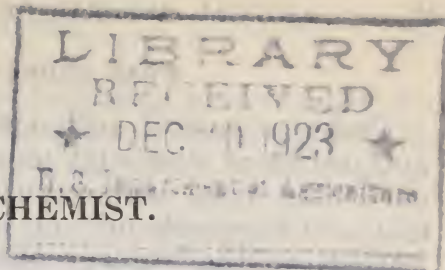


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REPORT OF THE CHEMIST.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF CHEMISTRY,
Washington, D. C., September 14, 1923.

SIR: I beg to submit herewith the report of the work of the Bureau of Chemistry for the fiscal year ended June 30, 1923, and recommend that it be printed in the usual manner.

Respectfully,

W. G. CAMPBELL,
Acting Chief.

Hon. HENRY C. WALLACE,
Secretary of Agriculture.

INTRODUCTION.

The Bureau of Chemistry is authorized in the appropriation act for the Department of Agriculture to conduct investigations relating to the application of chemistry to agriculture; to make biological investigations of food and drug products, including the physiological effects of such products on the human organism; to develop methods for the manufacture of table sirup and sugar; to investigate the composition, action, and application of insecticides and fungicides; to develop methods for the prevention of plant-dust explosions and fires in cotton gins and cotton-oil mills; to improve methods for dehydrating fruits and vegetables; to investigate the grading, weighing, handling, transportation, and uses of naval stores, and to demonstrate improved processes of preparing naval stores; to conduct experiments on the utilization, for coloring, medicinal, and technical purposes, of raw materials grown or produced in the United States; to collaborate with other departments of the Government in chemical investigations; to enforce the act to prevent the importation of impure and unwholesome tea; and to enforce the food and drugs act, commonly called the pure food law.

The purpose of this report is to outline briefly the specific work conducted and the important results accomplished during the fiscal year ended June 30, 1923.

AGRICULTURAL CHEMICAL INVESTIGATIONS.

Basic research work in agricultural chemistry, including the application of the results to agriculture and to the development of new or improved methods for the manufacture of products made from farm crops, was carried on during the year under one general authorization and under five specific authorizations.

WORK UNDER GENERAL AUTHORIZATION.

Under a general authorization for investigations relating to the application of chemistry to agriculture, work was done on crop chemistry, on a study of the odorous principles of the cotton plant, on proteins, on vegetable oils, on citrus fruits, on cassina, on tanning and leather, on the waterproofing, mildewproofing, and fireproofing of fabrics, on the utilization of cull and surplus sweet potatoes, on the production of gas from straw, and on methods of analysis of agricultural products.

CROP CHEMISTRY.

Research in the chemistry of plant constituents has yielded knowledge of tremendous value to agriculture. Upon this knowledge of fats, sugars, starches, proteins, etc., great industries, which have enhanced the value of the raw products of the farm, have been developed. A knowledge of the relation of the mineral matter in the soil and in the plant to the value of the plant as food is of fundamental importance. During the year a preliminary study was made of the migration of the mineral constituents from the stalks to the heads of wheat with the advancement of the growing season. Work was done on a study of the lime requirement of plants and on the analysis of plant materials. A study of wheat seedlings undertaken to determine the effect of initial hydrogen-ion concentration of the medium on the rate of absorption of phosphoric acid and potassium is being continued.

Although much of the research work heretofore undertaken on crop production has had for its object the laudable purpose of greater yield per unit, nutritive quality is of equal importance with quantity of yield. Hence the chemist seeks to learn whether or not there is danger of producing quantity at the serious expense of nutritive quality. Work on this subject is now under way.

ODOROUS PRINCIPLES OF THE COTTON PLANT.

A study of the odorous principles of the cotton plant, which are presumed to attract the boll weevil, was undertaken in cooperation with the Bureau of Entomology. If it should be found possible to identify the odorous compounds and obtain them from some other source in sufficient quantities for practical use, a method might be devised for the eradication of the boll weevil which is causing widespread destruction of cotton. The preliminary work is being conducted at Tallulah, La., while the more detailed operations will be carried on in the laboratory at Washington.

PROTEINS.

The most costly per unit as well as the most important constituent of our foods is the nitrogenous matter. Animals are wholly dependent, either directly or indirectly, upon nitrogenous products synthesized by plants. Recent researches have shown that vegetable proteins vary in composition. Some of the amino acids which constitute the various proteins are now known to be essential to animal

growth and development. Some of the vegetable proteins are deficient in these essential amino acids. Therefore a knowledge of the constituents of the vegetable proteins is essential to a knowledge of nutritional requirements and the value of our food materials.

During the year the physical and chemical properties of various proteins were determined. The cystine and tryptophane content of a large number of proteins is being determined. A study on the nutritive deficiency of arachin, which is the chief protein of the peanut, is in progress. Peanut meal, when fed to animals as the sole source of protein, has an unusually high degree of efficiency.

A study of the proteins of wheat bran is in progress. When this work was begun practically nothing was known regarding the chemical or physical properties of the proteins of wheat bran, notwithstanding the fact that 22 per cent of the total protein of the wheat kernel is in the bran. Bran has long been regarded by practical feeders of farm animals as having high nutritive value, and it has been considered that the proteins of wheat bran are superior in nutritive quality to those of the endosperm. Nearly 66 per cent of the total protein in the bran has been isolated and identified. The chemical properties and composition of these proteins have been studied. A study of the nutritive value of the proteins of the lentil has been made.

A critical study of the amino acids in the hydrolysis products of glycinin, the chief protein of the soy bean, is being continued. Special attention is being paid to the development and improvement in the methods and technique involved in the quantitative determination of amino acids. There is under way a study of the proteins of cacao beans and also a chemical study of the proteins of cottonseed. Analyses of several preparations of the cottonseed globulin have been made. In a study of the proteins of the navy bean, a hitherto unknown globulin, which has been called conphaseolin, has been isolated. The chemical properties of this globulin have been determined and analyses to determine the percentages of the nutritionally essential amino acids have been made.

A paper on "The nutritive value of mixtures of proteins from corn and various concentrates," in the *Journal of Agricultural Research*, shows that the proteins of peanut meal, soy-bean meal, coconut press cake, and tomato-seed press cake contain, in sufficient quantity to supplement satisfactorily the corn proteins, the amino acids which are lacking in corn. The various proportions of concentrate to corn which were used and found satisfactory for the normal growth and development of animals are reported.

VEGETABLE OILS.

In nutrition the fats and oils are second in importance only to the proteins. Through the application of chemistry to the refining of crude products and to the so-called hardening (hydrogenation) of vegetable fats there has been a tremendous development in the utilization of vegetable oils—a profitable development for the farmer and planter, which has added millions to our national wealth. Such research work is of no less importance to the consuming public in making available a nutritious and cheap food. This development has been dependent almost wholly upon agricultural chemical research.

During the last year an investigation was made of the composition of the free fatty acids and the nonglyceride constituents of crude cottonseed oil. Results of work on the chemical composition of soy-bean oil and of sunflower-seed oil were published during the year. An extensive research on the composition of the oil from chufa tubers was completed. A paper on lard and its relation to vegetable oils was published.

CITRUS FRUITS.

Work on the development of methods for the profitable utilization of cull and surplus oranges and lemons was continued. How this work has aided in the establishment of industries manufacturing useful products from oranges and lemons, thus providing a profitable outlet for fruit that would otherwise go to waste, has been covered in the reports for previous years.

During the last fiscal year the work was directed to the perfection of the method for the commercial production of pectin from waste orange and lemon peel. Pectins produced by various methods have been standardized as to their jellying power, and work has been done on the production of jellies of different consistency. Attention was given to the preparation of marmalades and jellies from dehydrated oranges. The effect of different temperatures and the length of time of dehydration upon the pectin content has been studied. New methods for the preparation of marmalade and orange butter have been evolved through the work on the production of pectin.

Preliminary work on the analyses of California orange and lemon oils has been undertaken.

CASSINA.

Cassina (*Ilex vomitoria*), a shrub-like plant which grows wild in profusion in the South Atlantic and Gulf Coast States, is believed to have great economic possibilities. Its leaves when properly cured resemble yerba maté or Paraguayan tea, millions of pounds of which are consumed annually in South American countries, especially Argentine and Chile. The development of an export and domestic trade in the cured cassina has inviting possibilities.

The technological processes for utilizing cassina have been developed to a high degree of efficiency, the process of manufacturing black cassina having been much improved during the past year. It has been demonstrated that it is practical to manufacture on a commercial scale the cured leaves of the cassina from which a delightful beverage, flavoring sirup, and concentrated extract can be made. This extract has been used as a flavor in the manufacture of ice cream with most promising results.

The development of a market for new foods and drinks is always a slow process. The question of whether a profitable domestic cassina industry will be established now depends upon finding an adequate market for the cassina products. The indications are that such a market may be developed in time. The foreign market for maté with which it will compete is already established. It would seem, therefore, that all that can be done by a Government agency has been accomplished. It now remains for private concerns to undertake the development of what may become a great national industry.

TANNING AND LEATHER.

The production of leather is of more interest to agriculture than to any other industry, for not only does agriculture produce the raw products of leather, the hides and the tanning materials, but it is by far the largest consumer of the finished product. The chemistry and the technology of leather making are therefore directly related to profitable agriculture.

The results of experiments to determine the relative wearing qualities of shoes made from different kinds of leather tanned by various processes are given in Department Bulletin 1168, *Wearing Qualities of Shoe Leathers*. The outstanding indications from this investigation are: (1) The superior pliability of retanned chrome and chrome-tanned upper leathers; (2) the features that are objectionable in fiber soles and the long wear of those that did not develop such features; (3) the greater serviceability of rolled vegetable-tanned sole leathers, as compared with unrolled leather of the same thickness; (4) the strikingly longer wear of chrome-tanned sole leathers, especially of the unwaxed chrome-tanned leather.

In addition to the wear data, extensive analytical data showing the composition of the original leathers and of parts of the worn soles from these leathers are reported. These data involved more than 1,500 determinations. The data obtained in this investigation will be of value to buyers of shoes, especially to the large buyers like the War Department, by indicating specifications for the most suitable shoes, to manufacturers by indicating the most efficient leather for making longer wearing shoes, and to tanners in aiding them to improve processes for making more durable leather.

Experiments were conducted to reduce deterioration in bookbinding leathers. Much of the bookbinding leather used to-day is of inferior quality. Attention was also given to bookbinding cloth to prevent rapid fading and destruction by roaches. Fading is a matter of some importance in binding yearly volumes which should match in color from year to year. Attempts were made to devise a roach-repellent treatment which might be applied at the bindery.

Detailed directions for making bark-tanned sole and harness leather, chrome-tanned leather, and alum-tanned lace leather on a small scale are given in *Farmers' Bulletin 1334, Home Tanning of Leather and Small Fur Skins*.

Investigations on raw materials for leather manufacture were continued. Attention was also given to the recovery and utilization of tannery and leather wastes.

WATERPROOFING, MILDEWPROOFING, AND FIREPROOFING FARM FABRICS.

The waterproofing, mildewproofing, and fireproofing of fabrics for farm and other uses are of importance because of the growing use of canvas as a protection against the weather. The introduction of long-distance hauling by truck has greatly increased the need for durable, water-resisting covers. Great quantities are used for wagon covers and for the protection of grain and hay in the cock or stack. Contractors and builders need dependable canvas to protect machinery and materials. The Army and Navy need a great deal of canvas, and the summer camper is a large consumer. Often

the serviceability of canvas may be doubled by proper treatment to protect it against moisture and sun.

The result of the investigation on the effects of waterproofing materials and outdoor exposure upon the tensile strength of cotton yarn showed that after exposure to the weather for one year the treated yarn was in most cases stronger than the untreated yarn after exposure. Exposure tests on cotton duck given the same and similar treatments indicated that the results on yarns are not strictly applicable to the woven fabric, since the treated canvas after exposure is usually weaker than the untreated canvas after exposure. An important investigation was completed on the effects of materials used in waterproofing and of outdoor exposure to the weather on the tensile strength and water resistance of canvas. The conclusions drawn from the investigation are that the addition of certain mineral pigments to waterproofing preparations is beneficial, since they reduce the weakening effect of solar light and heat without reducing the water resistance.

Investigations in cooperation with the Connecticut Agricultural Experiment Station and the Connecticut Valley Tobacco Improvement Association are now in progress to develop methods for treating tobacco shade cloth so that its serviceability may be materially increased. It is believed that the final results of this investigation, which is being conducted both in the field and in the laboratory, will be useful in increasing materially the life of tobacco shade cloth.

UTILIZATION OF CULL AND SURPLUS SWEET POTATOES.

Great areas in the Southern States are peculiarly adapted to the growing of sweet potatoes which, if produced with a reasonable assurance of profit, would serve a useful purpose in developing diversified farming in the South. The possibility of increasing the profitable production of sweet potatoes depends upon the development of a demand for sweet-potato products. Thus far it has been impossible to develop a market to an extent commensurate with the production possibilities. The technology of converting sweet potatoes into salable food products is a problem to which the bureau has given much thought and energy.

A laboratory investigation has shown that, upon cooking, sweet potatoes change from a starchy into a saccharine foodstuff which is largely maltose sugar, one of the most nutritious and digestible of the carbohydrates. It was found that the diastatic power of dried sweet-potato tissue is three or four times that of the best distillers' malt. This suggests the possibility of the development of an industry for the production of sweet-potato flour to be used because of its high diastatic power in bread making and in other ways.

Experimental work showed that the sweet-potato diastase has three striking properties: (1) It has less liquefying power than malt diastase; (2) it does not attack the complexes in the starch molecule as uniformly as does malt diastase; (3) it works at a higher temperature than malt diastase. Work on the technical significance of these properties is now under way.

The results of experimental work on the manufacture of sirup from sweet potatoes are published in Department Bulletin 1158, Production of Sirup from Sweet Potatoes.

PRODUCTION OF GAS FROM STRAW.

The tests at Arlington on the production of gas from straw and similar waste materials have been completed and the results of the entire experimental work have been prepared for publication as a department bulletin. The tests showed that gas produced from straw may be used successfully for lighting and heating and as a motor fuel, but indicated that the destructive distillation of straw and similar material for the production of gas on the farm is not practicable. The cost of the gas is practically prohibitive and much difficulty is encountered in the operation of the plant.

Although the general results of these tests may be considered negative, they have the very positive value of meeting the active demand for information on this subject.

METHODS OF ANALYSIS.

The development of methods of chemical analysis is one of the important functions of the Bureau of Chemistry. This work is done in cooperation with the Association of Official Agricultural Chemists and other scientific associations. The value of having uniform methods of analysis, so that results obtained by different chemists working on the same products may be comparable, is apparent. While the immediate results of this work are of interest only to chemists, the ultimate results are reflected in an improved agriculture and in the development or improvement of industrial processes for the utilization of agricultural products.

WORK UNDER SPECIFIC AUTHORIZATIONS.

Investigational and experimental work on table sirup and beet and cane sugar, insecticides and fungicides, plant-dust explosions and cotton-gin fires, dehydration of fruits and vegetables, and rosin and turpentine was conducted under separate authorizations.

MANUFACTURE OF SIRUP AND SUGAR.

The economic conditions that make imperative the need for chemical and technological work on the development of improved methods for the manufacture of sirup and sugar presented in last year's report should be considered in connection with the following statement regarding the continuation of the work.

Improvement in manufacture and handling of cane sirup.—The work on production of cane sirup of uniform quality outlined in the 1922 annual report was actively carried forward in cooperation with State farm bureau federations, particularly in Texas. A central blending and canning plant with a daily maximum capacity of 5,000 gallons, equivalent to 500,000 gallons for a 100 days' operating season, was designed by the bureau for the Texas Farm Bureau Ribbon Cane Growers Association. This plant was erected at Lufkin, Tex., at very moderate cost and was placed in operation during the season of 1922-23. A representative of the bureau was stationed at Lufkin to give advice on the technical operation of the plant.

A refining-in-transit freight rate was secured and cane sirup from various sections of eastern Texas was shipped by members of the association to the Lufkin plant where it was graded, mixed on a

sufficiently large scale to insure uniformity of grade, treated by the invertase process perfected by the bureau to prevent crystallization, canned, labeled, crated, and shipped to market. An improved system of commercial grading of sirup was devised.

Technically the process has proved to be an unqualified success and it has been operated at very moderate expense. Noncrystallizing sirup of high and uniform quality was produced from farm-made sirup of varying character. As a result of the working out of this chemical-technical problem, farmers producing cane sirup were able to consolidate their output on a sufficiently large scale and into such a uniform product as directly to interest brokers and wholesale grocers in its distribution in a systematic manner.

A study was made of the manner of production of cane sirup on the farms and directions showing how the quality of the product could be improved were distributed to producers. At the same time experiments were conducted for the purpose of improving the quality of low-grade sirup by various procedures, including treatment with decolorizing carbon. Promising results were obtained and investigations along this line will be continued. An investigation was also started for the purpose of working out all necessary details for the production of cane sirup on a larger scale in mills of increased capacity. It is believed that the development of the cane-sirup industry depends on larger scale operation and consequent reduction in costs, either by increasing the size of the unit mill or by the operation of cooperative blending and canning plants, taking advantage of a refining-in-transit freight rate.

The application of the invertase process for preventing crystallization or so-called sugaring of cane sirup was greatly extended for use at producing sirup mills during the year. Demonstrations of the process were made by representatives of the bureau in Georgia, Alabama, Mississippi, Louisiana, and Texas.

Sorgo sirup.—The situation with respect to the production and distribution of sorgo sirup, formerly known as sorghum sirup, is practically the same as that which is being corrected in the case of cane sirup. Approximately 40,000,000 gallons of this product is now manufactured annually in the United States by a large number of individuals, but on a relatively small scale in most cases. At the same time, sorgo sirup is an important product in the agricultural scheme of a large farming area. Sorgo sirup as produced by this large number of farmers varies greatly in quality and the producers are not able to furnish a sufficiently large volume of sirup of uniform quality to permit them to establish a stable market. Farm bureau federations in certain sorgo-growing States are planning to undertake cooperative marketing of sorgo sirup and have requested the bureau to work out the chemical and technological problems involved. Arrangements to this end have been made.

Use of invertase in products other than cane sirup.—As a by-product of the work on the use of invertase for preventing crystallization of cane sirup, and at practically no additional investigational expense, some important uses of this product in the confectionery industry have been developed and protected by public-service patents. These improvements make possible more rapid and continuous processes for producing candy of fondant-center type, thereby reducing time and expense of manufacture. Chocolate-coated fondant centers

of any desired degree of consistency, varying from completely liquefied centers of the cordial type to so-called slightly flowing centers, may be produced at very little expense. Invertase may also be used in further reduced quantities for the primary purpose of causing inversion of sucrose just sufficient to keep the centers moist for a greatly increased period, the drying out or aging of these types of candy being thereby much retarded.

Cane-sugar industry.—In continuation of the program outlined in last year's report, a systematic investigation of the refining value of raw sugar is now actively under way. Variations in the suitability of raw sugar for the production of standard granulated sugar may affect the returns to the plantation. Not only the particular process used in the mill for clarification of the juice, but also the variety of cane and various cultural conditions are apparently of great importance in this connection. The character of the soil appears to have an influence on the amount of inorganic constituents. Variations in the character of the impurities contained in raw sugar have in many cases caused great difficulty in refining and have consequently acted unfavorably to the interests of the planter. One of the principal troubles, difficult filtration of raw-sugar melts, is evidently of a colloidal nature.

Since the effect of the clarification processes used in the raw-sugar factory consists primarily in the elimination from the juice of colloidal material, it has been necessary first of all to devise means whereby the character and quantity of the colloidal matter present in the juice before and after clarification can be accurately determined. Means for doing this have not heretofore been available. The special methods and apparatus devised in the investigation of this problem make it possible for the first time to determine accurately the character and quantity, and eventually the exact origin, of the colloidal material originally present in the cane juice, that which remains after clarification, and that which is present in raw sugar. This work also makes possible a more exact determination of the value of various processes now in use for clarifying cane juice in both raw-sugar and white-sugar manufacture.

In further continuance of the work outlined last year, an investigation has been started for the purpose of determining sugar losses by inversion in different methods of manufacture. Very little accurate information on this important problem is available. Such data will be of value to domestic sugar technologists in helping them to select the most efficient and most economical method of manufacture. In order to prevent continued losses, there is urgent and immediate need for a determination of the fundamental conditions required to give efficient clarification of cane juice in connection with plantation white-sugar and raw-sugar manufacture and to reduce or eliminate losses caused by inversion of sugar. If the conditions most favorable for accomplishing these two objects do not prove to coincide entirely, it will be desirable to adopt a compromise procedure which will, on the whole, give the best results. Since the most favorable chemical condition for the clarification of the juice may vary decidedly with the quality of cane, it is necessary to consider fully this phase of the question in arriving at a solution.

During the past few years final or blackstrap molasses has commanded a very low price which is not at all commensurate with the

inherent value of the product from the standpoint of its composition. There is a distinct opportunity for securing from blackstrap molasses products of great value compared with the present low price of the molasses. Work directed toward a more profitable manner of utilizing blackstrap molasses has been actively under way during the past year and important progress has been made.

Beet-sugar investigations.—In furtherance of the work already under way, the investigations of the past year have been carried forward, with the object of obtaining more accurate knowledge of the objectionable organic nonsugar substances which are extracted from beets in the juice with sugar. This material varies in quantity, depending on the character of the beets, and is a primary factor in causing the sugar losses under investigation. The necessity for storing a large proportion of sugar beets after harvesting and before working the beets in the factory is predominantly associated with these sugar losses. There is a very great difference between the ease with which sugar can be extracted from unstored beets and the difficulty encountered in the case of stored and deteriorated beets. In addition, the total recovery of sugar from unstored beets is greater than that from stored beets. Furthermore, there are distinct indications that cultural conditions, such as type of soil and degree of maturity, predominantly determine the deterioration which sugar beets undergo in storage. As the net result is to reduce the value of sugar beets as an agricultural crop, the successful solution of this problem is of great economic importance.

Distinct progress has been made toward the solution of the problem. For this purpose it was necessary to devise and install equipment for reproducing on a small scale the factory operations employed in boiling and crystallizing beet liquors. Apparatus was also developed for more accurately determining the effect of the impurities in beet liquors on properties such as hydrogen-ion concentration, viscosity, solubility, and rate of crystallization of sucrose, and on the form and size of the sugar crystals.

As a by-product of the investigation as a whole, there was developed a much more accurate analytical method for the determination of sucrose, and incidentally raffinose, in beet products in connection with factory control of sugar recovery than has heretofore been available. This is most important in view of the fact that cost control of the entire processes of growing and handling beets and extracting sugar therefrom depends on an accurate knowledge of the quantity of sugar in the beets and the yield obtained. This method was tried out in actual practice by a representative of the bureau in one of the western beet-sugar factories during the season of 1922, and the results obtained permitted more accurate detection and estimation of sugar losses. The efficiency of the Steffen process now used in this country for the desugarization of beet molasses was more fully studied and the extent of known and unknown losses of sugar was more accurately determined.

INSECTICIDE AND FUNGICIDE INVESTIGATIONS.

As crop production becomes intensified new biological problems arise in the attempt to maintain an equilibrium which will be of benefit and profit to man. Some of our most acute agricultural problems originate from insect depredations or from plant diseases

transmitted or stimulated by insects. The control of insect pests depends upon effective and cheap insecticides and fungicides. Research work on the chemistry of insecticides and fungicides therefore has tremendous economic significance. This is recognized by the bureau as one of its most important fields of activity, which is being developed and expanded as rapidly as possible.

A study is being made of foliage injury by arsenicals and other insecticides and fungicides in order to develop spray materials which, while acting in an efficient manner, may be applied to tender foliage without injury. Owing to the importance which calcium arsenate has assumed in the dusting of cotton for control of the cotton boll weevil, an extensive investigation of the physical and chemical properties upon which its effectiveness in a measure depends is being made. The field work conducted at Tallulah, La., during the year has resulted in two achievements of importance—the development of a quick test for detecting high water-soluble arsenic in commercial calcium arsenate, and the discovery that the dew on cotton plants contains relatively large quantities of plant exudate, which compounds, in the presence of moisture, decompose calcium arsenate, thus affording a possible explanation of many cases of unanticipated plant injury which have been observed in the dusting of cotton.

The demand for calcium arsenate for boll-weevil control has had the effect of greatly increasing the price of arsenic and arsenicals. This is now a serious matter for fruit growers and others using arsenic in some form for the control of insect pests, and it is likely to develop into a more serious one. Work is being actively prosecuted in the chemical technology of arsenical production for the purpose of discovering methods for lowering the cost of production. Some very suggestive results have already been obtained. During the year Department Bulletin 1115, *Chemical Changes in Calcium Arsenate During Storage*, was published.

An investigation to determine the effect of copper sprays in increasing the yield of potatoes and the effect of such sprays on the composition of potato tubers and to determine the absorption and distribution of copper in sprayed plants has been completed. The copper sprays were shown not only to increase the yield of potatoes but also to produce potato tubers having a higher percentage of solids; that is, more starch and nitrogenous compounds. The results of this study are given in Department Bulletin 1146, *The Influence of Copper Sprays on the Yield and Composition of Irish Potato Tubers*.

The relative toxicity of a number of arsenicals to several species of insects was determined, and the results were reported in Department Bulletin 1147, *Chemical, Physical, and Insecticidal Properties of Arsenicals*.

An investigation, in cooperation with the Bureau of Entomology, of the toxicity of a number of the active constituents of plants and synthesized organic compounds as contact insecticides was conducted. The results of this work are reported in Department Bulletin 1160, *Studies on Contact Insecticides*.

Research to develop a contact insecticide as a substitute for nicotine has resulted in the synthesizing of two new compounds, derivatives of pyridine, which are highly toxic to certain insects. Work with these compounds is being continued and the development of methods

for their economical production on a commercial scale is being studied.

An extensive investigation is being made of fumigants for treating insect-infested grain in storage and in transit, in order to find a substitute for carbon disulphide, the use of which has been prohibited by the railroad officials of the United States on account of the fire hazard. About 250 fumigants have been tested.

Fumigating food products with hydrocyanic acid gas for the destruction of insects is now very widely practiced. In order to determine whether or not they may be rendered unfit for human consumption, a great variety of such fumigated products have been analyzed and the quantity of hydrocyanic acid remaining in them under different conditions of treatment has been determined. This work is reported in Department Bulletin 1149, Absorption and Retention of Hydrocyanic Acid by Fumigated Food Products. The work is being continued and extended to include domestic and imported dried and preserved fruits, candy, nut meats, etc.

A detailed chemical and microscopical study of oil emulsions, used for insecticides, particularly emulsions of kerosene with sodium oleate, potassium stearate, and palmitate, has been completed, and the results are published in the Journal of the American Chemical Society, for July, 1923, under the title "Emulsions of mineral oil with soap and water: The interfacial film."

In cooperation with the Bureau of Entomology, a project for the control of flies infesting domestic animals was continued during the year. A preliminary report, entitled "Progress report of investigations relating to repellents, attractants, and larvicides for the screw-worm and other flies," was published in the Journal of Economic Entomology for April, 1923.

PREVENTION OF PLANT-DUST EXPLOSIONS AND COTTON-GIN FIRES.

Investigations to determine the causes of dust explosions and the circumstances favorable to their origin are being made. Although the general scope of the investigations is confined to grain handling or milling operations, in some instances it has been possible to study dust explosions in other types of industries. As a result of the investigation of a large number of explosions, it may be definitely concluded that under certain conditions dust explosions can occur in any industrial plant or manufacturing establishment where combustible dust is created during the operating processes. The importance of this work is more fully realized when it is considered that over 21,000 establishments in the United States, manufacturing products with an annual value in excess of \$6,000,000,000, are subject to the dust-explosion hazard.

Special studies are being made to determine the practical possibility of installing an effective dust-collecting system for the control of the explosive dust created during the handling and storing of grain in terminal grain elevators.

The investigations have been planned not only to study installations of dust-collecting and ventilating systems, but to ascertain the lower explosive limits of the industrial-plant dusts that have caused these explosions, and then to determine whether or not the present systems are adequate. This has necessitated the establishment of a dust explosion laboratory in the bureau, the function of which may

be conceived as being of a twofold nature, (1) to carry on a type of research work which industrial and agricultural industries, State safety commissions, insurance associations or individuals can not perform, on problems of a physical-chemical nature, for the prevention and control of dust explosions, with the development of the proper instruments and devices for this purpose, and (2) to render expert advice, after proper testing, on the explosion hazards of dusts and powdered materials submitted by the agencies mentioned.

Instruments to determine the quantity of dust in the air are being devised. Determinations of the percentage of combustible and non-combustible constituents of dusts are made.

The bureau cooperates with national and commercial organizations interested in the reduction of fire and explosion losses, such as the National Fire Protection Association, National Safety Council, National Board of Fire Underwriters, Underwriters' Laboratories, Chamber of Commerce of the United States, and State industrial and welfare commissions.

Fires in cotton gins and cottonseed-oil mills.—As a result of investigational and experimental work at cotton gins in the Southwest during the 1922 ginning season, an improved and simplified grounding system for the control of static electricity during ginning operations was devised. The results of this work were published in Department Circular 271, Grounding Cotton Gins to Prevent Fires. Negotiations for the complete recognition of the effectiveness of the grounding system recommended were undertaken with the State Insurance Commission of Texas and various companies underwriting cotton gins in that State. As a result it is expected that the insurance rates on gins in Texas will be further revised, provided the gins are adequately grounded. Such recognition has already been given in a number of Southeastern States.

Preliminary investigations relating to a study of fires in cottonseed-oil mills were conducted during the early part of the milling season. Reports were received of approximately 20 fires in southern cottonseed-oil mills, with a loss aggregating \$900,000. Approximately two-thirds of these fires occurred in Texas oil mills.

Explosions and fires in threshing machines.—Further recognition of the dust-collecting fans developed by the department, in cooperation with various manufacturers of threshing machinery, has resulted in a natural saving to farmers in rates for insurance. Insurance rates for the 1923 season in the State of Washington were reduced an additional \$2 per \$100 of insurance for grain threshing machines fully grounded and properly equipped with an effective fan. The original rate in the Pacific Northwest was approximately \$11 per \$100, while the new rate made effective June 21 is \$7 per \$100, a reduction of \$4 per \$100. Arrangements have been made for the manufacturing companies to construct fans embodying the specifications worked out by department engineers, and the bureau is cooperating with the State fire marshal of Washington and other State officials in this work.

DEHYDRATION OF FRUITS AND VEGETABLES.

Under an authorization for the study and improvement of methods of dehydrating materials used for food and to disseminate

information on the value and suitability of such products for food, work has been continued in the development and improvement of a food-dehydration industry.

During the year experimental work on the dehydration of spinach was carried on. Ten tons of green spinach was dehydrated and distributed as samples and sold. The comments upon the quality of the product have been entirely favorable. While it is too early to report upon the keeping quality of the dehydrated product, it had a better color than that usually found upon the market. A careful study of the cost of material and of manufacture indicates that an industry in dehydrated spinach could be carried on satisfactorily in some parts of California where the dehydrator may be used for fruit when not drying spinach.

Experimental work was done in dehydrating cull oranges. About 2,700 pounds of dehydrated oranges was obtained from 10 tons of fresh material. This fruit was cull material and showed approximately 50 per cent waste. Some work was done on both cauliflower and onions, the results bringing out special problems which need further investigation before methods can be recommended for the utilization of the surplus crops of these vegetables. Attention was also given to methods for dehydrating cherries and rhubarb. A bulletin on dehydration, giving the data obtained from the experimental work, is in course of preparation.

IMPROVING PRODUCTION OF ROSIN AND TURPENTINE.

Naval stores of which turpentine and rosin are the most important, are farm and forest products that enter commerce in the form of paints, varnishes, soaps, paper and textile sizes, polishes, and innumerable other manufactured articles. Twenty-five million dollars' worth of turpentine and rosin are thus used in this country each year and quantities of approximately the same value are exported annually.

The investigations of methods of producing, weighing, handling, and grading and of the uses of rosin and turpentine have been continued.

The work is along two general lines: (1) Research on the properties of turpentine and rosin to determine the characteristics that control their adaptability to various uses, on improvements in methods of using turpentine and rosin, and on the differences between similar products made from the oleoresin or gum of the living tree and those made by steam or destructive distillation of pine wood; (2) laboratory and field studies on improvements on the methods of producing, packing, handling, shipping, and grading these commodities and other less important naval stores derived from the pine tree, as well as a study of the adulteration and methods of analysis, detecting the extent of adulteration, and the formulation of specifications for naval stores. Statistics are collected annually on the consumption of turpentine and rosin in the various industries and on the stocks held by consumers and by dealers and jobbers at the principal distributing points of the country. These statistics are published each year jointly with the statistics of the Bureau of the Census on production and stocks held by producers, in the preparation of which the Bureau of Chemistry assists.

Much work was done in perfecting the type samples for naval stores. Like rosin, turpentine is graded on the primary markets on its color, and preliminary standards for the various grades of turpentine have been prepared. Several sets of these standards are now in the hands of the trade for trial and comment. In order to make sure that the standard rosin types, which are now, under the naval stores act, the United States rosin standards, are kept in perfect condition, all sets have been recalled from the depositories, thoroughly overhauled, calibrated, and redeposited. This work must be done every year.

Demonstrations were made of improved processes for preparing rosin and turpentine. The bulk of the naval stores produced in this country is made at smaller places, owned in many instances by farmers in the Southern States. The naval stores industry is thus largely a plantation industry, where the possibilities for financial loss through wasteful methods of operation, insufficient and incorrectly designed equipment, poor location of plant, and faulty handling of the finished products are numerous. Most of the demonstration work is done in the field by an experienced naval stores man, who visits the naval stores places and demonstrates better methods of production and the elimination of wastes as adapted specially to the still under consideration.

COLOR, MEDICINAL, AND TECHNICAL INVESTIGATIONS.

The Bureau of Chemistry maintains a laboratory and a small experimental factory at the Arlington Experimental Farm to do the work authorized in the appropriation act as follows, "For investigations and experiments in the utilization, for coloring, medicinal, and technical purposes, of raw materials grown or produced in the United States."

INVESTIGATION OF COLOR SUBSTANCES.

The investigation of color substances is directed along lines which will help the manufacturer of dyes and intermediates to acquire better control of factory processes and to improve the quality of the products. This is accomplished by undertaking exhaustive studies on the physical and chemical properties of the crudes, intermediates, and dyes, and on those basic reactions which have a bearing on the whole industry. Special emphasis is placed on the development of new or improved methods of analysis for the detection and determination of the intermediates. The laboratory is well equipped with apparatus for production and tests on a semi-manufacturing scale, with which uniform batches of the substances studied may be obtained, and with which new processes may be studied on a larger scale than is possible in an ordinary laboratory. Cooperation not only with manufacturers but also with users of dyestuffs is encouraged to the fullest extent. Upon occasion the laboratory will produce special dyes which are needed for important work and which are not obtainable elsewhere, until a manufacturer can be interested in their production. The function of this laboratory is to aid in a stimulative, noncompetitive way the development of the American dye industry.

During the year the work included the standardization of biological stains used to identify disease organisms. The chemical

examination of the stains for identity, purity, and color strength is made. An improved method for the purification of tolidine was worked out. A process for the purification of benzidine also has been developed. A critical study is being made of the sulfonation of hydrocarbons, both by the old batch processes and by the continuous vapor phase process developed in this work. A paper giving the results of work on the sulfonation of cymene is in course of publication. Work was done on sulfonated indigotine, on dyes derived from cymene, on metallic salts of direct dyes, on the absorption curves of the permitted dyes, and on water of crystallization in dyes.

During the year 510,586 pounds of coal-tar colors were certified as suitable for use as food colors. Manufacturers of food products are recognizing more and more the value of certified colors, and the number of firms manufacturing such colors is steadily increasing, as is also the quantity of color offered for certification.

During the year 12 articles giving the results of the work in the color investigation laboratory have been published and 5 public-service patents have been granted on processes developed.

FURFURAL EXPERIMENTS.

Investigations on the manufacture of furfural and adhesives from corncobs and other crop wastes have been practically completed. A little further work is necessary on the development of certain uses for furfural, and to complete the preparation of the results for publication. Practical methods for the manufacture of furfural and adhesives from corncobs and other crop wastes at a comparatively low cost have been developed. Furfural has not been extensively used heretofore in the technical arts, because the cost of production was too great. It can now be manufactured at a cost that indicates that it may be used rather extensively as a substitute for formaldehyde in making synthetic phenol resins of the Bakelite type, as a paint and varnish remover, as an intermediate, with amines, in the production of soluble resins for varnishes and lacquers, as a repellent for the blow-fly, and as a possible intermediate in the production of mucic and pyromucic acids.

Work on the manufacture of adhesives from corncobs has been previously reported.

WORK FOR OTHER DEPARTMENTS.

Under an authorization for collaboration with other departments of the Government desiring chemical investigations, whose heads request the Secretary of Agriculture for such assistance, the Bureau of Chemistry does a great variety and volume of work, ranging from the testing of supplies furnished on contract to see that they comply with specifications to serving as a consulting expert on chemical problems.

Assistance is given the Post Office Department in developing cases involving the fraudulent use of the mails for the sale of fake medicines and appliances falsely claimed to cure diseases. Analyses are made of drugs, cosmetics, depilatories, fat reducers, poisons, narcotics, and commodities suspected of containing harmful agents. Assistance is also rendered the Post Office Department in collecting and preparing evidence for court cases where technical subjects are

involved, and expert testimony is furnished at hearings and in court cases. The sale of certain fraudulent remedies can be checked more effectively in some instances under laws administered by the Post Office Department than by action under the food and drugs act.

Several departments of the Government receive expert assistance in preparing specifications for the purchase of foods, drugs, chemicals, leathers, leather goods, paper, waterproofing materials and fabrics that have been waterproofed, rosin, turpentine, and the like, since specialists working on these commodities are available in the Bureau of Chemistry. Tests and analyses are made of samples of shipments of these commodities, which have been delivered on contract, in order to determine whether or not they comply with the specifications under which they were purchased. Practically all laboratories in the Bureau of Chemistry do testing and analytical work for other departments of the Government. The work of testing foods and drugs for the Army and the Navy is especially voluminous.

Paper investigations have been made to assist the Federal Specifications Board in the preparation of specifications, on the improvement of methods of examination and on the study of fruit and vegetable wrapping paper, and to assist the Joint Committee on Printing of Congress and other departments in the examination and preparation of specifications for papers. Three publications on these subjects have been prepared.

The specialists of the Bureau of Chemistry are constantly called upon by departments and independent establishments of the Government for advice regarding problems involving a knowledge of the science of chemistry. Because of the comparatively large number of chemists in the organization and the wide range of subjects covered by the work of the bureau, it is possible to furnish information and advice on a great variety of problems. This service makes it unnecessary for chemical laboratories to be maintained in a number of departments which have considerable chemical work to be done. The cost of maintaining small individual laboratories in several departments would be much greater in the aggregate to the Government than the cost of having the work done in the Bureau of Chemistry as an incident to its other chemical work.

ENFORCEMENT OF REGULATORY LAWS.

TEA INSPECTION ACT.

During the last fiscal year, 96,267,920 pounds of tea was examined for quality and purity at the ports of entry. Of this quantity 277,104 pounds, or 0.29 per cent, was rejected. This represents the smallest percentage of rejections in the last 12 years. Of the total quantity rejected, only 2,440 pounds was rejected for purity and this occurred in the case of a China green tea. All the other rejections were for quality.

The most noticeable increase in quantity imported was of Japanese green teas, of which more than 25,000,000 pounds was imported, as compared with about 17,000,000 pounds imported during 1922. The importation of China black teas was nearly twice that of the previous year, but there was a great decrease in the importation of China green teas. Of the total quantity offered for entry during

the year, 52 per cent was black tea, 35 per cent was green tea, and 13 per cent was Oolong tea. Japan, including Formosa, furnished approximately 38 per cent of the total; China, 15 per cent; India and Ceylon, 36 per cent; Java and Sumatra, 10 per cent; and other countries, about 1 per cent.

The largest rejections occurred in the case of Japanese green teas, owing to the fact that the rejected teas contained "woody floaters." The Japanese Government has already taken steps to regulate the manufacture of their teas so as to prevent a recurrence of this condition. The next largest rejections occurred in the case of Congou teas. The reason for this was that many old Congou teas had been mixed with the new crop and were so predominant in the mixtures that the teas were rejected on account of quality.

Table 1 shows the results of the examination of teas in the tea-inspection districts.

TABLE 1.—Results of examination of imported teas.

| Point of examination. | Tea examined. | Tea passed. | Tea rejected for quality. | Tea rejected for purity. | Tea rejected for purity and quality. |
|-----------------------------|----------------|----------------|---------------------------|--------------------------|--------------------------------------|
| | <i>Pounds.</i> | <i>Pounds.</i> | <i>Pounds.</i> | <i>Pounds.</i> | <i>Pounds.</i> |
| Boston..... | 16, 559, 221 | 16, 551, 853 | 7, 368 | ..... | 7, 368 |
| Chicago..... | 5, 075, 454 | 5, 059, 043 | 16, 411 | ..... | 16, 411 |
| Honolulu ¹ | 57, 128 | 57, 128 | ..... | ..... | ..... |
| Puget Sound..... | 11, 657, 731 | 11, 654, 961 | 2, 770 | ..... | 2, 770 |
| St. Paul..... | 1, 314, 199 | 1, 313, 800 | 399 | ..... | 399 |
| San Francisco..... | 11, 977, 661 | 11, 950, 328 | 27, 333 | ..... | 27, 333 |
| New York..... | 49, 626, 526 | 49, 403, 703 | 220, 383 | 2, 440 | 222, 823 |
| Total..... | 96, 267, 920 | 95, 990, 816 | 274, 664 | 2, 440 | 277, 104 |

¹ Includes examinations made in May and June. Before May teas imported at Honolulu were examined at San Francisco.

NAVAL STORES ACT.

The enforcement of the naval stores act, which was signed by the President on March 3, 1923, and went into effect June 1, 1923, has been assigned to the Bureau of Chemistry by the Secretary of Agriculture.

The act defines and establishes classes and grades for the several kinds of turpentine and of rosin, makes the rosin types prepared by the Bureau of Chemistry the United States official standards for rosin, authorizes the Secretary of Agriculture to revise or make new standards, requires the sale in interstate and foreign commerce of all turpentine and rosin under the standards provided, makes unlawful the use of words, parts, or derivatives of words resembling "turpentine" or "rosin," or of any misleading or false word or words in advertising, offering for sale, shipping, or selling anything which is not naval stores of the standards provided in the act. The law also authorizes the Secretary of Agriculture, upon request of interested persons, to examine and grade naval stores and to issue a certificate showing the analysis, classification, or grade, which certificate shall be prima facie evidence in any court. For this service the Secretary is authorized to make a charge intended to cover the cost of such work.

No funds have so far been provided for the enforcement of the act. Work on the preparation of regulations under the act is being done,

an organization for its enforcement is being created, and much correspondence on the subject is being conducted.

FOOD AND DRUGS ACT.

The report for the fiscal year ended June 30, 1922, referred briefly to the installation of the project system for the enforcement of the food and drugs act. The project system involves the formulation of a comprehensive and unified plan of operations for the entire field force, directed against specific classes of products which experience has shown to be most likely to be found in violation. Upon the completion of a campaign upon any type of products a detailed report covering the entire field of operations is prepared. A comparison of the reports for succeeding fiscal years furnishes a ready means of determining how successful the efforts have been to bring about a compliance with the requirements of the law. Such a comparison of reports made during the last year shows encouraging improvements in conditions in some classes of products, while in others continued regulatory activity is obviously necessary.

Experience in the enforcement of the food and drugs act has shown that where violations in staple foods are encountered the objectionable conditions are as a rule readily demonstrated to the courts and therefore easily corrected. Violations involving the less important food products are frequently of a more intangible character, difficult to establish by the usual court procedure, although they usually result in very real financial loss to the purchaser.

Because of this condition an apparently disproportionate amount of the time and energy of the regulatory force must be devoted to the nonstaple food products. In the knowledge, however, that adulteration and misbranding, if existent in the staple foods, are likely to have a most serious effect upon the public welfare, the bureau has given special attention to these types of foods.

Flour.—The report for the last fiscal year made brief reference to actions against shipments of flour. Many shipments, especially those moving to the western section of the United States, were short in weight or contained excessive moisture. The weight shortages and moisture excesses observed were greater than could be accounted for by normal changes during shipment and in the aggregate represented very serious losses to the consignees. The campaign of seizures begun last year was therefore continued, with the result that with few exceptions flour of full weight and standard moisture content is now being shipped.

Butter.—For several years attention has been given to interstate traffic in butter and action has been taken against many shipments which were high in moisture, low in butterfat, or short of the declared weight. The difficulty of enforcing the law as applied to butter has been very greatly lightened by the passage at the last session of Congress of an act establishing a standard for butter, which fixes 80 per cent as the minimum butterfat content. During the year 64 seizures against adulterated and misbranded butter and 117 criminal prosecutions were instituted.

An interesting and unusual feature of the work was the discovery that a concern in Jersey City, N. J., was adulterating butter with coconut oil or other foreign fat and shipping it to Philadelphia.

Seizures were promptly made, as a result of which the offending firm discontinued operations.

Eggs.—Continued work was performed on interstate shipments of shell eggs. The educational work by Federal and State officials in having eggs candled as near as possible to the place of production has done much to eliminate decomposed eggs from interstate commerce. This year a decided improvement in the quality of the eggs shipped was noted in several sections of the United States. Forty-nine prosecutions and 44 seizures were instituted during the year, because of the shipment of decomposed eggs.

In recent years the traffic in frozen and dried eggs, which are used extensively by hotels and bakeries, has assumed large proportions. The quality of the eggs used, as well as the sanitary conditions under which the dried or frozen products were prepared, has been investigated. Careful inspection of the large quantities imported was made at ports of entry, in order to exclude the consignments unfit for food or otherwise adulterated or misbranded. Four prosecutions and seven seizures were made during the year because of the interstate shipment of adulterated frozen eggs.

Salmon.—A discouraging phase of the regulatory work has been the persistent practice by certain packers of canning decomposed salmon. Seizures of 86 shipments of canned salmon were made and 10 criminal prosecutions were inaugurated during the year. The marketing of this type of product, notwithstanding the bureau's previous activity, indicates a degree of deliberation or extreme negligence on the part of some packers which calls for continued and intensive regulatory activity.

Jams and jellies.—The investigational work alluded to in the last report for the development of methods for the analysis of products labeled as fruit jams and jellies, which contain excessive added pectin and are deficient in fruit, has progressed to a point where it has been possible to take action against many shipments of such products. Thirteen prosecutions and 38 seizures were developed during the year.

Attention was centered chiefly on jams and jellies made with excessive quantities of added pectin which were labeled as true fruit products. In some instances so-called fruit jellies were found to be made wholly of pectin, sugar, water, citric or tartaric acid, and artificial color, containing no true fruit or fruit juice. In other cases products contained some true fruit, varying from a quantity sufficient for coloring only up to quantities barely sufficient to convey a faint fruit flavor.

The bureau's activities on these products have been met in a gratifying manner by the trade. The seizures have so far been adjusted without contest by the entry of consent decrees and release under bond, for appropriate relabeling. Furthermore, there has been a very general adoption of new and informing labels. The campaign has thus largely eliminated unfair competitive conditions heretofore existing and has in great measure insured the purchaser against fraud and deception.

Slack-filled canned goods.—A can of food in which water, brine, or sirup in excessive quantities has been substituted for the food which the can purports to contain is said to be "slack filled." Such an article is adulterated, in that a liquid has been substituted in whole

or in part for the article. From time to time the bureau has issued service and regulatory announcements giving the weights of certain foods, exclusive of liquid, which cans of different sizes should hold. During the year many seizure actions were directed against this form of violation, especially against canned shellfish. Several seizures of slack-filled canned vegetables were also made. As none of these actions have been contested, it is to be anticipated that the packers of the goods in question will in future market full-packed cans.

Imitation fruit beverages.—Reference has been made to violations occurring in nonstaple products which are difficult to demonstrate but which result in imposition upon the purchaser. In this class are the so-called fruit beverages and fruit beverage sirups, which of late years have been widely distributed under labels implying that they are largely or wholly of fruit origin. These products frequently owe their distinctive flavors to synthetics and contain little or no real fruit ingredient. Interstate traffic is restricted almost entirely to the concentrated sirups from which the finished products are manufactured. The bureau has therefore been able to proceed by seizure only against the concentrates, leaving to State or local officials the task of making sure that the finished beverages as locally distributed are properly labeled. The seizures which have been made have led to a satisfactory revision of the labels used upon interstate shipments of many of the beverage concentrates.

SUMMARY OF PROSECUTIONS AND SEIZURES.

Table 2 indicates the magnitude of the regulatory operations undertaken throughout the year, which can not be given in detail in a short report.

TABLE 2.—*Summary of prosecutions and seizures.*

| Product. | Prosecu- tions. | Seizures. | Total. | Product. | Prosecu- tions. | Seizures. | Total. |
|--------------------------------------|--------------------|-----------|--------|---------------------------------|--------------------|-----------|--------|
| Baking powder..... | 1 | ..... | 1 | Meal (corn)..... | ..... | 1 | 1 |
| Beverage sirups and flavors..... | 7 | 7 | 14 | Meat products..... | 3 | ..... | 3 |
| Butter..... | 117 | 64 | 181 | Milk (evaporated)..... | ..... | 4 | 4 |
| Cacao products..... | 5 | 11 | 16 | Nuts..... | 3 | 44 | 47 |
| Colors..... | 1 | 2 | 3 | Oils..... | 183 | 23 | 206 |
| Confectionery..... | 4 | 3 | 7 | Olives..... | ..... | 2 | 2 |
| Drugs (crude)..... | ..... | 3 | 3 | Pickles..... | ..... | 5 | 5 |
| Eggs: | | | | Potatoes..... | 8 | 11 | 19 |
| Frozen..... | 4 | 7 | 11 | Remedies..... | ..... | 146 | 146 |
| Shell..... | 49 | 44 | 93 | Spices and condi- ments..... | 7 | 6 | 13 |
| Feeds..... | 53 | 51 | 104 | Sugar and table sirups..... | 1 | 1 | 2 |
| Fish: | | | | Tea..... | 6 | ..... | 6 |
| Canned..... | 14 | 102 | 116 | Vanilla beans..... | ..... | 1 | 1 |
| Shell..... | 56 | 86 | 142 | Vegetables (canned) | 26 | 33 | 59 |
| Flour..... | 1 | 33 | 34 | Vinegar..... | 11 | 51 | 62 |
| Food flavors..... | 17 | 5 | 22 | Water..... | ..... | 1 | 1 |
| Fruits (fresh, canned, dried)... | 29 | 44 | 73 | | | | |
| Gelatin..... | 2 | ..... | 2 | Total..... | 621 | 829 | 1,450 |
| Jams, jellies, and preserves..... | 13 | 38 | 51 | | | | |

WORK OF STAFF LABORATORIES.

As a supplement to the statement of completed regulatory work which represents essentially the efforts of the bureau's field force, the work of the regulatory staff laboratories in Washington may be briefly recorded.

In addition to solving problems of a nonregulatory nature described elsewhere in this report, these laboratories collect data and study methods to be employed in applying the terms of the food and drugs act to products upon which necessary knowledge has been lacking.

FOOD CONTROL INVESTIGATIONS.

The investigation on the composition of egg noodles referred to in the last report was continued. The data obtained will be used in the application of the law to products deficient in egg solids.

A study of wheat flour, its manufacture, grading, and use, was continued. Special attention was given to methods for the determination of moisture in flour. About ninety commercial self-rising flours were analyzed chemically and microscopically and subjected to baking tests. Most of the samples examined were of satisfactory quality.

The sardine and clam packing industries in Maine and the oyster industry in New Jersey were investigated. The entire time of one chemist has been devoted to the development of chemical methods for detecting spoilage in canned salmon.

Considerable work was done on canned fruit and vegetables. The technique for the quick detection of small quantities of carminic acid, an added color in tomato products, has been perfected.

An extensive experimental pack of canned grapefruit was prepared by the Savannah and Porto Rico stations. This is now being examined and its keeping qualities in tin observed.

Authentic samples of malt extracts were analyzed, with a view to differentiating between an all-barley malt extract and one made in part from corn. The determinations made do not show any characteristic differences between the different kinds of extracts from a chemical standpoint. Much work was done on dairy products.

STOCK FOODS.

Studies to determine standards and definitions for various cattle feeds sold on the American market were continued. Attention was given to flour by-products and an information sheet on the subject was issued. Work was done on oat and meat by-products as feeds. Studies on the milling of buckwheat and barley are under way. An investigation of the manufacture of precipitated bone and of its merits as a mineral constituent of mixed feeds was made. A method for determining the presence of starch in linseed meal and similar materials containing interfering polysaccharides has been developed and published. A study of the composition of grain sorghums was completed.

Work on the utilization of waste by-products as cattle foods was continued. Department Bulletin 1166, *Apple By-Products as Stock Foods*, has been issued.

MICROBIOLOGICAL INVESTIGATIONS.

An investigation of oyster spoilage was made. Because of the perishable nature of oysters and the fact that they are often shipped for long distances, studies were made to determine the effect of time, temperature, and methods of handling upon the keeping quality of

shucked oysters, as well as the nature of the spoilage, the numbers and kinds of bacteria present in decomposing oysters, and the criteria by which it is possible to determine whether oysters are fresh, stale, or sour. The results of the investigation to date indicate that a test for hydrogen-ion concentration of the oyster liquor may supplement the organoleptic examination in determining the quality of shucked oysters. It is also indicated that a determination of the total numbers of bacteria present in decomposing oysters is of no value in judging the quality of oysters.

In work on the classification of bacteria in food products, a new method for separating the several sections or subgroups of the colon group of bacteria has been found. This method has been applied to a large series of cultures collected from soils and from fecal specimens in order to determine its usefulness in differentiating the fecal cultures from those of nonfecal origin. At present the application of this method to the estimation of the sanitary quality of water is being studied. Two papers giving the results of this work are now in press. It is believed that the continuation of this work will simplify and improve the methods used in the identification of pollution organisms in water supplies.

Work on a comparative study of the floras of spoiled canned foods was continued. Several cultures from food-poisoning outbreaks were collected and studied. A rather large collection of type cultures of *Bacillus botulinus* and of the para-typhoid-enteritidis group have been kept in stock.

A study of the biological factors in the deterioration of forage and feeding stuffs is under way. The possible agency of pure cultures of particular molds in animal disease is being tested in feeding experiments. Later it is proposed to deal with mixed cultures. In this way it may be possible to determine to what extent spoilage in feeding stuffs becomes a source of loss of domestic animals.

Cultural studies of *Penicillium* and *Aspergillus* and species of related genera were continued. The large collection of mold cultures maintained now includes about 900 numbers, representing species and strains obtained from widely different sources. During the year 238 cultures were furnished to correspondents for the identification and verification of molds.

The many data accumulated during the cultural work under this project, now in its twentieth year in the department, necessitated a restudy of the basis for nomenclature in the groups *Penicillium* and *Aspergillus*. This monographic undertaking has reached the form of a preliminary manuscript, but it will require one or more years for completion, since it is carried on in the intervals between other work.

During the year work was continued upon fermented foods—the methods of their preparation and preservation and a study of the organisms concerned in such fermentations. Fermentation of cucumbers raised at the Arlington Experimental Farm was continued, special attention being given to the relation which the quality of the cucumbers bears to the resulting pickles. Additional studies were made on the bacterial spoilage of pickles during fermentation. Cabbage was also fermented and sauerkraut was canned experimentally, on the basis of both a household and a commercial product.

Special attention was given to determining the cause of swells in canned sauerkraut and the proper procedure in canning to prevent this difficulty and at the same time produce the most desirable product. In this work No. 3 cans, subjected to a 10-minute exhaust in steam during the canning process without further processing, were sterilized. They were much less subject to swell than were cans handled in the ordinary commercial manner, which usually includes a very short exhaust and a very short process in the retort. Cans handled in the ordinary commercial manner were found to be unsterile and in most cases produced gas and corroded the metal of the container.

The work done upon soy sauce fermentation was published as Department Bulletin 1152, Soy and Related Fermentations.

MICROCHEMICAL INVESTIGATIONS.

An investigation of decomposition in filberts imported from Italy was made. Experimental work was continued on the decomposition of small fruits, especially cherries and strawberries, both in the field and in the laboratory. The manufacture of apple butter was studied and a general survey of apple butters on the market was made, with a view to determining the quality of the various materials employed. An investigation of the pollen in honey was continued. Investigational work is in progress to determine what effect the fineness of the grind has on calculating the quantity of cacao shell in cacao products. Work on tomato products was continued.

The method on the microscopical examination of flour referred to last year has been simplified and the new method is described in Department Bulletin 1130, Significance of Wheat Hairs in Microscopical Examination of Flour.

The results of a crystallographic study of the calcium oxalate crystals in official plant drugs have been published in collaboration with the Laboratory of Crop Chemistry.

The preparation of a table of optical constants of various organic crystalline compounds is in progress.

A large number of flour and feed mills in the Middle West have been visited to obtain information on the source and methods of handling grain by-products used in feeds. The handling of packing-house by-products was also studied.

WATER AND BEVERAGE CONTROL.

Sanitary surveys of certain springs from which mineral waters are sold were made. A method for the examination of imitation grape flavors was perfected. Several samples of alleged radioactive pads and of water and drugs, the labels of which bore statements that the products contained radium, were analyzed.

In the interest of the shellfish industry, trade waste surveys were made of the Housatonic River and the New Haven Harbor, Conn., in cooperation with the Bureau of Fisheries.

Methods were developed for the manufacture of flavoring sirups and extracts from cassina leaves. An investigation of the suitability of various solvents for extracting vanilla beans was begun.

DRUG CONTROL.

The work under the food and drugs act on drugs and medicinal products was reorganized during the year. An office of drug control was established to coordinate the entire work of the bureau on these products. This office will function in reference to drugs and medicines in the same manner that the food control laboratory functions with respect to foods. The chemist in charge will act as a staff adviser to the chief of the bureau in applying the provisions of the food and drugs act to drugs and medicinal products. Plans for the operation of this office now being formulated will be put into effect during the fiscal year 1924.

This office maintains a laboratory to work out special problems arising in connection with the chemical analysis of drugs, particularly with respect to the accuracy, adequacy, and adaptability of analytical methods to the various preparations to which they are to be applied. It is essential to know the conditions under which various analytical methods can be relied upon and what factors influence the results and to what extent. New methods for products for which no methods or only defective methods have heretofore been available, or for new medicaments which are continually being proposed, are essential to an adequate administration of the law as it relates to drugs.

The products coming within the scope of this office may be divided into four classes: (1) Crude drugs, including herbs, leaves, bark, roots, flowers, gums, etc.; (2) manufactured drug materials, such as synthetic preparations, inorganic compounds, extracts and fluid extracts of crude drugs, ferments, glandular extracts, and all other manufactured ingredients entering into the composition of medicines; (3) pharmaceutical preparations, such as hypodermic and other tablets, pills, medicines in capsules, wafers, etc., and all liquid and solid preparations having a recognized standard and intended for use as medicines without further manipulation; and (4) "patent medicines."

PHARMACOGNOSY INVESTIGATIONS.

Work to establish a scientific classification for plant species yielding mustard seed is under way. Seeds yielding this desirable condiment are similar and closely related to other seeds useful for fixed oil, but not for condimental purposes. This work, partly completed, deals in a comprehensive way with the anatomy and chemistry of the seed and the morphology of the plants. The chemistry comprises a study of the glucosides isolated and of the volatile oils yielded thereby. Thus, by establishing the definite chemical and anatomical characteristics of the seeds and the morphological characteristics of the plants, a satisfactory supply of seeds is assured. The methods of analysis have been materially improved and a new apparatus effecting uniform and efficient heat for the distillation of the volatile oils has been constructed. New species, mainly of oriental origin, have been made available for condimental and medicinal use and for fixed oil utilization.

Experiments on sublimation were conducted. Many plants and certain animal products used for medicinal, food, or other purposes contain substances of crystalline, sublimable nature. Some of these

substances represent the active constituents which usually must be isolated by involved methods of liquid extraction, precipitation, and purification. Less material, time, and money is needed if these substances can be isolated by sublimation. The quantity of material submitted for identification or examination is often limited. Attention has therefore been given to the development of sublimation. Extensive data on macrosublimation and microsublimation have been collected from the literature. Waste products of plant and animal origin have been examined, with striking success. It is found that the active substances usually can be obtained in a pure, or practically pure, state by fractional sublimation, preferably using diminished pressure. Apparatus for sublimation, microsublimation, and micromelting-point determinations, and an electrically heated oil bath have been developed.

A study was made of the occurrence and distribution of hydrocyanic acid or cyanogenetic compounds in plant products. Many products would be safely available for food or feed purposes but for the fact that they may develop hydrocyanic acid (prussic acid) in injurious quantities. One species (*Phaseolus lunatus*) yields many varieties of beans, all of which produce hydrocyanic acid upon maceration of the bean meal. Fortunately, domestic forms yield such small quantities that they can be consumed without danger. Many tropical varieties have been found to contain dangerous quantities. Detailed anatomical, chemical, and morphological data, which will be helpful in effecting an efficient control of the seeds, have therefore been collected. There is much evidence that the quantity of glucoside formed in the beans is an inherited factor and is characteristic of the particular strain.

Similar work is being carried out with seeds of bird's-foot trefoil, to be introduced by the Bureau of Plant Industry as an early forage crop. The plants tested thus far have yielded dangerously large quantities of hydrocyanic acid. The aim is to follow the procedure adopted in the study of *Phaseolus lunatus*, in the hope that strains of seed yielding such small quantities that the plants may be grown as a safe forage crop may be obtained.

It was found that the inert and objectionable material in crude drugs and spices can be removed effectively by selective siftings. A study was made of green and roasted coffee to develop means for the identification of coffee as to origin. During the year data were collected in connection with the revision of the United States Pharmacopœia and National Formulary.

PHARMACOLOGICAL INVESTIGATIONS.

The pharmacology of zinc, tin, and other heavy metals is being studied. Data which show the comparative toxicity of the metals are being collected. One of the purposes of this work is to develop new criteria by which toxicity may be studied and to make results of animal experiments more useful in setting food standards. A toxicity study of various arsenical insecticides was made. The results indicate that the insecticides can be considered practically as toxic as inorganic arsenious oxide. Results of work on the pharmacology of cadmium and zinc were published during the year.

Studies are being made of the pharmacology and toxicology of fat-soluble and water-soluble dyes which may be suitable as food colors.

IMPORTED FOODS AND DRUGS.

The joint regulations of the Department of Agriculture, the Department of Commerce, and the Treasury Department governing procedure on importation of goods subject to the food and drugs act were issued near the close of the fiscal year ended June 30, 1922. The past year has given opportunity to test these regulations in practice and they have been found satisfactory on the whole. In its import inspection the bureau is continually handicapped by the smallness of the force available to cope with the great volume of imports daily arriving at the larger ports, especially New York. In full appreciation that delays are costly to importers, every effort is being made to expedite inspections, and continued improvement in this respect may be anticipated.

REGULATIONS AND FOOD STANDARDS.

A revision of the rules and regulations for the enforcement of the food and drugs act of June 30, 1906, as amended, was issued during the year as Office of the Secretary Circular 21, eighth revision. This is the first complete revision of the regulations.

Upon the recommendation of the joint committee on definitions and standards, standards and definitions were published during the year for the following products: Ginger-ale flavor, ginger ale, cayenne pepper, oil of cassia, cacao butter, breads, condensed milk, butter, renovated butter, cacao beans, cacao nibs, chocolate, sweet chocolate, milk chocolate, cocoa, sweet cocoa, sweet milk cocoa, mustard, and mustard products.

The list of coal-tar colors admitted to certification for use in foods was amended by the addition of a green shade, Guinea green B.

COOPERATION WITH STATE AND CITY OFFICIALS.

The work of enforcing the Federal food and drugs act is greatly facilitated by close cooperation with State and city officials who are engaged in enforcing State laws and municipal ordinances relating to foods and drugs. Information developed by investigations made by Federal officials is often helpful to State and city food-control officials, and the State and city officials likewise furnish much information of value to Federal officials. Inspections of food factories are frequently made jointly by Federal and State inspectors. Some undesirable conditions in the distribution of food can be corrected more quickly and effectively under State than under Federal law. In other instances, the operation of the Federal law in connection with a particular form of adulteration may make regulatory action on the part of a State unnecessary.

The office of cooperation, which is maintained in the Bureau of Chemistry for the prime purpose of promoting effective cooperation among Federal, State, and city food and drug officials, has made gratifying progress in promoting team work.

INTERESTING COURT DECISIONS.

A number of appellate court decisions of outstanding interest were rendered during the year.

The Circuit Court of Appeals for the Ninth Circuit, in reversing the decision of the lower court against the Government in a case in which a shipment of salmon was libeled on the ground that it contained decomposed fish, defined the word "article" as used in the act and held that in a shipment of a food product in containers it is not necessary for the Government to prove that each individual can is adulterated.

In a seizure action brought against a product labeled as "Sparkling White Seal," which consisted of artificially carbonated apple juice flavored with capsicum, the Government alleged misbranding, holding that the name of the article and the general design and appearance of the bottled article simulated "White Seal Champagne." A verdict for the Government in the lower court was affirmed by the Circuit Court of Appeals for the Third Circuit, which held that evidence as to resemblance between the bottles and labels of the article in question and those used for champagne sold under the same name was a question of fact for determination by the jury.

The Circuit Court of Appeals for the Sixth Circuit reversed the decision of the lower court, which held that the label "Apple Cider Vinegar" constitutes a misbranding when used upon a vinegar made from evaporated apple products. A motion by the Government for a rehearing was denied, whereupon, with the consent of the Attorney General, proceedings were instituted with a view to a review of the case by the Supreme Court.

A consignment of coal-tar color offered for food purposes was seized on the ground that it was adulterated with salt and arsenic and misbranded in being labeled, "Warranted complies with all requirements." The verdict of the lower court upholding both charges was reversed by the Court of Appeals for the Seventh Circuit in so far as adulteration was concerned, but affirmed as to misbranding.

The Circuit Court of Appeals for the Sixth Circuit affirmed the judgment for the Government rendered by the district court in a criminal action brought against the manufacturer of a product known as "Eggno," represented to be a substitute for eggs in baking and cooking.

