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U. S. DEPARTMENT OF AGRICULTURE

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REPORT

OF

THE CHEMIST

FOR

1905.

BY

H. W. WILEY.

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## REPORT OF THE CHEMIST.

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U. S. DEPARTMENT OF AGRICULTURE,  
BUREAU OF CHEMISTRY,  
Washington, D. C., July 1, 1905.

SIR: I have the honor to transmit herewith the annual report of the work done in the Bureau of Chemistry during the fiscal year ended June 30, 1905, accompanied by a description of the work proposed for the present year.

Respectfully,

H. W. WILEY, *Chief.*

HON. JAMES WILSON, *Secretary.*

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### WORK OF THE YEAR, WITH RECOMMENDATIONS.

The investigations conducted by the Bureau of Chemistry during the fiscal year ended June 30, 1905, were largely along the same lines as are described in the report for the fiscal year ended June 30, 1904. The work of the Bureau continues to be of a widely diverse nature. The problems of a chemical nature which are regularly connected with the art of agriculture naturally receive first attention. These problems relate to the composition of fertilizers, the nutritive value of food, its adulteration, and the study of the technical processes dependent upon agriculture. The nature of these problems does not change from year to year, but their aspects are continually varying. New lines of investigation are opened up and new conditions are established. These variations in the aspect of the problems require a constant readjustment of the methods of investigation and the character of research best suited to solve the questions which are presented.

Of the technical problems of a chemical nature which have received special attention during the past year may be mentioned the industries relating to leather and paper making. The demands for leather with the increasing population and changes in the conditions of life make a corresponding demand upon those great industries which, in addition to furnishing the raw material of which the leather is composed, must supply the materials with which it is prepared for use. The tanning problem, therefore, assumes greater and greater importance, and special studies, as will be outlined farther on, have been made of tanning materials.

The character of the imported tanning materials has also received consideration. It is evident that in the near future the agricultural industries of the world must supply increasing quantities of tanning

materials, and these quantities can not be derived from the sources now available. The sources of the raw material must be increased and the tanning industry, instead of being simply dependent upon the stores which nature has provided in the forests and other places, must become an actual constructive industry, extending by artificial means the cultivation of plants which produce tannin and improving the technical applications which condition its use.

The source and supply of materials for paper making are also becoming a problem of great agricultural importance. The utilization of our forests for the manufacture of wood pulp has in the past few decades furnished an apparently inexhaustible supply of cheap and valuable material. It is true that paper made from wood pulp does not have the properties of paper made from linen or silk, and for certain characters of paper can not take the place of these materials, but for the ordinary purposes for which paper is used—such as the publication of newspapers and magazines, wrapping paper, etc.—the material made from wood pulp or straw pulp has proved reasonably satisfactory.

It is now realized, however, that the supply of wood pulp is not inexhaustible, and the utilization of other forms of cellulose for this purpose becomes almost a necessity. The investigations of this Bureau look not only to the supply and character of the product from these pulps, but also to their correct chemical treatment to secure their most economical application. In connection with these investigations an important investigation has been taken up relating to the quality of paper employed for the permanent records of the Government. Realizing that the cheaper papers made from wood pulp and other cheap materials have not the lasting qualities which are desirable in paper intended for permanent records, an investigation has been inaugurated of some of the older records of the Government for the purpose of comparing the composition of the paper on which they are printed with that which is at the present time used for similar purposes. The conclusion seems to be justified that at least some copies of every public document should be printed upon paper of superior lasting quality in order to preserve in a permanent shape—that is, as permanently as the best paper or parchment can secure—the records of governmental activity.

Directly connected with this problem, also, is the continued investigation of inks for printing purposes in connection with such written and printed documents. It is evident that an ink should be not only useful at the time of the publication of the writing, but, if intended for a permanent purpose, should not fade, oxidize, or disappear with advancing years.

The investigation by the Bureau during the year just ended into the character of drugs and chemicals has been of great practical as well as scientific interest.

One of the unfortunate circumstances connected with the almost universal use of drugs is found in the fact that the physician as a rule is not consulted in such matters. Representations of the virtues of remedies are made in such a way as to catch the eye, captivate the imagination, and lead to their use. There are thus placed within the reach of every citizen almost numberless drugs or remedies which are in a form to be purchased or used without the intervention of

the skilled physician and solely upon the whim or taste of the consumer. The most regrettable feature in connection with this condition of affairs is the fact that many of these remedies contain drugs which are of a character to induce a permanent and unfortunate habit of consumption. The danger which attends the use of drugs such as morphia, cocaine, chloral, chloroform, etc., is well known. Not less seductive is the presence of alcohol in remedies of this character. The result is that, even without the knowledge of the patient, an appetite for these drugs is established which may afterwards prove unconquerable. It is evident that drugs of this kind should be sold only under the strictest supervision of the State. Many of them are recognized as poisonous, and others when sold under their own names are subject to excise restrictions, both on the part of the General Government and of the States. It is therefore a loss of revenue on the part of the Government and a constant menace to the consumer to permit such drugs to be sold under fanciful names which do not reveal their character or quality and which lead the consumer to form the drug habit without at first any knowledge of the character of the drug consumed.

Investigations by this Bureau along this line during the past year have been very fruitful and extremely helpful to the Post-Office Department, which has appealed to this Bureau constantly for assistance in controlling the evils above referred to. Quite as important also in this respect have been the results of the examinations to secure purity of the drugs and chemicals employed in the Bureau for scientific purposes. The details of these investigations will follow.

The collaboration of this Bureau with other Departments of the Government has continued and increased during the past year. The beneficial results of having some central laboratory to which problems of various kinds connected with the general conduct of the affairs of the Government can be referred are becoming more and more evident. The establishment of special laboratories for the consideration of particular cases throughout all the Departments would entail vast expense and would institute a service which would be devoid of that unity of purpose and that directness of execution which attend a central laboratory.

The various problems which have been considered for the different Departments of the Government will appear in the proper place in this report. This work should be fostered and extended, not because of its special relation to agriculture—although many of the problems are of an agricultural nature—but because of the benefit which these investigations confer upon the Government at large.

The supervisory work which this Bureau exercised, at the request of the Secretary of the Treasury, over the polarization of the sugars at the various ports was terminated by the action of the Secretary of the Treasury December 31, 1904. This supervisory work had continued over a period of many years, and the results of the supervision were of the most favorable character. Before its institution the differences between the polarizations of the sugars at the various ports of entry were very pronounced, and at times approximated as much as 1 per cent. During the years in which this supervision was specifically exercised the agreement between the polarizations of the various ports became very close, rarely exceeding an average of one-tenth of 1 per cent per month, and often falling within that limit. The work above

referred to was transferred, at the request of the Secretary of the Treasury, to the Bureau of Commerce and Labor.

During the year the investigations of the Department respecting the growth, manufacture, and preservation of table sirups were continued at Waycross, Ga. A very elaborate investigation was also made under the same authority in regard to the purity of maple sugars and sirups manufactured in various parts of the United States. In connection with the manufacture and utilization of table sirups many intricate problems arise which can be answered only by an appeal to first sources. To this end, therefore, samples of the pure products were secured upon the certification of their manufacturers and subjected to a careful study in order that, if possible, some standard of purity might be reached.

Investigations by the Bureau of Chemistry respecting the effect of the different yeasts of pure cultures upon the chemical composition of cider have been continued with most gratifying results. It is evident, of course, that the flavor and general character of a beverage of this kind must depend upon its composition. In just what way, however, chemistry would associate the composition with the character of the product has not been entirely worked out. The object of the investigations has been not only to determine the value of pure-culture yeasts of different sources in producing a cider of value, but also to determine by the careful control of the fermentation and analyses of the raw and finished products the changes which have taken place in the composition of the article during the process. The enzymes secreted by the yeasts which produce the fermentation act as chemical reagents and the process of converting a fresh apple juice into a finished cider is a series of chemical reactions. These we have endeavored to trace in the work of the Bureau and to associate therewith the actual chemical composition of the cider and its food and condimental value. This is the character of a work which has been undertaken by chemists in other parts of the world, and one which should be extended to other food and condimental products.

An extensive investigation of the composition of cereals has been undertaken in connection with the Bureau of Plant Industry and has formed a very prominent part of the work of one section of the Laboratory of Plant Analysis during the past year. Important relations which exist between milling properties, nutritive value, and physical characteristics are disclosed in these investigations. Connected with these investigations are those specifically authorized by Congress in the study of American barleys in relation to their brewing qualities. Important progress has been made in this line of investigation, but it is necessarily one which requires a considerable time for its completion.

The investigation on the effect of environment upon the composition of the sugar beet, which has continued for a period of five years, has been concluded during the past year, and a detailed statement and a summary of the work prepared for publication. The results of this investigation show the relative importance of the various factors of environment in the production of a beet rich in sugar.

The collaborative work in connection with the Bureau of Animal Industry respecting the composition and character of renovated butter has been continued, and other studies of the chemical composition of dairy products have been conducted.



Important collaborative work has also been undertaken by the Bureau in connection with the Bureau of Plant Industry in the study of the quantity of hydrocyanic acid occurring in various species of cassava grown in Alabama and Florida. These data show a wonderful variation in the quantity of hydrocyanic acid present and lead to the belief that it is not a constant constituent, but that it is evolved and disappears in a somewhat continuous way during certain periods of the development of the plant.

The work in collaboration with the Bureau of Entomology in the study of insecticides has been continued, and in the same laboratory important investigations have been concluded respecting the composition of the mineral waters offered upon the markets in the United States for the general use of the consumer and for medicinal purposes.

The work of the Bureau in collaboration with the Association of Official Agricultural Chemists has been continued as usual. The officials and referees of this association have been made special correspondents of this Bureau in order to more certainly establish the organic relations which exist between the Department and this association, and which have been recognized by Congress in making this association the official adviser of the Secretary. The food standards committee of this association has held two meetings under the auspices of the Secretary of Agriculture to discuss the important problems relating to the standards of purity of food products. The first meeting was held in Washington in December, 1904, and the second in Chicago in May, 1905. At the former meeting the previous discussions which had been held before the committee were considered, together with the data submitted therewith, and additional standards were recommended for adoption and were promulgated by the Secretary.

At the meeting in Chicago the time was chiefly devoted to the hearings of the trade and experts on the proposed standards for edible oils, fruit products, and flavoring extracts.

During the year the experiments on the effect of preservatives, coloring matters, and other substances added to foods upon health and digestion have been continued. During the year formaldehyde and copper sulphate were subjected to a critical study, and additional investigations were made with salicylic, sulphurous, and benzoic acids. The data of these experiments are being prepared for publication as rapidly as their magnitude permits.

The inspection of imported food products has been considerably extended during the year. An additional laboratory was established in San Francisco, and the preliminary steps were taken for the establishment of laboratories at Boston, Philadelphia, New Orleans, and Chicago. Important modifications of the methods have been adopted with a view to facilitating the inspection, in order to avoid delay and to secure more speedy determination of the questions which are presented for solution. While there has been in some quarters considerable opposition to the execution of the law, it is satisfactory to know that the great majority of the importers as well as practically the whole body of consumers of our country heartily support the efforts of this Department to secure a high standard of purity and freedom from adulteration and injurious substances in imported food products.

Exporters from other countries have perhaps justly complained in some instances that the foods which they send to this country are subjected to more careful inspection than foods of a similar character manufactured in the United States. These statements are made as a rule by those who are not acquainted with our peculiar system of government and do not realize that the Congress of the United States has no authority to establish police regulations for the various States. The complaints of those in foreign countries who send food products to this country, however, would be modified and perhaps eliminated if Congress should establish a rigid inspection of food products entering into interstate commerce in this country, an inspection which practically would be the same as that required for imported food products. Were this accomplished, the inspection by this Department of imported food products and those offered for interstate commerce, supplemented by the thorough inspection on the part of the State authorities of food products manufactured and sold within the States, would secure for our people immunity from most of the frauds in food products to which they have been so long subjected.

While there are many things connected with the inspection of food products imported from foreign countries which might be improved, and which experience has shown to be inefficient, upon the whole the law has been effectual and no one has seen fit to deny its authority or restrict it by appealing to the courts. In the execution of the law an effort has been made to place upon the importer no undue restriction, to free him from every possible annoyance, and to facilitate in every possible way the speedy determination of all questions connected with the inspection.

The inspection of food products of American origin intended for export to foreign countries has not reached the magnitude which its value would warrant. Our exporters seem to prefer taking their chances with the regulations of the countries to which they send their products rather than to assure themselves before shipment that the products exported are satisfactory for entry into those countries. In a great many instances, therefore, during the past year exporters have appealed to our State Department for redress when the products which they have offered have been refused. This is a condition of affairs in which this Department is powerless to offer any aid to our exporters, since the law specifically requires that any inspection made by this Department shall be previous to exportation. It is believed that, as our exporters become better acquainted with the efficiency and purpose of the act authorizing the inspection of foods intended for export, they will, in greater numbers, avail themselves of the opportunity of securing from this Department a statement respecting the character of every exported food which may be submitted to the officials of the country to which the foods are sent.

The growth of the Bureau is such as to render necessary the securing of additional quarters, at least temporarily, pending the completion of the buildings now in progress, and steps have been taken looking to this end.

The clerical service of the Bureau has done efficient work during the year, but, owing to the peculiar difficulties of work of this kind in a chemical bureau, it has not always been possible to keep the work up to date. The correspondence of the Bureau constantly increases,

and, under present regulations, all requests addressed to the Bureau must receive not only consideration, but respectful answer. Very many of these requests seem to have no connection with the work of the Bureau, and yet they must receive attention.

In the preparation and compilation of the work of the Bureau for publication, special difficulties are encountered of a character which have made it desirable to secure clerical service in which a knowledge of chemistry is associated with the other qualifications necessary in this service. There has therefore been established by the Civil Service Commission a grade of chemical clerk, and during the year a number of persons have been appointed to service in this Bureau under certification of this kind.

In the work of the Bureau it is evident that a great part of the energy expended should be employed in the study of new problems, in the making of investigations. At the same time the Bureau endeavors to keep first in view the practical side of its work and to shape it so that it may prove of advantage to the American farmer and the American consumer.

#### DIVISION OF FOODS.

The study of the composition of fruit with special reference to the changes of composition during ripening and the different methods of storage has been continued in collaboration with the Bureau of Plant Industry. Samples of six varieties of peaches were taken at different stages of their growth and the composition was determined. In general, the plan of study and methods of examination were the same as those previously employed in the study of the ripening of apples. The results of this work are embodied in a bulletin which is now in press. A preliminary study was also made of the ripening of oranges and persimmons.

In connection with the study of the ripening of fruit considerable attention has been given to the composition of pectin bodies, and the results obtained serve to shed some light on the study of the so-called "ether-free extract" or carbohydrate bodies of agricultural products.

The materials precipitated by alcohol from second-pressing cider and from apple must were also studied and compared with each other and with the pecto-cellulose of the apple. The substance precipitated by alcohol from apple must is found to be very similar to that precipitated by alcohol from second-pressing cider, and both differ widely from the insoluble solids of the apple. It thus appears that the organisms present in the fermenting pomace have a very similar effect on the insoluble apple solids to that exercised by the natural forces of the fruit cell.

The Division of Foods has studied the chemical changes occurring during the manufacture of cider vinegar on a commercial scale. This study has been necessitated by the varying opinions of those interested in the subject regarding the composition of normal cider vinegar. A representative of the Division visited several large vinegar manufactories and obtained samples of the fresh apple musts, and also of vinegar made from them in different stages of its manufacture, first, in ordinary barrels, and, second, in a small generator patterned after the generators employed in the economical manufacture of vinegar.

In cooperation with the Drug Laboratory of this Bureau and in

collaboration with the Bureau of Fish and Fisheries of the Department of Commerce and Labor, the Division of Foods has undertaken a comprehensive study of the composition of cod-liver oil. The thirty-five samples of oil used in this study were prepared by the Bureau of Fish and Fisheries from fish obtained in several localities. Some of the results of this study were embodied in a paper on "Color tests of cod-liver oil," read before the meeting of the American Chemical Society and published in the journal of that society.

The Division has given considerable attention to the occurrence in nature of the chemical substances ordinarily used as food preservatives and to the various theories that have been advanced to explain the alleged presence of such preservatives in foods prepared without their addition. A number of common fruits were examined for the ordinary preservatives, with the result that, with the exception of benzoic acid in cranberries, no preservative was found in the natural fruit in sufficient quantity to lead to analytical error. The claim which has been recently advanced, however, that as much benzoic acid occurs naturally in the cranberry as is ordinarily added to other fruits for their preservation was found by this Division to be true. Samples of cranberries were, therefore, secured at various stages of maturity and the formation of benzoic acid was studied. This formation was found to begin with the appearance of color on the berry. It then increased somewhat slowly until the color was well advanced, after which it increased very rapidly until the picking time of the berry.

A study was also undertaken of the influence of the process of canning upon the content of chemical preservatives in canned goods and upon the reliability of the methods ordinarily used for detecting preservatives in foods. For this purpose several varieties of foods were prepared and canned by the ordinary commercial method after the addition of varying amounts of preservatives, and in some cases without the addition of any preservative. No reaction for preservatives was found in any case where preservatives were not added to the food before canning. In such cases the results of all experiments were clear and decisive. No reaction was obtained which should in any way confuse the experienced analyst. The examination of the food canned with varying amounts of preservatives has not been completed. In the case of formaldehyde, however, it was found that that preservative was largely destroyed by the process of canning.

During the last fiscal year, as heretofore, the Division of Foods has done an important work in studying and comparing analytical methods for the examination of foods. This work has been in connection with the Association of Official Agricultural Chemists, in which the chief of the Division of Foods is at present referee on food adulteration. It has also been influenced to some extent by the requirements of the regular work of the Division. As referee on food adulteration of the Association of Official Agricultural Chemists the chief of the Division of Foods has worked in collaboration with nineteen prominent food chemists in the United States and Canada; and in addition to this he and his collaborators, each in his special field, have had the collaboration of a much larger body of food chemists.

Among the contributions of the Division of Foods to this subject during the fiscal year may be mentioned the collaborative work on the Dalican titer test; on the cold test for oils; on the Belfield test for

the detection of beef stearin in lard, which were reported at the last meeting of the Association of Official Agricultural Chemists and published in the Proceedings of that meeting.

In addition to the preservative work mentioned above, considerable collaborative work was done with chemists of other food laboratories in the study of the methods ordinarily employed for detecting preservatives in foods. The results of this work were reported to the Association of Official Agricultural Chemists.

The study of methods for identifying and determining the relative amounts of nitrogenous compounds in meat extracts and other foods was continued and the results reported to the Association of Official Agricultural Chemists.

During the first three months of the fiscal year the entire time of the chief of the Division and that of two of his assistants was taken up with the exhibit of the Bureau of Chemistry at the Louisiana Purchase Exposition. This exhibit consisted of a working laboratory, illustrating the work of the Bureau of Chemistry.

A largely increased amount of time and attention has been devoted to the laboratory work relating to the enforcement of the law regarding imported foods. The manner of conducting this work has been changed during the last fiscal year by the establishment of laboratories at the ports of New York and San Francisco.

At the beginning of the last fiscal year arrangements were made by which the foods imported at the port of San Francisco were examined at the laboratory of the State University of California. This was continued until January, 1905, when the San Francisco laboratory was organized. Considerable time was occupied in equipping the laboratory before work could be begun, and with the exception of the last month the chief of the San Francisco laboratory was entirely without assistance of any kind.

The organization of these port laboratories has resulted in a largely increased efficiency in the enforcement of the imported food law. A much more complete inspection is possible than under the previous organization, and the work is so expedited as to remove the hardship that was previously felt by importers. Usually the chemical examinations necessary to determine whether a given shipment of foods is in conformity with the law are somewhat superficial, being confined to two or three tests on each sample. In a great many cases, however, a much more complete examination is necessary.

*Statement of imported food samples received by the Bureau of Chemistry and results of inspection reported from July 1, 1904, to July 1, 1905.*

Result of inspection.	Wine.	Meat.	Olive oil.	Miscellaneous.	Total.
Found contrary to law:					
Released without prejudice to future decisions in similar cases.....	78	5	2	186	271
Admitted after the labels were changed to harmonize with the law.....	9	2	-----	173	184
Required to be reshipped beyond the jurisdiction of the United States or destroyed.....	9	3	9	12	33
Condemned but not disposed of.....	1	-----	-----	-----	1
Total.....	97	10	11	371	489
Found to comply with the law.....	321	46	146	694	1,207
Total number of samples examined from invoices detained.....	418	56	157	1,065	1,696
Samples taken from invoices not detained.....	400	-----	1	331	732

In addition to the examinations made for the purpose of deciding whether or not shipments represented by the samples examined can be imported into the United States in conformity with the law of March 3, 1903, a complete examination has been made of 400 samples of wine, and the examination of about 650 samples of whisky and brandy is now under way.

As in previous years, a considerable amount of the time and energy of the employees in the Division of Foods was occupied with the investigation of the influence of preservatives on nutrition.

During the last fiscal year, in addition to the investigation of methods and other comparative studies for which materials in the laboratory were used and special samples were not required, the Division of Foods examined 3,750 samples of imported foods, 2,579 samples relating to the hygienic table, and 1,009 miscellaneous samples, making a total of 7,338 samples.

#### DIVISION OF TESTS.

During the year about 250 samples have been received and tested. Of these, 127 were rocks intended for road building; 30 were clays intended for the manufacture of brick, tile, pottery, etc.; 24 were asphalts; 3 were Portland cement; 8 were paving brick; 1 was wood paving blocks, and the rest miscellaneous and for identification.

In addition to the work necessary to make reports on these samples a variety of research investigations has been carried on. The investigation of the action of water upon rock powders from the special standpoint of the study of the cementing value of road materials has been carried on, and the results of this investigation have already been presented for publication as Bulletin No. 92 of the Bureau of Chemistry.

The investigation upon the manufacture of reinforced concrete fence posts has been made, and a larger number of posts have been molded with different forms and shapes of reinforcement and tested in the Olsen testing machine.

An investigation has been begun and is well under way in which the effort is being made to discover why modern steel wire sold to the farmers for fencing purposes corrodes and rusts so much more rapidly than the older wires that were in the market some twenty to thirty years ago. Some progress has been made, and it is hoped that practical benefit will accrue as a result of the investigation.

A number of investigations have been made on the subject of the physical properties of road materials with a view of seeing to what extent it will be possible to improve the binding power by artificial means.

Important investigations have been carried on to see what effect the admixture of clay in sand-cement concrete has on the strength of the material. A new and large impact testing machine has been designed and is now in process of construction by the Division. When completed this machine will be the largest impact testing machine—so far as we know—in existence in any laboratory. With our smaller impact testing machine a long series of investigations has been carried on in conjunction with Mr. Clifford Richardson, as special agent, to investigate the value of impact testing on asphalt street mixtures for city pavements. In the course of this investigation a very large number of

test pieces have been broken—several hundred, in fact—which are not included in the samples mentioned.

There is every reason to believe that this impact test is going to be of the greatest assistance to engineers in charge of laying city pavements by enabling them to make mixtures particularly adapted to different kinds of traffic.

With the beginning of the present fiscal year this Division was transferred in its entirety to the Office of Public Roads.

#### PLANT ANALYSIS LABORATORY.

During the past year considerable time has been devoted to checking, editing, and arranging the manuscript which embodies the very extensive soil studies that have been conducted in the previous organizations of this laboratory since 1895.

This laboratory has devoted most of the time during the past year to collaborative work with the Bureau of Plant Industry, this being the chief purpose of its creation. The work of a plant specialist, supplemented by that of a chemist, leads to a rational development that could not be attained by either in independent research. During the past year two bulletins, in collaboration with the Bureau of Plant Industry, have been completed and submitted for publication.

The chemical work on hemp developed some particularly interesting features. While the hemp plant is considered a heavy feeder on the principal plant foods, the amount removed per acre by the fiber, the only marketable product, is about 1 pound of phosphoric acid, 2 pounds of potash, and 5 pounds of nitrogen in an average crop. The great bulk of the plant food necessary to make the crop has been leached out in the retting process generally employed. While this leaching is accomplished on the ground where the crop was grown, it takes place in winter, when the ground is frozen, and probably a great portion of the plant food is lost. It developed that the vat retting would preserve this possible waste to an extent sufficient to justify its cost, the waste products in many instances being valued at \$20 per acre. Simultaneously the office of the Botanist developed the possibility that vat retting so improved the fiber and increased its market value that its cost was justified. There can be no better illustration of the value derived from collaboration in such work.

The addition of the economical discussion is a new feature in such bulletins and possesses much practical interest. To-day the producer must consider supply and demand.

The chemical work on cassava developed the fact before assumed, that the poisonous property of this plant varies with the environment. The same pedigreed varieties were grown in two States—Mississippi and Florida. Varieties which were deadly poison in Mississippi were harmless in Florida. This is of wide practical importance, inasmuch as cassava is utilized as food for animal and man. A second point developed was that the content of hydrocyanic acid is not of a stable character; that the same plant may be harmless at one time and later on become poisonous. Through this collaboration it has developed that poisonous varieties of cassava can not be identified through botanical means.

There has for a long time existed the belief that cassava exists in distinct classes, poisonous and nonpoisonous. There has been some

skepticism regarding this belief, and not until this collaboration was under way did the question become definitely settled that the poisonous nature of a variety could not be foreseen through its botanical characteristics.

This work has shown that the content of starch bears no definite relation to the content of hydrocyanic acid. The practical importance of these points is better realized when they are coupled with the large amount of work the Department is doing to introduce, improve, and acclimate this plant in the Gulf States.

A study of the tobacco plant was inaugurated at the beginning of the year and is now well under way. One variety—White Burley—has been collected so far in thirty-six distinct tobacco districts in Kentucky, this being the home of the White Burley, and the source of approximately 40 per cent of all the tobacco grown in the United States. Each sample represents the space of 20 feet of a selected row.

From this fair approximations of yield in leaf and stalk have been computed. These samples are being analyzed with a view to estimating the loss of plant food through improper uses of the stalk and stems, which are discarded and not returned to the soil, excepting in a very few instances where the stripping is done by large houses.

The value of this product can be realized when it is stated that in some of the heavy yields in the best Kentucky districts this work has shown that the phosphoric acid, potash, and nitrogen removed in the stalk and leaves, computed on the basis of the market quotations, are worth many dollars per acre. This work is one of a series of studies designed to illustrate the feeding nature and the influences which cause variations in the composition of the general farm products of this country.

#### CEREAL SECTION.

The work carried on in this section is in accordance with cooperative arrangements between the Bureaus of Chemistry and Plant Industry, dating from November, 1904. From that time to July 1, 1905, there have been analyzed 32 samples of wheat, in duplicates, for water, ash, fat, fiber, albuminoid nitrogen, pentosans, reducing sugars, sucrose, gluten, and phosphoric acid in ash. One hundred and thirty samples of barley and malt have been received, in which 101 determinations of total sulphur, 101 of total phosphorus, 112 of lecithin phosphorus, and 36 of phosphorus in ash have been made. Besides the above, 178 extra albuminoid nitrogen separations have been carried out, making a total of over 800 determinations of all kinds.

The results obtained by using different precipitants for the separation of albuminoid nitrogen (and hence amido bodies) show that Stutzer's method now used needs some modification. This determination is most important in arriving at a correct valuation of foods and feeding stuffs. A little more work (now going on) is needed before coming to any final conclusion.

The amounts of sulphur and phosphoric acid in barley vary from 0.127 to 0.255 per cent and from 0.71 to 1.09 per cent, respectively, these great variations indicating that the organic bodies from which the sulphur and phosphorus are derived may play an important rôle in brewing. Complete analyses of barleys and of the malts and beers made from them ought to give most valuable data.



Similar results are obtained in the lecithin-phosphoric acid determination, the per cent varying from 0.46 to 0.83. This variation also indicates that this substance may be of importance not only in brewing, but in nutrition.

The comparative determinations of total phosphoric acid and phosphoric acid in ash show that only a trace, if any, of phosphoric acid escapes on ashing in a muffle such substances as wheat, barley, and malt.

PHYSIOLOGICAL WORK.—The work for the past year has been along the following lines:

(1) The continuation of the work of the preceding year on the composition and properties of durum wheat. The object of this work was the determination of the composition of durum wheat and flour in comparison with standard varieties of wheat already grown in this country, and the testing of durum wheat flour as to its bread-making qualities. The work consisted of the analysis of numerous samples of durum wheat and flour, both the imported grain and that grown in the United States, and of three standard varieties of domestic wheat, viz, northwestern spring wheat, Kansas hard winter wheat, and soft winter wheat. In addition to this a large baking of both durum wheat patent flour and northwestern spring wheat patent flour was made through the cooperation of a local bakery, and the resulting bread was tested and analyzed. The results of this work are set forth in Bulletin No. 70 of the Bureau of Plant Industry, "The commercial status of durum wheat," by Mr. Mark Alfred Carleton and Mr. Joseph S. Chamberlain.

(2) The inauguration and the present continuation of work on the analysis and study of the relative feeding and commercial value of a large number of introduced varieties of oats and a special study of one particular variety, "Swedish Select," as to its particular merits, and the effect of change of environment, due to importation, on its composition and properties. This work has occupied the larger part of the year and is still going on.

(3) Research work. In connection with the first work spoken of, certain lines of abstract research have been followed out as time has permitted. The work has embraced two related problems: (a) Determination of "gluten" in wheat flour and a study of its composition and properties; (b) a study of the proteids of wheat and their relation to wheat gluten. In this connection, the chief of the cereal section has been, during the past year as during the preceding one, associate referee on the separation of vegetable proteids for the Association of the Official Agricultural Chemists.

The lines of work thus far mentioned were inaugurated and carried on through the suggestion and advice of Mr. Mark Alfred Carleton, cerealist in charge of cereal investigations of the Bureau of Plant Industry.

#### INSECTICIDE AND AGRICULTURAL WATER LABORATORY.

During the last year the Insecticide and Agricultural Water Laboratory has examined 625 samples. Some of these analyses were made as part of the work in special investigations of the laboratory, which will be published later, and part were done for other labora-

tories of this Bureau and other divisions and bureaus of this and other Departments of the National Government. The work may be summarized as follows:

Of irrigation waters 41 samples were examined, 39 for the Office of Irrigation and Drainage Investigations and 2 for farmers; of sanitary water analyses 45 were made, namely, 5 for the Bureau of Forestry, 5 for the War Department, 12 miscellaneous samples, and 23 for a special investigation on American mineral waters, the results of which will be published in due time; of mineral waters 29 were examined, 23 for a special investigation and 6 for miscellaneous parties.

Of insecticides 51 samples were examined, 11 for the Bureau of Entomology, 2 for the Bureau of Plant Industry, 4 for farmers, and 34 samples for a special investigation (the results of which will be published) on the composition of samples of formaldehyde sold on the American market.

Eighteen toxological examinations were made, all for the Bureau of Entomology.

Four samples of disinfectants were examined, 3 for the U. S. Census Bureau and 1 for the Panama Canal Commission.

Two complete analyses of samples of gases were made for the U. S. Bureau of Fisheries.

As regards cattle-food analyses, which have during the past two years been made in this laboratory, 242 samples were examined, 157 for a special investigation on the composition of cattle foods sold on the American market that will be published during the course of the next year; 62 samples for the jury of awards at the Louisiana Purchase Exposition, 15 samples of grasses for the Bureau of Plant Industry, and 8 samples for miscellaneous parties.

A more or less complete food analysis has been made upon 100 samples of malts and barleys, the results of which work are to be published in a bulletin. Food analyses were also made upon 33 samples of Indian corn for the Bureau of Plant Industry.

For the Food Laboratory of this Bureau 23 analyses have been made.

Besides the above a number of samples which do not fall under any of the above heads have been examined, and one member of the laboratory force, as referee on insecticides, fungicides, and disinfectants, of the Association of Official Agricultural Chemists, has devoted a considerable amount of time to the task of testing and unifying methods of analysis on these classes of goods.

The following articles not yet published have been prepared and are now ready for publication:

- (1) A study of American Mineral Waters.
- (2) A study of the Hydrogen Peroxid Method of Determining Formaldehyde.
- (3) A New Method of Determining Potassium.

#### DRUG LABORATORY.

During the past year there were 465 samples of material examined in this laboratory. Of this number 335 were chemicals, 64 plant drugs, 61 proprietary medicinal agents, and 5 of a miscellaneous character.

## CHEMICAL REAGENTS.

The chemicals examined were those regularly employed in chemical analyses in the Bureau of Chemistry, delivered on contract and special purchases. The objects of these examinations are, first, to insure reliable chemicals for analytical work; second, to secure data from which standards of purity can be constructed, and, last, to place competitors on a uniform basis.

The qualities usually specified were the best grades of the several respective types. It has been necessary to reject a goodly portion of the chemicals delivered, but it is gratifying to say that the proportion is appreciably less than a year ago. It is a common custom to append a label indicating high-grade goods to packages containing chemicals of an inferior grade. For example, "Chemically pure" can be found attached to containers filled with calcium oxid that is little better than the ordinary quicklime used in building, and what adds to the confusion is the fact that some of the designations used to indicate quality have both a commercial and a scientific meaning.

The committee on the testing of chemical reagents of the Association of Official Agricultural Chemists, in its first report clearly sets forth the necessity for the work in hand. Chemicals bearing the names of some of the best manufacturers were shown to be totally unfit for analytical work. The committee is continuing its work, and hopes to present an extended report at the next annual meeting of the association.

The Drug Laboratory has in its possession the analytical data of over 700 chemicals, and a bulletin is now in preparation giving these results and setting forth the proposed standards for these chemicals.

## PLANT DRUGS.

Plant drugs were examined, consisting of the powdered potent drugs placed on the market by several dealers in the United States, with a view of ascertaining to what extent the goods conformed to the representations on the packages, and how rapidly deterioration takes place under given conditions, and of making a careful study and comparison of the analytical methods in use. The first report on this line of work was presented at the twenty-first annual convention of the Association of Official Agricultural Chemists by the chief of the Drug Laboratory, as referee on medicinal plants and drugs, and consisted of a comparative study of the methods largely employed in determining the amount of morphine present in opium.

## PROPRIETARY MEDICINAL AGENTS.

The proprietary medicinal agents were examined at the request of the Post-Office Department, the Treasury Department, Senator W. B. Heyburn, chairman of the Committee on Manufactures, and in cooperation with the American Medical Association.

The Post-Office Department asked for the investigation of certain alleged remedies which, through their advertising literature, were heralded as being capable of curing all the ills that human flesh is heir to. One "complexion lotion" consisted of a solution of corrosive sublimate mixed with tincture of benzoin and glycerin. This mixture, it was claimed, would turn black skins white. A complex-

ion powder consisted of Rochelle salt, and a complexion tablet was composed of extract of nux vomica, reduced iron, calcium carbonate, and sugar. The indiscriminate distribution of these poisonous tablets without caution resulted in the death of a child. Lean people were to be made fat by taking a "predigested olive oil" that was not predigested, but simply an emulsion of the oil; and "kinks" were to be removed by ample applications of a mixture of cocoanut oil and crude petroleum flavored with oil of bergamot.

For the Treasury Department were determined the amount of alcohol in several samples and the degree of purity in a number of others.

Eleven samples were examined for the American Medical Association. Some of the results obtained on headache powders have been made public through the association's journal.

#### COD-LIVER OIL INVESTIGATIONS.

This investigation was undertaken at the suggestion of the chief of the Drug Laboratory for the purpose of making a comparative study of American and Norwegian cod-liver oil, chemically, medically, and commercially, including the method of preparation, with a view to ascertaining whether there is any good reason for the present discrimination against American oils by the medical profession, and, if so, what it is and how the same can be removed so as to place the products of our home industry on an equal footing with the foreign oils. This work is in cooperation with the Division of Foods of the Bureau of Chemistry and with the U. S. Bureau of Fisheries.

The Bureau of Fisheries is collecting oils concerning which there can be no doubt as to genuineness, investigating methods of manufacture, and sending the samples to this Bureau. Some of the oils have been examined chemically as to purity and their respective color reactions.

#### DRUG LEGISLATION.

Numerous requests have come from legislative bodies to present laws regulating the adulteration of drugs and the proper labeling of the same, as a result of which it was considered expedient to collect into bulletin form all Federal and State laws bearing on this subject, so that these inquiries could be fully and completely answered in the shortest possible time. This work is now in preparation.

#### PLANT ANALYSIS.

The analysis of one plant was begun with a view to determining, if possible, the active agent or agents of a plant claimed to have great curative properties. The work will be completed during the early part of the fiscal year beginning July 1, 1905.

#### MISCELLANEOUS.

One sample of essence of Jamaica ginger that had caused the death of an adult was examined and was found to be made up with wood alcohol, which is now known to be highly poisonous. Samples of bay rum and toilet water were also examined for wood alcohol, but it was not found. A sample of buckwheat was examined because

of certain physiological effects that it produced and was found to be mixed with stramonium seeds, which are highly poisonous. Of the remaining samples, one was a cigar which was supposed to have been "doctored" and the other was meal poisoned with corn-cockle.

#### LEATHER AND PAPER LABORATORY.

One of the first pieces of work undertaken in this laboratory was an investigation of the various processes of extracting tanning materials for analysis. All of the methods commonly used possess some objectionable feature either as to accuracy or as to the time required to complete the extraction. As a result of our work it has been possible to shorten considerably the time required to obtain an extract ready for analysis and also to reduce the inconveniences of the older methods. This investigation has been published in the *Journal of the American Chemical Society*.

Sicilian sumac is an important tanning material which is imported into this country. During the past year it has been very generally claimed that before shipment this material is largely adulterated with substances inferior in color and in tannin content. With the assistance of the Customs Division of the Treasury Department we have secured a large number of samples from original packages in order to determine the kind and quantity of adulterants used. This work is progressing rapidly and will be concluded as early as possible, as both the importers and the consumers are interested in the results.

American sumac, while as rich in tannin as the Sicilian, is more objectionable in color and consequently brings a lower price. We are endeavoring to overcome this objectionable feature and to so prepare the American sumac that it may approximate the Sicilian in quality.

Samples of sod oils and degreas have been collected as museum specimens and for analysis. Examination of these will be taken up as soon as practicable.

A number of miscellaneous samples of tanning materials have been analyzed, several of which were for the Bureau of Forestry. The study of the extraction of tannin from various tanning materials, begun during the year, is not yet completed.

#### PAPER AND PULPS.

The laboratory has examined a number of samples of various papers for the Post-Office Department and from this work has revised the formula for the postal-card contracts, making it definite and more difficult to evade. Decided improvement in the postal cards is expected from this work. The chief of this laboratory has also served upon the committee appointed by the Postmaster-General to open the bids for envelopes for all the Executive Departments and has tested a large number of envelope papers in this work. An examination of manila papers for the purpose of securing data upon which to base future envelope contracts has also been begun.

Many papers deteriorate so rapidly that they are valueless for public records. Many of the Government publications have shown

evidence of deterioration, and for the purpose of studying this problem as it applies to book papers we are now securing from the Government Printing Office samples of each invoice of book paper received, and from the several Departments copies of their older publications for careful examination in the laboratory. That the work may be more complete we have requested samples from public libraries and from paper makers, and have also asked for an expression of opinion as to the chief causes of deterioration and methods for its prevention. This line of work will be extended to include all other classes of paper.

Examination of new raw material for paper making has been delayed for lack of space in which to erect digestion and other apparatus. This difficulty will soon be overcome, when the work will be pushed vigorously.

#### TURPENTINE AND ROSIN.

Turpentine derived from wood, either through destructive distillation or by steam distillation, while possessing many, if not all, the essential characteristics of turpentine distilled from the gum, differs in some particulars from gum turpentine; and, notwithstanding the fact that the price of gum turpentine is higher and the output is likely to be scarcer as the years go by, wood turpentine has not yet found a stable and satisfactory market. We are now engaged in working out the many chemical problems connected with the production of so-called wood turpentine. Its composition and adaptability to various industrial pursuits are also being determined.

We have arranged to secure through the Bureau of Forestry samples of crude turpentine at three different periods of flow, that we may determine with accuracy the constant of turpentine as a basis for the work on turpentine adulteration, outlined in the last report of the Chemist.

#### MISCELLANEOUS WORK.

In addition to the regular lines of work, the laboratory has made analyses of soils and fertilizers used in the sirup and sugar-beet work, as well as of miscellaneous samples of these materials which have reached us from various sources. This laboratory also participated in the work of the Association of Official Agricultural Chemists on fertilizers and on tannins. A large share of the time of the chief of the laboratory has been devoted to correspondence which has been referred to us from the different bureaus and offices of the Department, not only on tanning leather, turpentine, destructive distillation of wood and paper, but also on fertilizers, their composition and proper use.

To this laboratory has been assigned a part of the work on whisky now in progress in this Bureau. This occupies about a third of one man's time. Much of the time has been given to the study of methods of analysis. The methods now used in the examination of tanning materials, leather, paper, and turpentine leave much to be desired both from the standpoint of accuracy and of utility. Several improvements have been made in these particulars.

The number and character of samples received in the laboratory during the year are shown in the following table:

Papers .....	139
Tanning materials.....	124
Turpentine .....	55
Fertilizers .....	21
Soils .....	36
Whiskies .....	76
Miscellaneous .....	40
<b>Total .....</b>	<b>491</b>

## CONTRACTS LABORATORY.

The work of this laboratory is divided as follows:

(1) Contracts, consisting of the examination of materials submitted with bids for or furnished upon contract in this Department or other Executive Departments.

(2) Special investigations, consisting of such work as is requested by the other Executive Departments, or as is done for this Department where the interests of the service warrant.

(3) Miscellaneous work, consisting of the examination of substances of a general nature where requested by the different Bureaus of this Department or by the other Executive Departments.

The amount and nature of the work for the past year are summarized in the following table:

Department.	Contract samples.	Samples for special investigations.	Miscellaneous samples.
Agriculture .....	64	123	31
Commerce and Labor.....		3	2
Interior .....	77		
Post-Office .....	105	80	
Treasury .....		79	10
War .....	11	3	2
<b>Total.....</b>	<b>257</b>	<b>288</b>	<b>45</b>

NOTE.—The foregoing table does not include Treasury sugar samples, of which 548 were examined during the year.

The nature of the contracts work and of the special investigations made for the different Departments was as follows. The miscellaneous samples deserve no special attention.

## DEPARTMENT OF AGRICULTURE.

A total of 64 samples of chemical glassware and library pastes were analyzed for this Department for guidance of the board of awards in awarding contracts for these materials. In addition to the above were conducted investigations of glassware, writing inks, and typewriter ribbons, in which investigations a total of 123 samples were examined. The work on glassware has been completed and the information gained has been used as the basis of a series of tests for glassware to determine wearing qualities and resistance to reagents. The work on writing inks and typewriter ribbons has progressed satisfac-

torily, and reports covering the investigations will be made about September 1. These reports will show that many of the inks and typewriter ribbons now in use in the various Executive Departments are not capable of furnishing records of sufficient permanence. Requirements for these items will be suggested with the view to obtaining more satisfactory material of this class for the Government service.

DEPARTMENT OF COMMERCE AND LABOR.

The samples of life-preservers were examined for this Department to determine their buoyancy, rate of water absorption, and the nature of the material from which they were made.

INTERIOR DEPARTMENT.

A total of 77 samples, consisting of coals, lubricating oils, and disinfectants, were examined for this Department for contracts purposes.

POST-OFFICE DEPARTMENT.

One hundred and five samples, consisting of canceling inks for both rubber and metal stamps, stamping inks, numbering-machine inks (both noncopying and copying), glues, glycerins, inking pads, and postal-card paper, have been examined for this Department for contract purposes. An investigation of rosin oils has also been taken up to determine the fitness of these oils in making canceling inks. Eighty samples of oils were collected for this investigation, and much of the work has already been completed.

TREASURY DEPARTMENT.

During the year ending June 30, 1904, the investigation of soap stocks, machinery oils, finishing soaps, etc., was taken up to determine whether any of these materials were of use as alizarin assistants or substitutes therefor. This work was completed early this year, when 73 samples were reported upon. Recently a number of other samples of this nature have been received for similar examination, and the work is now under way. During the first half of the year 548 samples of sugars were received for analysis. With the exception of 146 samples, this work was largely done in the sugar laboratory under the direction of the chief of this laboratory.

WAR DEPARTMENT.

Eleven samples, largely food products, were examined for this Department for contract purposes, and an investigation of the army emergency ration was made for the purpose of procuring some suitable binding material for this product. After considerable work a binding material was suggested that would enable the ration to be pressed into sufficiently firm cakes and at the same time would not materially affect the composition of the ration.

A total of 590 samples have been examined in this laboratory during the year. There has been a material increase in the amount of contract work requested, and in all cases the laboratory has been able to handle this work promptly.



## MICROCHEMICAL LABORATORY.

The first four months of the past fiscal year were spent in connection with the exhibit of the Bureau of Chemistry at the Louisiana Purchase Exposition at St. Louis, Mo. For nearly three months of that time the chief of the laboratory was the representative of the Bureau in charge of the exhibit. During the most of the time while with the exhibit there were given daily two public lectures describing the work of the Bureau of Chemistry, illustrated by lantern slides and also by microprojection of the samples upon the screen.

Another feature of the work involving considerable attention was that of answering inquiries concerning laboratory equipment and methods. This included conversations of a popular nature with visitors who knew little or nothing of the work of the Bureau and whose interest had been aroused by the exhibit. The second class of conversations was with instructors, both of chemistry and allied branches of science, as to apparatus and methods.

As a result of this feature of our work at the exposition, this laboratory, in collaboration with the Division of Foods, has completed a limited number of sets of samples for distribution to instructors of domestic science and food-analysis methods.

A number of samples of food products were examined for the juries of awards at the exposition.

What time could be obtained aside from the above lines of work was given to the regular work of the laboratory in the line of microscopical examination of samples and research work.

The regular work of the laboratory has of necessity been largely cooperative with the other laboratories of the Bureau or with other bureaus or branches of the Government. As a result, extremely little research work of a strictly independent character has been done.

The work upon the microscopical features of the starches has been continued as time and opportunity allowed, until at present our collection of photo-micrographs includes those of about 50 kinds.

The largest part of the collaborative work has been with the Division of Foods in connection with the hygienic table work, which involved the examination of a large number of urine and blood samples. Besides these there were examined samples of mustard, chocolate, pepper, coffee, and other miscellaneous food samples.

In collaboration with the Insecticide and Agricultural Water Laboratory nearly 300 cattle foods have been examined to determine as far as possible, from a microscopical analysis, of what ingredients they are composed.

For the Leather and Paper Laboratory has been examined a number of papers and paper materials and fabrics.

In cooperation with the Drug Laboratory a number of medicinal and drug samples have been examined to identify as far as possible the ingredients present.

For the Contracts Laboratory there have been examined miscellaneous samples, such as typewriter ribbons, emergency rations for the Army, and lampblack.

There were also examined some samples of a miscellaneous character, besides the making of a series of photo-micrographs for the Division of Tests, part of one set having already been used for illustrating Bulletin No. 92.

During the year there has been prepared a manuscript for the microscopic part of the forthcoming bulletin upon the ripening of apples.

During the present season microscopic work upon barleys has been begun in connection with chemical studies which are being conducted by other branches of the Bureau.

In condensed form the following will give some idea of the work of the laboratory during the year ended June 30, 1905:

Samples examined:	
For Division of Foods.....	384
For Insecticide and Water Laboratory.....	290
For Contracts Laboratory.....	61
For Leather and Paper Laboratory.....	15
For Drug Laboratory.....	25
Miscellaneous samples:	
For jury of awards Louisiana Purchase Exposition.....	99
Other samples .....	61
 Total samples examined.....	 935
Photographic negatives made:	
Macroscopic .....	41
Photomicroscopic .....	114
 Total .....	 155
Stereopticon lectures at Louisiana Purchase Exposition, about.....	200

#### DAIRY LABORATORY.

In this laboratory there have been analyzed or otherwise examined during the present fiscal year 253 samples, of which 129 were in connection with the work of this Bureau, most of them being samples of milk and butter used at the hygienic table for the investigation of the physiological effects of preservatives in food; 63 were from the Bureau of Animal Industry, mostly in connection with the work of enforcing the renovated butter laws; 14 were examined for the War and State Departments in connection with food supply for the Army and with certain butters of suspicious character exported from this country, and 47 were miscellaneous samples examined for parties other than those named above or used in investigations carried on by this laboratory. The investigations have included:

(1) A study of butters produced by heavy feeding of cotton-seed products, such butters often bearing a strong resemblance to adulterated butter. An authenticated sample of such a butter, produced by Mr. Fred H. Smith, of Fairbanks, Tex., by the heavy feeding of cotton-seed meal and hulls, was procured by the Dairy Division of the Bureau of Animal Industry. It was examined, with the following results:

Melting point .....	°C..	41.7
Volatile acids, Reichert-Meissl number.....		25.5
Saponification number .....		220
Insoluble acids .....	per cent..	89
Soluble acids, as butyric.....	do....	5.37
Iodin number .....		35.8
Mean molecular weight of insoluble acids.....		263.7

The Halphen test for cotton-seed oil gave a color equivalent to from 1 to 2 per cent of that oil in the butter. This butter, while

not strictly normal, aside from its content of cotton-seed oil, could hardly be regarded as adulterated.

(2) Examination of proposed methods for the rapid estimation of water in butter, in the hope of finding some method of use to creameries and renovating factories for controlling the amount of water in this output.

These methods as originally proposed were applied to unsalted butter, and therefore are not applicable to butters as generally found on the markets in this country. A modification of the process to apply to such butters was perfected, which gives fairly good results for factory purposes. The more rapid conduct of the common method, which consists in using a higher temperature and thus shortening the time for complete desiccation, is found to give more satisfactory and quite as speedy results for factory control.

(3) Examination of methods proposed for the detection of moderate or slight adulteration of butters. The only one of these methods that we have studied thoroughly is that which consists in rapidly stirring 5 or 10 grams of the suspected butter with a large quantity of milk (500 or 1,000 cc), held at the temperature of 37.5° C. The sample must not have been previously melted. Butter fat, it is claimed, will under the stated conditions readily emulsify with the milk and disappear therein in the form of small globules, while foreign fat will remain on the surface of the milk as an unemulsified residue, to be separated from the emulsion by running the latter through a sieve and to be then examined by the refractometer. It has been assumed that if any such residue is left from the treatment of pure butter it will show the same refractive power as did the original butter fat, and it has therefore been maintained that, whenever a residue shows a higher refractive power than did the original fat therein, this is proof that the butter was adulterated. We have studied this method carefully, but failed to obtain definite results. While it is true that adulterated butters will yield an unemulsified residue showing higher refractive power than did the original material, so also will pure butters, and we have obtained as great a difference between the refraction of the residue and the original material in the case of an undoubtedly pure butter as in the case of a butter adulterated in the laboratory with 10 per cent of oleomargarine, the latter having been worked into the butter by ladling them together while in a soft condition.

#### SECTION OF CHEMICAL ŒNOLOGY.

Our work in this important field of investigation was vigorously continued during the year. The pure cultures of yeast for the production of cider of predetermined chemical composition were continued and small quantities of these cultures were distributed to those interested in the manufacture of cider in Virginia, Pennsylvania, New York, Ohio, Missouri, Idaho, and Delaware.

Cooperative experiments in the control of the chemical composition of the cider produced were carried on in practical manufacture in Crozet, Va., and Dover Plains, N. Y.

A large number of letters of instruction and suggestion were sent to inquiring parties engaged in the cider industry throughout the United States.

The results of the investigations conducted during the year are almost ready for publication.

## CLERICAL WORK.

The amount of clerical work performed in the Bureau of Chemistry during the fiscal year ended June 30, 1905, may be summarized as follows:

Approximate number of typewritten letters.....	16,000
Approximate number of typewritten pages other than letters.....	3,000
Requisitions.....	1,400
Calculations in connection with hygienic table.....	250,000

The above tabulation does not include a large number of circular letters, a vast amount of work on the various card catalogues of the Bureau, or the work of receipt and disbursement of supplies and the checking of the accounts of the Bureau.

## PUBLICATION WORK.

The publications and miscellaneous printing of the Bureau for the past year were as follows:

## NEW PUBLICATIONS.

**BULLETINS.**—No. 83, Part II, Foods and Food Control, Legislation during year ended July 1, 1904; No. 84, Influence of Food Preservatives and Artificial Colors on Digestion and Health, Part I, Boric Acid and Borax; <sup>a</sup> No. 85, The Cementing Power of Road Materials; No. 86, Arsenic in Papers and Fabrics; No. 87, Chemical Composition of some Tropical Fruits and their Products; No. 88, The Chemical Composition of Apples and Cider; No. 89, Injury to Vegetation by Smelter Fumes; No. 90, Proceedings of the Twenty-first Annual Convention of the Association of Official Agricultural Chemists (in press); No. 92, The Effect of Water on Rock Powders; No. 93, Experiments in the Culture of Sugar Cane and its Manufacture into Table Sirup (in press); No. 94, Studies on Apples (in press); No. 95, The Influence of Environment upon the Composition of the Sugar Beet, 1903 (in press); No. 96, The Influence of Environment upon the Composition of the Sugar Beet, 1904, together with a Summary of the Five Year Experiment (in press). Approximate total number of pages, 1,182.

**CIRCULARS.**—No. 17, The Useful Properties of Clays; No. 18, Suggestions to Importers of Food Products; No. 19, Methods for the Detection of Renovated Butter; No. 20, Extracts from the Proceedings of the Association of Official Agricultural Chemists, 1904; No. 21, Proposed Regulations Governing the Labeling of Imported Food Products; No. 22, Cooperative Work on the Titer Test, Association of Official Agricultural Chemists, 1904; No. 23, Methods for the Examination of Maple Products; No. 13, of the Secretary's Office, Standards of Purity for Food Products. Total number of pages, 80.

**FOOD INSPECTION DECISIONS.** Nos 1 to 25 (in press). Number of pages, 25.

**ARTICLES IN 1904 YEARBOOK.**—Inspection of Foreign Food Products; Detection of Cotton-Seed Oil in Lard, Food Legislation and Inspection. Total pages, 23.

Total number of pages of original matter prepared for publication, 1,310.

## PUBLICATIONS REPRINTED.

**BULLETINS.**—No. 81, Proceedings of the Twentieth Annual Convention of the Association of Official Agricultural Chemists, 1903; No. 83, Foods and Food Control, Part I, Legislation during the year ended July 1, 1903; No. 71, A study of Cider Making in France, Germany, and England, with Comments and Comparisons on American Work; No. 70, Manufacture of Table Sirups from Sugar Cane (twice); No. 46 (revised), Methods of Analysis; No. 65, Provisional Methods for the Analysis of Foods; No. 68, The Chemical Composition of Insecticides and Fungicides; No. 69, Parts I to V, Foods and Food Control; No. 77, Olive Oil and its Substitutes; No. 88, The Chemical Composition of Apples and Cider; No. 74, The Influence of Soil and Climate upon the Composition of the Sugar Beet; No. 13, Foods and Food Adulterants, Part X, Preserved Meats.

<sup>a</sup> Reported as "in press" in report of 1904; not included in total for 1905.

CIRCULARS.—No. 14, Organization of the Bureau of Chemistry; No. 15, Results of the Borax Experiment; No. 20, Extracts from the Proceedings of the Association of Official Agricultural Chemists, 1904; No. 12 (revised), Methods for the Investigation of Canceling Inks and other Stamping Inks.

MISCELLANEOUS.—Farmers' Bulletin No. 52, The Sugar Beet—Cultivation, Seed, Development, Manufacture, and Statistics; Report of Cooperative Work on the Dalican Titer Test (separate from Bulletin 81); The Selection of Materials for Macadam Roads (Yearbook, 1900); The Adulteration of Drugs (Yearbook, 1903); Determination of the Effect of Preservatives in Food on Health and Digestion (Yearbook, 1903); Report of the Chemist, 1904.

Total number of pages of reprints, 1,880.

JOB PRINTING.—A total of 222 orders distributed approximately as follows: Miscellaneous (index cards, announcements Association of Official Agricultural Chemists, forms for food-table work, labels, etc.), 120; drawings and blueprints, 51; stationery, 52; circular letters, 18.

## OUTLINE OF WORK FOR THE FISCAL YEAR ENDING JUNE 30, 1906.

### DIVISION OF FOODS.

The work of the Division of Foods will be largely devoted to experiments relating to the influence of preservatives on health and to the enforcement of the imported-food law. The former study will occupy the attention of by far the greater part of the force of the Division of Foods located in Washington for about eight months of the year, and of a portion of the force for the whole year.

During the fiscal year ending June 30, 1906, almost all of the analytical work connected with the enforcement of the foreign-food law will be conducted in the port laboratories which are already in operation in New York and San Francisco, and are being installed in Boston, Philadelphia, Chicago, and New Orleans. The work of the Washington laboratory in connection with the enforcement of the imported-food law will be confined to checking the work of the port laboratories and to certain studies of analytical methods for the purpose of establishing standards.

The study of the changes of composition of fruit during ripening will be continued with special reference during the summer to the orange and persimmon. Attention will also be given to a number of problems connected with the storage of fruit.

The vinegar and cod-liver oil studies inaugurated during the last fiscal year will be continued. The collaborative work on the Dalican and Belfield tests for the detection of beef stearin in lard and the cold test will be continued during the coming year.

Work will also be continued on the most available methods for the detection of food preservatives, and on the natural occurrence of those preservatives in articles of food. The study relating to the composition of distilled liquors will be continued, and after its conclusion the composition of other articles of food will be carefully studied with a view to securing data for establishing standards to enable us to judge more intelligently of the purity of commercial samples.

### PLANT ANALYSIS.

So far as facilities will admit, the work for next year will be in collaboration with the Bureau of Plant Industry. This will begin with the collaborative cereal work, and the extension of the work now under way will be attempted.

Second in importance will be the continued study of the cassava plant with the purpose of selecting for propagation the best from the imported stock.

Twelve of these varieties were selected from forty pedigreed varieties during the past year and grown under actual field-culture conditions. It is intended to determine the actual yield of each variety in starch by milling tests; also to make experiments upon the cost of drying ground cassava and ascertaining its value for food or stock purposes in the open market. The study of this plant is to be taken up in other of the Gulf States.

Some collaborative work upon practical hemp retting is planned, the experiments to consist of the vat retting of green hemp. The fiber from green hemp is white and of a very fine texture, making the highest grade of linen.

Further collaboration, which will be arranged to such extent as the resources of the laboratory permit, will be on the study of cotton in connection with the improved varieties which are being developed by the Bureau of Plant Industry, some collaborative experiments in the fertilization of fruits, and some forage crop studies.

#### CEREAL SECTION.

Over one hundred samples of the best varieties of wheat found in Algeria, France, Italy, Russia, and elsewhere are on hand ready for analysis. This is part of the cooperative work with the Bureau of Plant Industry. Samples of these same wheats have been planted in various parts of this country having different climatic conditions, and it is expected to have the crops analyzed, so that in several years most valuable data will be secured concerning the effect of environment on the composition. This same kind of work is to be taken up with other cereals, e. g., rye, barley, oats, and corn.

When durum wheats are grown in this country white spots appear on the seed, the effect of which is to make a less readily salable, and therefore a less valuable, article. It is estimated that this white spot causes a loss of hundreds of thousands of dollars to the farmers, because the price per bushel of such wheat is about 2 cents less. Experiments have already been started in a preliminary way to study the causes and prevention of these white spots.

The rôle which organic phosphorus plays in the animal organism is still, in some respects, an unsettled question, and one of great importance. To study this question still further, it is the intention to inaugurate a series of experiments with small animals, feeding them organic and inorganic phosphorus compounds.

The work on the composition of barley and malt and its relation to the character of beer will be continued.

The influence of latitude on the sugar content of sweet corn will be studied, the same variety of corn being grown in various States, from South Carolina to Maine.

It is also intended to continue the work on the separation of amido bodies and their determination.

The contemplated work for the coming year and the work that has been begun under the new plan of cooperation between Cereal Investigations of the Bureau of Plant Industry and the Bureau of Chemistry is as follows:

- (1) Continuation of the aforementioned lines of work.
- (2) A study of the nitrogenous constituents of barley and malt, with special reference to malting and beer making qualities, and also a study of the ash constituents of the same materials.
- (3) A study of the composition and feeding value of the seeds or grain of sorghum, milo maize, Kafir corn, etc., in relation to problems of plant breeding and selection, carried on by Cereal Investigations of the Bureau of Plant Industry.

## MICROCHEMICAL LABORATORY.

The work outlined for the year includes a continuation of the work begun this year upon barleys in conjunction with the cereal section. It is hoped to finish the examination of poultry and stock foods and take up the examination of imported samples of sumac used as sources of tannin, which have been collected during the past year by the Leather and Paper Laboratory. Miscellaneous samples from the various laboratories, especially drugs, will also be examined.

## DRUG LABORATORY.

The work planned for the year beginning July 1, 1905, is a continuation of the investigations instituted in this laboratory and given in detail in the report of work for the past fiscal year, together with an examination of medicinal chemicals. The work can be briefly summarized as follows:

**CHEMICAL REAGENTS.**—Examination in the Bureau of Chemistry for the purpose of collecting data for standards and insuring the securing of reliable chemicals for analytical work.

**PLANT DRUGS.**—Study of quality, purity, keeping qualities, and an examination of the analytical methods at present in use.

**COD-LIVER OIL INVESTIGATION,** with a view of determining in what manner the American oils differ from the Norwegian; and, if they differ, what the causes of such differences are and how they may be eliminated.

**PROPRIETARY MEDICINAL AGENTS.**—Examination of these remedies so as to supply the Post-Office Department with the desired information relative to fraudulent medicines; to cooperate with the American Medical Association, and to supply recognized officials with proper data.

**EXAMINATION OF COMPOUNDED OILS AND ESSENCES,** used for the contemporaneous manufacture of liquor of any "age" from raw spirits.

**PLANT ANALYSIS,** to determine the medicinal value of indigenous plants which are represented as having great curative properties.

**DRUG LEGISLATION.**—To supply full and authentic information on the subject of laws regulating drug adulteration.

**MEDICINAL CHEMICALS.**—This line of work is expected to be instituted with the advent of the next revision of the United States Pharmacopœia, which is to become effective August 1, 1905.

## DAIRY LABORATORY.

The work for this laboratory for the year will be as follows:

(1) Continuation of work along the lines described in the account of last year's work.

(2) Cooperative work with the Bureau of Animal Industry on the digestibility of Cheddar cheese when ripened at different temperatures and for different lengths of time.

## CONTRACTS LABORATORY.

It is proposed that the work on writing inks be continued along different lines from those which have been followed during the past year, that the examination of typewriter ribbons be completed, and that the investigation of typewriter carbon papers be taken up, the examination of carbon papers to be for the purpose of ascertaining their fitness for record work. It is further proposed to make a study of the printing inks in use in the various branches of the Government service with a view to ascertaining the effect of the different inks on papers, and consequently on the permanence of printed public documents.

The contract work for the various Departments, and especially our own Department, should be greatly extended. All supplies suitable thereto should be submitted to chemical analysis. Among these may be mentioned coals, lubricating oils, paints and painters' supplies, writing inks, carbon papers, typewriter ribbons, etc.

## MISCELLANEOUS LABORATORY.

[Formerly Insecticide and Agricultural Water Laboratory.]

During the year ending June 30, 1906, the examination of irrigation waters for the Office of Irrigation Investigation will be continued.

The study of the composition of American mineral waters will be pursued, giving especial attention to these waters as they come from the ground rather than as they appear on the market. This investigation will be carried out in collaboration with the Hydrographic Office of the United States Geological Survey.

The work on insecticides in connection with the Bureau of Entomology will be continued and studies of the composition and methods of analysis of certain insecticides will be continued. It is hoped that with the data now on hand and such as will be obtained during the next six months a bulletin on Insecticide Studies will be ready before the end of the year.

A study of the methods of determining various constituents in the common disinfectants will be undertaken in the hope of improving the same.

The work on the composition of American cattle foods will be continued. It is hoped that a bulletin on this subject can be issued during the year.

The analysis of malts and barleys will also be continued.

In collaboration with the Bureau of Forestry, a study will be made of the injury to vegetation by smelter furnaces similar to the study recently made in California for the United States Department of Justice.



If time allow, certain hygienic studies similar to the bulletin on "Arsenic in papers and fabrics," recently published from this laboratory, will be undertaken.

Besides the above, this laboratory will from now on have charge of all the miscellaneous work of the Bureau which does not properly belong to any of the other laboratories.

#### LEATHER AND PAPER LABORATORY.

Because it is necessary to devise and improve methods for much of the work, which is along new lines, progress has been slow, and the work now on hand will be sufficient to occupy the time of the laboratory force during the coming year.

The following is the proposed scheme of work for the fiscal year 1906 in detail:

(1) Study of the extraction of tannin from tanning materials, with a view to reducing materially the large losses in this process. From one-eighth to one-third of the tannin contained in bark and other tanning materials is now lost annually.

(2) Study of quick-growing or hitherto but little used tanning materials for the purpose of determining their leather-making value, and also their susceptibility to improvement with a view to supplementing the rapidly decreasing supply of materials now generally used.

(3) Investigation and valuation of degreas or wool grease, and of methods for the detection of its adulterants.

(4) Investigation of the physical and chemical qualities of various leathers.

(5) Investigation of the chemical and physical properties of the more important kinds of papers and from these and other data the preparation of the standard specifications for papers designed for various uses.

(6) Investigation of new raw materials for pulp and paper making and demonstration of the value of such materials.

(7) Investigation of the distillation of turpentine, with particular reference to improving the yield and quality of the product from waste pine.

(8) Investigation of the adulteration of turpentine.

(9) Investigation of the destructive distillation of wood.

This laboratory will hold itself in readiness to cooperate, so far as its facilities will permit, with the other Bureaus and Divisions of this and other Departments in work which comes within its province.

#### PROPOSED WORK IN CHEMICAL GEOLOGY.

The investigations in chemical geology are to be continued in practically the same lines as heretofore. More attention, however, will be devoted in the future to the chemical control in the production of wine. This work will render necessary collaboration with those interested in the wine and cider industries in different localities, in order that practical skill may be combined with the chemical control and the work may be conducted with the least expense and lead to the most valuable results.

