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H. W. WILEY, Chief of Bureau.

FRUITS AND FRUIT PRODUCTS:

CHEMICAL AND MICROSCOPICAL EXAMINATION.

PREPARED UNDER THE DIRECTION OF

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BY

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Chemistry,
Washington, D. C., January 25, 1902.

Sir: I have the honor to transmit herewith the manuscript of a report on our investigations of fruit and fruit products, with the request that it be published as Bulletin No. 66 of the Bureau of Chemistry.

Respectfully,

H. W. Wiley,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

INTRODUCTION.

Questions affecting the purity of staple foods are of vital interest to practically our whole population. This interest is increased, from the moral and commercial standpoints, with foods produced and manufactured in this country.

During recent years the cultivation of fruit and the manufacture of fruit products have reached such proportions that information is often sought regarding the true character of the preparations on the market.

The adulterants mentioned in the following pages are to be criticised on the ground of deception rather than because of their being prejudicial to health. At the same time, salicylic acid and saccharin are regarded with disfavor by the majority of disinterested investigators, it is conceded that benzoic acid should be subjected to further study before its use be unrestricted, and it sometimes happens that colors are employed that are not altogether lacking in injurious properties. There is a demand for further study of the effects of preservatives in general on the health of the consumer.

As stated above, however, the great majority of samples reported in the following pages as adulterated are probably not injurious articles, and their sale under proper labels is not open to objection. Correct labeling, however, is essential to the welfare of reliable manufacturers as well as that of consumers.

Many large manufacturers find it advantageous to add a commercial preservative to hold fruit in a partially prepared condition and finish it up at their convenience; to add apple juice, not as a "make weight" alone, but to insure a good, firm jelly; and to employ artificial colors to compensate for dilution with apple juice and to prevent fading on the grocers' shelves.

When such practices as the above are not indicated on the label, jellies made of a given fruit and sugar alone are subjected to unfair competition. The two articles may be equally wholesome, but there are many who prefer the latter and are willing to pay for the increased cost of manufacture.

There are numerous small establishments engaged in the preparation of "home-made" jellies and jams that are really true to name, and the number of private families that add something to their income in the same way is very great. Their welfare requires correct labeling of imitation products.

Moreover, the consumer has a right to expect that food products shall be true to label in every respect. There should be no misrepresentation regarding quality of product, variety of fruit employed, place of production, or name of manufacturer. It is a common practice, for instance, to label all pears as Bartletts. This works injustice to both producers and consumers. Many canners place their own labels only on their best brands and pack inferior goods under the names of fictitious firms. This practice is less objectionable when the goods can be readily traced to the manufacturer, but it often happens that letters addressed to such fictitious firms are returned to the sender. The practice becomes most reprehensible when such inferior articles are marked "first quality."

Another form of mislabeling often resorted to is the branding of fruits of one locality with the name of a State or district which has attained an enviable reputation for the production of certain fruit. In this connection may be noted an injunction recently obtained in the Baltimore courts restraining certain packers from labeling their wares as California products.

For the purpose of comparison numerous analyses of fruits have been compiled, and fresh fruits, and jellies and jams prepared in the laboratory, have been examined.

The samples of fruit products examined were taken at random, no attempt being made to secure either high or low grade goods. On the contrary, attempts were made to secure a set of samples that would be thoroughly representative of the fruit products on the market. This matter is attended with great difficulty. The various manufacturers do not send their high-grade goods to the same markets. It often happens that a given firm which makes several brands of goods only finds sale for its lowest grade in some cities, where some manufacturers place only their best goods. The same conditions apply to different stores in the same city. It is quite possible that we have secured samples of high-grade goods of some manufacturers and overlooked stores which handled their cheap products, or vice versa.

As stated above, however, the samples were collected in such a manner as to preclude these conditions as far as possible. The cities of Washington, New York, Philadelphia, and New Orleans were visited by representatives of the Bureau and a list of stores selected where it was thought all grades of goods could be found. Samples were secured of all jellies, jams, and similar preparations on sale at these stores. A few additional samples were received from other sources.

All of the work in connection with this bulletin was accomplished by those whose names appear on the title-page, except the nitrogen determinations, which were made by Mr. T. C. Trescot.

As indicated above, the primary purpose of the work was to determine the character of the fruit products on the market. At the same time, the analyses given are of scientific value in extending our knowledge of the composition of fruits.

W. D. Bigelow,
Chief of Food Laboratory

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By L. S. Munson and L. M. Tolman.

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GENERAL DISCUSSION.

In making an examination of fruits or fruit products much depends upon the object of the analysis. Hence the preparation of the samples, the portions used for analysis, and the determinations to be made, must be left largely to the judgment of the analyst. In the examination of fresh fruits the determinations of pressed pulp and juice, the amount of waste material, and the relation between flesh and pit are often of considerable value. The examination should be so complete as to leave no doubt regarding the interpretation of the data obtained. It should be borne in mind that the more exhaustive the examination the greater is its scientific value and the broader is the view it gives of the nature of the product.

PRELIMINARY EXAMINATION.

Much valuable information may be obtained by a careful inspection of the samples under examination. The general appearance of fresh fruits, their size, color, and taste, are valuable in determining the quality. In the case of jellies and other fruit products preserved in glass this examination is of great importance. The label should be preserved and the general appearance, taste, odor, color, and consistency should be carefully noted, as they are valuable indications of the quality of the goods. The capacity of the receptacle should be noted by either measuring its volume or weighing the contents. In jellies containing starch there is a turbidity and often appreciable amounts of insoluble material, while in its absence the solution is perfectly clear. By this inspection low-grade fruits may be detected in jams, and an examination of the seeds may show the presence of foreign fruits. In the case of products put up in tins, any bulging of the can or escape of gas on opening, showing incomplete sterilization, should be carefully noted. The interior of the can will often show blackening or corrosion due to the attack of the metal by the fruit juices. This is especially true of goods that have undergone some fermentation or decomposition in the can.

PREPARATION OF SAMPLES.

FRESH FRUITS.

Pulp the whole, well cleaned, edible portion of the fruit in a large mortar, or by means of a food chopper, and mix thoroughly. With small fruits the entire fruit is employed, no effort being made to separate the seeds; with the apple, pear, and like fruits, the core is first removed, while with stone fruits the pits are separated. If desired the percentage of nonedible material may be determined in a weighed portion. Samples must be kept in well-stoppered bottles and in a cool place. Owing to the fact that fermentation begins in a very short time it is necessary to make the determinations of total and volatile acidity and sugars and the polarizations at once. Portions for polarizations and reducing sugars may be weighed and an excess of lead subacetate added. The samples may then be kept several days without danger of undergoing fermentation. The remainder of the sample may be preserved with about one-half cubic centimeter of formalin without danger of affecting the other determinations. It must be remembered that the sample so preserved can not be used for the determination of reducing sugars.

JUICES AND JELLIES.

Prepare the juices by pressing in a jelly bag a portion of the pulped fruit described under fresh fruits. Unless a clear liquid is obtained either filter through a muslin filter or decant the clear portion after allowing the liquid to settle for about an hour. Juices should be separated as completely as possible from the pulp in order to obtain a fair sample, as it is known that the first and the last pressings vary materially in composition. Colby,[a] of the California Experiment Station, finds it advantageous in case of such fruits as apricots and prunes, which are difficult to press in the fresh state, to warm them sufficiently to soften, but not to drive off any water. After this treatment the juice is much more easily separated. He considers the determination of the relative amounts of juice and pressed pulp of value in comparing the juiciness of such fruits as oranges, lemons, etc., and that the determination may to some extent serve as a guide for canners. By pressed pulp is meant the material left after drawing off the juice, consisting largely of fiber and water, some of the ash, and most of the insoluble nitrogen compounds.

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[a] Communication by letter.

In the case of jellies, thoroughly mix to insure uniformity in sampling. Place 60 grams in a 300 cc flask, dissolve in water by means of frequent shaking, make up to the mark with water, and use aliquot portions for the various determinations. With jellies that contain starch or other insoluble material thoroughly mix before taking aliquot portions for the various determinations.

JAMS, MARMALADES, PRESERVES, AND CANNED FRUITS.

Thoroughly pulp the entire contents of the jar or can as directed under fresh fruits. With this class of fruit products no effort need be made to remove any of the nonedible portions except the pits. Pears and similar fruits if put up as whole fruit are prepared for analysis without the removal of the cores.

In the examination of canned fruits it is often sufficient, when the analysis is for the sole purpose of detecting adulterants, merely to examine the sirups in which the fruits are preserved, as the sirup will contain the added ingredients, such as glucose and preservatives. In some products, however, such as Maraschino cherries, the fruit itself is colored with a coal-tar dye which is insoluble in the sirup, and it is necessary to pulp these in order to extract the color for identification. In such a case the liquor may be separated and the relative amounts of liquid and solid portions determined, as this may be of value in showing the presence of an excessive amount of water. The examination of the sirup need not be as complete as when the whole fruit is taken.

The price of the goods, as a rule, depends largely on the amount of sugar in the sirup.

DETERMINATION OF TOTAL SOLIDS.[a]

The determination of total solids was the subject of considerable work before the method of drying at 100° C. was finally adopted. The drying of the samples in vacuo was not considered practicable, as few laboratories are equipped to use this method, and the large bulk of work also prohibited it. There can be no doubt, however, that this is the most accurate method with samples containing large amounts of invert

[a] McGill's Water Oven.—A. McGill has devised a forced-draft water oven for drying at temperatures between 60° and 90° C. The oven is heated by means of ordinary gas burners, and the temperature is controlled by introducing at the bottom of the oven a blast of air from a blower that is run by a small water motor. Before discharging into the oven the air tube (which is about 1 inch in diameter) enters the water chamber and is coiled a number of times in order to sufficiently warm the air before it enters the oven. The exit end of the air tube is covered with a concavo-convex disk in order to distribute the blast and to prevent harmful currents. By regulating the burners and the flow of air a fairly constant temperature can be obtained. The bottom of the oven is curved instead of flat, to prevent bumping when the water is boiling, and a perforated plate serves as a false bottom.

sugar, as it has been shown[a] that levulose is dehydrated at 100° C. Of the other two methods employed the one depending upon the calculation of solids from the specific gravity of the 20 per cent solution gives results more nearly concordant with drying in vacuo than by drying at 100° C., the results being from 1 to 1.50 per cent higher than those obtained with the latter method. With pure jellies the specific gravity method gives very satisfactory results, but with glucose products containing large amounts of dextrin and with jellies containing soluble starch this method is not so reliable. For the purpose of obtaining comparative results with all classes of fruits and fruit products and with the different grades of goods the method of drying at 100° C. for from twenty to twenty-four hours is considered satisfactory. The method is an empirical one and all details must be followed closely in order to obtain comparative results. When neither sand nor asbestos was used as an absorbent the results were unsatisfactory and from 2 to 3 per cent too high.

IN JUICES AND JELLIES.[b]

By direct determination.—Measure 25 cc of a 20 per cent solution of jelly, or weigh 25 grams of juice into a large flat-bottomed dish which contains about 4 or 5 grams of freshly ignited asbestos to absorb it; dry for from twenty to twenty-four hours[c] in a water-jacketed oven. If care is taken, measuring will be found to be as accurate as weighing, but the pipette must be graduated to deliver 25 cc of a 20 per cent sugar solution. In the case of jellies that contain starch or other insoluble matter solids may be determined as directed under fresh fruits, jams, marmalades, etc.

By calculation from specific gravity.—Determine the specific gravity of the solution of jelly, or of the juice, by means of a Westphal balance, pycnometer, or specific-gravity spindle, and calculate the solids from the table given in bulletin 65.

IN FRESH FRUITS, JAMS, MARMALADES, PRESERVES, AND CANNED FRUITS.

Place a weighed quantity of about 20 grams of pulped fresh fruit, or such an amount of fruit product as will give not more than 3 or 4 grams of dried material, in a large flat-bottomed dish containing from 4 to 5 grams of ignited asbestos; add a few cubic centimeters of water, mix thoroughly, and dry as under "Direct determination" in "Juices and jellies."

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[a] Carr and Sanborn, U. S. Dept. of Agric., Div. of Chem. Bull. 47, p. 134.

[b] McGill by letter recommends the use of the Macfarlane tube described in the Analyst, 1893, **18**, 73, for the determination of total solids in substances containing large amounts of sugar.

[c] Wiley, Principles and Practice of Agricultural Analysis, vol. 3, p. 579, recommends drying first at a low temperature and completing the operation at 100° C. or a little higher.

DETERMINATION OF INSOLUBLE SOLIDS.

KREMLA'S METHOD.[a]

Fifty grams of the sample are weighed, transferred to a mortar, and thoroughly triturated. The mass in then transferred to a muslin filter and washed with warm water, care being taken at each addition of water to stir the pulp thoroughly. Collect the filtrate in a 500 cc flask, cool, and make up to volume. Usually this amount is sufficient to completely remove all soluble material; in some cases, however, it may be necessary to increase the washings to 1,000 cc. The insoluble residue is transferred to a tared dish, the excess of water is evaporated, and the residue dried in a water oven at 100° C. for four hours before weighing. The filtrate may be slightly turbid, showing that some of the insoluble matter has passed through the filter, but this amount will be inappreciable. Kremla used cold water and coarse filter paper, and the method has been modified in this work in these respects.

GERMAN OFFICAL METHOD.[b]

Transfer a weighed portion of the fruit product to a graduated flask, add water, shake thoroughly, and make up to volume.[c] Allow this to settle and either filter or decant off the supernatant liquid. Take an aliquot portion for the determination of soluble solids. Total solids less the soluble solids equals the insoluble solids.

This method may be employed to advantage with such fruits as cherries and small fruits, with which even the filtration through muslin is made with difficulty, but care must be taken that the fruit is thoroughly macerated to insure complete solution of the soluble matter.

DETERMINATION OF ASH.

Evaporate to dryness in a large platinum dish, 50 cc of a 20 per cent solution of jelly (see p. 11, under Juices and jellies), 25 grams of juice or fresh fruit, or 10 grams of jam, marmalade, preserve, or canned fruit; then thoroughly char at as low a heat as possible, extract with water, filter, and wash. Return the filter paper and insoluble material to the dish and thoroughly ignite; add the soluble portion and evaporate the whole to dryness after adding a few cubic centimeters of a solution of ammonium carbonate; then heat for a moment to very low redness; cool in a desiccator and weigh. The weighing must be made as quickly as possible, as the ash absorbs moisture very rapidly.

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[a] Ztschr. Nahr. Hyg. Waar., 1892, **6**, 483.

[b] Ver. Nahr. u. Genussm. f. Deutsche Reich., **2**, 105.

[c] McGill by letter recommends the use of a mechanical shaker to obtain complete solution of the soluble materâl.

EXAMINATION OF ASH.

ALKALINITY.

Into the platinum dish containing the ash run an excess of fifth-normal nitric acid and add a few drops of methyl orange. Carefully rub up the ash with a rubber-tipped stirring rod and titrate the excess of acid with decinormal potassium hydroxid. Calculate the alkalinity as per cent of potassium carbonate in the original substance. One cubic centimeter of decinormal acid equals 0.00691 gram of potassium carbonate.

SULPHATES AND CHLORIDS.

Wash the ash into a 50 cc flask and make up to the mark with water. In 25 cc of this solution determine the sulphates by precipitation with barium chlorid. The weight of barium sulphate times 0.7478 gives the weight of sulphates calculated as potassium sulphate.

In the other portion of the solution determine the chlorids by the Volhard[a] method for chlorin. The nitric acid added before making the titration will, if it contain enough nitrous oxid, completely destroy the red color of the methyl orange and leave a clear solution for the titration. Calculate the chlorin as sodium chlorid.

The determination of sulphates and chlorids in the amount of material above named is possible only with fruit products containing glucose. The ash from this amount of pure fruit juice or pure fruit products will contain only traces of sulphates and chlorids, while that from glucose products will contain determinable amounts of either sulphates or chlorids or both, depending upon the processes of manufacture of the glucose. If a complete ash analysis is to be made, the directions given in the official methods[b] may be followed.

DETERMINATION OF TOTAL ACIDS.

Ten grams of the juice, fresh fruit, or fruit product, or 25 cc. of the solution of jelly are diluted with boiling distilled water to about 250 cc. In the case of fruit pulp it takes some time to dissolve all the acidity from the fruit cells, and it is well to boil for a minute or so in order to aid the solution. A smaller volume may be employed if the product is not highly colored. Add phenolphthalein and titrate the acid with decinormal potassium hydroxid. Frequently with highly colored products it is impossible to determine with accuracy the end reaction in case phenolphthalein is used. In such cases delicate litmus paper may be used to advantage, but the product must not be highly

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[a] Ann. der Chem., 1877, **190**, 1; Sutton's Volumetric Analysis, 8th edition, p. 155.

[b] U. S. Dept. of Agr., Div. of Chem. Bul. 46, revised, p. 77.

diluted. Calculate the results as sulphuric acid (H_2SO_4). One cubic centimeter of decinormal potassium hydroxid equals 0.0049 gram of sulphuric acid.

Sulphuric acid was adopted as the term for the expression of acidity of fruit products because of its convenience in allowing comparison. If a single organic acid were the common and dominant acid of all the fruits that acid would serve the purpose better than the one chosen. But such is not the case. Citric, tartaric, and malic acids are each dominant in certain fruits, and the acidity of at least a large number of the fruits is due to mixtures of two or more of the organic acids. Besides, a part of the acidity may be due to the presence of acid salts, so that an attempt to express the total acidity in terms of a single organic acid characteristic of the fruit would meet with obvious difficulties. Sulphuric acid has already been suggested and adopted by a number of laboratories for similar work, and it is accepted here as offering the most satisfactory basis for the expression of acidity in fruits and fruit products.

DETERMINATION OF VOLATILE ACIDS.

The determination of volatile acids in fruit products may be desirable in cases where fermentation or the use of decayed fruit is suspected. Dissolve 25 grams of substance in water, dilute to 50 cc and distil in a current of steam until about 200 cc have passed over. Titrate the distillate with decinormal potassium hydroxid and express the results as acetic acid. Each cubic centimeter of decinormal alkali is equivalent to 0.0060 gram of acetic acid.

It should not require more than a few tenths of a cubic centimeter of decinormal alkali to neutralize the volatile acid obtained from this amount of fresh fruit.

DETERMINATION OF FREE MINERAL ACIDS.

A. S. Mitchell[a] has called attention to the presence of free sulphuric and phosphoric acids in jellies, added to gelatinize the skins, cores, and other waste material of the fruit. Phosphoric acid was found in several jellies (see Table 31), one of which (659) had an acid ash and another (660) an ash that was practically neutral.

Sulphuric acid may be estimated by the Hehner method used in determining free mineral acids in vinegar. To a weighed quantity of the jelly add an excess of decinormal alkali, evaporate to dryness, ash, and titrate the ash with decinormal acid. The difference between the number of cubic centimeters of alkali added in the first place and the number of cubic centimeters of acid needed to titrate the ash represents the equivalent of the amount of free mineral acid present. Phosphoric acid can be estimated in the ash.

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[a] Communication by letter.

DETERMINATION OF TARTARIC, CITRIC, AND MALIC ACIDS.[a]

Use the filtrate from the alcohol precipitate in the determination of the organic acids. After evaporating the alcohol and taking up the acids with water, add lead subacetate until the solution is alkaline, then filter and wash the precipitate until only a slight amount of lead remains in the washings. Wash the precipitate off the filter paper into a beaker with hot water, precipitate the lead with hydrogen sulphid and filter the lead sulphid while hot, washing with hot water. Evaporate the filtrate which contains the free organic acids to about 50 cc and neutralize exactly with potassium hydroxid, using phenolphthalein as indicator. Add an excess of strong solution of neutral calcium acetate with constant stirring, and allow to stand from six to twelve hours. Throw the precipitate of calcium tartrate on a filter paper and wash until filtrate and washings make exactly 100 cc; ignite the filter paper and precipitate, determine the lime by titration, and calculate the tartaric acid therefrom. A correction of 0.0286 gram of tartaric acid which is held in solution in the 100 cc of washings as calcium tartrate must be added. Evaporate the filtrate to about 20 cc, and if a precipitate of calcium citrate is formed filter it hot, wash with hot water, ignite, and titrate the lime. From this calculate the citric acid. Again evaporate the filtrate to about 20 cc and add 3 volumes of 96 per cent alcohol by volume, which will throw down the calcium salt of tartaric acid held in solution, the rest of the citrate, and the malate and succinate. Filter this, ignite, titrate, and after subtracting the tartaric acid present, calculate the rest as malic acid, since the amount of citric and succinic acid present is very small.

DETERMINATION OF TARTARIC ACID.[b]

To 100 cc of the fruit juice add 2 cc of glacial acetic acid, 2 or 3 drops of a 20 per cent solution of potassium acetate, and 15 grams of pure, finely powdered potassium chlorid. Dissolve this by shaking and then add 20 cc of 96 per cent alcohol. Stir vigorously for one minute, rubbing the walls of the beaker with the glass stirring rod to start the crystallization of the potassium bitartrate, and allow to stand for fifteen hours at room temperature. Filter and transfer the precipitate to a Gooch crucible with a thin asbestos felt and wash with a mixture of 15 grams of potassium chlorid 20 cc of alcohol and 100 cc of water, using the vacuum pump to aid filtration. The beaker is rinsed three times with a few cubic centimeters of this solution, and the precipitate is also washed with it, but in such a way that not more than 20 cc in all of the wash solution are used. The precipitate and asbestos filter are washed into the beaker with water and heated to boiling.

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[a] A modification of Schmidt and Hiepe's method. U. S. Dept. of Agric., Div. of Chem. Bul. 46, revised, p. 67. Ztsch. anal. Chem., 1882, **21**, 534–541.

[b] Halenke and Möslinger, Ztschr. anal. Chem., 1895, **34**, 283.

While still hot the solution is titrated with decinormal alkali, using phenolphthalein as indicator. To the number of cubic centimeters of alkali used must be added 1.5 cc for the potassium bitartrate remaining dissolved in the solution. One cubic centimeter of decinormal alkali equals 0.0150 gram of tartaric acid.

DETERMINATION OF CITRIC ACID.[a]

Fifty cc of the fruit solution are evaporated to sirupy consistency on the water bath. To this residue add 95 per cent alcohol until no further precipitation is formed, pouring very slowly at first and stirring constantly. From 70 cc to 80 cc are generally sufficient. Filter and wash the residue with alcohol of approximately 95 per cent. Evaporate the filtrate to eliminate alcohol, take up the residue with a little water, and transfer to a graduated cylinder, making up to 10 cc. To 5 cc of this solution add half a cubic centimeter of glacial acetic acid and then drop by drop a saturated solution of lead acetate. The presence of citric acid is shown by the appearance of a precipitate which disappears on heating and reappears on cooling. In order to separate the citric acid from other acids, heat to boiling, filter and wash with boiling water, then allow to cool, and the precipitate of lead citrate will reform. This lead precipitate may be filtered, washed with dilute alcohol, dried, weighed, and the citric acid calculated.

It is necessary that there shall be no tartaric acid present. If the tartaric acid has been estimated this error can be avoided by adding enough decinormal potash to exactly neutralize the amount of tartaric acid present before adding the alcohol.

DETERMINATION OF NITROGEN.

Use 5 grams of jelly or other fruit product or 10 grams of juice or fresh fruit for the determination of nitrogen according to either the Gunning or the Kjeldahl method. Express results as protein (nitrogen multiplied by 6.25).

DETERMINATION OF ALCOHOL.

Transfer 50 grams of the original material to an Erlenmeyer flask of from 250 to 300 cc capacity and increase the volume of the liquid to 150 cc. Attach to a vertical condenser by means of a bent tube and distill 100 cc. Determine the specific gravity of the distillate and calculate the percentage of alcohol from a suitable table.[b] Unless the specific gravity is taken at 15.6° the temperature correction may be made according to Table III, Bulletin 59, p. 95. Determinations should be made, however, at as nearly the standard temperature as practicable.

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[a] Möslinger, Ztschr. Unter. Nahr. u. Genuss. 1899, **2**, 93.

[b] U. S. Dept. of Agr., Div. of Chem. Bul. 59, p. 65.

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Where occasional determinations of alcohol are made it is found convenient to use an alembic saleron. This apparatus is made of copper and can be readily taken apart and placed in a small box. No rubber connections are necessary, so that the setting up requires only a few minutes.

POLARIZATION.

Dissolve half the normal weight of jelly or other fruit product, or the normal weight of juices or fresh fruits, in a sufficient quantity of water in a 100 cc sugar flask, add an excess of lead subacetate[a] (from 5 to 10 cc), make up to 100 cc, filter, and polarize in a 200 mm tube, observing the temperature of the solution. Invert 50 cc of this solution, using 5 cc of hydrochloric acid by heating to 68° in fifteen minutes. Polarize in a 220 mm tube at the same temperature as was employed in making the direct reading.

On account of the large amounts of invert sugar usually found in these products, it is necessary that the direct and invert readings should be made at the same temperature.

DETERMINATION OF CANE SUGAR.

BY CALCULATION FROM CLERGET'S FORMULA.

The cane-sugar results given in this bulletin were calculated from the direct and the invert readings according to Clerget's formula:

$$S=\frac{(a-b)\ 100}{144-\frac{t}{2}}$$

This method is as accurate as any for the examination of glucose goods. In the absence of glucose much greater accuracy may be secured by using a modified formula, which will correct for the change in optical power of the invert sugar present at the time of the direct polarization, caused by the addition of hydrochloric acid used in making the inversion. This formula, which is based on the effect of hydrochloric acid on solutions of invert sugar containing citric acid and on solutions containing no acid at all, is as follows:

$$S=\frac{[A-(B-.062B)]\ 100}{141.79-\frac{t}{2}}$$

S = cane sugar.
A = direct reading at t°.
B = invert reading at t°.
t = temperature.

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[a] Prepared by boiling for half an hour 430 grams of normal lead acetate, 130 grams of litharge, and 1,000 cc of water. The mixture is allowed to cool and settle, when the supernatant liquid is diluted to 1.25 specific gravity with recently boiled water.

This formula is that proposed by Tolman,[a] and is a modification of the Clerget-Herzfeld formula. The factor .062B is the increased reading to the left, due to the presence of 10 cc of hydrochloric acid (specific gravity 1.20) in 110 cc of invert sugar solution.

By the use of this formula it will be found that in the examinations of many fruits and fruit products the apparent change in polarization of a degree or two after inversion is not due to the presence of cane sugar, but to the change brought about by the addition of the acid used in inversion. It must be borne in mind that this formula is not applicable in the presence of glucose, but is of special value in the accurate determination of small amounts of cane sugar in fruits and fruit products.

Samples containing glucose may give results at least 1 per cent too high, which will give an invert reading too low, owing to the action of hydrochloric acid upon the maltose and dextrin. As will be seen by reference to the tables, many of the glucose products show small amounts of cane sugar (0.5 to 1.5 per cent), while, as a matter of fact, this is an error due to the cause stated.

BY COPPER REDUCTION.

When only a small amount of cane sugar is present, it is best determined by calculation from the increase in reducing sugars after inversion. For this purpose treat double the amount of fruit or fruit product named under "Reducing sugars" with lead subacetate, and after making up to volume and filtering, invert 50 cc in a 100 cc flask with 5 cc of hydrochloric acid. After inversion neutralize the acid with sodium hydroxid, precipitate the excess of lead with sodium sulphate, and dilute with water to 100 cc. Filter and dilute so that the solution does not contain more than 1 per cent of reducing sugar. The per cent of increase in reducing sugar after inversion multiplied by 0.95 equals the per cent of cane sugar.

DETERMINATION OF REDUCING SUGARS.

Treat 5 grams of jelly (25 cc of a 20 per cent solution may be employed) or other fruit product, or 25 grams of juice or fresh fruit, with lead subacetate in excess (2 to 5 cc); make up to 100 cc and filter. Transfer from 25 to 50 cc—depending upon the percentage of reducing sugar present—to a 100 cc flask and add a saturated solution of sodium sulphate in sufficient amount to precipitate the excess of lead; complete the volume to 100 cc and use the filtered solution for the determination of reducing sugars. The approximate amount of reducing

[a] Jour. Amer. Chem. Soc., 1902, 24, 515.

sugar present may be readily ascertained from the polarizations and from the per cent of solids. Use Allihn's method for the determination[a] and express results as dextrose, making the calculation from Allihn's tables.

Owing to the varied nature of the reducing sugars found in fruits and fruit products, and to the fact that no table has been constructed that will in all cases apply, it was thought best to express all results as dextrose, although it is well known that with pure invert sugar, as well as with glucose products, a material error will arise. In no case do we find that the reducing sugar is pure dextrose. With pure fruits and fruit juices the reducing sugars are made up of practically equal portions of dextrose and levulose. The same holds true with pure-fruit products, in which the invert sugar of the fruit is greatly increased by the inversion of the cane sugar by the organic acids present. With fruit products containing glucose, on the other hand, the problem is more complicated. Here is found not only invert sugar from the fruit used, but also dextrose and maltose, which are normal constituents of glucose sirups. If cane sugar were also used part may become inverted and thus add to the invert sugar. Since the reducing power of dextrose, levulose, and maltose vary widely, the expression of reducing sugars as dextrose in case of mixtures of the three sugars gives results far from the truth. The presence of cane sugar is also a disturbing factor, as it materially influences the power of reduction, depending upon the amount present. The quantity of invert sugar, where no other sugar is present, can be determined from reduced copper by reference to the table of Meissl and Wein.[b] Wein[c] has constructed tables from results obtained by Meissl for the calculation of reducing sugars in the presence of cane sugar from the amount of copper reduced, but these tables hold good only with pure fruits or pure-fruit products, and are not reliable when dealing with glucose products.

DETERMINATION OF DEXTRIN.

Dissolve 10 grams of the sample[d] in a 100 cc flask; add 20 mg of potassium fluorid and then about one-quarter of a cake of compressed yeast.[e] Allow the fermentation to proceed below 25° C. for two or three hours to prevent excessive foaming, and then place in an incubator at a temperature of from 27° to 30° C. for five days. At the end of that

[a] U. S. Dept. of Agr., Div. of Chem. Bul. 46, revised, p. 35.

[b] Wiley, Principles and Practice of Agricultural Analysis, Vol. III, pp. 159–160.

[c] Tabellen zur Quantitativen Bestimmung der Zuckerarten.

[d] In the case of jellies 50 cc of a 20 per cent solution prepared as directed (p. 11) may be used.

[e] Bigelow and McElroy, Jour. Am. Chem. Soc., 1893, **15**, 668.

time clarify with lead subacetate and alumina cream,[a] make up to 100 cc, filter, and polarize in a 200 mm tube. A pure fruit jelly will show a rotation of not more than a few tenths of a degree either to the right or to the left. If a Schmidt and Haensch polariscope be used and a 10 per cent solution is polarized in a 200 mm tube, the number of degrees read on the sugar scale of the instrument multiplied by 0.8755 will give the percentage of dextrin; or the following formula may be used:

$$\text{Percentage of dextrin} = \frac{C \times 1{,}000 \times V}{198 \times L \times W}$$

in which—

C = degrees of circular rotation.
V = volume in cubic centimeters of solution polarized.
L = length of tube in centimeters.
W = weight of sample in solution in grams.

DETERMINATION OF ALCOHOL PRECIPITATE.

Evaporate to 20 cc 100 cc of a 20 per cent solution of jelly, or 200 cc of the washings from the determination of insoluble solids; then add slowly and with constant stirring 200 cc of 95 per cent alcohol by volume, and allow the mixture to stand overnight. Filter and wash with 80 per cent alcohol by volume. Wash this precipitate off the filter paper with hot water into a platinum dish; evaporate to dryness; dry at 100° C. for several hours and weigh; then burn the organic matter and weigh the residue as ash, after treating with ammonium carbonate as directed under determinations of ash (p. 13). The loss in weight upon ignition is called alcohol precipitate.

The ash should be largely lime, and not more than 5 per cent of the total weight of the alcohol precipitate. If it is larger than this it is due to the presence of salts of the organic acids. Titrate the water-soluble portion of this ash with decinormal acid, as any potassium bitartrate precipitated by the alcohol can thus be estimated.

The general appearance of the alcohol precipitate of fruit products is one of the best indications as to the presence of glucose. Upon the addition of alcohol to a pure fruit product a flocculent precipitate is formed with no turbidity, while in the presence of glucose a white turbidity appears at once upon adding the alcohol, and a thick, gummy precipitate forms. In fresh fruit juices there is often a marked turbidity, closely resembling the precipitate given by glucose, which is caused by the starchy matters present.

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[a] Wiley, Principles and Practice of Agricultural Analysis, Vol. III, p .100, gives the following method for preparation of alumina cream: A solution of alum is treated with ammonium hydroxid and the precipitate washed until it is freed from ammonia. The hydroxid is then suspended in water in proportions necessary to produce a creamy liquid.

DETERMINATION OF TANNIN AND COLORING MATTER.

Tannin and coloring matter are estimated in fruits and fruit products by the permanganate or Neubauer-Loewenthal method, as used in wine analysis.[a] The following reagents are used:

(1) A solution of potassium permanganate containing about 1⅓ grams of the salt to the liter.

(2) A decinormal oxalic acid solution for determining the strength of the permanganate solution; 1 cc equals 0.004157 gram of tannin.

(3) An indigo-carmin solution to be used as an indicator and containing 6 grams of indigo carmin (this must be pure and free from indigo blue) and 50 cc of sulphuric acid to the liter. Sodium sulphindigotate may be used instead of indigo carmin. Dissolve 6 grams of the salt in 500 cc of water by aid of heat, cool, add 50 cc of sulphuric acid, make up the solution to 1 liter, and filter.

(4) Pure boneblack which has been treated with hydrochloric acid and washed with water until free from acid. This is kept covered with water.

The method of procedure is as follows:

A large porcelain evaporating dish is used for the titration. About 750 cc of water are placed in it and from 25 to 50 cc of fruit juice added, then 20 cc of the indigo solution, and the whole is well mixed. The permanganate solution is then run in very slowly, with constant stirring, and at the last added only a drop or two at a time, allowing the reaction considerable time. The end point is the golden yellow. To another portion boneblack is added and allowed to stand fifteen minutes. It is then filtered and carefully washed with water. This filtrate is treated in the same manner as the original portion, and the difference between the number of cubic centimeters of permanganate used the first time and that used the second time is the amount used in the oxidation of the tannin and coloring matter.

DETECTION OF PRESERVATIVES.

Dissolve about 25 grams of the sample in water, acidify with dilute sulphuric acid (1 to 3), and extract with ether. Remove the ether layer and allow to evaporate spontaneously. Take up the residue, which may contain salicylic acid, benzoic acid, and saccharin, with a few cubic centimeters of water, and apply the tests given below for these substances. If it is desired to make tests for other preservatives, consult Bulletin 65.

SALICYLIC ACID.

To a few drops of the extract add 1 or 2 drops of a 0.5 per cent solution of ferric chlorid. A purple coloration indicates the presence of salicylic acid.

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[a] Wiley, Principles and Practice of Agricultural Analysis, Vol. III, p. 593; U. S. Department of Agr., Bureau of Chem. Bul. 65, p. 86.

BENZOIC ACID.

Mohler's test.—Treat a second portion of the extract with 2 to 3 cc of strong sulphuric acid, and heat until white fumes appear. By this means benzoic acid is converted into sulphobenzoic acid. Add a few crystals of potassium nitrate, and continue the heating, with repeated additions of potassium nitrate until the solution is colorless or of a very light yellow color. This causes the formation of metadinitrobenzoic acid. When cool dilute with about 5 cc of water, neutralize with ammonia, and transfer to a test tube. Filter if not clear or if crystals of ammonium or potassium sulphate separate. Add to the filtrate a few drops of ammonium sulphid, care being taken that it does not mix but forms a layer on the top. The nitro compound becomes converted into the ammonium metadiamidobenzoate, which possesses a bright cherry-red color. The reaction takes place in a few seconds, and is readily seen at the plane of contact of the two liquids. This reaction is also given by saccharin, but benzoic acid may readily be separated from saccharin by distillation and the test applied to the extract from the distillate.

SACCHARIN.

Saccharin is indicated by the sweet taste of the ether extract. To confirm this test, add to the remaining portion of the extract 1 or 2 grams of sodium hydroxid, and heat in an oil bath at a temperature of 250° C. for from twenty to thirty minutes. The saccharin is converted into "Salicylic acid." After cooling, dissolve in water, acidify with dilute sulphuric acid, extract with ether, and test for salicylic acid as described under salicylic acid. If salicylic acid is present in the original material this test, of course, can not be applied, but reliance must in that case be placed in the sweet taste of the extract.

DETECTION OF FOREIGN COLORING MATTER.

The complete examination of dyes is too large a subject to take up here, and one will have to refer to such works as Schultz and Julius on Organic Coloring, Allen's Commercial Organic Analysis, and others that go into the subject in an exhaustive manner. The determination of the general nature of the dye can be made by the use of Rota's[a] scheme, which is the simplest of the many different methods proposed and is quite satisfactory, although it requires a great deal of care and experience.

The detection of the color in a fruit product and its identification are rather difficult, since the color must be separated in a somewhat pure condition and then tested. Almost all the methods for separating

[a] Chem. Ztg., 1898, **22**, pp. 437–442; Analyst, 1899, **24**, p. 41; U. S. Dept. of Agric., Bureau of Chem. Bul. 65, p. 114.

added color from the fruit will take up some of the natural color of the food as well.

As will be seen in Tables I and II, amyl alcohol extracts the coloring matter from many fruits, and these extracts may easily be mistaken for added colors.

Some of the highly colored fruit juices will dye wool, and the color will be permanent, but these will not be mistaken for coal-tar dyes if the double dyeing method is followed.

Mixtures of two or more dyes are often added to foods. This can sometimes be shown by a system of fractional dyeing where the dyes are taken up at different rates by the fabric. In examining mixtures of red, orange, and blue dyes, which are widely sold for coloring wine, the writers found that the woolen cloth took up the red much faster than the orange, and the blue was slowest; so that the first piece of cloth dyed was red, the second a lighter shade, the third greenish, and the fourth bluish.

In the examination of the coloring matter for the heavy metals, tin, lead, copper, and zinc will be found in the ash, and tests can be made for them by the methods used for heavy metals.

DETECTION OF COAL-TAR COLORING MATTERS BY DYEING WOOL.

Method of Sostegni and Carpentieri.[a]—From 10 to 20 grams of the sample are dissolved in 100 cc of water, filtered if necessary, acidified with from 2 to 4 cc of a 10 per cent solution of hydrochloric acid, and a piece of woolen cloth which has been washed in a very dilute solution of boiling potassium hydroxid and then washed in water, immersed in it, and boiled for five to ten minutes. The cloth is removed, thoroughly washed in water, and boiled with very dilute hydrochloric acid solution. After washing out the acid the color is dissolved in a solution of ammonium hydroxid (1 to 50). With some of the dyes solution takes place quite readily, while with others it is necessary to boil some time. The wool is taken out, a slight excess of hydrochloric acid is added to the solution, another piece of wool is immersed and again boiled. With vegetable coloring matter this second dyeing gives practically no color, and there is no danger of mistaking a fruit color for one of coal-tar origin. It is absolutely necessary that the second dyeing should be made, as some of the coal-tar dyes will dye a dirty orange in the first acid bath which might be easily passed for vegetable color, but on treatment in alkaline bath and second acid bath becomes a bright pink.

Arata's method.[b]—This method gives results comparable with those

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[a] Ztschr. anal. Chem., 1896, **35**, 397; U. S. Dept. Agric., Div. Chem. Bul. 46, revised, p. 68.

[b] Ztschr. anal. Chem., 1889, **28**, 639.

of the first dyeing of the preceding method. It was recommended for detecting coal-tar colors in wine, and has been modified by A. L. Winton.[a]

From 20 to 30 grams of the sample dissolved in 100 cc of water are boiled for ten minutes with 10 cc of a 10 per cent solution of potassium bisulphate and a piece of white wool or woolen cloth which has been previously heated to boiling in a very dilute solution of sodium hydroxid and thoroughly washed with water. After removal from the solution the wool is washed with boiling water and dried between filter papers. If the coloring matters are entirely from the fruit the wool will be either uncolored or will take on a faint pink or brown, which is changed to green or yellow by ammonia and not restored by washing.

In addition to this it is advisable in all cases to dissolve the coloring matter with ammonia as in the first method and dye again, since Arata's method gives practically the same results as the first dyeing in hydrochloric acid bath, and needs to be substantiated by the second dyeing.

Another advantage in the second dyeing is that if a large piece of woolen cloth is used in the first dyeing and a small piece in the second dyeing small amounts of coloring matter can be brought out much more decidedly in the second dyeing where practically all of the vegetable coloring matter has been excluded. The coloring matter can be identified to a certain extent by the schemes of Witt,[b] Allen,[c] Weingartner,[d] Dommergue,[e] Girard and Dupré,[f] and Rota.[g] The tests can be made directly on the dyed fabric or the dye can be dissolved out.[h] To remove the color wash the wool with dilute tartaric acid and then with water and dry between filter paper. Saturate the wool with strong sulphuric acid and press out the color with a glass rod after from five to ten minutes and dilute to 10 cc with water.

Remove the wool, make solution alkaline with ammonia, and when cold extract with from 5 to 10 cc of amyl alcohol. Separate the amyl alcohol, evaporate it to dryness, and test the residue. Treat this residue with strong sulphuric acid.

Ponceau R, 2R, 3R, S, and 3S give yellow red to carmine red.

Ponceau S and tropaeolin O give yellow to orange yellow.

Biebrich scarlet gives a green; Bordeaux red and crocein scarlet give blue; tropaeolin OOO and solid red give violet.

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[a] Conn. Exp. Sta. Rept., 1899, Pt. II, p. 131.

[b] Ztschr. anal. Chem., 1887, **26**, 100.

[c] Com. Org. Anal., Vol. III, pt. 1, pp. 399–420.

[d] Ztschr. anal. Chem., 1888, **27**, 232–249.

[e] Ibid., 1890, **29**, 369–377.

[f] Analyse des Matières Alimentaires, etc., 583–593.

[g] Analyst, 1899, **24**, 41.

[h] Ztschr. anal. Chem., 1889, **28**, 639; Bor[illegible]n, Anal. des Weines, p. 91; Winton, Conn. Expt. Sta. Rept., 1899, Pt. II, p. 131.

If the wool is well dyed most of these colors may be obtained on the fabric.

This gives only the reactions of a few of the more common colors. In order to carry the work farther the more complete works referred to will have to be used.

DETECTION OF COAL-TAR COLORS BY EXTRACTION WITH SOLVENTS.

In the Paris municipal laboratory[a] the following scheme of extraction of coal-tar color is used:

The acid colors, sulpho-fuchsin, azo derivatives, and phthaleins are not precipitated by tannin and are insoluble or only slightly soluble in acetic ether or amyl alcohol.

The basic colors (fuchsin, safranin, etc.) are precipitated by tannin and readily soluble in acetic ether or amyl alcohol.

I. To 50 cc of wine add ammonium hydroxid in slightest excess; then add 15 cc of amyl alcohol, shake, and allow to stand.

1. If the alcohol be colored red or violet, decant, wash, filter, evaporate to dryness in presence of a piece of wool, and test the dyed wool with sulphuric acid.

2. If the alcohol be not colored, separate, and add acetic acid. If the alcohol becomes colored the presence of basic aniline color is indicated.

3. If the amyl alcohol is uncolored, both before and after the addition of acetic acid, no basic coal-tar color is present.

II. Add an excess of calcined magnesia and then a 20 per cent solution of mercuric acetate and bring to a boil. A coloration before or after addition of acetic acid indicates the presence of coal-tar dyes, particularly acid dyes.

III. Extract with acetic ether the solution made alkaline by barium hydroxid. This dissolves basic colors.

In any case the colors must be fixed on wool, as many of the fruit colors are extracted and will give reactions with sulphuric acid, which may be mistaken for coal-tar colors.

The extraction of fruit colors is shown in Table 1, prepared by Truchon and Martin-Claude,[b] and Table 2, prepared by the writers. The fresh fruit juice was very slightly acidified by hydrochloric acid before extraction. In no case in the dyeing test was there any danger of mistaking the vegetable color for one of coal-tar origin where the double dyeing method was used.

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[a] Girard and Dupré, Analyse des Matières Alimentaires, etc., p. 167.

[b] Journ. pharm. chim., 1901, **13**, 174.

TABLE 1.—*Coloring matter of fruits.*

Fruit.	Coloration of acid solution.[a] Juice.	Coloration of acid solution.[a] Amyl-alcohol extract.	Coloration of ammoniacal solution. Juice.	Coloration of ammoniacal solution. Amyl-alcohol extract.	Addition of a drop of H_2SO_4 to dyed fabric.
Early cherries	Red	Yellow	Green	Uncolored	Yellow.
Ripe cherries	Red	Uncolored	Green	Uncolored	Yellow.
Early strawberries	Red	Rose	Green	Uncolored	Rose.
Ripe strawberries	Red	Red	Green	Uncolored	Rose (tints silk a rose red.)
Raspberries	Red	Red	Green	Uncolored	
Red currants	Red	Uncolored	Green	Uncolored	
White currants	White	Uncolored	Brown	Uncolored	
Black currants	Dark red	Red	Deep green	Uncolored	Tints silk rose.
Peaches	Yellow	Uncolored	Brown	Yellow red	Uncolored.
Pears	Yellow	Uncolored	Brown	Yellow red	
Quinces	Yellow	Uncolored	Brown	Yellow red	
Apples	Yellow	Uncolored	Brown	Yellow red	
Apricots	Yellow	Uncolored	Brown	Yellow red	
Green gage plums	Yellow	Uncolored	Brown	Yellow red	

[a] Acidity of the juice.

TABLE 2.—*Coloring matter of fruits.*

Fruit.	Color with NH_4OH.	Ether extract from acid solution.	Amyl-alcohol extract from acid solution.	Dyeing tests on the juice.
Strawberry	Purple	None	Deep red	Color washed out.
Red raspberry	Purple	None	Deep red	All color does not wash out, but does not dye in the second acid bath.
Blackberry	Blue-purple	None	Very deep red.	Dyes purplish red in acid solution, but does not dye in the second acid bath.
Cherry	Purple	None	Red	Dyes purplish red in acid solution, but does not dye in the second acid bath.
Blackberry	Blue-purple	None	Red	Dyes purplish red in acid solution, but does not dye in the second acid bath.
Wild dewberry	Blue-purple	None	Red	Dyes purplish red in acid solution, but does not dye in the second acid bath.
Currant	Blue-purple	None	Red	Dyes purplish red in acid solution, but does not dye in the second acid bath.

It will be seen from these two tables that amyl alcohol, as a rule, extracts fruit coloring matter from acid solution, while ether does not. Neither amyl alcohol nor ether extracted any color from alkaline solution of the fruit juices.

DETECTION OF ACID MAGENTA.[a]

Add to 100 cc of the solution to be tested 2 cc of potassium hydroxid (5 to 100); if this does not neutralize the acid, add enough to do it. Then add 4 cc of mercuric acetate (10 to 100), agitate, and filter. The filtrate should be colorless and slightly alkaline. Acidify with a slight excess of dilute sulphuric acid, and if the solution remains uncolored there is no acid magenta present. If it becomes a light violet red and there has been no other dye shown by the amyl-alcohol extracts, the presence of acid magenta is shown.

Acid magenta dyes wool a magenta red from acid solution.

Wool dyed with it is turned yellow by strong hydrochloric acid, decolorized by ammonium hydroxid, and regains its color when washed with water.

DETECTION OF COCHINEAL.

Cochineal is used to a certain extent as a coloring matter in foods, and a very satisfactory test for it is that given in Girard and Dupré.[b] Dissolve the food product in water, filtering if necessary. Acidulate with hydrochloric acid and extract with amyl alcohol, which becomes colored more or less yellow or orange, depending on the quantity of cochineal present. Separate the amyl alcohol and wash with water until neutral. Then separate into two portions; to the first add drop by drop a very dilute solution of uranium acetate, shaking thoroughly after each addition. In the presence of cochineal a characteristic emerald-green color is produced.

To the second portion add a drop or so of ammonia, and in presence of cochineal a violet coloration results. This, however, is not so sensitive to very small amounts as the first test, and many fruit colors give tests hardly to be distinguished.

Cochineal carmin is liable to contain tin, as it is often a tin lake, although alum is also used. It is also liable to adulteration with lead compounds.

DETECTION OF CARAMEL.

Amthor test.[c]—Place 10 cc of the solution to be tested into a high, narrow glass with perpendicular sides, as, for example, a small bottle; add from 30 to 50 cc of paraldehyde, depending on the intensity of the coloring, and enough absolute alcohol to make the solutions mix. In the presence of caramel a brownish-yellow to dark-brown precipitate will collect in the bottom of the glass. Decant the liquor, wash once with absolute alcohol, dissolve in a small amount of hot water, and filter. The color of this will give some idea as to the amount of caramel present.

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[a] Girard and Dupré, Analyse des Matières Alimentaires, etc., p. 169; Winton, Conn. Expt. Sta. Rept. 1899, Pt. II, 132.

[b] Analyse des Matières Alimentaires, etc., p. 580.

[c] Ztschr. anal. Chem. 1885, **24**, 30; Borgmann Anal. des Weines., p. 98.

It is not allowable to concentrate a solution by evaporation on a steam bath, as caramel may be formed; if it is necessary to concentrate, it must be done over sulphuric acid or at diminished pressure.

In order to further identify the color it is poured into a freshly prepared solution of phenylhydrazin (2 parts phenylhydrazin-hydrochlorid, 3 parts sodium acetate, and 20 parts of water). The presence of a considerable quantity of caramel gives a dark-brown precipitate in the cold, hastened by heating a little.

In the case of a very small amount it takes some hours for it to collect.

DETECTION OF GELATIN.

The presence of gelatin in jellies and jams is shown by a higher content of nitrogen. Precipitate a concentrated solution of jelly or jam with 10 volumes of absolute alcohol and determine nitrogen in dried precipitate by the Gunning method.[a]

E. Beckmann[b] recommends the following method for the determination of gelatin in jellies:

The jelly is treated with 95 per cent alcohol, the precipitate washed with alcohol to remove all sugar, and the alcohol finally removed by heating. The residue is taken up with water and the extract is neutralized with calcium carbonate and then treated with formalin. Upon evaporation to dryness the gelatin is rendered insoluble. With pure fruit jellies Beckmann found from 1 to 2 per cent of the precipitate insoluble, while with jellies to which gelatin had been added 70 to 86 per cent of the precipitate was found to be insoluble.

DETECTION OF AGAR AGAR.[c]

Boil the jelly with 5 per cent sulphuric acid, add a crystal of potassium permanganate, and allow to settle. If agar is present the sediment will be rich in diatomes, which can be detected by use of microscope.

Bömer gives the following analyses of two marmalades, one of which contained agar and the other gelatin, which show how the addition of these substances affects the different constants:

TABLE 3.—*Marmalade containing agar and gelatin.*

	Solids.	Insoluble solids.	Ash.	Protein.	Acid as malic.	Invert sugar.	Cane sugar.	Pectins.	Polarization.
With agar	67.78	1.39	0.84	0.85	1.26	39.32	19.60	2.93	+3.64
With gelatin	70.96	1.31	.74	1.94	1.23	43.92	17.86	2.52	+1.27

[a] A. Bömer, Chem. Ztg., 1895, **19**, 552.

[b] Forschungsberichte über Lebensmittel, 1896, **3**, 327; Chem. der Nahr. und Genussmittel, 1896, **11**, 378.

[c] G. Marpmann, Ztschr. angew. Mikrosk, 1896, **11**, 257.

The pectin precipitate had the following content of nitrogenous material:

	Pure marmalades.					With agar.	With gelatin.
	1.	2.	3.	4.	5.		
In per cent of substance	0.313	0.22	0.22	0.313	0.363	0.22	1.125
In per cent of pectins	28.2	17.6	20.7	13.3	16.5	7.6	44.6

DETECTION OF STARCH.

In the detection of starch it is first necessary to destroy the color of the fruit or fruit product. This is accomplished by bringing the solution of jelly or jam nearly to the boiling point, and after the addition of several cubic centimeters of dilute (1 to 3) sulphuric acid, adding potassium permanganate with constant stirring until the color disappears. By this treatment the starch remains unaffected, and the solution may be tested with iodin. If starch is found to be present it is well to examine the product microscopically in the case of jams and marmalades. If the starch is normally present in the fruit this point is easily decided by such an examination, as the starch grains may be readily detected within the cell walls after the treatment with iodin.

DETERMINATION OF HEAVY METALS.

Treat 100 grams of the preserve directly in a large porcelain evaporating dish with sufficient concentrated sulphuric acid to thoroughly carbonize the mass. If much water is present evaporate the material to a sirupy consistency before treating with the acid. From 10 to 15 cc of strong acid has been found sufficient to thoroughly carbonize the amount specified. Gently heat over a Bunsen burner until all danger of foaming is past, which will require not more than three minutes; then transfer the dish to a muffle furnace and keep it at a low red heat until all organic matter is destroyed. It is occasionally found necessary to add a few drops of nitric acid to completely destroy organic matter. When the material is completely ashed allow the dish to cool; add 25 cc of hydrochloric acid (1 to 8) and evaporate on a water bath to dryness; take up with water and acidify with two or three drops of hydrochloric acid. Transfer to a beaker without filtering and treat with hydrogen sulphid. After heating upon a water bath for a few minutes the precipitate and the insoluble residue are collected upon a filter. The precipitate and residue may contain sulphid of tin, lead, and copper, and oxid of tin; the filtrate will contain any zinc that is present. Fuse the sulphid precipitate and insoluble ash residue with about 3 grams of sodium hydroxid in a silver crucible for a half hour to render soluble any insoluble tin compounds. Dissolve the mass with hot water and slightly acidify with hydrochloric acid.

Again treat with hydrogen sulphid without filtering. By this treatment all the tin is thrown down as sulphid with the sulphids of copper and lead. Collect the precipitate upon a filter and wash thoroughly with hot water. The filtrate may be rejected. To separate the tin sulphid from those of copper and lead, wash several times upon the filter with separate portions of 10 cc of strong, boiling ammonium sulphid. Usually 50 cc of the ammonium sulphid will be found sufficient to completely dissolve all tin sulphid; but portions of the filtrate should be tested to make sure of this point. The filtrate is then made acid with hydrochloric acid to precipitate the tin sulphid, which, after standing for a few moments, is collected upon an ashless filter, ignited, and weighed as stannic oxid.

Treat the residue insoluble in ammonium sulphid with nitric acid, filter, wash, nearly neutralize with ammonia the excess of mineral acid, and add ammonium acetate, as there is usually a small amount of iron present. If any iron salt precipitates, filter, wash, and divide the filtrate for the determinations of copper and lead. In the absence of lead, copper may be determined electrolytically, or it may be titrated with potassium cyanid. Unless added as a coloring agent, copper will seldom be present in sufficient quantity to warrant its determination.

Precipitate lead with potassium chromate in an acetic acid solution, and weigh upon a tared filter as lead chromate.

Evaporate the filtrates from the hydrogen sulphid precipitate to about 60 cc; add bromin water to oxidize the iron salts and any remaining hydrogen sulphid. Boil off the excess of bromin and, unless the solution is distinctly yellow, add a few drops of concentrated solution of ferric chlorid to make it so. Nearly neutralize the mineral acid with ammonia, and add ammonium acetate to precipitate iron phosphate and excess of iron. Filter and thoroughly wash the precipitate. To the filtrate, made distinctly acid with acetic acid and boiled, add hydrogen sulphid to precipitate zinc. Unless the zinc sulphid comes down white it should be dissolved, again treated with ammonium acetate to remove traces of iron, and reprecipitated as sulphid. Finally collect the zinc sulphid upon an ashless filter, ignite, and weigh as zinc oxid.

ADDED SUBSTANCES.

GLUCOSE.

The substitution of glucose for the more expensive sugars is extensively practiced in the manufacture of various food materials, and in no class of foods is there better opportunity offered for this substitution than in fruit products. Of 214 samples of commercial fruit products examined, 110 samples contained glucose. The amount used varies widely. Many samples of the better classes of goods contained not more than from 10 to 15 per cent, while some of the cheapest jellies were made up almost entirely of glucose, and many of the jams and marmalades had only small proportions of fruit and apparently no cane sugar. While glucose may be considered as an article of food, and as such has no deleterious properties, its use in substitution for a more expensive sugar must be considered a fraud unless its presence is indicated in some way to the purchaser. If low-priced goods are purchased it is not expected that they will be made up of first-class materials, and the use of glucose is the most efficient means of producing a cheap article. At the same time all goods should be of the quality represented on the label. Many of the high-priced fruit products bought upon the market were found to contain glucose. While the amount of glucose used in the better grade of goods was usually small, there was nothing upon the label to indicate that any glucose had been used in their preparation.

Considering the importance of glucose in the interpretation of the results given in this bulletin, a brief account of methods of manufacture practiced in the United States is given. According to Saare[a] the raw product is always cornstarch. In the process of manufacture of sirups hydrochloric acid is used almost entirely as an inverting agent, but with sugars sulphuric acid may be used instead. The starch is mixed to a milk of about 22° to 23° Baumé and 0.75 part of concentrated hydrochloric acid per 100 parts of dry starch added. The mixture is then heated under from 2 to 2½ atmospheres pressure for a time sufficient to obtain the product desired. After inversion the material is drawn off into mixing tanks and the acid is nearly neutralized with sodium carbonate or a mixture of sodium and calcium carbonates. The salts obtained by neutralizing the above amount of acid would be about 0.25 to 0.30 per cent in the finished product. This thin sirup is filtered through presses and through charcoal, concentrated to about 30° Baumé, again filtered through charcoal, and finally concentrated to the desired consistency in vacuum pans. During the final concentration small amounts of acid sodium or calcium sulphite or sulphurous acid may be added to produce a light-colored product. The methods of procedure vary with the product to be obtained. Confectioner's glucose must give a decided starch reaction, and the percentage of reducing sugar must not be more than 48 per cent of the total solids indicated by the specific gravity. With brewer's glucose a high percentage of maltose is desirable; hence the dextrose will be low and the dextrin also high. Mixing glucose must give no starch reaction and the percentage of reducing sugars must be between 50 and 53 per cent of the

[a] Oscar Saare, Industrie der stärke, und der Stärke-fabrication in der Vereinigen Staaten vom Amerika und ihr Einfluss auf den englischen Markt.

solids indicated by specific gravity. In the manufacture of glucose sugars double the amount of acid used with the sirups is employed, and the inversion is continued until the dextrin reaction upon addition of alcohol is no longer shown. The sirups all have a high content of dextrin, and the reducing sugars present are variable mixtures of dextrose and maltose, the latter usually being in excess. The sugars have a low content of dextrin and maltose and a correspondingly high content of dextrose. The analysis, in this laboratory, of five representative samples of glucose sirups and sugars gave the following results:

TABLE 4.—*Composition of commercial glucose.*

Laboratory number.	Description.	Water.	Ash.	Reducing sugars as dextrose.	Polarizations. Direct.	Polarizations. Invert.	Polarizations. After fermentation 10 per cent solution.	Dextrose.	Maltose.	Dextrin.
		Per ct.	*Per ct.*	*Per ct.*	*Degrees.*	*Degrees.*	*Degrees.*	*Per ct.*	*Per ct.*	*Per ct.*
22009	Neutral glucose sirup	18.00	0.259	34.72	172.4	171.4	35.40	14.00	33.40	30.99
22010	XXX glucose	18.34	.459	36.40	167.6	167.6	30.30	14.53	38.24	26.53
22011	70 per cent sugar	18.56	.837	69.82	66.00	66.0	3.30	68.71	1.79	2.89
22012	80 per cent sugar	10.34	.796	79.84	73.8	73.8	4.20	79.28	.90	3.68
22013	Anhydrous glucose	6.18	.351	87.68	74.00	74.00	1.00	86.43	2.02	.88

In the above analyses the nonfermentable material is calculated as dextrin. This is not strictly correct, especially with the sirups, where small amounts of gallasin are also present. The two sirups are undoubtedly representative of the glucose sirups used with fruit products, although sirups having a much higher dextrin content may be used.

The composition of the ash of the above samples was as follows:

TABLE 5.—*Composition of the ash of glucose.*

Laboratory number.	Description.	Ash.	Chlorids. As per cent Cl.	Chlorids. As per cent NaCl.	Sulphates. As per cent SO_3.	Sulphates. As per cent K_2SO_4.	Lime. As per cent CaO.	Lime. As per cent $CaSO_4$.	Carbonates (soluble). As per cent Na_2CO_3.	Carbonates (soluble). As per cent K_2CO_3.
		Per ct.								
22009	Neutral glucose	0.259	0.0368	0.0607	0.0269	0.0585	0.0207	0.0506	0.0702	0.0915
22010	XXX glucose	.459	.0764	.1258	.0416	.0905	.0081	.0196	.1426	.1859
22011	70 per cent sugar	.837	.3962	.6528	.0654	.1422	.0669	.1624	.1008	.1314
22012	80 per cent sugar	.796	.2024	.3334	.0846	.1840	.0781	.1895	.1165	.1519
22013	Anhydrous dextrose	.351	.0575	.0948	.0468	.1018	.0273	.0663	.1265	.1650

The following analyses, made by J. S. C. Wells,[a] give the composition of the ash of a number of samples of American glucose:

TABLE 6.—*Composition of the ash of glucose.*

Mark.	Water.	Ash.	Sulphuric acid (SO_3).	Chlorin.	Ferric oxid.	Lime.	Magnesia.	Alkalies.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Glucose	11.50	0.325	0.202	0.055	0.020	0.012	0.027	0.097
Mixing sirup	17.15	.370	.177	.060	.015	.008	.023	.140
Glucose	12.18	.520	.039	.255	.030	.066	.005	.157
Mixing sirup	24.25	.890	.220	.155	.015	.014	.031	.380
Glucose	14.50	.420	.161	.065	.010	.014	.025	.150
Brewer's grape sugar	12.98	.380	.055	.010	.055	.029	.038	.070
Confectioner's grape sugar	10.00	.140	.091	.010	.025	.025	.007	.017
Cakes from centrifugal	4.20	.220	.139	.020	.035	.035	.023	.016
Anhydrous grape sugar	.53	.025	.009	.000	.006	.004	.004	.000
Mixed grape and cane sugar	1.75	.330	.029	.120	.025	.025	.004	.120
Grape sugar	13.25	.495	.230	.050	.100	.047	.004	.140
Do	11.55	.750	.395	.025	.030	.029	.004	.320
Glucose	23.10	.335	.094	.105	.010	.012	.009	.134
Grape sugar	16.50	.335	.159	.050	.055	.027	.004	.102
Maltose	22.26	1.060	.056	.125	.000	.021	.101	.337
Maize sirup	24.46	.815	.065	.120	.010	.008	.013	.374
Glucose	18.41	.335	.053	.025	.015	.080	.034	.012
Family sirup (mixed cane and grape)	21.17	1.535	.094	.205	.040	.226	.088	.340

PRESERVATIVES.

Preservatives find an extensive use with those classes of fruit products put up in glass and not hermetically sealed. With fruits put up in tin or in sealed glass jars the use of any preservative would be superfluous if the fruit and the receptacle were properly sterilized and the latter properly sealed at the time of canning. It would seem, too, that their use for the purpose of preserving jellies and jams subsequent to their preparation should not be necessary, as the high content of sugar present is sufficient to prevent any fermentation. This point is borne out in the home preparation of jellies, jams, and marmalades where no preserving agent is used, and yet the danger of the product spoiling is very slight. Furthermore, those products which were found to contain no preservatives showed keeping qualities in no way inferior to those that had been artificially preserved. While many manufacturers undoubtedly use preservatives to prevent spoiling subsequent to the preparation of the articles, others use them for the purpose of keeping the fruit until it is worked up into the finished product. The pulped fruit to be used for making jellies and jams is sometimes kept for several weeks after the addition of some sugar,

[a] Report on glucose to the Commissioner of Internal Revenue by The National Academy of Sciences.

but not sufficient to preserve it, before being worked up into the finished product. When this procedure is followed the use of some form of preservative is necessary. Canned fruits, on the other hand, are put up as fast as they are supplied to the factory, and hence need no artificial preservation.

Salicylic acid and benzoic acid or the sodium salts of these two acids are the preservatives most commonly employed with fruit products, and were found to be present in more than half of the jellies and jams examined, while the percentage of canned fruits found to be artificially preserved was comparatively small.

STARCH.

The presence of starch in fruit products may be attributed to one of two sources: It may have been added as such to jellies, and possibly jams and marmalades, in order to give them the proper consistency when converted by heat and moisture into paste, or it may have been normally present in the fruit used as a basis for the product. The ordinary means of detection afford no basis for determining to which source the starch found in jellies is due. With jams and marmalades from which portions of the fruit are still obtainable a microscopic examination will reveal whether the starch is normally present, as a larger part of the starch remains within the cell walls after the fruit has passed through the various stages of preparation. With jellies, however, if the amount of starch added has been small and the product has been thoroughly heated subsequent to its addition, or if the fruit from which the jelly was made contained starch, the starch, in the finished product, will be present in a soluble form. Only when an excessive amount has been added or when the boiling has not been sufficient to bring all the starch into solution can the addition be detected with certainty. Many jellies, of course, are made up purely artificially or with the use of only small amounts of fruit. In such cases the polarization and the per cent of dextrin present will reveal the character of the goods, and any appreciable amount of starch in such products may be considered as having been added.

Considerable amounts of starch are normally present in the apple, and probably some similar fruits, but the content gradually diminishes during ripening, and finally disappears in the thoroughly matured fruits. With the small fruits, on the other hand, starch is seldom found to be present in more than traces, even when these fruits are too green for use. As a result, pure apple jellies may contain considerable amounts of starch, while the pure jellies from the small fruits show no starch reaction. Not all pure apple jellies, however, contain starch, as the product may have been made subsequent to the complete conversion of the starch. The following table of analyses of the Baldwin apple, by C. A. Browne,[a] shows the changes that take place during the period of ripening:

TABLE 7.—*Composition of apples at various stages of maturity.*

Date.	Condition.	Solids.	Invert sugar.	Cane sugar.	Starch.	Acidity as per cent malic acid.	Ash.
1899.		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*		*Per cent.*
Aug. 7	Very green	18.47	6.40	1.63	4.14	1.14	0.27
Sept. 13	Green	20.19	6.46	4.05	3.67	....	....
Nov. 15	Ripe	19.64	7.70	6.81	.17	.65	.27
Dec. 15	Overripe	19.70	8.81	5.26	None.	.48	.28

Of particular importance is the rapid disappearance of starch as the period of ripening progresses. Many of the pure apple jellies examined showed no starch reaction whatever, showing that the starch had already been converted. Hence the absence of starch in any jelly can not be taken as evidence that apple was not used as a basis.

Owing to its excellent jellying property the apple is very extensively used as the basis with many fruits that alone will not produce a jelly of proper consistency. This addition is very difficult of detection when a sufficient amount of the particular fruit is used to give the proper flavor. Where the apple has been used with the small fruits the presence of a small amount of starch will be an indication although not a proof of its presence, since, as above stated, added starch can not be differentiated. The use of apple with the large fruits in making jelly is undoubtedly rather limited, but its use is frequent in connection with the small fruits.

Of the jellies examined a large number were found to contain starch. Many of these give only slight reactions, indicating that the starch was normally present in the fruit. In only a few cases was it apparent that starch had been added in making up the product, and these were the cheapest grade of goods found on the market.

COLORING MATTER.

The use of foreign coloring material in fruit products is very widespread for two reasons. One is that the color of the fruit is not very stable, and the processes of preserving are liable to dim or destroy it, and, furthermore, the color will not last in goods that are constantly exposed to the action of the light, as is the case with those placed on the store shelves. The other reason is that it enables the manufacturer to use fruit of deficient color and thus to conceal inferiority. The

[a] Pennsylvania Dept. of Agr. Bul. 58, p. 15.

preservation of this color is important, as the appearance of jellies and jams undoubtedly influences their real value, especially in the sick room, where they are used to a great extent, but the possibilities of deception as to the quality and purity which the addition of coloring matter affords entirely overbalance any argument in its favor. By the judicious use of coal-tar colors apple jelly flavored with currants can be given the appearance of the pure article, or a cheap fruit or a vegetable pulp can be mixed into a jam; a jelly made of glucose and starch may be served to consumers who demand pure goods. In most European countries certain stated colors are allowed in food products which have no natural color but are ordinarily colored commercially, such as candies, confections, liqueurs, and similar products, but great care has been taken in the selection of these colors to exclude any that may be injurious, either from being toxic in themselves or liable to contain injurious or poisonous impurities. Lists of the colors allowed by different countries have been published,[a] and from these it would be possible to select harmless colors. The use in fruit products of colors of a vegetable origin is unquestionably nearly obsolete, as coal-tar colors are both cheaper and more durable. The latter are always liable to contain metallic impurities, such as zinc, copper, tin, lead, and arsenic retained during the process of manufacture, and which, when introduced into the food, even in the small quantities that are used, are, to say the least, a source of danger. Others of the coal-tar colors contain metallic atoms in their molecules—for example, malachite green, which is a double chlorid of zinc combined with the organic group. Even some of the vegetable colors are lakes of tin or some other metal. These facts all go to show that manufacturers should use great care in the selection of only the purest colors for use in food products.

GELATINIZING AGENTS.

Many fruits do not readily form a good jelly, especially when a little overripe, and it is necessary that some material be added in order to give the product the proper consistency. There are several articles that may be used to effect this result. Gelatin, agar, or some fruit which has a high gelatinizing power may be added. It has been claimed[b] that gelatin is used, but in the large number of samples examined there was no indication that such was the fact. Gelatin is a very highly nitrogenized product, and even very small amounts would raise the nitrogen content far above the normal. Agar is another substance that might be used, and to much better advantage than gelatin, because of its very high gelatinizing power (a 1 per cent solution forms a stiff jelly) and because it is very similar in composition to

[a] U. S. Dept. of Agr., Bureau of Chemistry Bul. 61, p. 9.

[b] Rept. Dairy and Food Commission, Minnesota, 1900, p. 102.

the pectin bodies of the fruits and would be much more difficult to detect if it were not for the fact that being obtained from seaweed it contains large numbers of diatoms, which can be readily detected by the use of the microscope. But it must be said that careful examination of the jellies described in this bulletin did not show the presence of this material. There can be no doubt that apple juice in some form is by far the most common substance used to give the desired consistency.

ARTIFICIAL SWEETENING MATERIALS.

Artificial sweeteners are used to some extent in fruit products, especially where glucose is used, in order to obtain the required degree of sweetness. These may get into the product in two ways. The manufacturer may add them, or he may use glucose which contains a sweetener.

There is said to be a mixture of crystallized dextrose, cane sugar, and saccharin on the market, which ordinarily would pass as cane sugar.

The sweetener generally used is saccharin (benzolsulphimid, or its sodium salt), and it has been claimed that sucrol (phenetolcarbamid) is also used, but it has never been noted in this country.

Saccharin is a coal-tar product of great sweetening power, claimed by the producers to be five hundred times sweeter than sugar, but it is not a sugar and has no value as a food. It is also a powerful antiseptic. It is sold in this country under various names, such as garantose, sugarine, suchrin, and suchrine. Sugarose is another product on the market which is a mixture of about 20 per cent of saccharin and 80 per cent of cane sugar.

Another curious product is a sirup made of glycerin in which a large amount of saccharin is dissolved.

In many of the European countries the use of saccharin is prohibited in food stuffs of all kinds.[a]

The physiological action of both saccharin and sucrol have been studied somewhat extensively, and the literature on the subject collected.[b]

FOREIGN FRUITS.

Aside from the use of apples as a basis for jellies, and occasionally jams, the substitution of one fruit for a more expensive one is but little practiced in this country. In many of the cheaper jams inferior fruits were used; in others only small amounts of any fruit were used; but in only one case substitution other than that above stated was detected. One sample of currant jam contained a large number of

[a] U. S. Dept. of Agr., Bureau of Chemistry Bul. No. 61, p. 8.
[b] Ver. Nahr. Genuss, Deutsche Reich, Heft II, pp. 137–142.

raspberry seeds, indicating that raspberry pulp had been used as the basis of the jam. It is said that in Europe the fig serves as the basis of a large number of jams, but its use can easily be detected by examination of the seeds. It is probably true that the exhausted pulp left from the manufacture of jellies is sometimes used as a basis for the poorer grade of jams.

HEAVY METALS.

Tin is almost universally present in goods put up in tin cans, owing to the ease with which the metallic surfaces are attacked. Canned fruits as a rule dissolve a larger amount of tin than other classes of foods, not alone because of their high acidity, but because the sirup in which the fruits are put up allows better contact with the walls of the can and better diffusion of the acids than is possible in many other classes of foods, such as meats, fish, etc.

The frequent occurrence of zinc in canned foods makes the determination of this metal of particular importance. The zinc present in the product is undoubtedly due in most cases to the zinc chlorid used as a flux in soldering. Since this salt may readily be removed by washing after the cans are made, care should be taken by the manufacturer that necessary precautions are used to remove this objectionable material. This point is well illustrated by the work of Hilgard and Colby,[a] in which the presence of an excessive amount of zinc chlorid in canned asparagus was traced to the use of soldering fluid. By employing care in the manufacture of the cans and by careful washing before using, the manufacturers were able to reduce the amount of zinc to an inappreciable quantity.

The following table gives the results of the determination of heavy metals in 25 samples of fruit products:

TABLE 8.—*Percentage of heavy metals in fruit products.*

Serial number.	Kind of fruit.	Acidity of fruit as per cent H_2SO_4.	Metals, milligrams per kilogram.	
			Tin.	Zinc.
20232	Apple jelly	0.592	None.	None.
19900	Apricots	.882	264	None.
20027	Cherries	.380	269	None.
20248	Cherries	.823	168	Trace.
19895	Cherries	.702	458	Trace.
19898	Cherries (black)	.401	216	None.
19881	Currants	.457	224	None.
19958	Currant and raspberry	.477	122	None.
19891	Cranberries	.455	429	28
20231	Grapes	.303	400	16
20233	Peaches		96	45
19893	Peaches	.485	176	11
20134	Pears	.205	133	104

[a] California Experiment Station Report, 1897-98, p. 159.

TABLE 8.—*Percentage of heavy metals in fruit products*—Continued.

Serial number.	Kind of fruit.	Acidity of fruit as per cent H_2SO_4.	Metals, milligrams per kilogram.	
			Tin.	Zinc.
20168	Pears	....	1,259	32
20140	Pears	0.137	214	Trace.
20144	Pears	.161	106	26
20028	Plums	.289	232	Trace.
19894	Plums	.769	232	108
20238	Plums	.602	213	None.
20139	Plums	.710	342	None.
20234	Pineapples	.509	563	28
19896	Pineapples	.563	252	None.
20228	Pineapples	....	41	None.
19879	Raspberries	.328	145	None.
19959	Raspberries	.412	139	None.

Tin was found in all cases except the one sample of apple jelly, and here the consistency of the product was not such as to favor an attack of the metal. Thirteen samples, or more than 50 per cent, contained zinc. While in most cases the amount is small and could not be considered harmful, Nos. 19394 and 20134 have an excessive amount of this harmful metal. Neither lead nor copper was found in any of the samples. The former is not commonly found in appreciable amounts in tinned goods, and the latter is seldom present in more than traces except where it has been added as a coloring agent.

There is no direct relation between the acidity of the product and the content of tin. Such a relation is not to be expected, since the time of heating for the purpose of sterilizing varies materially with different products, and the quality of tin used is not always the same. Hilgard and Colby showed in their work that the acid-finish tin plate was much more susceptible to attack than the oil-finish plate.

Sample No. 20168, which contained 1,259 mg per kilogram of tin or 0.126 per cent, was put up in an ordinary tin pail with cover. In this case the poorer grade of tin plate was undoubtedly used, which accounts for the excessive amount dissolved.

Sample No. 20228, which contained 40.9 mg. of tin per kilogram, was put up in glass and only the tin cover came in contact with the contents of the receptacle.

ANALYTICAL DATA.

FRESH FRUITS AND FRUIT JUICES.

TABLE 9.—*Composition of fresh fruits.*[a]

Fruit and analyst.	Number of samples.	Total solids.	Ash.	Acidity expressed as H_2SO_4.	Protein (N×6.25).	Reducing sugar.	Cane sugar.	Crude fiber.
Apples:								
G. E. Colby—[b]		*Per ct.*	*Per ct.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per ct.*	*Per ct.*
Average	13	13.77	0.240	0.376	0.590	7.04	4.59	....
Maximum		16.47	.320	.670	.806	....	7.79	....
Minimum		9.37	.170	.190	.356	....	1.80	....
C. A. Browne—[c]								
Average	27	16.43	.27	.486	....	7.92	3.99	....
Maximum		23.36	.34	.811	....	11.75	6.81	....
Minimum		13.46	.17	.073	....	5.34	1.74	....
Edgar Richards—[d]								
Average	23	13.65	.288	.452	.694	8.73	1.53	0.96
Maximum		16.55	.404	.863	1.094	10.80	2.81	1.29
Minimum		10.60	.228	.139	.421	6.89	.15	.70
F. König[e]	17	16.42	.310	.614	.39	7.73	....	1.98
H. Kremla—[f]								
Average	5	15.07	.290	.234	....	10.12	.55	....
Maximum		16.03	.360	.329	....	10.69	1.11	....
Minimum		14.04	.240	.190	....	9.77	None.	....
Apricots:								
G. E. Colby—[b]								
Average	11	14.34	.491	.833	1.250	11.10		....
Maximum		15.75	.558	1.090	1.040	12.50		....
Minimum		12.75	.450	.560	.897	9.66		....
F. König[e]	6	18.78	.820	.848	.49	4.69	....	[g]5.27
Blackberries: F. König[e]	1	13.59	.48	.870	.51	4.44	....	5.21
Cherries:								
G. E. Colby—[b]								
Average	6	20.13	.443	.432	1.425	11.10		....
Maximum		38.84	.521	.605	1.727	12.75		....
Minimum		11.46	.403	.328	1.100	8.98		....
F. König[e]	9	19.74	.73	.665	.620	10.21	....	[g]6.07
Moleschott[h]	1	22.30	.65	.746	.810	11.72	....	.62
H. Kremla[f]	1	21.95	.38	.965	....	13.32	None.	....
Currants: F. König[e]	7	15.23	.72	1.57	.51	6.38	....	4.57
Figs:								
G. E. Colby—[b]								
Average	41	20.13	.578	.119	1.344	15.51		....
Maximum		38.84	1.160	.291	2.587	20.99		....
Minimum		11.46	.364	.073	.725	8.00		....
Oranges:								
G. E. Colby—[b]								
Average	12	13.87	.430	.672	.486	10.66	5.25	....
Maximum		14.71	.460	.714	.512	12.33	6.75	....
Minimum		13.20	.370	.518	.460	9.92	4.80	....

[a] From other laboratories.
[b] Calif. Expt. Sta. Rept., 1897–98, p. 143.
[c] Penn. Dept. of Agr. Bul. 58, p. 20.
[d] U. S. Dept. Agr. Rept., 1886, p. 354.
[e] Menschlichen Nahrungs. u. Genussmittel, p. 397.
[f] Ztschr. Nahr., Hyg. Waar., 1892, 6, 483.
[g] Includes pits.
[h] Des aliments hygiene et régimes alimentaires.

TABLE 9.—*Composition of fresh fruits*—Continued.

Fruit and analyst.	Number of samples.	Total solids.	Ash.	Acidity expressed as H_2SO_4.	Protein (N×6.25).	Reducing sugars.	Cane sugar.	Crude fiber.
Pears:		*Per ct.*	*Per ct.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per ct.*	*Per ct.*
F. König [a]	9	16.97	0.31	0.146	0.360	8.26	....	4.30
Moleschott [b]	....	16.77	.35	.022	.230	8.78	....	2.77
H. Kremla [c]	2	20.12	.45	.140	....	9.00	4.36	....
Plums:								
F. König [a]	3	15.14	.61	1.096	.40	3.56	....	4.34
G. E. Colby [d]	3	21.60	.524	.996	....	13.25		....
H. Kremla [c]	1	....	....	1.257	....	2.57	3.56	....
Raspberries: F. König [a]	4	13.79	.490	1.010	.53	3.95	....	5.90
Strawberries:								
F. König [a]	33	12.34	.810	.68	1.070	6.28	....	2.32
H. Kremla [c]	1	13.67	....	.965	....	6.36	None.	....
W. E. Stone— [e]								
Average	20	9.48	.606	1.001	.974	4.78	.58	1.518
Maximum		12.28	.818	1.389	1.232	6.71	1.17	2.266
Minimum		7.57	.372	.768	.723	3.91	.02	1.036

[a] Menschlichen Nahrungs. u. Genussmittel, p. 397.
[b] Des aliments hygiene et régimes alimentaires.
[c] Ztschr. Nahr., Hyg. Waar., 1892, 6, 483.
[d] Calif. Expt. Sta. Rept., 1897-98, p. 143.
[e] Tenn. Expt. Sta. Bul., Vol. II, No. 4, pt. 2.

TABLE 10.—*Composition of fresh fruit juices.* [a]

Fruit and analyst.	Number of samples.	Specific gravity.	Total solids.	Ash.	Acidity expressed as H_2SO_4.	Protein (N×6.25).	Reducing sugar.	Cane sugar.
Apples:								
C. A. Browne— [b]			*Per ct.*	*Per ct.*	*Per cent.*	*Per cent.*	*Per ct.*	*Per ct.*
Average	11	1.0553	13.18	0.279	0.490	....	7.86	3.56
Maximum		1.0736	16.82	.370	.906	....	10.52	7.05
Minimum		1.0488	11.36	.240	.073	....	5.47	1.63
Truchon and M. Claude [b]	....	1.0680	....	.340	.450	....	9.62	.61
Blackberries: A. L. Winton [c]	1	....	8.94	....	.854	....	8.70	None.
Cherries (red):								
Trucho and M. Claude [b]	1	1.055	....	.367	.510	....	9.14	None.
H. Kremla— [d]								
Average	8	1.0862	17.84	....	.351	....	12.25	....
Maximum		1.1023	19.65	....	.497	....	13.40	....
Minimum		1.0639	15.61	....	.212	....	9.50	....
W. Keim [e]	2	1.0517	17.57	.559	.409	....	12.86	....
Cherries (black): H. Kremla [d]	2	1.1019	24.12	....	.493	....	15.50	....
Currants:								
Truchon and M. Claude [b]	1	1.0650	16.25	.670	.206	....	10.96	None.
W. Keim [e]	1	1.0425	14.46	.560	.172	....	5.24	....
H. Kremla— [d]								
Average	9	1.0518	12.71	.518	1.805	0.440	6.91	....
Maximum		1.0644	15.70	.758	2.330	.711	8.22	....
Minimum		1.0400	9.90	.356	1.477	.248	4.61	....
Grapes: G. E. Colby [f]	....	....	23.70	.300	.377	....	22.23	....
Do	6	....	21.05	.210	.422	....	21.05	....
Do	9	....	23.47	.370	.234	....	23.14	....
Do	6	....	21.68	.230	.396	....	19.82	....

[a] From other laboratories.
[b] Journ. Pharm. Chem., 1901, vol. 13, p. 171-176.
[c] Conn. Expt. Sta. Report, 1899, pt. 2, p. 127.
[d] Ztschr. Nahr., Hyg. Waar., 1892, **6**, 483.
[e] Ztschr. anal. chem., 1891, **30**, 401.
[f] Viticultural Report, Cal. Expt. Sta., 1887-1893.

TABLE 10.—*Composition of fresh fruit juices*—Continued.

Fruit and analyst.	Number of samples.	Specific gravity.	Total solids.	Ash.	Acidity expressed as H_2SO_4.	Protein (N×6.25).	Reducing sugar.	Cane sugar.
			Per ct.	*Per ct.*	*Per cent.*	*Per cent.*	*Per ct.*	*Per ct.*
Huckleberries: A. L. Winton [a]	1	....	11.40	....	0.350	....	16.70	0.60
Peaches:								
A. L. Winton [a]	....	....	12.70	....	.595	....	2.10	5.40
Truchon and M. Claude [b]	....	1.0540	13.61	0.446	.421	....	3.18	1.87
Pineapples: A. L. Winton [a]	....	....	13.90	....	.476	....	9.10	7.40
Raspberries:								
A. L. Winton [a]	....	....	9.41	....	.833	....	8.60	.80
Truchon and M. Claude [b]	....	1.050	12.63	.411	1.100	....	8.39	None.
Strawberries: Truchon and M. Claude [b]—								
Ripe	....	1.048	12.14	.546	.856	....	9.54	None.
Early	....	1.026	6.71	.580	.576	....	5.37	None.
Quinces: Truchon and M. Claude [b]	1.	1.0480	12.14	.400	.285	....	7.24	None.

[a] Conn. Expt. Sta. Report, 1899, pt. 2, p. 127.
[b] Journ. Pharm. Chem., 1901, vol. 13, p. 171–176.

The composition of the pure fruits and fruit juices used as the basis of the fruit products is of great value in interpreting the results obtained in the analysis of these various materials. To meet this need Tables 9 and 10 have been compiled, the first giving the averages of analyses of whole fruits, the second of fruit juices. In addition, a large number of analyses of the fresh fruits and juices have been made by the writers, results of which are given in Tables 11 and 12. While the analyses compiled in Tables 9 and 10 are incomplete in many respects, they give a fair idea of the proximate composition of nearly all the fruits dealt with in the bulletin. It was not attempted to make this compilation complete. Only such analyses as seemed of particular value in aiding the interpretation of analytical data are included. It must be remembered that these analyses are of samples from extremely variable sources, and as a rule represent a large number of varieties, hence a wide variation in their composition is to be expected.

TABLE 11.—*Description of fresh fruits and juices.*

Serial number.	Description.	Variety.	From whom purchased.
	BLACKBERRY.		
22719	Whole fruit	Wild dewberries	White Bros., Center Market, Washington, D. C.
22743	.....do	Probably Erie	C. Engel & Son, Center Market, Washington, D. C.
22745	.....do	Early Harvest	F. R. Cooke, Center Market, Washington, D. C.
22718	Juice	Wild dewberries	White Bros., Center Market, Washington, D. C.
22742	.....do	Probably Erie	C. Engel & Son, Center Market, Washington, D. C.
22744	.....do	Early Harvest	F. R. Cooke, Center Market, Washington, D. C.

TABLE 11.—*Description of fresh fruits and juices*—Continued.

Serial number.	Description.	Variety.	From whom purchased.
	CHERRY.		
22747	Whole fruit	Morella Seedling	J. M. Abbott, Center Market, Washington, D.C.
22746	Juice	do	Do.
	CURRANT.		
22717	Whole fruit		Rice Bros., Center Market, Washington, D. C
22716	Juice		Do.
	RASPBERRY (BLACK).		
22695	Whole fruit	Probably Doolittle	Rice Bros., Center Market, Washington, D. C.
22697	do	Probably Gregg	F. R. Cooke, Center Market, Washington, D. C.
22694	Juice	Probably Doolittle	Rice Bros., Center Market, Washington, D. C.
22696	do	Probably Gregg	F. R. Cooke, Center Market, Washington, D. C.
	RASPBERRY (RED).		
22691	Whole fruit		Rice Bros., Center Market, Washington, D. C.
22693	do		Experiment Station, College Park, Md.
22690	Juice		Rice Bros., Center Market, Washington, D. C.
22692	do		Experiment Station, College Park, Md.
	STRAWBERRY		
22363	Whole fruit	Lovett	Experiment Station, College Park, Md
22365	do	Tennessee Prolific	Do.
22367	do	Buback	Do.
22369	do	Clyde	Do.
22370	do	Wild strawberry	Office of Experiment Stations.
22362	Juice	Lovett	Experiment Station, College Park, Md.
22364	do	Tennessee	Do.
22366	do	Buback	Do.
22368	do	Clyde	Do.

TABLE 12.—*Composition of fresh fruits and juices.*

Serial number.	Description.	Solids. Total.	Solids. Insoluble.	Protein (N×6.25).	Acidity expressed as H_2SO_4.	Sugars. Reducing sugar.	Sugars. Cane sugar.	Sugars. Total.	Polarizations. Direct.	Polarizations. Invert.	Polarizations. Temperature.	Alcohol precipitate.	Sugar free soluble solids.	Ash. Total.	Ash. Alkalinity as K_2CO_3.	Ash. Sulphates as K_2SO_4.	Ash. Chlorids as NaCl.
	BLACKBERRY.	*Per ct.*	*Per ct.*	*Per cent.*	*Per cent.*	*Per ct.*	*Per ct.*	*Per ct.*	°V.	°V.	°C.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
22719	Whole fruit	13.65	6.24	0.863	0.548	4.69	None.	4.69	+0.6	....	25	0.736	....	0.448	0.429	0.023	0.001
22743	....do	12.06	5.40	.788	.808	4.74	None.	4.74	+ .1	....	25	.700	....	.823	.634	.054	Trace.
22745	....do	12.37	4.72	1.106	.558	4.57	.49	5.06	+ .0	....	25	.608	....	.484	.382	.070	.003
	Average	12.69	5.45	.919	.638	4.67	.16	4.83	+ .3	....	25	.681	....	.585	.482	.049	.001
	Maximum	13.65	6.24	1.106	.808	4.74	.49	5.06	+ .6	....	....	.736	....	.823	.634	.070	.003
	Minimum	12.06	4.72	.788	.548	4.57	None.	4.69	+ .0	....	....	.608	....	.448	.382	.023	Trace.
22718	Juice from 22719	6.96	....	.069	.573	....	....	....	.0	....	25	....	....	.423	.411	.032	.003
22742	Juice from 22743	7.11	....	.319	.835	....	....	....	....	....	....	....	....	.346	.357	.029	Trace.
22744	Juice from 22745	7.80	....	.350	....	....	....	....	....	....	....	....	....	.377	.354	....	.005
	Average	7.30	....	.246	.704	....	....	....	....	....	....	....	....	.382	.374	.030	.003
	Maximum	7.80	....	.350	.835	....	....	....	....	....	....	....	....	.423	.411	.032	.005
	Minimum	6.96	....	.069	.573	....	....	....	....	....	....	....	....	.346	.354	.029	Trace.
	CHERRY.																
22747	Whole fruit	12.61	2.04	.650	1.627	6.84	None.	6.84	+ .2	....	26	.668	....	.602	.481	.023	Trace.
22746	Juice from 22747	....	....	.388	1.465	....	....	....	....	....	....	....	....	.553	.524	.023	Trace.
	CURRANT.																
22717	Whole fruit	12.97	6.90	1.369	1.546	3.44	None.	3.44	1.4	....	26	.804	....	.602	.437	.043	.003
22716	Juice from 22717	6.71	....	.300	1.642	....	....	....	1.2	....	26	....	....	.454	.390	.039	.003
	RASPBERRY, BLACK.																
22695	Whole fruit	18.67	8.59	1.125	.774	6.39	None.	6.39	3.0	3.8	28	....	....	.770	.538	.041	Trace.
22697	....do	21.97	11.23	1.299	.774	6.59	None.	6.59	3.6	-3.5	28	....	....	.854	.803	.082	Trace.
	Average	20.32	9.91	1.212	.774	6.49	None.	6.49	-3.2	3.6	....	....	....	.812	.670	.062	Trace.
22694	Juice from 22695	11.17	....	.194	.808	7.28	None.	7.28	....	....	....	1.002	....	.633	.596	.031	Trace.
22696	Juice from 22697	12.04	....	.312	.779	7.85	None.	7.85	....	....	....	1.620	....	.741	.696	.049	.002
	Average	11.60	....	.253	.794	7.56	None.	7.56	....	....	....	1.311	....	.687	.646	.040	.001

TABLE 12.—*Composition of fresh fruits and juices*—Continued.

Serial number.	Description.	Solids. Total.	Solids. Insoluble.	Protein ($N \times 6.25$).	Acidity expressed as H_2SO_4.	Sugars. Reducing sugar.	Sugars. Cane sugar.	Sugars. Total.	Polarizations. Direct.	Polarizations. Invert.	Polarizations. Temperature.	Alcohol precipitate.	Sugar-free soluble solids.	Ash. Total.	Ash. Alkalinity as K_2CO_3.	Ash. Sulphates as K_2SO_4.	Ash. Chlorids as NaCl.
	RASPBERRY, RED.	*Per ct.*	*Per ct.*	*Per cent.*	*Per cent.*	*Per ct.*	*Per ct.*	*Per ct.*	°V.	°V.	°C.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
22691	Whole fruit	13.16	6.62	.931	1.112	3.52	0.76	4.28	−1.0	−1.1	28	0.776	2.26	0.551	0.429	0.040	Trace.
22693	.....do	13.41	7.12	1.019	1.097	3.53	.83	4.36	− .6	−1.8	28	.696	1.93	.527	.415	.043	Trace.
	Average	13.28	6.87	.975	1.104	3.52	.80	4.32	− .8	−1.4	28	.736	2.10	.539	.422	.042	Trace.
22690	Juice from 22691	6.92	....	.406	1.127	3.65	....	....	− .4	....	....	.655	....	.522	.422	.031	Trace.
22692	Juice from 22693	7.03	....	.388	1.112	3.64	....	....	− .8	....	....	.728	....	.512	.384	.047	Trace.
	Average	6.98	....	.397	1.120	3.64	....	....	− .6	....	....	.692	....	.517	.403	.039	Trace.
	STRAWBERRY.																
22363	Whole fruit	8.18	2.80	.600	.918	3.94	.04	3.98	−1.3	−1.4	28	.494	1.40	.582	.387	.043	.007
22365	.....do	8.22	3.01	.613	.911	3.25	.26	3.51	−1.1	−1.2	28	.524	1.70	.538	.411	.035	.019
22367	.....do	7.55	2.88	.469	.808	3.22	....	....	−1.0	−1.2	28	.560	1.47	.515	.336	.027	.004
22369	.....do	6.85	2.57	.513	.737	2.72	.09	2.81	− .9	−1.0	28	.477	....	.704	.347	.044	.005
22370	.....do	12.88	5.67	.744	1.200	2.98	1.43	4.41	−1.0	−1.4	28	....	2.80	.758	.705	.032	Trace.
	Average	8.74	3.39	.588	.915	3.22	.46	3.68	−1.1	−1.2	28	.514	1.84	.619	.437	.036	.007
	Maximum	12.88	5.67	.744	1.200	3.94	1.43	4.41	−1.9	−1.0	28	.560	2.80	.758	.705	.044	.019
	Minimum	6.85	2.57	.469	.737	2.72	.09	2.81	−1.3	−1.4	28	.477	1.40	.515	.336	.027	.004
22362	Juice from 22363	7.04	....	.100	.887	3.94	.11	4.04	−1.2	−1.0	28	.689	....	.496	.385	.023	.008
22364	Juice from 22365	6.09	....	.113	.916	3.52	.21	3.73	−1.1	−1.2	28	.518	....	.500	.309	.033	.012
22366	Juice from 22367	6.02	....	.144	.789	3.15	.20	3.35	−1.0	−1.2	28	.480	....	.486	.359	.035	.018
22368	Juice from 22369	5.33	....	.106	.744	2.59	.40	2.99	− .7	− .8	28	.541	....	.488	.319	.029	....
	Average	6.12	....	.116	.834	3.30	.23	3.70	−1.0	−1.0	28	.557	....	.492	.343	.030	.013
	Maximum	7.04	....	.144	.916	3.94	.40	4.04	− .7	− .8	28	.689	....	.500	.385	.035	.018
	Minimum	5.33	....	.100	.744	2.59	.11	2.99	−1.2	−1.2	28	.480	....	.486	.309	.023	.008

Table 12 includes the analyses made in this laboratory of both fruits and juices. In the preparation of these samples the edible portion of the fruit was finely ground by passing through a food chopper, and a portion of this was saved for the analysis of the whole fruit. The other portion was placed in a jelly bag and the juice removed by pressure. Unless the juice came through clear it was filtered or allowed to stand and then decanted.

The table is so arranged as to best permit of comparison between the analyses of the fruits and the juices. The following points are of interest regarding the analytical results:

Solids.—The percentage of insoluble solids varies widely with different fruits, the lowest being 2.04 per cent in case of the cherry, and the highest 11.23 per cent in one of the samples of black raspberries. The insoluble material consists principally of fiber, although it also contains a small amount of ash and considerable nitrogenous material. The percentage of soluble solids in the whole fruit is usually considerably lower than the percentage of total solids in the corresponding juice on account of the concentration brought about in the separation of the juice.

Ash.—The content of ash also varies widely with the various fruits, but is fairly constant in the different samples of the same fruit. Invariably the whole fruits have a content of ash appreciably higher than the corresponding juices, indicating that a portion of the ash remains in the insoluble material, probably in the form of calcium salts. The composition of the ash of pure fruits and fruit juices is in some respects characteristic. As will be seen from the table, it consists largely of carbonates (sodium, potassium, calcium, and magnesium carbonates), while sulphates and chlorids are seldom present in appreciable amounts. With the amount of material taken for the determination of ash there is seldom more than a trace of either sulphates or chlorids. The alkalinity of the ash of pure fruit products is also characteristic, and this feature may be taken as an indication of the purity of the goods. Calculated as potassium carbonate, the average alkalinity of the ash of the fruits is 77 per cent of the total ash and of the juices 84.3 per cent of the total ash.

Acidity.—No attempt was made to separate and determine quantitatively the various organic acids, although it is well known that the acidity of the greater number of fruits is due not to a single organic acid, but to mixtures of organic acids and acid salts. The total acidity, therefore, was determined and results expressed as sulphuric acid (H_2SO_4). The acidity is exceedingly variable with different fruits, and even with different varieties of the same fruit.

Protein.—The nitrogenous material of the fruit is largely in an insoluble form. In the one sample of cherries examined the protein in the whole fruit was not greatly in excess of that in the juice, while in all the other fruits the relative amount was much larger, and in case of the strawberry the juice contained only one-fifth of the amount present in the whole fruit. This point is of value in the examination of jellies where the use of gelatin as a gelatinizing agent is suspected. The average content of protein in 14 samples of jellies (see Table 19) prepared in the laboratory was 0.215 per cent, and the extremes were 0.418 per cent and 0.069 per cent; and of 19 pure samples bought on the market the average content of protein was 0.205 per cent and the extremes 0.312 and 0.112 per cent. The use of gelatin would raise the protein content far above the normal.

Sugars.—The sugars normally present in the fruits are dextrose, levulose, and cane sugar. As is indicated by the polarizations made at 86°, dextrose and levulose are present in nearly equal proportions; frequently there is an appreciable excess of levulose, but seldom an excess of dextrose. Cane sugar is an extremely variable factor, and may range from none in many of the samples reported to several per cent. As a general rule, the large fruits, such as the apple, pear, peach, plum, and orange, have a much higher content of cane sugar than the small fruits, such as the strawberry, raspberry, blackberry, and currant. In apples Colby reported an average of 4.59 per cent, a maximum of 7.79 per cent, and a minimum of 1.80 per cent; Browne reported an average of 3.99 per cent, a maximum of 6.81 per cent, and a minimum of 1.74 per cent, while Richards gives 1.53 per cent as the average and limits of 2.81 per cent and 0.15 per cent. In oranges Colby gives an average of 5.25 per cent and limits of 6.75 per cent and 4.80 per cent, and results reported for oranges, plums, peaches, and pineapples are also high.

Stone found, in 20 samples of strawberries, the average percentage of cane sugar to be 0.58, the maximum 1.17, and the minimum 0.02. In this laboratory an average of 0.46 per cent was found in the same fruit; in blackberries, 0.16 per cent; cherries, none; currants, none; black raspberries, none, and red raspberries, 0.80 per cent. Results given in Tables 14 and 15 also verify the general statement.

Polarization.—Table 13 gives the polarizations of a number of pure fruits and fruit juices, together with the content of reducing and cane sugars. The cane sugar was calculated from the polarizations by the Clerget formula, $S=\frac{(a-b)\,100}{144-\frac{t}{2}}$. Here all the large fruits except the apple and the pear show a dextrorotatory direct reading, while all the small fruits show a levorotatory direct reading. The invert readings at room temperature were all negative with the single exception of the plum, which also has a positive reading at 86°, indicating an excess of dextrose over levulose. The polarizations on all the other samples indicated either a mixture of equal parts of dextrose and levulose, or an excess of levulose. There is no direct relation between either the direct or the invert reading at room temperature and the percentage of reducing sugar, owing to the variable amounts of cane sugar, but the invert polarization is in a general way indicative of the amount of total sugars. The approximate percentage of levulose in excess of dextrose may be figured from the polarization at 86° by multiplying the degrees of levorotation by 0.42 in case the normal weight has been used for the polarizations.

TABLE 13.—*Polarization of fruits and fruit juices.*

Laboratory number.	Description.	Direct polarization.	Invert polarization.	Temperature.	Invert polarization at 86°.	Per cent of invert sugar.	Per cent of cane sugar.
	JUICES.			°C.			
20400	Apple	−3.0	−4.6	18	−2.9	4.00	1.18
20396	Blackberry	−1.5	−1.6	18	−1.1	4.34	....
	.....do.[a]	−2.4	−2.4	30	−0.0	8.70	....
20404	Crab apple	−1.0	−2.4	18	−1.1	2.56	1.03
20401	Grape	−1.2	−2.4	18	−0.6	5.10	.89
20397	Huckleberry	−3.2	−4.4	18	−0.9	11.21	.89
	.....do.[a]	−4.0	−4.8	30	−1.0	16.70	.60
20430	Orange	+1.8	−1.3	18	0.0	1.52	2.29
20427	Peach	+4.0	−2.2	18	−0.7	....	4.59
	.....do.[a]	+4.8	−2.2	28	0.0	2.10	5.40
20431	Pear	+4.8	−6.4	18	−4.0	5.87	1.18
20429	Pineapple	+8.4	−3.7	18	−1.1	2.74	8.96
20426	Pineapple husk	+4.1	−2.3	18	− .7	....	4.73
	Pineapple[a]	+4.7	−4.8	28	− .8	9.10	7.40
20399	Plum	+2.0	+1.3	18	+2.4	4.86	.51
20402	.....do	+1.4	−2.4	18	−1.8	2.87	2.81
	Red raspberry[a]	−1.6	−2.8	28	0.0	8.60	.90
22362	Strawberry	−1.2	−1.0	28	....	3.94	.15
22364	.....do	−1.1	−1.2	28	....	3.52	.21
22366	.....do	−1.0	−1.2	28	....	3.15	.20
22368	.....do	− .7	− .8	28	....	2.59	.40
	WHOLE FRUIT.						
20449	Apple	−2.2	−3.6	18	−1.8	4.13	1.03
20415	Blackberry	−1.1	−1.0	18	.0	5.67	.00
20418	Crab apple	− .7	−3.0	18	− .8	5.68	1.70
20417	Grape	−1.6	−2.0	18	.0	1.11	.29
20425	Orange	+2.0	−2.5	18	− .8	4.13	3.33
20444	Pineapple	+1.0	−3.2	18	0.0	8.12	3.11

[a] A. L. Winton, Conn. Expt. Stat. Report, 1899, Pt. II, p. 127.

A number of the fresh fruits were fermented to determine whether any nonfermentable optically active bodies were present. It was found that in all cases the nonfermentable matter was inappreciable and that with a 10 per cent solution the polarization after fermentation was never more than three or four tenths of a degree either to the right or the left.

Alcohol precipitate.—The alcohol precipitate consists largely of pectin bodies, and the determination is valued only for the estimation of these substances. Starch, if present, will be thrown down here, as well as acid potassium tartrate and the calcium salts of organic acids. The acid potassium tartrate may be estimated by titrating the alkalinity of the water-soluble ash of the alcohol precipitate after ignition. The appearance of the solution as the alcohol is added in making the alcohol precipitate is a valuable indication as to the presence or absence of glucose or starch. In pure fruit products there is no turbidity, but the pectin bodies are thrown down in a flocculent mass, while if glucose is present there is a white turbidity and the precipitate is gummy.

The test for starch was made upon all the fruits given in Table 12, and in no case was there sufficient present to give an appreciable iodin reaction. This point is of particular importance in its bearing upon the examination of jellies, where apple is so frequently used as the basis. If it is safe to assume that starch is never present in appreciable amounts in these fruits—and the work done in this laboratory seems to warrant the assumption—then the presence of appreciable amounts of starch in the fruit jelly must be due either to apple or to added starch.

Attention is called to the composition of No. 22370, which is a sample of wild strawberry. In total solids, soluble solids, ash, cane sugar, proteids, and acidity it runs much higher than the four samples of cultivated strawberries, and in these respects, with exception of proteids, is higher than the average of the 20 analyses reported by Stone. Reducing sugars alone are lower than in the cultivated varieties.

JAMS AND JELLIES PREPARED IN THE LABORATORY.

Preliminary to the examination of the commercial fruit products it was thought desirable to have the analyses of a number of jams and jellies of known origin. Accordingly several different kinds of each product were prepared and were analyzed together with the pulped fruit and the juices from which they were made. The results of this investigation are given in Tables 14, 15, 16, and 17. The fruits were prepared by heating with sufficient water to prevent scorching until thoroughly softened and then well pulped. The juices were obtained by draining the pulped fruit, as above prepared, in a jelly bag. Neither the fruit nor the juice, therefore, is normal in its content of water, but is rather the material used as the basis for the jams and the jellies. The jams were prepared by adding approximately one part of sugar to two parts of crushed fruit, heating to boiling, and maintaining at this temperature for about twenty minutes. In the preparation of the jellies approximately equal parts of cane sugar and the strained juice were used and were heated to the point of boiling, which required about twenty minutes. In all cases the cane sugar, the fruit or juice, and the finished product were weighed, and from these weights the amount of added cane sugar in the finished product was calculated.

TABLE 14.—*Composition of fruit.* [a]

Serial number.	Description of sample.	Total solids.	Ash.	Total acids expressed as H_2SO_4.	Proteids ($N \times 6.25$).	Sugars. Reducing sugar.	Sugars. Cane sugar.	Polarizations. Direct at 18° C.	Polarizations. Invert at 18° C.	Polarizations. Invert at 86° C.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	°*V.*	°*V.*	°*V.*
20449	Apple (fall pippin)....	8.25	0.30	0.499	....	4.13	1.03	−2.2	−3.6	−1.8
20415	Blackberry	9.62	.60	.916	0.725	5.67	....	−1.1	−1.0	0
20418	Crab apple	14.34	.84	.705	.418	5.68	1.70	− .7	−3.0	− .8
20417	Grape (Ives seedling)..	12.50	.75	....	....	6.11	.29	−1.6	−2.0	0
20425	Orange (Florida navel)	13.11	.61	.686	.985	4.13	3.33	+2.0	−2.5	− .8
20444	Pineapple	13.71	.50	.392	.056	8.12	3.11	+1.0	−3.2	−0

[a] The composition here given is not that of the original fruit, but of the pulped mass used in the preparation of jams.

TABLE 15.—*Composition of juice.* [a]

Serial number.	Description of sample.	Total solids.	Ash.	Total acids expressed as H_2SO_4.	Proteids ($N \times 6.25$).	Sugars. Reducing sugar.	Sugars. Cane sugar.	Polarizations. Direct at 18° C.	Polarizations. Invert at 18° C.	Polarizations. Invert at 86° C.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	°*V.*	°*V.*	°*V.*
20400	Apple (fall pippin)....	7.95	0.47	0.627	0.543	4.00	1.18	−3.0	−4.6	−2.9
20396	Blackberry	8.54	.52	.978	.350	4.34	.00	−1.5	−1.6	−1.0
20403	Crab apple	5.62	.20	.372	.075	2.56	1.03	−1.0	−2.4	−1.1
20428	Grape (fox)............	6.67	.49	1.686	....	2.79	.37	− .8	−1.3	−1.1
20401	Grape (Ives seedling)..	8.83	.57	.902	.237	5.10	.89	−1.2	−2.4	− .6
20397	Huckleberry	16.33	.40	.454	....	11.21	.89	−3.2	−4.4	− .9
20430	Orange (Florida navel)	6.08	.36	.297	.581	1.52	2.29	+1.8	−1.3	0
20427	Peach	8.90	.45	....	.218	....	4.59	+4.0	−2.2	− .7
20431	Pear (Bartlett)	11.65	.45	.345	.087	5.87	1.18	−4.8	−6.4	−4.0
20429	Pineapple	13.27	.45	.588	.368	2.74	8.96	+8.4	−3.7	−1.1
20426	Pineapple-husk juice..	8.43	.77	....	.350	....	4.73	+4.1	−2.3	− .7
20399	Plum (damson)	12.72	.63	....	.431	4.86	.51	+2.0	+1.3	+2.4
20402	Plum (wild fox)........	11.23	.64	1.576	.137	2.87	2.81	+1.4	−2.4	−1.8
20398	Mixed fruit............	6.53	.32	.612	.150	2.68	.59	−1.0	−1.8	− .9

[a] The "juice" was prepared by boiling the fruit till soft, after the addition of sufficient water to prevent scorching, and straining through a jelly bag.

TABLE 16.—*Composition of jam.*

Serial number.	Description of sample.	Total solids.	Ash.	Total acids expressed as H_2SO_4.	Proteids ($N \times 6.25$).	Sugars. Reducing sugar.	Sugars. Cane sugar added.	Sugars. Cane sugar found.	Sugars. Cane sugar inverted.	Polarizations. Direct at 18° C.	Polarizations. Invert at 18° C.	Polarizations. Invert at 86° C.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	°*V.*	°*V.*	°*V.*
20446	Apple (fall pippin)	63.22	0.20	0.282	0.175	25.52	51.31	29.11	43.22	+26.3	−13.0	+4.8
20414	Blackberry	55.42	.48	.851	.737	18.77	43.99	29.00	34.08	+24.6	−14.6	+1.6
20445	Grape (fox)	61.80	.19	.698	.200	50.06	54.21	3.70	92.96	− 9.0	−14.0	+2.2
20416	Grape (Ives seedling) ...	56.64	.48	.744	.525	33.44	42.45	11.33	73.38	+ 3.5	−11.8	0
20443	Orange (Florida navel) .	80.52	.44	.433	.944	13.61	69.13	54.23	21.55	+55.9	−17.5	+2.0
20448	Pear (Bartlett)	61.52	.28	.163	.312	13.20	46.52	33.74	18.87	+32.3	−13.2	+1.0
20442	Pineapple	73.92	.30	.315	.312	14.05	60.20	46.40	22.90	+52.3	−10.3	+6.2
20421	Plum (damson)	50.43	.54	1.012	.525	28.29	37.75	9.70	74.42	+ 3.1	−10.0	+1.2
20423	Plum (wild fox)	62.10	.46	1.355	.212	28.78	47.86	23.26	53.43	+13.9	−17.5	0

TABLE 17.—*Composition of jelly.*

Serial number.	Description of sample.	Total solids.	Ash.	Total acids expressed as H_2SO_4.	Proteids ($N \times 6.25$).	Sugars.				Polarizations.		
						Reducing sugars.	Cane sugar added.	Cane sugar found.	Cane sugar inverted.	Direct at 18° C.	Invert at 18° C.	Invert at 86° C.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	°*V.*	°*V.*	°*V.*
20408	Apple (fall pippin)	59.18	0.22	0.279	0.175	20.78	51.76	33.04	36.17	+24.0	−20.6	−1.2
20405	Blackberry	59.63	.33	.475	.243	12.51	54.89	44.90	18.20	+47.0	−20.1	0
20410	Crab apple	63.28	.11	.171	.137	34.93	57.61	23.68	58.88	+13.0	−19.0	0
20405	Grape (Ives seedling)	63.66	.45	.524	.175	32.29	60.29	30.52	49.33	+22.3	−18.9	+ .2
20412	Huckleberry	63.02	.28	.245	.069	24.27	53.39	32.74	37.54	+24.1	−20.1	− .4
20435	Orange (Florida navel)	68.56	.30	.171	.418	3.95	65.59	62.52	4.91	+61.3	−23.1	− .2
20437	Peach	69.98	.21	.245	.175	8.75	63.70	56.59	11.16	+53.4	−23.0	− .6
20434	Pear (Bartlett)	69.12	.34	.181	.156	6.58	63.09	58.46	7.33	+52.7	−26.2	−1.8
20436	Pineapple	80.28	.43	.328	.387	22.13	72.98	56.70	28.45	+50.4	−26.1	0
20433	Pineapple husk	76.34	.73	.352	.350	7.40	70.22	65.22	7.12	+63.7	−24.3	− .6
20404	Plum (damson)	45.56	.68	1.127	.350	19.18	38.00	22.67	40.38	+17.8	−12.8	0
20409	Plum (wild fox)	54.49	.40	1.029	.138	24.00	48.05	25.48	46.97	+16.7	−17.8	0
20411	Plum (wild fox), boiled down	73.01	.65	1.529	.175	44.22	64.66	22.37	66.18	+ 7.6	−22.6	− .6
20407	Mixed fruit	66.58	.21	.367	.069	39.70	59.72	24.22	40.38	+14.8	−17.9	+2.2

The analyses of the fruits and juices in these tables are not comparable, owing to the fact that the amount of water added in their preparation was varied in order to obtain the desired product. Regarding the content of cane sugar, the analyses are in accord with those already given.

The inversion of cane sugar during the process of preparation, as shown in the analyses of jams and jellies, is of particular interest. The amount of inversion that takes place varies in general with the length of time of heating and with the content of acid, although other factors have a material influence. It is well known that the different fruit acids vary widely in their power of inverting cane sugar, and many of the variations are undoubtedly due to this cause. Apple jam, with an acidity of 0.282 per cent, shows a much larger amount of cane sugar inverted than blackberry, orange, and pineapple jams, which have an acidity of 0.851 per cent, 0.433 per cent, and 0.315 per cent, respectively, while grape jam, with an acidity of 0.698 per cent, shows almost complete inversion of the cane sugar. Wild fox plum jam, with an acidity of 1.355 per cent, shows but a slightly larger amount of sugar inverted than the apple jam. The amount of sugar inverted in the jellies is much less than in the corresponding jams, owing to the fact that they were heated for a much shorter time. The amount of inversion was very small in case of the orange, pineapple husk, and peach. In all of these cases the acidity is low. The Ives grape, wild fox plum, and mixed fruit jellies all show a high percentage of inversion as well as a high acidity. The crabapple jelly is a striking exception. Its acidity is very low, yet the amount of inversion is high.

The invert polarizations of the jams at 86° are peculiar in that they are strongly positive, with two exceptions, while the same readings made on the fruits, juices, and jellies are either zero or negative, with the exception of plum juice and mixed fruit jelly. The cause of this change has not been worked out, but it is probable that some of the insoluble matters of the fruit have been changed to soluble, optically active bodies by the continued heating of the jams.

Tables 16 and 17 show to very good advantage the relative amounts of protein present in the jams and the jellies. The average content of protein for the eight jams given is 0.468 per cent, while for the corresponding jellies the protein content is only 0.230 per cent. In no case is the content of protein sufficiently high in the jelly to interfere with the detection of added gelatin by the simple method of determining the nitrogen content.

COMMERCIAL FRUIT PRODUCTS.

The fruit products examined have been divided into jams, jellies, canned fruits and miscellaneous fruit products, brandied fruits, fruit butters, and marmalades. The meaning of the term "jelly" is well understood, but there is considerable difference of opinion regarding the definition of jams and marmalades. Undoubtedly the usage varies in different parts of the country and with different manufacturers.

The actual percentage of solids in these products has but little value in the determination of purity, for it varies within wide limits—from a maximum of 82.46 per cent to a minimum of 50.43 per cent, a difference of 32 per cent. The difference, however, between the total sugar and the soluble solids in glucose goods may serve as a valuable indication of the amount of dextrin present, and thus the approximate amount of glucose which has been added, as the amount of sugar-free soluble solids is fairly constant in pure products.

The percentage of ash is of little value in judging purity, although the glucose products as a rule have a high ash. Many of the pure-fruit products also have a high ash. The relation between the total ash and the alkalinity of the ash, calculated as potassium carbonate (K_2CO_3), is of marked value in the pure-fruit goods, and differs materially from that of the ash of goods mixed with glucose. The ash of fruits is largely potassium carbonate, as is shown in the following table:

TABLE 18.—*Ash of fruits.*

Fruit.	Pure ash.	K_2O.	Na_2O.	CaO.	P_2O_5.	SO_3.	Cl.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Apple [a]	0.264	55.21	11.69	4.79	12.83	4.62	0.83
Apricots [b]	.508	59.36	10.26	3.17	13.09	2.63	.45
Banana [c]	1.078	63.06	2.34	.86	1.62	2.32	26.93
Cherries [d]	.440	57.67	6.80	4.20	15.11	5.83	1.83
Figs [e]	.682	57.16	2.38	10.90	12.76	3.90	2.05
Grapes [f]	.500	50.95	6.32	4.96	21.27	4.28	1.54
Lemons [g]	.526	48.26	1.76	24.87	11.09	2.84	.39
Oranges [g]	.432	48.94	2.50	22.71	12.37	5.25	.92
Prunes [h]	.486	63.83	2.65	4.66	14.08	2.68	.34

[a] Tolman, Calif. Expt. Sta. Report, 1900, p. 146.
[b] G. E. Colby, Calif. Expt. Sta. Report, 1894, p. 266.
[c] Ibid., p. 279.
[d] Ibid., 1896, p. 179.
[e] Ibid., 1894, p. 233.
[f] F. T. Bioletti, Calif. Expt. Sta. Report, 1894, p. 274.
[g] G. E. Colby, Calif. Expt. Sta. Report, 1890, p. 113.
[h] Ibid., 1892, p. 266.

It will be seen that there are only small percentages of sulphates and chlorids in the total ash. The chlorid in nearly all is especially low. The banana ash is an exception, being practically all potassium chlorid. In the quantity of substances taken in the ordinary determination of ash of fruit products the sulphates and chlorids in products containing no glucose will amount only to traces, except as has been noted in the banana.

An appreciable addition of glucose, the ash of which is largely composed of sulphates and chlorids, will greatly change the relation between the alkaline carbonates and the sulphates and chlorids. If this table of fruit ashes be compared with that of glucose ashes (Table 5, p. 33) the great difference will be noted. If a still more complete examination of the ash is made a more striking difference might be shown in the proportion of the different bases. The bases in fruit ash are very largely potash with only small amounts of soda and lime, while in the glucose ash soda and lime are greatly in excess and only traces of potash will be found. Still, exceptions to this rule must not be overlooked. In several analyses of ash of apple considerable amounts of soda have been shown to be present. Also, in some fruits, such as lemons and oranges, the percentage of lime is much larger than is the case with most other fruits. The ash of a pure fruit product, however, should contain not less than 40 per cent of potash.

By consulting the tables of analyses it will be noticed that the ash of the glucose products varies exceedingly, according to the grade of glucose employed and the method of its preparation. The sulphates in some cases constitute almost the entire ash, while in other cases only a very small part of the ash is sulphate. The average percentage of ash of jams not containing glucose was 0.319, while the average alkalinity was 0.262. In the compound jams the average ash was 0.590 per cent and the alkalinity 0.285 per cent. These proportions, however, will not always hold good. For example, sample No. 19887, which is very largely glucose, has 0.387 per cent of ash and only small amounts of sulphates and chlorids. This sample evidently contains a better grade of glucose than that used in sample No. 19865, which has 0.648 per cent of ash and 0.546 per cent of sulphates. The dextrin and sugar in the sample of glucose last mentioned are present in about equal proportions. An ash of this sort indicates that there can be very little if any fruit present.

There is little value in a comparison of jams made from different fruits by taking as a basis the amount of any constituent present, as the variation is too great. The goods of one manufacturer, however, may be compared with considerable value sometimes, as is seen by consulting Table 31, prepared to show the probability of the use of a gelatinizing agent to produce a uniform product from different kinds of fruits. It is well known that some fruits jelly readily, while others do not, and with many fruits it is necessary to have a high content of solids in order to get the required consistency. By the use of apple as a basis it is possible to produce the desired consistency with a lower percentage of solids.

The relation between cane sugar and reducing sugar in jellies or jams is of little value, as the amount of hydrolysis caused by the fruit acids in the process of preparation is an exceedingly variable quantity, changing with the amount of boiling and the quantity and kind of acid present. Data of considerable value may be obtained by a consideration of the total sugar present and the invert polarization. The following table was made by calculating all the reducing sugar as cane sugar (reducing sugar × .95 = cane sugar), and adding it to the cane sugar found, and from the total cane sugar, calculating the invert reading at the temperature at which the polarizations of the sample were made. It is easily seen that if the fruit product had contained no sugar besides the sugar of the fruit and pure cane sugar the observed polarization and the calculated polarization would be very close together, while in the presence of glucose the calculated polarization to the left on the sugar scale is larger than the actual reading, the difference depending on the amount of glucose present. The difference between the calculated reading and the actual reading is marked plus (+) when the former is the greater and minus (−) when the actual reading is greater than that calculated. If all the sugar in the fruits were present as invert and cane sugar it would be possible to make quite exact calculations, but, as has been shown in Tables 14 and 16, there is often a small excess of either levulose or dextrose. This is not sufficiently marked, however, to make any serious difference, especially as in nearly all the fruits examined the levulose is in excess, which lessens the difference mentioned above. A small difference of one or two degrees either one way or the other should be disregarded, as it may be caused by the slight excess of levulose or dextrose in the fruit. The following table illustrates this point very plainly:

TABLE 19.

POLARIZATION OF JAMS NOT CONTAINING GLUCOSE.

Serial number.	Per cent total sugar as cane sugar.	Temperature in degrees C.	Invert polarization.	Calculated invert polarization.	Difference.
20446	53.36	18	−13.00	−18.7	+5.7
20183	62.95	20	−20.80	−21.4	+ .6
20414	46.77	18	−14.60	−16.4	+1.8
20175	51.47	20	−18.00	−17.5	− .5
21081	60.97	20	−20.00	−20.7	+ .7
21082	63.01	21	−12.40	−21.1	+8.7
20163	67.16	21	−17.00	−20.4	+3.4
20416	43.06	18	−11.80	−15	+3.2
20445	51.27	18	−14.00	−17.9	+3.9
21083	76.61	21	−25.20	−25.6	+ .4
20245	62.65	21	−19.80	−20.9	1.1
20025	59.33	20	−19.00	−20.1	1.1
20196	57.85	21	−18.80	−19.4	+ .6
20443	67.16	18	−17.50	−23.5	+4.0
20589	66.58	20	−23.00	−22.6	− .4
20968	60.05	20	−18.80	−20.4	+1.6
20448	46.28	18	−13.20	−16.2	+3.0
20181	57.82	20	−19.40	−19.6	+ .2
20967	59.54	20	−19.80	−20.2	+ .4
20179	60.75	20	−18.30	−20.6	+2.3
20421	36.58	18	−10.00	−12.8	+2.8
20423	50.60	18	−17.50	−17.71	+ .2
20591	55.38	20	−18.05	−18.8	+ .75
20182	66.72	22	−22.80	−22	− .8
20590	69.14	20	−21.50	−22.5	+2.0

POLARIZATION OF JAMS CONTAINING GLUCOSE.

Serial number.	Per cent total sugar as cane sugar.	Temperature in degrees C.	Invert polarization.	Calculated invert polarization.	Difference.
20166	57.45	20	− 7.70	−19.5	+11.8
20165	59.08	20	− 3.80	−20	+16.2
21021	66.16	20	− 1.60	−22.5	+20.9

The pure fruit jams prepared in the laboratory for comparison and those commercial products that contained no glucose are arranged first. The difference between the calculated and determined polarization is, as a rule, less than 3°. Among the jams of known origin there are three exceptions to this, the maximum being +5.7 on apple jam 20446. The commercial goods which would ordinarily be passed as free from glucose afford one exception, and this is probably due to the addition of a small amount of commercial dextrose which contained no dextrin, or possibly to the use of cane sugar adulterated with dextrose. There is said to be on the market at present cane sugar mixed with crystallized dextrose, often as high as 20 per cent of the latter being present. In some cases this is also mixed with saccharin in order to secure the desired sweetening power. The value of this calculation is brought out very plainly when these results are compared with those obtained with the three samples of jam which have a minus polarization but which contain a small amount of glucose, viz, 20166, 20165, and 21021, in which the minimum difference between the calculated and determined polarizations is +11.8 and the maximum +20.9.

In pure jellies the agreement between invert polarization and that calculated as indicated above is even more striking than in the case of jams, the maximum difference being 3.7° while as a rule the difference is not more than 1.5°. The five commercial jellies containing small amounts of glucose show a minimum difference of +11.86°

Table 20.

POLARIZATION OF JELLIES MADE IN LABORATORY.

Serial number.	Per cent total sugar as cane sugar.	Temperature in degrees C.	Invert polarization.	Calculated invert polarization.	Difference.	Polarization at 86°.
20408	52.79	18	−20.6	−18.48	− 2.2	−1.2
20405	55.81	18	−20.1	−19.5	− .6	0.0
20410	56.85	18	−19.0	−19.90	+ .9	0.0
20405	61.19	18	−18.9	−21.40	+ 2.5	+ .2
20412	55.80	18	−20.1	−19.5	− .6	− .4
20435	66.27	18	−23.1	−23.20	+ .1	− .2
20437	64.90	18	−23.0	−22.7	− .3	− .6
20434	64.71	18	−26.2	−22.6	− 3.4	−1.8
20436	77.73	18	−26.1	−27.2	+ 1.1	0.0
20433	72.25	18	−24.3	−25.2	+ .9	−0.6
20404	40.91	18	−12.8	−14.3	+ 1.5	0.0
20409	48.28	18	−17.8	−16.8	− 1.0	0.0
20411	64.41	18	−22.6	−22.5	− .1	−0.6
20407	61.92	18	−17.9	−21.6	+ 2.7	+2.2

TABLE 20—Continued.

POLARIZATION OF COMMERCIAL JELLIES CONTAINING NO GLUCOSE.

Serial number.	Per cent total sugar as cane sugar.	Temperature in degrees C.	Invert polarization.	Calculated invert polarization.	Difference.	Polarization at 86°.
20023	57.83	20	−17.9	−19.8	+ 1.9	
20226	60.47	20	−22.3	−20.5	− 1.8	
21062	53.75	20	−20.6	−18.2	− 2.4	
19890	56.35	20	−18.1	−19.1	+ 1.0	
20024	57.26	20	−18.7	−19.4	+ .7	
20169	62.99	20	−21.3	−21.3	0.0	
20170	62.93	20	−20.0	−21.3	+ 1.3	
20180	66.95	20	−22.3	−22.7	+ .4	
20210	61.80	20	−22.0	−21.0	− 1.0	
20214	52.50	20	−18.2	−17.9	− .3	
20184	61.63	20	−19.2	−20.9	+ 1.7	
20189	64.53	20	−21.9	−21.9	0.0	
20246	73.31	20	−24.8	−24.9	+ .1	
21084	73.39	20	−24.1	−24.9	+ .8	
20173	58.79	20	−19.8	−19.9	+ .1	
20185	60.93	20	− 8.8	−20.7	+11.9	
20188	67.31	20	−20.8	−22.8	+ 2.0	
20172	61.52	20	−17.6	−20.9	+ 3.3	
20186	60.34	20	−16.8	−20.5	+ 3.7	

POLARIZATION OF JELLIES CONTAINING GLUCOSE.

20213	51.55	20	− 5.35	−17.55	+12.20	
20966	64.59	20	− 4.00	−21.95	+17.95	
20212	49.57	20	− 5.00	−16.86	+11.86	
20211	51.76	20	− 4.00	−17.60	+13.60	
20185	60.93	20	− 8.80	−20.70	+12.90	

Sample 20185 is especially to the point. It has an invert reading of −8.80 and no dextrin was found by fermentation, but the difference of +12.90 indicates the presence of a dextrorotatory sugar, in all probability dextrose. It is in such cases that the method of comparison shows the great value of polarization after inversion for the detection of a small amount of added dextrose which may not contain enough dextrin to be detected by the fermentation process.

The polarization after fermentation with yeast, by which all the sugars are removed, is approximately zero and does not vary more than ±0.3° in the case of products which contain no glucose, but in the glucose products the right-handed polarization of the dextrin is unchanged. Great care must be used, however, to secure complete fermentation or very erroneous results will be obtained. Dextrose is more easily fermented than levulose, so that a zero reading could be obtained even though a considerable amount of dextrin were present, the left-handed reading of the levulose neutralizing the right-handed reading of the dextrin. The presence of preservatives interferes to a considerable extent and in some cases prevents complete fermentation. As a result left-handed readings were obtained which showed that considerable of the levulose was still unfermented. It is always well to test for reducing sugars even if a zero reading has been obtained for the reason mentioned above.

The percentage of nitrogenous material in the jams is quite variable—much more so than in the jellies—on account of the pulp present in the former, which contains a large part of the nitrogenized bodies in an insoluble condition, as can be seen by comparing the protein of juices and whole fruits in Tables 14 and 15. The percentage of protein in jam, therefore, will depend largely upon the amount of fruit pulp used and is thus an indication of the amount of fruit employed, which in some of the jams is evidently rather small. The protein contained in compound jams and jellies (see Tables 26 and 33) is nearly the same, which is quite different from the condition found in the fruit jams and jellies which contained no glucose. The other constituents of the compound goods also vary little, showing that there is little difference in the process of making them or the ingredients used.

The high protein content of sample 20175 perhaps needs some explanation. The currants used in the preparation of this jam were hard and tough and looked as though they had been dried before being used in the preparation of the jam. As a result the insoluble matter is very high (6.32 per cent), as are also the proteids (1.410 per cent), the ash (0.841 per cent), and the acid (1.117 per cent).

There is little that can be said about the acid content except that certain fruits, such as currants and plums, have a high content of acid as a rule, and jellies and jams made from them should also have a high acidity. For this reason the acid content may sometimes be of value as evidence that there has been some substitution of other fruits for those mentioned.

Jams containing no glucose.—Of the 18 commercial samples in the table, about one-third contained preservatives and 3 were artificially colored with coal-tar dyes.

TABLE 21.—*Description of jams not containing glucose.*

Serial number.	Manufacturer.	From whom purchased.	Claims of manufacturer.
	Apple.		
20446	Made in laboratory		
	Apricot.		
20183	J. Keiller, Dundee	N. W. Burchell, Washington, D. C.	
	Blackberry.		
20414	Made in laboratory		

TABLE 21.—*Description of jams not containing glucose*—Continued.

Serial number.	Manufacturer.	From whom purchased.	Claims of manufacturer.
	Currant.		
20175	Mrs. J. T. McCready, Buffalo, N. Y.	C. C. Bryan, Washington, D. C.	
21081		S. W. Clark & Son, 626 Canal street, New Orleans, La.	Bar le duc.
21082		do	Do.
	Fig.		
20241	Barataria Canning Co., Biloxi, Miss.	Park & Tilford, New York City	
	Grape.		
20416	Made in laboratory		
20445	do		
	Grape fruit.		
20163	Bishop & Co., Los Angeles, Cal	C. C. Bryan, Washington, D. C.	Grape fruitate.
	Guava.		
21083	J. Carnel, Ormonde, Fla	S. W. Clark & Son, 626 Canal street, New Orleans, La.	Marmalade.
20245	Bishop & Co., Los Angeles, Cal	Park & Tilford, New York City	Do.
	Orange.		
20025	J. Buchanan, Ltd., Glasgow, Scotland.	R. H. Macy & Co., New York City.	Homemade marmalade.
20196		G. G. Cornwell & Son, Washington, D. C.	Do.
20443	Made in laboratory		
20589	J. Keiller & Son, Dundee	Jackson & Co., 114 West 23d street, New York City.	
20968	Crosse & Blackwell, London	A. M. & J. Solari, Royal and Canal streets, New Orleans, La.	Orange marmalade.
	Pear.		
20448	Made in laboratory		
	Peach.		
20181	Oneida Community, Ltd., Kenwood, N. Y.	N. W. Burchell, Washington, D. C.	
20967	Crosse & Blackwell, London	A. M. & J. Solari, New Orleans, La.	Peach jam.
	Pineapple.		
20442	Made in laboratory		
	Plum.		
20179	Crosse & Blackwell, London	N. W. Burchell, Washington, D. C.	Green gage.
20421	Made in laboratory		
20423	do		
20591	J. Keiller & Son, Dundee	Jackson & Co., 114 West 23d street, New York City.	Damson.
	Strawberry.		
20182	Oneida Community, Ltd., Kenwood, N. Y.	N. W. Burchell, Washington, D. C.	
20590	J. Keiller & Son, Dundee.	Jackson & Co., 114 West 23d street, New York City.	Strawberry jam.

TABLE 22.—*Composition of jams not containing glucose.*

Serial number.	Description.	Per cent total solids.	Per cent insoluble solids.	Per cent protein (N × 6.25).	Acidity expressed as per cent H_2SO_4.	Sugars.			Polarization.			Per cent dextrin.	Per cent alcohol precipitate.	Per cent sugar-free soluble solids.	Per cent sugar-free solids.	Per cent total ash.	Alkalinity of ash as per cent K_2CO_3.	Sulphates as potassium sulphate.	Chlorids as sodium chlorid.	Preservatives.	Foreign coloring matter.
						Per cent reducing sugar.	Per cent cane sugar.	Per cent total sugar.	Direct.	Invert.	Temperature.										
											°C.										
20446	Apple	63.22	......	0.175	0.282	25.52	29.11	54.63	+26.30	−13.00	18	....	......	......	8.59	0.200	......	....	....	....	
20183	Apricot	70.15	1.72	.494	.407	38.96	26.00	64.96	+14.05	−20.80	20	None.	1.144	3.37	5.19	.348	0.295	Trace.	Trace.	....	
20414	Blackberry	55.42	......	.737	.851	18.77	29.00	47.77	+24.60	−14.60	18	....	......	......	7.65	.480	......	....	....	....	
20175	Currant	66.32	6.32	1.410	1.117	52.45	1.64	54.09	−15.80	−18.00	20	None.	.920	5.96	12.23	.841	.603	0.098	0.014	....	
21081	.....do	70.56	.98	.175	.431	58.52	5.37	61.89	−12.80	−20.00	20	None.	......	5.69	6.67	.159	.164	Trace.	Trace.	Benzoic acid.	Magenta
21082	.....do	71.30	......	.325	.475	51.04	14.53	65.57	+ 7.00	−12.40	20	None.	......	5.73	5.73	.123	.106	Trace.	Trace.	Salicylic acid.	
20241	Fig	69.89	......	......	......	......	45.92	......	+44.80	−20.10	20	....	......	......	......	.193	.184	....	....	....	
20416	Grape	56.64	......	.525	.744	33.44	11.33	44.77	+ 3.50	−11.80	18	....	......	......	11.87	.480	......	....	....	....	
20445	.....do	61.80	......	.200	.698	50.06	3.70	53.76	− 9.00	−14.00	18	....	......	......	8.04	.190	......	....	....	....	
20163	Grape-fruit	69.20	1.25	.350	.387	27.00	35.51	62.51	+30.40	17.00	20	None.	......	5.44	6.69	.334	.301	.043	.008	Benzoic acid.	
21083	Guava	82.46	1.04	.175	.299	25.14	52.73	77.87	+45.20	−25.20	21	None.	......	3.58	4.62	.301	.261	Trace.	Trace.	....	
20245	.....do	70.97	3.30	.388	.446	43.56	21.27	64.83	+ 8.60	19.80	21	None.	......	2.85	6.15	.332	.313	.068	.009	....	Red coal tar.
20025	Orange	65.41	.09	.212	.490	51.14	10.75	59.33	− 4.60	−19.00	20	None.	.540	3.46	3.55	.143	.100	Trace.	Trace.	....	
20196	.....do	63.90	1.03	.175	.206	45.18	14.91	57.85	+ 1.10	−18.80	21	None.	......	2.78	3.81	.138	.156	Trace.	Trace.	....	
20443	.....do	80.52	......	.944	.433	13.61	54.23	67.84	+55.90	17.50	18	....	......	......	12.68	.440	......	....	....	....	
20589	.....do	72.76	.89	.206	.485	33.41	34.85	68.26	+23.70	−23.00	20	None.	1.764	......	1.50	.207	.206	Trace.	Trace.	....	
20968	.....do	67.99	1.32	.244	.519	61.02	2.09	63.11	−16.00	18.80	20	None.	1.418	3.56	4.88	.292	.259	.028	Trace.	....	
20448	Pear	61.52	......	.312	.163	13.20	33.74	46.94	+32.30	−13.20	18	....	......	......	14.58	.280	......	....	....	....	
20181	Peach	65.65	1.68	.388	.500	36.48	23.16	59.64	+11.40	−19.40	20	None.	......	4.33	6.01	.391	.286	Trace.	Trace.	....	
20967	.....do	67.33	1.08	.350	.259	46.78	15.08	61.86	+ .45	−19.80	20	....	1.494	4.39	5.47	.275	.199	Trace.	Trace.	....	

TABLE 22.—*Composition of jams not containing glucose*—Continued.

Serial number.	Description.	Per cent total solids.	Per cent insoluble solids.	Per cent protein (N×6.25).	Acidity expressed as per cent H_2SO_4.	Sugars. Per cent reducing sugar.	Sugars. Per cent cane sugar.	Sugars. Per cent total sugar.	Polarization. Direct.	Polarization. Invert.	Polarization. Temperature.	Per cent dextrin.	Per cent alcohol precipitate.	Per cent sugar-free soluble solids.	Per cent sugar-free solids.	Per cent total ash.	Alkalinity of ash as per cent K_2CO_3.	Sulphates as potassium sulphate.	Chlorids as sodium chlorid.	Preservatives.	Foreign coloring matter.
											°C.										
20442	Pineapple	73.92	......	.312	.315	14.05	46.40	60.45	+52.30	−10.30	18	......	......	......	13.47	.300	......	......	......	......	
20179	Plum	70.19	.96	.281	.407	50.34	12.91	63.25	− 1.00	−18.30	20	None.	1.090	5.98	6.94	.263	.210	Trace.	Trace.	......	
20421	....do	50.43	......	.525	1.012	28.29	9.70	37.99	+ 3.10	−10.00	18	......	......	......	12.44	.540	......	......	......	......	
20423	....do	62.10	......	.212	1.355	28.78	23.26	53.04	+13.90	−17.50	18	......	......	......	10.06	.460	......	......	......	......	
20591	....do	64.78	2.57	.456	.804	45.76	11.90	57.66	− 2.20	−18.05	20	None.	1.630	4.55	7.12	.320	.270	Trace.	Trace.	Salicylic acid.	
20182	Strawberry	75.83	4.59	.769	.480	37.15	31.43	68.58	+19.00	−22.80	22	None.	......	2.66	7.25	.422	.318	.046	.010	....do	Red coal tar.[a]
20590	....do	69.16	1.90	.419	.529	38.50	22.57	61.07	+ 8.75	−21.50	20	None.	.902	6.19	8.09	.337	.222	Trace.	Trace.	....do	
	Average	65.98	1.92	.430	.536	36.41	22.15	......	......	......	......	0.007	1.119	4.40	7.71	.319	.262	.016	.002	......	
	Maximum	82.46	6.32	1.410	1.355	61.02	54.23	......	......	......	......	.070	1.764	6.19	14.58	.841	.603	.098	.014	......	
	Minimum	50.43	.09	.175	.163	13.20	.30	......	......	......	......	None.	.092	2.66	3.55	.143	.100	Trace.	Trace.	......	

[a] See correspondence with manufacturers, p. 103.

Jams containing glucose, but not so labeled.—The table of products coming under this head includes goods of nearly all grades from the poorest to the best. The nitrogen content is variable, depending somewhat upon the percentage of fruit used. The percentage of insoluble solids and of protein vary directly with each other. Out of 53 samples 28 were found to be colored, the reason being that the pulp does not retain its color as well as the juice does, and, further, the use of coloring materials permits the employment of a poor grade of fruit or the substitution of a cheaper fruit.

TABLE 23.—*Description of jams containing glucose, but not so labeled.*

Serial number.	Manufacturer.	From whom purchased.	Claims of manufacturer.
	Apricot.		
20206	Curtice Bros. Co., Rochester, N. Y.	G. G. Cornwell & Son, Washington, D. C.	Fresh fruit, apricot jam.
	Blackberry.		
20147	Williams Bros. & Charbonneau, Detroit.	Henry Barge, New York	Prepared with best granulated sugar, guaranteed absolutely pure.
F 651	Batavia Preserving Co., Batavia, N. Y.	Boston Store, Chicago, Ill	Quince; Genesee fresh fruit preserves.
	Cherry.		
19880	Milford Manufacturing Co., Chicago, Ill.	Siegel-Cooper Co., New York	Red cherry jam.
19883	do	do	Do.
19957	Alden & Nicholson, Rochester, N. Y.	H. Punchard & Sons, New York	Fresh fruit jam—cherry.
19960	Geo. K. McMechen & Son, Wheeling, W. Va.	do	Aunt Dinah brand, homemade fresh fruit jam.
20022	R. H. Macy & Co., New York City.	R. H. Macy & Co., New York	Lily White brand, strictly pure fruit.
20027	Anderson Preserving Co., Camden, N. J.	do	Cherry jam (in tin).
20159	Francis H. Leggett & Co., New York.	Henry Barge, New York	Fruit jam.
20177	Flaccus Bros., Wheeling, W. Va.	N. W. Burchell, Washington, D. C.	
20199	Curtice Bros. Co., Rochester, N. Y.	G. G. Cornwell & Son, Washington, D. C.	Fresh fruit, cherry jam.
20218	P. J. Ritter Conserve Co., Philadelphia, Pa.	J. C. Ergood Co., Washington, D. C.	XX brand, fresh fruit and granulated sugar.
	Currant.		
19881	Milford Manufacturing Co., Chicago, Ill.	Siegel-Cooper Co., New York	Red currant jam.
19884	do	do	Do.
20026	Anderson Preserving Co., Camden, N. J.	R. H. Macy & Co., New York	Currant jam (in tin).
20166	A. Cairns, Paisley, Scotland	C. C. Bryan, Washington, D. C.	Finest Scotch preserves, whole fruit, special quality.

TABLE 23.—*Description of jams containing glucose, but not so labeled*—Continued.

Serial number.	Manufacturer.	From whom purchased.	Claims of manufacturer.
	Currant—Continued.		
20204	Curtice Bros. Co., Rochester, N.Y.	G. G. Cornwell & Son, Washington, D. C.	Fresh fruit, currant jam.
20207	.....do	.....do	Do.
20220	P. J. Ritter Conserve Co., Philadelphia, Pa.	J. C. Ergood Co., Washington, D. C.	Pomona, pure fruit, currants.
21022	J. Moir, London	A. L. Buhler Co., Decatur street, New Orleans, La.	Red currants.
F 655	Batavia Preserving Co., Batavia, N. Y.	Boston Store, Chicago, Ill	Currant; Genesee fresh fruit preserves.
	Gooseberry.		
19878	Anderson Preserving Co., Camden, N. J.	Siegel-Cooper Co., New York	Gooseberry jam (in tin).
20201	Curtice Bros. Co., Rochester, N. Y.	G. G. Cornwell & Son, Washington, D. C.	Fresh fruit, gooseberry jam.
	Grape.		
19877	Anderson Preserving Co., Camden, N. J.	Siegel-Cooper Co., New York	Grape jam (in tin).
	Orange.		
20198	Curtice Bros. Co., Rochester, N.Y.	G. G. Cornwell & Son, Washington, D. C.	Fresh fruit, orange marmalade.
20584	W. P. Hartley, Liverpool	R. M. Delapenha & Co., 81 Murray street, New York.	Made from Seville oranges.
	Peach.		
19876	Anderson Preserving Co., Camden, N. J.	Siegel-Cooper Co., New York	Peach jam (in tin).
20158	Francis H. Leggett & Co., New York City.	Henry Barge, New York	Fruit jam.
	Pear.		
20187	Geo. K. McMechen & Son, Wheeling, W. Va.	N. W. Burchell, Washington, D. C.	Old Virginia brand.
20197	Curtice Bros. Co., Rochester, N. Y.	G. G. Cornwell & Son, Washington, D. C.	Fresh fruit, pear jam.
	Plum.		
20021	R. H. Macy & Co., New York City	R. H. Macy & Co., New York	Green gage.
20028	Anderson Preserving Co., Camden, N. J.	.....do	Plum jam (in tin).
20148	Williams Bros. & Charbonneau, Detroit.	Henry Barge, New York	Prepared with best granulated sugar and guaranteed pure.
20200	Curtice Bros. Co., Rochester, N. Y.	G. G. Cornwell & Son, Washington, D. C.	Fresh fruit, plum jam.
F 652	Batavia Preserving Co., Batavia, N. Y.	Boston Store, Chicago, Ill	Green gage; Genesee fresh fruit preserves.
	Quince.		
19967	Williams Bros. & Charbonneau, Detroit.	H. Punchard & Son., New York	Prepared with best granulated sugar; guaranteed absolutely pure.
20202	Curtice Bros. Co., Rochester, N. Y.	G. G. Cornwell & Son, Washington, D. C.	Fresh fruit, quince jam.
F 657	Batavia Preserving Co., Batavia, N. Y.	Boston Store, Chicago, Ill	Quince; Genesee fresh fruit preserves.

TABLE 23.—*Description of jams containing glucose, but not so labeled*—Continued.

Serial number.	Manufacturer.	From whom purchased.	Claims of manufacturer.
	Raspberry.		
19963	Franklin Preserving Co., New York.	H. Punchard & Son, New York	High grade goods.
19879	Milford Preserving Co., Chicago	Seigel-Cooper Co., New York	
19959	Alden & Nicholson, Rochester, N. Y.	H. Punchard & Son, New York	Highest grade fruit.
19961	Geo. K. McMechen & Son, Wheeling, W. Va.	do	Aunt Dinah brand, homemade fresh fruit jam.
19966	Williams Bros. & Charbonneau, Detroit.	do	Prepared with best granulated sugar, guaranteed absolutely pure.
20190	Alden & Nicholson, Rochester, N. Y.	N. W. Burchell, Washington, D. C.	Raspberry jam.
20208	Curtice Bros. Co., Rochester, N. Y.	G. G. Cornwell & Son, Washington, D. C.	Fresh fruit.
20585	W. P. Hartley, Liverpool	R. M. Delapenha & Co., 81 Murray street, New York.	Do.
19958	Alden & Nicholson, Rochester, N. Y.	H. Punchard & Son, New York	Highest grade fruit.
F 654	Batavia Preserving Co., Batavia, N. Y.	Boston Store, Chicago, Ill	Raspberry; Genesee fresh fruit preserves.
	Strawberry.		
19962	Franklin Preserving Co., New York.	H. Punchard & Son, New York	Highest grade fruit jam.
19964	Alden & Nicholson, Rochester, N. Y.	do	Highest grade fruit.
19988	Hazel Pure Food Co	Siegel-Cooper Co., New York	Hazel brand.
20146	Williams Bros. & Charbonneau, Detroit.	Henry Barge, New York	Prepared with best granulated sugar, guaranteed absolutely pure.
20165	Lutz & Schramm	C. C. Bryan, Washington, D. C.	
20167	A. Cairns, Paisley, Scotland	do	Finest whole fruit, special quality.
20205	Curtice Bros. Co., Rochester, N. Y.	G. G. Cornwell & Son, Washington, D. C.	Fresh fruit, strawberry jam.
21021	J. Moir, London	R. H. Macy & Co., New York	Strawberry jam.
F 653	Batavia Preserving Co., Batavia, N. Y.	Boston Store, Chicago, Ill	Strawberry; Genesee fresh fruit preserves.

TABLE 24.—*Composition of jams containing glucose, but not so labeled.*

Serial number.	Description.	Per cent total solids.	Per cent insoluble solids.	Per cent of protein (N×6.25).	Acidity expressed as per cent H_2SO_4.	Sugars.			Polarization.			Approximate per cent glucose (dextrin×3).	Per cent dextrin.	Per cent alcohol precipitate.	Per cent sugar-free soluble solids.	Per cent total ash.	Alkalinity of ash as per cent K_2CO_3.	Sulphates as per cent potassium sulphate.	Chlorids as per cent sodium chlorid.	Starch.	Preservatives.	Foreign coloring matter.
						Per cent reducing sugar.	Per cent cane sugar.	Per cent total sugar.	Direct.	Invert.	Temperature, degrees C.											
20206	Apricot	70.10	...	0.594	...	...	25.32	...	+ 46.4	+ 12.6	21	13.65	4.55	...	...	0.387	0.299	...	...	...	Benzoic acid.	
20147	Blackberry[a]	69.69	1.41	.281	0.461	32.96	1.12	34.08	+107.0	+105.5	20	72.24	24.08	...	35.61	.458	.344	0.076	0.016	...	...	
F651	do.[b]	74.95	...	...	...	34.72	20.53	55.25	+ 68.2	+ 41.2	21	(c)	(c)	...	19.70	.447	.273	...	...	Present.	Benzoic acid.	Red coal tar.
19880	Cherry	69.60	...	...	...	...	12.67	...	+ 76.8	+ 60.0	20	...	...	...	...	...	...	...	...	...	...	Do.
19883	do.	71.35	...	.319	...	...	11.05	...	+ 74.8	+ 59.0	20	34.92	11.64	...	...	.409	.293	...	...	...	...	Azo red.
19957	do.[a]	69.59	...	...	.333	...	2.86	...	+ 68.8	+ 65.0	20	...	...	...	...	.578	.226	...	...	...	Salicylic acid.	
19960	do.	68.58	.38	.281	.353	28.00	18.95	46.95	+ 78.6	+ 53.2	20	48.60	16.20	...	21.24	.454	.286	.201	.003	Present.	Benzoic acid.	
20022	do.	63.67	2.03	.562	.558	35.14	11.54	46.68	+ 55.0	+ 39.6	21	30.72	10.24	...	16.99	.391	.311	.077	.010	do.	...	Red coal tar.
20027	do.	71.82	...	...	.380	...	11.59	...	+ 84.9	+ 68.5	19.5	...	...	...	...	.475	.336	...	...	...	...	Do.
20159	do.	68.60	1.61	.594	.372	37.12	22.03	59.15	+ 31.1	+ 1.8	22	12.87	4.29	...	9.45	.395	.324	.039	Trace.	...	Benzoic acid.	
20177	do.	75.99	...	.525	...	...	8.54	...	+113.4	+102.0	20	59.10	19.70	...	...	.588	.375	...	...	...	Saccharin	
20199	do.	68.82	2.09	.563	.485	38.06	21.20	59.26	+ 25.8	+ 2.6	20	9.72	3.24	...	...	.353	.231	.043	.006	...	Benzoic acid.	
20218	do.[a]	75.32	...	.806	...	...	11.20	...	+ 58.6	+ 43.6	...	39.66	13.22	...	...	.526	.407	...	...	...	do.	Do.
19881	Currant	72.91	...	...	.457	...	10.24	...	+ 79.20	+ 65.40	19.5	...	...	...	...	.410	.294	...	...	...	...	Do.
19884	do.	71.00	1.39	.388	.470	33.92	12.39	46.31	+ 81.00	+ 64.4	20	49.89	16.63	...	24.69	.410	.330	.093	.011	...	...	Azo red.
20026	do.[a]	69.99	...	...	...	...	7.64	...	+ 77.20	+ 67.1	21	...	...	...	...	.472	.275	...	...	...	...	Red coal tar.

20166	do	68.29	3.12	.294	1.039	54.21	5.93	60.14	+ .25	− 7.70	20	6.18	2.06		8.15	.315	.201	.058	.002			Do.
20204	do	63.46	1.77	.494	.558	36.10	10.22	46.32	+ 50.00	+ 36.30	20	31.87	10.59		17.14	.433	.311	.072	.030		Salicylic acid.[a]	Cochineal.
20207	do	62.38	3.43	.738	.676	37.96	9.33	47.29	+ 26.60	+ 14.1	20	23.91	7.97		15.09	.456	.311	.054	.012		Benzoic acid.	Do.
20220	do.[a]	65.14	1.48	.419	.407	32.48	4.03	36.51	+ 94.40	+ 89.0	20	63.03	21.01		28.63	.565	.270	.279	.018	Present.	do	Red coal tar.
21022	do	73.30	2.83	.806	.647	52.96	10.68	63.64	+ 15.40	+ 1.2	22	13.41	4.47		9.66	.453	.286	Trace.	Trace.			
F655	Currant	71.32				41.60	12.47	56.07	+ 62.8	+ 46.4	21	(c)	(c)		15.25	.446	.246			Abundant.	Benzoic acid.	Do.
19878	Gooseberry[a]	71.02					4.36		+ 71.7	+ 65.9	19.5					.493	.322				do	Do.
20201	do	65.52		.456			5.84		+ 24.0	+ 16.2	20	21.0	7.00			.387	.311				Salicylic acid.[a]	
19877	Grape[a]	73.46					11.76		+ 81.6	+ 65.9	21					.397	.229					Do.
20198	Orange	68.97	1.06	.312	.319	25.25	27.61	52.86	+ 64.60	+ 27.5	20	31.53	10.51		16.11	.373	.345	Trace.	.019		Benzoic acid.	
20584	do	71.81	1.22	.206	.559	36.66	25.75	62.41	+ 37.30	+ 2.80	20	12.33	4.11	1.680	9.40	.227	.241	Trace.	Trace.			
19876	Peach[a]	73.54			.211		18.07		+ 97.8	+ 73.8	21.5					.316	.271					
20158	do	65.83	.91	.456	.353	28.61	28.65	57.36	+ 42.4	+ 4.3	22	13.41	4.47		8.57	.430	.341	.062	.010		Benzoic acid.	
20187	Pear	68.34		.175			19.85		+ 80.6	+ 54.2	22	50.70	16.90			.385	.281					
20197	do	69.83	1.86	.312	.286	33.66	22.54	56.20	+ 39.0	+ 8.8	20	19.71	6.57		13.63	.241	.150	.041	.006		Salicylic acid.[a]	
20021	Plum	60.52		.319			1.80		+ 32.4	+ 30.0	22	29.43	9.81			.573	.290				Benzoic acid.	
20028	do.[a]	68.22			.289		8.73		+ 76.5	+ 64.9	29.5					.450	.276					
20148	do.[a]	63.19		.319			None		+ 67.4	+66.80	20	44.13	14.71			.440	.273				Benzoic acid.	
20200	do	60.35		.456			6.29		+ 30.4	+ 22.0	21	16.85	5.95			.392	.279				do	
F652	do	73.22				37.10	18.86	55.96	+ 68.8	+ 44.0	21	(c)	(c)		17.26	.336	.225			Abundant.	do	None.
19967	Quince[a]	69.71		.212			1.80		+ 83.0	+ 80.6	20	45.18	15.06			.325	.235					
20202	do	65.08	1.33	.206	.333	31.53	15.60	50.13	+ 41.5	+ 20.6	20	24.42	8.14		14.95	.299	.227	Trace.	.006		Benzoic acid.	Cochineal.

[a] See correspondence with manufacturers, p. 100. [b] The sample was composed in large part of dry, hard berries and consisted entirely of blackberries. [c] Present.

TABLE 24.—*Composition of jams containing glucose, but not so labeled*—Continued.

Serial number.	Description.	Per cent total solids.	Per cent insoluble solids.	Per cent of protein (N×6.25).	Acidity expressed as per cent H_2SO_4.	Sugars. Per cent reducing sugar.	Sugars. Per cent cane sugar.	Sugars. Per cent total sugar.	Polarization. Direct.	Polarization. Invert.	Polarization. Temperature, degrees C.	Approximate per cent glucose (dextrin×3.)	Per cent dextrin.	Per cent alcohol precipitate.	Per cent sugar-free soluble solids.	Per cent total ash.	Alkalinity of ash as per cent K_2CO_3.	Sulphates as per cent potassium sulphate.	Chlorids as per cent sodium chlorid.	Starch.	Preservatives.	Foreign coloring matter.
F 657	Quince.....	73.60	......	......	......	22.38	39.70	62.08	+ 72.6	+ 20.4	21	([a])	([a])	......	11.54	0.252	0.095	....	....	Small amount.	Benzoic acid.	Red coal tar.
19963	Raspberry .	70.48	1.18	0.281	0.500	36.74	3.28	30.02	+ 88.8	+ 84.4	20	76.68	25.56	......	30.46	.676	.329	0.630	0.026	Present.	.....do	Do.
19879	.....do......	74.21	......	......	.328	......	16.79	......	+ 82.3	+ 60.0	19.5	......	......	......	......	.413	.295	....	....	....	....	Do.
19959	.....do......	64.13	......	......	.412	......	......	......	+ 61.7	+ 61.3	19.5	......	......	......	......	.340	.075	....	....	....	Salicylic acid.	Pink coal tar.
19961	.....do......	69.65	......	.350	......	......	9.02	......	+ 72.4	+ 60.4	22	57.00	19.00	......	......	.474	.266	....	....	....	Benzoic acid.	Red coal tar.
19966	.....do.[b]	66.80	......	.319	......	......	5.26	......	+ 47.2	+ 40.4	22	17.85	5.95	......	......	.331	.229	....	....	....	....	
20190	.....do......	74.04	2.62	.419	.490	......	4.03	47.29	+ 72.6	+ 67.2	20	49.26	16.42	......	26.45	.511	.321	.207	.010	....	Benzoic acid.	Ponceau red.
20203	.....do......	66.18	......	.525	......	......	......	......	+ 45.4	+ 25.0	21	23.64	7.88	......	......	.360	.284	....	....	....	Salicylic acid.[b]	Pink coal tar.
20585	.....do......	72.72	3.74	.700	.588	36.86	15.28	61.24	+ 33.9	+ 1.15	20	11.82	3.94	1.126	11.48	.332	.276	Trace.	.007	....	.....do	
19958	.....do......	66.02	......	......	.477	......	24.38	......	+ 62.0	+ 61.7	20	......	......	......	......	.510	.118	....	....	....	....	Do.
F 654	.....do......	74.38	......	......	......	29.77	27.22	56.99	+ 70.4	+ 34.6	21	([a])	([a])	......	17.39	.372	.260	....	....	Considerable.	Benzoic acid.	Red coal tar.
19962	Strawberry	71.32	.66	.319	.510	33.78	9.48	43.26	+ 85.5	+ 75.8	20	69.33	23.11	......	28.06	.699	.425	.352	.025	Present.	.....do	Pink coal tar.
19964	.....do......	70.01	......	......	.367	......	.83	......	+ 62.9	+ 61.8	19.5	......	......	......	......	.481	.174	....	....	....	....	Do.
19988	.....do......	70.00	2.35	.631	......	37.02	20.60	57.62	+ 31.0	+ 3.4	20	12.33	4.11	......	12.38	.428	.312	.084	.008	....	Salicylic acid.	Red coal tar.
20146	.....do.[b]	66.05	......	.244	.465	......	1.05	......	+ 84.2	+ 82.8	22	57.78	19.26	......	......	.413	.293	....	....	....	....	

20165	.....do......	68.83	1.52	.350	.617	58.74	3.28	62.02	+ 6.0	— 3.8	20	8.40	2.80	......	6.81	.385	.241	....	.003	....	....	Orange coal tar.
20167	.....do......	70.87	1.77	.594	.534	31.52	29.03	60.55	+ 42.9	+ 4.0	20	15.72	5.24	2.62	10.32	.476	.341	.111	.006	....	Salicylic acid.	Red coal tar.
20205	.....do......	65.65	......	.456	......	......	13.33	......	+ 35.2	+ 20.4	21	19.95	6.65	......	......	.342	.279	....	....	....	.....do.[b] ..	Cochineal.
21021	.....do......	75.56	1.34	.594	.387	38.30	29.77	68.07	+ 38.0	— 1.6	20	12.60	4.20	......	7.49	.388	.308	Trace.	Trace.	....	....	
F 653	.....do......	74.18	......	......	......	34.88	17.80	52.68	+ 89.8	+ 66.4	21	([a])	([a])	......	21.50	.392	.140	....	....	None...	Benzoic acid.	Red coal tar.

[a] Present.

[b] See correspondence with manufacturers, p. 101.

Compound jams.—A discussion of the compound jams will serve also for the compound jellies. There is little difference in the formulas given by the manufacturers for the compound jellies and jams, and the difference in their composition is also slight. As a rule, the difference amounts to the addition of a little fruit pulp to the jams. Evaporated apple juice is the basis, to which is added a little of the fruit pulp of the kind desired. The pulp from which the juice has been pressed for making jelly, mixed with glucose and apple juice, makes up many of the compound jams. The consistency of these products is that of thick sirup. No. 19867 has 86.65 per cent of solids and is practically all glucose. The percentage of sugar is practically the same in all compound goods, whether jellies or jams, and the same is true of ash and solids. The nitrogen is a little higher in jams on account of the presence of a small amount of pulp.

TABLE 25.—*Description of compound jams.*

Serial number.	Manufacturer.	From whom purchased.	Claims of manufacturer.
	Blackberry.		
19867	West Virginia Preserving Co., Wheeling, W. Va.	R. W. Crounse, 950 Louisiana avenue, Washington, D. C.	Fort Henry Preserves: Fresh fruit, 30 per cent; evaporated apple juice, 25 per cent; corn sirup, 35 per cent; sugar, 10 per cent.
20153	Anderson Preserving Co., Camden, N. J.	Donahue & Kiernan, New York.	Eagle brand compound.
19868	J. Weller Co., Cincinnati, Ohio.	R. W. Crounse, 950 Louisiana avenue, Washington, D. C.	60 per cent fruit, 15 per cent sugar, 25 per cent corn sirup; Queen City preserves.
	Currant.		
19874	Vannill Preserving Co., Baltimore, Md.	R. W. Crounse, 950 Louisiana avenue, Washington, D. C.	Maryland brand compound.
	Peach.		
20149	Williams Bros. & Charbonneau, Detroit, Mich.[a]	Henry Barge, New York......	Maple Leaf peach preserves; 50 per cent fruit, 25 per cent glucose, 25 per cent cane.
	Plum.		
19869	West Virginia Preserving Co., Wheeling, W. Va.	R. W. Crounse, 950 Louisiana avenue, Washington, D. C.	Fort Henry Preserves: Extra quality fresh fruit, 30 per cent; evaporated apple juice, 25 per cent; corn sirup, 35 per cent; sugar, 10 per cent.
20151	Williams Bros. & Charbonneau, Detroit, Mich.[a]	Henry Barge, New York	Maple Leaf brand; 50 per cent fruit, 25 per cent granulated sugar, 25 per cent corn sirup.
20225	Crescent Preserving Co., Camden, N. J.	J. C. Ergood Co., Washington, D. C.	Ivanhoe brand compound.
	Raspberry		
19969	American Preserve Co	H. Punchard & Son, New York.	American compound.

[a] See correspondence with manufacturers, p. 104.

TABLE 25.—*Description of compound jams*—Continued.

Serial number.	Manufacturer.	From whom purchased.	Claims of manufacturer.
	Strawberry.		
19968	American Preserve Co	H. Punchard & Son, New York.	American compound strawberry jam.
20150	Williams Bros. & Charbonneau, Detroit, Mich.[a]	Henry Barge, New York	Maple Leaf brand; 50 per cent fruit, 25 per cent granulated sugar, 25 per cent corn sirup.
20219	P. J. Ritter Conserve Co., Philadelphia, Pa.	J. C. Ergood Co., Washington, D. C.	Favorite brand pure fruit preserves.
20227	The E. G. Dailey Co., Detroit, Mich.	....do	Fresh fruit jam compound; 50 per cent fresh fruit, 15 per cent corn sirup, 35 per cent granulated sugar.

[a] See correspondence with manufacturers, p. 104.

TABLE 26.—*Composition of compound jams.*

Serial number.	Description.	Per cent total solids.	Per cent insoluble solids.	Per cent protein (N×6.25).	Acidity expressed as per cent H_2SO_4.	Sugars.			Polarizations.			Approximate per cent glucose (dextrin×3).	Per cent dextrin.	Per cent total ash.	Alkalinity of ash as per cent, K_2CO_3.	Sulphates as potassium sulphate.	Chlorids as sodium chlorid.	Starch.	Preservatives.	Foreign coloring matter.
						Per cent reducing sugar.	Per cent cane sugar.	Per cent total sugars.	Direct.	Invert.	Temperature, degrees C.									
19867	Blackberry	86.65	......	0.350	......	......	4.18	......	+101.6	+ 96.0	20	91.92	30.64	0.638	0.351	......	......	....	Benzoic acid....	
20153	.....do............	74.80	2.16	.419	0.328	30.45	8.80	39.25	+119.8	+108.0	20	71.76	23.92	.582	.366	0.129	0.022	....	....	Red coal tar.
19868	.....do............	62.73	1.92	.387	.588	32.35	1.04	33.39	+ 86.4	+ 85.0	20	55.73	18.91	.587	.308	.186	.032	....	Salicylic acid [a] .	
19874	Currant..........	71.50	.70	.350	.402	29.92	None.	29.92	+136.6	+136.2	20	89.55	29.85	.687	.301	.396	.053	....	.....do..........	Do
20149	Peach............	66.17	......	.319	......	......	5.89	......	+ 96.6	+ 88.8	20	29.67	9.89	.469	.281	.125	.009	....	....	
19869	Plum	74.27	......	.281	......	......	....	......	+111.2	+110.0	22	98.76	9.81	.524	.376	......	......	....	Benzoic acid....	Do.
20151	... .do............	63.41	......	.244	......	......	None.	......	+ 83.6	+ 83.2	20	43.35	14.45	.482	.293	......	......	....	....	Pink coal tar.
20225	.....do............	70.08	.35	.281	.490	39.92	5.52	39.44	+ 99.2	+ 91.80	21	84.03	28.01	.502	.357	.084	.054	....	Benzoic acid....	
19969	Raspberry [a]	67.74	......	.594	......	......	None.	......	+105 0	+104.6	21	61.20	20.40	.657	.391	......	......	Present...	.....do..........	Ponceau red.
19968	Strawberry [a]	71.96	......	.350	......	......	1.19	......	+111.0	+109 4	20	64.35	21.45	.622	.398	......	......	.....do....	.....do..........	Do.
20150	.....do............	65.94	......	.244	......	......	1.50	......	+ 91.0	+ 89.0	22	46.74	19.26	.461	.263	......	......	....	....	Red coal tar.
20219	.....do. [b]..........	56.41	2.19	.456	.578	33.41	1.17	34.58	+ 56.40	+ 54.8	20	37.02	12.34	.582	.357	.085	.006	Present...	Benzoic acid....	Do.
20227	.....do............	73.32	......	.175	......	......	2.99	......	+116.8	+112.8	20	58.05	19.35	.478	.335	......	......	....	.....do..........	Do.

[a] See correspondence with manufacturers, p. 99.

[b] See correspondence with manufacturers, p. 103.

JELLIES.

Fifty-eight samples of jellies were analyzed, of which number 44 were commercial products; the remaining 14 were prepared in the laboratory. Of the commercial samples, 19 contained no glucose, 13 contained glucose, but were not so labeled, and the remaining 12 were purchased on the market as compound goods. The general discussion under jams (p. 53 and following) applies also to jellies, owing to the similarity of the products. The jellies are classified upon the same basis as the jams into "Jellies containing no glucose," "Jellies containing glucose, but not so labeled," and "Compound jellies."

Jellies containing no glucose.—Thirty-three of the total number of 58 jellies examined were found to contain no glucose. The amount of solids is extremely variable, the maximum being 80.28 and the minimum 45.56 per cent. The commercial jellies are very much less variable than the homemade products and probably for the reason brought out in Table 31, which shows that the manufacturer, by the use of apple as a basis, is able to produce very uniform products with fruits of widely different gelatinizing powers. The percentage of ash is as variable as the solids, but the alkalinity, sulphates, and chlorids have the same relation to the total ash as in the pure fruit jams.

TABLE 27.—*Description of jellies containing no glucose.*

Serial number.	Manufacturer.	From whom purchased.	Price.	Claims of manufacturer.
	Apple.			
20023	R. H. Macy & Co., New York	R. H. Macy & Co., New York.	$0.29	Macy's crab-apple jelly.
20226	Campbell Preserving Co	J. C. Ergood Co., Washington, D. C.	.10	Apple jelly, lemon flavor.
20408	Made in laboratory			
21062	Dodson, Braun & Co., St. Louis	J. G. Swarbrick, 21 Camp street, New Orleans, La.	.20	Apple jelly.
	Blackberry.			
20405	Made in laboratory			
	Crab apple.			
20410	Made in laboratory			
	Currant.			
19890	Hazel Pure Food Co., New York and Chicago.	Siegel, Cooper & Co., New York.	.25	Hazel's currant jelly.
20024	R. H. Macy & Co., New York	R. H. Macy & Co., New York.	.29	Currant jelly.
20169	Miss Martin, Willowbank, N. Y.	C. C. Bryan, Washington, D. C.	.40	Do.
20170	Mrs. S. C. Stone, New Haven, Conn.	do	.40	Spiced currant jelly.
20180	Oneida Community, Ltd., Kenwood, N. Y.	N. W. Burchell, Washington, D. C.	.25	Black currant jelly.
20210	Curtice Bros. Co., Rochester, N. Y.	G. G. Cornwell & Son, Washington, D. C.	.25	Red currant jelly.
20214	do	do	.25	Black currant jelly.

TABLE 27.—*Description of jellies containing no glucose*—Continued.

Serial number.	Manufacturer.	From whom purchased.	Price.	Claims of manufacturer.
	Grape.			
20184	J. P. Smith, New York	N. W. Burchell, Washington, D. C.	$0.25	
20189	Geo. E. Wales, Newton Center Mass.	do	.40	
20405	Made in laboratory			
	Guava.			
20246	Jalma Lapham, Indianola, Fla.	Park & Tilford, New York	.35	
21084	S. W. Clark & Son	A. M. & J. Solari, Royal and Customhouse streets, New Orleans, La.	.40	
	Huckleberry.			
20412	Made in laboratory			
	Lemon.			
20173	Gordon & Dilworth, New York	C. C. Bryan, Washington, D. C.	.30	
	Orange.			
20435	Made in laboratory			
	Peach.			
20437	Made in laboratory			
	Pear.			
20434	Made in laboratory			
	Pineappple.			
20436	Made in laboratory			
	Pineapple husk.			
20433	Made in laboratory			
	Plum.			
20404	Made in laboratory			
20409	do			
20411	do			
	Raspberry.			
20185	J. P. Smith, New York	N. W. Burchell, Washington, D. C.	.25	Raspberry.
20188	Geo. E. Wales, Newton Center, Mass.	do	.40	Raspberry jelly.
	Strawberry.			
20172	Gordon & Dilworth, New York	C. C. Bryan, Washington, D. C.	.30	Strawberry.
20186	J. P. Smith, New York	N. W. Burchell, Washing- D. C.	.25	Do.
	Mixed fruit.			
20407	Made in laboratory			

TABLE 28.—*Composition of jellies containing no glucose.*

Serial number.	Description.	Per cent total solids.	Per cent protein (N × 6.25).	Acidity expressed as per cent H_2SO_4.	Sugars.			Polarization.			Per cent dextrin.	Per cent alcohol precipitate.	Per cent sugar-free solids.	Per cent total ash.	Alkalinity of ash as per cent K_2CO_3.	Sulphates as potassium sulphate.	Chlorids as sodium chlorid.	Starch.	Preservatives.
					Per cent reducing sugar.	Per cent cane sugar.	Per cent total sugar.	Direct.	Invert.	Temperature, degrees C.									
20023	Apple	62.67	0.175	0.235	34.08	25.45	59.53	+16.20	−17.90	20	......	0.81	3.11	0.100	0.150	Trace.	Trace.	....	Salicylic acid.
20226	.....do	66.06	.112	.608	51.52	11.53	63.05	−6.90	−22.35	20	......	1.13	2.90	.260	.248	Trace.	0.011	....	
20408	.....do	59.18	.175	.279	20.78	33.04	53.82	+24.00	−20.60	18	......	......	5.36	.220	......	....	....	....	
21062	.....do	60.86	.213	.686	37.50	18.13	55.63	+4.00	−20.30	20	......	1.30	5.23	.354	.302	0.054	Trace.	Present.	
20405	Blackberry	59.63	.243	.475	12.51	44.90	57.41	+47.00	−20.10	18	......	......	2.22	.330	......	....	....	....	
20410	Crab apple	63.28	.137	.171	34.93	23.68	58.61	+13.00	−19.00	18	......	......	4.67	.110	......	....	....	....	
19890	Currant	64.21	.312	1.362	54.37	4.70	59.00	−11.80	−18.10	20	......	3.36	5.14	.438	.416	.035	Trace.	....	
20024	.....do	62.46	.175	1.058	52.74	7.16	59.90	9.10	−18.70	20	......	1.39	2.52	.272	.264	Trace.	Trace.	....	Do.
20169	.....do	66.22	.212	.923	54.20	11.50	65.70	5.90	−21.30	20	......	1.18	.52	.222	.221	Trace.	Trace.	....	
20170	.....do	70.31	.281	.926	58.79	7.09	65.79	−10.50	−20.00	20	......	2.11	4.43	.334	.312	Trace.	Trace.	....	Do.[a]
20180	.....do	75.03	.212	1.146	46.56	22.69	69.25	+8.10	−22.30	20	......	2.87	5.78	.474	.436	.054	Trace.	....	
20210	.....do	68.77	.212	1.078	53.97	10.52	64.49	−7.90	−22.00	20	......	1.70	4.28	.414	.393	Trace.	Trace.	....	Benzoic acid.
20214	.....do	59.37	.312	1.573	51.20	3.96	55.16	−12.90	−18.20	20	......	......	4.21	.624	.511	.058	Trace.	....	
20184	Grape	70.66	.175	.314	49.76	14.37	64.13	+.15	−19.15	20	......	1.25	6.53	.214	.276	Trace.	Trace.	....	
20189	.....do	72.22	.212	.833	64.27	3.47	67.74	−17.25	−21.90	20	......	2.49	4.48	.346	.234	Trace.	Trace.	....	
20405	.....do	63.66	.175	.524	32.29	30.52	62.81	+22.30	−18.90	18	......	......	.85	.450	......	....	....	....	
20246	Guava	79.97	.175	.470	31.46	43.43	74.89	+33.40	−24.80	20	......	1.36	5.08	.448	.414	Trace.	Trace.	....	
21084	.....do	79.14	.175	.470	30.66	44.25	75.91	+35.20	−24.10	20	......	1.59	4.23	.384	.349	Trace.	Trace.	....	
20412	Huckleberry	63.02	.069	.245	24.27	32.74	57.01	+24.10	−20.10	18	......	......	......	.280	......	....	....	....	
20173	Lemon	64.62	.112	.456	54.18	7.31	61.49	10.00	−19.80	20	......	.73	3.13	.206	.194	Trace.	Trace.	....	
20435	Orange	68.56	.418	.171	3.95	62.52	66.47	+61.30	−23.10	18	......	......	2.09	.300	......	....	....	....	
20437	Peach	69.98	.175	.245	8.75	56.59	65.34	+53.40	−23.00	18	......	......	4.64	.210	......	....	....	....	
20434	Pear	69.12	.156	.181	6.58	58.46	65.04	+52.70	−26.20	18	......	......	4.08	.340	......	....	....	....	
20436	Pineapple	80.28	.387	.328	22.13	56.70	78.83	+50.40	−26.10	18	......	......	1.45	.430	......	....	....	....	

[a] See correspondence with manufacturers, p. 103.

TABLE 28.—*Composition of jellies containing no glucose*—Continued.

Serial number.	Description.	Per cent total solids.	Per cent protein (N×6.25).	Acidity expressed as per cent H_2SO_4.	Sugars.			Polarization.			Per cent dextrin.	Per cent alcohol precipitate.	Per cent sugar-free solids.	Per cent total ash.	Alkalinity of ash as per cent K_2CO_3.	Sulphates as potassium sulphate.	Chlorids as sodium chlorid.	Starch.	Preservatives.
					Per cent reducing sugar.	Per cent cane sugar.	Per cent total sugar.	Direct.	Invert.	Temperature, degrees C.									
20433	Pineapple husk	76.34	0.350	0.352	7.40	65.22	72.62	+63.70	−24.30	18			3.72	0.730					
20404	Plum	45.56	.350	1.127	19.18	22.67	41.85	+17.80	−12.80	18			3.71	.680					
20409	do	54.49	.138	1.029	24.00	25.48	49.48	+16.70	−17.80	18			5.01	.400					
20411	do	73.01	.175	1.529	44.22	22.37	66.59	+ 7.60	−22.60	18			6.42	.650					
20185	Raspberry	70.07	.175	.333	46.46	16.79	63.25	+13.70	− 8.80	20		1.45	6.82	.244	0.257	Trace.	Trace.		
20188	do	74.53	.312	.828	65.52	5.07	70.59	−14.00	−20.80	20		.77	3.94	.310	.241	Trace.	Trace.		
20172	Strawberry	68.11	.175	.289	40.83	22.24	63.07	+12.20	−17.60	20		.89	5.04	.208	.207	Trace.	Trace.		
20186	do	67.50	.175	.294	44.56	18.00	63.56	+ 7.50	−16.60	20		1.47	5.44	.210	.311	Trace.	Trace.		
20407	Mixed fruit	66.58	.069	.367	39.70	24.22	63.92	+14.80	−17.90	18			2.66	.210					
	Average	67.13	.208	.633	37.07	25.96						2.53	4.05	.345	.302	.011	.001		
	Maximum	80.28	.418	1.573	65.52	65.22						3.36	6.82	.730	.511	.058	.011		
	Minimum	45.56	.069	.171	3.95	3.47						.73	.52	.100	.150	Trace.	Trace.		

The polarization after fermentation in all these jellies was practically zero, showing that there was no dextrin present. The percentage of sugar-free solids is fairly uniform, averaging 4.05 per cent, with a maximum of 6.82. The value of this fact will be seen in dealing with the commercial jellies containing glucose in which the sugar-free solids may be from 30 to 40 per cent.

The protein content is chiefly of value in the detection of the addition of gelatin, but in all the samples examined, of all grades and kinds, there were none that gave any indication of having received additions of gelatin.

The average content of protein is but 0.208 per cent, and it would take only a very slight addition of gelatin to raise the protein content much above the normal. It is very probable that gelatin would not be used for other reasons, since it spoils very easily.

The most striking fact brought out by the table is that none of these jellies shows any added coloring matter. They are the highest grade products, except that some of them contain preservatives, and this would indicate that a good product can be made on a commercial scale without the use of glucose or coloring matter. This also disproves the claim made by some manufacturers that it is necessary to add glucose to jellies in order to prevent crystallization of the sugar. In the jellies in this table the sugar content ran as high as 74 per cent, and in only two cases was there any crystallization of sugar. These were 20188, having 70.59 per cent of total sugar, of which 65.52 per cent was reducing sugar, and 20170, with 65.88 per cent of total sugar, of which 58.79 per cent was reducing sugar. In both cases it was the dextrose that had crystallized.

To show the uniformity of jellies from one manufacturer, and also to call attention to the desirability of comparing closely the products of a single manufacturer, the following table has been prepared, which shows that it is possible for the manufacturer to obtain from strawberries and raspberries, two fruits which jelly only with difficulty, as firm a jelly as can be made from the apple and the quince, which are considered the best jellying fruits.

TABLE 29.—*Analyses of the products from one manufacturer.*

Samples.	Solids.	Ash.	Protein N × 6.25.	Acid, as H_2SO_4.	Total sugar.	Dextrin.	Alcohol precipitate.	Sugar-free solids.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Apple	64.46	0.210	0.249	0.625	57.00	....	4.22	7.46
Grape	63.26	.342	.216	.634	54.76	2.94	4.35	8.50
Quince	60.48	.355	.139	.510	52.34	3.22	3.31	8.14
Raspberry	61.28	.316	.178	.574	55.04	3.31	4.01	6.24
Strawberry	62.94	.387	.249	.684	52.60	5.10	3.46	10.34

All these jellies were uniform in consistency and appearance, except in color, and the analyses show practically the same percentage of solids and sugar. When we consider that the apple and the strawberry are nearly opposites as far as gelatinizing power goes, it is remarkable that this can be accomplished with the same amount of sugar. The explanation is simple. There is little doubt that apple is the basis of all these products, and only enough of the fruit indicated on the label is added to give the desired flavor.

Jellies containing glucose but not so labeled.—There is little to be said about the jellies included in these tables. They embrace jellies of nearly all grades, from the cheapest to the highest priced. Six contain only very small amounts of glucose, which may have been added for the purpose of preventing the crystallization of the cane sugar. But the firm putting out these goods have since decided that glucose is not necessary for this purpose and claim to have given up its use. What has been said in the general discussion of jams and jellies applies here as well. Five of these jellies were colored and nine contained preservatives.

TABLE 30.—*Description of jellies containing glucose but not so labeled.*

Serial number.	Manufacturer.	From whom purchased.	Price.	Claims of manufacturers.	Remarks.
	Apple.				
20174	....	C. C. Bryan, Washington, D. C.	$0.25	Apple................	Full of coarse particles; moldy on top.
20209	Curtice Bros. Co., Rochester, N. Y.	G. G. Cornwell & Son, Washington, D. C.	.25	Pure apple jelly.	
	Currant.				
20221	P. J. Ritter Conserve Co., Philadelphia, Pa.	J. C. Ergood & Co., Washington, D. C.	.15		
	Grape.				
20213	Curtice Bros. Co., Rochester, N. Y.	G. G. Cornwell & Son, Washington, D. C.	.25	Pure grape jelly.	
F 662	Sprague, Warner & Co., Chicago, Ill.	See & Co., Chicago, Ill.	.10	Grape; Manhattan brand fresh fruit jelly. Packed from choicest stock.	
	Guava.				
20996	Viaberay & Co., Habana.	A. M. & J. Solari, New Orleans, La.	.20		
	Lemon.				
19882	Hazel Pure Food Co., New York and Chicago.	Siegel-Cooper Co., New York.	.25	Hazel lemon jelly..	Strongly flavored with lemon.
F 661	Sprague, Warner & Co., Chicago, Ill.	See & Co., Chicago, Ill.	.10	Lemon jelly; Manhattan brand fresh fruit jelly. Packed from choicest fruit.	

TABLE 30.—*Description of jellies containing glucose, but not so labeled*—Continued.

Serial number.	Manufacturer.	From whom purchased.	Price.	Claims of manufacturers.	Remarks.
	Plum.				
19887	Milford Manufacturing Co., Chicago.	Siegel-Cooper Co., New York.	$0.17	....	Moldy on top; also contained large number of crystals of acid tartrate of potash.
	Quince.				
20212	Curtice Bros. Co., Rochester, N. Y.	G. G. Cornwell & Son, Washington, D. C.	.25	Pure quince jelly.	
20222	P. J. Ritter Conserve Co., Philadelphia, Pa.	J. C. Ergood & Co., Washington, D. C.	.15		
F 660	Sprague, Warner & Co., Chicago, Ill.	See & Co., Chicago, Ill.	.10	Quince jelly; Manhattan brand fresh fruit jelly. Packed from choicest fruit.	
	Raspberry.				
19886	Milford Manufacturing Co., Chicago.	Siegel-Cooper Co., New York.	.17	Raspberry jelly.	
20154	Ayer Preserving Co., Ayer, Mass.	Donahue & Kiernan, New York.	.12		
20211	Curtice Bros. Co., Rochester, N. Y.	G. G. Cornwell & Son, Washington, D. C.	.25	Pure raspberry jelly	
F 658	Sprague, Warner & Co., Chicago, Ill.	See & Co., Chicago, Ill.	.10	Raspberry jelly; Manhattan brand fresh fruit jelly. Packed from choicest fruit.	
	Strawberry.				
20208	Curtice Bros. Co., Rochester, N. Y.	G. G. Cornwell & Son, Washington, D. C.	.25	Pure strawberry jelly.	

TABLE 31.—*Composition of jellies containing glucose but not so labeled.*

Serial number.	Description.	Per cent total solids.	Per cent protein (N×6.25).	Acidity expressed as per cent H_2SO_4.	Sugars. Per cent reducing sugar.	Sugars. Per cent cane sugar.	Sugars. Per cent total sugars.	Polarizations. Direct	Polarizations. Invert.	Polarizations. Temperature, degrees C.	Approximate per cent glucose (dextrin×3).	Per cent dextrin.	Per cent alcohol precipitate.	Per cent sugar-free solids.	Per cent total ash.	Alkalinity of ash as per cent K_2CO_3.	Sulphates as per cent potassium sulphate.	Chlorids as per cent sodium chlorid.	Starch.	Preservatives.	Foreign coloring matter.
20174	Apple......	65.57	0.281	0.614	38.13	None.	38.13	+114.7	+114.5	20	71.7	23.90	9.61	27.44	0.392	0.276	0.110	0.011	....	Saccharin.	
20209	.....do......	63.19	.244	.613	38.13	17.76	55.89	+ 35.0	+ 11.2	20	Present.[a]	......	4.14	7.30	.206	......	.076	Trace.	Present.	Benzoic acid.	
20221	Currant[b]...	71.86	.175	.417	37.66	17.24	54.90	+ 58.9	+ 35.8	20	31.50	10.50	11.37	16.96	.444	.376	.088	.011	Present.	.....do....	Coal-tar dye.
20213	Grape......	62.02	.212	.622	44.35	9.37	53.72	+ 7.2	− 5.35	20	[a]8.67	2.89	4.27	8.30	.336	.330	Trace.	Trace.	Present.	Salicylic acid.[a]	Cochineal.
F662[c]	Grape......	61.87	......	......	33.93	1.50	35.43	+ 95.8	+ 93.8	21	....	......	......	26.44	.686	.071	......	......	Small amt.	Benzoic acid.	Red coal tar.
20996	Guava.....	78.57	.175	.450	36.32	32.09	68.41	+ 39.0	− 4.0	20	11.82	3.94	9.69	10.36	.538	.422	.112	.010	....	....	
19882	Lemon.....	67.74	.281	.607	53.76	4.33	58.09	+ 22.0	+ 16.2	20	19.95	6.65	8.11	9.65	.262	.253	.026	.020	....	....	
F661[d]	.....do......	61.03	......	......	30.16	None.	30.16	+103.8	+102.2	21	....	......	......	30.87	.419	.225	......	......	([e])	Benzoic acid.	Yellow coal tar.
19887	Plum......	66.58	.175	.897	37.02	None.	37.02	+ 97.2	+ 97.4	20	72.75	24.25	31.50	29.96	.387	.315	.059	.034	Trace.	....	
20212	Quince.....	59.27	.137	.500	34.91	16.42	51.33	+ 17.0	− 5.0	20	[a]9.48	3.16	3.25	7.94	.348	.315	Trace.	.005	....	Benzoic acid.	Do.
20222	.....do.[b]....	65.92	.175	.402	34.56	17.01	51.57	+ 53.8	+ 31.0	20	27.06	9.02	11.77	14.35	.422	.319	.088	.010	Present.	.....do....	
F660[f]	Quince.....	60.82	......	......	32.45	None.	32.45	+100.4	+100.4	21	....	......	......	28.37	.715	.002	......	......	Abundant.	.....do....	Slight coal tar.
19886	Raspberry.	62.80	.212	.662	38.53	None.	38.53	+ 68.2	+ 68.2	20	52.53	17.51	14.98	24.29	.500	.290	Trace.	Trace.	....	....	
20154	.....do......	72.67	.244	.607	46.13	1.20	47.33	+ 84.20	+ 82.6	20	....	13.31	14.26	25.34	.386	.338	Trace.	.052	Present.	Salicylic acid.	
20211	.....do......	60.08	.175	.563	44.26	9.70	53.96	+ 9.0	− 4.0	20	[a]9.75	3.25	3.93	6.12	.310	.259	Trace.	.005	Present.	Benzoic acid.	Do.
F658[g]	Raspberry.	62.97	......	......	32.53	1.05	33.58	+102.6	+101.2	21	....	......	......	29.39	.684	.106	......	......	Abundant.	.....do....	Red coal tar.
20208	Strawberry	61.70	.244	.671	47.84	3.73	51.57	+ 10.6	+ 5.6	20	[a]15.00	5.00	3.40	10.13	.380	.338	Trace.	.017	Present.	Salicylic acid.[a]	Do.

[a] See correspondence with manufacturers, page 101.
[b] See correspondence with manufacturers, page 103.
[c] Sample contains 0.17 per cent phosphoric acid.
[d] Sample contains 0.04 per cent phosphoric acid.
[e] Very strong test.
[f] Sample contains 0.14 per cent phosphoric acid.
[g] Sample contains 0.15 per cent phosphoric acid.

Compound jellies.—The table of compound jellies includes only the goods marked compound. The formulæ for eight of these samples are given, and according to these there is great similarity in composition. All claim at least 50 per cent of fruit juice, mostly apple, from 5 to 10 per cent of cane sugar, and from 35 to 45 per cent of glucose. A jelly prepared according to such a formula would contain less than 50 per cent of solids, whereas the majority of the samples examined contained over 70 per cent. It is therefore apparent from the percentage of solids that, if the formula is correctly represented on the label, the products have either been highly concentrated by evaporation or else the apple juice was very concentrated.

Only two samples, 20223 and 20224, were actually jellies; the others were thick sirups with not the slightest appearance of jelly. If these jellies were boiled down after the sugar was added it might account for the entire lack of any cane sugar in the final product; but if highly concentrated apple juice was used and only heated a little, as is ordinarily the case in making jellies, there should be some of the cane sugar uninverted, especially where, as in 20232, it is claimed that sugar has been added. The percentage of dextrin in some of these products is very high, and it is evident that the factor 3 can not be used for the calculation of the approximate per cent of glucose. It is probable that in the preparation of such samples confectioners' glucose has been used, which is not completely converted, and consequently the product has a very high dextrin content. But even using the factor 2 to determine the amount of added glucose, a factor which is very much lower than that given by any glucose product described by Saare,[a] the amount of glucose is still much higher than is indicated in the formula. The ash also indicates that a very different kind of glucose has been used from that employed in the samples mentioned in Table 4.

It is said that some manufacturers of cheap jellies use starch as a base, which they partially hydrolyze with phosphoric or sulphuric acid, without purifying the product in any way, except neutralizing the acid.

In seven of these samples the amount of sulphates in the ash is very much higher as a rule than in the pure glucose ashes in the above-mentioned table. As might be expected, starch was found in nearly all the compound jellies. The source of the starch was probably the apple used as the basis. In case confectioners' glucose is used, however, it may give an appreciable starch reaction.

[a] O. Saare, Die Ind. der Stärke und Stärkefabrikate in den Vereinigten Staaten von Amerika. Berlin, 1896.

TABLE 32.—*Description of compound jellies.*

Serial number.	Description and manufacturer.	From whom purchased.	Price.	Claims of manufacturer.	Remarks.
	Apple.				
19865		R. W. Crounse, 950 Louisiana avenue, Washington, D. C.	$0.20	50 per cent evaporated apple juice, 45 per cent glucose, 5 per cent sugar.	Large amount of insoluble matter present; 3-pound pail, 20 cents.
20224	P. J. Ritter Conserve Co., Philadelphia.	J. C. Ergood & Co., Washington, D. C.	.10	Strawberry flavor; Favorite brand compound.	
20232	The E. G. Dailey Co., Detroit	Park & Tilford, New York		Compound, 50 per cent evaporated apple juice, 40 per cent corn sirup, 10 per cent sugar.	
	Currant.				
19864	Grocers Preserve Co., Boston	R. W. Crounse, 950 Louisiana avenue, Washington, D. C.	.15	50 per cent evaporated apple juice, 45 per cent glucose, 5 per cent sugar.	Large amount of insoluble matter present; 3-pound pail, 15 cents.
19970	E. G. Dailey Co., Detroit	H. Punchard & Son, New York	.18	do	Large amount of insoluble matter present; 2 pounds for 18 cents.
20155	Ayer Preserve Co., Ayer, Mass.	Donahue & Kiernan, New York	.12	40 per cent evaporated apple juice, 10 per cent fruit, 35 per cent glucose, 15 per cent sugar.	Moldy on top.
20156		do	.15	50 per cent evaporated apple juice, 45 per cent glucose, 5 per cent sugar.	Large amount of insoluble matter present; 3-pound pail, 15 cents.
20216	American Preserve Co., Philadelphia.	J. C. Ergood & Co., Washington, D. C.	.10	Compound jelly	
20223	P. J. Ritter Conserve Co., Philadelphia.	do	.10	Currant flavor; Favorite brand compound.	
	Grape.				
19971	E. G. Dailey Co., Detroit, Mich	H. Punchard & Son, New York	.18	Flavored grape jelly; 50 per cent evaporated apple juice, 45 per cent glucose, 5 per cent sugar.	2 pounds for 18 cents
	Peach.				
20217	American Preserve Co., Philadelphia, Pa.	J. C. Ergood & Co., Washington, D. C.	.10	Compound jelly	
	Strawberry.				
20157		Donahue & Kiernan, New York	.15	50 per cent evaporated apple juice, 45 per cent glucose, 5 per cent sugar.	Large amount of insoluble matter present; 3-pound pail, 15 cents.

TABLE 33.—*Composition of compound jellies.*

Serial number.	Description.	Per cent total solids.	Per cent of protein. (N × 6.25.)	Acidity expressed as per cent H_2SO_4.	Sugars. Per cent reducing sugars.	Sugars. Per cent cane sugar.	Sugars. Total sugar.	Polarization. Direct.	Polarization. Invert.	Polarization. Temperature, degrees C.	Per cent glucose (dextrin × 3).	Per cent dextrin.	Per cent alcohol precipitate.	Per cent sugar-free solids.	Per cent total ash.	Alkalinity of ash as per cent K_2CO_3.	Per cent potassium sulphate.	Per cent sodium chlorid.	Starch.	Preservatives.	Foreign coloring matter.
19865	Apple	75.05	0.244	0.745	37.44	None.	27.44	+131.80	+131.8	20	([a])	35.98	......	37.61	0.648	0.146	0.546	0.005	Present...	....	Red coal tar.
20224	.....do.[b]	65.34	.244	.515	35.70	4.44	40.14	+99.85	+ 94.00	20	64.35	21.45	8.22	25.20	.616	.396	.216	Trace.	Present...	Benzoic acid.	
20232	.....do.[c]	63.82	......	.592	......	None.	......	+119.20	+119.2	21	......	......	......	......	.538	.245	....	....	....	....	
19864	Currant	77.02	.244	.686	37.66	None.	37.66	+136.2	+136.2	20	94.02	31.34	39.83	39.36	.644	.215	.498	.027	Present...	....	Do.
19970	.....do.[c]	70.80	.244	.588	30.53	None.	30.53	+133.6	+134.4	20	92.64	30.88	40.63	40.27	.626	.374	.058	Trace.	Present...	....	
20155	.....do	69.65	.244	.598	44.03	1.34	45.37	+ 78.30	+ 76.50	20	43.86	14.62	13.20	24.28	.576	.307	.200	.029	Present...	Salicylic acid.	
20156	.....do	76.37	.175	.549	29.73	None.	29.73	+153.8	+152.4	20	([a])	38.25	43.84	46.64	.648	.229	.448	.011	Present...	....	Do.
20216	.....do.[d]	74.01	.212	.304	27.44	21.20	48.54	+100.30	+ 71.90	20	......	......	23.43	25.37	.379	.314	Trace.	.090	....	....	Do.
20223	.....do.[b]	65.53	.350	.418	30.94	4.92	35.86	+ 96.30	+ 88.70	20	63.90	21.30	25.30	29.69	.736	.400	.344	.060	....	Benzoic acid.	Do.
19971	Grape[c]	72.77	.212	.578	31.84	None.	31.84	+141.40	+141.40	20	92.43	30.81	38.05	40.93	.636	.395	.179	.005	Present...	....	
20217	Peach[d]	70.04	.244	.318	32.32	14.74	47.06	+ 85.35	+ 65.65	20	......	......	16.49	22.98	.336	.192	Trace.	.040	Present...	....	
20157	Strawberry ...	75.90	.175	.686	29.98	None.	29.98	+159.2	+159.2	20	([a])	39.14	40.99	45.92	.688	.229	.557	.016	Present...	....	Do.

[a] A grade of glucose was used having very high content of dextrin.

[b] See correspondence with manufacturers, p. 103.

[c] See correspondence with manufacturers, p. .102

[d] See correspondence with manufacturers, p. 99.

Six of these jellies are important enough to be put in a separate table, as they illustrate several points very well. They are the cheapest jellies on the market, not costing at retail more than 5 cents a pound. Nos. 19964, 19965, 19970, 19971, 20156, and 20157 are products of three different factories. The glucose used in 19970 and 19971 is evidently not the same grade or made by the same process of manufacture as that employed in the others, as its ash is entirely different. In four of these the percentage of dextrin exceeds that of the sugars. Apparently they are glucoses much like the confectioners' glucose, of which 46 to 48 per cent of the solids are sugar and there is still a slight starch reaction.

TABLE 34.—*Six of the cheapest jellies.*

Serial number.	Solids.	Ash.	Sulphates as potassium sulphate.	Chlorids as sodium chlorid.	Total sugar.	Polarization.	Sugar-free solids.	Dextrin.
19864	77.02	0.644	0.498	0.027	37.66	136.2	39.36	31.34
19865	75.05	.648	.546	.005	37.44	131.8	37.61	35.98
19970	70.80	.626	.058	Trace.	30.53	133.6	40.27	30.88
19971	72.77	.636	.179	.005	31.84	141.4	40.93	30.81
20156	69.65	.576	.448	.011	29.73	153.8	46.64	38.25
20157	75.90	.686	.557	.016	29.98	159.2	45.92	39.14

CANNED FRUITS.

Fruits put up in hermetically sealed receptacles of either glass or tin are so distinctly in a class by themselves that the discussion already given of jams and jellies is applicable only so far as it concerns the original fruit and the detection of the various forms of adulteration. In the manufacture of jams and jellies the tendency is to produce a material of uniform consistency, and to do this it is necessary that the products have a somewhat constant composition. With canned fruits, on the other hand, consistency is not an essential feature, and the ingredients added, depending upon the product desired, may vary within wide limits. Goods of this class do not yield themselves so readily to adulteration as do those already considered. They are preserved whole or in pieces of considerable size. The general appearance of the fruit is thus retained, and by means of a macroscopic examination the analyst can detect the presence of foreign fruit. Thus the substitution of cheap fruit for the more expensive kinds is not practiced here.

The most important considerations in the examination of canned fruits are: The general quality of fruit employed, the density of sirup, the presence or absence of such materials as glucose, saccharin, foreign coloring matter and preservatives, and the fidelity of label regarding the variety of fruit employed and the name and location of manufacturer.

The fruits examined are described in Table 35, following.

TABLE 35.—*Description of canned fruit.*

Serial number.	Description and manufacturer.	From whom purchased.	Claims of manufacturers.	Remarks.
	Apples.			
20236	Dale Bros., Oneida County, N. Y	Park & Tilford, New York	Clover brand apples	
	Apricots.			
19900	Vacaville Preserving Co., Sacramento Cal.	Siegel-Cooper Co., New York	Royal Red apricots, finest quality	
20239	Maryville Fruit Packing Company, Maryville, Cal.	Park & Tilford, New York	Extra dessert fruit	
20611	August Schmidt	R. H. Macy & Co, New York	Aprikosen	
21049	L. Morel, Posen, Germany	J. G. Swarbrick, 321 Camp street, New Orleans, La.	Apricots	
	Blackberries.			
19892	Gibbs Preserving Co., Baltimore, Md	Siegel-Cooper Co., New York	Lawton dessert blackberries	
	Blueberries.			
20249	J. & E. A. Wyman, Cherryfield, Me	Park & Tilford, New York	Extra quality Maine blueberries	
	Cherries.			
19885	Hazel Pure Food Co., New York and Chicago.	Siegel-Cooper Co., New York	Red cherries	
20195	Gordon & Dilworth, New York	G. G. Cornwell & Son, Washington, D. C	Fresh red cherries	
20240	Hooven Mercantile Co., New York	Park & Tilford, New York	Bonita brand	
20242	Mack & Lyon, Detroit, Mich	do	Fresh cherries	
20243	Ellen H. North, Genesee, N. Y	do	Red cherry preserves	
20248	Wayne Preserving Co., Fairport, N. Y	do	Pitted cherries	
20546	W. Laaff, Mainz, Germany	Hanscom Bros., 1311 Market street, Philadelphia.	Kirschen	
19895	Oneida Community, Ltd., Kenwood, N. Y.	Siegel-Cooper Co., New York	Choice red pitted cherries	
19898	Sacramento Preserving Co., Sacramento, Cal.	do	Royal Red brand black cherries (all goods under this brand guaranteed).	
20136	Sutter Canning and Packing Co., Yuba City, Cal.	Henry Barge, New York	Extra California black cherries	

TABLE 35.—*Description of canned fruit*—Continued.

Serial number.	Description and manufacturer.	From whom purchased.	Claims of manufacturers.	Remarks.
	Cherries—Continued.			
20138	Seeman Bros., New York	Henry Barge, New York.	Waverly California white cherries	
20230	G. Amandus, Mainz, Germany	Park & Tilford, New York	Red cherries	
20834			Compote de Cerises au Sirop guaranti pur sucre.	
21035	Augustus Besse, Bordeaux	Popovich & Abramovich, New Orleans, La.	Bigarreaux au Marasquin	
21052	La Porte Frère et Fils, Paris	J. G. Swarbrick, New Orleans, La	Cerises—Bigarreaux au Marasquin	
21053	Moray Fils et Cie, Lyons	do	Bigarreaux au Marasquin	
21079	G. Amandus, Mainz	S. W. Clark & Son, New Orleans, La	Kirschenweiss	
21085	Teyssonneau, Jeune, Bordeaux	do	Bigarreaux au Marasquin	
	Figs.			
19897	G. W. Dunbar's Sons, New Orleans, La	Siegel-Cooper Co., New York	Fresh ripe figs	
21086	Teyssonneau, Jeune, Bordeaux	S. W. Clark & Son, New Orleans, La	Figues	
	Grapes.			
20231	A. Lusk & Co., California Canning Co., Cal.	Park & Tilford, New York	Bear Brand Muscat grape	
	Oranges.			
21088	G. W. Dunbar & Sons, New Orleans, La	S. W. Clark & Son, New Orleans, La	Fresh fruit preserved in heavy sirup	
	Peaches.			
20193	Jos. Campbell Co., Camden, N. J	N. W. Burchell, Washington, D. C	Preserved peaches	
19866	Jas. Madison, San Francisco, Cal	R. W. Crounse, 950 Louisiana ave, Washington, D. C.	Choice California standard fruit	
19871	Cosmos Packing Co., San Francisco, Cal	do	Cosmos brand peaches, extra standard quality.	
19893	San Leandro Packing Co., San Leandro, Cal.	Siegel-Cooper Co., New York	Selected fruit packed in pure white sugar sirup, Holly brand.	
20233	Sacramento Packing Co., Sacramento, Cal.	Park & Tilford, New York	Derby lemon cling peaches, extra standard California fruits.	

21046	Dandicolle & Gaudin, Bordeaux	J. G. Swarbrick, New Orleans, La		Cork layer between lead top and fruit.
	Pears.			
20140	Golden Gate Packing Co., Yuba City, Cal.	Henry Barge, New York	Golden State extra Bartlett pears. Selected California fruit put up in heavy sirup.	
20144	Francis H. Leggett & Co., New York	do	Ceres brand Bartlett pears	
20832	Felix Potin	E. R. Lake, Corvallis, Oreg	Compote de poires au sirop guaranti pur sucre.	
19870	Thos. J. Meyer & Co., Baltimore, Md	R. W. Crounse, 950 Louisiana avenue, Washington, D. C.	Maryland brand Bartlett pears; first quality.	
19872	——, San Francisco, Cal	do	Iron city brand Bartlett pears, extra standard. Guaranteed.	
19899	Oregon Packing Co., Portland, Oreg	Siegel-Cooper Co., New York	Oregon brand Bartlett pears from selected graded fruits packed in best granulated sugar sirup.	
20134	B. S. Ayar, Bridgeton, N. J	Henry Barge, New York	Jersey pears, a superior quality. A brand selected with great care.	
20137	Flour City Packing Co., Rochester, N. Y	do	Flour city brand Bartlett pears. All goods bearing this brand are guaranteed equal to any so-called standards.	
20235	The J. H. Flickinger Co., San Jose, Cal	Park & Tilford, New York	Bartlett pears. Pure sugar sirup, extra table fruit; put up ripe in orchard where grown.	
20609	Henry Doraix	R. H. Macy & Co., Fourteenth street, New York.	Conservirte Früchte (pears), Eugene Duraix.	
21048	Dandicolle & Gaudin, Bordeaux	J. G. Swarbrick, New Orleans, La		Do.
19875	H. Masten, jr., Felton, Del	R. W. Crounse, Washington, D. C	Pears. Pure sugar sirup	
	Pineapple.			
19896	Hazel Pure Food Co., New York	Siegel-Cooper Co., New York	Grated pineapple, finest quality	
20135	F. H. Leggett & Co., New York	Henry Barge, New York	Premier pineapple	
20143	R. C. Williams & Co., New York	do	Sliced pineapple	
20234	Gordon & Dilworth, New York	Park & Tilford, New York	First quality pineapple	

TABLE 35.—*Description of canned fruit*—Continued.

Serial number.	Description and manufacturer.	From whom purchased.	Claims of manufacturers.	Remarks.
	Pineapple—Continued.			
20228	E. G. Dailey Co., Detroit, Mich	Park & Tilford, New York	Poyet pineapple preserves	
20612	Eugene Duraix, Hoflieferant	R. H. Macy & Co., New York	Pineapple Conservirte Früchte	
	Plums.			
19894	Milford Manufacturing Co., Chicago, Ill	Siegel-Cooper Co., New York	Extra standard, Milford egg plums	
20139	Seeman Bros., New York	Henry Barge, New York	Green gage plums, Waverley brand	
21250	Moral's Conserven, Berlin	Park & Tilford, New York	Geschällte Pflaumen	
20142	Golden Gate Packing Co., Yuba City, Cal	Henry Barge, New York	Green gage plums, Golden State extra selected California fruits packed in heavy sirups.	
20238	Golden Gate Packing Co., San Jose, Cal	Park & Tilford, New York	Green gage plums. Selected California fruit. Packed for Park & Tilford.	
20836	Felix Potin	E. R. Lake, Exp. Sta., Corvallis, Ore	Reines Claude	
21047	Dandicolle & Gaudin, Bordeaux	J. G. Swarbrick, Camp street, New Orleans, La.	Prunes	Cork layer between lead top and fruit.
	Raspberries.			
21051	S. Morel, Posen, Germany	do	Framboises au jus	
21078	Gustav Amandus, Hoflieferant, Wiesbaden.	S. W. Clark & Son, 624 Canal street, New Orleans, La.	Himbeeren	
20191	L. Bradbury & Son, Webbs Mills, N. Y	N. W. Burchell, Washington, D. C	Willow Bank brand raspberries	
	Strawberries.			
20229	G. Amandus, Mainz, Germany	Park & Tilford, New York	Ananas erdbeeren	
20544	W. Laaff	Hanscom Bros., Philadelphia, Pa	Ananas erdbeeren	
20610	August Schmidt, Hoflieferant, Wiesbaden	R. H. Macy & Co., New York	Erdbeeren	
20953	Carl Berg	A. M. & J. Solari, New Orleans, La	Erdbeeren	
21045	Teyssonneau, Jeune, Bordeaux	J. G. Swarbrick, New Orleans, La		
21050	S. Morel, Posen, Germany	do	Cerise	

Miscellaneous.

19891	Cape Cod Preserving Co.	Siegel-Cooper Co., New York	Choice Cape Cod cranberry sauce
20247	Bishop & Co., Los Angeles, Cal	Park & Tilford, New York	Pickled figs
20164	....do	C. C. Bryan, Washington, D. C	Pickled watermelon
20545	W. Laaff, Mainz	Hanscom Bros., Philadelphia, Pa	Melange
20244		Park & Tilford, New York	Peach chutney.

TABLE 36.—*Composition of canned fruits.*

Serial number.	Description of sample.	Total solids.		Per cent insoluble solids.	Per cent protein (N×6.25).	Acidity expressed as per cent H_2SO_4.	Sugars.			Polarizations.			Per cent dextrin.	Approximate per cent glucose (dextrin×3).	Per cent total ash.	Alkalinity as per cent K_2CO_3.	Sulphates as per cent potassium sulphate.	Chlorids as per cent sodium chlorid.	Preservatives.	Foreign coloring matter.
		Per cent in entire contents of can.	Per cent in sirup.				Per cent reducing sugar.	Per cent cane sugar.	Per cent total sugar.	Direct.	Invert.	Temperature, degrees C.								
20236	Apples		8.17					None.		− 4.4	− 4.5	19			0.147	0.115				
19900	Apricots		16.84			0.882		0.59		− 3.2	− 4.0	20.5			.479	.344				
20239	....do.[a]		26.50					6.80		+ 4.0	− 5.0	24			.355	.299				
20611	....do.[b]		71.87					25.32		+58.8	+25.0	21	7.71	23.13					Benzoic acid	
21049	....do.[c]		35.00		0.211		29.86	.90	30.76	− 8.6	− 9.8	22			.345	.170	0.044	0.009	Salicylic acid	
19892	Blackberries		28.20					None.		− 8.1	− 8.1	20			.423	.192				
20249	Blueberries		12.18					None.		− 3.1	− 3.1	20.5			.166	.134				
19885	Cherries[a]	59.32						23.02		+18.0	−12.4	24			.150	.152				Red coal tar.
20195	....do.[a]	25.02						None.		− 5.4	− 5.2	24			.318	.260				
20240	....do.[a]	24.81						2.26		− .8	− 3.8	24			.363	.311				
20242	....do.[a]	31.26						None.		− 6.8	− 6.8	24			.371	.275				
20243	....do.[a]	63.90						11.36		− .6	−15.6	24			.187	.170				
20248	....do	50.88				.823		1.88		−12.5	−15.0	20			.361	.237				
20546	....do.[b]	70.82			.494	.151	35.23	22.70	57.93	+48.8	+18.6	22.5		Present.	.198	.167	.032	.070		
19895	....do		47.37			.702		.75		−13.0	−14.0	20			.338	.232				
19898	....do		12.23			.401		1.04		− 1.4	− 2.8	21			.408	.283				
20136	....do		27.11					2.00		− 4.9	− 7.6	19			.321	.228				
20138	....do		24.73					2.37		− 2.2	− 5.4	19.5			.313	.214				
20230	....do.[b]		68.86	1.65	.594			17.45		+65.2	+42.2	24.5	8.14	24.42	.334	.248	.027	.001		
20834	....do.[b]		26.41					2.88		− 1.5	− 5.3	24.5			.395		Trace.	Trace.		
21035	....do.[b]		31.10					5.40		.0	− 7.2	22			.179	.100	.047	.009		Do.
21052	....do.[b]		33.57			.053		.98		+ 2.3	+ 1.0	22	None.		.048	.017	.069	.008		
21053	....do.[b]		43.13					.60		−11.1	−11.9	24.5	None.		.045	.022	Trace.	Trace.	Salicylic acid	Do.
21079	....do.[b]		67.05			.215		12.75		+61.0	+44.0	21.5	3.68	11.04	.216	.114	.072	Trace.		

21085	....do.[b]		46.01			.169		17.59		+ 9.3	−14.1	22			.186	.091	.012	Trace.	
19897	Figs[c]		63.53					41.34		+51.4	− 4.2	19			.236	.199			
21086	....do.[b]		56.98			.088		23.83		+14.1	−17.6	22			.131	.081	.064	.016	
20231	Grapes					.303				− 5.0	− 5.0	20			.260	.147			
21088	Oranges[c]		62.70					15.00		+15.1	− 4.8	20			.468	.245			
19896	Pineapples	29.67				.563		None.		− 8.0	− 8.1	21			.462	.411			
20135	....do.		21.90					5.02		.0	− 6.7	21.5			.318	.267			
20143	....do.		23.81					1.11		− 5.0	− 6.5	19			.292	.196			
20234	....do.		20.79			.509		1.05		− 4.4	− 5.8	21			.319	.243			
20228	....do.[a]		38.60					6.50		+ .4	− 8.2	24			.059	.060			
20612	....do.[b]		59.94					17.45		+55.6	+32.6	24.5	5.60	16.80	.629	.457	.092	.017	Benzoic acid
19894	Plums	22.82				.769													
20139	....do.	26.74				.710		.37		− 5.90	− 6.40	20			.196	.155			
21250	....do.[b]	21.90		1.01	.319	.730		.23		.00	− .30	24.5	None.		.236	.161	.023	.002	
20142	....do.		36.40					.44		− 9.4	−10.0	20			.281	.215			
20238	....do.		33.30			.602		.52		− 8.7	− 9.4	20			.234	.176			
20836	....do.[b]		26.99					6.46		+ 1.6	− 7.0	22			.156	.110	.032	.023	
21047	....do.[b]		41.07					.60		−11.0	−11.8	21	None.		.211	.104	.054	Trace.	
20193	Peaches[d]	77.89						46.40		+68.0	+ 5.6	19		Present.	.299	.268			Benzoic acid
19866	....do.		18.75					2.52		− 1.50	− 4.90	19			.332	.239			
19871	....do.		16.78					4.63		+ 1.20	− 5.00	20.5			.338	.239			
19893	....do.		20.39			.485		3.82		− 1.00	− 6.20	21			.346	.268			
20233	....do.		21.88			.303		7.31		+ 3.20	− 6.60	21.5			.351	.228			
21046	....do.		27.20					.68		− 7.30	− 8.20	21.5	None.		.253	.171	.089	Trace.	
20140	Pears	27.14				.137		5.46		− 3.30	−10.50	21			.189	.140			
20144	....do.	14.10				.161		.97		− 6.50	− 7.80	21			.249	.183			
20832	....do.[b]	31.86		3.78		.110	6.59	13.51	20.10	+10.00	− 7.80	24.5			.151	.145	.028	Trace.	
19870	....do.		14.22					.96		− 4.0	− 5.3	19			.165	.097			
19872	....do.		16.02					1.93		− 5.0	− 7.6	19			.230	.157			
19899	....do.		16.05					5.31		− 1.4	− 8.5	21			.182	.114			
20134	....do.		11.36			.205		1.72		− 4.0	− 6.3	20			.170	.116			
20137	....do.		13.31					3.27		− 2.4	− 6.8	19			.210	.149			
20235	....do.		29.21					10.94		+ 2.1	−12.5	21			.180	.141			
20609	....do.[b]		60.94					27.26		+66.4	+30.5	24.5	6.65	19.95	.207	.157	Trace.	.009	Benzoic acid

[a] American samples put up in glass. [b] Foreign samples put up in glass. [c] Contains a small amount of glucose. [d] Stone jar.

TABLE 36.—*Composition of canned fruits*—Continued.

Serial number.	Description of sample.	Total solids.		Per cent insoluble solids.	Per cent protein (N×6.25).	Acidity expressed as per cent H_2SO_4.	Sugars.			Polarizations.			Per cent dextrin.	Approximate per cent glucose (dextrin×3).	Per cent total ash.	Alkalinity as per cent K_2CO_3.	Sulphates as per cent potassium sulphate.	Chlorids as per cent sodium chlorid.	Preservatives.	Foreign coloring matter.
		Per cent in entire contents of can.	Per cent in sirup.				Per cent reducing sugar.	Per cent cane sugar.	Per cent total sugar.	Direct.	Invert.	Temperature, degrees C.								
21048	Pears[a]		41.46					.90		−12.5	−13.7	21			0.081	0.052	0.065	0.008		
19875	do.		8.95					.37		− 4.0	− 4.5	21			.139	.087			Saccharin	
21051	Raspberries[a]	34.36		3.45	0.562	0.656		.60		− 7.8	− 8.6	21			.308	.280	.051	.021	Salicylic acid.	
21078	do.[a]	69.12		3.06		.43		3.34		+60.00	+55.60	24.5	10.16	30.48	.305	.252	.038	.001		Red coal tar.
20191	do.[b]		37.53					1.06		− 8.0	− 9.4	24			.279	.206				
20229	Strawberries[a]	71.76		1.28	.350	.205	45.76	19.08	64.84	+22.6	− 2.8	22	2.54	7.62	.177	.099	.081	.021		Do.
20544	do.[a]	69.41		2.87		.37		6.53		+26.0	+17.4	24.5	4.81	14.43	.345	.281	.024	.003		Cochineal.
20610	do.[a]	68.82		3.96	.700	.419	51.67	7.13	58.80	+15.0	+ 5.5	22		Present.	.356	.210	.055	.009		Red coal tar.
20953	do.[a]	67.85		3.47	.562	.345	52.13	6.60	58.73	+18.4	+ 9.6	22		Present.	.355	.220	.090	.022		Do.
21045	do.[a]	48.72		2.00	.385	.240		.60		−11.2	−12.0	24.5	None.		.169	.136	Trace.	Trace.	Salicylic acid.	Cochineal.
21050	do.[a]	31.86			.456	.563	29.28	.45	29.73	− 8.0	− 8.6	22			.385	.250	.047	.026	do	
19891	Cape Cod cranberry sauce.	64.36				.455		.62		+92.0	+91.2	20		Present.	.248	.158			Benzoic acid	
20247	Pickled figs[c]	59.56						26.96		+32.2	− 3.4	24			.264	.232				
20164	Pickled watermelon.[b]				.137			20.60		+17.6	−10.0	22								
20545	Melange[a]	62.29						12.92		+ 7.4	− 9.8	22			.184	.120	.072	.023		Do.
20244	Peach chutney[b]	44.67			.775			.30		−10.6	−11.0	20	None.		1.052	.520				

[a] Foreign samples put up in glass. [b] American samples put up in glass. [c] Stone jar.

Table 36 gives the results of analysis of 74 samples representative of this class of goods. Of this number, 39 were put up in glass, 1 in a stone jar, and the remaining 34 in tin. Of the 39 samples put up in glass, 28 were of foreign origin. All of the tinned goods were of American manufacture.

A large number of the analyses given here consist merely in the examination of the sirup in which the fruit was put up, as this is sufficient to determine the presence or absence of glucose, preservatives, artificial sweetening materials, and, except in a few cases where the fruit alone was colored, of coloring matter, as well as the density of sirup employed.

A good idea of the quality of the fruit used for canning may be obtained from the general appearance of the product. Small, immature, and defective fruit is easily distinguished from the better goods. The quality of fruit governs, to some extent, the manner of its preparation. The lowest grade is commonly canned without the addition of sugar, and is always preserved in tin. A cheap but wholesome article is thus provided, for which there is great demand; at the same time the value of these goods will only warrant their preservation in the cheapest manner possible.

As an illustration of this class of goods may be mentioned "pie peaches," very small and imperfect fruit put up in water, after the removal of the pit, but without peeling. In this connection may also be mentioned the article prepared by soaking and canning dried fruit. This grade of goods is far inferior to canned fresh fruit, but finds a ready sale, at a relatively low price, in bad fruit years.

The grade of product prepared from a given quality of fruit depends largely on the amount of sugar added, or, in other words, the density of sirup employed. Generally speaking, the heaviest sirup is used with the best fruit, but good fruit is put up in sirup of all degrees of concentration, and even in water, according to the abundance of fresh fruit and the demands of commerce.

TABLE 37.—*Composition of fruits canned with glucose sirup.*

Serial number.	Description of sample.	Per cent total solids in entire contents.	Per cent total solids in sirup.	Per cent insoluble solids.	Per cent reducing sugars.	Per cent cane sugar.	Approximate per cent glucose.	Per cent total ash.	Alkalinity of ash as per cent K_2CO_3.	Preservatives.	Coloring matter.
20611	Apricots	......	71.87	......	......	25.32	23.13	......	......	Benzoic acid.	
20546	Cherries	70.82	......	......	35.23	22.70	Present.	0.198	0.167	....	
20230	.....do	......	68.86	1.65	......	17.45	24.42	.334	.248	....	
21079	.....do	......	67.05	......	......	12.75	11.04	.216	.114	....	
19891	Cranberries	64.34	......	......	......	.62	Present.	.248	.158	Benzoic acid.	
19897	Figs	......	63.53	......	......	41.34	....	.236	.199	....	
21088	Oranges	......	62.70	......	......	15.00	....	.468	.245	....	
20193	Peaches	77.89	......	......	......	46.40	Present.	.299	.268	Benzoic acid.	
20609	Pears	......	60.94	......	......	27.26	19.95	.207	.150	.....do...	
20612	Pineapples	......	59.94	......	......	17.46	16.80	.629	.457	.....do...	
21078	Raspberries	69.12	......	3.06	......	3.34	30.48	.305	.252	....	Coal-tar dye.
20229	Strawberries	71.76	......	1.28	45.76	19.08	7.62	.177	.099	....	Do.
20544	.....do	69.41	......	2.87	......	6.53	14.43	.345	.281	....	Cochineal.
20610	.....do	68.82	......	3.96	51.67	7.13	Present.	.356	.210	....	Coal-tar dye.
20953	.....do	67.85	......	3.47	52.13	6.60	Present.	.355	.220	....	Do.

Table 37 gives the results of analysis of goods of this class that contain glucose. The samples containing glucose constitute but 17.6 per cent of the number examined—much less than in either jams or jellies. With one exception, the amount of glucose is below 30 per cent. Sample 19891 indicates from the polarizations that no cane sugar was used in its preparation. By reference to this table it is seen that all the glucose samples have a content of solids of 60 per cent or more, while Table 36 shows that only 8 samples having more than 50 per cent of solids are free from glucose. This condition seems to bear out the impression that glucose is very commonly employed where its substitution for the more expensive sugars can be made of financial interest to the manufacturer, hence the limited use of glucose in the whole-fruit product is due to the fact that in many cases no sugar is added, while in others the amount used is not sufficient to warrant adulteration.

The table following shows the amount and nature of adulterants found in canned fruit products examined, together with the sources of the samples.

TABLE 38.

	American foods.	Foreign foods.	Total.
Total number of samples	46	28	74
Number of samples containing glucose	4	11	15
Number of samples containing preservative	3	8	11
Number of samples containing foreign coloring matter	1	9	10
Number of samples containing more than one adulterant	1	10	11
Number of samples adulterated	6	18	24

The use of coloring matter was confined to the fruits put up in glass. Of six samples of strawberries examined but one was free from artificial coloring matter. Coloring matter is probably most frequently used with this fruit, as it so readily loses its natural color after canning. But two samples of goods preserved in tin contained any form of preservative, and in one case the material used was saccharin, which performs the double function of preservative and sweetening agent.

The addition of preservatives to fruit put up in hermetically sealed packages and sterilized is unnecessary. In some classes of foods it is advantageous to preserve the product in a partially prepared condition for a considerable length of time, and complete the process in a much smaller plant than would otherwise be required. This is not customary, however, in the preparation of canned fruit. The only condition, therefore, that would call for preservatives is the use of imperfectly sealed receptacles or the lack of complete sterilization. The difficulty of hermetically sealing glass receptacles, especially those with a wide mouth, is well known, and the problem is made more complex when the goods are shipped to a great distance.

The customs of different firms differ so widely regarding the relative character of fruit packed in tin and glass that generalizations are difficult. It may be said, however, that the lowest grade of products is preserved in tin. Pie peaches, restaurant goods, and soaked goods (canned dried fruit) are prepared for a market that demands cheap products. It is necessary to choose the least expensive package available. In addition to this the appearance of these articles would not be inviting in glass.

In high-grade fruits, on the other hand, some canners place exactly the same products in glass and tin. Again, the expense of shipping bottled goods, both on account of breakage and freight rates, practically prohibits the preservation in glass of even high-grade goods that are to be shipped to a great distance, and many firms pack all their fruit in tin even for local markets. The average quality of tinned fruit is inferior to that preserved in bottles, and the lowest quality of the former is far below that of the latter.

BRANDIED FRUITS.

The brandied goods, aside from their content of brandy, are very similar to the canned fruits. While a number of samples were found upon the market, it is probable that the demand for this class of goods is not large. Seven samples were examined, of which five were imported. No adulterants were detected in any of these samples. Three were put up without the addition of cane sugar. The others contained amounts varying from 5.84 per cent to 21.20 per cent. Alcohol was determined on four of the samples, and was present in sufficient amount to prevent any fermentation.

TABLE 39.—*Description of brandied fruits.*

Serial number.	Manufacturer.	From whom purchased.	Claims of manufacturers.
20162	Gordon & Dilworth, New York...	C. C. Bryan, Washington, D.C....	Brandied cherries.
21033	A. Jourde, Bordeaux..............	Popovich & Abramovich, New Orleans, La.	Cherries mirabells.
21058	Marx, Bordeaux..................	J. G. Swarbrick, 321 Camp street, New Orleans, La.	Cerises à l'eau-de-vie.
20192	G. W. Dunbar & Sons, New Orleans, La.	N. W. Burchell, Washington, D. C..	Fig preserves.
19810	A. Azema.........................	U. S. appraiser, Port of New York.	Peaches in brandy.
21034	A. Jourde, Bordeaux..............	Popovich & Abramovich, New Orleans, La.	Peches a l'eau de vie.
21032	.....do..........................	.....do..........................	Do.

TABLE 40.—*Composition of brandied fruit.*

Serial number.	Description.	Per cent total solids.	Per cent total ash.	Per cent alcohol.	Per cent cane sugar.	Polarization.			Alkalinity of ash as potassium carbonate.	Acidity calculated to per cent H_2SO_4.	Sulphates as potassium sulphate.	Chlorids as sodium chloride.
						Direct.	Invert.	Temperature, degrees C.				
20162	Cherries	......	......	......	10.90	+ 8.40	−6.00	24	......	......	......	....
21033	.....do..............	20.70	......	16.60	.30	− 1.00	−1.40	25	......	......	......	....
21058	.....do..............	11.20	......	17.70	None.	− .40	− .50	25	......	......	......	....
20192	Figs.................	38.36	0.274	......	21.20	+26.00	−2.00	24	0.209	......	......	....
19810	Peaches..............	5.42	.210	......	5.84	− 1.00	−8.80	21	.129	0.159	0.055	Trace.
21034	.....do..............	15.10	......	16.10	7.18	+ 6.20	−3.00	25	......	......	......	....
21032	Prunes...............	20.80	......	16.60	None.	− 1.30	−1.40	25	......	......	......	....

FRUIT BUTTER.

The limited number of fruit butters found upon the market indicates that this class of fruit products in small receptacles does not have an extensive sale. Of the three samples examined, one was peach and the other two apple, and only one of these (No. 20160) is, in the strict interpretation of the term, a fruit butter. In the manufacture of this product as ordinarily produced outside of the factory, the juice is concentrated and then boiled with sufficient amount of the fruit to give it the desired consistency. The product should be tart in flavor and thick, but not jelly-like, in consistency. No. 20141 is a peach-butter compound, said to contain 50 per cent peach, 30 per cent glucose, and 20 per cent cane sugar. Only a small amount of cane sugar was found, and it is possible that that originally present might have been nearly completely inverted, since these goods are usually boiled for a considerable length of time. No. 20160 contained but a very small amount of cane sugar, which might have been normally present in the apple; and the composition of this sample shows it to be typical of this class of fruit products. No. 20237 contains glucose, and the high polarizations indicate that no cane sugar had been added in the process of manufacture.

TABLE 41.—*Description of fruit butter.*

Serial number.	Manufacturer	From whom purchased	Claims of manufacturer.
	Fruit butter.		
20141	Williams Bros. & Charbonneau, Detroit.	Henry Barge, New York	Peach-butter compound: 50 per cent peach, 30 per cent glucose, 20 per cent granulated sugar.
20160	H. J. Heinz Co., Pittsburg, Pa.	do	Heinz's apple butter, Keystone brand.
20237	West Virginia Preserving Co., Wheeling.	Park & Tilford, New York	Fort Henry brand, apple butter.

TABLE 42.—*Composition of fruit butter.*

Serial number.	Description.	Per cent total solids.	Per cent total ash.	Per cent cane sugar.	Polarization. Direct.	Polarization. Invert.	Polarization. Temperature.	Alkalinity of ash.	Per cent of protein (N × 6.25).	Acidity calculated to per cent H_2SO_4.	Preservative.
20141	Peach butter	43.12	1.127	0.89	+33.2	+32.0	19	0.680	......	......	
20160	Apple butter (in stone jar)	47.91	.703	.75	—12.0	—13.0	20	.448	0.350	......	Benzoic acid.
20237	Apple butter [a]	37.55	.463	.30	+54.4	+54.0	21	.176	......	0.441	Do.

[a] See correspondence with manufacturers, p. 102.

SOLID MARMALADES.

Three samples of solid marmalades were examined. These were secured in Mexico by Dr. E. Palmer, of the Division of Botany. Two were prickly-pear marmalade, the third was quince. Nos. 22294 and 22295 were made without the addition of cane sugar, and this fact accounts for the high content of ash, reducing sugars and protein. Of particular interest in the analysis of these two samples is the positive polarization after inversion. This may be due to an excess of dextrose, or, as was indicated in the discussion of the data in Table 18, the processes of heating might have converted some of the otherwise insoluble constituents into soluble optically active bodies. No. 22296, the quince marmalade, contained a large amount of cane sugar, and hence can not be compared with the two samples of prickly-pear marmalade. It is probable that this class of fruit preserves finds little, if any, sale in the markets in the States.

TABLE 43.—*Composition of solid marmalades.*

Serial number	Description.	Per cent total solids.	Per cent total ash.	Per cent reducing sugar.	Per cent cane sugar.	Per cent total sugar.	Polarization. Direct.	Polarization. Invert.	Polarization. Temperature, degrees C.	Alcohol precipitate.	Per cent of protein (N×6.25).
22294	Prickly-pear preserve.....	87.74	1.76	77.18	1.37	78.55	+ 8.4	+ 6.6	24.5	5.37	2.437
22295	.....do.....................	87.48	1.92	73.98	.76	74.74	+ 5.8	+ 4.8	24.5	5.96	2.687
22296	Quince preserve............	91.93	.577	23.50	56.15	79.65	+47.0	—27	24.5	8.30	.487

CORRESPONDENCE WITH MANUFACTURERS.

In all cases where results were obtained that might in any way be considered unfavorable to the manufacturer of the goods these results have been reported to the manufacturer previous to their publication in order to give an opportunity for such explanation as might be considered pertinent. The substance of the correspondence of the manufacturers upon various points that have arisen in regard to the analyses reported in this bulletin is given below.

It must be remembered that in purchasing goods upon the market it is not possible to always obtain samples representative of the product that is being put out at the time the goods are purchased. The methods of manufacturers frequently change in reference to the ingredients employed, and goods may remain some length of time upon the grocers' shelves. The difficulty encountered in obtaining fresh products is apparent. This fact accounts for many of the objections that have been offered to the results obtained in the analyses.

Generally each manufacturer puts upon the market more than one grade of goods, the number depending upon the demands of the trade. In making a miscellaneous collection of samples it is not probable that all these grades have been obtained, since no special effort has been made to secure all the grades of each manufacturer.

It frequently occurs that only the cheaper grades of goods were obtained, hence the results reported are not always representative of the entire output of each manufacturer. The explanations offered by the manufacturers likewise apply frequently to their cheaper grades rather than to their products as a whole. (See introduction, p. 3.)

The correspondence follows:

I am in receipt of your favor addressed to Alden & Nicholson giving some tests you have made on some preserves and jams made by them. This firm has been out of existence for some time, and had no successors. The goods you tested were made some time ago, and as no goods are now made under the name of Alden & Nicholson in any way, there should be only isolated cases where parties had not disposed of their stocks on hand at time of dissolution of the company. I thank you for the courtesy shown in your letter.

Yours, truly, C. S. ALDEN.

NOTE.—This communication is one of several which illustrate the fact that the goods found on the market are not always representative of the output of manufacturers at that time. A failure to appreciate this fact might readily lead to unjust criticism of manufacturers, and to controversies between them and control laboratories.

We have yours of the 11th instant to hand, giving us results of analysis on jelly (currant flavor and peach flavor), serial numbers 20216 and 20217, also on raspberry jam, serial number 19969, and strawberry jam, serial number 19968. In reply we would say that we * * * find numbers 20216 and 20217 correct, with the exception of the mention of starch being present; as far as the employment of same is concerned by us in the manufacture of jelly. A very small per cent of glucose is used in order to prevent it from crystallizing, but never any starch in any jams or jelly. If present, then it must appear in the fruit employed itself. We note further that no sugar is found in the raspberry or strawberry jam, while the fact is that 50 per cent of granulated sugar is used in the berries themselves at the time of preparing the fruit when in season. When these berries are made in low-grade jams a jelly of apple juice and glucose is made and the berries boiled and mixed therein. Whether all the granulated sugar used could be turned into invert sugar through two processes of boiling we know not, but such are absolutely the facts as to our method of making the lowest grade of strawberry, raspberry, or other jams. * * *

THE AMERICAN PRESERVE COMPANY.
LEWIS J. LINK, *President*.

NOTE.—The samples of raspberry jam above mentioned contained no cane sugar, and the strawberry jam contained only 1.19 per cent. According to the method of manufacture reported for these jams it is probable that the addition of the mixture of fresh berries and cane sugar was comparatively small, and the amount of cane sugar thus added could very easily have been completely inverted in the process of preparation. For the effect of the preserving process on cane sugar, see p. 52.

We have your circular of the 11th with reference to your bulletin giving the results of examination of fruit products. * * *

In reference to starch, we have to say that * * * it is not our custom to use starch or any farinaceous adulterative in fruit jams or preserves. We think the tendency * * * is to substitute apples in the place of so much glucose, for the reason that it makes a better jam in many ways.

In regard to the use of preservatives in fruit jams, we consider it a waste of money. If the goods are properly made we don't think a preservative is necessary. * * * There is, however, a certain line of very high grade preserved fruits that seem to be demanded by the people in good circumstances, in which it is necessary to use a very small quantity of preservative. This is owing to the fact that the goods are demanded in glass. They are entirely filled with sugar and sunk in a sugar sirup.

These goods at this time in the year will keep, but in the Southern climate or during hot weather they will not keep.

This is entirely owing to the fact that no manufacturer has been able to find a glass package that can be hermetically sealed and stand transportation. If this package could be found it would cure a whole lot of these difficulties.

ANDERSON FOOD COMPANY.

Your favor of the 11th instant, giving the results of your analysis of our grape fruitate, guava jam, and pickled figs received. We thank you for submitting same. * * * We aim to put up pure goods, but in the fruits that are of a red color, namely, berries, guava, and currants, we use some red coloring to make the appearance better. We have for years used ——— "sugar red color," which we understood passed the pure-food laws of Ohio, and which Mr. ——— (the manufacturer) assured us was purely vegetable color; hence we are surprised that your analysis shows coal-tar dye in our guava jam. We do not put coloring matter in to cheapen the goods in in any manner, but only to aid the appearance. We are trying to make an aim on our goods as pure foods. * * * Regarding the samples of grape fruitate, it is impossible for us to account for any benzoic acid being in same unless it could have been one of the first few batches we made. In this we put a small amount of preservaline No. 1. Since that time, which was over two years ago, we have not used any antiseptic whatever, and if this sample contains benzoic acid it must have been some of the first lot that went into Washington.

BISHOP & CO.

NOTE.—Two additional samples of grape fruitate (probably old stock) bought at Washington, D. C., also contained benzoic acid. Its presence is doubtless due to the use of the commercial preparation mentioned above. A sample of the above-named color furnished by Bishop & Co. was found to be of coal-tar origin, hence the color was misrepresented by the manufacturer when sold as a vegetable color.

Replying to your results of analysis under date of November 11 to the Campbell Preserve Company and the Crescent Preserving Company, we would state that * * * your results are relatively correct; that is to say, in the Crescent goods the percentage of glucose is twice as much as sugar. The preservative used in all instances is sodium benzoate, not benzoic acid in its literal sense.

JOS. CAMPBELL PRESERVE CO.
ARTHUR DORRANCE, *President.*

Replying to your circular letter of the 11th, and in reference to the examination of various items of our product, would say that we * * * feel warranted in making the following general statement: During the past three years we have used no glucose whatever in the jelly that we have made. In the same period of time we have used no salicylic acid either in jelly or jam. * * * If your examinations, as shown by your report, have been carefully made, we are at a loss to understand the occasion that would warrant the findings unless you have gotten hold of extremely old items produced by us, and even then in some instances we can not understand the occasion of the reports being as you state. We feel that in all fairness to us, analyses should be made of new goods or those of more recent production. * * * After discontinuing the use of salicylic, we may have had up to the next season some goods that had been prepared with it, but in reconditioning these we used no more salicylic, but attempted to volatilize this, and then used benzoate for the direct preservative.

CURTICE BROTHERS COMPANY.

Your letter of the 11th instant received, and we note all you have to say. We use no starch whatever in any of our product; if it shows any starch it must come through the glucose. In the item of jam No. 20227 we note that you show no sugar; there is about 10 per cent granulated sugar in our cheap jams. We have discontinued using benzoate of soda in our jams, as we knew that the Pennsylvania food law had ruled against it.

THE E. G. DAILEY COMPANY.

We are in receipt of your circular letter of the 11th, and we note your report on analysis No. 20237 of our Fort Henry brand apple butter. We suppose, of course, that your report is correct, excepting it does not show the percentage of sugar. We use a certain percentage of sugar in this apple butter, but do not use starch in any of our fruit products.

GEO. K. MCMECHEN & SON.

We are in receipt of your favor of the 11th instant advising us of the result of an analysis made of our apple jelly, which was presumably bought in open market, as we have no record in our office of having sent you any.

As stated by you, there is no comment to make, except to explain the presence of starch, which evidently is in so small quantity that no record was made of its percentage. This starch is undoubtedly due to the character of the apples used (not as a thickener), as we have made no change in our recipe for several years, or, possibly, to imperfect filtering of the apple juice, or both. We have endeavored to overcome this (only) objection, but have not succeeded so far. We shall continue our efforts, however, to remedy this phenomenon.

DODSON-BRAUN MFG. CO.

In reply to your letter of November 11, would say that the analysis given our products is undoubtedly correct in every case, and excepting the strawberry jam, No. 20182, entirely satisfactory to us. * * * We have never put salicylic acid into strawberry jam except in one instance, and it evidently so happens that your sample has been selected from this particular lot. Last season we became sold out of strawberry jam, and to supply the demand we used some berries which had been barreled with sugar and preservaline and carried until midwinter. This is the only case in forty years of packing in which we have done this, and it will perhaps not be necessary again in the next forty years. It is much more satisfactory to make the jam from fresh berries, and certainly does not need any preservative in making. We can only say that we regret that the sample which you happened to get must have been taken from this lot.

ONEIDA COMMUNITY, Limited.

We have your favor of the 11th instant and note contents. * * * One item which strikes us as particularly incorrect is number 20218 (Table 30), which you call cherry jam XX brand. This is our best brand, and we take extraordinary pains with the goods. We use fresh fruit and granulated sugar only in the manufacture of these goods, and your analysis says 40 per cent glucose. We do not use starch for any of our preserves, jams, and jellies. * * * Undoubtedly you have obtained the samples which you analyzed from dealers in Washington. Washington trade buys principally the cheapest grade of goods we make. We sell only a small amount of such goods; we do not care to make and make no effort to sell them. We make six different grades of preserves, jams, and jellies, each grade differing from the other in quality and price. * * * Buying up a lot of samples in a market where a large percentage of low grade goods is used, making an analysis of these samples

PART II.—MICROSCOPICAL EXAMINATIONS OF FRUITS AND FRUIT PRODUCTS.

By Burton J. Howard.

The close structural similarity of many of the fruits used in canning makes the problem of the identification of the constituents by no means easy. Apple pulp, which is used as a filler in many fruit products, is so devoid of characteristic structure that any method giving hints as to its presence is of value. It is a well-known fact that starch is usually present in most fruits during some periods of growth, but that in many it more or less completely disappears when the fruit is ripe. With this in mind, some examinations were made of apples, pears, peaches, quinces, grapes, raspberries (red and black), strawberries, and tomatoes, in various stages of ripening. Apples more than any other fruit are used in an immature state, and starch can often be detected in fruit products composed wholly or in part of apples. Concerning the morphological features of apple starch it may be said that it consists of both simple and compound grains. The simple grains are globular in form, and according to Browne[a] are about 9 microns in size. This size, however, we have found to vary greatly, since in maturing the grains are converted into sugar and during this period decrease in size. In one specimen the average size was found to be 9 (3.5 to 14) microns, while in another it was 11.8 (7 to 17.5) microns. This fact of change in size was strikingly shown in the case of two Kieffer pears. In one which was nearly ripe the average was 4 (1.5 to 5) microns, while in a green specimen the size was 13 (3 to 29) microns. The compound grains, which are very abundant in green fruit, are composed of 2 to 5 grains attached together, giving a clustered or tetrahedral effect. Such grains are seldom seen in samples of apple starch obtained by grating and sedimentation, since they are easily broken up into truncated simple grains in the process of grating. The grains are marked by a stellate or linear fissure or depression and some with a good light show faintly concentric rings. The grains are active toward polarized light, and show colors with the selenite plate. As the apple ripens, starch begins to disappear near the center of the fruit, and later at the periphery. The last traces are to be found in the cells adjacent to the fibrovascular bundles. Fully ripe apples contain no starch whatever except in bruised portions.

[a] Penna. Dept. of Agric., Bull. 58.

From the above it is evident that in the examination of jams and similar products starch can best be detected in cells clinging to the fibrovascular bundles, which may be separated as directed under "Technique" (p. 106). In the tomato the last traces are found in the placental region. In the strawberry it remains longest in the central part of the pulp or enlarged receptacle. As in the apple, portions of the fruit bruised before maturing retain the starch practically unchanged.

In green pears considerable starch is present, but it disappears at a comparatively earlier stage of ripening than in the apple. In peaches it seems to disappear still earlier, for only in specimens greener than would probably be used in canning was there an appreciable amount found. In the quinces, though firm and sound, only a faint trace was found October 8, while apples—Rambo, Northern Spy, Baldwin, Greening, Russet, and others—obtained at the same time from the same orchard in Michigan showed an abundance of starch.[a] Although grapes were examined in various stages of maturing, from green to perfectly ripe, no starch was found. The same was true of the raspberries. It should be said here, however, that the grapes were gathered late in the season, after the first frosts, which may have hastened the disappearance of the starch had there been any in normal conditions. Strawberries, up to the time the flush of ripening appears, show a small amount of starch, but this seems to disappear before many of them would have been picked for market or canning. In the case of tomatoes the starch persists somewhat longer, but seems to disappear approximately with the last traces of green color, although the main portion is gone before this. Tomato starch, except on long boiling, does not swell up and become as mucilaginous as that of apple, but remains as little clots within the cells.

From the above it appears that we are able to assign the presence of starch in fruit products to any one or all of three causes, viz, (1) the use of immature or green fruit; (2) the use of apple pulp; (3) the addition of starch as such. It should be remembered here, however, that the absence of starch in no way precludes the possibility of apple pulp having been used. Although boiling tends to remove starch from the cells, as is readily seen in the case of many apple jellies, yet long-continued boiling is required to remove it so thoroughly from the cells that they will not show a greater starch content than the surrounding liquid when the iodine test is applied. Even in the case of apple butter more starch was found within than outside the cells. This fact may be used to advantage for detection of commercial starch in pulped products, such as jams, preserves, and marmalades; but it must be used with caution, since a small amount of starch might be added to products made from starch-containing fruits without detection. Even

[a]All of these varieties, with the exception of Rambo, are winter apples, some of them ripening late in the winter.

in apple butter, where the cells were well separated from each other, the starch was found to be much more abundant inside than outside the cells. In making this test a small amount of rather strong iodine solution (iodine, 1 gram; potassium iodide, 2 grams; water, 300 cc) should be used, else a considerable diluting effect will occur.

Adams[a] gives Hoffman's violet (Dahlia), followed by iodine, as a color test for apple pulp, claiming that the stain for apple is very different than that obtained for other fruits. Although we have tried the aqueous and anilin water solution, the color has not been found sufficiently characteristic to be reliable in most cases. What at first seemed to be characteristic differences on closer work were found to be caused by differences in the sugar or acid content, which served to mask or vary the normal staining effect.

Malfatti[b] has gone quite carefully into some of the anatomical characteristics of apple and pear, but as he confined his efforts largely to features of the epidermis, capsule walls, and seeds—parts usually removed in preserved goods—the differences are obviously of little value where the pulp alone is used. In the table at the end of this article the effort has been made to bring together in concise form the leading morphological and chemical characteristics of some of the fruits most like apple in the pulp condition to assist in the identification of apple when present.

A careful histological study of the seeds of those fruits in which the entire fruit is used will aid greatly in their identification. Marpmann[c] has worked out certain histological features of the seeds of figs, raspberries, currants, gooseberries, whortleberries, blackberries, strawberries, and elderberries which characterize these species and assist in their identification. Since A. L. Winton, of the Connecticut Experiment Station, had already begun a careful histological study of various fruits, no further detailed work of that nature was undertaken in connection with this bulletin.

The writer became identified with the Bureau of Chemistry after the chemical work described in Part I was completed and the samples discarded. It was therefore impossible to apply these methods to those samples, as it was not deemed advisable to procure new samples of the same goods on account of the press of work in other fields.

PREPARATION OF SAMPLE.

To prepare the sample for microscopical examination a portion, after being warmed with several times its bulk of water, is shaken up sufficiently to free the particles from sugar and allowed to settle. If the sample is finely pulped the settling process can be greatly hastened

[a] Analyst, 1884, **9**, 101.
[b] Ztschr. Nahr. Hyg. 1895, **10**, 265, 297, 313, 329.
[c] Ztschr. aug. Mikros., II Bd., 4 Heft.

by using a centrifuge. By decanting the supernatant liquid and placing the final product in a large watch glass a macroscopic examination can be made, which will usually be found suggestive as to the probable components. Portions can then be mounted for microscopic examination.

TECHNIQUE OF EXAMINATION.

The examination for starch in cells is made by iodine in potassium iodide solution.

To examine the pulp cells a sample was fixed to the slide by evaporating to dryness at about 50°, or by smearing the slide with Mayer's albumen fixative before putting the sample upon it and then rinsing with 90 per cent alcohol before beginning the staining process. The former method, however, was found more satisfactory. For a temporary mount no clearing agent is used. For Adams's test the best results were obtained by using a solution of Grübler's dahlia, made up according to the usual formula (dry stain, 1 gram; anilin water, 80 cc; 95 per cent alcohol, 20 cc). A drop of stain was added and allowed to act one minute, rinsed in water carefully thirty seconds to remove excess stain, and then treated with iodine solution thirty seconds before covering. For permanent specimens Gram's gentian violet or anilin safranine (these stains are made up of dry stain, 1 gram; alcohol, 20 cc; anilin oil, 3 cc; water, 80 cc) gives good results when sections are mounted in balsam. If the material is stained two to three hours in the safranine and then after rinsing with water stained for one minute in gentian violet, the stone cells are differentiated from the pulp cells, since, being composed of lignified tissue, they take the safranine well, but very slowly the gentian violet which, on the other hand, stains the cellulose pulp cells very readily.

The scheme of identification outlined is quite largely based upon an examination of the components of the fibro-vascular bundles, which in many cases have characteristic elements. The sample for such examination is mounted in a drop of chloral hydrate (crystals 8 parts, water 5 parts) and heated for a few seconds to boiling, covered, and by gently tapping the cover glass the bundle is broken up into its elements. Marpmann [a] recommends the use of alcoholic phenol as a clearing agent, but we have used chloral hydrate with better results, and it has the advantage of assisting in the maceration process.

A second method consists of staining with acetic acid-methyl green, and after withdrawing the excess of stain with a strip of filter paper and mounting in water, separating the component elements by tapping the cover glass as before. By this means the elements are easily distinguished, though they are not cleared, as in the chloral-hydrate method.

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[a] Ztschr. ange. Mikros., II. Bd., 4 Heft, p. 97.

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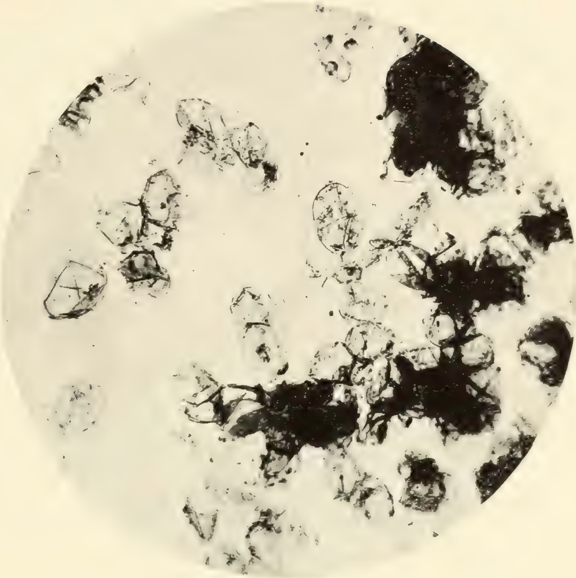

FIG. 1.—FRUIT-PULP CELLS, APPLE. × 30.

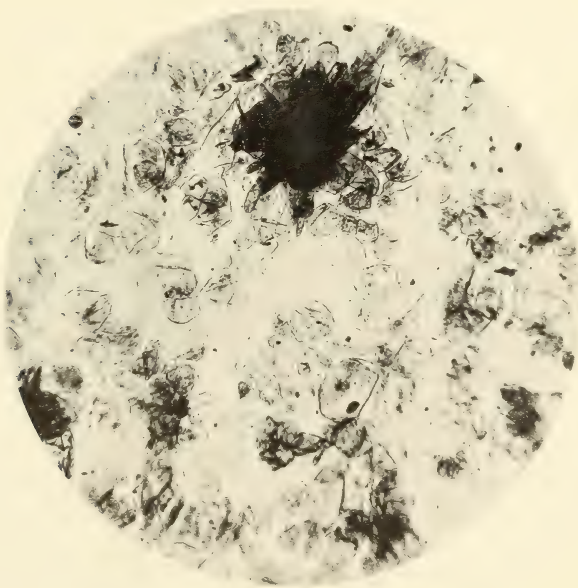

FIG. 2.—FRUIT-PULP CELLS, PEAR. × 30.

Photographs by Burton J. Howard.

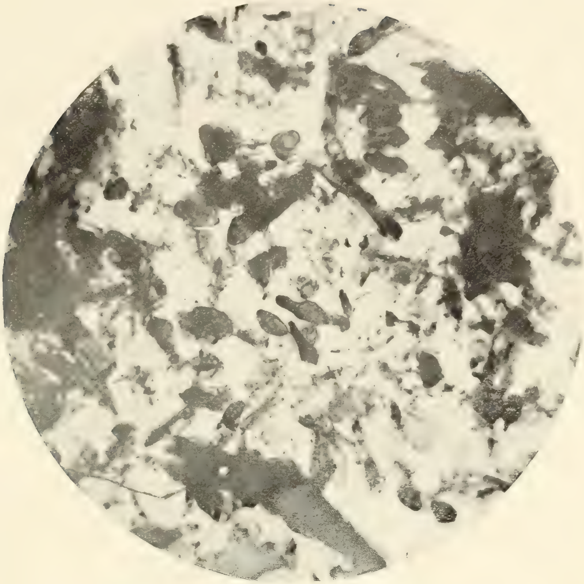

FIG. 1.—FRUIT-PULP CELLS, QUINCE. × 30.

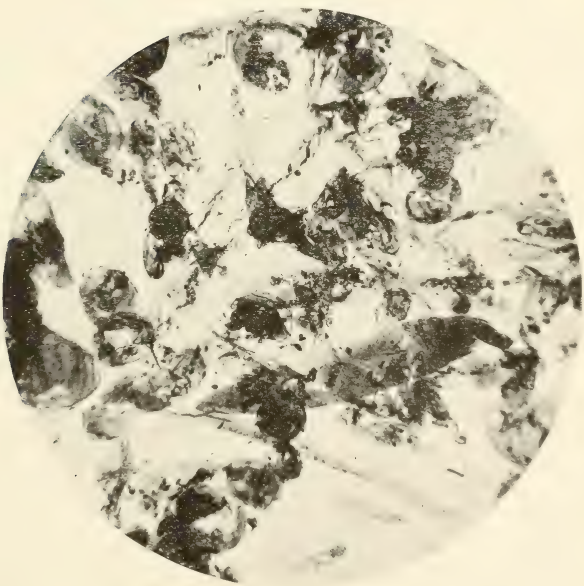

FIG. 2.—FRUIT-PULP CELLS, PLUM. × 30.

Photographs by Burton J. Howard.

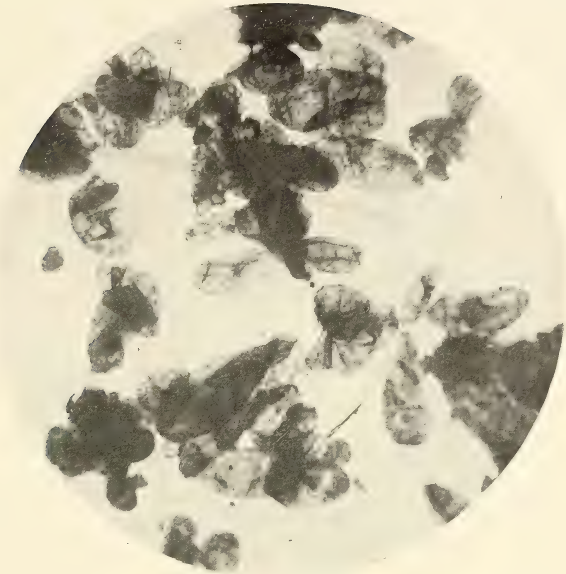

FIG. 1.—FRUIT-PULP CELLS, PEACH. × 30.

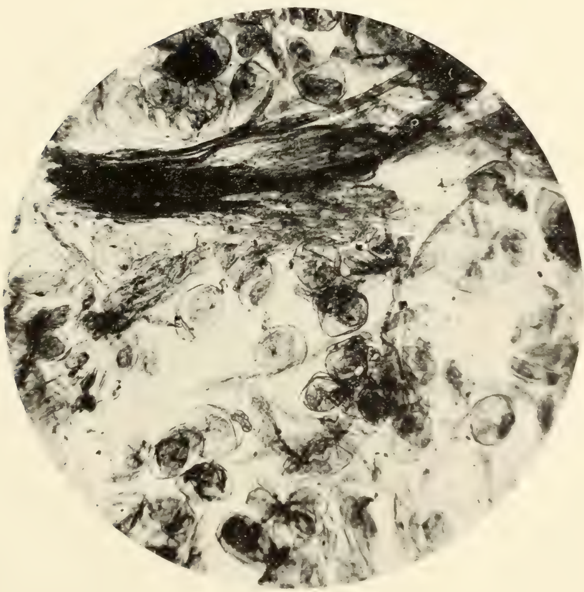

FIG. 2.—FRUIT-PULP CELLS, APRICOT. × 30.

Photographs by Burton J. Howard.

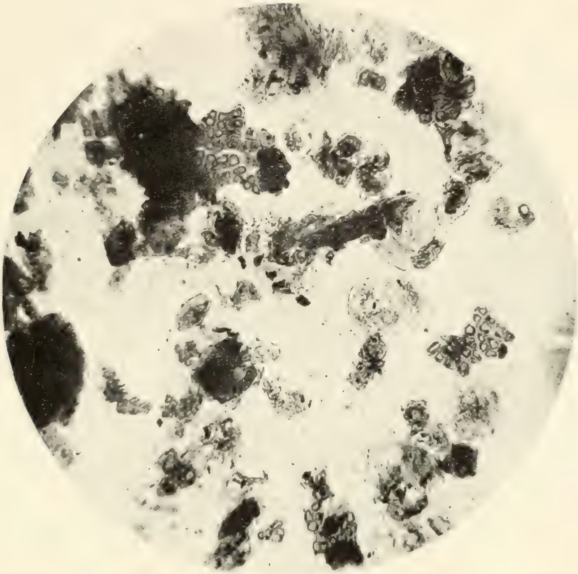

FIG. 1.—FRUIT-PULP CELLS, GRAPE. × 30.

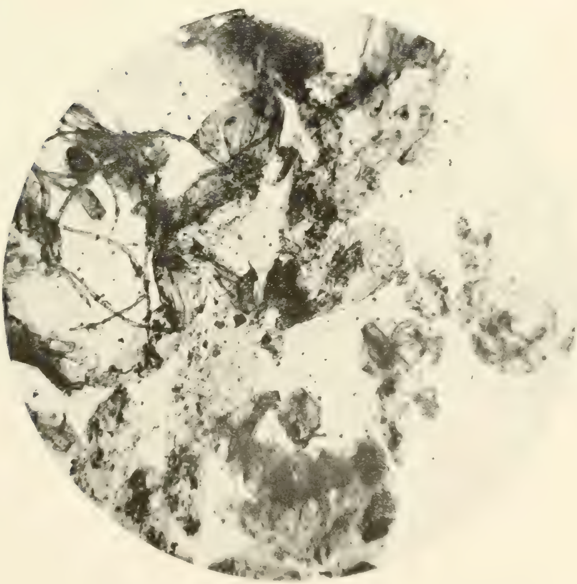

FIG. 2.—FRUIT-PULP CELLS, STRAWBERRY. × 30.

Photographs by Burton J. Howard.

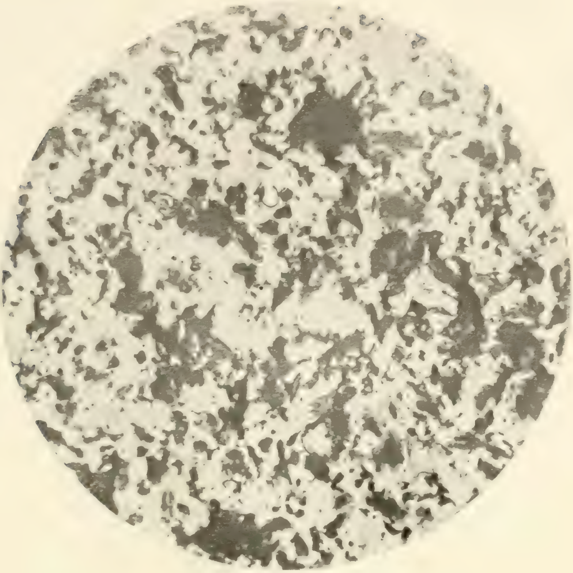

FIG. 1.—FRUIT-PULP CELLS, RED RASPBERRY. × 30.

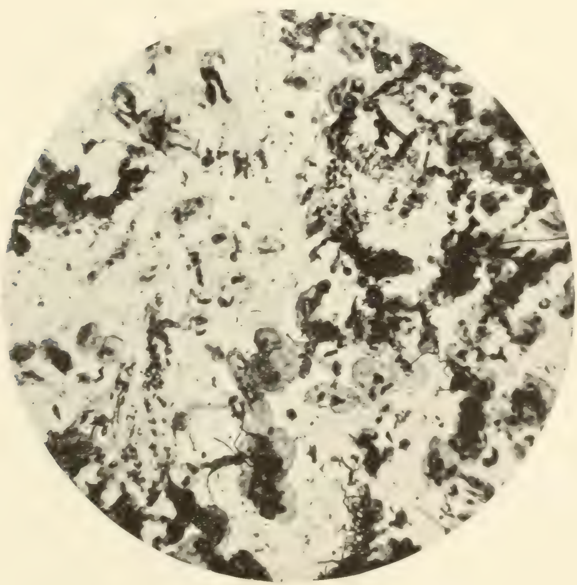

FIG. 2.—FRUIT-PULP CELLS, BLACK RASPBERRY. × 30.

Photographs by Burton J. Howard.

FIG. 1.—FRUIT FIBROVASCULAR BUNDLES. × 2.

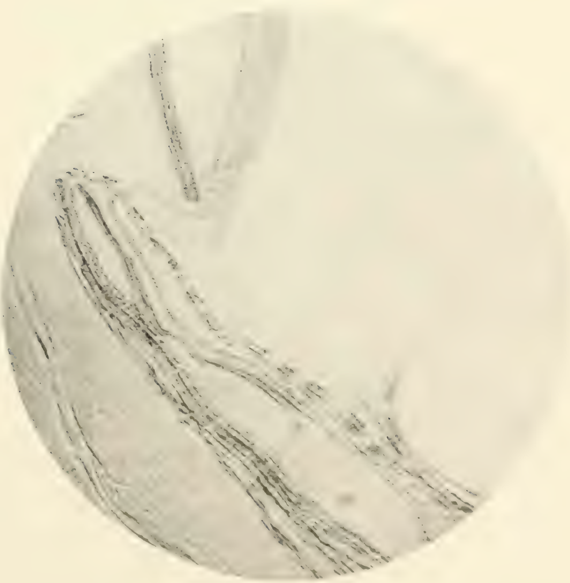

FIG. 2.—FIBROVASCULAR BUNDLES OF APPLE. × 75.

Photographs by Burton J. Howard.

FIG. 1.—FIBROVASCULAR BUNDLES OF PEAR. × 75.

FIG. 2.—FIBROVASCULAR BUNDLES OF QUINCE. × 75.

Photographs by Burton J. Howard.

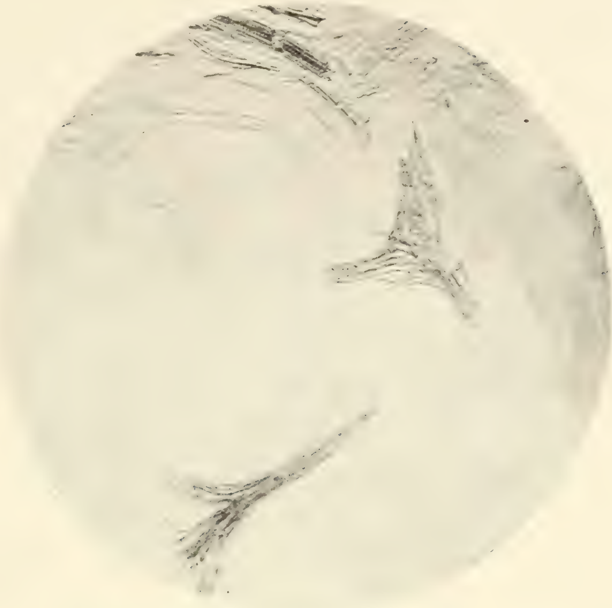

FIG. 1.—FIBROVASCULAR BUNDLES OF PLUM. × 75.

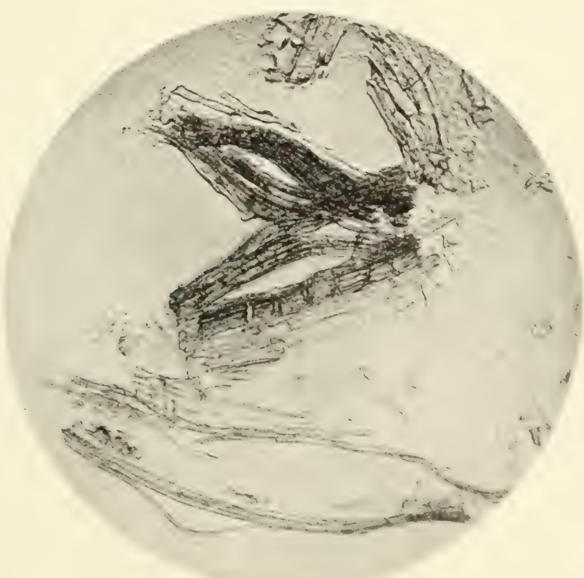

FIG. 2.—FIBROVASCULAR BUNDLES OF PEACH. × 75.

Photographs by Burton J. Howard.

Fig. 1.—Fibrovascular Bundles of Apricot. × 75.

Fig. 2.—Fibrovascular Bundles of Grape. × 75.

Photographs by Burton J. Howard.

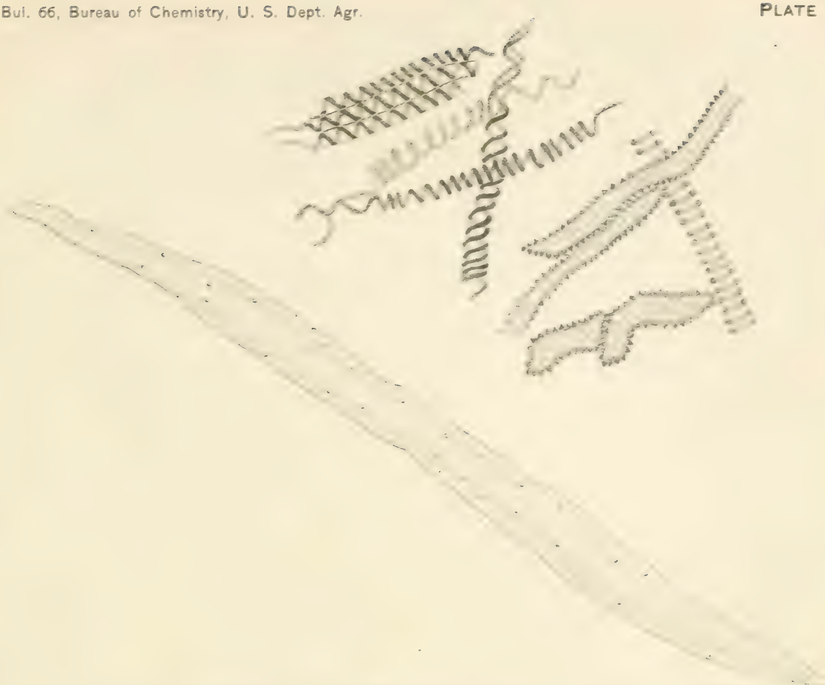

FIG. 1.—ELEMENTS OF FIBROVASCULAR BUNDLES OF APPLE. X 425.

DRAWN BY BURTON J. HOWARD.

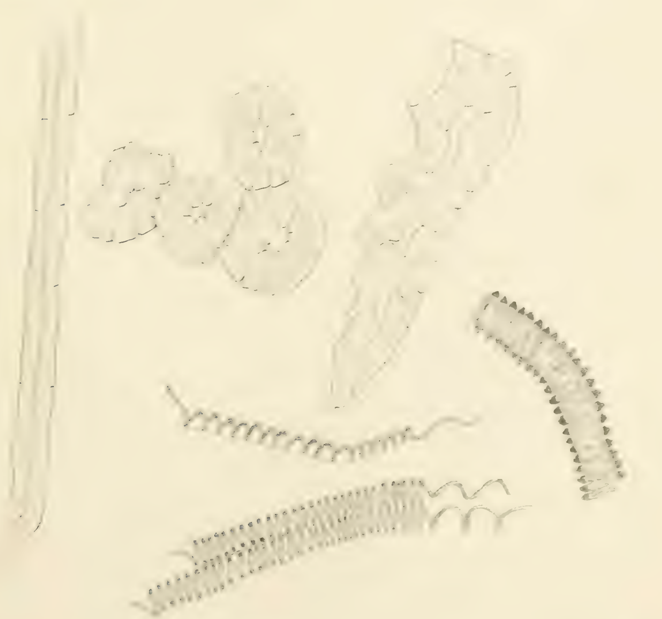

FIG. 2.—ELEMENTS OF FIBROVASCULAR BUNDLES OF PEAR. X 425.

DRAWN BY BURTON J. HOWARD.

FIG. 1.—ELEMENTS OF FIBROVASCULAR BUNDLES OF QUINCE. X 425.

DRAWN BY BURTON J, HOWARD.

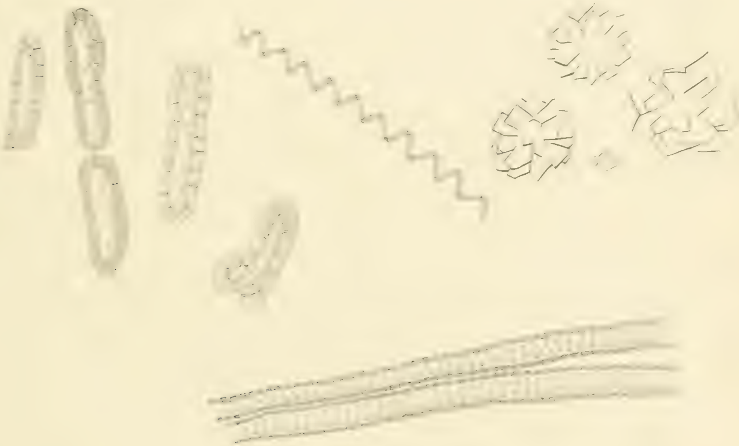

FIG. 2.—ELEMENTS OF FIBROVASCULAR BUNDLES OF PLUM. X 425.

DRAWN BY BURTON J, HOWARD.

FIG. 3.—ELEMENTS OF FIBROVASCULAR BUNDLES OF GRAPE. X 425.

DRAWN BY BURTON J, HOWARD.