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U. S. DEPARTMENT OF AGRICULTURE.

REPORT

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OF THE

U. S. Department of Agriculture.

CHIEF OF THE DIVISION OF CHEMISTRY

FOR

1898.

BY

H. W. WILEY.

[FROM THE REPORT OF THE SECRETARY OF AGRICULTURE.]



WASHINGTON:

GOVERNMENT PRINTING OFFICE.

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U. S. DEPARTMENT OF AGRICULTURE.

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CHIEF OF THE DIVISION OF CHEMISTRY

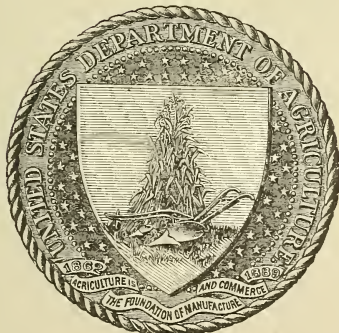
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CONTENTS.

	Page.
Work of the year.....	7
Composition and adulteration of foods	7
Cooperation with official chemist.....	9
Street sweepings, garbage, and sewage.....	9
Soils studies	10
Cooperative work with the Treasury	10
Sugar-beet investigations	11
Study of the composition of pigs.....	12
Cooperation with other Departments.....	12
Miscellaneous work.....	13
Outline of work for the year ending June 30, 1899.....	13
Statements regarding plan of work.....	14

REPORT OF THE CHEMIST.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF CHEMISTRY,
Washington, D. C., September 7, 1898.

SIR: I have the honor to submit herewith for your consideration the executive report of the Division of Chemistry for the fiscal year ended June 30, 1898.

Respectfully,

H. W. WILEY,
Chemist.

Hon. JAMES WILSON, *Secretary.*

WORK OF THE YEAR.

COMPOSITION AND ADULTERATION OF FOODS.

The investigations made in this line during the year ended June 30, 1898, were directed chiefly to completing the work on cereals and cereal products. The analyses, by the best modern methods, of samples of typical cereals collected from all parts of the United States afforded a reliable basis for the study of cereal products. Under the term "cereal products" are included the flours and meals made from cereals, together with the waste products incident to their milling and preparation. Since the chief object of the study is the composition and character of man foods, the studies of the waste or side products has only been of an incidental character. The number of such products is very great, including bran, germs, and coarse products of various degrees of nutritive value. These products are used chiefly for feeding domestic animals, but their nutritive and economic importance must not be neglected. So perfect has the system of milling cereals become and so sharp the competition, that a miller who would neglect the side products of his industry would speedily find the markets closed against him.

Starting from the mean composition of the principal cereals, as indicated above, the chemical studies of the products made therefrom have included the flours and meals, breads of every description, breakfast foods, sweetened cakes, and biscuits. In order to have the samples represent as nearly as possible the character of the products actually found on the markets they were bought, with few exceptions, in the open market, without intimation to the seller of the purpose to which they were to be devoted. While this method is the best

for ascertaining the character of cereal products entering into consumption, it renders a proper classification of the purchased samples extremely difficult. These products are often sold under names which are either misleading or wholly un-descriptive. In classifying the results of the analyses in tabular form, therefore, it was often uncertain where a given sample belonged. In many cases, however, the description obtained on the purchase of the sample was at least a guide to classification, and those samples which were wholly un-described were classified together as miscellaneous. In so far as is necessary to an accurate comprehension of the manner in which the various products are obtained, a brief description of the processes of milling and separating the milled products and methods of fermentation and baking are given. These are in no sense technical in their nature, but only in a general way descriptive of the chief methods of preparation. The chemical studies of these bodies have in many cases been supplemented with experiments in artificial digestion. By these studies the effect of the different methods of preparation and baking on the digestibility of the nitrogenous constituents has been determined.

Further, there has been marked out during the year a method whereby the heat-forming value of these foods can be accurately calculated from the data obtained by chemical analysis. This relation was established by an experimental study of the calories of combustion of the food products in compressed oxygen. The result of this work has been the addition to chemical processes of a new method of testing the accuracy of work. It is evident that a system of comparison established by hundreds of experimental determinations will furnish a valuable guide in the study of analytical data. Wherever there is a marked deviation between the numbers representing the calories of combustion determined directly and by calculation, the analyst is certain that some fault in the work must exist. These methods, which are purely scientific, have been published in various scientific journals. All the results of the work above outlined are collected and published as Part IX of Bulletin No. 13 of this division.

The researches made by this division in respect of food adulteration have been richly supplemented by the work of chemists in many of the States. The result has been the enactment of State laws regulating commerce in adulterated foods. As types of these laws, the statutes of Massachusetts, Connecticut, Ohio, and Kentucky may be cited. Many of the other States also have laws more or less comprehensive on the subject. The necessity of national legislation on this subject has long been apparent, for it is evident that State laws, however excellent and well executed, can not realize their full purpose without the supplement of Federal legislation. Bills regulating interstate commerce in adulterated foods are now before Congress and have met with your approval.

During the year extensive studies have been made in simple methods of detecting some common adulterants, and a report on that subject was presented to the Association of Official Agricultural Chemists and published in the last volume of the proceedings of that association.

An interesting study in the history of food adulteration has also been made in which many ancient laws relating to the matter have been discovered. This valuable contribution to the literature of food adulteration has been published in *Science*. The interests of honest agriculture, as well as of public health, are directly concerned in these studies.

COOPERATION WITH OFFICIAL CHEMISTS.

The valuable results of the cooperative work of the Department of Agriculture with the official chemists grow annually in importance. The official chemists who take part in the cooperative work are those connected with the various experiment stations and agricultural colleges, chemists attached to State boards of agriculture, State dairy control, and other industries employing chemists under State authority or direction, chemists of State boards of health, and municipal chemists and all others exercising in any way official control over food or other agricultural products. The total number of chemists in the United States eligible to membership in the Association of Official Agricultural Chemists is estimated at about 300, and nearly 100 attend the annual meetings. The Division of Chemistry, from the inception of this organization, fourteen years ago, has been in most intimate relations with it, and the Chemist has been the secretary and executive officer of the association for eleven years. The proceedings of the association are published annually as a bulletin of the Division of Chemistry, as are likewise the official methods of analysis authorized by the association. As a result of this systematic study of methods of investigation of soils, fertilizers, and agricultural products, the United States has now a uniform method of research everywhere practiced and recognized as official, both by trade chemists and the courts of justice. The nations of Europe have been impressed with the value of this work and are now organizing similar associations. It can be safely said that the value of the cooperation of this division, standing as it has for fourteen years as the recognized leader in this movement, is inestimable.

During the time of your administration the bond of union between the Department and the association has been strengthened, both by your personal participation in the meetings of the association and by your cordial sympathy with the aims and motives of its work. A perusal of the volumes containing the proceedings of the association will show how large a part of the work has been done under the auspices of this division and how cordial has been the cooperation between its members and the other members of the association. In view of the facts presented above, the question arises whether it would not be proper to recognize in some more official way the intimate relations outlined. A recommendation by you to Congress to recognize the existence of the Association of Official Agricultural Chemists by appropriate legislation would be warmly appreciated by the members of that body and give additional weight to its proceedings, both among foreign nations and in courts of justice.

STREET SWEEPINGS, GARBAGE, AND SEWAGE.

During the year the division began a study of the agricultural value of street sweepings, garbage, and sewage. The question of the disposal of these materials is one which has long puzzled municipal authorities. The general value of these waste materials for fertilizing purposes has long been recognized, but no systematic study of them, from a chemical-agronomical point, has heretofore been undertaken. Circulars were sent to all towns of over 10,000 inhabitants in the United States, asking in detail for information in regard to the disposal of street sweepings, garbage, and sewage. Similar circulars were sent to our consular agents in Europe. The replies to these circulars have been quite general, and

the division is now in possession of information, which has already been tabulated, concerning the methods of street sweepings, garbage, and sewage disposal in all of the principal cities of America and Europe. Large numbers of samples of sweepings and garbage have been obtained, and many of them were analyzed during the year. When the work is completed it will be possible, for the first time, to make a systematic publication of the comparative methods of disposing of these troublesome materials and of the value which they have for agricultural purposes. With the aid of this information, municipal authorities and farmers will be able to determine how far it will be practicable to transport such material for fertilizing purposes, and great mutual benefit will ensue.

SOIL STUDIES.

The study of the comparative producing power of various soils, under controlled conditions, has been continued on the lines of investigation defined in previous reports. These soils have been studied by many different methods of chemical examination, and since the last report two additional crops have been grown on them. The importance of continued studies is shown in the fact that although the control of moisture and cultural conditions has been rigidly the same for six successive crops, remarkable variations in yield have been observed. This shows that those atmospheric and climatic conditions (moisture excluded) which are beyond human control, have a great potency in crop production. These causes are chiefly heat and light. There are, however, evidently other meteoric causes which must be considered. These experimental data throw new light on the fact which has long been observed, namely, that the great variations in yield in successive years in agricultural crops are not dependent on the distribution of the rainfall alone. The solar influences are evidently of great importance, and the distribution of solar heat is a factor not to be neglected. Excessive or deficient temperatures at critical moments of the growth of a crop are doubtless factors of prime importance in harvest products. The factor of "soil fatigue" is also one not to be neglected, and this factor is shown in the tendency of the soil to rest after the gathering of a rich harvest. In the experimental studies of the year the influence of these various factors has been manifest. It is evident that valuable conclusions can not be drawn from a few studies of this kind. It is only after a series of years that the relative magnitudes of the various uncontrollable factors begin to assume definite shape.

COOPERATIVE WORK WITH THE TREASURY.

Under your direction, the Chemist undertook, at the request of the Secretary of the Treasury, the work incident to the chairmanship of a commission to establish the methods of polarizing sugars for dutiable purposes at the ports of entry, and for preparing suitable regulations therefor. This was supplemented by an investigation, conducted in the laboratories of the collectors and appraisers of the ports of Philadelphia, New York, and Boston. Preliminary to this investigation a long series of research investigations was made in the laboratory to properly standardize the necessary apparatus and to fix the values of the several quartz plates. The Chemist, having been

appointed a member of the international committee to fix sugar standards, made use of the data of these investigations in preparing a paper to present to the Third International Congress of Applied Chemistry at the Vienna meeting. A detailed report of the investigations which have been made has been submitted to you for transmission to the Secretary of the Treasury. The purely technical part has been included in papers to be presented to the Vienna Congress and to the American Association for the Advancement of Science at the Boston meeting. These technical papers will be published in the proper scientific journals. It is evident, from the investigations which have been made, that there is great need of an international agreement in all that pertains to the official determination of the true content of sugar in a given sample. Constant differences are found to exist in the results of analyses in different countries, and even by different chemists in the same country. Disputes and suits at law often arise from these differences, and these can only be prevented by the adoption of some international standard of sampling and analysis. To this end the results of our work during the year will be helpful, and the continued cooperation of the division in similar researches advisable.

SUGAR-BEET INVESTIGATIONS.

The widespread interest throughout the country in the culture of the sugar beet led to a renewal of the work of the division in these investigations. Cooperative work was established with the experiment stations and with several thousand farmers. The production of high-grade beets for seed propagation was one of the chief objects kept in view in the cooperative station work, and the influence of climate on the character of the beets was the principal study in cooperation with the farmers. The magnitude of the analytical work in both fields of investigation was very great, many thousands of analyses having been made. The analytical data obtained were studied with a view to a proper classification, facilitating further studies. From the stations high-grade beets were preserved for seed propagation, and after analysis the beets were preserved over winter and redistributed to the stations in the spring for seed production. A few of the high-grade beets were planted in the Department garden.

The studies of the miscellaneous analyses, together with a comparison of all the available analyses made during the past ten years, led to the construction of a map showing the probable area in the United States where beets of a superior quality could be produced. All the data bearing on the subject are published in a special report by the Congress of the United States. The results of the analyses show that there are many localities in the United States where beets can be grown quite equal in saccharine strength to those produced in Europe. There is lacking, however, among our farmers knowledge of the proper methods of cultivation; and a certain indisposition is shown to exercise the care in tillage which is necessary to secure the best results. The data further show that where contour and character of land are favorable, and there is a proper distribution of rainfall, the best beets are produced on a belt of varying width, through which runs the isotherm of 70° for the months of June, July, and August. The data further show that under irrigation, with other conditions favorable, excellent beets can be produced.

STUDY OF THE COMPOSITION OF PIGS.

Samples of eight breeds of pigs, grown at the Iowa Experiment Station, were subjected to an analytical study during the year. The carcasses of these animals were sent to the laboratory from the slaughterhouse in Chicago. Each carcass was systematically dissected into representative parts, and these prepared for analysis. It is easily seen that only with extreme care is it possible to secure representative samples of such materials. After the analysis of each part the data obtained were calculated on the fresh material in the state in which it was received at the laboratory. The pigs were not only of different breeds, but they had been subjected to different methods of feeding. The data, therefore, show not only the influence of breed, but also of food, on the character of the product. These studies, when fully completed, will not only afford valuable data to the swine grower, but also to the food economist. Although the chemical work is of the most exacting kind, yet the end in view appears sufficiently valuable to warrant the extension of the same method of investigation to all domestic animals used as human food.

COOPERATION WITH OTHER DEPARTMENTS.

Attention has already been called to the cooperative work undertaken by the division, with the Treasury, in relation to the collection of duties on imported sugars. In various other ways the division has also assisted the Treasury and other Departments of the Government.

Section 61 of the tariff act of August 27, 1894, provided for a rebate of the tax on alcohol used in the arts and in the manufacture of medicinal or other like compounds, when the alcohol was used under regulations to be prescribed by the Secretary of the Treasury. On June 3, 1896, this provision of the act just mentioned was repealed by a special act of Congress, which also provided for a joint select committee, composed of three members of the Senate and three members of the House of Representatives, whose duty it should be to consider all arguments pro and con relative to the granting by Congress of tax-free alcohol for use in the arts and manufactures of the country. During the twenty-one months intervening between the passage of the tariff law of 1894 and the repeal of section 61 thereof, the Secretary of the Treasury did not find it practicable to establish the regulations necessary for the execution of the rebate provision. Consequently, the Court of Claims was deluged with claims for a rebate of the tax paid on alcohol used by various manufacturers. Much expert chemical testimony was presented in support of those claims. At the request of the Assistant Attorney-General in charge of the cases, the testimony of the chemists testifying for the plaintiffs was carefully reviewed by the Division of Chemistry, and many laboratory experiments were made which required the time of one chemist for several weeks. The result was the presentation of valuable testimony in support of the Government's position and in rebuttal of the testimony of the witnesses for the plaintiffs.

The Post-Office Department during the year referred to this division a number of inks, with a request that a study be made of their comparative merits for use in the cancellation of postage stamps. Many laboratory experiments were made, and a full report of the results was transmitted to the Postmaster-General.

A similar request came from the State Department in regard to an

ink and typewriter ribbon which it was proposed to use for the permanent records of that Department. A careful chemical study of the ink and ribbon was made, and the results were duly transmitted to the Secretary of State.

From the War Department several samples of wheat flour, supposed to be adulterated with maize meal, were sent for examination. From the customs division of the Treasury a large number of samples of concentrated fruit juices was received for the purpose of ascertaining their exact composition, in order to properly classify them for duty. The Division of Chemistry, in accordance with your instructions, holds itself in readiness to comply, in the shortest possible time, with all reasonable requests of the other Departments for chemical services. Inasmuch as this partial collaboration has been going on for years, the thought is naturally suggested that all the chemical work of the Government might with great economy and administrative advantage be placed under a single direction. The United States could well afford to erect and equip a model laboratory for the prosecution of all the various forms of chemical investigations which the exigencies of the Government require. Unity of purpose and direction are the prime factors which promote economy of administration and attainment of results. The fact that the chemical laboratory of one Department is so often called upon by other Departments of the Government for assistance shows in a practical way that such a union of all official chemical investigations is not chimerical.

MISCELLANEOUS WORK.

As in previous years, the division has been called upon to do a great deal of miscellaneous work which can not be grouped under any distinctive head. Miscellaneous analyses of waters used for agricultural purposes, soils, and fertilizers are made from time to time. As a rule, however, such analyses are referred to the several experiment stations of the States whence the samples are sent. In spite of the inadequate assistance in the laboratory, and in the absence of any legal requirement, the division has from time to time undertaken for Members of Congress and others analyses which have no direct reference to agricultural matters. These analyses have been undertaken on request from you, the Assistant Secretary, or the Chief Clerk. Where such analyses tend to promote the public interests or develop directly or indirectly any agricultural industry, there seems to be no valid objection to performing them. It should be understood, however, that the laboratory is not equipped for the analysis of mineral waters, ores, and patent medicines, and hundreds of requests for such analyses are necessarily refused.

OUTLINE OF WORK FOR THE YEAR ENDING JUNE 30, 1899.

The work planned for the year ending June 30, 1899, is briefly as follows:

(1) Arrangements for the growth of sugar beets have been made with farmers and experiment stations similar to those described for the preceding year. The number of beets expected for analysis is, however, very much larger than for the past year. Samples of seed were sent to nearly every State and Territory of the Union. Samples for analysis are expected to begin to come by September 15 and continue to arrive until December 15.

(2) The work in the investigation of foods and their adulterants will be continued. The classes of foods proposed for the present study are those for children and invalids. There is a widespread desire for information concerning these varieties of foods, and an attempt will be made to get all the leading brands in the market.

(3) The behavior of typical soils, under controlled conditions, will be further studied and at least two crops, produced under those conditions, be added to those already obtained. It is possible to secure two crops in a year without artificial heat, by growing first oats or beans and following these crops with buckwheat.

(4) Cooperative work with the experiment station chemists and other official chemists will be continued under the direction of the Association of Official Agricultural Chemists.

(5) International cooperative work on methods of analysis of various agricultural products will be continued under the auspices of the various international committees, of which the Chemist is a member, appointed by the Third International Congress of Applied Chemistry at Vienna.

(6) Further work in the investigation of the agricultural value of street sweepings, garbage, and sewage will be carried on.

(7) Investigations of the composition of domestic animals used as human food, as affected by environment, will be continued.

(8) Critical studies of agricultural imports from the countries which exclude similar imports from our country, on the ground of adulteration or unwholesomeness, will be carried on with a view of securing a scientific basis of reciprocal retaliation.

(9) Cooperative work with the various Departments of the Government will be continued as requested.

(10) Such miscellaneous work as relates directly or indirectly to agricultural development will be undertaken, and such other miscellaneous work as may be directed by the Secretary or Acting Secretary of the Department.

STATEMENTS REGARDING PLAN OF WORK.

The new laboratory which is in progress of construction will afford increased facilities for work. It is desirable, therefore, that the chemical force of the laboratory be enlarged by the addition of one or two skilled analysts. At the present time all the pay of the watchman and engineer and fireman is charged to the fund provided for additional chemical assistance. This does not seem to be just. Congress appropriates a certain sum for such services, and other divisions, especially those occupying the main building, profit by these services. The Division of Chemistry receives no aid whatever from this source. It is therefore suggested that provision be made in the general estimates for such services, including messenger. This would leave the fund voted by Congress for chemical work wholly for that purpose. It seems that this suggestion is so just as to require no further amplification. The grade of clerk of class 1 should be raised to class 2, to provide for the slight increase in salary which the clerk of this grade received on July 1.

It is hoped that the time may soon come when the skilled scientists of the Department may receive a compensation commensurate with their ability and the time and money they have spent on their education. At present, several skilled chemists in the Division of Chemistry are receiving less salary than is paid for clerical work. The organic

law establishing the Department of Agriculture provides that the scientists employed therein shall receive the same compensation which is given scientists in other branches of the Government. The increase of the salaries of the chiefs of the three original divisions to a sum equal to that received by chiefs of divisions in the Smithsonian Institution, in the Coast and Geodetic Survey, and in the Geological Survey, would therefore be strictly in harmony with the organic law. These chiefs receive from \$3,000 to \$4,500 per annum. The three original divisions of the Department of Agriculture created by the organic law are those of Chemistry, Botany, and Entomology. These, as the senior divisions, are entitled to first consideration, and the salaries of their chiefs should be made \$4,000 per annum.

If the messenger, watchman, and fireman charges are taken off the sums asked for chemical work, the salaries of the present chemists can be modestly increased, and at least one additional assistant employed. This would permit the vigorous prosecution of the lines of work marked out above.

The slight increase in the estimates given below are asked for the purpose of bringing the division back into the high state of efficiency reached under the administration of Secretary Rusk. During the administration of his successor the work of the division was seriously crippled, and the total sum now appropriated for its work is but little more than half of what it was formerly. Under Secretary Rusk, four experiment stations devoted to the study of sugar-producing plants were under the direction of the Division of Chemistry. These stations were all subsequently abolished, and property which had cost nearly \$50,000 condemned and sold for a very small sum. The reestablishment of these stations is not recommended, because of the great cost it would now entail. However, it is earnestly recommended that the sum available for scientific investigations be increased to bring it up to what it was formerly, and to provide for the largely increased amount of work which the division will probably be called on to do.

It will doubtless be found advisable to widen the scope of the study of food and drink adulterations to include those imported from foreign countries. The amount of money formerly voted for this purpose was \$15,000 annually, but in the appropriations for 1895 this was reduced to \$5,000. It is therefore recommended that the sum estimated for this purpose, and to continue the vegetation experiments with soils, be increased to \$10,000. If this be done, and the expense of messenger, watchman, and fireman be included in the general estimates for that service, the scientific work of the division will be able to assume the position which it formerly occupied, and which it is your evident intention it should occupy.

