897.
Do	25	14	Rept. Ohio Dairy and Food Comm., 1895.
Do	16	5	Do.
Wheat middlings, cotton-seed meal, cocoanut shells and starchy matter.[a]	33	7	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1901.
Do.[a]	42	3	Rept. Conn. Agr. Expt. Sta., Pt. 3, 1902.
Do.[a]	31	3	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1904.
Do.[a]	10	5	Rept. Mich. Dairy and Food Comm., 1901.
Do.[a]	133	38	Rept. Minn. Dairy and Food Comm., 1901.
Do.[a]	3	2	Rept. Ohio Dairy and Food Comm., 1903.
Wheat, exhausted ginger, turmeric.[b]	203	6	Rept. Mass. State Bd. Health, 1901.
Do.[b]	215	5	Rept. Mass. State Bd. Health, 1902.
Do.[b]	227	6	Rept. Mass. State Bd. Health, 1903.

[a] In cinnamon only. [b] In cassia only.

TABLE XIII.—*Spices*—Continued.

CLOVES.

Adulterant.	Extent of adulteration.		Reference.
	No. samples examined.	No. samples adulterated.	
Cocoanut shells	37	7	Rept. Conn. Agr. Expt. Sta., 1897.
Do	20	1	Rept. Conn. Agr. Expt. Sta., 1898.
Wheat	37	10	Rept. Conn. Agr. Expt. Sta., 1897.
Wheat or starchy matter	20	2	Rept. Conn. Agr. Expt. Sta., 1898.
Allspice	37	2	Rept. Conn. Agr. Expt. Sta., 1897.
Do	20	1	Rept. Conn. Agr. Expt. Sta., 1898.
Starchy matter	37	2	Rept. Conn. Agr. Expt. Sta., 1897.
Clove stems	20	3	Rept. Conn. Agr. Expt. Sta., 1898.
Redwood	37	1	Rept. Conn. Agr. Expt. Sta., 1897.
Not specified	11	2	Bull 13, Pt. 2, Div. Chem., U. S. Dept. Agr., 1887.
Cocoanut shells	12	11	Rept. Ohio Dairy and Food Comm., 1895.
Not specified	12	11	Do.
Do	18	14	Rept. Ohio Dairy and Food Comm., 1897.
Woody matter	8	1	Rept. Mich. Dairy and Food Comm., 1900.
All adulterants	37	17	21st Ann. Rept. Conn. Agr. Expt. Sta., 1897.
Do	20	6	22nd Ann. Rept. Conn. Agr. Expt. Sta., 1898.
Clove stems, cocoanut shells, wheat products, roasted peas, starchy matter.	17	4	Rept. Conn. Agr. Expt. Sta., 1901.
Do	43	6	Rept. Conn. Agr. Expt. Sta., 1902.
Do	23	5	Rept. Conn. Agr. Expt. Sta., 1904.
Do	163	19	Rept. Mass. State Bd. Health, 1901.
Do	196	31	Rept. Mass. State Bd. Health, 1902.
Do	208	21	Rept. Mass. State Bd. Health, 1903.
Do	2	1	Rept. Mich. Dairy and Food Comm., 1901.
Do	79	32	Rept. Minn. Dairy and Food Comm., 1901.
Do	2	2	Bull. N. C. State Bd. Agr., 1902.

GINGER.

Rice middlings	91	20	Rept. Conn. Agr. Expt. Sta., 1898.
Rice hulls and rice flour	4	1	Rept. Ohio Dairy and Food Comm., 1895.
Corn meal	91	1	Rept. Conn. Agr. Expt. Sta., 1898.
Wheat	91	2	Do.
Mustard hulls	91	1	Do.
Cayenne	4	1	Rept. Ohio Dairy and Food Comm., 1895.
Sawdust	91	1	Rept. Conn. Agr. Expt. Sta., 1898.
Turmeric	91	11	Do.
Do	4	1	Rept. Mich. Dairy and Food Comm., 1900.
Gypsum	91	3	Rept. Conn. Agr. Expt. Sta., 1898.
Not specified	7	4	Bull. 13, Pt. 2, Div. Chem., U. S. Dept. Agr., 1887.
Do	4	2	Rept. Ohio Dairy and Food Comm., 1895.
All adulterants	91	24	Rept. Conn. Agr. Expt. Sta., 1898.
Do	234	11	Rept. Mass. State Bd. Health, 1900.
Do	4	3	Rept. Ohio Dairy and Food Comm., 1895.
Wheet, rice, dirt, turmeric, buckwheat.	31	5	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1901.
Do	253	20	Rept. Mass. State Bd. Health, 1901.
Do	246	17	Rept. Mass. State Bd. Health, 1902.
Do	224	9	Rept. Mass. State Bd. Health, 1903.
Do	89	13	Rept. Minn. Dairy and Food Comm., 1901.
Do	2	2	Bull. N. C. State Bd, Agr., 1902.

MACE.

Bombay mace, corn starch, cereals, turmeric, wild mace.	1	1	Rept. Conn. Agr. Expt. Sta., Pt. 3, 1902.
Do	52	19	Rept. Mass. State Bd. Health, 1901.
Do	24	12	Rept. Mass. State Bd. Health, 1902.
Do	31	18	Rept. Mass. State Bd. Health, 1903.
Do	12	12	Rept. Mich. Dairy and Food Comm., 1904.

TABLE XIII.—*Spices*—Continued.

MUSTARD.

Adulterant.	Extent of adulteration.		Reference.
	No. samples examined.	No. samples adulterated.	
Mustard cake	35	3	Rept. Ohio Dairy and Food Comm., 1897.
Oil cake	35	2	Do.
Seeds of radish	Infrequent.		Bull. 51, Div. Chem., U. S. Dept. Agr., 1898.
Seeds of rape	do.		Do.
Seeds of *Sinapis arvensis*	do.		Do.
Seeds of cayenne	do.		Do.
Seeds of ginger	do.		Do.
Wheat flour	39	17	Rept. Ohio Dairy and Food Comm., 1895.
Wheat product	36	13	Rept. Mich. Dairy and Food Comm., 1900.
Do	35	6	Rept. Ohio Dairy and Food Comm., 1897.
Corn meal	35	3	Do.
Corn starch	36	3	Rept. Mich. Dairy and Food Comm., 1900.
Starchy materials	69	26	Bull. 123, Conn. Agr. Expt. Sta., 1896.
Starch	39	10	Rept. Ohio Dairy and Food Comm., 1895.
Do	36	3	Rept. Mich. Dairy and Food Comm., 1900.
Lime or plaster	69	4	Bull. 123, Conn. Agr. Expt. Sta., 1896.
Clay	Infrequent.		Bull. 51, Div. Chem., U. S. Dept. Agr., 1898.
Turmeric	69	45	Bull. 123, Conn. Agr. Expt. Sta., 1896.
Do	39	15	Rept. Ohio Dairy and Food Comm., 1895.
Do	35	12	Do.
Do	36	17	Rept. Mich. Dairy and Food Comm., 1900.
Martius yellow	69	7	Bull. 123, Conn. Agr. Expt. Sta., 1896.
Do	39	1	Rept. Ohio Dairy and Food Comm., 1895.
Color not specified	39	8	Do.
Do	35	2	Rept. Ohio Dairy and Food Comm., 1897.
Volatile oil removed	35	13	Do.
Not specified	19	10	Bull. 13, Pt. 2, Div. Chem., U. S. Dept. Agr. 1887.
Starchy materials, mustard hulls, turmeric.	326	76	Rept. Mass. State B J. Health, 1900.
All adulterants	39	38	Rept. Ohio Dairy and Food Comm., 1895.
Do	35	19	Rept. Ohio Dairy and Food Comm., 1897.
Do	36	27	Rept. Mich. Dairy and Food Comm., 1900
Do	69	54	Bull. 123, Conn. Agr. Expt. Sta., 1896.
Wheat, corn flour, plaster, turmeric, starchy matter.	31	14	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1901.
Do	14	10	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1904.
Do	297	84	Rept. Mass. State Bd. Health, 1901.
Do	285	257	Rept. Mass. State Bd. Health, 1902.
Do	250	66	Rept. Mass. State Bd. Health, 1903.
Do	26	15	Rept. Mich. Dairy and Food Comm., 1901.
Do	4	4	Rept. Mich. Dairy and Food Comm., 1904.
Do	79	20	Rept. Minn. Dairy and Food Comm., 1901.
Do	9	3	Bull. N. C. State Bd. Agr., 1902.
Do	11	7	Bull. N. C. State Bd. Agr., 1903.
Not specified	11	7	Rept. Ohio Dairy and Food Comm., 1900.
Do	54	15	Rept. Ohio Dairy and Food Comm., 1901.
Do	1	1	Rept. Ohio Dairy and Food Comm., 1903.

NUTMEGS.

Wheat	15	1	Rept. Mass. State Bd. Health, 1900.

PAPRIKA.

Foreign starch	3	1	Rept. Mass. State Bd. Health, 1900.

PEPPER.

Buckwheat (flour or hulls)	102	14	Bull. 123, Conn. Agr. Expt. Sta., 1896.
Do	26	5	Rept. Ohio Dairy and Food Comm., 1895.
Wheat	102	19	Bull. 123, Conn. Agr. Expt. Sta., 1896.
Do	66	17	Rept. Mich. Dairy and Food Comm., 1900.
Wheat product	26	6	Rept. Ohio Dairy and Food Comm., 1895.
Grain hulls	102	4	Bull. 123, Conn. Agr. Expt. Sta., 1896.
Rice	66	8	Rept. Mich. Dairy and Food Comm., 1900.
Rice product	26	4	Rept. Ohio Dairy and Food Comm., 1895.
Pea or bean shells	26	1	Do.
Corn meal	66	7	Rept. Ohio Dairy and Food Comm., 1897.

TABLE XIII.—*Spices*—Continued.

PEPPER—Continued.

Adulterant.	Extent of adulteration.		Reference.
	No. samples examined.	No. samples adulterated.	
Sago	26	1	Rept. Ohio Dairy and Food Comm., 1895.
Farinaceous matter	102	1	Bull. 123, Conn. Agr. Expt. Sta., 1896.
Cocoanut shells	102	17	Do.
Do	26	6	Rept. Ohio Dairy and Food Comm., 1895.
Cayenne	102	18	Bull. 123, Conn. Agr. Expt. Sta., 1896.
Do	26	8	Rept. Ohio Dairy and Food Comm., 1895.
Do	66	2	Rept. Ohio Dairy and Food Comm., 1897.
Ginger, pepper shells, olive stones	415	23	Rept. Mass. State Bd. Health, 1900.
Red sawdust	66	1	Rept. Mich. Dairy and Food Comm., 1900.
Foreign hulls	66	2	Do.
Sawdust	102	1	Bull. 123, Conn. Agr. Expt. Sta., 1896.
Do	26	2	Rept. Ohio Dairy and Food Comm., 1895.
Charred matter	102	13	Bull. 123, Conn. Agr. Expt. Sta., 1896.
Sand in excess	66	4	Rept. Mich. Dairy and Food Comm., 1900.
Turmeric	26	1	Rept. Ohio Dairy and Food Comm., 1895.
Coloring matter	66	2	Rept. Ohio Dairy and Food Comm., 1897.
Not specified	57	7	Rept. Conn. Agr. Expt. Sta., 1898.
Do	14	10	Bull. 13, Pt. 2, Div. Chem:, U. S. Dept. Agr.
All adulterants	102	32	Bull. 123, Conn. Agr. Expt. Sta., 1896.
Do	415	23	Rept. Mass. State Bd. Health, 1900.
Ginger, pepper shells, olive stones, buckwheat.	129	74	Rept. Mich. Dairy and Food Comm., 1904.
Do	217	94	Rept. Minn. Dairy and Food Comm., 1901.
Wheat, cocoanut shells, mustard hulls, corn meal.[a]	51	20	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1901.
Do	58	26	Rept. Mass. State Bd. Health, 1902.
Do	62	28	Rept. Mass. State Bd. Health, 1904.
Corn meal, wheat, buckwheat middlings.[b]	17	4	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1901.
Do.[b]	28	1	Rept. Mass. State Bd. Health, 1902.
Do.[b]	15	8	Rept. Mass. State Bd. Health, 1904.
Plaster, wheat, corn meal, coal-tar dye, dirt, ginger, pepper shells, olive stones, s wdust.[c]	20	3	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1901.
Do.[c]	66	6	Rept. Mass. State Bd. Health, 1902.
Do.[c]	39	9	Rept. Mass. State Bd. Health, 1901.
Do.[c]	61	1	Rept. Mass. State Bd. Health, 1903.
Do.[c]	17	6	Rept. Mass. State Bd. Health, 1904.
Do.[c]	27	19	Rept. Mich. Dairy and Food Comm., 1901.
Do	129	74	Rept. Mich. Dairy and Food Comm., 1904.
Red sandalwood[c]	30	1	Rept. Conn. Agr. Expt. Sta., 1897.
Red woody matter[c]	30	2	Do.
Starchy matter (wheat)[c]	30	5	Do.
Starchy matter (corn)[c]	30	4	Do.
Buckwheat[c]	30	4	Do.
Red dye[c]	30	2	Do.
Aniline dyestuffs[c]	28	4	Rept. Mass. State Bd. Health, 1900.
All adulterants[c]	30	12	Rept. Conn. Agr. Expt. Sta., 1897.
Do.[c]	28	4	Rept. Mass. State Bd. Health, 1900.
Do.[c]	6	4	Bull. 13, Pt. 2, Div. Chem., U. S. Dept. Agr., 1887.
MISCELLANEOUS.			
Not specified	14	11	Rept. Ky. Agr. Expt. Sta., 1900.
Do	1,690	383	Rept. Minn. Dairy and Food Comm., 1903.
Do	45	5	Rept. N. H. State Bd. Health, 1903–4.
Do	Frequent.		Rept. N. D. Agr. Expt. Sta., 1905.
Coal-tar colors	Rare.		Do.
Deficient in volatile oils	do.		Do.

[a] In black pepper. [b] In white pepper. [c] In cayenne.

SUGARS, SIRUPS, ETC.

As a class the sugars, both high and low grades, as found on the market are practically free from adulteration. During recent years, however, a product has been put on the market to a limited extent which consists of a mixture of cane sugar with starch sugar (glucose)

and saccharin, the latter being an artificial sweetening material derived from coal tar. There is a popular belief that granulated sugar is often adulterated with white sand or pulverized rock, and that pulverized sugar is commonly adulterated with starch or lime dust. Cases of such adulteration, however, have never been found by this Bureau, and it may safely be said that they occur rarely if at all.

Considering the obvious simplicity of a method of determining the presence of such a substance, it is strange that the idea that material of this nature commonly occurs in sugar should be as prevalent as it is. Sugar is readily soluble in water, and sand and mineral substances insoluble. If a spoonful of sugar be placed in a glass of water, therefore, and the mixture stirred, solution will be complete. The substances mentioned above, if present, would remain undissolved. Of course solution will occur more readily if the water is warm, and care must be taken to continue the mixing for a considerable time. A sample of granulated or powdered sugar, suspected of being adulterated with sand or pulverized rock, may, therefore, be readily examined by anyone who is interested.

TABLE XIV.—*Sugar products, sirups, etc.*

CONFECTIONERY.

Adulterant.	Extent of adulteration.		Reference.
	No. samples examined.	No. samples adulterated.	
Glucose	250	173	Bull. 13, Pt. 6, Div. Chem., U. S. Dept. Agr., 1892.
Starch and gum	250	72	
Organic colors	250	218	
Mineral colors	250	2	
Grease	250	14	
Copper	250	4	
Gelatin	250	2	
Colors (organic)	8	5	Rept. Ohio Dairy and Food Comm., 1895.
Do	17	13	Rept. Ohio Dairy and Food Comm., 1897.
Artificial flavors	Frequent.		
Iron oxid	56	1	Rept. Mass. State Bd. Health, 1901.
Decomposed peppermint oil	31	1	Rept. Mass. State Bd. Health, 1902.
Coal-tar dyes	68	16	Rept. Minn. Dairy and Food Comm., 1901.
Do	28	18	Rept. N. D. Agr. Expt. Sta., 1902.
Not specified	3	2	Rept. Ohio Dairy and Food Comm., 1901.
Do	19	14	Rept. Ohio Dairy and Food Comm., 1902.
Coal-tar dyes	Very frequent.		Rept. N. D. Agr. Expt. Sta., 1905.

HONEY.

Glucose	400	127	Bull. 13, Pt. 6, Div. Chem., U. S. Dept. Agr., 1892.
Do	27	11	Rept. Mass. State Bd. Health, 1890.
Do	20	1	Rept. Mass. State Bd. Health, 1891.
Do	5	2	Rept. Ohio Dairy and Food Comm., 1898.
Do	22	9	Rept. Ill. Dairy and Food Comm., 1900.
Do	21	11	Rept Mich. Dairy and Food Comm., 1900.
Do	68	16	Rept. Minn. Dairy and Food Comm., 1900.
Do	400	15	Bull. 13, Pt. 6, Div. Chem., U. S. Dept. Agr., 1892.
Glucose or cane sugar	88	39	Rept. Mass. State Bd. Health, 1900.
Glucose and cane sugar	53	17	Rept. Mass. State Bd. Health, 1901.
Do	43	15	Rept. Mass. State Bd. Health, 1902.
Do	59	24	Rept. Mass. State Bd. Health, 1903.
Do	4	2	Rept. Mich. Dairy and Food Comm., 1904.
Do	114	16	Rept. Minn. Dairy and Food Comm., 1903.
Do	5	3	Bull. N. C. State Bd. Agr., 1902.
Do	6	2	Rept. Ohio Dairy and Food Comm., 1900.

TABLE XIV.—*Sugar products, sirups, etc.*—Continued.

MAPLE PRODUCTS.

Adulterant.	Extent of adulteration.		Reference.
	No. samples examined.	No. samples adulterated.	
Sugars:			
Cane sugar	18	4	Rept. Mass. State Bd. Health, 1890.
Brown or molasses sugar	20	2	Rept. Mass. State Bd. Health, 1901.
Cane sugar	13	4	Rept. Mass. State Bd. Health, 1903.
Not specified	37	3	Rept. Minn. Dairy and Food Comm., 1903.
Sirups:			
Glucose	63	23	Bull. 13, Pt. 6, Div. Chem., U. S. Dept. Agr., 1892.
Do	8	3	Rept. Mich. Dairy and Food Comm., 1900.
Do	24	1	Rept. Ohio Dairy and Food Comm., 1899.
Do	15	1	Rept. Ohio Dairy and Food Comm., 1898.
Do	15	3	Rept. Ohio Dairy and Food Comm., 1895.
Do	21	13	
Cane sugar	24	9	Rept. Ohio Dairy and Food Comm., 1899.
Do	15	3	Rept. Ohio Dairy and Food Comm., 1898.
Do	15	2	Rept. Ohio Dairy and Food Comm., 1895.
Do	57	14	Rept. Mass. State Bd. Health, 1903.
Do.[a]	82	8	Rept. Mass. State Bd. Health, 1900.
Glucose and cane sugar	28	5	Rept. Mass. State Bd. Health, 1902.
Water	3	3	Bull. N. C. State Bd. Agr., 1902.
Not specified	66	7	Rept. Minn. Dairy and Food Comm., 1903.
Do	55	10	Rept. Ohio Dairy and Food Comm., 1901.
Do	129	102	Rept. Ohio Dairy and Food Comm., 1903.
Not properly labeled[a]	Frequent.		Rept. N. D. Agr. Expt. Sta., 1905.

MOLASSES.

Glucose[b]	334	167	Bull. 13, Pt. 6, Div. Chem., U. S. Dept. Agr., 1892.
Do.[b]	91	6	Rept. Mass. State Bd. Health, 1890.
Do.[b]	17	10	Rept. Ohio Dairy and Food Comm., 1895.
Do.[b]	6	4	Rept. Mich. Dairy and Food Comm., 1900.
Do.[b]	20	13	Do.
Do.[b]	86	12	Rept. Mass. State Bd. Health, 1900.
Do.[b]	8	1	Do.
Do	231	25	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1901.
Do	384	66	Rept. Conn. Agr. Expt. Sta., Pt. 3, 1902.
Do	414	15	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1903.
Do	419	8	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1904.
Do	93	22	Rept. Mass. State Bd. Health, 1901.
Do	146	13	Rept. Mass. State Bd. Health, 1902.
Do	107	4	Rept. Mass. State Bd. Health, 1903.
Do	15	5	Rept. Mich. Dairy and Food Comm., 1904.
Do	13	8	Rept. Minn. Dairy and Food Comm., 1903.
Do	51	16	Rept. N. H. State Bd. Health, 1903–4.
Do	13	8	Rept. Ohio Dairy and Food Comm., 1901.
Tin	17	1	Rept. Ohio Dairy and Food Comm., 1895.
Do	307	103	Bull. 13, Pt. 6, Div. Chem., U. S. Dept., Agr., 1892.

SIRUPS (TABLE).

Glucose	13	7	Rept. Mass. State Bd. Health, 1901.
Do	10	10	Rept. Mich. Dairy and Food Comm., 1901.
Do	7	5	Rept. Mich. Dairy and Food Comm., 1904.
Do	44	18	Rept. Ohio Dairy and Food Comm., 1900.
Do.[a]	Rare.		Rept. N. D. Agr. Expt. Sta., 1905.
Cane sugar[a]	Frequent.		Do.
Glucose and molasses	10	10	Rept. N. C. State Bd. Agr., 1902.
Not specified	19	8	Rept. Ohio Dairy and Food Comm., 1902.

[a] Sirups and sugars. [b] In molasses and sirups.

VINEGAR.

Vinegar in the United States is understood to be the product of the acetic fermentation of apple juice without any other addition whatever. In France vinegar is understood to be the product of the acetic fermentation of wine.

Several other classes of vinegar are made in considerable amount. Malt vinegar, prepared by the acetic fermentation of an infusion of malt, is made in large quantities in the United States and in England. Large quantities of distilled vinegar are made by the acetic fermentation of alcohol. This product is made in considerable quantity by distilleries, and is frequently sold incorrectly as white-wine vinegar.

The chief frauds practiced in the sale of vinegar are, first, the dilution of cider vinegar and wine vinegar; second, the adulteration of those vinegars with vinegars of the cheaper sorts, such as distilled vinegar; third, the sale of distilled vinegar as cider vinegar or wine vinegar, with or without the addition of coloring matter and other substances to make it resemble those products.

TABLE XV.—*Vinegar.*

CIDER VINEGAR.

Adulterant.	Extent of adulteration.		Reference.
	No. samples examined.	No. samples adulterated.	
Spirit vinegar and caramel	Frequent.		Rept. Ohio Dairy and Food Comm., 1895.
Do	do.		Rept. Ohio Dairy and Food Comm., 1899.
Do	Very frequent.		Rept. Mich. Dairy and Food Comm., 1900.
Do	do.		Rept. N. Y. Dairy and Food Comm., 1898.
Do	do.		Rept. Minn. Dairy and Food Comm., 1901.
Do	do.		Rept. Conn. Agr. Expt. Sta., 1897.
Do	do.		Rept. Bd. Health, Oakland, Cal., 1899.
Do	do.		Rept. San Francisco Bd. Health, 1897–8.
Do	do.		Rept. Wis. Dairy and Food Comm., 1893.
Low in acetic acid	463	83	Rept. Conn. Agr. Expt. Sta., Pt. 2, 1903.
Do	40	23	Rept. Mass. State Bd. Health, 1901.
Do	99	53	Rept. Mass. State Bd. Health, 1903.
Do	126	59	Rept. Ky. Agr. Expt. Sta., 1900.
Do	74	55	Rept. Mich. Dairy and Food Comm., 1904.
Do	1,080	483	Rept. Minn. Dairy and Food Comm., 1901.
Do	2,977	1,517	Rept. Minn. Dairy and Food Comm., 1903.
Do	68	39	Rept. N. H. State Bd. Health, 1903–4.
Do	105	47	Rept. Ohio Dairy and Food Comm., 1900.
Artificial products and low in acetic acid.	270	178	Rept. Mass. State Bd. Health, 1902.
Low in acetic acid and not product represented.	45	31	Rept. Mich. Dairy and Food Comm., 1901.
Not specified	77	39	Rept. Ohio Dairy and Food Comm., 1901.
Do	70	24	Rept. Ohio Dairy and Food Comm., 1902.
Do	38	7	Rept. Pa. Dept. Agr., 1900.
Do	41.8 per cent		Rept. Mass. State Bd. Health, 1899.
Spirit vinegar and apple jelly solids.	Very frequent.		Rept. Pa. Dept. Agr., 1898.

MALT VINEGAR.

Spirit vinegar	Frequent.	Rept. Ohio Dairy and Food Comm., 1895.
Do	do.	Rept. San Francisco Bd. Health, 1897–8.
Do	do.	Rept. Ill. State Food Comm., 1900.

WINE VINEGAR.

Spirit vinegar	Frequent.	Rept. Ohio Dairy and Food Comm., 1897.
Do	do.	Rept. San Francisco Bd. Health, 1897–8.
Do	do.	Rept. Minn. Dairy and Food Comm., 1901.
Do	do.	Bull. N. C. State Bd. Agr., 1900.

SIMPLE TESTS FOR THE DETECTION OF FOOD ADULTERANTS.

INTRODUCTION.

Generally speaking, the methods of chemical analysis employed in food laboratories can be manipulated only by one who has had at least the usual college course in chemistry, and some special training in the examination of foods is almost as necessary. Again, most of the apparatus and chemicals necessary are entirely beyond the reach of the home, and the time consumed by the ordinary examination of a food is in itself prohibitive.

Yet there are some simple tests which serve to point out certain forms of adulteration and can be employed by the careful housewife with the reagents in her medicine closet and the apparatus in her kitchen. The number may be greatly extended by the purchase of a very few articles that may be procured for a few cents at any drug store. In applying these tests, one general rule must always be kept carefully in mind. Every one, whether layman or chemist, must familiarize himself with a reaction before drawing any conclusions from it. For instance, before testing a sample of supposed coffee for starch, the method should be applied to a sample of pure coffee (which can always be procured unground) and to a mixture of pure coffee and starch prepared by the operator.

Many manufacturers and dealers in foods have the ordinary senses so highly developed that by their aid alone they can form an intelligent opinion of the nature of a product, or of the character, and sometimes even of the proportion, of adulterants present. This is especially true of such articles as coffee, wine, salad oils, flavoring extracts, butter, and milk. The housewife finds herself constantly submitting her purchases to this test. Her broad experience develops her senses of taste and smell to a high degree, and her discrimination is often sharper and more accurate than she herself realizes. The manufacturer who has developed his natural senses most highly appreciates best the assistance or collaboration of the chemist, who can often come to his relief when his own powers do not avail. So the housewife, by a few simple chemical tests, can broaden her field of vision and detect many impurities that are not evident to the senses.

There are here given methods adapted to this purpose, which may be applied to milk, butter, coffee, spices, olive oil, vinegar, jams and jellies, and flavoring extracts. In addition to this some general methods for the detection of coloring matter and preservatives will be given. All of the tests here described may be performed with utensils found in any well-appointed kitchen. It will be convenient, however, to secure a small glass funnel, about 3 inches in diameter, since filtration is directed in a number of the methods prescribed. Filter paper can best be prepared for the funnel by cutting a circular piece

about the proper size and folding it once through the middle and then again at right angles to the first fold. The paper may then be opened without unfolding in such a way that three thicknesses lie together on one side and only one thickness on the other. In this way the paper may be made to fit nicely into the funnel.

Some additional apparatus, such as test tubes, racks for supporting them, and glass rods, will be found more convenient for one who desires to do considerable work on this subject, but can be dispensed with. The most convenient size for test tubes is a diameter of from one-half to five-eighths inch and a length of from 5 to 6 inches. A graduated cylinder will also be found very convenient. If this is graduated according to the metric system, a cylinder containing about 100 cc will be found to be convenient; if the English liquid measure is used it may be graduated to from 3 to 8 ounces.

CHEMICAL REAGENTS.

The word "reagent" is applied to "any substance used to effect chemical change in another substance for the purpose of identifying its component parts or determining its percentage composition." The following reagents are required in the methods here given:

Turmeric paper.
Iron alum (crystal or powdered form).
Hydrochloric acid (muriatic acid) concentrated.

CAUTION.—*All tests in which hydrochloric acid is used should be conducted in glass or earthen ware, for this acid attacks and will injure metallic vessels, such as iron, tin, zinc, etc. Care must also be taken not to bring it into contact with the flesh or clothes. If by accident a drop of it falls upon the clothes, ammonia, or in its absence a solution of saleratus or sal soda (washing soda), in water, should be applied promptly.*

Iodin, tincture.
Potassium permanganate, 1 per cent solution.
Alcohol (grain alcohol).
Chloroform.
Boric acid or borax.
Ammonia water.
Halphen's reagent.

With the exception of the last reagent mentioned, these substances may be obtained in any pharmacy. The Halphen reagent should be prepared by a druggist rather than by an inexperienced person who desires to use it. This is especially important because of the inflammable nature of carbon bisulphid which enters into its composition.

CAUTION.—*Carbon bisulphid is a very inflammable substance and is at least as dangerous to handle as gasoline. For this reason the Halphen reagent, into the composition of which carbon bisulphid enters, must be handled with care, and only a small portion of it taken into the vicinity of the fire. When it is employed the end of the test tube may be loosely stoppered with cotton. The carbon bisulphid in the amount of reagent used for a single test, however, is so small as not to cause any particular danger in its use.*

Halphen's reagent is prepared as follows: An approximately 1 per cent solution of sulphur is made by dissolving about one-third of a teaspoonful of precipitated sulphur in 3 or 4 ounces of carbon bisulphid. This solution mixed with an equal volume of amyl alcohol forms the reagent required by the method. A smaller quantity than that indicated by these directions may of course be prepared.

If turmeric paper be not available it may be made as follows: Place a bit of turmeric powder (obtainable at any drug store) in alcohol, allow it to stand for a few minutes, stir, allow it to stand again until it settles, dip a strip of filter paper into the solution, and dry it.

DETERMINATION OF PRESERVATIVES.

The following methods cover all of the more important commercial preservatives with the exception of sulphites and fluorids. These are quite frequently used for preserving foods—the former with meat products and the latter with fruit products—but, unfortunately, the methods for their detection are not suitable for household use.

DETECTION OF SALICYLIC ACID.

The determination of salicylic acid can best be made with liquids. Solid and semi-solid foods, such as jelly, should be dissolved, when soluble, in sufficient water to make them thinly liquid. Foods containing insoluble matter, such as jam, marmalade, and sausage, may be macerated with water and strained through a piece of white cotton cloth. The maceration may be performed by rubbing in a teacup or other convenient vessel with a heavy spoon.

Salicylic acid is used for preserving fruit products of all kinds, including beverages. It is frequently sold by drug stores as fruit acid. Preserving powders consisting entirely of salicylic acid are often carried from house to house by agents. It may be detected as follows:

Between 2 and 3 ounces of the liquid obtained from the fruit products, as described above, are placed in a narrow bottle holding 5 ounces, about a quarter of a teaspoonful of cream of tartar (or, better, a few drops of sulphuric acid) is added, the mixture shaken for two or three minutes, and filtered into a second small bottle. Three or four tablespoonfuls of chloroform are added to the clear liquid in the second bottle and the liquids mixed by a somewhat vigorous rotary motion, poured into an ordinary glass tumbler, and allowed to stand till the chloroform settles out in the bottom. Shaking is avoided, as it causes an emulsion which is difficult to break up. As much as possible of the chloroform layer (which now contains the salicylic acid) is removed (without any admixture of the aqueous liquid) by means of a medicine dropper and placed in a test tube or small bottle with about an equal

amount of water and a small fragment—a little larger than a pinhead—of iron alum. The mixture is thoroughly shaken and allowed to stand till the chloroform again settles to the bottom. The presence of salicylic acid is then indicated by the purple color of the upper layer of liquid.

DETECTION OF BENZOIC ACID.

Benzoic acid also is used for preserving fruit products. Extract the sample with chloroform as in the case of salicylic acid; remove the chloroform layer and place it in a white saucer, or, better, in a plain glass sauce dish. Set a basin of water—as warm as the hand can bear—on the outside window ledge and place the dish containing the chloroform extract in it, closing the window until the chloroform has completely evaporated. In this manner the operation may be conducted with safety even by one who is not accustomed to handling chloroform. In warm weather the vessel of warm water may, of course, be omitted. Benzoic acid, if present in considerable amount, will now appear in the dish in characteristic flat crystals. On warming the dish the unmistakable irritating odor of benzoic acid may be obtained. This method will detect benzoic acid in tomato catsup or other articles in which it is used in large quantities. It is not sufficiently delicate, however, for the smaller amount used with some articles, such as wine. It is often convenient to extract a larger quantity of the sample and divide the chloroform layer into two portions, testing one for salicylic acid and the other for benzoic acid.

DETECTION OF BORIC ACID AND BORAX.

Boric acid (also called boracic acid) and its compound with sodium (borax) are often used to preserve animal products, such as sausage, butter, and sometimes milk. For the detection of boric acid and borax, solids should be macerated with a small amount of water and strained through a white cotton cloth. The liquid obtained by treating solids in this manner is clarified somewhat by thoroughly chilling and filtering through filter paper.

In testing butter place a heaping teaspoonful of the sample in a teacup, add a couple of teaspoonfuls of hot water, and stand the cup in a vessel containing a little hot water until the butter is thoroughly melted. Mix the contents of the cup well by stirring with a teaspoon and set the cup with the spoon in it in a cold place until the butter is solid. The spoon with the butter (which adheres to it) is now removed from the cup and the turbid liquid remaining strained through a white cotton cloth, or better, through filter paper. The liquid will not all pass through the cloth or filter paper, but a sufficient amount for the test may be secured readily.

In testing milk for boric acid 2 or 3 tablespoonfuls of milk are placed in a bottle with twice that amount of a solution of a teaspoonful

of alum in a pint of water, shaken vigorously, and filtered through filter paper. Here again a clear or only slightly turbid liquid passes through the paper.

About a teaspoonful of the liquid obtained by any one of the methods mentioned above is placed in any dish, not metal, and 5 drops of hydrochloric (muriatic) acid added. A strip of turmeric paper is now dipped into the liquid and then held in a warm place—near a stove or lamp—till dry. If boric acid or borax was present in the sample the turmeric paper becomes bright cherry red when dry. A drop of household ammonia changes the red color to dark green or greenish black. If too much hydrochloric acid is used the turmeric paper may take on a brownish red color even in the absence of boric acid. In this case, however, ammonia changes the color to brown just as it does turmeric paper which has not been dipped into the acid solution.

DETECTION OF FORMALDEHYDE.

Formaldehyde is rarely used with other foods than milk. The method for its detection in milk is given on page 52. For its detection in other foods it is usually necessary to first separate it by distillation, a process which is scarcely available for the average person without laboratory training and special apparatus. For this reason no method is suggested here for the detection of formaldehyde in other foods than milk.

DETECTION OF SACCHARIN.

Saccharin has a certain preservative power, but it is used not so much for this effect as because of the very sweet taste which it imparts. It is extracted by means of chloroform, as described under the detection of salicylic acid (p. 43). In the case of solid and semisolid foods, the sample must, of course, be prepared by extraction with water, as described under salicylic acid. The residue left after the evaporation of the chloroform, if a considerable amount of saccharin is present, has a distinctly sweet taste.

The only other substance having a sweet taste which may be present in foods, i. e., sugar, is not soluble in chloroform, and therefore does not interfere with this reaction. Certain other bodies (tannins) which have an astringent taste are present, and as they are soluble in chloroform may sometimes mask the test for saccharin, but with practice this difficulty is obviated.

DETERMINATION OF ARTIFICIAL COLORS.

DETECTION OF COAL-TAR DYES.

As has been stated, coloring matters used with foods are usually soluble in water. If the food under examination be a liquid, it may therefore be treated directly by the method given below. If it be a

solid or a pasty substance, soluble in water either in the cold or after heating, it may be dissolved in sufficient water to form a thin liquid. If it contains some insoluble material, it may be treated with sufficient water to dissolve the soluble portion with the formation of a thin liquid and filtered, and then strained through a clean white cotton cloth to separate the insoluble portion. About a half teacupful of the liquid thus described is heated to boiling, after adding a few drops of hydrochloric acid and a small piece of white woolen cloth or a few strands of white woolen yarn. (Before using, the wool should be boiled with water containing a little soda, to remove any fat it may contain, and then washed with water.) The wool is again washed, first with hot and then with cold water, the water pressed out as completely as possible, and the color of the fabric noted. If no marked color is produced, the test may be discontinued and the product considered free from artificial colors. If the fabric is colored, it may have taken up coal-tar colors, some foreign vegetable colors, and if a fruit product is being examined, some of the natural coloring matter of the fruit. Rinse the fabric in hot water, and then boil for two or three minutes in about one-third of a teacupful of water and two or three teaspoonfuls of household ammonia. Remove and free from as much of the liquid as possible by squeezing or wringing. Usually the fabric will retain the greater part of the natural fruit color, while the coal-tar color dissolves in dilute ammonia. The liquid is then stirred with a splinter of wood and hydrochloric acid added, a drop or two at a time, until there is no longer any odor of ammonia. (The atmosphere of the vessel is sometimes charged with the ammonia for several minutes after it has all been driven out of the liquid; therefore one should blow into the dish to remove this air before deciding whether the ammonia odor has been removed or not.) When enough acid has been added the liquid has a sour taste, as may be determined by touching the splinter, used in stirring, to the tongue.

A fresh piece of white woolen cloth is boiled in this liquid and thoroughly washed. If this piece of cloth has a distinct color the food under examination is artificially colored. The color used may have been a coal-tar derivative, commonly called an anilin dye, or an artificial color chemically prepared from some vegetable color. If of the first class the dyed fabric is usually turned purple or blue by ammonia. In either case if the second fabric has a distinct color it is evident that the product under examination is artificially colored. Of course a dull, faint tint must be disregarded.

DETECTION OF COPPER.

The presence of copper, often used to deepen the green tint of imported canned peas, beans, spinach, etc., may be detected as follows: Mash some of the sample in a dish with a stiff kitchen spoon. Place

a teaspoonful of the pulp in a teacup with three teaspoonfuls of water and add 30 drops of strong hydrochloric acid with a medicine dropper. Set the cup on the stove in a saucepan containing boiling water. Drop a bright iron brad or nail (wire nails are the best and tin carpet tacks will not answer the purpose) into the cup and keep the water in the saucepan boiling for twenty minutes, stirring the contents of the cup frequently with a splinter of wood. Pour out the contents of the cup and examine the nail. If present in an appreciable amount the nail will be heavily plated with copper.

CAUTION.—*Be careful not to allow the hydrochloric acid to come in contact with metals or with the flesh or clothing.*

DETECTION OF TURMERIC.

In yellow spices, especially mustard and mace, turmeric is often employed. This is especially true of prepared mustard to which a sufficient amount of starch adulterant has been added to materially reduce the natural color. If turmeric be employed to restore the normal shade an indication of that fact may sometimes be obtained by mixing a half teaspoonful of the sample in a white china dish and mixing with it an equal amount of water, and a few drops (4 to 10) of household ammonia, when a marked brown color, which does not appear in the absence of turmeric, is formed. At the present time turmeric or a solution of curcuma (the coloring matter of turmeric) is sometimes added to adulterated mustard in sufficient amount to materially increase its color, but not to a sufficient extent to give the brown appearance with ammonia described above. In such cases a teaspoonful of the suspected sample may be thoroughly stirred with a couple of tablespoonfuls of alcohol, the mixture allowed to settle for fifteen minutes or more and the upper liquid poured off into a clean glass or bottle. To about 1 tablespoonful of the liquid thus prepared and placed in a small clear dish (a glass salt cellar serves excellently) add 4 or 5 drops of a concentrated solution of boric acid or borax and about 10 drops of hydrochloric acid,[a] and mix the solution by stirring with a splinter of wood. A wedge-shaped strip of filter paper about 2 or 3 inches long, 1 inch wide at the upper end, and one-fourth inch at the lower end is then suspended by pinning, so that its narrow end is immersed in the solution, and is allowed to stand for a couple of hours. The best results are obtained if the paper is so suspended that air can circulate freely around it, i. e., not allowing it to touch anything except the pin and the liquid in the dish. If turmeric be present a cherry red color forms on the filter paper a short distance below the upper limit to which the liquid is absorbed by the paper, frequently from three-fourths of an inch to an inch above the surface of the

[a] Caution: See page 52.

liquid itself. A drop of household ammonia changes this red color to a dark green, almost black. If too much hydrochloric acid is used a dirty brownish color is produced.

DETECTION OF CARAMEL.

A solution of caramel is used to color many substances, such as vinegar and some distilled liquors. To detect it two test tubes or small bottles of about equal size and shape should be employed and an equal amount (2 or 3 tablespoonfuls or more) of the suspected sample placed in each. To one of these bottles is added a teaspoonful of fullers' earth, the sample shaken vigorously for two or three minutes and then filtered through filter paper, the first portion of the filtered liquid being returned to the filter paper and the sample finally collected into the test tube or bottle in which it was originally placed, or a similar one. The filtered liquid is now compared with the untreated sample. If it is markedly lighter in color it may be taken for granted that the color of the liquid is due to caramel, which is largely removed by fullers' earth. In applying this test, however, it must be borne in mind that caramel occurs naturally in malt vinegar, being formed in the preparation of the malt. It is evident that the tests require practice and experience before they can be successfully performed. The housewife can use them, but must repeat them frequently in order to become proficient in their use.

EXAMINATION OF CERTAIN CLASSES OF FOODS.

CANNED VEGETABLES.

As before stated, canned vegetables are relatively free from adulteration by means of foreign substances. The different grades of products may with care be readily detected by the general appearance of the sample. The purchaser is, of course, at the disadvantage of not being able to see the product until the can is opened. By a study of the different brands available in the vicinity, however, he can readily select those which are preferable. As stated in an earlier part of the bulletin, canned tomatoes sometimes contain an artificial coloring matter, which may be detected as described on page 45.

Canned sweet corn is sometimes sweetened with saccharin, which may be detected as described on page 45.

It is believed that as a rule canned vegetables are free from preservatives, although some instances of chemical preservation have recently been reported in North Dakota, and some imported tomatoes have been found by this Bureau to be artificially preserved. The presence of copper, often used for the artificial greening of imported canned peas, beans, spinach, etc., may be detected as described on page 46.

COFFEE.

There are a number of simple tests for the presence of the adulterants of ground coffee. These tests are called simple because they can be performed without the facilities of the chemical laboratory, and by one who has not had the experience and training of a chemist. It must be understood, however, that they require careful observation and study, and that one must perform them repeatedly in order to obtain reliable results. Before applying them to the examination of an unknown sample, samples of known character should be secured and studied. Unground coffee may be ground in the home and mixed with various kinds of adulterants, which can also be secured separately. Thus the articles themselves in known mixtures may be studied and when the same results are obtained with unknown samples they can be correctly interpreted. These tests are well known in the laboratory and may be used in the home of the careful housewife who has the time and perseverance to master them.

PHYSICAL TESTS.

The difference between the genuine ground coffee and the adulterated article can often be detected by simple inspection with the naked eye. This is particularly true if the product be coarsely crushed rather than finely ground. In such condition pure coffee has a quite uniform appearance, whereas the mixtures of peas, beans, cereals, chicory, etc., often disclose their heterogeneous nature to the careful observer. This is particularly true if a magnifying glass be employed. The different articles composing the mixture may then be separated by the point of a penknife. The dark, gummy-looking chicory particles stand out in strong contrast to the other substances used, and their nature can be determined by one who is familiar with them by their astringent taste.

The appearance of the coffee particles is also quite distinct from that of many of the coffee substitutes employed. The coffee has a dull surface, whereas some of its substitutes, especially leguminous products, often present the appearance of having a polished surface.

After a careful inspection of the sample with the naked eye, or, better, with a magnifying glass, a portion of it may be placed in a small bottle half full of water and shaken. The bottle is then placed on the table for a moment. Pure coffee contains a large amount of oil, by reason of which the greater portion of the sample will float. All coffee substitutes and some particles of coffee sink to the bottom of the liquid. A fair idea of the purity of the sample can often be determined by the proportion of the sample which floats or sinks.

Chicory contains a substance which dissolves in water, imparting a brownish-red color. When the suspected sample, therefore, is dropped into a glass of water, the grains of chicory which it contains may be

seen slowly sinking to the bottom, leaving a train of a dark-brown colored liquid behind them. This test appears to lead to more errors in the hands of inexperienced operators than any other test here given. Wrong conclusions may be avoided by working first with known samples of coffee and chicory as suggested above.

Many coffee substitutes are now sold as such and are advertised as more wholesome than coffee. Notwithstanding the claims that are made for them, a few of them contain a considerable percentage of coffee. This may be determined by shaking a teaspoonful in a bottle half full of water, as described above. The bottle must be thoroughly shaken so as to wet every particle of the sample. Very few particles of coffee substitutes will float.

CHEMICAL TESTS.

Coffee contains no starch, while all of the substances, except chicory, used for its adulteration and in the preparation of coffee substitutes contain a considerable amount of starch. The presence of such substitutes may, therefore, be detected by applying the test for starch as given on page 58. In making this test less than a quarter of a teaspoonful of ground coffee should be used, or a portion of the ordinary infusion prepared for the table may be employed after dilution. The amount of water that should be added can only be determined by experience.

CONDIMENTAL SAUCES.

Tomato catsup and other condimental sauces are frequently preserved and colored artificially. The preservatives employed are usually salicylic acid and benzoic acid or their sodium salts. These products may be detected by the methods given on pages 43 and 44.

Coal-tar colors are frequently employed with this class of goods, especially with those of a reddish tint, like tomato catsup. They may be detected by the methods given on page 45.

DAIRY PRODUCTS.

BUTTER.

Methods are available which, with a little practice, may be employed to distinguish between fresh butter, renovated or process butter, and oleomargarin.

These methods are commonly used in food and dairy laboratories, and were originally suggested as household tests.[a] They give reliable results. At the same time considerable practice is necessary before we can interpret correctly the results obtained. Some process butters are on the market which can be distinguished from fresh butter only with

[a] Patrick, Household tests for the detection of oleomargarin and renovated butter, Farmers' Bulletin No. 131.

extreme difficulty. During the last few years considerable progress has been made in the attempt to renovate butter in such a way that it will appear like fresh butter in all respects. A study must be made of these methods if we would obtain reliable results.

The "spoon" test has been suggested as a household test, and is commonly used by analytical chemists for distinguishing fresh butter from renovated butter and oleomargarin. A lump of butter two or three times the size of a pea is placed in a large spoon and heated over an alcohol or Bunsen burner. If more convenient, the spoon may be held above the chimney of an ordinary kerosene lamp, or it may even be held over an ordinary illuminating gas burner. If the sample in question be fresh butter it will boil quietly, with the evolution of many small bubbles throughout the mass which produce a large amount of foam. Oleomargarin and process butter, on the other hand, sputter and crackle, making a noise similar to that heard when a green stick is placed in a fire. Another point of distinction is noted if a small portion of the sample be placed in a small bottle and set in a vessel of water sufficiently warm to melt the butter. The sample is kept melted from half an hour to an hour, when it is examined. If renovated butter or oleomargarin, the fat will be turbid, while if genuine fresh butter the fat will almost certainly be entirely clear.

To manipulate what is known as the "Waterhouse" or "milk" test, about 2 ounces of sweet milk are placed in a wide-mouthed bottle, which is set in a vessel of boiling water. When the milk is thoroughly heated, a teaspoonful of butter is added, and the mixture stirred with a splinter of wood until the fat is melted. The bottle is then placed in a dish of ice water and the stirring continued until the fat solidifies. Now, if the sample be butter, either fresh or renovated, it will be solidified in a granular condition and distributed through the milk in small particles. If, on the other hand, the sample consist of oleomargarin it solidifies practically in one piece and may be lifted by the stirrer from the milk.

By these two tests, the first of which distinguishes fresh butter from process or renovated butter and oleomargarin, and the second of which distinguishes oleomargarin from either fresh butter or renovated butter, the nature of the sample under examination may be determined.

MILK.

The oldest and simplest method of adulterating milk is by dilution with water. This destroys the natural yellowish-white color and produces a bluish tint, which is sometimes corrected by the addition of a small amount of coloring matter.

Another form of adulteration is the removal of the cream and the sale as whole milk of skimmed or partially skimmed milk. Again,

the difficulty experienced in the preservation of milk in warm weather has led to the widespread use of chemical preservatives.

Detection of water.—If a lactometer or hydrometer, which can be obtained of dealers in chemical apparatus, be available, the specific gravity of milk will afford some clew as to whether the sample has been adulterated by dilution with water. Whole milk has a specific gravity between 1.027 and 1.033. The specific gravity of skimmed milk is higher, and milk very rich in cream is sometimes lower than these figures. It is understood, of course, that by specific gravity is meant the weight of a substance with reference to the weight of an equal volume of water. The specific gravity of water, therefore, is exactly 1. It is obvious that if water be added to a milk with the specific gravity of 1.030, the specific gravity of the mixture will be somewhat below those figures.

An indication by means of a hydrometer or lactometer below the figure 1.027 therefore indicates either that the sample in question is a very rich milk or that it is a milk (perhaps normal, perhaps skimmed) that has been watered. The difference in appearance and nature of these two extremes is sufficiently obvious to make use of the lactometer or hydrometer of value as a preliminary test of the purity of milk.

Detection of color.—As previously stated, when milk is diluted by means of water the natural yellowish-white color is changed to a bluish tint, which is sometimes corrected by the addition of coloring matter. Coal-tar colors are usually employed for this purpose. A reaction for these colors is often obtained in the method given below for the detection of formaldehyde. When strong hydrochloric acid is added to the milk in approximately equal proportions before the mixture is heated a pink tinge sometimes is evident if a coal-tar color has been added.

Detection of formaldehyde.—Formaldehyde is the substance most commonly used for preserving milk and is rarely, if ever, added to any other food. Its use is inexcusable and especially objectionable in milk served to infants and invalids.

To detect formaldehyde in milk 3 or 4 tablespoonfuls of the sample are placed in a teacup with at least an equal amount of strong hydrochloric acid and a piece of ferric alum about as large as a pinhead, the liquids being mixed by a gentle rotary motion. The cup is then placed in a vessel of boiling water, no further heat being applied, and left for five minutes. At the end of this time, if formaldehyde be present, the mixture will be distinctly purple. If too much heat is applied, a muddy appearance is imparted to the contents of the cup.

CAUTION.—*Great care must be exercised in working with hydrochloric acid, as it is strongly corrosive. It must not come in contact with the flesh or clothes of the operator nor with any metallic vessels and must be greatly diluted with water before it is poured into the sink.*

EDIBLE OILS.

DETECTION OF COTTON-SEED OIL.

With the exception of cotton-seed oil, the adulterants ordinarily used with edible oils are of such a nature that the experience and training of a chemist and the facilities of a chemical laboratory are essential to their detection. There is, however, a simple test for the detection of cotton-seed oil, known as the Halphen test, which may be readily applied.

The reader is cautioned that great care must be taken in the manipulation of this test, as one of the reagents employed—carbon bisulphid—is very inflammable. The manipulator should use every possible safeguard and should see to it that only a small portion of his reagent is exposed at one time.[a] The chemicals employed in the preparation of the reagent used for this test are not household articles. They may, however, be obtained in any pharmacy. The mixture should be prepared by a druggist rather than by an inexperienced person who desires to use it.

In order to perform the test 2 or 3 tablespoonfuls of this reagent are mixed in a bottle with an equal volume of the suspected sample of oil and heated in a vessel of boiling salt solution (prepared by dissolving 1 tablespoonful of salt in a pint of water) for ten or fifteen minutes. At the end of that time, if even a small percentage of cotton-seed oil be present, the mixture will be of a distinct reddish color, and if the sample consists largely or entirely of cotton-seed oil, the color will be deep red.

EGGS.

There is no better method for the testing of the freshness of an egg than the familiar one of "candling," which has long been practiced by dealers. The room is darkened and the egg held between the eye and a light; the presence of dark spots indicates that the egg is not perfectly fresh, one that is fresh presenting a homogeneous, translucent appearance. Moreover, there is found in the larger end of a fresh egg, between the shell and the lining membrane, a small air cell which, of course, is distinctly transparent. In an egg which is not perfectly fresh this space is filled and hence presents the same appearance as the rest of the egg.

It is now a matter of considerable importance to be able to distinguish between fresh eggs and those that have been packed for a considerable time. Until recently that was not a difficult matter. All of the solutions that were formerly used extensively for that purpose gave the shell a smooth, glistening appearance which is not found in the fresh egg. This characteristic, however, is of less value now than

[a] See Caution, p. 42.

formerly, owing to the fact that packed eggs are usually preserved in cold storage. There is now no means by which a fresh egg can be distinguished from a packed egg without breaking it. Usually in eggs that have been packed for a considerable time the white and yolk slightly intermingle along the point of contact, and it is a difficult matter to separate them. Packed eggs also have a tendency to adhere to the shell on one side and when opened frequently have a musty odor.

FLAVORING EXTRACTS.

Although quite a large number of flavoring extracts are on the market, vanilla and lemon extracts are used so much more commonly than other flavors that a knowledge of their purity is of the greatest importance. Only methods for the examination of those two products will, therefore, be considered.

VANILLA EXTRACT.

Vanilla extract is made by extracting vanilla beans with alcohol. It consists of an alcoholic solution of vanillin (the characteristic flavoring matter of the vanilla bean) and several other products, chiefly resins, which, though present in but small amount and having only a slight flavor in themselves, yet affect very materially the flavor of the product. Vanilla extract is sometimes adulterated with the extract of the tonka bean. This extract to a certain extent resembles vanilla extract. The extract of the tonka bean, however, is far inferior to that of the vanilla bean. It has a relatively penetrating, almost pungent odor, standing in sharp contrast to the flavor of the vanilla extract. This odor is so different that one who has given the matter some attention may readily distinguish the two, and the quality of the vanilla extract may often be judged with a fair degree of accuracy by means of the odor alone.

Another form of adulteration and one that is now quite prevalent is the use of artificial vanillin in place of the extract of either vanilla or tonka beans. Artificial vanillin has, of course, the same composition and characteristics as the natural vanillin of the vanilla bean. Extracts made from it, however, are deficient in the resins and other products which are just as essential to the true vanilla as is vanillin itself. Since vanillin is thus obtained from another source so readily, methods for the determination of the purity of vanilla extract must depend upon the presence of other substances than vanillin.

Detection of caramel.—The coloring matter of vanilla extract is due to substances naturally present in the vanilla bean and extracted therefrom by alcohol. Artificial extracts made by dissolving artificial vanillin in alcohol contain no color of themselves, and to supply it caramel is commonly employed. Caramel may be detected in arti-

ficial extracts by shaking and observing the color of the resulting foam after a moment's standing. The foam of pure extracts is colorless. If caramel is present a color persists at the points of contact between the bubbles until the last bubble has disappeared. The test with fullers' earth given for caramel in vinegar (p. 48) is also very satisfactory, but of course requires the loss of the sample used for the test.

Examination of the resin.—If pure vanilla extract be evaporated to about one-third its volume the resins become insoluble and settle to the bottom of the dish. Artificial extracts remain clear under the same conditions. In examining vanilla extract the character of these resins is studied. For this purpose a dish containing about an ounce of the extract is placed on a teakettle or other vessel of boiling water until the liquid evaporates to about one-third or less of its volume. Owing to the evaporation of the alcohol the resins will then be insoluble. Water may be added to restore the liquid to approximately its original volume. The resin will then separate out as a brown flocculent precipitate. A few drops of hydrochloric acid may be added and the liquid stirred and the insoluble matter allowed to settle. It is then filtered and the resin on the filter paper washed with water. The resin is then dissolved in a little alcohol, and to one portion of this solution is added a small particle of ferric alum and to another portion a few drops of hydrochloric acid. If the resin be that of the vanilla bean, neither ferric alum nor hydrochloric acid will produce more than a slight change of color. With resins from most other sources, however, one or both of these substances yield a distinct color change.

For filtering, a piece of filter paper should be folded once through the middle, and again at right angles to the first fold. It may now be opened with one fold on one side and three on the other and fitted into a glass funnel. When the paper is folded in this manner the precipitated resins may be readily washed with water. When the washing is completed the resins may be dissolved by pouring alcohol through the filter. This work with the resins will require some practice before it can be successfully performed. It is of considerable value, however, in judging of the purity of vanilla extract.

LEMON EXTRACT.

By lemon extract is understood a solution of lemon oil in strong alcohol. In order to contain as much lemon oil as is supposed to be found in high-grade extracts the alcohol should constitute about 80 per cent of the sample. The alcohol is therefore the most valuable constituent of lemon extract, and manufacturers who turn out a low-grade product usually do so because of their economy of alcohol rather than of lemon oil. Owing to the fact that lemon extract is practically a saturated solution of oil of lemon in strong alcohol the sample may be examined by simple dilution with water. A teaspoon-

ful of the oil in question may be placed in the bottom of an ordinary glass tumbler and 2 or 3 teaspoonfuls of water added. If the sample in question be real lemon extract the lemon oil should be thrown out of solution by reason of its insolubility in the alcohol after its dilution with water. The result is at first a marked turbidity and later the separation of the oil of lemon on the top of the aqueous liquid. If the sample remains perfectly clear after the addition of water, or if a marked turbidity is not produced, it is a low-grade product and contains very little, if any, oil of lemon.

FRUIT PRODUCTS.

Adulteration of fruit products is practically confined to jellies and jams. Contrary to the general belief, gelatin is never used in making fruit jelly. In the manufacture of the very cheapest grade of jellies starch is sometimes employed. Jellies containing starch, however, are so crude in their appearance that the most superficial inspection is sufficient to demonstrate that they are not pure fruit jellies. From their appearance no one would think it worth while to examine them to determine their purity.

Natural fruit jellies become liquid on being warmed. A spoonful dissolves readily in warm water, although considerable time is required with those that are especially firm. The small fruits contain practically no starch, as apples do, and the presence of starch in a jelly indicates that some apple juice has probably been used in its preparation. (As stated above, jelly that has been thickened by starch paste will not be mistaken for fruit jelly.)

DETECTION OF STARCH.

Dissolve a teaspoonful of jelly in a half teacupful of hot water, heat to boiling and add, drop by drop, while stirring with a teaspoon, a solution of potassium permanganate until the solution is almost colorless. Then allow the solution to cool and test for starch with tincture of iodin, as directed on page 58. Artificially colored jellies are sometimes not decolorized by potassium permanganate. Even without decolorizing, however, the blue color can usually be seen.

DETECTION OF GLUCOSE.

For the detection of glucose, a teaspoonful of the jelly may be dissolved in a glass tumbler or bottle in 2 or 3 tablespoonfuls of water. The vessel in which the jelly is dissolved may be placed in hot water if necessary to hasten the solution. In case a jam or marmalade is being examined, the mixture is filtered to separate the insoluble matter. The solution is allowed to cool, and an equal volume or a little more of strong alcohol is added. If the sample is a pure fruit product the addition of alcohol causes no precipitation, except that a very

slight amount of proteid bodies is thrown down. If glucose has been employed in its manufacture, however, a dense white precipitate separates and after a time settles to the bottom of the liquid.

DETECTION OF FOREIGN SEEDS.

In addition to the forms of adulteration to which jellies are subject, jams are sometimes manufactured from the exhausted fruit pulp left after removing the juice for making jelly. When this is done residues from different fruits are sometimes mixed. Exhausted raspberry or blackberry pulp may be used in making "strawberry" jam and vice versa. Some instances are reported of various small seeds, such as timothy, clover, and alfalfa seed, having been used with jams made from seedless pulp.

With the aid of a small magnifying glass such forms of adulteration may be detected, the observer familiarizing himself with the seeds of the ordinary fruits.

DETECTION OF PRESERVATIVES AND COLORS.

With jellies and jams salicylic and benzoic acids are sometimes employed. They may be detected by the methods given on pages 43 and 44.

Artificial colors, usually coal-tar derivatives, are sometimes used and may be detected as described on page 45.

MEAT PRODUCTS.

As in many other classes of foods, certain questions important in the judgment of meats require practical experience and close observation rather than chemical training. This is especially true of meat products. The general appearance of the meat must largely guide the purchaser. If, however, the meat has been treated with preservatives and coloring matter its appearance is so changed as to deceive him. The preservatives employed with meat products are boric acid, borax, and sulphites. The methods for the detection of sulphites are not suitable for household use.

DETECTION OF BORIC ACID AND BORAX.

To detect boric acid (if its sodium salt, borax, has been used the same reaction will be obtained) about a tablespoonful of the chopped meat is thoroughly macerated with a little hot water, pressed through a bag, and 2 or 3 tablespoonfuls of the liquid placed in a sauce dish with 15 or 20 drops of strong hydrochloric acid for each tablespoonful. The liquid is then filtered through filter paper, and a piece of turmeric paper dipped into it and dried near a lamp or stove. If boric acid or borax were used for preserving the sample the turmeric paper should be changed to a bright cherry-red color. If too much hydrochloric acid has been employed a dirty brownish-red color is obtained,

which interferes with the color due to the presence of boric acid. When a drop of household ammonia is added to the colored turmeric paper, it is turned a dark green, almost black color, if boric acid is present. If the reddish color, however, was caused by the use of too much hydrochloric acid this green color does not form.

CAUTION.—*The corrosive nature of hydrochloric acid must not be forgotten. It must not be allowed to touch the flesh, clothes, or any metal.*

DETECTION OF COLORS.

The detection of coloring matter in sausage is often a difficult matter without the use of a compound microscope. It may sometimes be separated, however, by macerating the meat with a mixture of equal parts of glycerin and water to which a few drops of acetic or hydrochloric acid have been added. After macerating for some time the mixture is filtered and the coloring matter detected by means of dyeing wool in the liquid thus obtained. (See p. 45.)

SPICES.

Although ground spices are very frequently adulterated, there are few methods that may be used by one who has not had chemical training, and who is not skilled in the use of a compound microscope, for the detection of the adulterants employed. The majority of the substances used for the adulteration of spices are of a starchy character. Unfortunately for our purposes, most of the common spices also contain a considerable amount of starch. Cloves, mustard, and cayenne, however, are practically free from starch, and the presence of starch in the ground article is proof of adulteration.

DETECTION OF STARCH IN CLOVES, MUSTARD, AND CAYENNE.

A half teaspoonful of the spice in question is stirred into half a cupful of boiling water, and the boiling continued for two or three minutes. The mixture is then cooled. If of a dark color, it is diluted with a sufficient amount of water to reduce the color to such an extent that the reaction formed by starch and iodin may be clearly apparent if starch be present. The amount of dilution can only be determined by practice, but usually the liquid must be diluted with an equal volume of water, or only one-fourth of a teaspoonful of the sample may be employed originally. A single drop of tincture of iodin is now added. If starch is present, a deep blue color, which in the presence of a large amount of starch appears black, is formed. If no blue color appears, the addition of the iodin tincture should be continued, drop by drop, until the liquid shows by its color the presence of iodin in solution.

DETECTION OF COLORS.

Spice substitutes are sometimes colored with coal-tar colors. These products may be detected by the methods given on page 45.

VINEGAR.

A person thoroughly familiar with vinegar can tell much regarding the source of the article from its appearance, color, odor, and taste.

If a glass be rinsed out with the sample of vinegar and allowed to stand for a number of hours or overnight, the odor of the residue remaining in the glass is quite different with different kinds of vinegar. Thus, wine vinegar has the odor characteristic of wine, and cider vinegar has a peculiar, fruity odor. A small amount of practice with this test enables one to distinguish with a high degree of accuracy between wine and cider vinegars and the ordinary substitutes.

If a sample of vinegar be placed in a shallow dish on a warm stove or boiling teakettle and heated to a temperature sufficient for evaporation and not sufficient to burn the residue, the odor of the warm residue is also characteristic of the different kinds of vinegar. Thus, the residue from cider vinegar has the odor of baked apples and the flavor is acid and somewhat astringent in taste, and that from wine vinegar is equally characteristic. The residue obtained by evaporating vinegar made from sugarhouse products and from spirit and wood vinegar colored by means of caramel has the peculiar, bitter taste characteristic of caramel.

If the residue be heated until it begins to burn, the odor of the burning product also varies with different kinds of vinegar. Thus, the residue from cider vinegar has the odor of scorched apples, while that of vinegars made from sugarhouse wastes and of distilled and wood vinegars colored with a large amount of caramel has the odor of burnt sugar. In noting these characteristics, however, it must be borne in mind that, in order to make them conform to these tests, distilled and wood vinegars often receive the addition of apple jelly.

As stated above, the cheaper forms of vinegar, especially distilled and wood vinegar, are commonly colored with caramel, which can be detected by the method given on page 48.