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REPORT OF THE CHIEF OF THE BUREAU OF CHEMISTRY

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF CHEMISTRY,
Washington, D. C., September 1, 1926.

SIR: I beg to submit herewith the report of the work of the Bureau of Chemistry for the fiscal year ended June 30, 1926.

Respectfully,

C. A. BROWNE, *Chief.*

Hon. W. M. JARDINE,
Secretary of Agriculture.

The Bureau of Chemistry is authorized to investigate problems in the field of agricultural chemistry and to enforce certain regulatory statutes controlling the purity and truthful labeling of foods, drugs, tea, and naval stores.

In the field of agricultural chemistry the work of this bureau is largely concerned with crop chemistry, especially with that part of crop chemistry which includes the study of the composition and utilization of farm products.

CROP CHEMISTRY

Experimental work conducted during the year has shown that the high-protein wheat resulting from the application of sodium nitrate to the soil at the time of heading yields as much flour as normal wheat raised under the same conditions and that this flour gives a bread having superior qualities. In a field-plot study of the practicability of increasing the protein of wheat by fertilizer applications attention was directed to the quantity of sodium nitrate to be applied to produce the optimum effect, to the possibility of replacing the sodium nitrate by other nitrogenous fertilizers, such as ammonium sulphate, and to the practicability of spacing the rows of wheat so as to permit heading-time applications on a large scale. The best time for applying the fertilizer had been determined in previous years.

Work was done on the possibility of increasing the iron content of green vegetables by applying iron com-

pounds to the soil or by changing the soil reaction, but the results thus far obtained are inconclusive. Some experiments were carried on to determine the effect of soil reaction on the yield and composition of certain crops.

A paper on Soil Reaction in Relation to Horticulture was published to meet the widespread interest in the subject of soil reaction and its effect on plant growth. Such related subjects as the correlation between soil reaction and nitrogen content and the composition of the ash of air plants were studied to obtain information as to the mineral constituents available to plants from atmospheric sources.

CONSTITUENTS OF THE COTTON PLANT

The results of research work to determine the odorous constituents of the cotton plant have been previously reported. As all those substances were volatile, the investigations already reported were restricted to those products from the plant that could be obtained by distillation with steam. It seemed important, however, to extend the investigation by examining also the nonvolatile constituents of the plant. This work was completed and the results of the investigations were prepared for publication.

FRUIT AND VEGETABLE UTILIZATION

The demands of the market for more carefully graded fruits and vegetables result each year in larger quantities of culls remaining at the

producing centers. One of the pressing problems of fruit and vegetable growers is to find more profitable outlets for the culls and for the surplus which can not, for one reason or another, be marketed profitably in the fresh state through the regular channels of commerce. The bureau has been working for a number of years on the development of technological processes for manufacturing usable substances from cull and surplus fruits and vegetables to aid in the solution of this problem. The development of such processes not only brings greater returns to the growers but creates new manufacturing industries, which give profitable employment to capital and labor.

The development of new processes for utilizing fruits and vegetables is slow and tedious work, requiring extensive and patient research. The composition of fruits and vegetables as a rule is very complex, and the various chemical substances contained in these products can only be determined by laborious and extended research. After the chemical composition in detail has been determined there remains the experimental work to develop practical processes and devices for manufacturing profitably on a commercial scale the various substances which the researches have shown may be produced. Although progress in both research and development work is often slow, the results are in the long run highly profitable to the growers of fruits and vegetables, as well as to the manufacturing industries. It has been found in this and other countries that the basic research and experimental work must be done by the Government, but that the application of the results may be left to private capital and individual initiative. The returns from the basic research work are often so long delayed that it can not well be financed by individuals, who must ordinarily expect a return upon their investment within a reasonable time.

The report of the chemist for 1925 outlined the steady growth of the commercial application of methods worked out in the bureau for the utilization of cull and surplus oranges and lemons, particularly in California. Several commercial concerns are now manufacturing on a profitable scale numerous marketable products from large quantities of cull oranges and lemons which would otherwise go to waste. The research work begun in the Bureau of Chemistry laboratory at Los Angeles about 12 years ago is now

proving most profitable to the citrus-fruit industries of California.

The basic research work of the Los Angeles laboratory was continued during the year. A chemical study is being made to ascertain the exact composition of orange and lemon oils for the purpose of determining whether the inability to manufacture satisfactory terpeneless oils from the California citrus fruit is due to some fundamental chemical difference between these oils and those made from European oranges and lemons or to variations in the processes of manufacture. The results of this research should show the relative values of the oils for certain uses, such as the manufacture of ice creams, hard candies, cake icings, perfumery, and beverages. By means of an improved machine to press the oil from orange peel and lemon peel developed during the year at least 5 pounds of oil can be extracted from the peels of a ton of lemons. One concern in Los Angeles uses 60 tons of citrus fruit a day in making juice by means of a revolving burr-type machine. As citrus oils are worth approximately \$2.50 a pound, the extraction and utilization of the oil would mean an additional return of \$12.50 for each ton of cull fruit or, on the output of this one plant, a gross additional income of \$750 a day. More work must be done to perfect the machine and the process for extracting the oil before this possible additional return can be realized. It is believed that research work now under way on the detailed chemical composition of the oils from orange and lemon peel will develop information that will enable California manufacturing concerns to utilize these oils for all purposes for which the European product can now be used.

Work was continued on the utilization of pomegranates, the production of which is increasing rapidly in California. Pomegranates must be carefully graded for the market, with the result that large quantities of culls are available. A satisfactory concentrated juice and jelly have been experimentally manufactured in the Los Angeles laboratory. One commercial concern is now producing juice and may shortly take up the manufacture of this product in concentrated form. The development of juice manufacture is retarded by marketing problems. Other concerns are considering the manufacture of concentrated juice and jelly from pomegranates. An improved press devised for extracting pomegranate juice in experimental

work has delivered a very satisfactory yield.

Work was carried on in concentrating pineapple juice. Up to the present time manufacturers have not been able to produce satisfactory concentrated juice from the skins and cores of pineapples, the juice being bitter and dark. In experimental work at the Los Angeles laboratory a light-colored well-flavored sirup has been produced directly from the pineapple juice. Only a limited amount of work has been done on the juice from skins and cores and the concentrate produced up to the present time is only of medium quality, being too dark and not well flavored. Further work will be necessary to develop processes for making an entirely satisfactory article. From work already completed, however, it is thought that the juice from cores and skins might with proper concentration be used as a vehicle for carrying shredded pineapple at soda fountains.

Another important problem now confronting the growers of fruits and vegetables is to know at exactly what stage of maturity the fruit should be picked in order that it may reach the market in the best possible condition. If fruit is picked too early, it never attains its finest flavor. On the other hand, if fruit is not picked until too late it is very likely to begin to deteriorate before it reaches the consumers, resulting in large losses, particularly when it is shipped for long distances. It is not practicable to determine by physical examination alone when the fruit has reached that degree of maturity which is best for picking. Some chemical test is necessary. The Los Angeles laboratory has made a study of the chemical factors that are affected by the degree of maturity in various fruits in order to devise tests by which the growers can determine when the fruit should be picked.

In previous reports the results of work on tests to determine the maturity of cantaloupes and oranges have been outlined. These tests for maturity have been applied commercially to oranges for a number of years and to cantaloupes for two years. The bureau has received many letters from growers stating that the use of these standards has prevented great losses. Work has been completed on maturity standards for raisins and the results await publication. A tentative standard worked out for maturity in the pomegranate has been tested through one crop. It will be necessary to test this standard through at least one

more crop before it can be certainly determined that it is the most satisfactory standard that can be developed. At a recent meeting of growers of pomegranates it was decided to ask the California Legislature at its next session to legalize the standard. In the meantime it will be tested during another season.

Research work was conducted to determine the chemical changes taking place in oranges during freezing in order that methods may be developed for detecting and for separating the frozen oranges. It is highly important, both for the producer and for the consumer, that frozen fruit be eliminated before being shipped to the market. Unfortunately frozen oranges can not be detected by visible inspection. A sure method for sorting out all frozen oranges would be of immense benefit to the fruit-growing industries and also to consumers by reducing the risk they run of getting frosted oranges. If separated out in time at the point of production, the frozen oranges can be used in the manufacture of certain by-products.

Investigations designed to reduce the quantity of sulphur dioxide used in drying fruits were continued.

COMPOSITION OF VEGETABLE OILS

Studies of the complex chemical composition of vegetable oils were continued in order to develop the more profitable utilization of these oils. A method was found for the quantitative estimation of the mucilaginous impurities of raw linseed oil. Linseed-oil foots can also be determined in the same manner. For years chemists of the paint and varnish industries have been seeking a method for the quantitative determination of these impurities in connection with their studies on the relative quality of different lots of raw linseed oils.

Researches on crude cottonseed oil were continued. The glycerides palmitin and dipalmitin were isolated from crude cottonseed oil and identified. This is the first instance on record where pure glycerides have been separated from cottonseed oil. A knowledge of the character of the glycerides composing this oil has long been desired by the industry. The dipalmitin, which was present in small quantities, was undoubtedly formed from the hydrolysis of a triglyceride. The glucoside phytosteroline was also separated from crude cottonseed oil. It occurs in very small amounts. This is

the first instance where a compound of this class has been observed in a vegetable oil.

The chemical composition of rice oil has been determined. It was found to contain glycerides of myristic, palmitic, stearic, arachidic, lignoceric, oleic, and linolic acids. Rice oil is characterized by the very rapid development of large quantities of free fatty acids owing to the presence of a powerful fat-splitting enzyme. These acids are set free to a notable extent even before the oil is extracted from the bran or polishings.

The keeping-quality experiments on filtered crude oils and on oils kept in contact with foots have been in progress with cottonseed, linseed, and peanut oils. With cottonseed oil the conclusion has been reached that it is preferable to separate the foots as soon as possible after the expression of the oil. This study has shown that it is impossible to predict how crude oil will keep. Oils of the same quality behaved differently upon storage.

DETERIORATION OF FORAGE AND FEEDING STUFFS

The "spontaneous" heating of foodstuffs and feeding materials, one of the chief causes of the deterioration of grains, cattle feeds, and breadstuffs of many kinds, is responsible for enormous losses each year. Occasionally such heating becomes excessive and causes destructive fires, which may involve railroad cars loaded with grains or cattle feeds, grain elevators, or barns filled with improperly cured hay.

In seeking to define the cause of such losses, experimental work has been pursued for the past three years. An apparatus has been devised with which it is possible under well-controlled conditions to measure (1) the thermogenic powers of widely different products under various conditions, (2) the thermogenic powers of significant species of bacteria and molds, and (3) the influence of certain physical factors upon the amount and rate of heat production. Oxygen (air) has been shown to be essential to the heating, and when continually supplied it facilitates the production of high temperatures. It has been shown, for example, that corn meal containing more than the critical moisture content for storage will heat under certain conditions to 145° F., resulting in a moldy product that appears to have been badly burned.

Study of pure cultures has shown that many bacteria in their metabolism liberate appreciable quantities of heat. Moistened sterilized cracked corn was used as a medium for bacterial growth. After a period of incubation, during which marked growth and heat production had taken place, the corn showed a definite decrease in carbohydrate, with little loss of protein.

NUTRITIONAL INVESTIGATIONS

Work was continued to determine the exact chemical composition and nutritive value of the proteins of various foodstuffs.

Feeding experiments to determine the nutritive value of the proteins of wheat bran have been brought to a close, and the results are published in the third of a series of papers entitled "The Proteins of Wheat Bran." The other articles of this series had stated that the proteins of bran contain high percentages of those amino acids which are essential for the normal nutrition of animals. Therefore it seemed probable that bran would furnish proteins of a satisfactory nutritive character. The feeding experiments have substantiated that view. Young animals receiving no other protein than that furnished by commercial wheat bran have grown at a rate better than normal. On the other hand, after reaching maturity they did not do so well relatively. It appears that the bran contains some factor which meets the nutritive requirements of the young growing animal but is deficient in some other factor necessary for the satisfactory nutrition of the adult.

The work on the nutritive value of certain types of sea foods has been confined chiefly to oysters and clams. Both the nutritive character* of their proteins and their vitamin content have been studied. The work is still in progress. The results thus far obtained show that oysters are a good source of vitamins A and B. Clams do not appear to be a good source of vitamins. On the other hand, the proteins of the clam have given better results than those of the oyster. The proteins of shrimp have also been studied, both chemically and by feeding experiments. The amino acid content of this muscle has been determined and the results published. Shrimp muscle does not seem to vary much from the muscle of other animals. Feeding experiments have

shown that the proteins of shrimp muscle are of a good nutritive character.

A study was made of the proteins of timothy and orchard grass pollen and their relation to hay fever. The causation of hay fever is generally attributed to the proteins of pollen carried by the air during the pollination season. A thorough study of the individual protein or proteins responsible for hay fever had not been made before. If protein is the cause of hay fever, then by isolating the different proteins of pollen it might be possible to determine directly which one is responsible for the disease. The isolation of the proteins of timothy and orchard-grass pollen was therefore undertaken. Three fractions of each protein were prepared. With the cooperative assistance of an authority on hay fever, it has been found, by means of so-called skin-reaction tests, that the substances of the proteose fraction of the pollen are the exciting cause in all hay-fever patients sensitive to timothy pollen, and that the albumin fraction is an added toxic factor in about 50 per cent of the subjects. The importance of the glutelin fraction is negligible. A patent based on the results of this work has been granted. It relates to the preparation of specific solutions containing one or both of the active fractions in pollen obtained from plants substantially free from other extractives. This permits accurate dosage and prevents the introduction into the human system of nonspecific substances.

The determination of the dicarboxylic amino acids, aspartic and glutamic acids, is being carried out in a number of typical well-known proteins. Materially larger quantities of these acids have been found in several proteins than have been previously reported.

Work was undertaken during the year to determine the vitamin potency of various foods and drugs in order to develop information for the guidance of officials in the enforcement of the Federal food and drugs act. Several well-known brands of cod-liver oil are being tested for their antirachitic properties.

LEATHER, PAPER, AND FABRICS

Special attention has been given to the conservation of hides and skins in order that more leather and eventually longer-lasting shoes and other leather articles may be made. An interdepartmental committee on hides and

skins has been formed by the Secretary of Agriculture and the Secretary of Commerce to plan, in cooperation with representatives of agricultural interests and of hide and leather industries, a broad program of work by the Department of Agriculture for the conservation of hides and skins. At a conference attended by the Secretary of Agriculture, the Secretary of Commerce, and representatives of the various interests concerned all phases of the problem of hide conservation, including damage by grubs and other insects, diseases, brands, and other physical defects, processes of skinning, curing, classifying, and marketing, and the collection of statistics were presented and discussed. It was the consensus of opinion of those at the conference that the first efforts should be concentrated upon grub eradication, because it promises the greatest benefit, both to agricultural interests and to users of hides and skins.

The damage to hides and leather resulting from follicular mange was studied with a view to prevention. So far no practical results have been obtained.

Further work has been done on the tannin content of chestnut stumps and roots, and other possible new sources of tannin have been investigated.

The study of the deterioration of leather has shown that corrosion by polluted atmosphere is one of the causes of the rapid decay of leather bindings and other leather articles. Means of reducing this serious damage have been indicated. The results of this work, which have been published, show that leather in the different sections of a deteriorated binding exhibits marked difference in physical condition and chemical composition. That part of the binding most exposed to air and light is the most deteriorated, has the highest acidity and sulphate content, and shows the greatest modification of leather into water-soluble nitrogen compounds. Light, although already proved to be harmful to leather, can not alone account for such an increase in the sulphur or sulphate content of the binding. The indications are that part of the deterioration is caused by the accumulation within the leather, in destructive quantities, of harmful sulphurous and acidic impurities from the usually polluted atmosphere, particularly that of large cities and industrial centers where most important libraries are located. Proper finishing of the leather in the making and proper oiling from time to

time while it is in use are the chief remedial measures.

Work has been continued on roach damage to book cloths, with confirmation of the earlier findings that the practical solution of the problem lies in the elimination of foodstuffs from the loaded cloth or in the application of a suitable repellent finish to the cloth.

Defective shoes are being studied to determine causes of failure and means to prevent recurrence. A study is being made of the ripping of thread in shoe soles. This work is being done with the idea that the acidity of the bottom leathers may be correlated with the ripping or breaking of the thread. Sometimes the results suggest that acid in the leather is the cause of loss of strength and consequent breaking of the thread with which the leather is sewed; at other times they do not. A number of preliminary laboratory experiments are being made to determine what factors other than acids might be involved, as, for example, different tanning materials.

Experiments were started during the year to ascertain the effect of syntans upon leather. The strength of the leather will be determined at the end of different periods of aging. Experiments started several years ago to show the effect of sulphuric and other acids upon the strength of leather are still in progress.

A detailed study has been made of the application to miscellaneous tannery materials of the toluol distillation method for the determination of moisture, particularly in materials like oils, greases, soaps, emulsions, and sirups, which can not be handled readily by a direct-flame or oven-drying method. The results have been prepared for publication.

Physical tests were completed on a large number of fruit and vegetable wrapping papers collected in various parts of the country from paper manufacturers and dealers and from fruit and vegetable packers and shippers. Many of these wrappers were known to lack enough flexibility and strength to withstand the vigorous rapid twist given the paper under service conditions. The data collected showed that paper for wrapping apples, citrus fruits, pears, tomatoes, etc., should weigh 10 to 12 pounds per ream of 500 sheets, 24 by 36 inches, and should have a bursting strength of not less than 6 points. This information has been of direct service to the growers and packers of citrus fruits.

Because of its importance in the quality and conservation of paper, an investigation was started to determine the moisture content of various kinds of paper at different humidity conditions. The results so far obtained indicate a rather wide variation in the moisture content of paper exposed to a definite relative humidity and temperature. The results also indicate that there may be more than one possible value for the moisture content of paper for a given definite relative humidity and temperature, depending upon the previous atmospheric conditions to which the paper was exposed.

The work on the development of processes for waterproofing, mildew-proofing, and fireproofing fabrics for farm and other uses was continued.

Observations on samples of treated canvas that had been exposed under conditions favorable to mold and bacterial decay showed that many of the pigments used in connection with waterproofing treatments for the purpose of decreasing damage by sunlight also have a marked preservative effect against mildew and rot. The work on tobacco shade cloth showed definitely that treatments devised by the bureau will at least double, if not triple, the life of this cloth. These results, if properly used by tobacco growers, will save them from one to two million dollars annually.

NAVAL STORES

A study was made of the by-product turpentine obtained by condensing the vapors arising from digesters in which resinous wood is cooked to produce paper pulp by the sulphate process. A number of samples of this type of turpentine from various domestic manufacturers and from importations have been examined in the laboratory in order to obtain as much knowledge of the properties, characteristics, constituents, and constants as possible.

Methods for determining the so-called melting point of rosin and for determining the percentage of dirt or foreign matter other than rosin were studied in collaboration with the committee on naval stores of the American Society for Testing Materials. Analytical work in collaboration with the Association of Official Agricultural Chemists to develop methods of analysis was continued.

Statistics on the consumption of turpentine and rosin by consuming indus-

tries during the 12 months ending March 31, 1925, and on stocks held at primary ports, distributing centers, and consumers' plants on March 31, 1925, the close of the 1924-25 producing season, were compiled and published.

Assistance was rendered to a number of independent producers of rosin who were having trouble in getting their rosin correctly graded. Samples which were used for grading were sent to the laboratory for check grading, and the results were transmitted to the manufacturers.

Work on the preparation of definite type samples for naval stores was continued. The glass standards for rosin, which under the naval stores act were made the official rosin standards of the United States, were greatly improved and made more serviceable for the regular grading of rosin. Ten sets of improved glass standards for rosin were completed during the year. Work was started on the assembly of 10 additional sets, but these were not completed at the end of the year. One of the sets was deposited with the United States consul at Bordeaux, France, for the use of the French trade and as a guide to the Pine Institute of France in its recently adopted program of preparing official standards for rosin for the French naval-stores industry.

In conformity with a ruling of the Florida secretary of state all rosin inspected in Florida must be graded according to the United States official standards, and all inspectors in Florida have been supplied with sets of these standards for use in grading rosin. The Florida naval stores law was amended to conform to the Federal naval stores act. A tentative scheme for grading wood rosin has been worked out and new types have been prepared and submitted to the trade.

Work was continued in demonstrating to the industry improved processes for producing naval stores. An experimental gum-cleaning plant, designed to clean the gum before it is distilled, has been operated in southern Georgia during the season.

Interesting and important data on the properties of American turpentine gum and on the difficulties to be encountered in cleaning, handling, and distilling it by improved methods have been obtained as the result of the experimental work done so far. From the information obtained it has been possible for the representatives of the bureau who have worked on this

project to give valuable assistance to private concerns working on similar lines to improve the processes of making and handling naval stores.

SIRUP AND SUGAR INVESTIGATIONS

In response to the urgent demand, a procedure for making maple cream of improved quality was worked out and circulars describing it were distributed throughout the maple-producing sections. This method makes possible the production of maple cream of desirable consistency. It reduces the danger of fermentation and retards the separation of sirup from the cream on standing. As maple cream affords an important market outlet for the sale of maple products, this method has great economic possibilities.

Progress was made in the work on a method for producing unsulphured cane sirup of good quality from low-purity cane juice. This procedure will permit heavy milling and greater extraction of juice in the manufacture of this type of cane sirup and reduce the loss resulting from low juice extraction. When used in conjunction with sugar production it will be possible to use the higher-purity juice for sugar, the lower-purity juice, representing higher extraction, being used for making sirup. This will make for greater economy in the commercial utilization of sugar cane under domestic conditions. As a part of this investigation a method for producing a new article called "cane cream" has been devised. The production of cane cream on a semifactory scale will be undertaken during the season of 1926. Cane cream, which is also made from the lower-purity juice, has a consistency similar to that of confectionery fondant and a characteristic cane flavor. It can be made of widely varying consistency, and can be used for many purposes, for instance, in sandwiches, on griddle cakes, and in the preparation of cake icing. The cost of manufacture is moderate, and the use of lower-purity juices for producing cane sirup and cane cream will make possible greater efficiency and economy in the manufacture of sugar from higher-purity juices when used in conjunction with it. The fabrication of these products is part of a general plan for the production of specialties which is believed to be of great economic importance to the Louisiana sugar industry.

Progress was made in an investigation of the fundamental conditions

governing the clarification of cane juice in the production of raw and plantation granulated sugar. Because of the lack of a full understanding of the various factors which control clarification of juice, the elimination of nonsugar substances from juice in sugar manufacture is conducted with a varying degree of efficiency, and the maximum clarification possible is far from being consistently attained. It is known that the exact combination of conditions required for maximum clarification varies greatly from one kind of cane juice to another, depending on such factors as variety of cane, soil, kind of fertilizer used, degree of maturity of cane, whether the cane has been burned or not, and length of time the cane has been cut. Methods are being devised whereby the juice can be tested from time to time and suitable adjustment made in clarification conditions so as to obtain uniformly the maximum efficiency possible with the clarification process used. This work is being conducted in conjunction with the development of means for controlling the addition of lime to cane juice automatically by means of a potentiometer, which also continuously records the pH values. The pH value maintained by the potentiometer control can be readily changed from time to time, as the condition and type of the juice may demand.

A method of selective fermentation has been devised whereby the invert sugar of cane molasses may be transformed into alcohol without fermenting sucrose. This makes possible the application of methods for the desugarization of cane blackstrap molasses and at the same time affords a profitable utilization of the invert sugar present, which would otherwise not only be wasted but would also interfere with the recovery of sucrose. A public-service patent covering this process has been issued.

Information of much value has been obtained in an investigation of the fundamental conditions governing the action of decolorizing carbons, including bone char, in removing colloidal substances present originally in cane and beet juices and also produced as a result of decomposition reactions during the course of sugar manufacture. This investigation, which is being continued, throws much light on the particular types of colloidal substances that are best removed by decolorizing carbons and those that could be eliminated most profitably at an earlier stage in the clarification of the juice.

Tests have been devised which show the types and quantities of colloidal substances present at each stage in the sugar process, so that exact control can be exercised. The data obtained also suggest means for the more efficient use of decolorizing carbons.

A method has been worked out whereby the clarification of acid digestion liquors in the manufacture of glucose and corn sugar may be greatly improved. This is of much importance in view of the fact that uneliminated colloidal substances interfere with the growth of corn-sugar crystals. If the crystals are too small, difficulty is experienced in separating them from the mother liquor by centrifuging. High elimination of colloidal substances is desirable both from this standpoint and from the standpoint of producing corn sirup of greater clarity. This improvement is of distinct benefit to the rapidly growing corn-sugar industry, which in 1925 produced almost 600,000,000 pounds.

A systematic investigation has been made of the carbohydrate constituents of a number of plants about which insufficient information was available. This work is designed to yield fundamental information on the basis of which new uses may be found for plants now cultivated or capable of cultivation and by-products of existing processes of utilization may be used more profitably.

An investigation of the variation in viscosity of beet molasses in relation to its retarding effect on the crystallization of low-purity massecuites was practically completed. Viscosity measurements were made after adjusting the molasses samples to constant sucrose-water ratio, constant sucrose- raffinose-water ratio, etc., and the influence of different constituents and groups of constituents on the viscosity of molasses was indirectly determined. The data were also examined from the standpoint of their relation to the discarding of molasses in the Steffen process for desugarizing beet molasses.

In cooperation with 25 beet-sugar factories, an improved method for determining sucrose and raffinose in beet products which had been worked out by the bureau was tested with satisfactory results. This method makes possible closer chemical control of the recovery of sucrose, thereby assisting in locating and ultimately reducing sucrose losses.

An extensive investigation was made in the field on the relation between the composition of sugar beets and the

recovery of sucrose from them, particular attention being given to the efficiency of elimination of colloidal nonsugar substances at various hydrogen-ion concentrations and at various stages of the process.

Work was started for the purpose of determining the character of substances present in various grades of cane and beet sugar which give rise to objectionable color in a number of commercial products, including confectionery, made from them. The ultimate purpose is to devise suitable means whereby these substances may be eliminated.

A number of publications giving the results of completed investigations were issued during the year.

INSECTICIDE AND FUNGICIDE INVESTIGATIONS

The Bureau of Chemistry under a specific appropriation investigates and develops methods of manufacturing insecticides and fungicides and studies chemical problems relating to their composition, action, and application. The need for more effective and cheaper insecticides and fungicides to check the enormous losses caused by the depredation of insects and by fungus growths has long been apparent. The chemical work of the bureau is done in cooperation with the Bureau of Plant Industry, which is concerned with the control of fungous diseases, and with the Bureau of Entomology, which is concerned with the control of insect pests.

OIL EMULSIONS

The use of lubricating-oil emulsions and miscible oils for the control of San Jose scale, citrus white fly, and citrus scale insects has increased greatly in recent years. The formula now most generally employed for making lubricating-oil emulsions requires heat or a large proportion of soap. In the preparation of boiled emulsion the use of heat is both time consuming and expensive, and the use of the cold-emulsion formula, calling for an increased proportion of soap, greatly increases the cost of the product. As the result of a cooperative study of this problem, the Bureaus of Chemistry and Entomology have developed a modification of the method of making cold-mixed emulsions which gives a product that is apparently as stable and as effective as the best boiled emulsions and can readily be made by the orchardist. The proportion of soap

is the same as or smaller than that used in the present formula for boiled emulsions, so that the cost of the product is materially decreased. This emulsion may be made and shipped in the form of a paste, containing only 8 per cent of water, thus reducing the packing and shipping charges below those necessary for ordinary concentrated emulsion. Using the new formula, one grower made several thousand gallons of emulsion, which was used against the San Jose scale with satisfactory results.

There was also developed a soap-cresol-oil emulsion which contains less cresol, the most expensive ingredient, than the ordinary miscible oil, and is therefore less expensive. When diluted for spraying it has the small-drop size and stability in hard water characteristic of miscible oils, and spraying experiments made by the Bureau of Entomology indicate that it is as toxic to insects as a product made by the old formula.

CHEMOTROPIC WORK WITH FLIES

Work was continued during the year to obtain satisfactory attractants and repellents for flies which infest animals and insecticides for flies at the various stages of their development. Experiments with repellents for the screw-worm fly and other meat-breeding flies carried on in collaboration with the Bureau of Entomology have produced valuable information regarding the chemical responses of these insects and the development of control measures. The screw-worm fly alone is estimated to cause a loss of \$4,000,000 annually among animals in the Southwestern States. The repellent or attractant action of several hundred compounds and mixtures were tested in the proximity of packing houses and other places where flies are abundant. Of the organic chemicals tested which show the greatest repellent action against the screw-worm fly, using treated beef liver as bait, four were naphthalene derivatives and seven were tear gases. Field tests with repellents on domestic animals have shown that pine-tar oil, which is obtained by the destructive distillation of stumps and dead wood of the long-leaf pine, is effective and is at the present prices the most economical to use. Pine-tar oil does not injure animals upon which it is applied and has met with the favor of ranchmen, who are now using it on a large scale.

FOLIAGE INJURY BY CALCIUM ARSENATE AND OTHER INSECTICIDES

To determine why some commercial calcium arsenates are more injurious to cotton foliage than others, a study was made of the effect of such conditions as temperature, concentration, and time of stirring on the chemical nature of calcium arsenate made from hydrated lime and arsenic acid. No definite conclusions have been reached. An investigation of colloidal arsenical insecticides is being conducted. Colloidal insecticides may be of importance because of their greater subdivision, which gives them higher covering power and makes them more easily ingested by insects. It has been found that gum arabic, gelatine, and other protective colloids strongly repress the rate of solubility of white arsenic, which may permit its use as such on some foliage. A paper describing this work is ready for publication. True colloidal calcium arsenate has been prepared and the conditions under which it can be formed have been studied in detail.

CHEMICAL COMPOSITION OF PLANTS HAVING INSECTICIDAL ACTION

Work was carried on to find substitutes for insect flowers and to determine whether compounds corresponding to the active constituents of plants can be made synthetically in such a way that they will have insecticidal action. The oil and alkaloid of staves-acre seed have been isolated and the pure oil in quantity is now available for entomological tests. Obtaining the alkaloid in pure form presented many difficulties. Delphinine was the only alkaloid obtained. Early investigators reported as many as four alkaloids, but the existence of this number is extremely doubtful, as most recent investigators have found only the one. The results of the work are now ready for publication.

The investigation of pyridine derivatives during 1925 showed that the dipyridyls would not account for the unusual toxicity of the "dipyridyl" insecticide. The year's work covered by this report has shown that this "dipyridyl" insecticide contains an extremely toxic body, probably a partially reduced dipyridyl, which from its resemblance to nicotine in toxicity has been designated "neo-nicotine." Unsuccessful attempts were made to oxidize it to dipyridile. Work is being continued to complete its final identification.

A large number of substituted pyrrol, pyrrolin, and pyrrolidin compounds have been prepared and tested on insects, on the theory that the pyrrolidin nucleus of the nicotine molecule is the carrier of toxicity. Although most of these compounds showed marked insecticidal properties, none of them proved to be as effective as nicotine. Moreover, there were no significant differences in the effects of the various derivatives. On the other hand, several compounds prepared from nicotine containing the pyridin ring, but having groups, generally straight chains, substituted for the pyrrolidin, proved to be of about the same order of toxicity as nicotine. As far as the evidence goes, it seems that the pyrrolidin group in nicotine is not essential, and purely synthetic compounds may be prepared with simpler groups substituted for it. This theory is now being tested.

Department Bulletin 824, Insect Powder, issued in 1920, was revised and brought up to date. The most recent results by the Bureau of Chemistry and other investigators on the active principles of pyrethrum are now included in it.

PREPARATION OF INSECTICIDES AND FUNGICIDES

Work was continued on the project to determine cheap and effective methods of preparing insecticides and fungicides and to study their properties. In the search for substitutes for carbon disulphide in grain fumigation about 85 organic compounds have been carefully tested to determine their insecticidal action upon the rice weevil. Several of these compounds were found to be from 5 to 10 times as toxic to rice weevils as ethyl acetate. In combination with carbon tetrachloride they show promise of proving economical, practical, noninflammable, and free from the objections of the grain trade to the residual odor of the ethyl acetate-carbon tetrachloride mixture. The results of this experimental work will be published as soon as some large-scale experiments in box cars loaded with grain have been completed. These tests will be made later in the year when weevil-infested grain in sufficient quantity is available.

Studies were continued on copper compounds for grain smut control. In work on basic cupric sulphates, 20 or 25 products were prepared under different conditions of temperature, ratios of reactants, and concentrations, with the view of determining

the effects of these varying factors on the finished products. The results have been prepared for publication.

In working with the cupric carbonates a number of products were prepared both for study in the laboratory and for field testing. As it has been found that basic copper carbonate is very effective in the control of a fungous disease of sugar beets, a dozen products were prepared and turned over to the office of sugar-plant investigations of the Bureau of Plant Industry. The results of these tests were encouraging in that one or two of the preparations were very effective in the control of this disease. A large sample has been prepared and sent to a commercial firm for further field tests. Results of these tests have not yet been received.

Work on calcium, barium, and sodium sulphur sprays has been completed and the results published in Department Bulletin 1371, entitled "Effectiveness Against San Jose Scale of the Dry Substitutes for Liquid Lime-Sulphur."

An investigation on the deterioration of bleaching powder in storage was completed and the results published in Department Bulletin 1389, "Deterioration of Commercially Packed Chlorinated Lime."

PLANT-DUST EXPLOSIONS AND FIRES

Research investigations by the bureau have indicated that practically all types of combustible dusts when mixed with air in proper proportions may, when ignited by various external sources, produce disastrous explosions. Approximately 28,000 industrial plants in the United States, employing 1,324,422 people and manufacturing products worth more than \$10,000,000,000 annually, are subject to dust-explosion hazards. Dust explosions result often in the loss of many lives and great property destruction.

The bureau has endeavored to determine the causes of these explosions and to develop methods of control and prevention. Recent experimental work includes the determination of ignition temperatures of dusts of various types, the pressures produced upon ignition, the limits of concentration, and other essential data related to the degree of relative flammability of the dusts. Incidental to the research work, various dusts submitted by manufacturers have been tested for explosibility. In addition to relative flammability and ignition temperatures, the tests included the determination of the par-

ticle size and sometimes moisture and ash. When sufficient information was received from the manufacturer concerning the nature of the operation producing the dust, suggestions were made as to how the dust-explosion hazard might be reduced or eliminated. Reports on numerous dust explosions and fires were received during the year. Investigations were made wherever practicable to ascertain the exact causes of the explosions and resultant fires.

Department Bulletin 1373, entitled "Dust Control in Grain Elevators," was published and distributed to grain elevator operators and milling companies interested in dust control. This bulletin covers the results of a survey of a number of elevators on the Atlantic seaboard and in the Middle West, and deals with the development of dust-control systems which will operate efficiently in terminal grain elevators to reduce the dust-explosion hazard. Much interest was manifested in the recommendations made in the bulletin concerning a satisfactory method of dust collection in grain elevators.

METHODS FOR CONTROL OF STATIC ELECTRICITY

Experimental work to develop suitable compositions for the elimination of static electricity on several types of belts was continued, previous work having shown that static electricity generated by the friction of belts is one of the common causes of the ignition of explosible dusts. Arrangements have been made for conducting large-scale tests under operating conditions. Experiments have shown that a leather belt requires a composition of a type entirely different from that required by a rubber belt. A great many compositions were made for rubber belts that were satisfactory for the elimination of static electricity. The material that seemed to be the best was applied to belts in the machine shop of the department. The composition removed the static and was found to wear exceptionally well. This composition was also tried on the belts in the shops of a railroad company preliminary to testing it on the belts of a large grain elevator.

The desirability of having a composition which can not possibly introduce an additional fire hazard led to an investigation to find suitable solvents by the use of which a nonflammable composition could be produced. This required the use of mixed sol-

vents. Several were tried. Finally a mixture of carbon tetrachloride and mineral spirits, consisting of at least 50 per cent carbon tetrachloride, was found to be satisfactory. This dressing is nonflammable, removes static, should increase the life of the belt, and increases the coefficient of static and moving friction. Sixteen gallons of this material were applied to two rubber conveyor belts and to one fabric stitched power-transmission belt in a grain elevator. The small transmission belt was heavily charged with static, the voltage being well over 10,000 volts. By simply coating the exterior of the belt and not even waiting for the material to dry every trace of static on the belt was eliminated. The conveyor belts before coating held from 5,000 to 6,000 volts of static. The belt, which was coated on both sides, was made entirely free of static. The material on the belt was permitted to dry for 36 hours before the belt was used. A hard, dry, elastic coating was obtained and in the preliminary tests there were indications that it would wear for a long time.

The coating material was also tested on threshing machines at a factory in Wisconsin. The belts on four threshing machines were coated with the new preparation. Two of the machines were of the regular stationary threshing-machine type and two of the combine type. All belts coated held charges well over 10,000 volts, the maximum reading which could be obtained by the electrometer used to measure the difference of **electrical** potential. In every case the preparation seemed to remove all traces of static. The composition for rubber belts was found to be very satisfactory on impregnated fabric stitched belts, which are commonly used as main drive belts on threshing machines.

It is proposed to try out these belt dressings further in experimental work during threshing operations in the Pacific Northwest. Tests were conducted with various types of belts at plants of commercial firms in Minneapolis. The material gave excellent results on the rubber belts and removed the static on leather belts. It is not considered advisable at this time to recommend the composition for use on leather belts. The results of the tests show the desirability of having an entirely distinct type of dressing for leather belts, a dressing that will keep the belt soft and pliable, remove static, cause no deterioration of the belt, and increase its coefficient of friction. Several compositions hav-

ing these qualifications have been made, but have not as yet been tested on a large scale.

INERT GAS

Experiments were carried on at the Arlington Experimental Farm to determine the best methods of introducing inert gas into grain-grinding machines, where dust is necessarily generated and where friction is likely at any time to cause a spark that may produce an explosion. A small building, with an apparatus for testing the gas obtained from boilers, has been completed. Tests have been run to determine the quality of gas obtained from the boilers and the quantity necessary to maintain an inert atmosphere within the grain-grinding machines. It has been demonstrated by these experiments that when the gas from the boilers is applied in sufficient quantities the dust generated by the grinding machinery will not explode, even when sparks which would ordinarily produce explosions are applied regularly. Demonstrations of this method of controlling explosions were given during the year to representatives of a number of industries interested in dust-explosion prevention. Two large industrial companies have undertaken the installation of inert gas units on the recommendation of the engineers of the bureau.

LABORATORY TESTS

Experimental work has been done in developing an apparatus by which ignition temperatures can be checked within plus or minus 1° or 2°. This could not be done by methods previously used. A method has been developed by which the ignition temperature of solid combustibles can be checked within a reasonable degree of accuracy. With some refinements it may even be possible to approach more nearly the true ignition temperature. By this method the ignition temperatures of 24 dusts have been determined. As soon as limitations of time and personnel permit other dusts will be tested. Work was also done to determine the effect of prolonged heating on the ignition temperature of several dusts.

CONFERENCE AND COMMITTEE WORK

Cooperative relations were maintained with the dust-explosion hazards committee of the National Fire Protection Association. This committee, under the direction of the Bureau of

Chemistry, has prepared regulations for dust-explosion prevention in flour and feed mills, sugar-pulverizing systems, cocoa-pulverizing systems, pulverized-fuel installations, terminal grain elevators, and starch factories. These regulations have been adopted by the National Fire Protection Association and also by the National Board of Fire Underwriters and have become the standards for insurance and State officials. The American engineering standards committee has acted favorably upon the dust-explosion codes recommended by the bureau. These codes have been accepted as tentative American standards. It is believed that the adoption of these safety codes for dust-explosion prevention in American industries will result eventually in their becoming international standards.

Specialists engaged in dust-explosion work have held conferences with leaders of various industries who were interested in applying the methods and principles developed for dust-explosion prevention.

In cooperation with the National Fire Protection Association a committee on farm fire protection has been organized. The annual fire losses in the United States have been estimated at approximately \$570,000,000. Of this amount at least \$150,000,000 represents a loss from farm fires. It is recommended that work be taken up to assist in the development of control measures for the reduction of these extensive losses. The committee on farm fire protection includes representatives of the United States Department of Agriculture, American Society of Agricultural Engineers, American Farm Bureau Federation, Mortgage Bankers Association of America, American Agricultural Editors Association, the Farm Association, National Board of Fire Underwriters, Underwriters' Laboratories, Lightning Rod Manufacturers Association, Mutual Fire Insurance Association, Fire Equipment Manufacturers Institute, Association of Canadian Fire Marshals, National Association of Mutual Insurance Companies, and the Fire Marshals Association of North America. It has perfected plans to obtain statistical data on fire losses on farms, preparation of material for educational purposes, and recommendations for fire-prevention and fire-protection methods. The bureau is also cooperating with the national fire waste council of the Chamber of Commerce of the United States, which is now giving

attention to the matter of farm fire protection.

COLOR, MEDICINAL, AND TECHNICAL INVESTIGATIONS

The bureau is authorized to investigate and experiment in the utilization, for coloring, medicinal, and technical purposes, of raw materials grown or produced in the United States. Much experimental work has been done with a view of developing processes for the manufacture of dyes. Previous reports have indicated the manner in which the bureau has been a contributing factor in the rapid development of the American dye industry. Large quantities of fast dyes are now being made in the United States, which is rapidly becoming independent of any foreign country in the manufacture of coloring materials. Many of the substances developed in the utilization of coal-tar products are useful not only as dyes but also as medicines and in the technical arts.

Ortho-dichlor-benzol is an isomer, produced, along with para-dichlor-benzol, in the chlorination of benzol. Until recently both by-products have found little use in industry. Lately, however, the development of the para compound as an insecticide has increased the demand for it, although no extended use has been found for the ortho derivative. As the latter is formed in the ratio of about 1 part to 2 of the para compound, the growth in the demand for para-dichlor-benzol has made the problem a serious one. Work done under this project has shown that ortho-dichlor-benzol can be combined with phthalic anhydride through the Friedel and Craft's synthesis to produce 2, 3-dichlor-anthraquinone. Upon fusion with caustic, his product is converted into alizarina, one of the most important synthetic dyes. It is hoped that additional uses for dichlor-anthraquinone may be found as an intermediate for vat dyes. The results of this investigation should prove most valuable to the manufacturers of chlorine products. Dye manufacturers have evinced great interest in the results of this investigation.

MEDICINAL PREPARATIONS AND BIOLOGICAL STAINS

The work in the general field of biological stains and dyes of therapeutic application has been extended. A large number of new dyes, or dyes which at least have never been made available to microscopists, have been

synthesized and tested. These include a variety of halogenated fluoresceins, alkylated thionins, and acid fuchsins. The most important specific accomplishment in this connection has been the isolation of azure C, monoethyl thionin, by means of the acid oxidation of methylene blue. This new product has proved to be a very valuable nuclear and bacterial stain in tissue and of great utility in blood staining.

Several of the more important staining technics of the biologist have been investigated in a preliminary manner and some little improvement obtained by various modifications which the studies have suggested.

It has become increasingly evident in the course of the study of the staining properties of dyes that these properties are often closely connected with bacteriocidal or bacteriostatic properties, which render the dyes potential therapeutic agents of great promise. The outstanding development in this connection has been the discovery that basic dyes react with cyclic derivatives containing phenolic groups to form additive products, which not only are very valuable bacterial stains but also give every promise of utility as practical germicidal agents for the treatment of external wounds. It is even anticipated that certain of these complexes may find effective internal application against malignant organisms.

The routine examination of biological stains and dyes for therapeutic application in order to determine the identity and relative proportions of their components has been conducted, together with extended research in analytical methods for the purpose.

UTILIZATION OF FARM PRODUCTS IN INDUSTRY

Work was inaugurated to bring about a closer connection between agriculture and industry. This is not directed so much to the industries ordinarily dependent upon agriculture, such as clothing and food, but rather to those industries whose relations to agriculture are not so widely realized. This includes the further utilization of by-products, such as lignin or furfural, and also a broadening of the use of regular farm products as well as waste materials.

Any additional outlets for corn, one of the leading crops, that may be created by the development of new industrial uses will be of direct benefit to growers. A study has been undertaken of the breaking down of glucose, one of the products from corn, with

various fermentative organisms, such as bacteria, yeasts, or molds, and the consequent development of these fermentation products. It is believed that there is a large opening for the production of either the organic acids which are now in use or some that may be substituted for similar products in industrial applications. This is mentioned as but one example of what it is hoped to do in the matter of providing additional industrial outlets for corn.

Mention has been made in previous reports of the discovery of solvents for lignin and the possibility of using it as a varnish. Lignin, for which no profitable use has yet been found, constitutes approximately 25 per cent of all cell tissues and the supply is practically unlimited. It is even more complex than coal tar, and when it has been as thoroughly studied as has coal tar, it may have even wider uses.

Some preliminary work has been done looking to the utilization of peanut hulls. Up to the present time the uses of peanut hulls have been entirely physical. They are not being used as raw materials in any chemical process. The hulls are brought from the shelling plant and ground to various sizes in an attrition mill. The ground hulls have been used for polishing tin plate, as a substitute for middlings in removing the palm oil after tinning, as a dynamite filler, as a fertilizer filler, and, when mixed with molasses, as a cattle food. The amount of peanut hulls available at the present time is approximately 25,000 tons a year. This is a conservative figure and will undoubtedly increase with more extended uses for the material and with larger consumption of peanuts. Plans have been made to start an investigation by a complete analysis of the peanut hulls in order to determine the actual composition of the material.

EXAMINATION OF COMMERCIAL FOOD COLORS

In the enforcement of the Federal food and drugs act commercial food colors are analyzed to determine their suitability for use in food products. During the last year there were certified 311,434.5 pounds of straight dyes under foundation certificates, 32,234 pounds of repacked straight dyes, and 304,040.22 pounds of mixtures. Thirty-eight firms certified food colors, 14 of which were new certifiers. Six batches of straight dye, two repacks, and 33 mixtures were rejected. Miscellaneous

Circular No. 52, Certification of Coal-Tar Food Dyes, a codification and revision of existing certification regulations, and Department Bulletin 1390, Chemistry and Analysis of the Permitted Coal-Tar Food Dyes, which describes the chemistry of the per-

mitted colors and gives a statement of the limits of tolerance of impurities and a compilation of approved methods of analysis, were published.

Table 1 shows the progress of color certification work during the last four fiscal years:

TABLE 1.—Coal-tar food dyes certified, 1923–1926

Year	Straight dyes	Repacks	Mixtures	Batches	Number of firms	
					Total	New
	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Number</i>		
1923.....	250,756.0	20,216.00	239,614.00	633	27	4
1924.....	232,305.0	26,956.00	286,148.00	724	30	6
1925.....	315,848.0	39,013.79	284,060.00	883	34	9
1926.....	311,434.5	32,234.00	304,040.22	1,075	38	14

The figures show that although the gross poundage of dyes examined has not increased greatly, the number of batches has gone up by about 20 per cent, which means a corresponding increase in the analytical work. The number of certifiers has also increased.

COLLABORATION WITH OTHER DEPARTMENTS

Other departments of the Government have continued to call upon the bureau for a great volume of chemical work, including the examination of samples and the direction of extended chemical investigations.

One of the chief lines of work is that done with the Post Office Department. Samples of various products for which medicinal claims are made are analyzed by the bureau and evidence is developed to assist the Post Office Department in the prosecution of cases under the fraud order law. The products examined for the Post Office Department during the year included those making false claims for the cure of kidney and bladder diseases, asthma, catarrh, hay fever, tuberculosis, pyorrhea, rheumatism, lumbago, partial paralysis, pleurisy, pneumonia, venereal diseases, Bright's disease, diabetes, high blood pressure, cancer, and a host of other ills. The samples also included spurious grass seed, various beauty schemes, eye tonic, manhood restorer, fat reducers, and the like.

Samples of drugs were analyzed for the Veterans' Bureau, Federal Trade Commission, St. Elizabeths Hospital, General Supply Committee, and the Government Printing Office. Tea was

examined for the Navy and the Treasury Departments. Insecticides were examined for the Bureau of Reclamation, Public Health Service, General Supply Committee, and Navy Department. Stock feeds were analyzed for the Panama Canal Commission and waters were analyzed for the Federal Trade Commission and the War Department. Samples of paper were tested for the Smithsonian Institution and the Government Printing Office. Bookbinding leather was also tested for the Government Printing Office.

Foods were tested for the Veterans' Bureau, for various branches of the War and Navy Departments, including the Marine Corps, and for the General Supply Committee, Federal Trade Commission, Department of Commerce, Government Printing Office, and the District of Columbia. Samples of turpentine were analyzed for the General Supply Committee.

Several specialists of the bureau served on committees of the Federal Specifications Board, to assist in the preparation of specifications for various items of supplies and equipment purchased by the Government. Technical advice on a variety of subjects was furnished.

ENFORCEMENT OF TEA INSPECTION ACT

In carrying into effect the provisions of the act approved March 2, 1897, entitled "An act to prevent the importation of impure and unwholesome teas," 98,551,814 pounds of tea was examined at the various ports of entry. The tea inspection act requires that all tea imported into the United States shall be examined for both

quality and purity, and only such tea admitted as meets the standards set each year by the Board of Tea Experts appointed under the act. Tea inspectors, stationed in the principal ports of entry, work under the direction of the supervising tea examiner, with headquarters in Washington. Samples from the ports are forwarded to Washington for checking in order to obtain uniformity of inspection. A review of the samples sent in during the year indicates that a very high degree of uniformity of inspection exists in all the tea-inspection ports.

The work of examining tea has been greatly facilitated through a recent amendment to the customs regulations providing that all shipments of tea must go to designated tea warehouses. For some time the practice has been to permit teas to be stored in so many different warehouses, especially in New York, that it was impossible for the tea samplers to sample all the

shipments without causing delay. This change in the customs regulations has greatly relieved the situation. Teas are now sampled, examined, and released with a minimum delay.

The tea standards selected by the Board of Tea Experts and approved by the Secretary of Agriculture have been found to be entirely satisfactory. Instead of using the Congou standard for all fully fermented teas, as was done in 1925, the tea board increased the number of standards from six to seven and selected a fully fermented East India tea to be used in examining all fully fermented East India teas. This addition to the standards will be a great help, especially in examining East India teas, where a very close comparison to the standard has to be made.

Table 2 shows the quantity of tea imported during the fiscal year examined at the different tea-examining stations and the quantity rejected.

TABLE 2.—Tea examined during fiscal year 1926

Station	Examined	Passed	Rejected	Station	Examined	Passed	Rejected
	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>		<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Boston.....	18,163,841	18,047,705	116,136	New York.....	54,410,223	54,080,163	330,060
Chicago.....	3,299,810	3,299,690	120	San Francisco..	10,087,320	10,078,824	8,496
Honolulu.....	336,246	336,246	-----	Total.....	98,551,814	98,094,277	457,537
Puget Sound...	12,254,374	12,251,649	2,725				

The tea-inspection staff passed on all purchases of tea for the Marine Corps, General Supply Committee, and District of Columbia, and recently has taken on the work of passing on all teas for the Veterans' Bureau. Tea examiners also served as customs examiners for the purpose of appraising all tea containers under the tariff act. The tea examiner at New York assists in the purchase of tea for the Navy Department at the Brooklyn Navy Yard. The tea examiner at San Francisco aids the Navy Department in the purchase of tea in the Mare Island Yard for the Pacific fleet.

INVESTIGATION OF TYPES OF TEA CONTAINERS

A study of the effects of different types of containers on the keeping of tea was conducted during the year, in cooperation with tea packers, tea-container manufacturers, and tea-container manufacturers' associations. The work already completed has shown that organoleptic tests on tea packed in different containers will enable a tea expert to ascertain the

relative value of types for the keeping of tea and indirectly for the keeping of other food products to some degree. In nearly all cases when samples packed in these different containers are forwarded to tea experts of the trade the trade experts agree with the Government experts as to the comparative value of the containers for the keeping of tea.

The experiments so far have shown that the cost of the container has no bearing on its value for preserving the quality of tea. Some of the cheaper containers preserve as well as the more expensive ones. Although the experimental work on tea containers is only one-fourth completed, the information already gained enables the bureau to give valuable information to the trade in connection with the packing of tea and other food products.

ENFORCEMENT OF THE NAVAL STORES ACT

One hundred and ninety samples of turpentine and other paint thinners sold in place of turpentine were col-

lected and analyzed during the year. Of these, 116 samples were found to be pure gum spirits of turpentine, 18 pure steam-distilled wood turpentine, and 8 pure destructively distilled wood turpentine. Thirteen samples of turpentine were adulterated and 17 samples of mineral-oil substitutes were being sold under names prohibited by the naval stores act or were in violation of the act in some other particular. There were issued 8 citations covering shipments of adulterated or mislabeled turpentine and other thinners substituted therefor and 32 citations to hearings covering shipments of badly misgraded rosin. The policy of the bureau in the enforcement of this act, as with the food and drugs act, is to apply educational methods to obtain a compliance with the law whenever possible, the punitive sections of the act being invoked only when other means are ineffective. In nearly all cases compliance with the requirements of the naval stores act was obtained. In a few cases prosecution is under consideration. A comparison of the foregoing figures with data compiled on the extent of adulteration and misbranding of turpentine existing prior to and shortly after the passage of the naval stores act shows that a purchaser of small quantities of turpentine in the open market is much more sure of obtaining a pure product correctly labeled and sold—that is, of getting what he asks and pays for—than ever before.

Fifty-one lots of rosin, totaling 5,725 barrels, were examined and graded upon request. Seven samples of turpentine were analyzed for persons requesting such analysis under the naval stores act.

ENFORCEMENT OF THE FOOD AND DRUGS ACT

The close of the fiscal year marks the twentieth anniversary of the Federal food and drugs act, which became a law on June 30, 1906. The intervening period has been one of extraordinary development in the food industries and of steady improvement in effective food and drug control by the Federal, State, and Municipal Governments.

Progress in effective food control has been due principally to three factors:

(1) The gradual transfer of the manufacture of food from the home to the factory. Before the advent of food legislation much of the food con-

A conference of representatives of the naval-stores industry was held to discuss the proposed establishment of grades or designations for crystal rosin and rosin containing dirt and specks. This brought out a preponderance of opinion from those present against the promulgation of separate grades or standards. The matter is still under investigation. Government rosin graders are not permitted to designate dirty and specky rosin in the usual manner—that is, by drawing a circle around the grade mark. If the grader believes that the rosin is too specky or dirty to be graded as one of the standard grades set forth in the naval stores act, he has no alternative but to refuse to grade it as rosin of any recognized grade.

A conference of Federal rosin classifiers was held for the purpose of establishing, by check grading a large number of representative rosin samples by several experienced and careful graders, the maximum allowable or possible variation.

A survey was made throughout the entire naval-stores producing territory for the purpose of checking up on the grading of rosin stocks held ready for shipment at the stills and concentration points. This survey showed the producers of rosin and their inspectors the degree of accuracy of their grading and the causes of misgrading. Due notice of the need for improvement was given wherever serious misgrading was found. Investigations following this survey have shown that rosin moving from certain parts of the South to northern distributing and consuming points is much more accurately graded than ever before.

sumed was produced in the home or in the immediate neighborhood of the home, so that consumers knew where and how it was made, of what it was composed, by whom it was handled, and whether or not it was kept under sanitary conditions. As the manufacture of food was transferred to the factory and foods were shipped for longer and longer distances it became increasingly difficult for consumers to know much about the food they bought. At the present time few city consumers have any personal knowledge of the methods of production, manufacture, and handling of the food they eat, and a larger and larger pro-

portion of food now consumed on the farms is purchased at the grocery.

(2) Advances in the sciences of chemistry and bacteriology have enabled the food official to detect with a greater degree of certainty various forms of adulteration and misbranding and they have also furnished the food manufacturer with tools for the more effective control of his processes.

(3) The enactment of more effective legislation, the interpretation of such legislation by court decisions, and the education of food industries by the various State, Federal, and municipal food officials have been potent factors in making food-law enforcement more effective. The educational work has been both in the nature of informing the food industry of the requirements of the law and of the regulations issued thereunder, and in the nature of helping the industry to improve its processes to insure a better product and one that more nearly complies with all of the provisions of food-control legislation.

The 20-year period of the Federal food and drugs act has brought about also a marked change in the problem of food officials, in the viewpoint of leaders in the food industry, and in the attitude of the consuming public.

In the beginning food officials were confronted with the necessity of charting out the course of action and making precedent decisions of vital interest to great food industries and to the consuming public without the guidance of interpretive court decisions and sometimes without adequate scientific data. It was sometimes necessary in those early days of food-law enforcement work to make prompt decisions. In many instances it was impossible to wait until the courts could pass upon questions and until extensive scientific investigations could be completed to furnish complete data upon the questions at issue. There were conflicting opinions among food officials, leaders of the food industries, and others vitally concerned with the problems involved in the enforcement of the new legislation. During the last 20 years many of the problems which confronted the food officials in the early days have been solved. The higher courts have rendered numerous decisions, which have clarified the meaning of the law and have shown more clearly its limitations. The food officials and the food industries know to-day better than ever before exactly what constitutes adulteration and misbranding under the Federal food and drugs act. Much light has been shed

upon these troublesome problems, not only by precedent court decisions, but also by data that have been accumulating through extensive scientific investigations relating to the problems involved. Although great improvement has been made in this respect and many of the vexatious problems have been solved, yet food-law legislation is still comparatively new and much remains to be done in the way of determining the meaning of the law in its application to varying conditions in the food and drug industries and there is still need for further progress through scientific investigations to improve the processes of manufacturing, transporting, storing, and utilizing food materials.

The principal problem of the food administrative officer to-day, however, is not the determination of the meaning or the limitations of the law but rather the determination of questions of fact and the procuring of evidence adequate to the establishment of court action within the limitations laid down by the numerous judicial decisions. The problem of food-law administration, through the elucidation of appellate decisions and the data of scientific investigations, has been tremendously simplified. The procurement of necessary evidence and the organization of such facilities as will procure this evidence most efficiently and economically are now the primary problems of the enforcing agencies.

The viewpoint of the leaders of the food industry has changed with the progress in food-law enforcement. When Federal food legislation was first under consideration by Congress many in the food and drug industries vigorously opposed the enactment of such legislation, believing that it would harass trade and be of little or no benefit to their industries. Others in the food industries, though not hostile to such legislation, looked upon it rather as a necessary evil than as desirable from their point of view. A few leaders in the food industry had the vision to see from the first that such legislation, if properly enforced, would be of constructive benefit to the food industry as well as a protection to the public. With few exceptions, the leaders in the food industries now look upon food-control legislation as of very great benefit to the food industries. They have found that food officials have been able to assist them in many practical ways in improving their processes and their products. Their attention has been directed to the need for effective technical fac-

tory control, and they have found such control to be of very great value to them, not only in enabling them to meet the requirements of the law but also in improving their products and in effecting more economical production. Perhaps the greatest benefit that has come to the food industry through efficient food-law enforcement has been the increased confidence of consumers in the purity and wholesomeness of the food supply of the Nation.

To-day the leaders in the industries, with few exceptions, also support the fair enforcement of the food law. Those in the food industries who are opposed to food-law enforcement are confined principally to a few individuals who desire deliberately to adulterate and misbrand their products. To-day the vast majority in the food industries accepts with confidence the conclusions of food officials and adopts loyally and with finality administrative decisions which are rendered, because they are recognized not only as legal but as constructive from the standpoint of the best interests of the industry itself.

The change in the attitude of the public has been no less marked. Before the days of effective food-control legislation the public looked upon all food, especially that in package form, with suspicion. Too frequent experience in buying adulterated and misbranded foods made them wary of all foods. This attitude upon the part of the public was intensified by exaggerated rumors regarding forms of adulteration that were prevalent. In those days sanitary conditions in some food factories were disgusting, if not revolting. The occasional use of harmful preservatives made the public attribute almost every illness of unknown origin to adulterated food.

The enactment and the enforcement of the Federal food and drugs act and State food legislation has restored the confidence of the public in the purity and wholesomeness and truthful labeling of the food supply of the Nation. So marked has been this change that many consumers are sometimes too complacent in regard to the food supply. Some consumers, relying upon the efficiency of the enforcement of food laws, do not take the trouble to read labels on the packages of food they buy, nor do they inspect the contents with any degree of care. They expect food officials to do what only the buyers themselves can do. It was never intended that food-law legisla-

tion should relieve consumers of the duty of carefully inspecting the food they buy. Vigilance on the part of consumers, as well as on the part of officials, is necessary for the full protection of the public.

This complacency on the part of the public is also reflected to some degree in its apparent indifference to proposed amendments to the Federal food and drugs act, which would greatly weaken its effectiveness and let down the bars to adulteration and misbranding. Within the last year or two amendments to the act were introduced in Congress which would permit certain highly objectionable forms of adulteration. The public as a whole has given little indication that it is concerned about these attempts to weaken food and drug control legislation.

PLAN OF OPERATION

The volume and value of the food and drug products which enter interstate commerce and which are imported into this country are enormous. To supervise this traffic effectively with a force which is necessarily limited it is essential that a systematic plan of operation be adopted. Accordingly a project system has been put into effect by the bureau. The various types of food and drug products which come within the scope of the act are divided into classes or projects, such as canned goods, cereal products, fruit and fruit products, cattle feeds, proprietary medicines, and pharmaceutical products.

It is a well-established fact that the majority of American food and drug manufacturers are doing an honest and legitimate business. If the products of these ethical manufacturers can be eliminated from consideration, the efforts of the bureau may be concentrated on that very small proportion which is deliberately, negligently, or unknowingly violating the law in some respects. In order to determine which manufacturers are complying with the law, factory inspections of a very thoroughgoing character are made by trained inspectors. The visits of these inspectors are ordinarily heartily welcomed by the manufacturer who is doing a legitimate business. Where admission to an establishment for the purpose of making inspection is refused the information necessary to determine whether infractions of the law are occurring can be obtained by the collection of samples on the market and chemical analysis in the laboratories. Through

the medium of these factory inspections, as well as by means of chemical analysis when necessary, it is possible to determine what particular food and drug commodities are adulterated or misbranded and what particular types of violations are to be anticipated, and to segregate the comparatively small section of the industry which is doing a questionable business.

With this information available the bureau is able at the beginning of each year to formulate comprehensive plans for the enforcement of the law in a uniform manner throughout the United States. The field agents are fully advised of these plans and work in harmony with them. The plan of operation is made sufficiently flexible, so that should an emergency arise, for example, an outbreak of food poisoning, the less important lines of operation may be set aside and efforts concentrated on tracing and removing from the market the product involved.

Where the preliminary inspection made by the field force has revealed a type of violation requiring correction, several courses of action are open. If it appears that the infraction is one of a deliberate character, damaging the health or the pocketbooks of consumers, there is no justification for withholding an application of the punitive section of the law. If, for example, a manufacturer is found deliberately shortweighting his product or so negligently controlling his output as to result in serious shortages even in the absence of deliberation, or if a substitution of a low-priced article for a high-priced one, such as the adulteration of maple sirup with glucose, is encountered, no ground exists for the exercise of leniency and immediate steps are taken to remove the product from the market by seizure and also to prosecute the offending individual or firm through the criminal section of the law. If, on the other hand, the infraction is one which appears to be the result of a misunderstanding and the ensuing damage to the public is not of such a character as to require immediate removal of the goods from the market, it is the practice before initiating action to give notice to the trade advising that on or after a certain date legal action under the food and drugs act will be instituted if continued violations are encountered. Where the facts seem to warrant it such notice may be preceded by a public hearing at which interested persons are accorded opportunity for free discussion. Disinterested experts are freely consulted to

supplement facts derived from investigations in reaching conclusions as to the proper administrative procedure.

The Federal food and drugs act provides for the prosecution of the person or concern responsible for violating its provisions and for the seizure of the adulterated or misbranded products. Seizure actions are instituted in four classes of violations: (1) In the case of food products containing added poisonous or other added deleterious ingredients which may be harmful to health; (2) in the case of food products consisting in whole or in part of filthy, decomposed, or putrid animal or vegetable substance, or any portion of an animal unfit for food, or a product of a diseased animal, or one that has died otherwise than by slaughter; (3) in the case of food or drug products so grossly adulterated or misbranded with false or fraudulent claims that their distribution constitutes a serious imposition upon the public; (4) in the case of deliberate frauds in the shipment of adulterated and misbranded food products which seriously demoralize legitimate trade practices. Unless a violation falls clearly within one of these four classes seizure action is not taken, but the party responsible for the violation may be prosecuted.

The Federal food and drugs act is administered on the theory that more is to be accomplished by acting in an advisory capacity under such conditions as will insure legal products than by accumulating a record of successful prosecutions with attending fines. In this belief the bureau is always willing to advise a manufacturer coming to it with an honest desire to comply with the act as to the conditions which he should observe in marketing a fully legal product. It is believed that more effective compliance with the law may be obtained by showing reputable manufacturers how to bring their products into conformity with its terms than by imposing fines or effecting seizures and confiscations after the violation has been committed. Its policy, therefore, is to pursue educational methods as a preliminary to legal action where this can be done without jeopardizing the public interest or legitimate competitive conditions.

Two instances of how the project plan of operation and the policy of using educational methods under certain conditions work out in actual practice may be cited.

A few years ago a survey showed that canned blueberries from Maine contained excessively large quantities of maggoty berries. Several shipments

of the adulterated blueberries were seized in various parts of the United States. Canners and growers claimed that it was impossible to reduce materially the number of maggots in the berries. The blueberry-canning industry was informed that it would be absolutely necessary to eliminate maggoty blueberries shipped in interstate commerce, as maggots in canned food constitute a violation under the Federal food and drugs act. The blueberry-canning industry was threatened with ruin. Blueberries are the chief crop of one county in Maine, most of these berries being marketed after they have been canned. The entire livelihood of many people was threatened unless means could be found to put up a legal product.

Staff specialists were sent from the bureau to study the situation, working in collaboration with the State officials, who were also interested in the problem. As the result of the study of specialists an apparatus was devised by means of which it is possible to eliminate maggoty blueberries. During the first season after its invention this device was used by a few canners with marked success. During the next season a still larger number of canners used it and had no difficulty in putting up a product that met the requirements of both Federal and State food laws. During the season of 1926 practically all of the principal canners adopted means that insured a legal product. Federal and State food inspectors patrolled the canneries to assist in eliminating maggoty blueberries and to see that the canned product in every way met the requirements of the law. Thus the educational methods followed by the Federal and State food officials have been effective in saving an industry great losses and in enabling consumers to obtain a product free from objectionable material.

Surveys of the sardines packed in Maine in past years showed that a large portion of fish which had undergone a form of decomposition known as "belly blown" was included in the pack. Numerous shipments of decomposed sardines were seized and an extensive educational campaign to demonstrate methods for putting up a good pack was carried on for several years.

A comprehensive survey of the Maine sardine-packing industry was made during the past year. Each of the packing plants, about 40 in number, was visited five or six times during the season to ascertain whether or not the educational work done among the packers through the past

several years had been effective. About 100 investigational and nearly 150 official samples were collected and analyzed. This resulted in seizure of 21 shipments, covering 3,682 cases of adulterated and misbranded sardines. These seizures were in every instance cases packed during 1924. So successful were the educational and regulatory campaigns of previous years that, notwithstanding comprehensive sampling this year, no goods of this season's pack were found of a character warranting a recommendation for seizure.

A reorganization of the regulatory work involved in the enforcement of the food and drugs act, the tea inspection act, and the naval stores act was effected during the year, all such work being placed under the immediate supervision of an assistant chief appointed for the purpose.

Food-control work in the United States suffered a severe loss in the death on April 25, 1926, of R. E. Doolittle, chief of the central inspection district of the bureau. Mr. Doolittle entered the service of the bureau in 1904 as chief of the New York station to enforce an act controlling imported foods and drugs. He had previously served as a State food-control official in Michigan. Since the enactment of the Federal food and drugs act Mr. Doolittle has been active in food-control work, having served as chief of the eastern inspection district, chief of the central inspection district, member of the Board of Food and Drug Inspection, and member of the Food Standards Committee.

COOPERATION WITH STATE AND CITY OFFICIALS

Dovetailing into the activities of the bureau are the functions of the various officials who enforce State food and drug laws. Many of these laws are identical with or very similar in phraseology to the Federal act. Obviously it is in the interest of good business that State and Federal laws be uniformly enforced; otherwise manufacturers are continually harrassed by the necessity of complying with varying requirements. As a means of promoting uniformity of State and Federal action the bureau has maintained for more than 10 years an office of State cooperation, presided over by a competent official, who has had both State and Federal experience. The duties of this official are to maintain constant contact between the State and Federal offices, keep the State officials as fully informed as to

policies of enforcement as are the field forces of the bureau, supply them with information regarding violations which require their attention, and, in turn, obtain from them information on matters needing the attention of the bureau. There is a generous interchange of information on methods and practices, and, as authorized by the Fed-

eral act, many State officials collect samples of products subject to the law.

PROSECUTIONS AND SEIZURES

The food and drug products involved in court actions instituted during the year are listed in Table 3.

TABLE 3.—*Summary of prosecutions and seizures by the Bureau of Chemistry during 1926*

Product	Prosecutions	Seizures	Total	Product	Prosecutions	Seizures	Total
Alimentary paste.....	6	4	10	Flour.....	8	2	10
Baked products.....		5	5	Fruit:			
Beverage ingredients				Fresh.....	7	26	33
(malted milk).....		1	1	Canned.....	0	38	38
Beverages.....		1	1	Dried.....	46	6	52
Cereal products.....		3	3	Jellies.....	9	28	37
Chocolate coating.....		3	3	Maple sugar.....	4	0	4
Cocoa.....		2	2	Mincemeat.....	0	1	1
Coffee.....	14	10	24	Mustard.....	8	0	8
Confectionery.....	9	3	12	Nuts.....	0	34	34
Dairy products:				Oils.....	54	10	64
Butter.....	59	143	202	Oleomargarine.....	1	3	4
Cream.....	2	0	2	Paste (almond, lemon)...	0	3	3
Milk (condensed)....	0	1	1	Sauerkraut.....	0	2	2
Drugs:				Sirups.....	0	6	6
Crude drugs.....	0	4	4	Spices.....	4	3	7
Remedies.....	92	169	261	Tea.....	0	1	1
Eggs:				Vegetables:			
Shell.....	16	29	45	Canned.....	53	114	167
Frozen.....		13	13	Fresh.....	1	0	1
Feeds.....	52	92	144	Vinegar.....	0	2	2
Fish:				Water.....	0	7	7
Canned.....	22	37	59	Total.....	491	853	1,344
Shell.....	24	44	68				
Flavoring extracts.....	0	3	3				

STAFF-CONTROL LABORATORIES

Staff-control laboratories are maintained to develop information on which to base administrative action in the enforcement of the Federal food and drugs act. These laboratories conduct investigations relating to the composition, manufacture, storage, preservation, and methods of handling of food and drug products. Methods of analysis for detecting adulteration and misbranding are developed, and information to be used in the planning of regulatory campaigns is furnished. The staffs of these laboratories review cases developed by the field force when special technical questions are involved. They assist the field force in planning and carrying out surveys and campaigns to bring about compliance with the Federal food and drugs act. The results of their work are reflected in the progress made in the control of food and drugs. Some of the lines of work for 1926 in which they have rendered assistance have already been outlined.

Mention may be made of other investigations carried on by them during the year.

DRUG-CONTROL INVESTIGATIONS

The survey of pharmaceutical products begun three years ago has been practically completed. A sufficient number of samples of pharmaceutical products from each manufacturer in the United States has been analyzed to furnish a fair estimate of the character of the output of this industry. Through the earnest effort of the industry itself, in cooperation with the bureau, a very general improvement in the quality of these important products has been brought about. Although no evidence of any deliberate substitution or other deliberate adulteration in drug products has been discovered, the survey demonstrated the necessity for increased care on the part of many manufacturers, and in most cases such additional supervision has been installed. The manufacture of pharmaceuticals is a highly

specialized profession, requiring unusual care and skill from the receipt and examination of crude materials to the packaging and labeling of the finished products. Many of the medicaments used are powerful poisons as well as valuable therapeutic agents. It is vitally important that these preparations conform in strength and purity with the representations under which they are sold. The manufacturers' contact committees mentioned in the 1925 report of the chemist have given most helpful cooperation.

Special attention has been given to the character of the representations made by manufacturers of medicines intended to be sold directly to the public. The Federal food and drugs act provides essentially that therapeutic representations made for medicines shall not exceed the limitations of the ingredients of which they are composed. The manufacturers in general cooperate heartily in effecting any needed revision in the labels of their products. In order to systematize the work, as well as to avoid discrimination among competing manufacturers, these products have been handled by classes rather than as isolated individuals. The labelings of many proprietary medicines have been the subject of action, with a view to bringing the therapeutic representations more closely into harmony with present-day medical opinion.

A general investigation of ether was made during the year. Ether is perhaps the most generally used of all anesthetics. Administered in serious emergencies, it is essential that only the purest ether be permitted for sale as an anesthetic. Investigation showed that some of the ether on the market intended for anesthesia contained peroxide, aldehyde, excess acid, or excess non-volatile matter, bringing it below the standard prescribed by the United States Pharmacopœia and therefore making it adulterated under the Federal food and drugs act. A number of consignments of such ether have been seized and thus effectively removed from the possibility of use as an anesthetic. The principal manufacturers of ether have recently held a conference to discuss methods for guarding against the possibility of contaminating ether with objectionable impurities. It is highly probable that as a result of this conference and of the researches initiated thereby important advances in the art of manufacturing, packing, and preserving ether may be effected.

Ethylene has recently come into prominence as an anesthetic. An investigation of this gas, as found on the market, was inaugurated.

A number of investigations have been undertaken for the purpose of adding to the existing knowledge on the composition of drugs and methods for their analysis. It has been found that the present methods for the analysis of ipecac and hyoscyamus indicate a content of alkaloidal constituents in these drugs considerably below the truth. During the year there has been established a laboratory the primary function of which is to study the methods of drug analysis, in order that accurate information may be available for the use of analysts of the bureau and also that chemists generally may have the benefit of the researches.

FOOD-CONTROL INVESTIGATIONS

The study of the composition of alimentary pastes and of the raw material used in their manufacture was continued. A method of determining the moisture content of alimentary paste in its original unground condition was developed. Moisture determinations were made on farina, semolina, and egg pastes by the ordinary vacuum-oven method and the rapid-routine method, not only by using the regular drying periods but also by extending the periods to ascertain if there was a point beyond which there would be no loss in weight. No such point was found, however. Five hours' drying by the vacuum method gave results which checked with those obtained by the rapid-routine method in one hour. Ten hours' drying by the vacuum method corresponded to two hours' drying by the routine method, and so on. No advantage was found in extending the drying periods for products of this kind beyond the periods given in the two methods.

A brief study of the ethyl acetate content of distilled vinegar was made.

Reports on the methods of analysis of baking powder and baking chemicals and of bread were made to the Association of Official Agricultural Chemists. Variations in the method of handling doughs and the influence of the amount of salt in the dough batch were studied. Work was continued on wheat flour, its manufacture, grading, and use. An article upon the quantitative determination of unsaponifiable matter in wheat flour, alimentary pastes, and eggs was published during the year. A careful compari-

son of the moisture content of 20 selected samples of flour was made by the vacuum-oven method, the rapid-routine method, the water-oven method, and the Bidwell-Sterling method.

A study of the effect of aging on the fat constants of cheese was completed. Much work has been done on malted milk, including a review of the literature and manufacturing processes and general information regarding chemical analysis. The constants of the fat extracted from four well-known brands were determined, the results showing a decided variation. The subject of methods for determining casein emulsifiers in processed cheese was given attention, principally a determination of citrates by the pentabrom-acetone method.

Experimental work on fruit jellies, preserves, and butters was undertaken. It included the analyses of samples of strawberries, strawberry juice, apple pomace, and cranberries.

A survey of the shrimp-packing industry was made, and experimental packs of shrimps were put up. Preliminary work has been done on Scotch-cured herring.

Work was carried on upon the direct determination of the total milk protein content of milk chocolate, this attempt replacing that previously made to determine casein alone directly, and to estimate the remaining milk protein by a factor. The method has been developed to a point where results can now consistently be obtained within 0.2 per cent and usually within 0.15 per cent of the calculated value.

In collaboration with the pharmacological laboratory, work was carried out on the toxicity of tin. A modification of a colorimetric method for the determination of lead has been developed.

MICROBIOLOGICAL INVESTIGATIONS

The occurrence of several cases of botulism called for a restudy of the problems surrounding the occurrence of this disease as a result of the consumption of canned food. The examination of canned sardines from a pack accountable for two outbreaks, resulting in four deaths, furnished important evidence of the necessity for demanding that canned foods offered for human use should comply with all requirements for soundness not only in the food examination but in the absence of those marks which ordinarily give warning of spoilage. A large percentage of cans in this pack,

although perfectly sound, were so full that they bulged, giving the appearance usual in incipient spoilage. Unfortunately, in addition to these perfectly sound but slightly bulging or springing cans, a small number of actually swelled cans containing poisonous material was also present. It was clearly shown that dealers and consumers, becoming accustomed to this abnormal appearance of a sound pack, lost the necessary discrimination which would have resulted in the elimination of the bad product. This series of observations was so strikingly conclusive that the trade has formally recognized the necessity of insisting upon a rigid inspection of all canned food at every point in the distributing line and the removal of all abnormal-appearing products, such as swells, springers, and flippers of all degrees, from the channels of trade.

For many years reports of bacteriological and chemical investigations of oysters have been accumulating in the files of the bureau, and for more than a quarter of a century investigators have been presenting in scientific and technical journals the results of their investigations of various problems dealing with the handling of oysters. The unpublished data filed in the bureau and a summary of other information available on the bacteriology and chemistry of oysters have been compiled with a view to their publication as a department bulletin.

The occurrence of human food-poisoning cases attributed to cheese has been frequently recorded over a long period of years. There is reason to believe that these cases were more frequent in the early days of factory cheesemaking in the United States than they are now. Nevertheless they still occur and in most cases their interpretation has baffled the skill of both the chemist and the bacteriologist. During the past year it has been possible to demonstrate the occurrence in two such cases of a streptococcus capable of producing illness. The demonstration of this organism opens up an entirely new field of food poisoning, fortunately limited, so far as the experimental results thus far show, to milk and its products.

An investigation of the bacteriology involved in the curing of certain fish products was begun. There are imported into the United States from the Scandinavian Peninsula, Scotland, France, Italy, and Spain, as well as from the Orient, large quantities of various pickled and salted fish products. Alaska also produces salted herring

packed in the Scotch or Norwegian style. Such imported products as anchovies in salt, sardines in salt, filets of sardines, Scotch-cured herring, Norwegian-cured herring, kryddersild, appetitsild, gaffelbiter, sardelrings, Bismark herring, Kaiser-Friedrich herring, roll-mops, milt-herring, delicatessesild, suresild, and smörgaassild are marketed in this country for consumption mostly by an alien population. Our lack of knowledge of the curing process and of the nature of the normal and abnormal products obtained makes it necessary that biological and chemical investigations of the process be conducted. The chemical work for this investigation is being done in the food-control laboratory. The bacteriological work up to the present time has consisted mainly in collecting and examining samples of some of the fish products on the market, with a view to determining the types of predominating bacteria. The predominating groups of organisms in all the samples examined are acid-producing streptococci, resembling the lactic-acid streptococci. In some of the samples there were typical lactobacilli. The results so far obtained are significant in showing that the bacterial flora is almost entirely Gram positive in character and is composed mainly of streptococci, lactobacilli, spore-forming anaerobes, and aerobic spore formers.

MICROCHEMICAL INVESTIGATIONS

A method was developed for testing cherries as received at the factory to determine the amount of infestation by maggots. By means of this method it is possible for factory managers to ascertain the percentage of cherries that contain maggots in each delivery and to refuse those offerings which are unfit to pack. As a result, the cherries packed during the last season were far more free from these pests than the packs of previous years.

A process was developed and a machine devised for removing maggots from blueberries, a very serious pest in Maine. The total value of the pack has been estimated at from \$700,000 to \$1,000,000, and it is believed that the machine devised for eliminating the maggots was responsible for saving a large proportion of the crop.

PHARMACOLOGICAL INVESTIGATIONS

Work was continued to determine whether food contaminated with tin is injurious to health. Most of the

pharmacological work heretofore done has been with tin which was added to food in the form of tin salts and not with food contaminated from the usual sources. Experiments were conducted with pumpkin containing tin from corrosion and also with pumpkin to which tin had been added. The purpose of the experiments was to determine (1) if there was any apparent difference between the added tin and that occurring there naturally because of corrosion and (2) if tin in the combinations fed is absorbed and deposited in the body. All guinea pigs used in the experiments, whether fed the pumpkin to which tin was added or that containing tin from corrosion, grew well and appeared healthy. There was therefore no outward evidence of harm. No tin was found deposited in the organs analyzed (liver, kidneys, and spleen).

In collaboration with the Bureau of Biological Survey the manufacture on a commercial scale of a stable rat poison in powder form from squill bulbs has been developed. This product has the advantage of cheapness, efficiency, and apparently little likelihood of killing other animals exposed to poisoned rat bait.

Work was continued on bioassay standards of fluid extract of ergot, fluid extract of cannabis, pituitary powder, epinephrin, and ouabain. These have been prepared and distributed upon request to 24 American manufacturers. Standards have also been supplied to individuals, in Canada, Spain, Belgium, Austria, and Hungary. Through the use of these standards in bioassay tests greater uniformity in the potency of certain United States Pharmacopœia drugs will be effected.

PRODUCTS ALLEGED TO BE RADIOACTIVE

A nation-wide survey of products alleged to be radioactive was completed during the year. Samples of hair tonics, bath compounds, suppositories, tissue creams, tonic tablets, face powders, ointments, mouth washes, demulcents, opiates, ophthalmic solutions, healing pads, and other preparations in solid, semisolid, and liquid form were analyzed for their content of radium. About 60 samples, representing the product of 20 manufacturers, were examined. Of these only three contained radium in sufficient quantities to be of therapeutic value, and then only in certain very limited cases. Therapeutic claims of an ex-

aggerated nature are being made for many of the products examined. One curious sample consisted of a short glass rod, coated on one end with a yellow substance and inclosed in a glass bulb. The bulb is supposed to be hung over the bed, when according to the claims of the inventor it causes the dispersion of "all thoughts and worry about work and troubles and brings contentment, satisfaction, and bodily comfort that soon results in peaceful, restful sleep."

INSPECTION OF IMPORTED FOODS AND DRUGS

The Federal food and drugs act provides that shipments of foods and drugs offered for entry into the United States which are found to be adulterated or misbranded within its meaning or which are otherwise injurious to health shall be excluded from this country. Inspections are made of the invoices and public store cases covering all shipments of the foods and drugs offered for entry at the leading ports. Not all shipments offered for entry are actually sampled, however, because the nature of many shipments offered for entry makes sampling unnecessary and the limited personnel would make it impossible. Sampling is largely confined to products or shipments which Government officials have reason to suspect of being adulterated or misbranded. Furthermore, in order to obtain a survey of the whole field, a schedule for an intensive sampling of certain products selected each year is followed.

FOOD STANDARDS

The joint committee on food standards and definitions, which consists of three representatives each of the Bureau of Chemistry, of the Association of American Dairy, Food, and Drug Officials, and of the Association of Official Agricultural Chemists, prepares standards and definitions of food products for the guidance of officials in the enforcement of food control laws.

This has been a year of accomplishment. Although but two regular meetings of the committee were held, more time than usual was devoted to the work and a determined effort was made to complete the revision of certain schedules which have been in controversy for a number of years.

New standards were adopted for almond paste and kernel pastes, for sauerkraut, and for Dutch-process

chocolate and Dutch-process cocoa. Revisions of the extended schedules for meat and meat products and fruit and fruit products were completed. The standard for butter was amended so as to conform with recent legislation. The standards for moisture in flour, and for glucose, Pasteurized milk, evaporated milk, evaporated skimmed milk, sweetened condensed milk, malt vinegar, and wine vinegar were amended. Faulty or obsolete definitions and standards for self-raising gluten flour, diabetic food, canned pea grades, blended milk, and sterilized milk were revoked.

Hearings were held upon the subjects of alimentary pastes, wheat flour, fruit and fruit products, and so-called process cheese. The hearings upon the moisture content of wheat flour and upon fruit and fruit products, particularly with reference to the increasing use of pectin and pectinous products, were of especial importance. Minor changes, mainly editorial in character, were recommended with respect to the revision of Circular 136, Office of the Secretary. The following subjects were considered, although action was postponed: Sweet cream butter, ice cream, whipping cream, sirup, and process cheese.

It is gratifying that these definitions and standards are being increasingly accepted by food officials in States having no special legislation providing for their recognition. The food-control officials in Louisiana, Mississippi, and Texas have recently adopted the definitions and standards for sirups and molasses, thereby harmonizing their regulations and procedure and promoting uniformity in food-law enforcement throughout the States.

PUBLICATIONS ISSUED

Eight department bulletins, including one revision, four miscellaneous circulars, including one revision, two food inspection decisions, the report of the chemist, three articles in the Journal of Agricultural Research, 850 notices of judgment, 1 index to notices of judgment, 1 book, and 102 articles in scientific and technical journals were published during the year.

The miscellaneous circulars are: No. 9, Importation and Inspection of Tea (revision); No. 22, Supplement 1, Amendment to Regulations for the Enforcement of the Naval Stores Act; No. 22, Supplement 2, Notice of Establishment and Promulgation of a Stand-

ard for Opaque Rosin; and No. 52, Certification of Coal-Tar Food Colors.

The food inspection decisions are: No. 196, Sauerkraut, and No. 197, Almond Paste and Kernel Pastes.

The department bulletins are: No. 824, Insect Powder, by C. C. McDonnell, R. C. Roark, F. B. LaForge, and G. L. Keenan (revision); No. 1335, Commercial Dehydration of Fruits and Vegetables, by P. F. Nichols, Ray Powers, C. R. Gross, and W. A. Noel; No. 1345, Salt Bushes and Their Allies in the United States, by G. L. Bidwell and E. O. Wooten (B. P. I.); No. 1370,

Sugarcane Sirup Manufacture, by H. S. Paine and C. F. Walton; No. 1371, Effectiveness Against the San Jose Scale of the Dry Substitutes for Liquid Lime-Sulphur, by W. S. Abbott and J. J. Culver (Ent.) and W. J. Morgan; No. 1373, Dust Control in Grain Elevators, by H. R. Brown and J. O. Reed; No. 1389, Deterioration of Commercially Packed Chlorinated Lime, by C. C. McDonnell and Leslie Hart; and No. 1390, Chemistry and Analysis of the Permitted Coal-Tar Food Dyes, by J. A. Ambler, W. F. Clarke, O. L. Evenson, and H. Wales.

The first part of the report deals with the general situation of the profession in the United States. It is noted that the number of physicians has increased steadily since 1900, and that the distribution of physicians is still uneven, with a concentration in the large cities and a shortage in the rural areas. The report also discusses the various organizations of the profession, including the American Medical Association, the American College of Physicians, and the American College of Surgeons. It is pointed out that these organizations have been successful in securing recognition for the medical profession as a learned profession, and in securing the right to practice medicine without restriction.

The second part of the report deals with the medical education of the physician. It is noted that the standard of medical education has risen steadily since 1900, and that the medical schools are now producing a higher quality of graduates than in the past. The report also discusses the various reforms that have been introduced in medical education, including the requirement of a pre-medical course, the requirement of a longer course of study, and the requirement of a higher standard of entrance. It is pointed out that these reforms have been successful in raising the standard of medical education, and in producing a higher quality of graduates.