ably low optical densities. One pair (Nos. 6 and 7) did not refine to give oils of as low optical density as would be expected from the curve, while another (No. 5) which, as a crude, had a higher value than the first pair, refined to give an oil of much lower optical density. There is then appreciable variation in response to the refining process. Bleaching however does not change the order of optical densities from those of refined oils. It is somewhat surprising that the upper curve in Figure 8 is so nearly a straight line, but reference to Figures 5 and 6 shows that the two curvatures representing the crude oil are similar.

To increase the optical densities, readings at 690 mμ could be used. These optical densities of refined oils are plotted in Figure 9 against nickel sulphate values of the parent crude oils at 0 days. Limits for Grade 2 oils would be approximately 0.4 and 0.7.

Summary

Possible spectrophotometric methods which could replace the present system of grading crude green soybean oils are given below in order of convenience. The limits are approximate values.

a) Measurement of optical density of crude oils at 700 mμ in 21.8-mm. tubes. Grade 2 limits would be at optical densities of 0.5 and 0.7.

b) Measurement of refined oils at 690 mμ in 21.8-mm. tubes. The limits for Grade 2 would be at optical densities of 0.4 and 0.6.

c) Measurement of refined oil at 670 mμ in 8.0-mm. tubes. Limits would be at optical densities of 0.4 and 0.6.

d) Measurement of refined and bleached oils at 670 mμ in 21.8-mm. tubes. Limits would be at optical densities of 0.1 and 0.7.

e) Measurement of optical density of crude oils at 670 mμ in approximately 4-mm. I.D. tubes. Limits would be at optical densities of 0.4 and 0.7.

f) Measurement of optical density at 670 mμ of crude oils in 15% solutions of oil in carbon tetrachloride in 21.8-mm. tubes. Limits would be at optical densities of 0.5 and 0.7.

Acknowledgments

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Single Number Systems for the Color of Transparent Objects[1]

PROCTER THOMSON, Chemical Division, Procter and Gamble Company, Cincinnati, Ohio

THE American Oil Chemists' Society has sponsored three color systems: the Lovibond, the Fat Analysis Committee, and the photometric. There are a great many such systems as will be noted. The color comparison chart (Figure 1) shows the approximate relations between a number of such systems. The relations are not exact, but the chart has value in showing about the amount of color present.

Color is a quantity with three dimensions. Two of these are immediately perceived. The first and most important dimension of color is lightness. From water white to inky black, transparent objects can be arranged in a series with little disagreement between observers. The other obvious characteristic is hue. Violet, blue, green, yellow, red, and purple are perceived by all persons with normal vision.

The third dimension of color is a little more difficult to visualize. Imagine a rotating disc with a red sector and a grey sector of equal brightness. Revolving it with nearly all grey, a certain hue is perceived. As the red is increased and the grey is decreased, the basic hue does not change and the lightness does not change, but the color gets more pure. This characteristic is called saturation or purity. To define a color, then, three values are necessary.

The problem of defining color was undertaken by the International Commission on Illumination, properly known by capital letters of its name in French, C.I.E. Due partly to the fact that they were describing lights and light sources, the C.I.E. did not use the hue, saturation, and lightness, but three colors, blue, green, and red. These C.I.E. coordinates of transparent objects are calculated from the transmittancy. Having the X (red), Y (green), and Z (blue) values, they are ordinarily shown as the fraction of red + the fraction of green and the original green. Models in this scale are shown in Figures 3 and 4, which are described more fully as their purpose is explained.

Why then do we struggle to define color with a single number? In this group of oil chemists we see

COLOR COMPARISON CHART

GARDNER-HOLDT COLOR STANDARDS 1933	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
GARDNER-HOLDT COLOR STANDARDS 1921	1			2			3		4		5	.	6	7		8		9
LOVIBOND ANALYSIS 1¼" COLUMN RED YELLOW	0 23 2 3	0 32 3.2	0 45 4.5	0 65 6 5	0.80 8.0	1 20 12 0	1 70 17 0	2.15 21 5	2 90 29.0	4 00 40 0	5 50 55.0	7 30 73 0	10 0 100.0	14 9 149 0	20 0 200 0	25 0 250 0		
UNION COLORIMETER A.S.T.M.	09	1.1	13	1 5	17	18	21	2.3	2 5	2 8	3.3	3.8	4.3	4 6	5.0	6.0	7.3	9.0
U.S. OFFICIAL ROSIN GRADE STANDARDS ·										X	WW	WG	M	K-H	H	G	F-G	F
HELLIGE COLOR COMPARATOR 1930	-1	-1	-1	-1	1L	1-2L	2	3L	3	4	5L	5	6	7L	7	8L	8	9L
HELLIGE STOCK FONROBERT COLORIMETER	1	1	2	3	4	5	6	7	10	20	30	40	70	100	150	230	310	730
PFUND COLOR GRADER HONEY TYPE					0.5	2.0	3.0	4 0	5.5	8 0	9 0	12	15					
PRATT & LAMBERT COLOR STANDARDS					1	2	3	4	5	6	7	8	9	12	14	16	17	18
F A C COLOR STANDARDS				1	3		5	7	11	11A 13	11B 15	11C 17	19		21 33	25 37	29 41	43
$K_2Cr_2O_7$ - H_2SO_4 GMS $K_2Cr_2O_7$ PER 100ML H_2SO_4	0039	0048	0071	0112	0205	0322	0384	0515	0078	0164	0250	0380	0572	0763	1 041	1 28	2 22	3.0

FIG. 1

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[1] Presented at the 26th annual fall meeting, American Oil Chemists' Society, Oct. 20-22, 1952, Cincinnati, O.

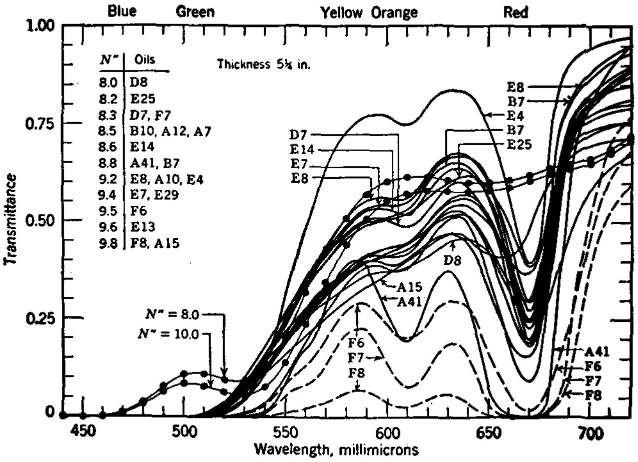

FIG. 2

that the need arises out of the trading in cottonseed and soybean oils and tallow and greases on a color basis. If discounts are to be collected for darkness in oils and fats, the color (for simplicity) must be expressed in a single number or its equivalent. The practice of grading oils for use in a company adds to this need.

JUDD indicates that a simple effective single number system can be made by filling tubes with known concentrations of the substance to be estimated and finding the one that matches the unknown (1). For a number of reasons it is not practical to have the standards of the same material as the unknowns. Glass is frequently used as standard because of its permanence. Thus we have a situation where the permanent colorants in the standards do not have the same spectral characteristics as the unknown. The observer is faced with a difficult and sometimes impossible task for often it will seem to him that the unknown is not equal to any of the standards or intermediate between any two of them. If the colors of the scale vary importantly, both in luminance and chromaticity, and the observer makes the setting on the nearest color match, there is yet no way of predicting the result.

The reason for this comment of Dr. Judd is evident from the comparison of the color of oils and of Lovibond glass combinations from McNicholas (2). The lines with solid circles in his Figure 14 represent the Lovibond glasses 8 and 10 of the N″ standardization.

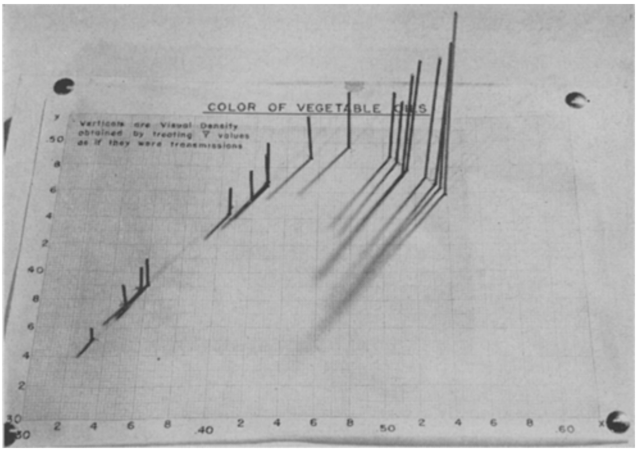

FIG. 3

What we are trying to do can best be explained by these space models of oils (Figure 3) and of F.A.C. colors (Figure 4). These models are based on the

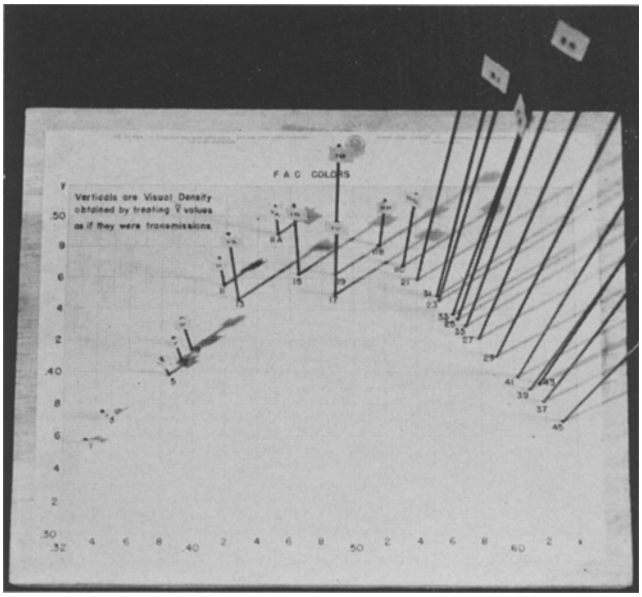

FIG. 4

C.I.E. standard observer. The abscissa and ordinates are the fraction red and the fraction green. The fraction blue is 1.00 — (X + Y). The verticals in the C.I.E. system are the Y original values, equivalent to lightness. In this case since we are dealing with optical density or absorbance values, the verticals are log 1/Y.

A break in these curves will be noted at a point near to x + y = 1.00. When x + y = 1.00, the blue has disappeared. This same break is noted in Figure 5 from Judd's book, page 215 (1). The large circles are the A.S.T.M. Union colorimeter values. The petroleum products themselves are the small circles, and the U.S. color standards for rosin are the solid circles. At this break point for all transparent objects of the yellow, brown, red type, the blue is almost completely

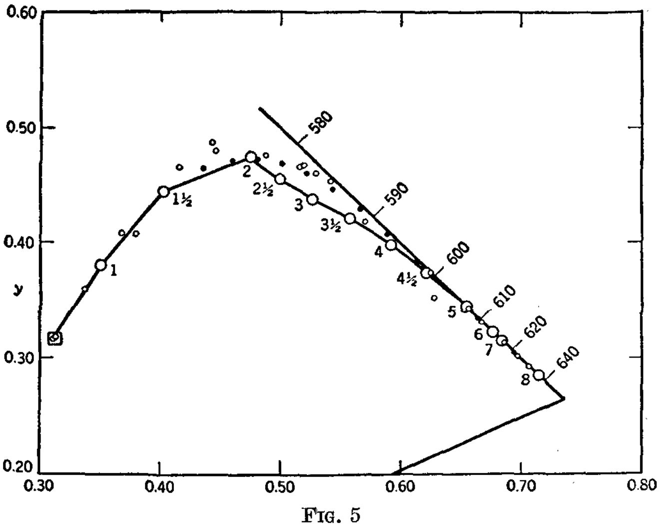

FIG. 5

absorbed, the green is decreasing, and only the red is increasing. This near (more than 95%) disappearance of the blue makes it possible to study single number systems for objects darker than the break point on a two-dimensional diagram. All we have to do is to plot the original red and green values. Figure 6 shows the values of these F.A.C. colors from 21 to 35 plotted in this fashion. Since the F.A.C. numbers are density numbers, that is, the higher the number the darker, it is more satisfactory to plot absorbency values rather than transmittance values. Figure 7 shows the F.A.C. colors plotted with the values of log 1/T substituted for the corresponding T values. The irregularities of the F.A.C. colors are immediately apparent. By comparison, Figure 8 shows the A.S.T.M. Union colorimeter values. These are much more regularly spaced.

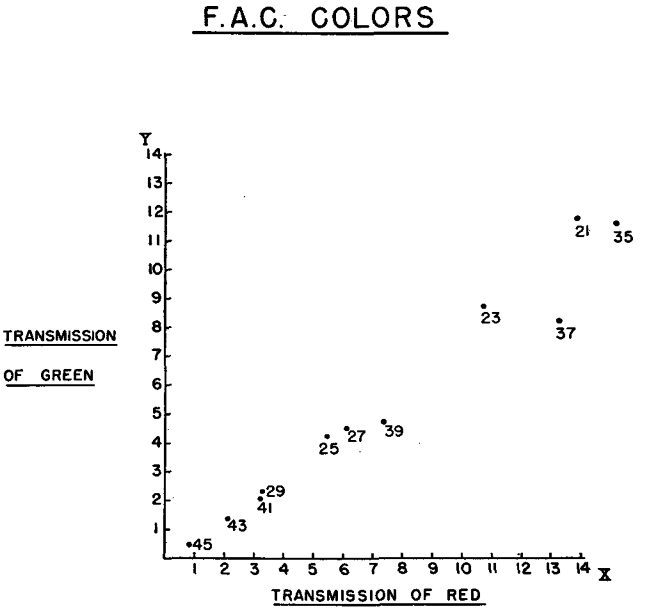

FIG. 6

IT can be seen that a single number system assumes that the objects to be judged lie along a line or clustered about a line in trichromatic space (Figures 4 and 5). The problem arises when an object has to be judged that is away from this line. Reference is again made to Dr. Judd's statement that "if . . . the observer makes the setting on the basis of the nearest color match, there is yet no reliable way of predicting the result" (1).

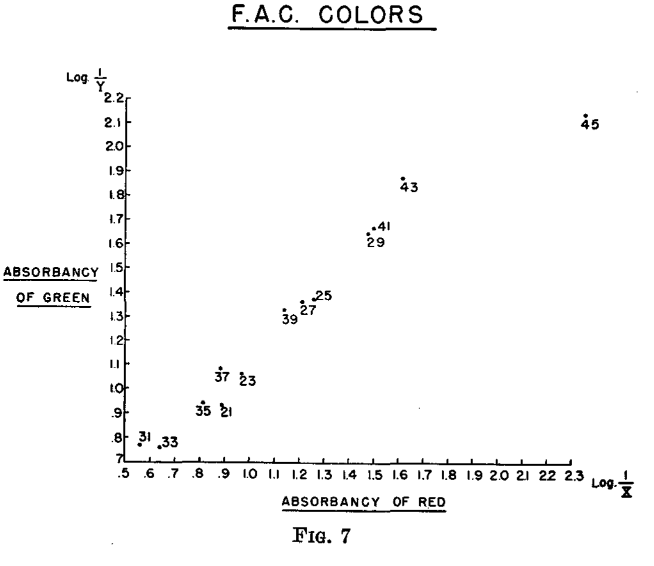

FIG. 7

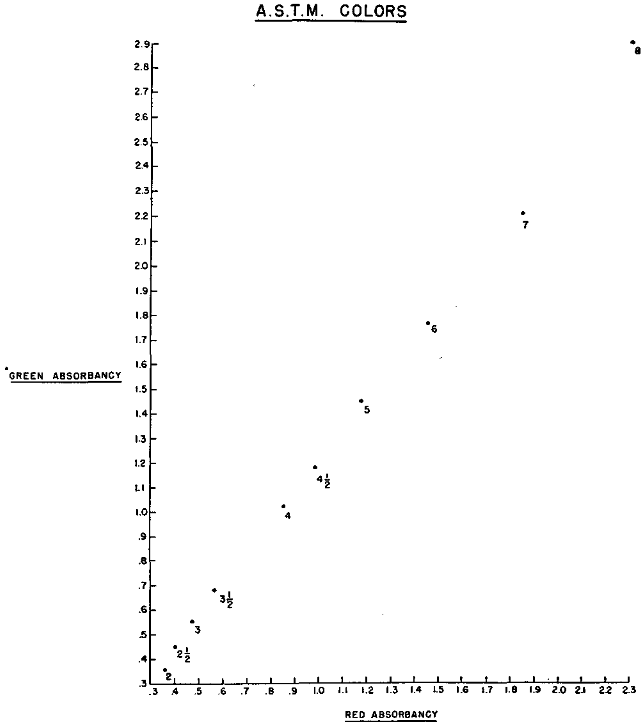

FIG. 8

With single number systems devised to use the results of instrumental measurement, the result can be controlled and predicted. Of course, the decision has to be made in setting up the equations as to whether one wants a hue match or a lightness match or a mixture of the two.

As a result of work on the photometric color, the author would like to set forth the values that should be embodied in a single number system.

The measurements should be made with a photoelectric instrument, a spectrophotometer, or a filter photometer. The values should be density or absorbency values; that is, if equal parts of a no. 10 and a no. 5 are mixed, the mixture should read reasonably close to 7½.

The values should do no violence to a visual grading for lightness. Exception to the latter may be made when one component of color is more easily removed (as by bleaching) than another.

In practice, the instrument readings may be broken into two parts. The light specimens can be characterized by the blue and green absorbencies, with only slight attention to the red. It will be noted in all of the trichromatic diagrams for the materials described, the green and red values rise from the neutral point along a straight line at about 45°. Thus the addition of the red value adds no precision. The dark specimens can be characterized by the green and red values because the blue is low or non-existent.

With this scheme a system for refined and bleached cottonseed and soybean oils has been devised. Our choice of 670 for the red is a special one for oils containing or likely to contain chlorophyll. For objects not likely to contain chlorophyll, the choice of peak wavelength for the red would be near 600 mμ. Our equations are:

For unbleached oils
a) Color $= 70.6D_{550} - 10.7D_{670}$
For bleached oils
b) Color $= 4.7D_{460} + 34D_{550}$

In a companion paper, "The Effect of Chlorophyll on the Color and Value of Oils," published in the Journal of The American Oil Chemists' Society, the development of these values is shown.

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ABSTRACTS . . . . E. S. Lutton, Editor

• Oils and Fats

R. A. Reiners, Abstractor

Fractional determination of free and esterified vitamin A. M. Aoyama (Kitasato Inst., Tokyo). *Kitasato Arch. Exptl. Med.* **25**, 63(1952). Approximately 10 mg. liver oil (containing less than 10 γ vitamin A alcohol and less than 20 γ of its ester) is dissolved in 5 ml. petroleum ether. One ml. of this solution is passed twice through an alumina column. The ester comes through quantitatively and the alcohol is removed by using 2 ml. of benzene or 20% acetone in petroleum ether. The fractions are analyzed by the glycerol dichlorohydrin or fluorometric method. Most liver oils contain about 97% ester and only 3% alcohol. (*Chem. Abs.* **47**, 3392)

Direct determination of the genuine vitamin A in liver oils. M. Aoyama (Kitasato Inst., Tokyo). *Kitasato Arch. Exptl. Med.* **25**, 65-66(1952). Directions are given for the preparation of an activated alumina suitable for separating vitamin A alcohol and ester. (*Chem. Abs.* **47**, 3392)

Effects of high-intensity electron bursts upon various vegetable and fish oils. A. Astrack, O. Sorbye, A. Brasch and W. Huber (Electronized Chemicals Corp., Brooklyn, N. Y.). *Food Research* **17**, 571-83(1952). The effects of sterilizing doses of high-intensity electron bursts on cottonseed oil, castor and linseed oils, as well as cod-liver, herring, mackerel, and whale oils were examined by chemical and organoleptic methods. The radiation mechanism includes polymerization, bond breakage, as well as a variety of oxidative changes. The organoleptic changes in irradiated oils are not parallel with chemical changes and are uninfluenced by the presence or absence of antioxidants. Oxygen as well as air plays a role in the formation of radiation-induced off-flavors since treatment in vacuum or under inert gases successfully inhibits off-flavors. (*Chem. Abs.* **47**, 3009)

New salts of undecenoic acid. A. Calo and Olga Mariani-Marelli (Ist. super. sanita, Rome). *Ann. chim.* (Rome) **41**, 594-9; *Rend. ist. super. sanita* (Rome) **14**, Pt. 9, 647-53(1951). Three new salts of 10-undecenoic acid, which may have pharmaceutical applications, have been prepared: $Hg(C_{11}H_{19}O_2)_2$, $Al(C_{11}H_{19}O_2)_3$, and $BiO(C_{11}H_{19}O_2)$. (*Chem. Abs.* **47**, 3231)

A study on the determination of polymerized fatty acids. G. N. Catravas and G. M. Knafo. *Oleagineux* **8**, 139-140(1953). The acids are prepared from the polymerized oil and the monomeric acids precipitated as adducts by a methanolic solution of urea while the polymerized acids remain in solution. The maximum error is 3 to 5%.

The chemical composition in fatty acids of a grape fusel oil. P. Cattaneo, A. Iacobacci, Germaine K. de Sutton and A. R. Lynch (Univ. nacl., Buenos Aires). *Anales asoc. quim. argentina* **40**, 150-9(1952). A residue, obtained from direct distillation of the oil, contained fatty acids. This is 10.5% of the crude fusel oil. The major acids were capric, caprylic, and lauric; the minor ones are caproic, myristic, palmitic, linoleic, probably isovaleric, and saturated acids containing more than 16 C atoms. Small amounts of monoethylenic acids of 6-16 C atoms are also present. (*Chem. Abs.* **47**, 3008)

Synthesis of some effective antioxidants. L-C Chiang and O. Gisvold (Univ. of Minnesota, Minneapolis). *J. Am. Pharm. Assoc., Sci. Ed.* **41**, 348-51(1952). Some new biphenyltetrols were prepared for use as antioxidants. The antioxidant properties of 2,2′,3,3′-biphenyltetrol, 5,5′-diethyl-2,2′,3,3′-biphenyltetrol, and 3,3′-dimethoxy-2,2′,5,5′-biphenyltetrol were determined by the Swift stability test. In lard and oil they are less active than 5,5′-dimethyl-2,2′,3,3′-biphenyltetrol, but 3,3′-dimethoxy-2,2′,5,5′-biphenyltetrol with citric acid was more than twice as effective as the 5,5′-dimethyl derivative with citric acid or NDGA with citric acid in lard. (*Chem. Abs.* **47**, 3282)

Determination of the saponification equivalent of low boiling esters. R. Davis (North Central College, Naperville, Ill.). *Chemist Analyst* **42**(1), 20(1953). The apparatus described by Shriner and Fuson is modified by attaching a balloon to the side arm of the reflux tube.

Some oxidation products of dl-α-tocopherol obtained with ferric chloride. V. L. Frampton, W. A. Skinner and P. S. Bailey (Univ. of Texas, Austin). *Science* **116**, 34-5(1952). Five products, 4 colored oils and a colorless wax, were isolated from the oxidation of *dl-α*-tocopherol with $FeCl_3$ in methanol. (*Chem. Abs.* **47**, 3306)

The technique of extracting olive oil without pressure and solvent. G. Frezzotti. *Oleagineux* **8**, 141-145((1953). The numerous methods proposed to replace pressing are divided into 5 groups and discussed. It is concluded that none of them is likely to replace the classic methods of grinding and pressing.

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Determination of the sebaceous secretion on the dorsal region of the hand during the summer period. K. Iversen (Washington Univ., St. Louis, Mo.). *Acta Dermato- Venereol.* **32**, 206-8 (1952). The 24-hr. sebaceous secretion of the dorsal region of the hand during the summer months averaged 11.6 γ of lipide per sq. cm. of skin. (*Chem. Abs.* **47**, 3442)

Determination of the skin lipide secretion in the dorsal region of the hand. S. G. Johnsen (Washington Univ., St. Louis, Mo.). *Acta Dermato- Venereol.* **32**, 168-73(1952). The 24-hr. lipide secretion of the dorsal region of the hand during the winter months averaged 13 γ per sq. cm. for 75 individuals aged 13-93. The magnitude of the secretion was not affected by age or sex. (*Chem. Abs.* **47**, 3442)

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