METHOD FOR
MEASURING COLOR
OF SOYBEAN OIL

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By G. E. HALLIDAY and H. R. KRAYBILL*

Department of Agricultural Chemistry, Purdue University Agricultural Experiment Station

Fonrobert[1] proposes that the color number of resins, varnishes, oils, etc., be expressed as the number of milligrams of free iodine in 100 c.c. of an iodine-potassium iodide solution of similar color. The determination is made by comparing in transmitted light a column of definite height of the sample with a column of variable height of the iodine-potassium iodide solution and then determining the amount of free iodine by titration with sodium thiosulphate. Fonrobert and Pallauf[2] define the color number as the number of milligrams of free iodine in 100 c.c. of a solution of iodine in potassium iodide that matches a sample 10 mm. in thickness. Greitemann[3] expresses the color value in terms of the number of milligrams of free iodine in 10 c.c. of an iodine-potassium iodide solution which matches the color of the substance in a layer 25 mm. deep. Comparisons may be made with sealed tubes of solutions of various concentrations of free iodine or by means of a colorimeter. Pallauf[5] describes a wedge shaped instrument for making the color comparisons.

In determining the color number of various samples of soybean oil Smith and Kraybill[6] compare the color in transmitted day light of the oil in test tubes with a series of solutions of various concentrations of iodine in potassium iodide in similar test tubes. The color number is expressed as the number of milligrams of iodine in 100 c.c. of an iodine-potassium iodide solution which matches the color of the oil.

If iodine in a potassium iodide solution obeys Beer's law, which briefly states that the specific light absorption coefficient is proportional to the concentration in grams per liter, satisfactory color comparisons may be made with a colorimeter. Groh and Papp[4] found that iodine solutions in carbon tetrachloride, carbon disulfide and hexane obey Beer's law in the visible spectrum but we found no studies in the literature which show whether solutions of iodine in potassium iodide in water obey Beer's law.

Determinations of the specific light absorption coefficients were made for 11 different concentrations (100 mg. to 2,000 mg. free iodine per liter) of iodine-potassium iodide solutions at 560 milli mu. Determinations were made of the molecular extinction coefficients of 2 concentrations (200 and 1,000 mg. free iodine per liter respectively) at 9 different wave lengths from 460 milli mu to 640 milli mu. The results show that within the ranges studied the solutions obey Beer's law. On the basis of these data a colorimetric method of determining the color number of soybean oil was devised which is simple, rapid and accurate.

Absorption Coefficients of Iodine-Potassium Iodide Solutions

In accordance with Lambert's law the amount of radiant energy absorbed by an homogeneous medium is expressed by the equation: $\log \frac{\text{I sov}}{\text{I sol}} = \beta X$; when I sov = intensity of light transmitted by solvent-filled cell; I sol = intensity of light transmitted by solution-filled cell; X = thickness of absorption cell in centimeters; and β = the specific light absorption coefficient. When β is proportional to the concentration C (in grams per liter) Beer's law is obeyed.[7]

The specific light absorption coefficients at 560 milli mu of 11 solutions of iodine in two per cent solution of potassium iodide in water in concentrations from 100 to 2,000 mgs. per liter of free iodine were determined by means of the Bausch and Lomb spectrophotometer. The values for the $\log \frac{\text{I sov}}{\text{I sol}}$ are the average of five readings. The data are given in Table 1.

TABLE 1.—SPECIFIC LIGHT ABSORPTION COEFFICIENTS OF IODINE IN POTASSIUM IODIDE SOLUTIONS AT 560 MILLI MU.

Mgs. I_2 per liter	X Depth of Cell in cm.	$\log \frac{\text{I sov}}{\text{I sol}}$	β Specific Light Absorption Coefficient
100	10.00	0.410	0.0410
200	10.00	0.778	0.0778
300	10.00	1.194	0.1194
400	10.00	1.603	0.1603
500	10.00	1.966	0.1966
600	2.002	0.487	0.2432
800	2.002	0.626	0.3126
1,000	2.002	0.806	0.4025
1,400	2.002	1.091	0.5449
1,800	2.002	1.403	0.7008
2,000	2.002	1.556	0.7772

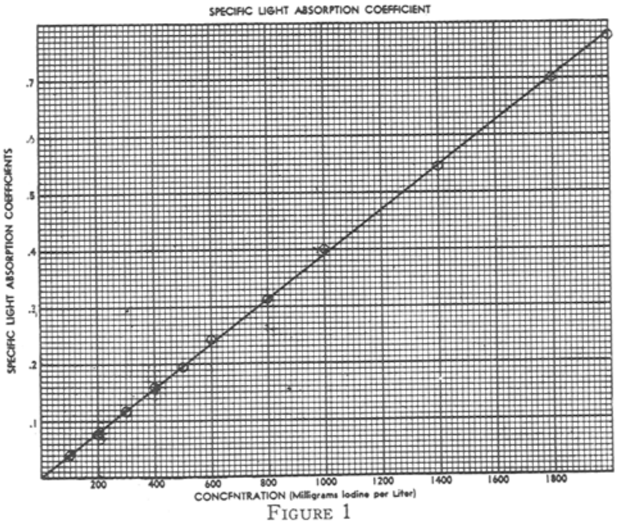

FIGURE 1

In figure 1 the values for β, the specific light absorption coefficients are plotted against the concentration of free iodine in grams per liter. It will be observed that these values fall on a straight line within the experimental errors and that the values for β are proportional to the concentration in grams per liter. Within these limits of concentration and at 560 milli mu the free iodine of iodine-potassium iodide solutions in water obeys Beer's law.

The molecular extinction coefficients of two solutions (0.00788 and 0.0394 molar I_2) of iodine in a two per cent solution of potassium iodide in water were determined at nine wave lengths from 460 milli mu to 640 milli mu. The data are given in Table 2. The values for $\log \frac{\text{I sov}}{\text{I sol}}$ are the average of five readings. The molecular extinction coefficients were calculated from the following formula: $E = \frac{1}{bc} \log_{10} \frac{\text{I sov}}{\text{I sol}}$; when E is the molecular extinction coefficient, c is the molar concentration and b is the length of the cell in centimeters.

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*Part of these data are from a thesis submitted by G. E. Halliday to the Faculty of the Graduate School of Purdue University in partial fulfillment of the requirements for the degree of Master of Science, August, 1934.

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H. R. KRAYBILL

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GEORGE E. HALLIDAY

TABLE 2.—MOLECULAR EXTINCTION COEFFICIENTS OF IODINE IN POTASSIUM IODIDE SOLUTIONS.

	——0.00788 Molar I_2——			——0.0394 Molar I_2——		
Wave Length Milli Mu	Depth of Cell cm.	Log $\frac{\text{I sov}}{\text{I sol}}$	E Molecular Extinction Coefficient	Depth of Cell cm.	Log $\frac{\text{I sov}}{\text{I sol}}$	E Molecular Extinction Coefficient
460...	2.002	1.629	103.2	0.497	2.028	103.6
470...	2.002	1.179	74.7	0.497	1.445	73.8
480...	2.002	0.859	54.4	0.497	1.027	52.4
500...	10.00	1.952	24.8	2.002	1.944	24.6
520...	10.00	1.272	16.1	2.002	1.314	16.7
540...	10.00	1.003	12.7	2.002	1.027	13.0
560...	10.00	0.778	9.9	2.002	0.806	10.2
600...	10.00	0.355	4.5	10.00	1.764	4.5
640...	10.00	0.133	1.7	10.00	0.603	1.5

The molecular extinction coefficients of both concentrations are in good agreement. In figure 2 the molecular extinction coefficients are plotted against the wave lengths. The values for both concentrations fall on the same curve. Within the range of wave lengths studied the free iodine of iodine-potassium iodide solutions in water obeys Beer's law.

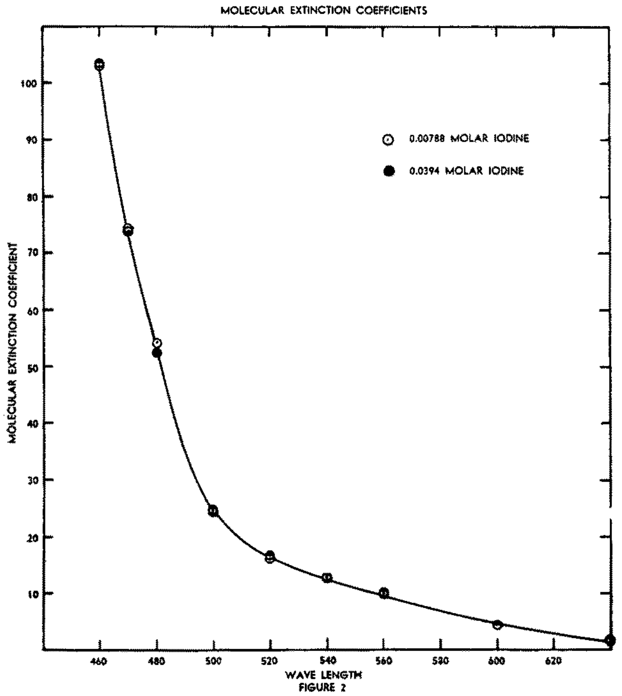

FIGURE 2

Transmission of Iodine-Potassium Iodide Solution and Soybean Oil

The percentage transmissions of a sample of soybean oil and of a solution of iodine in potassium iodide which matched it in color were determined at twelve wave lengths from 440 milli mu to 600 milli mu. These data are given in Table 3. In figure 3 the percentages of transmission are plotted against the wave lengths. There is very good agreement between the values for the iodine solution and the soybean oil.

TABLE 3.—TRANSMISSION OF IODINE SOLUTION AND SOYBEAN OIL

Wave Length Milli Mu	Per Cent Transmission Iodine	Oil
440	40.2	41.2
450	48.0	48.8
460	57.4	59.4
470	69.2	65.2
480	77.4	73.4
490	81.4	79.4
500	85.6	81.4
520	88.2	84.6
540	90.8	85.6
560	96.4	91.6
580	96.4	96.8
600	96.2	98.4

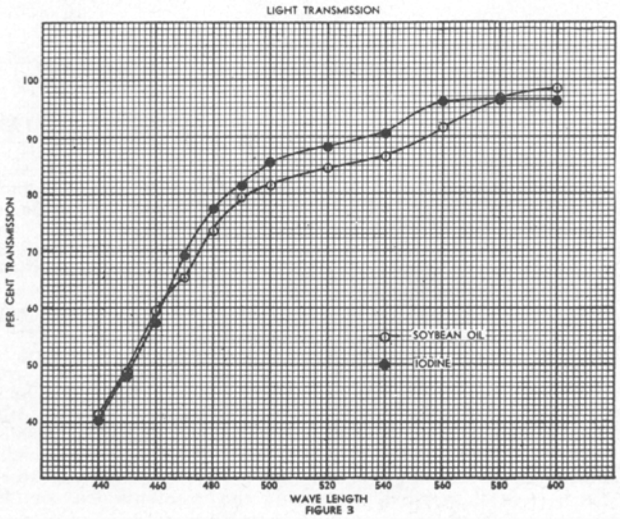

FIGURE 3

Colorimetric Method

The Leitz Dubosque colorimeter is used in a dark room with a constant source of white light furnished by the Leitz attachment. The depth of the oil is kept constant at 50 mm., while that of the iodine solution is changed until the fields of the eye-piece match. The iodine solutions are freshly prepared each time and the solution in the colorimeter is replaced at the end of thirty minutes. The matching point is approached first from one side and then from the other. The average of six readings is reported.

The concentration of an iodine solution in mgs. per 100 c.c. which matches a fifty millimeter layer of oil at a depth of 50 millimeters is calculated from the equation:

$$X = \frac{\text{mm } I_2 \text{ solution} \times \text{conc. } I_2 \text{ solution in mgs.}}{\text{mm oil}}$$

when X equals the concentration of an iodine solution which would match the oil if both were compared in the colorimeter at 50 millimeter depths. Best results are obtained when the depth of the iodine solution approaches that of the oil.

Comparisons were made of the color values of a number of samples of oil when compared with iodine solutions of different concentrations. These data are shown in Table 4. Good agreement was obtained even with a rather wide range in concentrations of iodine solutions.

Determinations of the color numbers of six samples of soybean oil were made and then some time later a second series of determinations were made on the same oils. These data (Table 5) show that good agreement is obtained in duplicate tests.

The colorimetric method described for the determination of the color of soybean oils is reliable, rapid, simple and convenient. It has the advantage that a color standard equivalent to the color number can be made up conveniently and such a standard has a color by transmitted day light that is very similar to the soybean oil.

TABLE 4.—EFFECT OF CONCENTRATION OF I_2 SOLUTION ON THE ACCURACY OF THE COLORIMETRIC METHOD

Oil Number	Concentration of I_2 solution Mg I_2 per 100 cc.	Average Depth of I_2 solution mm.	Color Number Mg I_2 per 100 cc.
119............	10	78.16	15.63
	20	50.76	20.30
	30	31.52	18.91
	40	25.12	20.09
	50	19.98	19.98
	60	14.76	17.71
169H...........	10	93.62	18.72
	20	50.04	20.01
	30	32.76	19.65
	40	22.80	18.24
	50	19.44	19.44
	60	16.26	19.51
	70	13.26	18.56
	80	11.94	19.10
12B............	20	66.26	26.50
	30	45.64	27.38
	40	34.04	27.22
	50	26.90	26.90
	60	23.44	28.12
	70	20.74	29.03
	80	16.68	26.68

TABLE 5.—COLOR VALUES OF SAMPLES OF SOYBEAN OIL

Oil Number	Color number Mg. I_2 per 100 cc.	
65......................	149.6	148.1
60......................	13.1	12.6
69......................	20.9	20.8
75......................	17.9	16.2
76......................	14.6	13.3
82......................	21.7	24.4

Summary

1. The specific light absorption coefficients of concentrations of iodine (100 to 2,000 mgs. per liter) in two per cent potassium iodide solution in water at 560 milli mu are given. These absorption coefficients are proportional to the concentration.

2. The molecular extinction coefficients of two solutions of iodine (0.00788 and 0.0394 molar I_2) in two per cent potassium iodide solution in water at nine wave lengths from 460 milli mu to 640 milli mu are given. These values for both concentrations are in close agreement.

3. Within the limits studied solutions of iodine in two per cent potassium iodide solution in water obey Beer's law.

4. A rapid, convenient and reliable colorimetric method for determining the color number of soybean oil is described. The color number is expressed as the number of milligrams of free iodine per 100 c.c. dissolved in a two per cent solution of potassium iodide in water, of which a 50 millimeter column just matches a 50 millimeter column of oil.

5. The spectral transmission curves of a solution of iodine in a two per cent solution of potassium iodide which matches the color of soybean oil, and of the oil are very similar.

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World Flaxseed Prospects

The outlook for the 1934-35 world flaxseed crop points to a still further continuance of recovery in flaxseed production, which became marked in 1933 after a drastic decline since 1928. The output was increased in practically all of the principal flax producing countries with the exception of the United States, Canada and to a less degree Russia. In each of the two former countries weather conditions in the flax producing belt were exceptionally unfavorable. In spite of restrictions and quotas export trade in flaxseed has also been well mantained. During the past 2 years shipments from Argentina, which is the largest producer and exporter of flaxseed, have been very heavy. India, another large producer which prior to 1930 exported from 50 to 78 per cent of the annual production, has increased its exports with the improvement in flaxseed prices.

By an order dated November 27, 1934, Germany places further restrictions on fats and oils, such as fatty oils in casks, including linseed oil and practically all other vegetable oils, tallow and wood oil, castor oil, and whale oil not hardened. By this order anyone desiring to sell any of the above mentioned commodities "whether manufactured in Germany, imported from abroad, or for export from Germany or desiring to carry out sales contracts already made, may only do so under a permit from the State Office of Milk Products, Oils and Fats, in the case of articles intended for food, and from the Control Office for Industrial Fats, in the case of other articles. German firms who have manufactured the goods concerned in their own establishments must also obtain permission before they can subject them to further processes." The order became effective January 1, 1935, except in the case of exports from Germany, which were made subject to control November 29, 1934.