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REPORT

U. S. Department of Agriculture.

OF

# THE CHEMIST

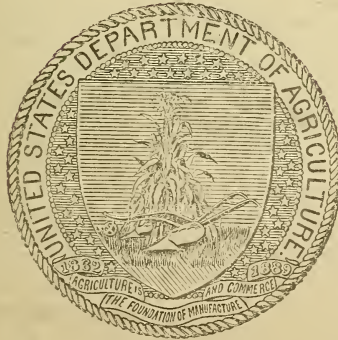
FOR

1901.

BY

H. W. WILEY.

[FROM ANNUAL REPORTS, DEPARTMENT OF AGRICULTURE.]



WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1901.

## CONTENTS.

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	Page.
Work of the year.....	95
New work.....	95
Investigation of the influence of environment on the sugar content of the beet.....	96
Influence of environment on the gluten content of wheat.....	97
Investigation of insecticides.....	98
Soil studies.....	99
Composition and adulteration of foods.....	99
Investigation of imported foods.....	100
Investigation of foods intended for export.....	101
Chemical composition of wines, ciders, and other fermented beverages.....	101
Collaborative work with divisions of this Department.....	102
Collaborative work with other Executive Departments.....	102
Treasury Department.....	102
War and Navy Departments.....	103
Post-Office Department.....	103
Interior Department.....	103
Collaborative work with the Association of Official Agricultural Chemists.....	103
Plan of work for the fiscal year ending June 30, 1902.....	104
Soil work.....	104
Composition and adulteration of foods.....	104
Investigation of sugar-producing plants.....	104
Chemical composition of wheat.....	105
Effects of cold storage on the chemical composition of foods.....	105
Chemical composition of wines, ciders, etc.....	105
Dendro-chemical investigations.....	105
Dairy chemistry.....	106
Revision of Bulletin No. 13.....	106
Insecticides.....	106
Collaboration with the Association of Official Agricultural Chemists.....	106
Investigation of road materials.....	106
Collaboration with other Departments of the Government.....	107
Proposed work for the fiscal year ending June 30, 1903.....	107
Food studies.....	107
Study of plant foods.....	107
The composition of sugar-producing plants.....	108
Dendro-chemistry.....	108
Chemistry of dairy products.....	108
Investigation of materials used in road construction.....	109
Collaborative work with other divisions and Bureaus and with other Departments of the Government.....	109
Clerical services.....	109
Salaries of heads of laboratories.....	110
The form of the estimates.....	110
Wording of the appropriation bill.....	110
Recommendation regarding chemical work.....	110
Conclusion.....	111

## REPORT OF THE CHEMIST.

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U. S. DEPARTMENT OF AGRICULTURE,  
BUREAU OF CHEMISTRY,  
Washington, D. C., July 24, 1901.

SIR: I beg to submit herewith a statement of the work carried on in the Division of Chemistry for the fiscal year ended June 30, 1901, with plan of work in the Bureau of Chemistry for 1902 and proposed work for 1903.

Respectfully,

H. W. WILEY,  
*Chemist.*

Hon. JAMES WILSON, *Secretary.*

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### WORK OF THE YEAR.

#### NEW WORK.

The most important new work during the year was the establishment of a laboratory for the investigation of the physical and chemical properties of the materials used in building roads. This work has both a high scientific and practical value in the construction of good roads.

It is a well-known fact that the agricultural value of farm products depends largely upon the accessibility to markets. Accessibility to a market is not judged alone by distance in miles from the place where the crop is grown; it is judged rather by the facilities and cheapness of transportation. New York City is a market which is reasonably accessible to the West India Islands, on account of the cheapness of transportation by water. It is, however, judged from a market point of view, at a great distance from many places in New York State, in the Adirondacks for instance. Farms which lie within a few miles of a market are often so difficult to reach as to render it almost impossible to realize any profit on the products of their fields. The building of good roads is, therefore, directly related to the progress of agriculture.

It is perfectly evident that many millions of dollars have been wasted in the building of roads because the nature of the material used for surfacing has not been known. The surface of a road must be hard enough to resist the ordinary wear and tear of traffic, and should be composed of materials which, when reduced to powder, have a certain cementing value which prevents the comminuted particles from being removed by wind and water. The character of the materials used in a road must also be adapted to the kind of traffic to which the road is to be subjected. A roadway constructed for the light carriage traffic of a city and its suburbs should be composed of quite different materials, placed in a different manner, from a road over which heavily loaded wagons are to be drawn.

All these problems connected with the nature of road materials are of a physical and chemical nature. It is true they can all be worked out by actual experience, but experience in this case is extremely costly. The most certain and economic way of solving these problems is in the laboratory. There small quantities of material can be subjected to all the tests of stress, friction, and cementation to which they would be subjected if actually placed in a road for use. Thus, with only a very small quantity of material, had at a comparatively low cost, the actual value of the material can be ascertained with a high degree of accuracy.

For the purpose of studying these problems, a laboratory, as has been stated, was established in the basement of the chemical building, in which a large part of the machinery necessary to the testing of road materials has already been installed. No chemical work in connection with the structure of road materials, in relation to their surfacing and cementing properties, was undertaken during the year, by reason of a lack of chemical force. Full preparation, however, was made for the beginning of this interesting part of the investigations during the present fiscal year.

#### INVESTIGATION OF THE INFLUENCE OF ENVIRONMENT ON THE SUGAR CONTENT OF THE BEET.

Since the beginning of the investigation of the chemical composition of sugar-producing plants by the Division of Chemistry, now more than a quarter of a century ago, the great influence of environment, that is, soil and climatic conditions, upon the sugar content of the beet has been recognized. By reason of the extreme variation in environment of this nature in different parts of the United States, it is evident that this influence is more pronounced in the case of the beets grown in this country than in those grown in Europe. In a general way, for the last fifteen years the Division had been able to point out with a reasonable degree of accuracy the areas in the United States which, in the light of the investigations which had been conducted, were best suited to the growth of sugar beets with a maximum content of sugar. These widely extended investigations, covering a period of nearly thirty years, formed a substantial basis from which to begin in a more systematic way the practical study of the influence of environment.

The object in view was to determine, first of all, the exact force of environment, and, second, by analysis of the various factors of environment to determine those which were most active either in increasing or diminishing sugar content.

It is evident that in a study of this kind the Division must have recourse to the collaboration of other Bureaus and workers. In the present instance the Division was most fortunate in securing the active cooperation of the Weather Bureau in determining as nearly as possible the conditions of the weather during the periods of growth of the experimental fields. It was also fortunate in securing the active and hearty cooperation of a number of the agricultural experiment stations, which were selected with a view of securing as widely different conditions of environment as could be obtained. The stations cooperating in this work were those of Indiana, Iowa, Kentucky, Michigan, North Carolina, Utah, Virginia, Wisconsin, and the two stations in New York. The plan adopted for the work was as follows:

A high-grade beet seed of uniform character was distributed to each of the collaborating stations. Portions of the same lot of seed

were also planted at the experiment station of the Department on the island below Long Bridge, District of Columbia. Each collaborating station kept a complete field record of its operations, including the method of preparing the soil, time of planting, character of cultivation, and time of harvest. The observers of the Weather Bureau, at or near the points at which the experiments were made, kept a regular, full record of precipitation, temperature, and hours of sunshine. Analyses of the beets grown were made both at the collaborating stations and in this laboratory. Since the beets were all produced by seed of the same kind, grown in the same locality and of the same quality, and since the conditions, aside from environment, were practically the same in all cases, it is evident that any variation in the chemical composition of the beets produced must have been due to soil and seasonal influences.

The analytical data were tabulated, and from these data descriptive charts were drawn, three in number. In each of the three charts the content of sugar was taken as the basic line of illustration. The collaborating stations, together with the station at Washington, D. C., were arranged in the order of the sugar content. The first chart represents by platted curves the percentage of sugar in the beets, the latitude of the collaborating stations, the hours of sunshine in a percentage of the total possible sunshine, and the distribution of sunshine by months, that is, the number of clear days calculated on a scale of 30.

The second chart contains, platted in like manner, the sugar in the beets in percentage, the total rainfall on a scale of inches, the altitude, being the distance of the collaborating stations above the sea level in feet, and the distribution of rainfall by months, scale in inches.

The third chart contains the percentage of sugar in the beets, the coefficient of purity of the juice of the beets on a scale of 100, the temperature during the growing months, scale in degrees Fahrenheit, and the average length of the days, scale in hours and minutes.

These charts, with the accompanying text, are believed to present the first really systematic statement of the effects of environment upon the sugar beet which has ever been published in this country. This is said without casting any reflection whatever upon the previous publications of this Department on the same subject. It must not be forgotten, however, that the previous publications were merely incidental to the principal end which was kept in view, viz, the determination of the sugar content of the beet over wide areas of distribution. A bulletin containing the chemical data, descriptive text, and the graphic charts above mentioned will soon be published.

#### INFLUENCE OF ENVIRONMENT ON THE GLUTEN CONTENT OF WHEAT.

Under authority of Congress, the investigation of the influence of environment on the gluten content of wheat was conducted through the collaboration of experiment stations in different parts of the country. The stations engaged in the work were those of California, Colorado, Indiana, Kentucky, Maryland, Michigan, and Missouri. The wheat which was sown at these various stations was all of the same kind. The chemical composition of this wheat was carefully determined before the distribution of the seed. Samples of the wheat grown in the different stations were sent on for analysis and the analytical data were obtained in the same manner as in the original

sample. The results were of the most surprising nature, showing that even in the course of a year the influence of environment was so great as to cause a variation from the original content of gluten of 50 per cent or more. In most instances the content of gluten was less than in the original seed. In one or two cases it was greater.

In addition to the study of the gluten content, as has been mentioned, a complete analysis of the wheat was made; sections were also made for microscopical examination for the purpose of showing any alteration in the character of the grain itself. When the extent of these variations has been carefully determined and the causes which produce the variations ascertained, in so far as possible, valuable practical deductions can be drawn which will help scientific farmers to a certain extent to control the content of gluten as well as of other valuable materials in the crop. Since for bread making and macaroni making the content of gluten is of the utmost importance, it is evident that the value of a wheat in the market can be greatly increased if some practical method of maintaining and increasing the gluten content can be devised.

#### INVESTIGATION OF INSECTICIDES.

In collaboration with the Division of Entomology, the determination of the chemical constituents of the insecticides sold throughout the United States was continued and completed, in so far as we are able to secure the samples. It is believed that we have secured, through the collaboration of the Division of Entomology, a sample of every insecticide which is made in any quantity in the United States. Some remarkable facts have been brought out in this investigation. The most important to the farmer, from the practical point of view, is that many of the so-called insecticides contain only a mere trace, or none at all, of insect-killing drugs or poisons. In many others where poisonous principles were present we found them so diluted and adulterated with inert materials as to greatly lessen their value for the purpose for which they were sold, without correspondingly diminishing their price to the consumer. It is not right that a farmer should risk his potatoes, tobacco, or other crops subject to insect ravages by reason of the worthless character of the insecticide which he purchases. While there is no National law regulating the subject, it is believed that an investigation of this kind will awaken the interest of farmers throughout the country to the necessity of at least enacting State laws for their local protection, eventually leading to a National law which will make the State laws more effective and the protection to the farmer more certain.

It is, of course, evident that the only object of adding inert substances to insecticides is to increase weight without correspondingly diminishing the selling price. There can be no objection to the diluting of a powerful insecticide with some inert substance for the purpose of rendering its action less vigorous, and thus preventing its injuring the crop. In such a case, however, every package of insecticide as sold should bear a plainly printed label on which the character of the diluent and the amount thereof employed are distinctly set forth. The purchaser, then, would not be the victim of a fraud, and if he should not care to purchase a cheapened article, thus described, he could simply invest in other and more powerful remedial agents.

The results of this investigation have been prepared for publication in two forms: One, a Farmers' Bulletin, in which some of the general principles relating to the composition of insecticides are set forth,



with illustrations of adulteration given by numerous citations from the work done in the Division; the other giving in more technical form full details of the work, describing the methods employed and the analytical data obtained and soon to be submitted as one of the technical publications of this Bureau.

#### SOIL STUDIES.

The studies of soils, in relation to their composition as affecting plant growth and the nature and character of the microorganisms which they contain, authorized by Congress, have been pushed steadily forward. The magnitude of this work has been described in previous reports. It is only proper to add, however, a brief statement of what was done during the year.

After five years of experimentation, the soils were thoroughly sterilized so as to destroy adventitious ferments, and the proper ferments were added to the sterilized soils by seeding the pots with some solution of soil taken from a very fertile spot. The pots were thus prepared for a new series of determinations which it is proposed to carry forward during the coming five years.

The data of the first five years have now been collected and are ready for publication in the following particulars:

(1) The chemical composition of the soils, as determined by all the standard methods.

(2) The available plant food in the soils as determined, first, by all the ordinary chemical methods; and, second, by the quantities of plant food removed from the soil during a period of five years, with two crops each year, making a total of ten crops.

(3) The relation of available fertility in the soil to the production of crops, studied by a new method devised in the Division, whereby the soil is subjected to the solvent action of a very weak solution of hydrochloric acid, at a temperature of 40°, for a definite period of time.

This late method of treatment has been more successful in establishing the relation between the availability of plant food in the soil, as determined by chemical analysis, and the actual crop produced than any other method now in vogue. The data obtained in this way so far relate solely to the availability of the phosphoric acid and potash. For the purpose of including the nitrogen content of the soil in these investigations a new series has been commenced, in which all three of the elements mentioned, viz, phosphoric acid, potash, and nitrogen, will be taken into consideration in the discussion of the problem.

The importance of this investigation will only be fully appreciated when, in case the laboratory data are borne out by practice in the field, it can be shown that a full and speedy soil survey, from a chemical point of view, can be made of a field without the elaborate and time-consuming investigations which heretofore such studies have required.

#### COMPOSITION AND ADULTERATION OF FOODS.

During the year the chief part of the work done in this direction was in the investigation of preserved foods, preserved meats, especially canned meats of all kinds, and the delicatessen of animal origin kept in high-grade grocery stores. In order to have a solid scientific basis for these investigations, fresh meats were secured, their composition determined, and then the meats canned in the ordinary way. After a time the cans were opened and the meats they contained

subjected to chemical examination. By this method a direct comparison was secured between the great number of meat products examined and the original fresh products from which they were made. The amount of chemical work involved in this examination was of great magnitude, and the bulletin containing the data of this work will consequently be of a bulky nature. It is now ready for submittal.

An elaborate investigation was also made of the character of horse meat, with the object of determining whether or not it is sold surreptitiously in this country for beef and also to determine whether or not when mixed with other meats, as in the instance of making sausage, the parts derived from the horse could in any way be identified. The two obvious methods of procedure which would be naturally suggested in this case were followed, viz, (1) microscopic examination of the meat fibers and (2) determination of the chemical composition of the mixtures. To this end mixtures of horse meat with other meats in known proportions were made, converted into sausage, and afterwards given to the analysts without their knowledge of its contents for the purpose of determining whether or not horse meat was contained therein. The microscopic efforts in this line were futile, since it was not possible to discover with certainty the fibers due to horse meat in a mixture of that meat with certain other forms previously subjected to the vigorous action of the sausage grinder.

In the study of the chemical composition as a means of discriminating between horse meat and other kinds of flesh, more favorable results were obtained. The meat of the horse contains quite a large quantity of a sugar-producing substance known as glycogen. Other common edible meats, with the exception of the meat of the lobster, crab, and crayfish, contain only small quantities of this substance. It is evident, therefore, that a determination of glycogen in a mixture would be a valuable indication in regard to the origin of the meats therein in so far as the horse is concerned. When the elucidation of this problem was begun, however, it was discovered that none of the accepted standards of examination was satisfactory. It was, therefore, first of all necessary to develop, by modification and otherwise, a method of determining glycogen in horse meat which was reasonably accurate. This, happily, was accomplished, and we were then able to detect the presence of horse meat in a mixture, provided the amount thereof was not reduced to too low a percentage. Working with the greatest care, it is believed that as little as 10 per cent of horseflesh with beef can be detected with certainty by the methods used in this laboratory and described in full in the forthcoming bulletin above referred to.

Not only is it possible to use the glycogen content for the purpose of detecting a mixture of horse meat in sausages, but the iodine number of the fat is also valuable. The iodine absorption of the fat of horse meat is very distinctly higher than that of beef, when both are determined in the fresh state, and this is an additional evidence on which a discrimination between the two can be based.

In the case of smoked meats, however, this number is not so valuable, since it has been found that in the fat of beef after smoking, the iodine number is markedly higher than it was before.

#### INVESTIGATION OF IMPORTED FOODS.

Under renewed authority from Congress, the work of the investigation of the character of imported foods was carried on during

the year, and the reports of these investigations have been confidentially submitted to the Secretary of Agriculture. The value of the data which have been obtained in this way, however, is so great as to warrant the belief that their publication would be advisable. The scope of this investigation has been very broad, including wines and beers, dairy products, especially cheeses, salad oils, delicatessen of all kinds, preserved fruits, jellies, jams and marmalades, and, in fact, nearly every article of food imported. These data would be so valuable to the food chemists of this country and to food experts in general, if published, that I am led to recommend their collection into a form proper for publication as a bulletin of the Bureau of Chemistry.

#### INVESTIGATION OF FOODS INTENDED FOR EXPORT.

Congress has authorized the Secretary of Agriculture, through the Division of Chemistry, to inspect food products intended for export to foreign countries where chemical and physical tests are required of foods offered for sale. Unfortunately, Congress gave no appropriation for carrying this work into effect, and therefore it has not been possible to institute the control contemplated by the act. Full preparation, however, has been made for the inception and prosecution of this work whenever the funds are forthcoming, and as a preliminary step a careful study of the foreign laws regulating the sale of foods has been made. The results of this investigation were published as Bulletin No. 61 of the Division of Chemistry. Exporters of foods interested in knowing to what tests their exports will be subjected in foreign countries can ascertain them by applying to the Secretary of Agriculture for a copy of the bulletin mentioned.

#### CHEMICAL COMPOSITION OF WINES, CIDERS, AND OTHER FERMENTED BEVERAGES.

Work has been continued during the year, in collaboration with the viticultural associations of the country, in a study of the composition of American wines. This work was particularly opportune in consequence of the exhibition of a large number of standard American wines at the World's Fair in Paris. Not only were our own wine makers gratified, but the wine growers of Europe were somewhat astonished at the fine showing made by our wines in Paris. More than 90 per cent of all the samples exhibited received awards. When it is remembered that only about 40 per cent of the objects exhibited received recognition, this high number for our own wines is extremely flattering. Among the awards was a large percentage of gold and silver medals, and, in one instance, an American wine was marked the highest possible number below that which would have entitled it to the grand prize, viz, 18 on a scale of 20. Had it not been that the particular wine in question bore as parts of its label names indicative of foreign origin it is probable that it would have received the grand prize.

Not only the American still wines, but, what is more surprising, the American sparkling wines received very high awards. When it is borne in mind that the jury was composed almost exclusively of foreigners, having only two American representatives, and that there was a certain trade prejudice against American wines, this high rating becomes the more noteworthy.

In connection with this study a special agent of the Department was

commissioned to go into the wine districts of southern France for the purpose of studying particularly the methods of vinification employed and to ascertain whether or not any adulterations were practiced. A valuable report of the observations of this special agent is almost ready for publication.

Another special agent of the Department was commissioned to study the methods employed in cider making in England, France, and Germany, with special reference to the influence of the different ferments upon the chemical composition of the product. Large numbers of samples of these ciders have been analyzed in the Division in Washington, and a report of the special agent, together with a report of the chemical study, will soon be ready for publication.

The practical information in these reports will be of the greatest value to the wine and cider makers of our country in helping them to secure a product from the ripened fruits of a high grade and a greater market value than heretofore. In this way the chemical studies supplement the practical work of the orchardist and viticulturist by taking their product after the ripening of the fruit and showing in what way the best composition of the wines and ciders can be secured.

#### COLLABORATIVE WORK WITH DIVISIONS OF THIS DEPARTMENT.

In addition to the collaborative work mentioned above, the Division conducted extensive investigations during the year in dairy products for the Bureau of Animal Industry. For the Division of Vegetable Physiology and Pathology an extensive series of analyses of wheats used for the manufacture of flour employed in making macaroni was undertaken and completed. This work was supplemented with a chemical study of the macaronis themselves. All the data of these cereal investigations have been transmitted to the Bureau of Plant Industry, and I believe will soon be published.

#### COLLABORATIVE WORK WITH OTHER EXECUTIVE DEPARTMENTS.

The collaborative work with other Executive Departments of the Government continued during the year.

#### TREASURY DEPARTMENT.

In order to make the collaborative work more useful to the Treasury, the chief of the Division of Chemistry was, with the consent of the Secretary of Agriculture, appointed during the year by the Secretary of the Treasury as supervisor of sugar tests for the appraisers' laboratories at Philadelphia, New York, and Boston. In connection with this work a systematic check test of exchange samples of sugar was carried on in the laboratory of the Division during the year. The manual and clerical labor necessary to this work would be justly charged to the account of the Treasury, but so far it has been given by the Department of Agriculture without expense to the Treasury.

This work is of the greatest importance on account of the fact that the levying of duties on imported sugars is determined wholly, with the exception of high-grade white sugars, by the polariscopic test. The importance of having this correct and uniform is, therefore, at once apparent. The results obtained in the laboratory of the Division, with those secured in the various laboratories of the appraisers above mentioned, are compared monthly, and if any notable discrepancy is

discovered attempts are at once made to ascertain the cause of such discrepancy and to devise means for obviating it. The result of this collaborative work is that the various chemists in the appraisers' laboratories are working more and more upon a uniform plan and securing by far more uniform classifications than have ever heretofore been obtained.

## WAR AND NAVY DEPARTMENTS.

During the year large numbers of samples of foods and supplies for the Army and Navy have been examined in the Division of Chemistry upon request addressed to the Secretary of Agriculture. Most of these examinations have been for food supplies, but many of them have been for clothing and other things necessary to the Army and Navy at home and in the Tropics.

It seems desirable that there should be some central laboratory of this kind where the various Departments of the Government can secure chemical services, and the equipment and scope of the work of the Bureau of Chemistry seems to indicate that it is here that such work will be principally done. This is the more probable on account of the hearty sympathy of the Secretary of Agriculture with the other Departments in their efforts to secure a proper chemical control of the foods and supplies which are demanded for the public service.

## POST-OFFICE DEPARTMENT.

A number of investigations was made during the year for the Post-Office Department with reference to the composition of articles which it was desired to have forwarded through the mails and in the study of problems submitted by the Postmaster-General relating to the needs of his service. Among these may be mentioned the examination of inks, used not only in the service of the Post-Office Department, but by the Department of State and many other Departments of the Government. It is important that these inks should be plain, legible, and, so far as possible, indelible. Large numbers of such inks have been submitted to us by the Post-Office and State Departments. Their composition has been studied, the character of the imprints they made ascertained, and reports made in regard to comparative efficiency to the various Departments requiring our aid.

## INTERIOR DEPARTMENT.

The Division of Chemistry continued its cooperation with the Interior Department in regard to the study of the composition of all the important springs on the Government reservation at Hot Springs, Ark. This work employed one of the chemists of the Division for the greater part of the fiscal year, and the salary and traveling expenses of this chemist were paid by the Department of the Interior. The general details of the results of the investigation have been reported from time to time through the Secretary of Agriculture, and it is believed that a full report on this investigation will be ready to go forward not later than the first of November.

## COLLABORATIVE WORK WITH THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS.

The cooperative work with the Association of Official Agricultural Chemists has been prosecuted during the year as usual. All the

referees of the association sent samples to the División for comparative determinations.

The annual meeting of the association was held, as usual, under the patronage of the Secretary of Agriculture. The proceedings of this meeting were published as Bulletin No. 62 of the División of Chemistry.

#### PLAN OF WORK FOR THE FISCAL YEAR ENDING JUNE 30, 1902.

By act of Congress, the División of Chemistry, on the 1st of July, 1901, became a Bureau. This change in name and status of the División, however, did not in any way interrupt the character of the work already undertaken. It did, however, open the way to a much broader field of work in the way of collaborating with the various Divisions and Bureaus of the Department and with the other Departments of the Government.

#### SOIL WORK.

The investigation of soils, with relation to determining their chemical constituents available as plant food, will be continued in the line of work described in the first part of this report.

#### COMPOSITION AND ADULTERATION OF FOODS.

During the fiscal year this work will be directed chiefly to a study of infants and invalids' foods and to the adulteration of salad oils. It has been a matter of comment that alleged pure olive oils are imported into this country and sold at a price below the market value of the pure olive oils of California. The object of the study will be to determine whether or not the imported so-called olive oils are really pure.

In the case of infants and invalids' foods, an attempt will be made to study all the leading brands upon the market for the purpose of ascertaining, first, in the case of infants' foods, whether their composition resembles that of the natural food of the infant, and, second, in the case of invalids' foods, whether they contain the proper nourishment and in the proper form for the sustenance of invalids whose digestive organs are usually far below the normal standard.

#### INVESTIGATION OF SUGAR-PRODUCING PLANTS.

This work will be continued during the present fiscal year on the lines already referred to. The collaboration of the experiment stations in studying the effect of environment on the composition of the beet will be continued. Miscellaneous analyses of samples sent in by farmers throughout the country will be made. An experimental plot planted to several varieties of beets is growing at the Department's station on the island below Long Bridge, District of Columbia. A complete series of studies of this plot will be conducted.

Arrangements have been made with Capt. D. G. Purse, president of the Board of Trade of Savannah, for a systematic examination of the soils in southern Georgia and Florida on which sugar cane is grown for the manufacture of molasses, sirups, and sugars. Samples of these canes will also be forwarded for analysis during the harvesting season.

The presence of sugar in the muskmelon or cantaloupe is one of the

most desirable properties for table consumption. The excellence of these melons is usually judged by their sweetness. An extensive comparative study of melons has been arranged for in cooperation with a number of experiment stations. The melons are all grown from the same variety of seed, and in so far as possible the cultivation has been the same. The difference in composition will therefore show the influence of environment upon the sugar content of this highly prized product.

#### CHEMICAL COMPOSITION OF WHEAT.

The collaboration of a number of experiment stations in determining the influence of environment upon the chemical composition of wheat will be continued for the present year. In connection with these studies, a complete system of milling has been arranged for whereby the flour-producing properties of the cereals can be determined in connection with their chemical composition. It is proposed to supplement this grinding with baking tests to determine the qualities of the flour for bread making.

The properties of other cereals in respect of their technical uses is another branch of chemical investigation which will be undertaken during the year. This is particularly true of barley used for the preparation of malt and the development of the diastatic ferment for converting starch into sugar.

#### EFFECTS OF COLD STORAGE ON THE CHEMICAL COMPOSITION OF FOODS.

In conjunction with the National Warehouse Association an investigation of the effects of cold storage on the composition and nutritive value of foods will be undertaken. The association will bear the expense of the storage and transmission of the samples. The line of work marked out is, first, the determination of the composition and nutritive value of the foods when placed in storage, and, second, the withdrawal of certain portions of the whole amount, from time to time, for a similar examination. The length of time for the whole study will be that of the usual time of storage.

#### CHEMICAL COMPOSITION OF WINES, CIDERS, ETC.

In conjunction with the viticultural associations of the country, and in collaboration with the agricultural experiment station at Blacksburg, Va., extensive analyses of wines and ciders will be made. The object of these analyses is to determine the chemical composition of wines and ciders, with reference to the effect which different processes of vinification and fermentation have upon the chemical properties. The importance of this investigation to our fruit-growing interests is evident. A work of this kind will supplement in a practical way the work of the orchardist and viticulturist by showing the best methods of securing a higher grade product for the market after the fruits have been grown.

#### DENDRO-CHEMICAL INVESTIGATIONS.

Extensive investigations of the chemical composition of forest products of the country will be undertaken in collaboration with the Bureau of Forestry. The first work of this kind will be the study of the tannin products in the different varieties of tannin-bearing trees. There has

never been a systematic study of the chemistry of our forest products, and this work promises much of interest and benefit in this direction.

#### DAIRY CHEMISTRY.

In collaboration with the Bureau of Animal Industry, the study of dairy products will be continued. Many problems of great importance await investigation, and work will be done in this line in so far as the routine analyses of dairy products will permit.

#### REVISION OF BULLETIN NO. 13.

The early editions of the parts of Bulletin No. 13, on food adulteration, are out of print. Work has already been commenced toward the revision of these parts, for which such an unusual demand has been made. A large amount of material for the rewriting of Part I, on dairy products, has already accumulated. Work has already been commenced for the rewriting of the part devoted to tea, coffee, and chocolate. Other parts of the bulletin will be revised and brought up to date as soon as possible.

#### INSECTICIDES.

The study of insecticides, in collaboration with the Division of Entomology, will be continued for the purpose of making a complete study of the chemical composition of all the insecticides sold in the United States. This work will be devoted to the study of the composition of new forms of insecticides as they are brought upon the market.

#### COLLABORATION WITH THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS.

This very important part of our work will be continued during the year in all branches of investigation. The Secretary of Agriculture has made the referees of the association special correspondents of the Department, whereby they are privileged to use the frank of the Department in correspondence relating to their work and in transmitting samples for comparative study. There is probably no branch of the work of the Division, now Bureau, of Chemistry which has been of such direct practical benefit to the farming interests as the work of this association. The existence of the association has been made possible only through the patronage of the Department, which has made its work a part of the studies of the Division, and enabled the results of its proceedings to be placed in a suitable form in the hands of agricultural analysts throughout the country. This work has been fully appreciated, not only in this country, but also in Europe, and the official methods adopted by the association are now accepted throughout the world as standard methods of analysis.

#### INVESTIGATION OF ROAD MATERIALS.

The laboratory for the investigation of road materials will be more fully equipped during the year, and, in collaboration with the Office of Public Road Inquiries, an extensive investigation will be made of the physical and chemical properties of the materials used for road building.



## COLLABORATION WITH OTHER DEPARTMENTS OF THE GOVERNMENT.

The work of supervision of the sugar laboratories of the appraisers of customs in Philadelphia, New York, and Boston will continue to be directed by the Chief of the Bureau of Chemistry under the agreement between the Secretary of Agriculture and the Secretary of the Treasury.

The examination of foods and other supplies for the commissary department of the War and Navy will be continued.

The work in water analysis for the Interior Department will be completed about November 1, 1901.

The examination of miscellaneous articles, of inks, substances supposed to be unmailable, etc., for the State, Post-Office, and other Departments will be continued.

**PROPOSED WORK FOR THE FISCAL YEAR ENDING JUNE 30, 1903.**

The proposed work for the year ending June 30, 1903, will be a development and extension of the lines of work already pointed out. An effort will be made to complete the organization of the Bureau of Chemistry so as to segregate, so far as possible, the different lines of investigation. It is evident, however, that all forms of chemical work are interlocked in such a way that a complete segregation is not desirable nor possible. The principal lines of work for the Bureau of Chemistry, as planned up to the end of the fiscal year June 30, 1903, are as follows:

**FOOD STUDIES.**

The study of the composition, adulteration, and nutritive properties of foods will be devoted particularly to a revision of Bulletin No. 13. The object of this work will be to extend the investigations to bring the work up to date and to coordinate in a better manner than was possible in the first series of investigations the different parts of the work. The food laboratories will afford one of the principal fields of investigation for the Bureau.

Congress has authorized the Secretary of Agriculture, through the Bureau of Chemistry, to analyze and certify to the character of exported food products sent to countries where physical and chemical tests are required in commerce in foods. There is, perhaps, no part of the work of the Bureau which would be of more practical advantage in enlarging our foreign markets than this. Unfortunately, no funds were appropriated to carry out the provisions of the act of Congress, and therefore a special appropriation is recommended in the estimates for the purpose mentioned. If Congress will give the required funds, we will be able to send our food products abroad with a certificate of character which will not permit them to be lightly dealt with by officials of foreign countries interested in excluding them from their markets.

**STUDY OF PLANT FOODS.**

The investigation of soils, in regard to the available plant food which they contain, and fertilizers will be continued and extended in collaboration with the Association of Official Agricultural Chemists. It is believed that the investigations which have already been completed have opened a new field of study which is full of promise for practical agriculture.

## THE COMPOSITION OF SUGAR-PRODUCING PLANTS.

The increasing interest in this country in the sugar industry renders it advisable to continue, somewhat more systematically, the investigations which the Division of Chemistry has conducted during the past quarter of a century on sugar-producing plants. The appropriation to be asked for will include the study of all sugar-producing plants, viz, sorghum, sugar cane, and the sugar beet. The consumption of sugar is rapidly increasing, and, even with the aid of our insular possessions, we are still very far from supplying our own consumption. There is, perhaps, no other one industry, the development of which means so much to our agricultural interests, as that of our domestic sugar supply. This can only be accomplished in conjunction with careful chemical studies of the plants themselves, the changes which they suffer by environment, and the foods which supply their growth. It is hoped that this branch of investigation in the Bureau may include the following points:

(1) The collection of statistics relative to the sugar industry of the United States and its possessions.

(2) Investigations and collection of data concerning the adaptability of various parts of the United States to beet and sugar-cane production.

(3) Collection of technical data relative to the foreign sugar industry, for the purpose of keeping domestic producers advised of new methods in manufacture, etc.

(4) Publication, at regular intervals, of circulars including abstracts of descriptions of new methods, processes, machinery, and of investigations appearing in foreign sugar journals.

## DENDRO-CHEMISTRY.

The progress of the Bureau of Chemistry will be, perhaps, more pronounced in the direction of dendro-chemistry than in any other one line of investigation. It is proposed to undertake, in collaboration with the Bureau of Forestry, investigations of the constitution of trees, products of distillation of wood, manufacture of wood alcohol, wood tar, acetone, and other products of the destructive distillation of wood; investigation of tanning materials, manufacture of tanning extracts, studies of distribution of resins and gums in wood, investigations of the use of wood pulp for paper making, the manufacture of cellulose, studies of the methods of preserving wood, and other chemical and techno-chemical processes relating to forest products.

## CHEMISTRY OF DAIRY PRODUCTS.

The investigation of the chemical composition of dairy products will be continued, in collaboration with the Bureau of Animal Industry, and all proposed methods which have any promise of merit will be investigated. By act of Congress, the exporters of food products which are subjected to chemical and physical tests in foreign countries have a right to demand in the Bureau of Chemistry an analysis and certificate of the character of their goods before shipment. This work, when funds are provided for it, will be a prominent feature of the investigation. There are many other chemical questions connected with the composition of foods fed to dairy cows, and the effects pro-

duced on the chemical composition of butter, which demand further investigation.

#### INVESTIGATION OF MATERIALS USED IN ROAD CONSTRUCTION.

It is hoped that the investigations conducted in the Bureau of Chemistry in this important line may take first rank among similar investigations in different parts of the world. To this end this laboratory should be enlarged and more fully equipped and its working force increased. It is only in this way that the best results can be obtained and applied in the most practical manner.

#### COLLABORATIVE WORK WITH OTHER DIVISIONS AND BUREAUS AND WITH OTHER DEPARTMENTS OF THE GOVERNMENT.

This feature of the work of the Bureau of Chemistry becomes more important each year. Definite arrangements for collaboration are now in force and will, without doubt, be continued for the fiscal year ending June 30, 1903, with the Bureau of Forestry, with the Office of Public Road Inquiries, and with the Division of Entomology. A less definite system of collaboration is also established with the Bureau of Animal Industry and with the Bureau of Plant Industry. It is hoped that all these methods and systems of collaboration will assume definite form so as to secure the highest results more economically. For this purpose, I believe it is the unanimous opinion of all those interested in this collaboration that the appropriations for this work should be made directly to the Bureau of Chemistry instead of to the collaborating Divisions and Bureaus, and then assigned to the Bureau of Chemistry.

The collaboration with other Departments of the Government will undoubtedly also be continued and enlarged, as the tendency to the growth of this collaboration has been very great within the past two or three years. Since this collaboration has employed during the past year the time of at least two assistants in the Division, it is evident that a special appropriation should be made covering it. The Departments of the Government interested in this matter will thus be directly benefited and the organic relation of the Bureau of Chemistry of the Department of Agriculture to the general chemical work of the Government be strengthened.

#### CLERICAL SERVICES.

The expansion of the Division of Chemistry into a bureau, enlarging its work and perfecting its affiliations with other Divisions and Bureaus, and with other Departments of the Government, render necessary a considerable increase of the clerical force. The work of the Bureau of Chemistry peculiarly demands extra clerical services on account of the large amount of computation and tabulation which it requires, as well as the extensive correspondence involved. Through the courtesy of the Division of Statistics we have had a great deal of help in this line during the past year or two, but it is hardly fair to expect this help to be continued when it should be provided for in the Bureau itself. The organization of two new laboratories and the completion of the equipment of three others, making five in all, also involve a considerable extension of the clerical service. As in the

other Bureaus, the services of a chief clerk are necessary. A property clerk has also become a necessity. Perhaps there is no other Bureau, with the possible exception of the Weather Bureau, that has so valuable a collection of property as is found in the Bureau of Chemistry. The platinum ware alone in the possession of the Bureau is worth several thousand dollars. A great deal of the property of the Bureau is constantly passing into use and has to be replaced. The services of an additional stenographer and typewriter are necessary, besides additional assistants for the tabulating work before mentioned.

For the present, it is the purpose of the Bureau to retain the clerical force in a single body and not distribute it among the different laboratories. It is believed that a more economical and efficient use of the force can be secured in this way than in any other.

#### SALARIES OF HEADS OF LABORATORIES.

Under the present appropriation only one assistant in the Bureau of Chemistry receives a salary of \$2,500. The importance of the laboratory work in the Bureau, it seems to me, is quite as great as that in any other, and merits an equal compensation. It is not my purpose to ask for the whole of this increase at once, but only for a moderate amount. It is therefore recommended that the heads of the laboratories receive from \$2,000 to \$2,500 each.

#### WORDING OF THE APPROPRIATION BILL.

In order that the scope of the work outlined in the Bureau of Chemistry may be fully set forth before the committee of Congress having charge of the appropriations, a draft of the appropriation bill, in so far as it relates to the Bureau of Chemistry, is submitted. In this draft the estimated amounts for each branch of the work follow each section, but placed in brackets. It is desirable that the whole amount for the Bureau be appropriated in one sum, which is placed at the end, in order not to complicate the accounts of the Disbursing Office.

#### RECOMMENDATION REGARDING CHEMICAL WORK.

I strongly recommend that all the work of the Department of Agriculture of a chemical nature not otherwise specifically provided for by law be assigned to the Bureau of Chemistry, to be conducted in accordance with a plan to be mutually agreed upon by the chief of Bureau and the officials desiring the work done, and approved by the Secretary. The establishment of chemical laboratories is expensive, and the distribution of chemical work under various directions will lead to duplication, overlapping, and unnecessary expenditure. It is evident that the best and most economical work can be done under a single bureau, and doubtless Congress in establishing such a bureau intended it to have charge of all the chemical work of the Department. Among the investigations of this kind we may mention the study of the nutritive value of foods. These investigations are chiefly chemical, and would find in the Bureau of Chemistry an appropriate direction. The Bureau of Chemistry has sometimes been held responsible for chemical publications with which it had nothing whatever to do and to which its attention was never called until after the publication had been made. It is evident, if in the public mind work of this kind is attributed to the Bureau of Chemistry, that this is an

additional reason why this Bureau should have the supervision of the work and its preparation for publication.

#### CONCLUSION.

In closing this part of the report, I desire to call your attention to the fact that the Bureau of Chemistry is now organically connected not only with other Bureaus and Divisions of the Department of Agriculture, but with at least three of the great Departments of the Government. Its work is of the utmost practical importance to the farmer and to the public at large. It should receive generous support at the hands of Congress, and the estimates submitted are as modest as is consistent with the actual work which the Bureau will be called upon to do during the fiscal year ending June 30, 1903.

