REPORT OF THE CHEMIST

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF CHEMISTRY,
Washington, D. C., September 15, 1924.

SIR: I beg to submit herewith the report of the work of the Bureau of Chemistry for the fiscal year ended June 30, 1924.

Respectfully,

C. A. BROWNE, *Chief.*

Hon. HENRY C. WALLACE,
Secretary of Agriculture.

The present chief of the Bureau of Chemistry took over the direction of its work on October 1, 1923. His return to a former field of activity after 16 years of absence in a commercial position has caused him to observe a number of changes not only in the general status of agricultural chemistry as a science, but also in the relationship of chemistry to the Department of Agriculture as a whole.

The aims of agricultural chemistry, as defined by the pioneers of the science in Europe and America three-quarters of a century ago, were the relatively simple ones of determining the chemical elements which were necessary for the growth of crops, of ascertaining the forms in which these elements could be most economically supplied, and of devising methods of analyses for preventing the commercial substitution of worthless or inferior fertilizing substances. The early demarcation of agricultural chemistry into the two fields of research and regulatory work was thus distinctly drawn. Moreover, the aims and methods of the science as thus laid down were purely chemical. The immense benefit which resulted from the establishment of the great artificial fertilizer industry caused chemistry to be regarded as the science of pre-eminent value to agriculture. Chemists wrote leading works on agriculture, and chemists were usually appointed to the directorships of the agricultural experiment stations.

The conditions which obtained in this first or crop-feeding era of agricultural chemistry prevailed to a somewhat less extent in the second or stock-feeding period of the science. Chemistry was called upon to determine the food constituents which were necessary for the growth of farm animals, to ascertain the forms in which these constituents could be most economically supplied, and to devise methods of analyses for preventing the commercial substitution of worthless or inferior feeding materials. The same twofold division of the science into research and regulatory lines of activity prevailed in this second stage of development. There was here, as before, a definite practical problem which awaited solution—in the first case, the maximum production of crops; in the second case, the maximum yield of animal products, such as meat or milk. If the aims and methods of research were less chemical in the second case it was not a difference of kind but only of degree, and chemists maintained their leadership in the field of stock-feeding as in that of soil and fertilizer investigation.

It was a curious anomaly that the third and most important period of agricultural-chemical research — that pertaining to investigations upon human food—should have come last. Serious attention has been given to this field only within the last 30 years. In its work of determining what nutritive constituents are necessary for the best development of man, of ascertaining the forms in which these constituents can be most economically sup-

plied, and of devising methods of analysis for preventing the commercial substitution of worthless or inferior articles of diet, agricultural chemistry continued to perform its double research and regulatory function. A definite practical problem, such as claimed the general attention of chemists in each of the first two periods of the science, was, however, lacking in this third, more diversified period of agricultural-chemical research. It also began to be realized, as never before, that the final aims of agricultural research were no more chemical than physical or biological, and that the various sciences in their relationship to agriculture were simply the means to an end. In thus ceasing to exercise the direct ng part in agricultural research, however, chemistry has not contracted but has enlarged its sphere of action. It is in that borderland where chemistry touches upon physics, biology, physiology, and the other sciences that chemical research is performing to-day its greatest service to agriculture. This requires for the best results a state of most active cooperation upon the part of every science, instead of the former attitude of independent aloofness.

It was but natural that this gradual transition in the general relations of chemistry to agriculture from a directing to a cooperating science should have been reflected by a similar change in the scientific organization of the bureaus of the Federal department. The division of chemistry, as originally conceived and developed, was an agency in which all the chemical work of the Government should be performed. With the rapid expansion of scientific work in the different departmental bureaus, however, this plan became too extensive for practical continuance. An increasing need for chemists was felt in every branch of Governmental service, with the result that chemical work on contract supplies, soils, road materials, forestry products, dairy products, meat products, and other commodities, which had been initiated by the Bureau of Chemistry, was gradually taken over by Federal agencies that were specifically charged with the investigation of these materials. Because of this, together with the responsibility conferred upon it by Congress for the enforcement of the food and drugs act, the Bureau of Chemistry has concentrated its attention increasingly on the research and regulatory work connected with foods and drugs.

RESEARCH WORK

The Bureau of Chemistry conducts researches on the chemical composition of agricultural and related products, on the technical methods of their production and on the industrial uses to which they are put. Practical applications of the bureau's researches are made toward developing methods for improving the chemical composition and quality of agricultural crops, toward finding means for preventing the enormous losses which occur annually from deterioration, dust explosions, and other causes, toward devising processes for the profitable utilization of waste and surplus crops, and toward improving existing methods of manufacture in industries which employ agricultural products as raw material in order to create for such products a wider and more stable market.

The bureau's extensive researches on the composition, manufacture, and sophistication of foods, drugs, beverages, rosin, turpentine, insecticides, disinfectants, etc., are also practically applied in preventing the adulteration and misbranding of these products through the enforcement of the Federal food and drugs act, the naval stores act, the tea inspection act, and the insecticide and fungicide act. The regulatory and research operations of the Bureau of Chemistry are so closely allied that an intimate contact between the two must be maintained for the most successful performance of its various activities. The regulatory contacts with industry, through chemists and inspectors, furnish the scientific staff of the bureau with an important means, unavailable to other Governmental agencies, of suggesting and devising methods for improving the quality of foods, drugs, naval stores, insecticides, etc., and of introducing economies in their manufacture. Moreover, the Bureau of Chemistry has acquired through its regulatory service a vast amount of detailed information, in the form of correspondence, testimony, and reports, that is of the greatest assistance to research, which it stimulates and prevents from going astray into lines that are visionary and unproductive. This unpublished material, which is constantly increasing in volume, is a most valuable asset upon which bureau investigators may constantly draw in the preparation of announcements and publications.

One of the most pressing economic problems now awaiting solution in

agricultural-chemical research is the reduction of the enormous losses that occur from the deterioration of fruits, vegetables, grain, sugars, sirups, and other foods. Closely related to this problem of deterioration is that of the spontaneous combustion of agricultural products. Reports by the National Board of Fire Underwriters show that during the period 1918 to 1921 the adjusted fire losses attributed to spontaneous combustion on farms in the United States amounted to $4,196,386. This does not include the far greater loss from the spoilage of farm products due to spontaneous heating, where there was no combustion, and for which there would be no fire-loss adjustment. In 1921 the total losses from spontaneous combustion in the United States amounted to $20,186,392, this ranking as the second largest known cause of fire loss on the list. Among the lines of industry which suffer from this cause are many that handle agricultural products, more particularly the manufacturers and shippers of dairy feeds. A study of the losses which occur from the deterioration and spontaneous combustion of agricultural products is being conducted by the bureau in so far as the limited available funds permit.

Several changes have been made during the year in the organization of the bureau to effect a closer combination of the units which are engaged in related work. The Pharmacognosy Laboratory was discontinued as a separate unit, some of the work formerly done in this division being transferred to the Drug Control Laboratory. Similarly, the work of the Animal Physiological Laboratory was combined with that of the Protein Laboratory. The Fruit and Vegetable Utilization Laboratory was abolished, its work on the manufacture of maltose sugar being transferred to the Carbohydrate Laboratory. These combinations of related lines of activity will effect not only a greater economy of operation, but an increase in the efficiency of the bureau's work.

CROP CHEMISTRY

How to improve the quality of wheat, corn, and other crops by increasing their protein and mineral content is a problem which the Bureau of Chemistry is endeavoring to solve by means of chemical investigation. The chief constituents that give nutritive value to a food are proteins, fats, carbohydrates, mineral salts, and vitamins.

Progress was made during the year in the work on increasing the protein content of wheat. Wheat high in protein has greater nutritive value and the flour from it better baking qualities than wheat with lower protein content. As a rule, consumers will pay a higher price for a product of superior quality. Much wheat is now bought for the baking industries on the basis of its protein content, and when climatic conditions in a particular wheat-growing region during a given season cause the crop to be low in protein, the buyers for the baking industry go elsewhere for grain with a higher protein content. Moreover, improvement in quality seems likely to create a greater demand for American wheat in the world market. Information as to how to increase the protein content of the grain is therefore of direct, practical value to wheat growers as well as to consumers.

Experimental work has shown that the application of a nitrate fertilizer at about the time the grain is beginning to head materially increases the protein content of wheat. Data fixing more precisely than heretofore the exact stage of growth at which the application of a nitrate produces the maximum increase in the protein content are being obtained from experiments during the current season. How to apply such fertilizer to the growing crop in the best practical manner is being studied, as well as the effect of cultivation on the protein content of the wheat. Sufficient progress has been made to show that leaving space for entering the wheat field and applying fertilizer at advanced-growth stages does not decrease the yield for a given area, and may even increase the yield as well as improve the quality of the grain.

Guided by experience gained in the study of wheat, an investigation of the possibility of increasing the protein content of corn has been started. Corn is low in protein, and nutrition studies have shown that what protein is present is of poor quality, needing supplemental proteins from other sources. Any method that can be devised to increase either the quantity or the quality of the protein in corn will therefore proportionately increase the nutritive and economic value of the corn crop. Attention is also being given to cornstalks, used extensively for animal feeding in the form of silage, with the object of discover-

ing the most economical method of increasing their nutritive value.

A diet which fails to furnish mineral salts in adequate variety and quantity gives rise to diet-deficiency diseases. Two of the most important constituents in nutrition are iron and iodine. Investigations are now being planned to study means of increasing the iron content of such green vegetables as furnish the most important supply of these elements in human food.

The application of chemistry to the improvement of food plants is thus yielding results of real practical value. Progress in this work, however, depends upon basic research in the chemical composition of crops, the composition and action of fertilizers and soils, and the observation over a period of years of the effects of variations in soil, fertilizers, methods of cultivation, and other environmental factors on the chemical constituents. Such basic research must precede any intelligent attempt to improve the composition of food crops.

An investigation is under way on soil reaction (acidity or alkalinity) and its relation to the composition and yield of crops. The importance of the reaction in all biochemical studies is now widely appreciated, and its significance in the growth of crop plants is constantly receiving greater recognition. The methods which have been proposed for determining the reaction and the methods of stating the results so that they will be intelligible to the nonspecialist are being critically studied. It is hoped that work now in progress will lead to the development of methods which can be applied practically in the field by the farmer. Experiments have been started to ascertain the reaction best suited to individual crop plants, so that after the farmer has determined the reaction of his soils, he can find out what crops can be most successfully grown without the addition of lime or sulphur to change the reaction, or, if circumstances make a choice of crops impracticable, to what extent these reaction-modifying agents must be added to bring the reaction toward that best suited to the crop he finds it necessary to grow.

PROTEIN INVESTIGATIONS

A few years ago it was thought that a given quantity of protein from one source was equal in nutritive value to the same quantity of protein from any other source. Researches in recent years have shown that proteins of different origin vary materially in chemical composition, some proteins being deficient in certain amino acids essential to proper nutrition. When foods containing proteins of such deficiency are fed to growing animals as the sole source of their protein, the animals will cease to increase in weight, even though the diet is otherwise adequate. When either young or mature animals receive such foods for continued periods they will die. In determining what foods will furnish an adequate protein supply for both human beings and animals it is essential to know the chemical composition of the proteins of the various foods. This requires extended and exceedingly difficult research work.

Previous work had shown that while the chief protein of corn is lacking or deficient in some of the essential amino acids, the addition to corn of certain concentrates which contain the missing amino acids will produce a mixture that will be satisfactory for the normal growth and development of animals. Concentrates which the work has shown to be effective as supplements to corn include peanut meal, soybean meal, coconut press cake, and tomato-seed press cake. An article published during the year in the Journal of Agricultural Research gives the proportions of a concentrate which was used with corn and found satisfactory.

Feeding experiments with albino rats on the proteins of the lentil have shown that this is deficient in the amino acid cystine. Young animals when fed a diet the sole source of protein in which is derived from the lentil decline rapidly and die in about two weeks. When to this diet is added 0.36 per cent of cystine, growth at almost the normal rate is obtained. Experiments to determine the vitamin content of this seed have shown that when it constitutes 25 per cent of the diet it furnishes sufficient vitamin B and nearly enough vitamin A, but that 12½ per cent of this seed does not furnish enough vitamins. The lentil proteins share with the bean proteins, although to a smaller degree, a form of indigestibility which can be corrected by cooking.

The published digestibility figures for the proteins of the cottonseed are lower than those established for some of the good proteins, such as casein. Since it is known that certain toxic substances frequently inhibit the action of digestive enzymes, it was

thought that the toxin gossypol which is present in cottonseed might account for the low digestibility of cottonseed proteins as reported. These digestion experiments were conducted on pure, isolated cottonseed globulin. It was found that the pure cottonseed globulin was fully as digestible as casein, but that the addition of 1 per cent of gossypol produced a marked lowering of the digestibility of this protein. A like decrease in the digestibility of casein was produced by the addition of 1 per cent of gossypol.

Progress was made on the study of the proteins of wheat bran as reported last year. By a special treatment, bran practically free from other parts of the kernel has been obtained, and in such a form it can be ground to pass through a 100-mesh sieve. From this meal nearly 66 per cent of the total protein in the bran has been isolated and identified. The proteins isolated consist of albumin (17 per cent), globulin (14 per cent), and alcohol-soluble protein (33 per cent). Further work on the proteins of wheat bran is under way.

Feeding experiments with young rats showed that the proteins of palm-kernel meal were adequate for the normal growth of the rats, in so far as protein alone is concerned, but they contained no appreciable quantities of vitamin A or vitamin B. Since the meal used for these experiments was a commercial product obtained as a residue from the nuts after the removal of the oil by the solvent process, these results with reference to vitamin content may not apply to the fresh, untreated palm-kernel nut.

Work to determine the effect of long-continued storage at a low temperature on the vitamin A content of eggs has now been completed. Very little difference was found between the vitamin A content of fresh eggs and that of eggs which had been in storage for nine years in a frozen condition, showing that no serious deterioration of the vitamin had taken place during the long storage of the eggs at a temperature ranging from below 0° F. to 10° F.

Until recently there have been no methods whereby the tryptophane and cystine content of proteins could be accurately ascertained. Quantitative figures for these two amino acids are therefore lacking in most tables giving the amino acid composition of proteins. Since tryptophane and cystine are indispensable for the normal nutrition of animals, it is important to have information on the quantities of these two amino acids in the proteins of foods and feedstuffs. More than 100 proteins from important food materials have been examined and their content of these two amino acids has been determined by methods recently published.

Work to determine the nutritive properties of oysters, clams, and shrimp has been started. It is planned to study them from the standpoint of their protein and vitamin value, and to determine the amino acid composition of their proteins by chemical analyses and feeding experiments.

ODOROUS PRINCIPLES OF THE COTTON PLANT

It is well known that for many years enormous destruction has been caused to the cotton crop by the depredations of the boll weevil and that this entails an annual loss of many millions of dollars. The numerous attempts which thus far have been made to prevent the destruction caused by this insect have, however, resulted only in a mitigation of the evil, and each year the application of some poisonous compound has been necessary in order to prevent a complete loss of the cotton crop.

Inasmuch as the cotton plant possesses some specific attraction for the weevil, it is presumed that this may be due to some odorous substances emitted by it. In cooperation with the Bureau of Entomology, an investigation was accordingly undertaken to determine the nature of these odorous substances. The preliminary work was conducted at Tallulah, La., during the summer of 1923, when several thousand pounds of the cotton plant were distilled. The products obtained by this method since then have been subjected to chemical investigation in the laboratory at Washington, and they have been found to be of an exceedingly complex nature. The separation and identification of the individual constituents has consequently been a very difficult task, but it is gratifying to report that the work in this direction has been attended with a considerable measure of success. Some very interesting observations have been made in this connection, and one of the compounds obtained, which can be prepared synthetically, will now be available for chemotropic tests. If this compound should prove to possess the desired attractive properties, it can be produced at a cost which would permit of its practical application. It is anticipated that

the chemical investigation of the odorous constituents of the plant can be completed during the present year, and when this is accomplished a complete account of the results will be presented, together with such deductions of practical import as may be made from them.

VEGETABLE OILS

Further progress in the manufacture and utilization of cottonseed, corn, peanut, sesame, and other vegetable oils depends upon a more complete knowledge of the raw and finished products. After cottonseed oil had been a commercial commodity for 50 years or more and scientists had studied it for many years, accurate information concerning the constituents in the crude oil was still lacking. Realizing that the complex composition of cottonseed and other fatty oils would make it impossible for works' chemists to obtain much more information about them, manufacturers asked the aid of the Department of Agriculture in solving their fundamental problems.

The determination of all the constituents of crude cottonseed oil was assigned to the Bureau of Chemistry. To date it has been shown that this oil contains proteoses, peptones, pentosans, raffinose, resin, and various phosphatides, including what is believed to be inosite phosphates in combination with calcium and magnesium. Evidence has been obtained that xanthophyll is also present.

It has been shown that the phosphatides, resin, etc. readily emulsify the oil with water and that they are partly the cause of the retention of neutral oil by the soap stock in the caustic soda refining process. The nature and proportion of saturated and unsaturated acids present as free fatty acids has been determined in both crude cottonseed and peanut oils. A method for the determination of the total quantity of neutral oil in a crude oil has been perfected, so that it is now possible to estimate the quantity of oil in any crude oil as accurately as iron or other metal in an ore may be estimated. This method is already in use in several laboratories for the examination of crude oils and for the determination of neutral oil in soap stock. It is probable that crude oil will be purchased in the future on the basis of the oil present as determined by this method.

An investigation of the composition of sesame oil has been completed. Although it has been an important commercial oil in Europe and Asia for many years, large quantities have become available in the United States only recently, through the importation of seed and oil from China. The oil is used for both edible and technical purposes.

It is believed that the work on the study of oils now under way will aid in developing a more profitable utilization of vegetable oils, with benefit to producers, manufacturers, and consumers. The value of domestic vegetable oils to the industry of our country is indicated by the following statistics of production in 1923 of a few of the leading oils: Approximately 110,000,000 pounds of corn oil; 165,000,000 pounds of linseed oil; and 1,016,000,000 pounds of cottonseed oil.

FRUIT AND VEGETABLE UTILIZATION

Work to improve the methods used in preparing raisins from California Sultana grapes is under way. These raisins are sold in Europe where they come into competition with the same variety of raisins produced in Asia Minor which command a premium in the market because of their lighter color. The object of this work is to devise means of drying the California Sultanas in such a way that they may compete in color with the Asiatic product.

The standardization of raisins is also receiving attention. Raisins have been standardized heretofore in an arbitrary way, no mechanical or other device being used. It is now desired to substitute mechanical means of standardization, and, as far as possible, eliminate the personal equation which often gives unsatisfactory results. It is proposed to ascertain what part the moisture, sugar, acid, and insoluble solids play in the standardization of raisins, and to attempt to grade raisins mechanically for size and for defective berries.

The investigations on the composition of California citrus oils have been continued. Some experimental work on candying citron has been done. Grapefruit juice of excellent quality made by methods worked out in the Bureau of Chemistry is now being marketed. The results of the work on citrus pectin are in course of publication.

A method devised for the use of ethylene in the coloring of mature citrus fruit is rapidly coming into general use in California. Hundreds of carloads of oranges and lemons have been colored during the year

by the process. This has many advantages over the kerosene-stove method previously used. Some means for coloring citrus fruit is necessary because certain varieties are green in color when fully mature. As a rule, consumers judge the maturity of oranges and lemons mainly by the color and will not buy green-colored fruit, even though it is fully mature. The coloring of immature citrus fruit to give it the appearance of ripe fruit is prohibited under the terms of the Federal food and drugs act.

The ethylene method is more convenient than the old stove method, it offers less fire risk, it does not need constant supervision, it does away with the danger of smutting the fruit with smoky stoves, it imparts no odor to the finished product, and, during the warm season, it causes no wilting and shrinking of the fruit, as is the case when stoves are used. The ethylene method can be rigidly standardized with respect to temperatures, humidities, and gas concentrations in a manner productive of uniform results.

Work was continued on a study of the effect of freezing on the composition of oranges and lemons.

The investigational work on the development of improved methods for dehydrating fruits and vegetables has been terminated, and the results of the completed work have been assembled for publication.

Extensive correspondence during the past 5 years on the problems involved in the manufacture of vinegar in the home has led to the preparation of Farmers' Bulletin 1424, entitled "Making Vinegar in the Home and on the Farm," issued in June, 1924. It has been shown repeatedly that the home manufacture of vinegar offers a method of saving quantities of fruit which would otherwise be lost on account of the inadequacy of the local market or the failure of the fruit to reach market quality. It is entirely practicable, however, to salvage this material to supply the needs for vinegar in the home and possibly even to supply the local market.

The manufacture of sauerkraut offers a favorable means for marketing large quantities of cabbage. This industry is already fairly well established in some parts of the country where cabbage production is practicable on a commercial scale. After studying the problems involved in the manufacture of sauerkraut for a period of years, the bureau is now preparing directions for its commercial production.

For many years products other than cucumbers and cabbage have been pickled on a small scale commercially. Many inquiries on the possibility of pickling these products in the home have been received during the past few years. To obtain tangible information, a series of experiments on the pickling of martynias, mango melons, burr gherkins, onions, peppers, string beans, green tomatoes, and cauliflower were performed in 1923. All of these products appear in commercial brands of mixed pickles. The results showed that the brining of onions, mango melons, peppers, burr gherkins, and cauliflower is practical and desirable. The brining of martynias, string beans, and tomatoes is possible, but the resulting pickles are not generally useful, because long standing in strong and acid brine injures the flavor and texture which make the fresh product attractive.

PROCESS FOR MAKING MALTOSE SUGAR

A new process for making crystalline maltose sugar from cornstarch or from corn hominy or other starch materials was completed. That it is possible to make crystalline maltose sugar from cornstarch has been known to chemists for many years, but control of the process has been lacking, and it has not been possible heretofore to produce crystalline maltose sugar from starch economically. The new method enables the chemist to control the process so that it proceeds with regularity and certainty. The process is simple and involves no unusual equipment. The final cost will be lower than the cost of making cane sugar.

While the process for making maltose sugar is simple, it will not be practicable for the farmer to make the product for family use from his own corn, as the method requires technical control similar to that necessary in making sugar from beets or cane. The new product is obtained in the form of fondantlike masses and not in a granulated form like granulated cane or beet sugar. It can be melted and cast in molds like fondant made from cane or beet sugar. It may be used in the candy industry in producing chocolate-cream centers and other cream confections.

The process consists essentially of mashing either cornstarch or corn hominy with malt, which liquefies the product and in the course of from 7

to 10 days completely converts the starch into maltose sugar. Afer decolorizing with carbon and evaporating to a given density, the sirup is allowed to cool. It is then inoculated with a little crystalline maltose and allowed to stand from one to several days at room temperature, when it sets into the solid crystalline fondant, the crystals being so fine that they can be distinguished only under a high-power microscope.

As this new advance in producing crystalline masses of maltose sugar from corn has yet to be industrialized, it is too early to realize its bearing on the utilization of corn. The investigational work is not entirely complete, but it has proceeded far enough to show that it is practicable to make an excellent grade of crystalline maltose sugar from cornstarch or hominy.

TANNING AND LEATHER INVESTIGATIONS

Chestnut wood furnishes approximately 75 per cent of our domestic supply of vegetable tanning materials. Because of the rapid destruction of the chestnut tree by the blight, the leather industry will soon require new sources of tannin, for which reason it is considering the introduction and propagation in this country of foreign tannin-bearing trees and plants. In this connection information has been collected on wattles, some of which in South Africa and Australia produce an excellent tanbark. In cooperation with the blight investigations of the department, examination and analysis have been made of wood and bark from chestnut trees showing different degrees of blight resistance.

Possible sources of tannin among our domestic materials are being investigated. During the past year a number of domestic materials have been analyzed for tannin. Eucalyptus bark and certain redwood samples were found to contain from 5 to 8 per cent tannin. One sample of screened crystals from redwood cones showed 76 per cent tannin, and an unscreened sample showed 55 per cent. These results confirm the results of a previous analysis of a powder from sequoia cones which showed 73 per cent tannin. The tannin seems to be almost entirely of the catechol class, and is accompanied by much objectionable red coloring matter. It is believed that large quantities of the cones will be available in a few years if reforestation programs are carried out.

Investigations were continued on the properties and uses of leather and leather substitutes, and of leather dressing, finishing, and treating materials, in order to assist in developing methods and materials for producing longer wearing leathers and leathers better suited for specific purposes. The results of an elaborate wear experiment conducted with soldiers' shoes have been published as Department Bulletin 1168, "Wearing Qualities of Shoe Leathers." The first edition was soon exhausted and a revised edition issued. The bulletin has been reprinted in two American trade journals and in one English journal.

A third reprint of Farmers' Bulletin 1183, "The Care of Leather," was necessary during the year. About 110,000 copies had already been issued. This bulletin gives practical directions for the treatment of boots, shoes, harness, belts, and other articles made of leather in order to prolong their life.

Additional analyses have been made of old deteriorated leather bindings in a study of the causes of deterioration of leather. The significant results will be published. Since light is believed to be one of the causes of deterioration of leather, an experiment on about 600 pieces of leather from goatskin, sheepskin, and cowhide exposed to different light effects has been started. The results of this experiment will be of scientific interest and of practical value.

During the year work was done on the development of a roach-resistant book cloth, including experiments with approximately 100 chemicals and mixtures. Promising results, which are being further developed, have been obtained.

A treatment for the production of waterproof fiber counters has been developed and is now being tried out in actual service by a large shoe manufacturer.

The methods of analysis of tanning materials and of leather have been thoroughly revised. An improved method for the determination of sugar in leather has been developed, published, and recommended for adoption by the American Leather Chemists' Association. A procedure whereby moisture in leather can be determined with much greater accuracy than by the methods now in use has been developed and is being subjected to further and more rigid trial. Cooperative work with the American Leather

Chemists Association has been done on the development of methods for the analysis of chrome leather, on the effect of hydrogen-ion concentration upon the hide-powder method of determining tannin, and on comparative tannin analyses. Work was done on the determination of water solubles in leather, on the Wilson-Kern method of determining tannin, on the age effect of chrome-alum solutions used in the hide-powder method, and on modifications of the time, concentration, and quantity of hide powder as affecting the hide-powder method for determining tannin.

Farmers' Bulletin 1334, "Home Tanning of Leather and Small Fur Skins," was reprinted during the year, the first edition of 30,000 copies having been soon exhausted.

WATERPROOFING, MILDEWPROOFING, AND FIREPROOFING FARM FABRICS

Tobacco shade cloth, varying in cost from $200 to $350 per acre, is a large item in the cost of growing wrapper-leaf tobacco. From 10,000 to 12,000 acres of tobacco are grown under shade cloth. In the Connecticut Valley, where most of this material is used, it must be purchased every year, because after one season's use it is so weak that it will not resist the strain of windstorms, which are frequent during the growing season. While some cloth is used a second season for the sides of the tents and some is sold for a second season's use over slats in Florida, the net cost of annual replacement is high. Mildew is not troublesome in the Connecticut Valley, and it is generally agreed that the deterioration of tobacco shade cloth there does not result from this cause. From the results of our previous work in connection with waterproofing, it is believed that the deterioration is due almost entirely to the injurious effect of sunlight.

In order to develop a treatment which would make tobacco shade cloth serviceable for two and possibly three seasons instead of one, experimental treatments were applied last year to four 250-square-yard pieces of tobacco shade cloth for service tests in Connecticut, and to about thirty 2-square-yard pieces for exposure tests near Washington. Since most of these treatments color the fabric, the effect of the various colors upon the growth of the tobacco must also be taken into consideration in deciding upon a suitable treatment. After the first season's exposure, three of the large pieces and several of the small pieces subjected to experimental treatment were decidedly stronger than untreated cloth similarly exposed. There was no noticeable effect upon the growth of the tobacco from the use of colored cloth in these small-scale experiments. All but the least effective of the treated samples are being exposed for a second season.

There is great need for a practical fireproofing treatment for tobacco shade cloth and for other fabrics used out of doors for agricultural purposes, not only to preserve the fabrics, but also to reduce losses from fire to crops, supplies, machinery, and livestock.

A survey has been made of all fireproofing processes and a search has been made for a process that would be applicable to outside farm fabrics. Several satisfactory processes are now available for fabrics not exposed to wetting and one process resists wetting, but, because of its high cost, it is limited to clothing or other high-priced and light-weight fabrics. No treatment suitable for tobacco shade cloth or canvas for outside use has yet been found. The search for a suitable fireproofing treatment for outside farm fabrics is being continued.

FRUIT AND VEGETABLE WRAPPERS

The use of paper to protect fruits and vegetables from the time they leave the producers' hands until they reach the consumer is increasing at a rapid rate. Suitable paper wrappers afford not only an effective means for advertising but several other distinct advantages. They retard evaporation of moisture and thus tend to keep fruits and vegetables in a fresh condition; they reduce the damage in shipment from rubbing or jarring; they form a barrier to outside bacterial and mold infections that cause decay; they retard final ripening until removed by the retailer; they keep out dust and dirt; and they tend to equalize the temperature, protecting from frost when the temperature is near freezing. It can not be expected that all these effects in the highest degree can be obtained with one kind of paper, nor can it be expected that one kind of paper will prove suitable for all kinds of fruits and vegetables.

Fruit growers' associations and individual growers and packers have appealed to the bureau for instructions in specifying paper for certain kinds of wrappers and in distinguishing between paper which would probably prove satisfactory and that which would probably prove unsatisfactory. The results of careful study of the com-

position and physical properties of paper wrappers collected from manufacturers and from fruit and vegetable dealers, packers, and shippers clearly indicate that satisfactory and unsatisfactory papers for wrapping fruits and vegetables may be distinguished by physical tests. Tentative specifications sent to makers and users of the papers for criticism, when in final form, will be printed.

BLUEPRINT AND BROWN-PRINT PAPERS

The Government, as well as many commercial concerns, uses blue and brown-print paper in large quantities. Coated, undeveloped brown-print paper deteriorates rapidly and when not used promptly soon becomes unfit for use. In the hope of suggesting a remedy for this and of obtaining definite information on the durability of sensitized paper, an investigation was undertaken on the effect of the common commercial blue and brown-print sensitizing materials on the physical properties of the paper to which they are applied. It was found that when coated brown-print paper was kept for only two weeks before being developed and washed, its folding endurance was reduced about 75 per cent in comparison with that of the same paper uncoated. Paper coated with blueprint sensitizing materials generally used in this country, however, was kept four months without any deterioration in its strength. The results of the part of the investigation already completed were published in the April 24, 1924, issue of the Paper Trade Journal.

METHODS OF ANALYSIS

The results of chemical analyses of agricultural products as made by chemists in State experiment stations and colleges, in industrial work, and in the bureaus of the U. S. Department of Agriculture, are comparable only when uniform, standardized, accurate methods of analysis are used. The development of new methods of analysis or the improvement of existing methods is the constant aim of chemists working in the field of agricultural chemistry. The Bureau of Chemistry has for many years taken a leading part in this work, recognizing that progress in agricultural science can be made only as methods of chemical analysis are developed and standardized. This work is done in cooperation with the Association of Official Agricultural Chemists, and the methods developed are published from time to time by that association.

References to some of the specific methods developed during the year are made in different parts of this report under the subject headings to which they relate. Substantial progress was made during the year in this most important field of agricultural chemistry.

ANALYTICAL WORK FOR OTHER BUREAUS

The Bureau of Chemistry is called upon to make analyses and chemical investigations for other bureaus in the Department of Agriculture which are not equipped to do chemical work or to handle specific problems of a chemical nature which arise in their work. This analytical work covers a wide range of products. During the year analyses were made and reports prepared for the Bureaus of Plant Industry, Entomology, Biological Survey, Agricultural Economics, Public Roads, Soils, and Animal Industry, the Insecticide and Fungicide Board, the Forest Service, and other offices of the department. Practically all the chemical work on insecticides required by the Bureau of Entomology is done by this bureau.

SIRUP AND SUGAR INVESTIGATIONS

Cooperation with cane-sirup producers was continued, and assistance was rendered in the further extension and use of the invertase process for preventing crystallization. Advice was also given on other phases of cane-sirup production. Descriptions of the procedures for improving cane-sirup manufacture developed by this bureau have been embodied in a bulletin, which also gives up-to-date information on precautions to be observed in the manufacture of cane sirup, a description of the types of equipment employed, and the design and layout of cane-sirup plants of various types and sizes.

As a by-product of the original application of invertase to cane-sirup manufacture for the purpose of preventing crystallization, further valuable applications of invertase have been made to sorghum sirup, maple sirup, maple cream, maple sugar, and golden sirup. The use of invertase in connection with sorghum-sirup manufacture has been found of value in practice for the purpose of preventing crystallization, which occurs to a marked degree, although not so frequently as with cane sirup. In the manufacture of golden sirup, the use

of invertase permits the production of this sirup direct from an intermediate refinery sirup, thereby greatly simplifying the process and obviating the necessity of using a granulated sugar to produce the invert sugar sirup required for mixing with refiners' sirup. By using invertase, maple sirup of higher density may be made without undergoing crystallization, and the tendency to crystallize at lower temperatures is likewise diminished. Maple sugar of finer texture may be produced with less tendency to undergo "spotting." The application of invertase to the manufacture of maple cream results in a product of greatly improved consistency, with increased resistance to fermentation and from which sirup does not separate on standing, thus solving difficulties heretofore existing.

The investigation on the determination of sugar losses by inversion in various methods of manufacture of cane sugar, described in a previous report, has been almost completed. Important data have been obtained which serve to outline more definitely the conditions under which such losses may be avoided, thereby establishing the most correct conditions for operation of processes now in use.

Valuable information has been obtained as a result of the investigation of the refining value of raw sugar and the conditions which determine its suitability for the refining process. This investigation has included a study of the factors determining the filtrability of raw-sugar melts.

As indicated in the last report, the quantity, character, and behavior of the colloidal material present in cane and beet juices is of foremost importance in the consideration of processes for clarifying these juices in order to permit the crystallization of sugar of suitable quality and satisfactory yield therefrom. Fundamental information, scientifically determined, has every indication of being of great constructive and practical value. As a result of methods specially devised for this investigation, a quantitative separation of colloids within certain limits of degree of dispersion has been made possible, thereby permitting more accurate comparison of the efficiency of various clarification processes. Colloids thus separated from various typical sugar-factory liquors have been subjected to different types of examination, including a determination of their effect in producing viscosity. Separation of colloids from various grades of commercial sugar has been made, and the presence of this colloidal material has been found to have an important influence in determining the appearance of the sugar.

The improved analytical method for the determination of sucrose and raffinose in beet products, mentioned in the last report in connection with factory control of sugar recovery, was further tested in actual practice at two western beet-sugar factories during the season of 1923. The results obtained confirmed the value of the method for more accurate determination of sugar losses in the factory.

The factors which determine the recovery of sugar from cane and beets converge in two general effects—the influence on viscosity of sugar liquors and the influence on solubility of sucrose. For this reason a careful investigation is being conducted to determine the influence of various uneliminated constituents and groups of constituents of cane and beet juice upon the viscosity of factory liquors and solubility of sucrose therein. Valuable data which permit application in a practical manner toward reduction of sugar losses have been obtained.

Work on more profitable means of utilizing final or blackstrap cane molasses has been continued and, while it is not yet completed, important progress has been made.

In the course of the investigations here outlined it has been necessary to develop special methods and apparatus not heretofore available.

INSECTICIDE AND FUNGICIDE INVESTIGATIONS

To find combinations of chemicals which can be obtained or made cheaply and at the same time are effective in destroying or driving away the insect pests that annually destroy or cause deterioration of millions of dollars' worth of fruits, vegetables, grains, cotton, and other farm crops is one of the major projects of the Bureau of Chemistry. Some chemicals which are effective as insecticides are injurious to the foliage of the plants or trees to which they are applied. Therefore an investigation was conducted to determine why lead arsenate causes foliage injury, what effect the impurities in lead arsenate have on foliage, and what action distilled water and natural water containing various salts have on lead arsenate. The foliage-burning properties of calcium arsenate, which is used extensively to check the boll weevil, are being studied.

Progress was made in determining the composition of the salts exuded by the leaves of the cotton plant and in recognizing the great influence of these salts, when dissolved in the dew, on the action and effect of calcium arsenate and other insecticides on plants. A paper giving some of the preliminary results of this work was published in the Journal of Agricultural Research, volume 26, page 191, October 27, 1923. A method developed for the determination of free lime in calcium arsenate is timesaving and of great assistance in examining commercial preparations of this material. By its use the presence of basic calcium arsenates in commercial calcium arsenates has been demonstrated. Experiments in the use of colloidal arsenicals have shown that colloids such as gelatin, when added to sprays containing white arsenic, have a protective effect against leaf injury.

The results of the work to find a satisfactory substitute for carbon disulphide for grain fumigation have been very encouraging. Carbon disulphide is not satisfactory because of the high fire risk involved in its use. It is believed that a satisfactory substitute for carbon disulphide for the fumigation of insect-infested grains has been developed in the form of a mixture of 2 parts of ethyl acetate and 3 parts of carbon tetrachloride. Of more than 250 preparations tested in this work, the mixture of ethyl acetate and carbon tetrachloride is the most satisfactory. It is effective against the usual insects infesting stored grains, is noninflammable, if reasonably pure leaves no odor or taste in the fumigated grain or products made from the grain, is readily obtainable at a price that is not prohibitive, is not poisonous to man, and can be readily applied. Department Bulletin No. 1313 will give the details of this work.

Because practically all nicotine-soap preparations that have been placed on the market in the past lose their nicotine rapidly on standing, such products have practically disappeared from the market. The Bureau of Chemistry has shown how stable commercial nicotine soaps may be prepared, and the use of these effective insecticides may now be continued.

An investigation of the oxidation of white arsenic showed that the inactivity of many commercial lots when treated with nitric acid is due to the presence of traces of mercury. This information enables manufacturers of arsenic acid to improve their process by eliminating lots that contain mercury.

The results of work on the loss of nicotine from nicotine dusts during storage, showing how nicotine dusts can be prepared and packed so as to retain their nicotine strength, will be published in Department Bulletin No. 1312.

Pure oil of larkspur seed was isolated, and its properties were determined. A preliminary entomological test indicates that this oil is poisonous to insects like the red spider. Tests of its effectiveness on other insects will be made. The effectiveness as insecticides of three alkaloids which were isolated will be tested. The object of this work is to determine whether the oil and the alkaloids are effective insect killers and to find a way to make synthetically the most active ingredient or ingredients.

In a study of pyridine derivatives for the purpose of preparing chemical compounds toxic to insects, when used as an ingredient of sprays and dusts, it was found that one of the derivatives resembles nicotine in its physical and chemical properties. As a contact insecticide on different species of aphids it acted like nicotine. Efforts are being made to perfect the reactions so as to produce the new mixtures on a commercial basis.

Progress was made on the problem of producing a synthetic insecticide similar to that contained in pyrethrum (ordinary insect powder), of which 2,973,863 pounds was imported in 1923 at a cost of $1,397,910. The constitution of the toxic principle in pyrethrum has been solved by other investigators. The way is now open to a study of the constitution of the substance with a view to its possible synthesis and the synthesis of compounds having the insecticidal properties of pyrethrum. Compounds similar to the toxic constituents will be prepared in order to find simpler bodies containing the essential groups.

Work was done in cooperation with the Bureau of Entomology to obtain satisfactory attractants and repellents for flies which infest animals, and insecticides for flies during the various stages of their development. Experiments have been carried on, mainly with goats and cattle on the ranges, to discover a substance that can be applied to wounds that will repel flies and other insects and aid in the healing of wounds. This work has shown that small quantities of chloropicrin in mineral oil, or in pine-tar oil, are very effective in repelling

flies and that wounds treated with the mixture appear to heal rapidly. The mixture does not irritate or injure the animal in any way. The discovery of the action of this mixture gives promise of being of great value in the treatment of barbed-wire cuts and other injuries to stock on the ranges in protecting such wounds against infection, which in past years has caused the loss of thousands of dollars worth of animals annually.

A study of the absorption of hydrocyanic acid by meats, dried fruits, and confectioners' materials, fumigated with this gas, has been made and the results obtained are being published as Department Bulletin 1307, "Absorption and Retention of Hydrocyanic Acid by Fumigated Food Products, Part II."

PREVENTING PLANT DUST EXPLOSIONS AND FIRES

The heavy losses of life and property that sometimes result from dust explosions in threshers, grain elevators, flour mills, and starch mills, and in other industries where dusts accumulate, have been studied by specialists of this bureau with the object of ascertaining the exact causes of such explosions and of developing effective methods of prevention. Ten explosions were investigated during the year. The most recent one, an explosion in a grain elevator in Milwaukee, caused a property loss of $600,000. Another, in a starch factory in Pekin, Ill., resulted in the death of 42 men, injury to 22 others, and a property loss of $525,000. More than 21,000 establishments manufacturing products with an annual value of over $6,000,000,000 in the United States are subject to dust-explosion hazards.

As previously reported, effective methods have been developed for preventing dust explosions in threshers. A few seasons ago it was not uncommon for as many as 300 threshers to be blown up in one year in Oregon and Washington, and insurance rates on threshers in some parts of the country became prohibitive. As a result of the more extended use of the methods and appliances developed by the Bureau of Chemistry, the hazard of dust explosions has been reduced to the minimum, and insurance rates have been greatly reduced on threshers equipped with the appliances made in accordance with specifications drawn up in this bureau. As a result of conferences with the Washington State Surveying and Rating Bureau and the State fire marshal of Washington, additional recognition has been given to the dust-collecting fans designed by the Bureau of Chemistry for dust-explosion control in threshing machines. Arrangements for the manufacture of fans and fire extinguishers in Seattle afford a local service of fan production and will encourage the use of the fans and make it possible for threshermen to secure this equipment more promptly than heretofore.

During the year studies were made of dust-collecting systems and pneumatic cleaning systems in grain elevators as a means of reducing the dust-explosion hazard. The bureau obtained enough data from dust-collecting systems in Chicago, New York, Philadelphia, Baltimore, New Orleans, St. Paul, Duluth, Superior, Minneapolis, and Buffalo to be able to design dust-collecting systems of practical value for explosion control in grain elevators. This work was done in cooperation with the National Fire Protection Association, Underwriters' Laboratories, and the Terminal Elevator Grain Merchants Association. A special nozzle suitable for use in pneumatic cleaning systems was designed and patented, and arrangements have been made for installing it in the pneumatic cleaning system of a new elevator being erected in Baltimore.

Special studies relating to the type and operation of industrial drying machinery and similar devices used in handling dusty products were conducted. Conferences pertaining to control measures for the prevention of dust fires and explosions in grain-handling plants were held with industrial operating companies and machinery manufacturers. Explosions following dust fires in such plants have caused great loss of property, and special efforts are being made to assist the manufacturers of drier equipment in the control of this hazard. This work is being conducted in cooperation with a number of industrial companies, manufacturers of mechanical equipment, and State safety commissions.

Investigations relating to the application of inert gas for the prevention of explosions in grinding machinery have shown that the reduction of the oxygen content of the atmosphere will prevent flame propagation in explosive dust clouds. As a result of this work, successful operating units have been installed at two large hard-rubber plants. The installation of a similar

unit, for use in grinding oat hulls, is the first adaptation of inert gas to the grain industry. The successful application of inert gas in grain handling will be of great value in reducing losses from dust explosions and fires.

Progress was made in the laboratory investigations in determining the effect of lowered oxygen content of air on the explosibility of dust in suspension, and a preliminary report was published. The experimental work on the effect of humidity on the explosibility of flammable dusts in the air was completed, and a report was prepared for publication. The positive, if not striking, results obtained should eliminate uncertainty as to the effect of gaseous water vapor on the explosibility of dust. The experimental work on the effect of humidity on the dissipation of static electricity indicates that about 40 per cent relative humidity at 25° C. is approximately the minimum humidification required to prevent the accumulation of static electrical charges. Plans were made to study the effect of prolonged heating on several type dusts. Investigations in the field indicate that a number of explosions have been caused by the ignition of dust much below the usual ignition temperatures, and in these cases it is thought probable that ignition resulted from prolonged contact with a source of heat. Service testing was done through the year to determine the explosibility of representative industrial dusts submitted by manufacturing companies, State industrial commissions, and insurance associations.

In cooperation with the dust explosion hazards committee of the National Fire Protection Association and the industries concerned, regulations were prepared for the prevention of dust explosions in the following industrial plants: Sugar-pulverizing systems, pulverized-fuel plants, grain elevators, flour and feed mills, cocoa-grinding installations.

Progress was made in negotiating for further reductions in insurance rates on cotton gins which use the methods and appliances developed in the Bureau of Chemistry for preventing fires.

IMPROVING ROSIN AND TURPENTINE PROCESSES

As a rule rosin and turpentine are produced in small plants scattered throughout the pine-growing sections of the South. Because of inefficient methods in many of the plants the yield is low and the rosin and turpentine are too often below a fair standard of quality. The Bureau of Chemistry has made a scientific study of rosin and turpentine production, with the result that improved methods of production have been developed.

During the last year work on demonstrating methods for making more and better turpentine and rosin and for reducing costs of operation was pushed actively. Turpentine stills were visited and conferences on methods of operation were held with producers. As a result the industry has been awakened to the need for improvements in production.

Demonstrations were held at many plants, at which there was a good attendance of visiting operators and stillers from nearly all the stills within easy traveling distance. At one place 35 visiting naval-stores men, representing 29 producing firms, were present. The usual procedure was for the regular stiller to run a charge according to his practice, under the observation of the demonstrator and the visiting operators. Careful note was made of the character of the crude gum stilled and the yield and quality of the products. This was followed by a similar charge run by the demonstrator or by the stiller under the demonstrator's immediate direction. Improvements in procedure were called to the attention of the operators and stillers, and the reasons and results were explained. The plant and equipment were then carefully inspected, both good and bad features being pointed out, and recommendations for improvements were made. Those in attendance were supplied with blueprints showing the construction and operation of various kinds of equipment which could be readily made by the operators, and which would yield more and better products and save avoidable losses.

Six special circulars on various phases of naval-stores production were prepared and distributed to all naval-stores producers.

Much attention was given to the study of methods for detecting steam-distilled wood turpentine in gum spirits. The existing methods are not entirely satisfactory, and work on this problem will continue. Work was also done on the analysis of rosin, particularly on the determinations of the "iodine number" and melting point. In manufacturing "gloss oil," a low-cost and extensively used varnish, consisting primarily of rosin or limed rosin dissolved in naphtha or kerosene, there is a material clouding and

settling out from some batches. This behavior, which is characteristic of some rosins, greatly decreases the value of the gloss oil and causes heavy losses in its manufacture. A method to predetermine the behavior of any lot of rosin in this respect has been worked out, as has also a procedure whereby the clouding and settling out can be prevented.

The standards of quality for the various grades of rosin as represented by the permanent glass types have been made the official rosin standards of the United States. The naval stores act requires that all rosin sold within its jurisdiction must be graded in accordance with these standards.

A statistical report showing stocks of turpentine and rosin held by dealers at the main ports and distributing centers of the country, as of March 31, 1923, was published. Statistics on the stocks of turpentine and rosin held at manufacturing plants by the principal consuming industries, as of the same date, together with the figures showing consumption during the year 1922 by the same industries and stocks at ports and distributing points, were published in a joint report by the Bureau of Chemistry and the Bureau of the Census.

Statistics have been collected on the consumption of turpentine and rosin by industries during the year 1923, together with data on the stocks held by consuming industries and at ports and distributing points, as of March 31, 1924, which is the close of the fiscal year in the naval-stores trade.

COLOR INVESTIGATIONS

Basic research work to aid in the development of the dye industry in the United States was continued during the year. Previous reports have told of the development of improved methods of the manufacture of various dyes and of intermediates used in the manufacture of dyes. Highly satisfactory dyes and intermediates are now being manufactured commercially by methods developed in this bureau. The fact that in 1923 there were produced in the United States over 93,500,000 pounds of coal-tar dyes, with a value of about $50,000,000, as compared with the production of only 6,620,000 pounds, valued at about $2,500,000, in 1914, indicates the growth of this industry in the United States. Furthermore, most of the dyes manufactured in the United States in 1914 were made from intermediates imported from Germany. The production of intermediates in the United States in 1923 was about 230,000,000 pounds. The United States now produces about 96 per cent of the dyes consumed here.

During the last year, special attention was given to the analysis of biological stains for the purpose of establishing specifications for their certification. These dyes are used by bacteriologists, health officers, and physicians for identifying microorganisms that produce disease. Formerly these stains could be obtained only from Germany. While biological stains are not of great importance commercially, they are of the very greatest importance from the point of view of public health, and the war showed that it is essential for this country to be independent of any foreign supply. The work has resulted in the drawing up of specifications for the certification of hemotoxylin, safranin, basic fuchsin, and acid fuchsin, in addition to methylene blue, which was reported last year. Work is now under way for the certification of eosin, gentian violet, pyronin, and orange G. This work has shown that some of the American stains are as good as, or better than, the pre-war imported stains, and has led to more exhaustive researches on the question of staining.

A water-soluble tar, very difficult to remove, is always formed in the preparation of sulphonic acids. A simple, inexpensive method of rendering this tar insoluble, devised in the bureau, promises to be of general application.

Work started on the production of beta-aminoanthraquinone, needed as an intermediate for vat dyes, has resulted in the determination of suitable conditions for its production. Another new intermediate, methylisopropylanthraquinone, has been prepared from para-cymene obtained as a by-product from the bisulphite process of manufacturing paper pulp. Heretofore, para-cymene has been largely a waste by-product.

A method of determining the dissociation constants and hydrogen-ion concentration of indicators by use of the spectrophotometer has been devised and successfully applied to two of the new indicators. The spectrophotometer has also been successfully applied to the determination of the identity of closely related dyestuffs which formerly defied chemical differentiation.

One of the most pressing needs of the day is the accurate determination of physical constants, such as freezing and boiling points and vapor-

pressure curves. The Color Laboratory, therefore, has undertaken the determination of these constants for a large number of compounds. The determinations on four of these have been completed and will be published shortly.

The examination of commercial food colors to see that they were free from harmful impurities was continued. During the year, 232,305 pounds of straight dyes, 26,956 pounds of repacks of straight dyes, and 286,148 pounds of mixtures were certified by manufacturers. Food colors were certified by 30 firms, six of which had never certified colors before. Nine batches of straight dyes and one batch of mixture were rejected.

CHEMICAL WORK FOR OTHER DEPARTMENTS

The Bureau of Chemistry is called upon by the various departments of the Government for a great volume and variety of chemical work, ranging from making a chemical analysis of a food product for the Army or Navy, to see that it complies with the specifications under which purchased and that it is otherwise suitable for food, to giving expert advice on an involved technical chemical problem. The specialists of this bureau are being called upon daily for information and advice on chemical problems by many branches of the Government service.

The requests for chemical analyses by other departments have grown to such proportions that this work threatens to encroach seriously on the regular duties of the bureau. The advantage of having this work done in a thoroughly equipped central bureau, manned with specialists, rather than in a number of small laboratories in widely scattered departments, is obvious. The work can be done more efficiently and at a smaller cost because of the higher degree of specialization possible where a comparatively large staff of chemists is employed and because of the volume of data already available on many of the questions that arise. How far this work should be permitted to retard the regular work of the bureau for which specific appropriations are made, however, is a grave question. It may be necessary for the Bureau of Chemistry to limit the work it does for other departments or to effect a plan whereby some compensation may accrue from it.

At the request of the Post Office Department, this bureau investigates the composition and medicinal properties of many so-called remedies and cures which are advertised and sold through the mails, in order to assist that department in determining whether they should be classed as fraudulent under the postal laws. Analyses of the products are made when necessary, and expert testimony is furnished at hearings and at court trials. Some of the misbranded medicinal preparations sold direct to consumers can be reached more effectively under the postal laws than under the Federal food and drugs act. Fraud orders have been issued denying the use of the mails to a number of concerns putting out worthless preparations for which false and fraudulent claims were made by the proprietors.

Examinations were made of 301 samples of blueprint and brown-print papers and cloths from the Navy Department and 58 miscellaneous samples of paper from other departments. Forty-nine samples of bookbinding leather and 17 samples of rosin-oil varnish were examined for the Government Printing Office. Assistance was given to the Federal Specifications Board in furnishing data on and preparing specifications for paper, paint, lime, and leather. Assistance on paper specifications was also given to the Congressional Joint Committee on Printing. Several hundred samples of food were examined for the War Department, the Navy Department, the Marine Corps, General Supply Committee, United States Shipping Board, Panama Canal Commission, Internal Revenue, Bureau of Indian Affairs, Federal Trade Commission, Department of Justice, Customs Division, and Walter Reed Hospital. Samples of drugs were also examined for other departments. The laboratories of the bureau in 16 of the larger cities throughout the United States have made chemical analyses for other departments.

ENFORCEMENT OF THE NAVAL STORES ACT

No appropriation for the enforcement of the naval stores act, approved March 3, 1923, was available for the fiscal year ended June 30, 1924, but regulations authorized by the act were prepared, and plans were formulated for the actual work of enforcement.

The naval stores act provides that the Secretary of Agriculture "shall examine, if practicable, upon request of any interested person, any naval stores and shall analyze, classify,

or grade the same on tender of the cost thereof as required by him, under such regulations as he may prescribe. He shall furnish a certificate showing the analysis, classification, or grade of such naval stores, which certificate shall be prima facie evidence of the analysis, classification, or grade of such naval stores and of the contents of any package from which the same may have been taken, as well as of the correctness of such analysis, classification, or grade and shall be admissible as such in any court."

The Secretary of Agriculture is authorized to purchase from time to time samples of spirits of turpentine and of anything offered for sale as such, for the purpose of analysis, classification, or grading, and of detecting any violation of the act. Naval stores offered for import or export, as well as naval stores that enter interstate commerce, are subject to all the provisions of the act.

Regulations for the enforcement of the act have been issued covering, among other things, samples and directions for taking samples, form of request for and cost of analysis, classification and grading, issuance of United States certificates, labeling United States examined turpentine and rosin, loan and care of duplicates of United States standards, and publications and hearings.

An appropriation of $10,000 for the enforcement of the act became available on July 1, 1924. The necessary equipment for the sampling, grading, classification, analysis, and marking of naval stores has been secured, and the necessary forms for the work devised and printed. A force of three men has been organized, and provision has been made for the active enforcement of the act to the extent which the funds available will permit.

TEA INSPECTION ACT

All tea imported into the United States is examined at ports of entry for quality and purity, as determined by comparison with United States standards for tea established under authority of the tea inspection act. During the last fiscal year 104,492,743 pounds of tea was examined at all of the ports of entry. Of this, 63,159 pounds, or 0.06 per cent, was rejected. All of the rejections were for quality. No coloring or facing material was found in any teas during the year. This indicates a marked improvement, since at one time most of the rejections were caused by teas not being up to the Government standard in purity because of coloring and facing.

Table 1 shows the quantity of each variety of tea imported, passed, and rejected and the quantity of tea examined at each port of entry.

TABLE 1.—*Kinds and quantities of tea passed and rejected during the fiscal year ended June 30, 1924*

Variety or port of entry	Examined	Passed	Rejected for quality
	Pounds	*Pounds*	*Pounds*
Formosa Oolong	12,515,606	12,501,802	13,804
Foochow Oolong	18,467	18,467	-------
Congou	8,579,588	8,557,412	22,176
India	15,054,374	15,052,819	1,555
Ceylon	23,790,430	23,790,347	83
Blended Ceylon and India	458,205	458,205	-------
Java	8,030,578	8,018,737	11,841
Sumatra	1,909,013	1,909,013	-------
Ceylon Green	1,304,334	1,304,334	-------
Ping Suey Green	6,975,044	6,975,044	-------
Country Green	2,246,681	2,246,661	20
Japan	21,232,269	21,231,541	728
Japan dust	1,360,430	1,360,430	-------
Capers	7,800	7,800	-------
Scented Orange Pekoe	47,473	47,473	-------
Scented Canton	580,017	579,917	100
Canton Oolong	294,165	281,313	12,852
Tabloid	660	660	-------
India Green	80,443	80,443	-------
African tea	7,166	7,166	-------
Total	104,492,743	104,429,584	63,159
Boston	20,136,148	20,121,494	14,654
Chicago	3,849,159	3,849,099	60
Honolulu	358,075	358,075	-------
New York	54,365,243	54,336,880	28,363
Puget Sound	11,978,189	11,977,889	300
St. Paul	986,800	986,800	-------
San Francisco	12,819,129	12,799,347	19,782
Total	104,492,743	104,429,584	63,159

ENFORCEMENT OF THE FEDERAL FOOD AND DRUGS ACT

The volume and the variety of foods and drugs that are shipped into interstate and foreign commerce increase steadily from year to year. The value of all foods manufactured annually is 4 times greater than the value of all men's and women's clothing manufactured each year; it is 6 times greater than the value of the yearly production of automobiles; it is 10 times greater than the value of all boots and shoes manufactured annually; and it is more than 4 times the

value of the output of all iron and steel mills. These comparisons are based on the value of manufactured foods and do not take into consideration the enormous traffic in unmanufactured foods, such as eggs, milk, nuts, fruits, vegetables, grains, and the like, to which the Federal food and drugs act applies when they are shipped within its jurisdiction. Important as the food industry is from an economic point of view, it is even more important when considered from the point of view of the public health and of the general well-being of the people everywhere.

To maintain an effective supervision over the production, manufacture, transportation, and sale of the food, medicine, and drink that are consumed by 110,000,000 people is a stupendous task, requiring the solution of many intricate problems to determine what constitutes adulteration and misbranding in food and drugs and to demonstrate how products of a fair standard of purity can be manufactured or produced under widely varying conditions. The Federal food and drugs act was enacted at a time when gross adulterations and misbrandings were prevalent in the foods and drugs that entered interstate and foreign commerce. It supplemented State and city legislation. The marked improvement in the quality and purity of foods and drugs that has been brought about in recent years is the result of the united efforts of Federal, State, and city food, drug, and health officials working in close cooperation on common problems, and of the assistance of various leaders in the food and drug industries who have had the vision to see that the elimination of objectionable practices would be of benefit to the industries as well as to the consumers.

Under a project system of planning work to which reference has been made in previous reports, attention is systematically directed toward the staple foods which constitute the bulk of the diet and toward such other products as are most commonly sophisticated.

Twelve thousand seizures and prosecutions based on the adulteration or misbranding of foods and medicines under the Federal food and drugs act have been completed, and the results of each published, since the enactment of the law. The twelve thousandth notice of judgment was issued during the year.

FORMS OF ADULTERATION AND MISBRANDING ENCOUNTERED

New forms of adulteration and misbranding are found from time to time, and the work during a year covers a great variety of products and many forms of sophistication, although in accordance with the project system attention is centered on staple products. Specific reference can be made in this report to only a few of the products which received special attention during the year.

Canned salmon.—The practice of canning decomposed salmon in certain canneries was mentioned in the last report. The necessity for continued and intensive regulatory activity forecast at that time has been fully justified by developments during the past fiscal year. Seizures of 62 shipments of the product were made, and 49 criminal prosecutions were inaugurated. No improvement in conditions prevailing during preceding seasons was apparent. Six seizure cases were vigorously contested by the packers during the year. Decomposed fish, varying from 10 to 50 per cent, was found in the shipments. The packers contended that it was impracticable to eliminate all rotten fish from their product and made the point that no harmful effects have resulted from the consumption of rotten salmon. The Government introduced testimony to the effect that it was practicable to eliminate rotten fish from the pack. The question of whether canned rotten fish is harmful to health was not an issue, since the law defines decomposed products as adulterated, regardless of whether they may or may not be harmful to health. Juries before whom these seizures were tried upheld without exception the contention of the Government that these shipments violated the law. It is to be hoped that the uniform success in winning these court cases may have the effect of curbing the illegal practices of those canners who have not kept pace with the better elements of the industry in adopting precautionary measures to prevent the canning of decomposed fish. Recent inspections, however, have shown a continuation of objectionable practices on the part of certain canners which will necessitate continued and intensive regulatory activity.

Butter.—During the year special attention was given to interstate shipments of butter to determine whether or not it complied with the recently enacted legal standard which provides

that butter shall contain not less than 80 per cent by weight of milk fat, all tolerances having been allowed for. Examinations of many shipments showed that some butter being shipped into interstate commerce did not contain 80 per cent fat. During the year 194 prosecutions were instituted and 102 seizures effected. This has resulted in a decided improvement in the butterfat content of the butter shipped into interstate commerce.

Jams, jellies, and preserves.—Fifty-eight court actions, including 22 prosecutions and 36 seizures, were instituted during the year because of the adulteration or misbranding of jams, jellies, preserves, and similar products. The most common form of adulteration in these products is the substitution of pectin for a part of the fruit. A decision outlining a method for labeling correctly certain compound and imitation jams and preserves was issued.

Nuts.—The shipment interstate within the jurisdiction of the Federal food and drugs act of wormy and moldy nuts resulted in 6 prosecutions and 34 seizures. Several consignments of various nuts offered for entry into the United States from foreign countries were excluded because they were found to contain worms and mold.

Edible oils.—Every year it is necessary to take legal action because of the adulteration or misbranding of vegetable oils. A common form of adulteration is the substitution in whole or in part of cottonseed oil for olive oil. Cottonseed oil is an excellent table oil, but its sale as olive oil at a higher price than it would command under its own name is a fraud. Violations of the law involving edible oils were responsible for 27 court actions during the year.

Stock feeds.—One hundred and eleven prosecutions and 120 seizures were brought on charges involving the adulteration or misbranding of stock feeds. The most common form of violation in these products is the overstatement on the labels of the protein content of the various feeds. As the price of feeds is usually determined by the protein content, there is a continual temptation for dealers to overstate the percentage of protein and thus obtain a higher price for the feed.

Canned fruits and vegetables.—Sixty-one court actions involved canned fruits and canned vegetables. A common violation of the law where these products are concerned is the use of too much brine or sirup and too little vegetable or fruit. The Bureau of Chemistry holds that a can should be as full of solid food as is practicable and has devoted much attention to securing a proper fill of can.

Oats.—A special campaign to break up the practice of adulterating oats was conducted in the Middle West. The chief adulterants were added screenings and excess water. Several carloads from various shippers were seized. An improvement in the prevailing practices has undoubtedly resulted.

Flavoring sirups and concentrates.—The traffic in flavoring sirups, flavoring concentrates, and other flavoring preparations is extensive. It is estimated that the total annual production of fountain sirups is about 60,000,000 gallons, most of which enters interstate commerce. Much attention was directed toward adulterated and misbranded sirups alleged to contain grape juice, but which consist of sugar, fruit acid, imitation grape color, and imitation grape flavor. Attention has been given also to orange sirups and other orange preparations alleged to contain orange juice, but which are flavored merely with oil of orange and are made turbid or cloudy by the use of gum. Sirups which contain some fruit juice, but not enough to characterize them as genuine fruit sirups, also fell into this class of products. Improvement has been made in the labeling of these preparations.

Eggs.—One hundred and three court actions were brought on adulterated eggs. Included in this number are cases involving frozen eggs, which are used extensively by commercial bakeries, hotels, and restaurants in baking and cooking. Most of the cases, however, were based upon the shipment into interstate commerce of consignments of shell eggs, a part of which were rotten. Interstate shippers of eggs have been warned frequently to candle them in order that the rotten eggs might be eliminated, but although there has been a very great improvement in the quality of eggs shipped into interstate commerce, it is still necessary to seize shipments containing rotten eggs.

PROSECUTIONS AND SEIZURES

The court actions instituted during the year summarized in Table 2 indicate the scope and variety of the products involved.

TABLE 2.—*Summary of prosecutions and seizures*

Product	Prosecutions	Seizures
Alimentary pastes	3	3
Baked products	24	3
Beverages	6	30
Butter	194	102
Cheese	1	10
Coffee	11	3
Colors	4	1
Confectionery	20	7
Drugs (crude)	1	2
Eggs:		
Frozen	1	19
Liquid		1
Shell	52	30
Substitutes		1
Feeds	111	120
Fish:		
Canned	49	100
Shell	36	20
Flour	5	33
Food flavors	6	9
Fruit:		
Canned	1	21
Dried	7	4
Fresh	4	8
Frozen		2
Juice		2
Ice cream	3	
Jellies, jams, preserves	22	36
Meal (corn)	3	4
Milk (condensed)	1	2
Molasses	4	2
Mustard		5
Nuts	6	34
Oils	16	11
Olives		4
Pickles	1	1
Pie filling	3	1
Remedies	47	117
Sirup (table)	11	6
Spices and condiments	2	4
Tea	3	1
Vegetables:		
Canned	2	37
Fresh	12	4
Vinegar	18	1
Water		7
Total	690	808

DRUG CONTROL INVESTIGATIONS

The Drug Control Laboratory and the field forces of the Bureau of Chemistry work in very close cooperation in enforcing the provisions of the food and drugs act which relate to drugs.

Activities in connection with drugs have been concentrated principally on the following subjects: (1) Medicinal tablets containing important therapeutic agents; (2) galenicals; (3) crude drugs, including herbs, leaves, barks, roots, flowers, seeds, etc.; (4) medicines offered for the treatment or prevention of serious diseases; (5) nitrous oxide manufactured and sold in the United States; (6) methods of analysis for certain important drugs.

Medicinal tablets.—During the year analyses have been made of approximately 700 samples of the more important medicinal tablets manufactured and sold in the United States, including tablets of strychnine sulphate, quinine sulphate, nitroglycerin, morphine sulphate, heroin hydro-chloride, codeine sulphate, atropine sulphate, aspirin, and acetphenetidin, which are labeled to show their purported content of active ingredients. Unusual care has been given to the analyses of these preparations. Where appreciable variations from declared standards have been found, check analyses by a second and sometimes by a third analyst have been made. This investigation has shown that while most of the products comply reasonably well with their declared standards, many need improvement. In some instances the variations were so great that prosecutions are being instituted against manufacturers. The number of manufacturers of these products, the wide variety of medicines prepared in tablet form, and the existing conditions made it impossible to complete an investigation adequate to remedy the conditions during the year. This work will be actively prosecuted during the next fiscal year. The pharmaceutical manufacturing industry has taken an active interest in effecting improvement in this class of preparations and has appointed a committee to cooperate with the Bureau of Chemistry with a view to extending investigations, pooling information, and taking such other steps as may be necessary for improving the quality of medicinal products, especially tablets. It is hoped that this gratifying action on the part of the industry will result in an improvement which will obviate in large measure the necessity for using strictly regulatory measures.

U. S. Pharmacopœial, National Formulary, and other galenicals.—An exhaustive survey of some official and unofficial galenicals on the American market was made, primarily to obtain information on which to base a comprehensive regulatory project in the event that the results obtained indicated the necessity for it. The products examined include tincture of belladonna leaves, fluid extract of belladonna leaves, tincture of belladonna root, fluid extract of belladonna root, fluid extract of colchicum seed, tincture of colchicum seed, fluid extract of colchicum corm, powdered extract of colchicum corm, wine of colchicum corm, wine of colchicum seed, colchicine, fluid extract of nux vomica, tincture of nux vomica, powdered extract of nux vomica, fluid extract of ipecac, tincture of aconite, tincture of digitalis, etc. The products investigated are highly important

drugs, used principally in filling physicians' prescriptions. Many of the samples examined varied materially from the official or declared standards of strength, showing the necessity for an exhaustive investigation.

Crude drugs.—The study of methods and the effect of atmospheric humidity, temperature, drying agents, etc., on moisture determinations in crude drugs was continued. An apparatus for melting-point determinations of minute quantities of substances was devised. Further experimental work on the direct sublimation of crystalline substances from plant and animal products was conducted. Methods for the detection of hydrocyanic acid in plants were studied. Regulatory questions arising in connection with the importation of *Cactus grandiflorus*, N. F., and the disposition of adulterated or substituted Wahoo bark (*Euonymus atropurpureus*) necessitated investigations of these products to determine their sources, means of identification, and chemical and anatomical characteristics.

Patent or proprietary medicines.—Previous activities of the Bureau of Chemistry in connection with proprietary medicines have been continued. While there has been a great improvement in the labeling of this class of preparations, as a result of the consistent support of the department's interpretation of the law by the United States courts and attorneys and the prompt action of Congress in remedying the only serious defect which the courts have found in the food and drugs act, much is yet to be desired. During the past year special attention has been given to misbranded medicines sold in large volume for the treatment of serious diseases, such as diseases of the kidney. As a result of this activity improvement in the labeling of this class of products has been made. The work during the next year will be continued along the same general lines.

Nitrous oxide.—Owing to its importance and increasing use as an anæsthetic in dental surgery, general surgery, and obstetrics, a comprehensive survey of the nitrous oxide manufactured in the United States was undertaken. Practically every factory producing this article was inspected and samples in the channels of commerce from each of such factories were analyzed. While the manufacturing methods of some of the producers are not above criticism, on the whole the conditions seem comparatively satisfactory. None of the samples examined contained more than a trace of nitric oxide, the poisonous contaminant most likely to occur in this preparation. Careful control should be maintained over this important anæsthetic by municipal, State, and Federal regulatory officials in guaranteeing to patients the use of a pure and safe product.

Methods of analysis.—As adequate control of drug products is dependent on reliable methods of chemical analysis, a critical study of existing methods, with a view to improving or simplifying them, is necessary, and methods for drugs for which no methods or inadequate methods only are available must be devised. During the past year a critical study has been made of the methods of analysis of preparations of nux vomica and ipecac. The methods devised will probably be applicable to other drugs containing alkaloids. In collaboration with the Color Laboratory, a report on the detection and identification of small quantities of phenols has been published. The methods employed give promise of having wide application in the detection and identification of phenols, many of which occur in drug products. The study of methods of analysis of phenolphthalein, an important laxative drug, has been continued, as a result of which the method of analysis previously devised has been simplified and applied to more complex mixtures than heretofore. Several new pieces of apparatus have been devised for the purpose of either increasing the accuracy of chemical analysis or decreasing the time of the analyst in making analyses.

FOOD CONTROL INVESTIGATIONS

As the result of a study on the composition of alimentary pastes and the raw material used in their manufacture, the analysis of noodles of known composition was reported in the Journal of the Association of Official Agricultural Chemists. The data compiled have been valuable in estimating the egg solids content of noodles.

Baking tests were made on prepared waffle flours with egg contents varying from 0 to 5 per cent. The waffles containing the most egg were considered best. A similar investigation on pancake flours did not show a correlation between egg content and the quality of the pancakes. An investigation of the value of sweet-potato flour as a bread improver was made.

The bakings did not indicate in any way that the addition of small quantities of sweet-potato flour in the formula improved definitely any quality of the loaf, but rather that frequently somewhat inferior loaves were produced.

It was shown that cocoa can be used to advantage in the baking formulas of rolls and bread.

Moisture determinations of various grades of flour indicated that flour with a moisture content within the limits of the standard is being produced throughout the country. Further work will be necessary to obtain definite information regarding the moisture content of the output of mills in different sections of the country and at different times of the year. A thorough study of the methods for determining moisture in flours was made, and a rapid method for determining the ash in flour, which gives results in half the time required by the regular official method, was developed.

Work was done on the improvement of methods for analyzing dairy products.

An investigation of mixtures of fruit, sugar, and commercial pectin, using fruit of known composition, was conducted for the purpose of collecting data for use in actions under the law against preserves and other fruit products adulterated with pectin.

Much work was done in the development of both organoleptic and chemical tests to detect spoilage in canned salmon, the results being used in the presentation of evidence in court cases. Work was also done on sardines in connection with the problem of "feedy" fish.

Commercial processes of packing Lima beans, peas, pitted cherries, and corn were investigated. A laboratory study of the proper fill of blanched and unblanched string beans was made. Work was done on the proper fill-of-can and the chemical composition of canned grapefruit.

MICROBIOLOGICAL INVESTIGATIONS

The food products involved in the outbreak of botulism at Sterling, Colo., were examined, and *Bacillus botulinus*, Type A, was isolated from the home-canned string beans responsible for the outbreak. The organism was also found in sausage actually consumed by those suffering from the poisoning, but the sausage itself when fed to experimental animals proved nontoxic. On the other hand, the string beans when fed were poisonous. This outbreak was followed by the poisoning of a group of people at Coalinga, Calif., from commercial canned ripe olives. Two olives from the container responsible for the poisoning were strongly toxic when fed to experimental animals. An investigation of a whole series of cans from the same lot disclosed the presence of no more poisonous olives. The condition of the olives and the presence of various species of bacteria in viable condition in the containers, however, point to careless methods in the factory.

In connection with the study of soundness in canned food, it has become increasingly evident that the problem of preservation is closely bound up with the bacteriology of the raw materials entering the cannery. Vegetable products are always contaminated with microorganisms from the soil or other sources. Ordinarily entirely fresh products carry these organisms only as spores or as inactive bacteria. In the gathering, handling, and transportation of vegetables to the market or to the factory many opportunities for active bacterial growth occur. Students of the canning industry have shown that the difficulties in producing sterility in the can are closely correlated with the bacteriological conditions in the raw materials.

A study of the bacteriology of a series of vegetables, product by product, offers a clue to the precautions necessary to insure soundness in these food products, whether for manufacturing purposes or for direct consumption. Such a study of spinach was previously reported. During the past year studies of corn and asparagus have been conducted upon the same lines.

In the corn-canning regions of Illinois and Iowa the fresh sweet corn was followed from the field through to the finished pack. Even in the field the ear of corn is contaminated with small numbers of microorganisms inside the husk and in contact with the grains of corn. The course of multiplication of this initial contamination was followed through the steps of handling. Masses of sweet corn pulled from the stalk and in transit to the factory or in the storeroom of the factory before husking heat very quickly and become wet and subject to tremendous multiplication of microorganisms, so that the initial contamination reaches fabulous numbers if the product stands overnight or over Sunday. The heat in such piles quickly rises

above blood heat, occasionally almost to the temperature of pasteurization. The difficulties of producing a sound product from corn in such condition are tremendously increased. Many of these organisms are heat-resistant spore-formers, which not only multiply vegetatively but produce great numbers of spores, even in a comparatively few hours of heating. It is thus clearly indicated that there is substantial reason for great haste in handling corn for canning.

A continuation of the bacteriological studies in oyster spoilage has made possible a report covering the types of organisms found and a special consideration of the types of bacteria responsible for the significant phases of spoilage in this product.

Extensive abuses in the canning of sardines necessitated the bacteriological examination of many cans. Objectionable practices in sardine canning were evidenced, first, by spoilage in the can as indicated by swelled cans found in such quantities in the output of a single factory as to necessitate the seizure of almost the entire season's pack of that concern, and, second, by the packing of rotten or partially rotten fish. This represented a resumption of objectionable practices which had largely disappeared for a time as a result of the campaign conducted by the bureau in 1915 and 1916. A survey of the problems involved showed the necessity for further work during the current fiscal year to correct the sardine situation in Maine.

Reference has been made on page 3 to the extensive losses in handling forage and feeding stuffs and, to some extent, human foods which occur as a result of biological heating processes. Sometimes these heating processes, if occurring under the most favorable conditions, bring about the spontaneous combustion of large masses of the product, together with such other property as may be in contact with the burning materials. During the last quarter of this year a systematic series of experiments was begun to produce these heating processes under known and controlled conditions. For this purpose special apparatus was devised—insulated chambers, into which known quantities of oxygen could be introduced at any desired rate. Under these conditions it has been possible readily to produce temperatures of 60° C. or slightly higher. Experiments to determine the agents responsible for this heating process and to define as closely as possible the conditions under which such heating may be anticipated are in progress.

Cultural studies of Penicillium and Aspergillus and species of related genera were continued. Cultures have been maintained for the past 10 years. This series of organisms in culture now contains nearly 1,000 strains to which contributions are constantly being made. All studies of material are being brought together into a monographic key to these two great genera of saprophytic molds.

The experience obtained in the cultural examination of these collections, together with the possession of authentic cultures representing the species described in the literature, makes it possible to assist in the solution of many problems. The correspondence during the past year has included mold problems involving human pathology, the decomposition of sugar and sugar products, the molding of tobacco, the deterioration of rubber, the activity of molds in the fermentation industries, and the significance of species and groups of species in the soil, as well as the taxonomic study of the fungi themselves.

MICROCHEMICAL INVESTIGATIONS

A study was made of cacao products with special reference to the shell content. Preliminary studies were made on methods of quantitative estimation of wheat and rye middlings when mixed, of barley in ground mixed-feed barley, of hoof meal in digester tankage, and of flax-plant waste in alfalfa. Work was continued on the source of products and by-products used in feeds.

A survey was made of the character of the strawberry, raspberry, and blackberry products on the market. As a result of studies on the methods of packing blueberries and cherries, suggestions for improvements in packing methods and in the quality of the products have been made to canners. Microscopic examinations were made of a variety of products as a basis for court actions, especially with respect to adulteration in nuts, tomato products, stock feeds, and fruits.

A paper on the "Microscopical identification of some sodium and potassium salts" has been published, and one on "The determination of the optical properties of the amino acids" is in press. Work is being continued on photographic tests on radioactive and pseudo-radioactive substances and on the pollen content of honeys.

PHARMACOLOGICAL INVESTIGATIONS

Certain drugs for which chemical assay methods are not feasible are tested biologically. Among these drugs are digitalis and strophanthus, which are vitally needed in some types of heart disease; ergot and pituitary preparations, which are frequently used in obstetrics; and insulin, which is used in the treatment of diabetes. Bioassay methods for aconite, cannabis, digitalis, strophanthus, squill, epinephrine, ergot, and pituitary preparations will be included in the forthcoming tenth revision of the United States Pharmacopœia. The physiological effects produced by a commercial preparation are to be compared with the effects produced by a standard sample. Great variations have been found in the strength of the commercial preparations of these drugs now appearing upon the market, the products of some manufacturers being more than ten times as active as corresponding preparations made by other manufacturers. Believing that the use of common standards would directly assist in reducing such variations and in improving the character of marketed preparations, the bureau has arranged to furnish prototype standards upon request. The use of such standards is expected definitely to reduce the variation of commercial preparations of these potent drugs. Attention is also being directed to the physiological effects produced by various pancreatic preparations recommended for use in the treatment of diabetes.

Work was continued on the pharmacology of arsenic, tin, and other heavy metals. Information on the toxicity of various food preservatives was collected. A study of the comparative toxicity of aliphatic alcohols and alkyl esters was made, and, in collaboration with the Bureau of Biological Survey, the efficiency of dried squill preparations as rat poisons was investigated.

STOCK FEED CONTROL

Work to determine standards and definitions for various cattle feeds sold on the American market has been continued. This includes the study of products and methods of preparation, as well as the proper way to state definitions and the desirability and correctness of standards. A paper on barley and its by-products and one on the milling of buckwheat have been prepared. Work on a method for the determination of leaves and stems in alfalfa meal is in progress. The results of the work on oat by-products and corn by-products will soon be published.

CONTROL OF WATER AND BEVERAGES

Control of the purity of mineral water shipped in interstate commerce is now maintained largely by inspection at the springs or wells. Work of this type is essentially educational. The shippers of the water are shown that near-by toilets, broken curbing, rusted-out casings, cold-water rinsing of bottles, dusty corks, and the like may result in contamination dangerous to health. It is very difficult sometimes to convince a bottler that his procedure is at fault and still more difficult to persuade him to change long-established habits. Three large mineral-water resorts in the United States now maintain constant analytical control of the purity of the mineral waters shipped in interstate com merce.

Surveys of commercial water supplies were made in Kentucky, Tennessee, Mississippi, Texas, Arkansas, and Missouri. Ninety-four wells and springs were inspected, and suggestions for improving the purity of the waters shipped into interstate commerce were made.

Numerous court actions were developed against imitation grape soda-water flavors made with grape wine and oil of cognac, with a little added methyl anthranilate. None of the court actions involving this point so far brought to trial have been contested. The manufacturers are generally labeling such products as imitations in compliance with the law.

INSPECTION OF IMPORTED FOODS AND DRUGS

All consignments of foods and drugs offered for entry into the United States from foreign countries come within the jurisdiction of the Federal food and drugs act. The act provides that all consignments found to be adulterated or misbranded within the meaning of the act, or that are otherwise injurious to health, are to be excluded from the country. Inspections are made, in so far as the limited personnel available will permit, of the foods and drugs offered for entry at the leading ports. Since it is not practicable to inspect all consignments, it is the aim to center attention on those which there is reason to believe may be adulterated or misbranded. However, it is not possible to inspect ade-

quately even all the consignments which may be in violation of the law. Certain classes are selected from time to time to receive attention, and the means available are used to the utmost to find as many as possible of the consignments that are in violation of the law.

COURT DECISIONS

The following court decisions rendered during the year are of interest:

The United States Supreme Court ruled that a label reading "Apple Cider Vinegar Made from Selected Apples," applied to vinegar made from dried-apple products, was a misrepresentation with respect to such vinegar. This reversed the decision of the Circuit Court of Appeals for the Sixth Circuit, which was reviewed by the Supreme Court upon proceedings instituted by the Government. In rendering the decision the court said:

> The statute is plain and direct. Its comprehensive terms condemn every statement, design, and device which may mislead or deceive. Deception may result from the use of statements not technically false or which may be literally true. The aim of the statute is to prevent that resulting from indirection and ambiguity, as well as from statements which are false. It is not difficult to choose statements, designs, and devices which will not deceive. Those which are ambiguous and liable to mislead should be read favorably to the accomplishment of the purpose of the act. The statute applies to food and the ingredients and substances contained therein. It was enacted to enable purchasers to buy food for what it really is.

On an agreed stipulation of facts, the United States Court for the Western District of Virginia held that the sale of an artificial mixture of cultivated oats with wild oats and other foreign material under a designation "Sample Grade Star Oats" was a misbranding in that the article was sold under the distinctive name of another article.

The Court of Appeals of the District of Columbia has reversed the judgment against the United States in a seizure proceeding against a certain brand of pills which were alleged to be falsely and fraudulently labeled as to their curative and therapeutic effect. The appellate court held that the trial justice committed error in not permitting the Government's expert witnesses to testify as to the consensus of medical opinion upon a given subject.

The United States Pharmacopœia prescribes that "powdered colocynth" must be made from colocynth pulp containing not more than 5 per cent of seeds. The United States Court for the Eastern District of Pennsylvania has held that colocynth apple ground with approximately 25 per cent of the seed and labeled "powdered colocynth apple" is misbranded. Although it is not expressly stated that the product is what is known to the trade as "powdered colocynth," but is stated to be "powdered colocynth apple," the court held it is none the less true that the difference in the product is not so stated as to command attention to the fact that there is a difference. The product is so labeled that the difference may be overlooked and the purchaser may be buying the product with the thought that he is buying another. Because of its ambiguity such branding was held to be misleading.

COOPERATION WITH STATE AND CITY OFFICIALS

The effectiveness of cooperation with State and city food and drug officials was demonstrated in the case of the recent poisoning outbreaks caused by ripe olives. Immediately upon the conclusion of the investigation of the Bureau of Chemistry, which proved that the fatalities in Wyoming had been caused by canned ripe olives, letters were sent to every State official charged with the enforcement of regulatory food laws, and to similar officials in the larger cities, advising them of the results of this investigation and, in view of the great danger to the public, requesting their assistance in surveying immediately, so far as practicable, all stocks of ripe olives in the hands of jobbers, wholesalers, and retail dealers and removing all packages which were in any respect suspicious. Supplementing these letters, the field stations of the Bureau of Chemistry addressed similar requests to the health officials of many cities, large and small, within their territories. The response to these requests was immediate, and the bureau was very soon receiving samples of olives from every section of the United States. These were examined and reported upon as fast as possible. The bureau gratefully acknowledges this prompt response to its appeals and the able assistance so effectively rendered by State and city authorities, which resulted in segregating and eliminating from the market olives wholly unfit for sale and consumption.

During the past year attempts have been made to supplement the usual cooperative work by a plan for more closely coordinating the administrative procedure of all food and drug officials. Tentative uniform rules and regulations have been devised and even adopted in two sections of the

United States, and they are under consideration by other groups of food and drug officials. It is believed that this endeavor should be continued, since the adoption of a uniform method of procedure by all concerned will not only prove effective from a regulatory standpoint, but ought to appeal to the food manufacturer, who must arrange his labeling so as to comply not only with various local laws and ordinances, but with the terms of the Federal food and drugs act.

PUBLICATIONS ISSUED

Five department bulletins, 4 farmers' bulletins, 2 miscellaneous circulars, 7 articles in the Journal of Agricultural Research, 125 articles in scientific and technical journals, and 700 notices of judgment were published during the year.

The department bulletins were: No. 1158, "Production of Sirup from Sweet Potatoes"; No. 1166, "Apple By-Products as Stock Foods"; No. 1168, "Wearing Qualities of Shoe Leathers"; No. 1194, "A Chemical and Structural Study of Mesquite, Carob, and Honey Locust Beans"; and No. 1203, "Experimental Production of Straw Gas."

Of the 4 farmers' bulletins, 3 were revisions of previous bulletins which were brought up to date and expanded to include much new material. The revised bulletins were: No. 1334, "Home Tanning of Leather and Small Fur Skins"; No. 1366, "Production of Maple Sirup and Sugar"; and No. 1389, "Sorgo-Sirup Manufacture." The new bulletin is No. 1424, "Making Vinegar in the Home and on the Farm."

Miscellaneous circulars No. 9, "Importation and Inspection of Tea," and No. 22, "The Naval Stores Act and Regulations for Its Enforcement." were also published.

WASHINGTON: GOVERNMENT PRINTING OFFICE: 1924