the sole criterion of the end-point, as indicated below.

During the course of some stability experiments in which it was desired that the results be as accurate as possible, the end-points were estimated visually before making the peroxide number determinations, and in Table II are given the results obtained by the two methods. A respect in which our practice in the use of this test differs from that formulated by King, Roschen & Irwin[2] is that the end-point is taken as the time at which the peroxide value curve crosses the ordinate line for 125 in the case of cottonseed oil, and 75 in the case of hydrogenated fat. This enables closer comparisons to be made in tests differing only by fractions of an hour. Had the keeping times in Table II been determined in accordance with the practice of reporting the nearest whole hour value greater than the threshold value for a given fat, the agreement between the two sets of data would probably have been closer.

For the most accurate work, for example, in experimental studies of antioxidants and proöxidant conditions and materials, it is not suggested that this method of estimating the end-point be used as a substitute for peroxide number determinations; but for refinery control tests, especially when these are quite numerous, this new modification offers distinct time and labor-saving advantages.

REFERENCES

[1]Wheeler, Oil & Soap, 9, 89 (1932).
[2]King, Roschen & Irwin, Oil & Soap, 10, 105 (1933).
[3]Freyer, Oil & Soap, 12, 139 (1935).
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Proposed Research Program of the Regional Soybean Industrial Products Laboratory

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THE Bankhead-Jones Act of June 29, 1935, states as one of its purposes—"The Secretary of Agriculture is authorized and directed to conduct research . . . relating to the improvement of the quality of, and the development of new and improved methods of production of, distribution of, and new and extended uses and markets for, agricultural commodities and by-products and manufactures thereof . . . "

In accordance with these and other objectives, the U. S. Department of Agriculture has set up a limited number of specialized laboratories in the major agricultural regions of the country to study some of the broad agricultural problems peculiar to those areas. At a conference of representatives of the Department of Agriculture and the Experiment Station Directors of North Dakota, South Dakota, Nebraska, Kansas, Minnesota, Iowa, Missouri, Wisconsin, Illinois, Indiana, Ohio and Michigan, it was decided to establish a laboratory at the University of Illinois, Urbana, Illinois, for a study of the industrial utilization of soybeans and soybean products. The reasons for reaching such a decision are not hard to find. While the soybean has been an important crop in North China and Japan for thousands of years, and while it has been known in this country for more than 100 years, it is only within the past decade that this legume has assumed an important position in the agricultural and manufacturing industries of the United States. Thus, in 1934 approximately 2,000,000 acres were planted to soybeans, while in 1935 this figure had more than doubled, falling just short of 5,000,000 acres.

In 1925, 5,000,000 bushels of beans were harvested, in 1934 around 20,000,000 bushels, and in 1935 more than 40,000,000 bushels. In 1935, the three states leading in the production of soybeans were Illinois (22,000,000 bu.), Iowa (7,000,000 bu.) and Indiana (6,000,000 bu.). There are at present around 35 mills crushing soybeans, 15 plants engaged in the manufacture of soybean flour, 20 in the manufacture of soybean food products, and more than 50 in the manufacture of other industrial products. While only 2,646,000 pounds of soybean oil were produced in the United States in 1926, it is estimated conservatively that the crush from the 1935 crop might well exceed 200,000,000 lbs., which is more than 5 times the production from the 1934 crop. The production of soybean meal naturally has increased to the same degree. It can be realized readily that the large increase in soybean acreage and the enormous jump in oil and meal production have created actual and potential problems of considerable import to the industry. It would, therefore, seem to be the part of wisdom to develop a well-integrated research program which might solve or anticipate these problems and assist in placing the soybean industry, in all its phases, upon a sound and stable basis.

Naturally the members of the American Oil Chemists' Society are more interested in soybean oil than in other soybean products. Most of you are familiar with its physical and chemical properties. It is classed as a semi-drying oil with an iodine number ranging from 125-137, and a saponification number of 189. Its fatty acids consist of approximately 14% saturated and 86% unsaturated acids. Palmitic acid (7%) and stearic acid (6%), together with small quantities of myristic and arachidic acids, make up the saturated acids. Oleic acid (26%), linoleic acid (55%) and linolenic acid (5%) constitute the components of the unsaturated acid fraction.

The percentage of the various fatty acids in the oil apparently varies widely with variety of bean and conditions of culture. As an example, linolenic acid has been reported by different investigators as accounting for from 2% to as high as 9% of the total fatty acids, but whether this represents a real variation in composition or simply variations due to analytical technique is difficult to ascertain.

The fact that soybean oil is a semi-drying oil, makes its utilization possible in both the edible and protective coatings fields. Thus, in 1934 approximately 50% of the total consumption was used in paint and varnish products, while in 1935 this percentage dropped to around 14%, although the consumption for this purpose rose from 10 million pounds in 1934 to 13 million pounds in 1935. In 1935 soybean oil found its greatest outlet in the edible oil field, due to the relative scarcity and consequent high price of cottonseed oil. It finds a more limited use as a binder in casting cores, in the manufacture of linoleum, soap, printing inks, insecticides, and as a source for glycerol and fatty acids.

All of this is only by way of being a very brief introduction to the presentation of the program of research of the Regional Soybean Industrial Products Laboratory. The immediate objectives of the new laboratory are (1) the improvement of present industrial uses and the development of new industrial outlets for soybeans and soybean products; (2) the determination of the variation in composition of soybeans resulting from differences in varietal, soil and climatic factors.

It is not planned to do any work relating to the use of soybeans or soybean meal as a food or feed. These phases of the soybean problem are being very extensively investigated in the various State Experiment Stations, in university and in other governmental laboratories. An effort will be made, however, to integrate and correlate these investigations with those to be undertaken by the new laboratory.

The agronomic phases of the work are to be carried out under the supervision of the Bureau of Plant Industry of the U. S. Department of Agriculture. Experiments are to be initiated this year with five varieties of beans to be grown at the Experiment Stations of the States of Ohio, Indiana, Illinois, Missouri, and Iowa, under a number of different conditions. The chemical laboratory has been set up on the basis of four sections (1) Oil; (2) Meal; (3) Development; and (4) Analytical. After conferring with a number of representative soybean processors, it became apparent that the most important problem to be solved in connection with the utilization of soybean oil for edible purposes was that of so-called flavor reversion. As many of you undoubtedly know, freshly refined and deodorized soybean oil possesses a smooth, bland taste, entirely free from objectionable flavor. However, on standing for certain periods of time, an undesirable flavor develops described variously as "painty" or "grassy" in contradistinction to the beany taste of the unrefined oil. Efforts to treat the oil so as to prevent this flavor reversion have been almost entirely unsuccessful. The cause of the flavor reversion is at present unknown, although a number of hypotheses have been advanced to explain it. The laboratory has, therefore, set up as its leading oil project, an investigation into the improvement in flavor and stability of soybean oil, confident that if the problem of reversion can be solved, the oil will retain its place on a basis of merit as an important factor in the edible oil industry. The second oil project deals with the improvement of its utility in the field of protective films and coatings. Much pioneer work has already been done in this field, particularly by Dr. W. L. Burlison at the University of Illinois, and it is hoped that a carefully planned program of agronomic and chemical research will lead to a wider use of the oil in paints and varnishes. At the present time the extensive diversion of the oil to the higher priced edible oil field has made it difficult for it to compete with linseed oil in the lower priced paint oil industry. It is hoped, however, that out of the agronomic research program will be established varieties and culture conditions whereby oil with higher iodine numbers will be obtained, which will prove to be more suitable for use in paints. In addition to these two projects, more limited investigations will be carried out dealing with the use of the oil in soaps, the effect on the oil of processing and refining practices, the phosphatides and sterols present in the oil, and the use of the oil as a starting material in chemical manufacture.

The Analytical Section is being set up to provide facilities for the determination of the effect upon chemical composition of varietal and cultural variations. Routine determinations of moisture, ash, crude fiber, oil and its iodine number, nitrogen and phosphatides will be made for each bean variable using small samples. Oil content will be measured by extracting the ground beans in a butt type extractor. Iodine number will be determined according to the Wijs method. More complete analyses, including a determination of saponification number, unsaponifiable material, free fatty acids, color, flavor, stability, composition, hydrogenation characteristics, and drying qualities will be made on oils derived from larger samples of such beans as appear to warrant further investigation upon the basis of the analyses made on the smaller samples mentioned above. The effect upon chemical composition of soybeans of storage under various conditions will be determined by detailed analyses, and it is hoped that much interesting and valuable information will be obtained. A high type research analyst will be placed in charge of this section, with the hope that the laboratory will be in a position to cooperate fully and effectively with interested groups in the improvement of old methods and the development of new and more precise procedures involved in the analysis of soybeans.

Projects to be undertaken in the Meal Section include investigations of the development of plastics, the development of adhesives and paper-sizing materials, the production of textile fibers, study of the carbohydrate fraction, and a study of the composition and possible utilization of soybean husks. Other projects set up for future investigation include the preparation of various amino acids from soybean protein and a study of the enzymes of the soybean and their effect upon its characteristics and composition.

A development section is being set up to study the design and improvement of equipment used in processing soybeans and to carry out any investigations necessary in the transfer of processes from laboratory to semi-works scale. As its first project, the section will be charged with assembling the various data necessary to get a complete and unbiased picture of the soybean industry, particularly those phases related to production, present and potential uses, processing and distribution costs and competitive materials.

From this brief presentation, I hope you have obtained some idea of what we plan to do in the new laboratory. It is our hope that active work will be under way by fall. We wish to cooperate fully with all laboratories and organizations interested in the industrial utilization of the soybean and soybean products and will welcome any constructive suggestions as to how we may best accomplish our objectives. In the name of the laboratory I wish to extend a cordial invitation to each of you to pay us a visit any time you may happen to find yourself in the vicinity of Urbana.

The Destruction of Vitamin A By Rancid Cod Liver Oil*

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A RECENT survey[1] of the chemical condition of cod liver oil being dispensed in the city of Philadelphia revealed the fact that a large number of institutions were dispensing an oil that was decidedly rancid. The development of rancidity in these oils was almost wholly due to ignorance of its perishability on the part of those in charge of handling it. In most institutions no precautions against deterioration were taken and it was the usual thing to find the open container of cod liver oil on a shelf in the drug room, exposed to light and air and the fluctuation of room temperature. In one institution a spigot at the bottom of the 10 gallon bottle necessitated the bubbling of air through the entire supply whenever a sample was withdrawn. It is not surprising, therefore, that many samples of oil collected from these institutions showed high peroxide values.

A similar survey[1] of the chemical condition of cod liver oil in the homes of families using it, disclosed the fact that by the time the "last dose in the bottle" was reached many families had a very rancid oil.

When it was found that many institutions were dispensing rancid cod liver oil, and that many families were permitting their supply to deteriorate, a parallel investigation was undertaken to determine in the laboratory the keeping qualities of several samples of cod liver oil, under conditions designed to simulate various home conditions. It was found that a good grade of cod liver oil, kept in the icebox, would have a low peroxide value at the end of six weeks, but that the same oil, kept on the open shelf in the laboratory, exposed to ordinary daylight and the average fluctuations of room temperature, showed detectable rancidity in a week, and marked rancidity in two weeks, and in addition, oil kept in an incubator, under conditions simulating a warm kitchen or bathroom shelf, became markedly rancid in three or four days.

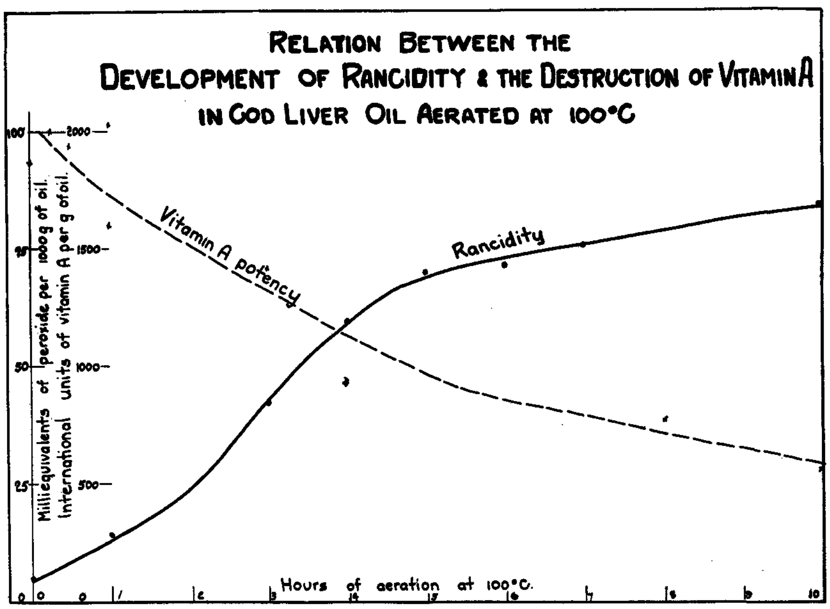

CHART I.

Friderica[2] in 1925 found that rancid oils destroyed their own vitamin A and suggested that it was the presence of the peroxides which inactivated the vitamin. Powick[3] confirmed Friderica's findings and stated further that rancid fat destroyed vitamin A in other dietary ingredients when the fat was mixed with the ration.

Dr. Charles E. Bills determined by the Vitameter the vitamin A content of several series of our cod liver oils. A characteristic curve was obtained, which showed a gradual drop in vitamin A potency as the peroxide value increased when the oil was aerated at 100°C. in the Swift stability test apparatus (Chart 1). In those oils in which rancidity was allowed to develop naturally by exposure to light and air at ordinary temperatures, there was a drop in vitamin A potency as

*A paper presented at the CINCINNATI MEETING of the American Oil Chemists Society.