[1] Reports of Local Government Board of England, 1896, 1897, 1898.
[2] Die Apotheker-Gesetze nach Deutschen Reichs- und Preussischen Landes-Rechts, Berlin, 1894.
[3] N. Roe Bradner: Report of Committee on Nostrums, Proprietary Medicines, and New Drugs, Hartford, Conn., 1890.
[4] C. Lewis Diehl: Report on Deterioration, Adulteration and Substitution of Drugs. Supplement No. 6, Bulletin of National Board of Health, 1884.
[5] Reports of Massachusetts State Board of Health, 1883-1900.
[6] C. V. Chapin: Municipal Sanitation in the United States, pp. 325-327, Providence, R. I.
[7] Reports of State Board of Health of New York, 1881-1895.

FOOD: METHODS OF INSPECTION AND ANALYSIS.—There is no field of chemical analysis more unique in itself than that covered by the food analyst, who necessarily employs methods of a much more varied character than almost any other chemical specialist. Processes of food analysis are not exclusively chemical. Physical methods are frequently employed, especially those along optical lines involving the use of the microscope, the polariscope, the spectroscope, and the refractometer. Besides these instruments, the food analyst should be provided with a water bath, a delicate balance, a Babcock centrifuge, the usual laboratory glassware and reagents, and, if possible, with a number of platinum dishes.

It is desirable in the examination of foods to employ quick processes for separating the pure from the impure, afterward applying special methods to the impure samples to ascertain the nature and extent of the adulteration.

No attempt is made in what follows to deal with the processes of analyzing foods for their nutritive values, but simply briefly to outline methods of detecting, and in some instances estimating adulterants in such classes of food products as experience has shown to be most liable to fraudulent adulteration. Wherever possible, methods are selected involving the simplest possible apparatus. The usual laboratory reagents are used, mainly solutions of simple salts, and for their preparation the reader is referred to any text book in qualitative analysis.

Baking Powder.—The adulterants of cream of tartar are, of course, to be looked for in baking powder, and are tested for as indicated under "Cream of Tartar."

Alum is tested for by burning a small quantity of the sample to an ash, which is then treated with boiling water and filtered. If, on the addition of ammonium chloride to the filtrate, a flocculent precipitate is formed, this will indicate the presence of alum in the sample. The test is applicable in presence of phosphates.

Butter.—If accustomed to the odor and taste of oleomargarine, one can usually distinguish by these senses alone between it and pure butter. The odor of the melted fat is very distinctive, the melted oleomargarine lacking the butyric odor so characteristic of the butter and possessing a distinct "meaty" smell that generally betrays its nature. Certain quick physical tests are sometimes employed to distinguish pure from adulterated butter.

The Spoon Test.—If about a gram of the sample be placed on a spoon, held over the free gas flame and brought to the boiling point, the mass will assume a "foamy" appearance if the butter is pure. If the sample is oleomargarine or "process butter" (old butter reworked), the mass will bump and spatter like hot grease containing water, but does not foam.

The Milk Test.—Five to 10 c.c. of the sample are added to 50 c.c. of sweet milk heated nearly to boiling. The contents are stirred with a rod till the fat is melted, after which the container is placed in cold water and the stirring is continued till the fat congeals. If oleomargarine, the fat can readily be collected into one lump with the stirring rod, and if butter, it cannot be gathered together, but granulates.

Under the microscope pure butter should theoretically show no crystalline structure when viewed by polarized light, being uniformly bright throughout and, if the selenite plate be used, showing an evenly colored field entirely devoid of fat crystals. With process butter or oleomargarine, both of which have been melted and subsequently cooled, the crystalline structure should be marked, showing with polarized light a mottled appearance, and a play of colors with the selenite. These conditions are, however, not sufficiently sharp to be reliable in unskilled hands.

The Zeiss Butyro-Refractometer furnishes a ready means of distinguishing between butter and oleomargarine. This instrument is so constructed that the degree of refraction of a beam of light reflected from a mirror obliquely through a thin film of the melted fat is read on an arbitrary scale of sufficient extent to cover the widest limits of deviation possible for butter fat and oleomargarine under ordinary temperatures. The butter fat is kept at a constant temperature above the melting point by a circulation of heated water maintained through a jacket that encloses it, the temperature being read on a thermometer. Each fat has fixed limits of reading at a given temperature, the scale reading of oleomargarine being from six to twelve degrees higher than that of butter.

The Volatile Fat Acids.—The presence of a considerable percentage of volatile fatty acids in genuine butter and the lack of them in oleomargarine furnishes the most ready chemical means of distinguishing between the two. The result is usually expressed by the number of cubic centimetres of decinormal alkali necessary to neutralize the volatile fatty acids in 5 gm. of the fat, being known as the "Reichert number." The method of obtaining this is fully described in Bulletin 46, United States Department of Agriculture, Division of Chemistry.

Cheese.—*The Fat Content* of cheese is the most important factor in determining whether whole or skimmed milk has been used in its manufacture, and the Babcock milk tester is used with advantage in estimating the fat.

Weigh 5 gm. of the finely divided sample into a tared Babcock milk testing bottle. About 15 c.c. of hot water are then added, and the mixture is shaken until an emulsion is formed. A few drops of ammonia aids in softening the cheese. The mixture is kept warm by immersing the test bottle in hot water. When a complete emulsion is formed, the bottle is cooled, 17.5 c.c. of concentrated sulphuric acid are added and the test is completed in the usual manner for carrying out the Babcock test (see Milk Fat). The reading of the fat in the bottle is multiplied by 18 and this result divided by the number of grams of the sample taken gives the percentage of fat in the cheese, which in case of a whole-milk cheese should be at least thirty per cent.

Detection of Foreign Fat.—The presence of foreign fat in cheese is best detected by submitting the separated cheese fat to the same examination as is given to butter fat (*q. v.*), the fat for chemical examination being best removed by extraction of the cheese with ether.

Cocoa.—The purity of cocoa is best determined by means of the microscope. See "Spices" for brief directions as to mounting, etc. Samples of known purity should be studied for comparison with doubtful specimens. Under the microscope pure cocoa shows a loose mass of yellowish-brown matter, with small starch granules and oil globules.

Coffee.—This, like cocoa, is best examined microscopically, being first ground to a fine powder in a mortar. Figs. 6, 7, 8, Plate XXVI., show the characteristic appearance under the microscope of both pure and adulterated samples. Pure coffee appears as a mesh-work of irregular hexagonal thick-walled cells enclosing oil droplets and amorphous material.

Condensed Milk.—Forty grams of the thoroughly mixed sample are weighed out and made up to 100 c.c. with water.

Total Solids.—An aliquot part of the above solution is further diluted with an equal amount of water, and 5 c.c. of the diluted mixture is evaporated over the live steam of a boiling water bath for three hours in a platinum dish and the residue weighed.

Ash.—The residue from the total solids is burnt to a white ash and weighed.

Fat.—This is the most important factor in determining

EXPLANATION OF
PLATE XXVI.

EXPLANATION OF PLATE XXVI.

FIG. 1.—Pure Cayenne. Patches of the inner and outer skin appear most prominent, with scattered bits of cellular tissue.

FIG. 2.—Cayenne Adulterated with Wheat. The mass to the left of the centre is cayenne. The circular granules are of wheat starch.

FIG. 3.—Allspice Adulterated with Cayenne. The large mass is cayenne skin. The small stone cell and mass of gum below are of allspice.

FIG. 4.—Pepper Adulterated with Buckwheat. Large masses of buckwheat starch granules are above the centre, and a small mass of finer pepper-starch grains below and to the left.

FIG. 5.—Olive Stones in Alleged Pepper. Elongated, thick-walled stone cells of the ground fruit stones are grouped together in the centre.

FIG. 6.—Pure Coffee. A meshwork of cells tending to hexagonal in shape, enclosing amorphous material and droplets of oil.

FIG. 7.—Coffee Adulterated with Peas and Pea Hulls. Masses of pea-starch granules are most prominent. The rectangular billets, like bunches of matches around the lower edge, constitute the pea hulls.

FIG. 8.—Chicory in an Adulterated Coffee. Chicory shows as a mass of cellular tissue, traversed by broad bands (juice ducts) having striking transverse markings.

FIG. 1.—Pure Cayenne.
× 110.

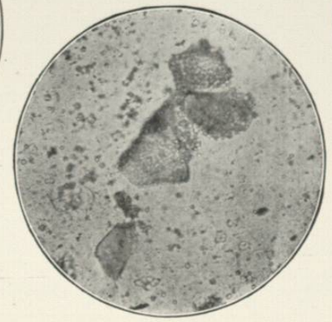

FIG. 4.—Pepper Adulterated with Buckwheat.
× 130.

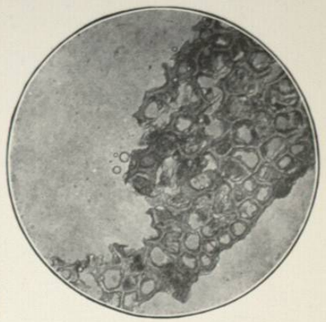

FIG. 6.—Pure Coffee.
× 130.

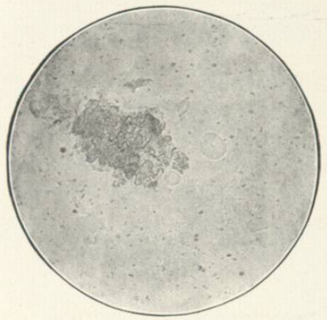

FIG. 2.—Cayenne Adulterated with Wheat.
× 130.

FIG. 5.—Olive Stones in Alleged Pepper.
× 110.

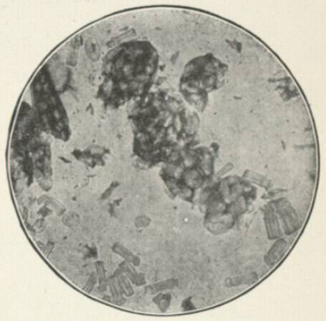

FIG. 7.—Coffee Adulterated with Peas and Pea Hulls.
× 130.

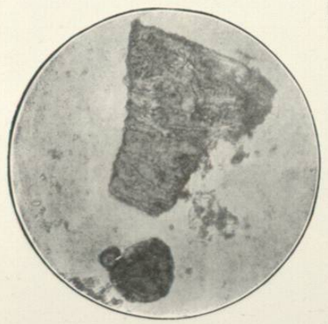

FIG. 3.—Allspice Adulterated with Cayenne.
× 110.

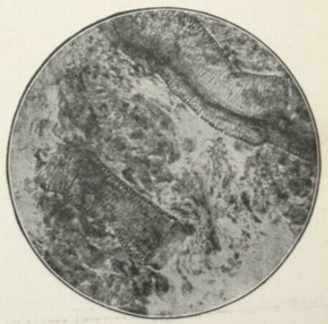

FIG. 8.—Chicory in an Adulterated Coffee.
× 130.

PHOTOMICROGRAPHS OF PURE AND TYPICALLY ADULTERATED FOODS AND ADULTERANTS

the purity of the sample. Twenty-five cubic centimetres of the forty-per-cent. solution are measured into an ordinary Babcock test bottle, which is then filled nearly to the neck with water. The contents are shaken and 4 c.c. of a seven-per-cent. solution of copper sulphate are added. The bottle is then well shaken and whirled in the centrifuge until the precipitate has settled out. The clear supernatant liquid is drawn off by means of a pipette, a small wisp of absorbent cotton being lightly twisted about the lower end to serve as a filter. After the liquid is drawn up into the pipette, the cotton is removed by rubbing against the inside of the bottle, and the pipette is withdrawn. The precipitate is washed twice as above by decantation, and after the final washing, sufficient water is added to amount to about the quantity of milk measured for the Babcock test (17.6 c.c.). From this point on the usual Babcock centrifuge method is followed, adding the regular 17.5 c.c. of strong sulphuric acid (see Milk Fat). Multiplying the final reading by 1.8, we get the percentage of fat.

The above process is to be used for the ordinary condensed milk containing added cane-sugar. The fat in "evaporated cream," which is really condensed milk without the cane-sugar, is best determined by the ordinary Babcock method as in the case of milk, using 17.6 c.c. of a uniform mixture of equal volumes of the sample, and water.

CREAM is treated similarly to milk (*q. v.*) for total solids, color, and preservatives.

Fat.—A weighed portion of the sample is introduced into the specially constructed cream bottle furnished for the Babcock test. The test is then conducted as in the case of milk fat (*q. v.*), the final reading being multiplied by 18 and the result divided by the number of grams of the sample taken to give the exact percentage of fat.

Gelatin, sometimes used to thicken cream, is best detected by mixing 10 c.c. of the cream with an equal volume of a dilute solution of acid nitrate of mercury. After diluting and shaking, the mixture is allowed to stand a few minutes and filtered. To a portion of the filtrate an equal quantity of a saturated solution of picric acid is added. A yellow precipitate indicates gelatin.

CREAM OF TARTAR.—The purity of this substance is usually established if the sample is found to be readily soluble in hot water; since most adulterants other than alum are insoluble. It is best to weigh out 0.1881 gm. of the cream of tartar and dissolve in hot water, titrating the solution with one-tenth normal sodium hydroxide, and using phenolphthalein as an indicator. If the sample is pure, it should require just 10 c.c. of the alkali to neutralize.

If *alum* is the adulterant, the alum would be precipitated by the sodium hydroxide, the precipitate being soluble in an excess of the alkali.

Starch is detected by adding a drop of iodine reagent to the solution of the sample, a blue color being produced if starch is present. The starches are most readily identified under the microscope.

Calcium (present as sulphate or phosphate) is best shown by burning the sample to an ash, dissolving in water acidified with hydrochloric acid, filtering, and treating a part of the filtrate with ammonia and ammonium oxalate. A precipitate shows calcium.

A Sulphate is indicated, if, on treatment of a part of the acid filtrate above obtained with barium chloride reagent, a precipitate is formed.

A Phosphate is detected by boiling a little of the sample with nitric acid and adding ammonium molybdate reagent. A yellow precipitate indicates phosphate.

HONEY.—*Commercial Glucose* and *Cane-Sugar* are best estimated by means of a Schmidt and Haensch polariscope. 26.048 gm. of the sample are weighed out in a flask graduated to hold 100 c.c., 5 c.c. of alumina cream* are added to clarify, and the solution is made up to 100 c.c. with water. It is well shaken and filtered, the filtrate being polarized in a 200 mm. tube and the reading taken. If the scale reading is to the left of the zero point, the honey may usually be considered pure; if it is to the right, the honey is probably adulterated with cane-sugar or commercial glucose or both. Fifty cubic centimetres of the filtrate are taken, 5 c.c. of strong hydrochloric acid are added, after which the solution is made up to 100 c.c. with water and heated in the flask to 68° C., cooled and filtered. This process is termed inversion. The filtrate is then polarized in the 200 mm. tube, and the result multiplied by two gives the invert reading. The amount of cane-sugar is obtained by the following formula (Clerget's):

$$R = \frac{100\ S}{144 - \frac{1}{4}t}$$

wherein R is the per cent. of cane-sugar, S the difference of the two polarizations before and after inversion, and t the temperature at which the readings are taken. If commercial glucose is suspected, the portion of the sample subjected to inversion is heated and polarized at 87° C. in a 200 mm. jacketed tube, the reading being multiplied by two. This result, divided by 175, gives the approximate per cent. of commercial glucose in the sample.

The presence of commercial glucose may usually be qualitatively detected by submitting the sample to a test for dextrin, one of the chief ingredients of glucose. A solution of the honey is treated with an excess of strong alcohol. A precipitate indicates dextrin. Pure honey should give no precipitate.

LARD.—The color, smell, and consistency of the sample of adulterated lard often serve to betray its character to a careful observer, and, as in the case of butter, the odor of the fat when melted is much more distinctive than when in its natural condition. The adulterants commonly to be looked for are cotton-seed oil and beef tallow.

Reaction with Strong Acid (sulphuric or nitric).—A small amount of melted fat is poured into a test tube, an equal quantity of acid is added and the contents are well shaken. Genuine lard and beef stearin usually give but slight coloration, while mixtures containing cotton-seed oil invariably give a red-brown color, more or less intense in proportion to the amount of cotton-seed oil present.

The Zeiss Refractometer, described under "Butter," is useful in the examination of lard as well as other fats and oils. The refracting degree of cotton-seed oil on this instrument is about 8.9 in excess of that of lard, while that of beef tallow is about 3.8 less. If the scale reading of the sample is unusually low, the presence of beef stearin is to be suspected; if unusually high, cotton-seed oil should be looked for. A mixture of the two adulterants either with or without pure lard may be such as to give refractometric readings within the limits of pure lard. In such a case the positive detection of the cotton-seed oil by the Halphen test (given below) will indirectly show the presence of the tallow, which should be confirmed by crystallization and microscopic examination.

Halphen's Test for Cotton-Seed Oil.—A mixture is made of equal volumes of amyl alcohol and carbon bisulphide containing one per cent. of sulphur. From 3 to 5 c.c. of melted fat is mixed with an equal volume of the above reagent in a test tube and heated in a bath of boiling water for fifteen minutes. If cotton-seed oil is present, a deep red or orange color is produced. If the lard is pure, little or no color is developed.

Microscopical Examination of the Crystallized Fat.—From 2 to 5 gm. of the fat are dissolved in 10 to 20 c.c. of a mixture of equal parts of ether and alcohol in a test tube, and the solution is allowed to stand a few hours, the tube being loosely stoppered with cotton. The crystals obtained vary somewhat with the condition of heat, rate of crystallization, etc. A careful study of these crystals and comparison with samples of known purity, crystallized under similar conditions, should be made.

Theoretically, pure lard crystallizes under the best conditions in thin, flat, rhomboidal plates, while beef-stearin crystals are more in the form of cylindrical rods

* Prepared by adding ammonia water in excess to a saturated solution of alum and washing free from ammonia. The aluminum hydrate held in water is shaken so as to form a thin, emulsion-like paste to clarify.

or needles, often bent or curved. Both forms are often found in fan-shaped clusters, which, however, differ from each other in certain important particulars, best distinguished by a careful study of their appearance.

Maple Sugar and Syrup.—Commercial glucose is determined in maple syrup precisely as in the case of molasses (*q. v.*) excepting that as a rule no clarifier need be used for maple syrup. A normal solution of pure maple syrup should polarize at from 60° to 64° on the cane-sugar scale. Cane-sugar other than maple is best detected both in syrup and sugar by the sense of taste.

Milk.—There are various simple appliances for roughly testing the quality of milk, but most of them are of little value. The lactometer test is perhaps the best of these, if used with judgment.

The Lactometer is simply a hydrometer covering the widest variations in specific gravity of milk. A thermometer is also necessary and for this reason a Quevenne lactometer, combining in one instrument both the hydrometer and thermometer is convenient. Milk of good quality should have a specific gravity between the limits of 1.027 and 1.033. A watered milk would run below the former, and a skimmed milk above the latter figure, though a milk unusually rich in fat would also run low. It should easily be apparent from the taste and appearance of the milk whether a low specific gravity is due to watering or to unusual richness in cream.

Feser's Lactoscope gives an approximation of the amount of fat in the milk, and its use, especially in connection with the lactometer, is of some value. This instrument consists of a glass cylinder with graduations indicating the per cent. of fat. A measured amount of milk being introduced by means of a pipette, sufficient water is added with thorough mixing to allow certain black lines on a spindle within the cylinder to become apparent through the translucent fluid. The height of the level of milk and water in the cylinder is then read off, indicating roughly the per cent. of fat in the milk.

Total Solids.—Five grams of the thoroughly mixed milk are weighed from a pipette into a tared shallow platinum dish on the pan of a delicate balance, and the dish is transferred to a boiling water bath, where it is kept for at least two hours in direct contact with the live steam. It is afterward cooled and weighed, the residue being the total solids and the loss in weight being reckoned as water.

Ash.—The residue from the total solids is burnt to a white ash and weighed.

Fat.—The fat is most readily determined by the Babcock process. There are various forms of Babcock centrifuge from the simple hand machine to the steam or electrically driven variety, all carrying the same form of graduated bottle. Into this bottle 17.6 c.c. of the thoroughly mixed milk to be examined is introduced by a pipette, the same amount of concentrated sulphuric acid is added and well mixed with the milk to dissolve the albuminoids and set free the fat, after which, by whirling and by the addition of hot water, the fat is driven into the graduated neck of the bottle, where the exact percentage is directly read off.

Calculation of the Total Solids.—The total solids may readily be calculated with considerable approach to accuracy, if the specific gravity and the fat are known, from the formula of Babcock:

$$\text{Total solids} = 0.25\ G + 1.2\ F.$$

G being the lactometer reading and F the fat. This method of obtaining the total solids by calculation is convenient, when, as is often the case, dairymen and others are provided with the inexpensive and easily operated Babcock apparatus and lactometer, but do not have the more involved and costly appliances necessary for the direct determination of the solids.

Distinguishing Watered from Skimmed Milk.—The proportion of solids not fat to fat determines whether a sample below the standard is skimmed or watered. If both these factors are abnormally low, and the proportion of fat to solids not fat is about the same as, or higher than in a normal milk, the sample may as a rule be assumed to be watered; if both total solids and fat are considerably below the standard, and the solids not fat nearly normal, the milk has undoubtedly been skimmed; if total solids and solids not fat are proportionally low, while the ratio of fat to solids not fat is abnormally small, the milk has probably been both skimmed and watered. From legal standards fixed in various States the total solids in pure milk should run from 11.5 to 13.0 per cent., the fat from 3 to 4 per cent., and the solids not fat from 8.5 to 9.3 per cent.

Foreign Coloring Matter.—This may be determined as follows: about a gill of the milk is curdled by heat and acetic acid, the curd being separated and gathered by a stirring rod into one mass. It is then squeezed free from whey and shaken with ether in a corked flask, where it is allowed to macerate for an hour or more. The ether extract containing the fat and annatto, if present, is evaporated and the residue made alkaline with sodium hydroxide and filtered through a wet filter. If annatto is present, it will permeate the filter paper, coloring it a more or less deep orange more apparent when the fat is washed off and the filter is dried. Stannous chloride solution will turn the orange stain pink, if the color is annatto. After pouring off the ether, if the curd is left white, neither caramel nor aniline orange is present. If the aniline dye has been used, the curd will show a more or less brilliant orange color; if caramel, the curd will be brown.

Shake a small portion of the fat-free curd in a test tube with strong hydrochloric acid. The caramel-colored curd will, like an uncolored curd, gradually produce a deep blue color in the strong acid solution. The aniline orange if present in the curd will *immediately* produce with the hydrochloric acid a deep pink color.

Preservatives.—(*a*) *Formaldehyde* is best tested for by heating about 10 c.c. of the milk with an equal quantity of concentrated hydrochloric acid and a drop of ferric chloride solution. A violet coloration is produced if formaldehyde be present, delicate to 1 part formaldehyde in 300,000.

(*b*) *Boracic Acid* is tested for by soaking turmeric paper in a solution of the milk ash, acidified slightly with hydrochloric acid. On drying the turmeric paper, a cherry red color indicates the presence of boracic acid, which is confirmed by applying to the reddened paper a drop of a dilute solution of sodium hydroxide. This reagent turns the paper a dark olive if boracic acid was present.

(*c*) *Carbonate of Soda* is indicated by an effervescence on treating the milk ash with acid, and may further be tested for by mixing 10 c.c. of milk with an equal volume of alcohol and a few drops of a one-per-cent. solution of rosolic acid. A rose red coloration indicates carbonate.

Molasses.—*Determination of Commercial Glucose.* Direct and invert polariscopic readings are obtained as directed under "Honey," except that instead of clarifying with alumina cream as in the case of honey, from 5 to 25 c.c. of United States Pharmacopœia subacetate of lead solution are used, depending on the color of the sample, the darker the molasses the more clarifier being necessary. The polarizations should be made in a 100 mm. tube, if the sample is high in glucose, and the proper correction made. If molasses is of average color, its normal solution should polarize less than 60° in the 200 mm. tube on the cane-sugar scale. A dark sample should, if pure, polarize under 50°. Determine the cane-sugar by Clerget's formula (see *Honey*). The cane-sugar deducted from the direct polariscopic reading gives the reading due to glucose. This result, divided by 175, gives the per cent. of commercial glucose.

Olive Oil.—As in the case of lard, the presence of cotton-seed oil, which is the most common adulterant, may often be roughly shown by the reaction with strong nitric acid. When shaken in a test tube with an equal volume of the acid, pure olive oil should show a green coloration, while if cotton-seed oil is present, a red color is quickly developed.

The Zeiss Refractometer, though primarily intended for

EXPLANATION OF
PLATE XXVII.

EXPLANATION OF PLATE XXVII.

FIG. 9.—Pure Cloves. A large mass of the loose spongy cellular tissue is shown, filled with brown granular material.

FIG. 10.—Cloves Adulterated with Cocoanut Shells. Little show in the field but the long dark colored stone cells of the adulterant.

FIG. 11.—Corn Starch. Hexagonal granules with rifted central hila.

FIG. 12.—Ginger Adulterated with Corn, Wheat, and Sawdust. Ginger starch granules are egg-shaped with protuberances at one end. A mass of soft wood fibre appears at the top.

FIG. 13.—Wheat Starch. Circular granules of various sizes, many having concentric rings.

FIG. 14.—Pure Mustard. The fine granular masses are the mustard substance. The globular bodies are oil drops.

FIG. 15.—Mustard Adulterated with Wheat. Nothing but masses of wheat starch and bran ap pear in this field.

FIG. 16.—Rice Starch. Small sharply pointed polygonal granules.

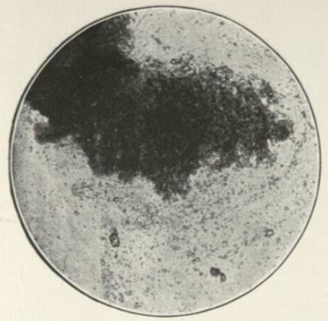

FIG. 9.—Pure Cloves.
× 130.

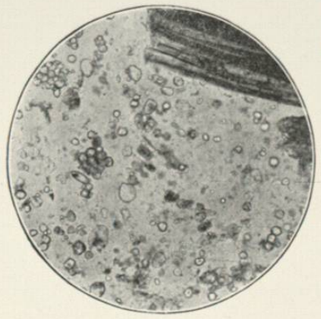

FIG. 12.—Ginger Adulterated with Corn, Wheat, and Sawdust.
× 130.

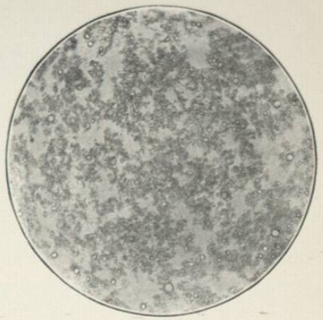

FIG. 14.—Pure Mustard.
× 130.

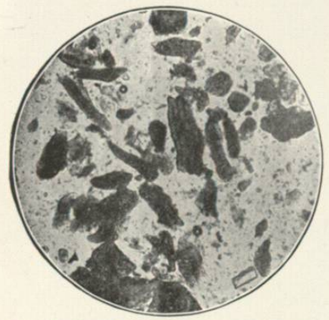

FIG. 10.—Cloves Adulterated with Cocoanut Shells.
× 130.

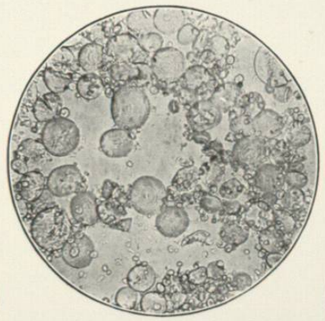

FIG. 13.—Wheat Starch.
× 220.

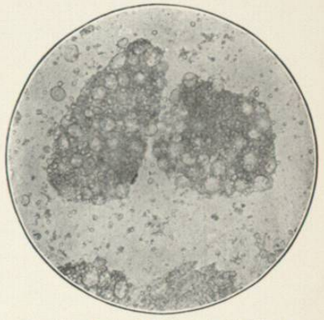

FIG. 15.—Mustard Adulterated with Wheat.
× 130.

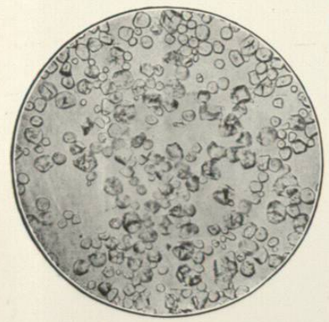

FIG. 11.—Corn Starch.
× 220.

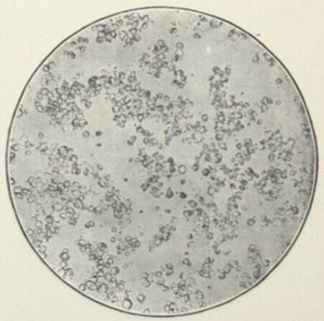

FIG. 16.—Rice Starch.
× 220.

PHOTOMICROGRAPHS OF PURE AND TYPICALLY ADULTERATED FOODS AND ADULTERANTS

use with butter and lard, is of great service in examining olive oil. The refracting degree of cotton-seed oil on the scale of this instrument is about 4.8° higher than that of pure olive oil at a given temperature. Peanut oil, which has been used as an adulterant of olive, has nearly the same degree of refraction as cotton-seed oil, while corn oil, found by the author in alleged olive oil, is at least 13° higher on the Zeiss scale than pure olive oil.

The presence of cotton-seed oil is best confirmed by the Halphen test described under Lard.

SPICES.—Adulterants of spices are best detected by submitting them to microscopical examination. The finely ground sample is mounted by placing a small portion on a glass slide by means of a knife blade, treating with a drop of distilled water, and rubbing out under the cover glass between the thumb and finger. The specimen is best examined with a one-sixth-inch objective and a medium ocular, giving a magnification of from 240 to 330 diameters.

It is extremely difficult to describe the actual microscopical appearance of such composite substances as the spices. Each has its own particular characteristics, and the analyst should provide himself with a complete set of powdered pure spices, and of starches, ground olive and date stones, nut shells, bark, pea hulls, sawdust and other adulterants of known purity, and familiarize himself with their microscopical appearance, making his own standards for comparison. Plates XXVI. and XXVII. illustrate both pure and typically adulterated samples of some of the spices as they appear under the microscope. A few of the most striking features to be looked for in the common spices are as follows:

Allspice.—Small circular starch granules, often arranged in clusters; very striking amber-colored lumps of gum; a considerable quantity of stone cells, mostly colorless.

Cassia.—Small starch granules, intermingled with patches of yellow skin and bundles of brown and yellow wood fibres; stone cells, often of a brown color.

Cayenne.—No starch; yellow droplets of oil; patches of skin with striking markings not unlike the convolutions of the intestines.

Cloves.—No starch; occasional, though very few colorless stone cells; colorless oil drops; masses of spongy, brown cellular tissue of indefinite structure, but unmistakable; spiral ducts.

Ginger.—Large starch granules, egg-shaped with small protuberances at one end; colorless cellular tissue; masses of wood fibre.

Mace.—No starch; colorless oil drops; characteristic cellular tissue.

Mustard.—No starch; colorless oil drops; spongy, colorless cellular tissue with both yellow and colorless patches of hull, filled with brown spots.

Nutmeg.—Small, circular starch granules with central hila; colorless, indefinite cellular tissue.

Pepper.—Very minute starch granules; arranged in large masses; rectangular stone cells.

TEA.—The percentage of ash is a ready means of ascertaining whether or not any considerable amount of dirt or mineral matter has been added. Five grams of the sample are carefully burnt in a tared platinum dish to a white ash over a free flame at a low red heat, and the residue is cooled and weighed. The ash of a pure tea should not exceed seven and one-half per cent. If the ash is abnormally low, the presence of spent or exhausted leaves is indicated. Tea stems and fragments as well as foreign leaves are best recognized by soaking the leaves in boiling water, which opens them out so that their nature is readily apparent.

VINEGAR.—Although the percentage of solids and acidity in cider vinegar are important factors in determining its purity and strength, standards being fixed for these in many localities, it by no means follows that a sample of cider vinegar high in both solids and acidity is pure.

Total Solids.—Five grams are weighed from a pipette into a tared platinum dish, which is then transferred to a boiling water bath and kept in contact with live steam for at least an hour and a half. It is then cooled and weighed, the residue representing the vinegar solids. If the solids have been reinforced by apple pomace, this is rendered apparent by burning the residue to an ash in the platinum dish and determining the weight of the ash. If the ash is less than six per cent. of the entire solids, there is no doubt that unfermented sugar-containing material has been added. The normal percentage of ash in total solids of pure cider vinegar should be at least eight and one-half.

Acidity.—This is commonly determined by titrating 6 c.c. of the vinegar with decinormal sodium hydroxide, using phenolphthalein as an indicator. The per cent. of acetic acid is exactly one-tenth of the number of cubic centimetres of the alkali required for neutralization.

It is possible to use lime water as a reagent in determining approximately the acidity of vinegar. A saturated solution of air-slaked lime has a nearly constant alkalinity. If 2.75 c.c. of vinegar are titrated against saturated lime water, the number of cubic centimetres of the latter required to neutralize, divided by ten, gives directly the per cent. of acetic acid very closely.

Reaction with Lead Acetate.—The *absence* of a precipitate with this reagent shows positively that the vinegar is not genuine, but a precipitate does not necessarily prove the vinegar to be pure.

The Polariscope Test.—A genuine cider vinegar should always polarize to the left of the zero point, a right-handed polarization being absolute evidence of adulteration, the adulterant often being in this case apple jelly containing glucose.

The vinegar sample may usually be sufficiently clarified for polarization in a 100 mm. tube by simply passing through a double filter.

Sulphuric Acid or Sulphates are indicated, if on the addition of barium chloride reagent to the sample, a precipitate is formed. *Albert E. Leach.*

BIBLIOGRAPHY.

Leffmann and Beam: Select Methods in Food Analysis, 1901.
A. H. Allen: Commercial Organic Analysis, 1898.
H. D. Richmond: Dairy Chemistry, 1899.
C. A. Mitchell: Flesh Foods, 1900.
J. König: Chemie der menschlichen Nahrungs- und Genussmittel, 1889.
Villiers et Collin: Traité des Alterations et Falsifications des Substances Alimentaires, 1900.
Bulletins of United States Department of Agriculture. Division of Chemistry: No. 13. Food and Food Adulterations. (Nine Parts.) 1887–1898.—No. 45. Analysis of Cereals, 1895.—No. 46. Official Methods of Analysis, 1899. Office of Experiment Stations: No. 28. Chemical Composition of American Food Materials.
H. W. Wiley: Principles and Practice of Agricultural Analysis, 1897.
Zeitschrift für Untersuchung der Nahrungs- und Genussmittel, 1898–1901.
Vierteljahresschrift der Chemie der Nahrungs- und Genussmittel, 1844–1897.
The Analyst, 1877–1901.
T. F. Hanausek: Die Nahrungs- und Genussmittel aus dem Pflanzenreiche, 1884.

FOOD POISONS.—From the earliest times poisoning from diverse foods has attracted the attention of the laity and of medical men. Numerous explanations, many of these decidedly absurd as viewed from the standpoint of our present knowledge, have been put forth, and it is only within comparatively recent years that vague hypotheses have given way to exact chemical and bacteriological studies. As a result, a flood of light has been thrown upon the causation of food poisonings, and the observations thus made have in turn served their purpose of indicating the relatively simple means by which many of these intoxications may be avoided.

Individual susceptibility plays a most important part in all poisonings. It is very well known that a given poison may affect two individuals in a wholly different manner. Moreover, observations are not wanting which show that a substance which we may have good reason to consider as wholly innocuous is nevertheless very deleterious to some. The fortunately very rare instances of fatal results following the injection of antitoxic sera may be taken as an example of such idiosyncrasy. In like manner one may meet with individuals to whom a given article of food invariably plays the part of a poison, and justifies the oft-quoted adage that "what is meat to one