The following analysis was accompanied by proper controls.

(a) *Direct.*—The syrup (equivalent to 250 Gm. Pollen) + 6.25 cc 0.5 N sodium phosphate solution + hydrochloric acid (final acidity = 0.001 N) and thymol water q.s. to 250 cc. Rotation in 2 dcm. tube at 26° = + 0.52° V. Walker-Munson process. 5 cc gave 0.0565 Gm. Cu_2O. Levulose, 0.5%.

(b) *Action of Invertase.*—200 cc of the above solution + 0.25 Gm. active invertase. Readings at 24 hour intervals in 2 dcm. tube at 26° is constant at —1.55° V. 5 cc gave 0.1024 Gm. Cu_2O. Sucrose by reduction is 0.39%. By Clerget's formula it was 0.40%.

(2) Calculated to normal solutions, the direct rotation is 0.135° V and the calculated rotation for sucrose is 0.4° V. Hence the other sugar is levorotatory.

(c) *Action of Emulsin.*—100 cc of the above solution was plunged into boiling water-bath for 10 minutes. The solution was cooled to room temperature and 0.5 Gm. active emulsion added. After 3 days no increase in the reducing power was observed. 5 cc gave 0.1032 Gm. Cu_2O. The reading, which was obscure in 2 dcm. tube at 27°, was —1° V.

Pentose sugars could not be detected. The remainder of this material (33.5 Gm.) was treated with phenylhydrazine hydrochloride and sodium acetate and a yield of d. phenylglucosazone (0.12 Gm.) melting at 208° was obtained.

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COLOR STANDARDIZATION IN THE U. S. PHARMACOPŒIA.*

BY E. N. GATHERCOAL.

Color perception is due to the appreciation through the retina of light waves of differing wave lengths. The spectrum of white light is the physicist's basis of color study, but in nature colors are developed that are of greater intensity and clearness than the spectrum of white light displays.

The color of opaque or partially opaque objects is due to the absorption of all the color waves falling on the object, except those particular colors which are reflected from the object and can thus be received by the eye. The color of transparent objects, solid or liquid, results from the transmission through the object of those colors seen by the eye and the absorption of any others that may be present. The color of flaming gases is due to the actual production of certain color waves which may then be perceived by the retina. One can readily understand, therefore, that a color chart prepared with opaque pigments might be more valuable for determining the color of opaque objects than for matching the color of a transparent object or a flaming gas. This is true perhaps to a limited extent.

The three Primary colors—yellow, red and blue, as indicated in chart I[1] are called primary because they are the basis of all other colors. In the white light spectrum these three colors cannot be seen with the intenseness and clearness displayed by the pigments used in this chart. However, by the sodium flame it is possible to produce an intense yellow, by the lithium a brilliant red, etc.

* Scientific Section A. Ph. A., Cleveland meeting, 1922.

[1] The charts were displayed during the reading of the paper.

By mixing equal parts of any two primary color pigments it is possible to produce a third color, and in this way the binary colors—orange, green and violet, are formed as indicated in chart II[1].

While the six colors here presented[1] form the color basis of a great many objects it soon becomes evident in color study that relatively few objects exactly match any one of the six colors on chart II. We find in nature a great range of color "value," the intensity varying from a high degree of "lightness" to an intense "darkness" of the color. Many attempts have been made to name or describe the intensity of colors, but no scheme so far presented is perfect. It is customary to select a middle point half way between White and Black; the color intensity that falls at this middle point is known as "Normal" while those intensities between Normal and White are called "Tints" and those between Normal and Black are "Shades." The term "Tone" includes all Tints, Shades and Normal of a color. Tints are made by the addition of opaque white to Normal, or with water colors, dilution with water. Shades are made by adding black to Normal. Therefore, theoretically, an unlimited number of tints and shades of any color can be prepared, but, practically, it requires high training in color perception to distinguish more than ten tints of color or as many shades. Even ten tones, ranging from a light tint to a dark shade gives a fairly fine gradation of color intensities. See charts III[1] and IV[1].

In the study of Binary colors it is noted that each Binary is produced by mixing equal parts of two Primaries. The third Primary, *i. e.*, the one that does not enter into the Binary, is said to be Complementary to the Binary. Orange is a mixture of yellow and red in equal proportions. Blue does not enter into it and is therefore the one thing lacking to complete the Color circuit. Therefore orange and blue are each complementary to the other. Complementary colors are in the strongest possible contrast to each other, yet when placed in juxtaposition remarkably enhance each other's values. However when mixed in equal proportions they produce no tone or hue of either color but a gray—Neutral Gray. If a larger quantity of one complement be used, its color will be apparent, but "softened" or "grayed." By varying the proportions of the complements in the mixture, and by adding white or black varying degrees of grayness can be produced. Here again, theoretically, an unlimited number of grayed tones are possible, but, practically, the limit of differentiation for the untrained eye is about ten of these tones.

In addition to that quality of color known as the tone or intensity, and that peculiarity of color known as softening or graying, we have a third quality of color to consider, namely "Hue." It is Hue that makes one color distinguishable from another. The three Primary colors give us the Primary Hues. The Binaries are hues produced by mixing equal parts of any two Primaries. It is evident that by varying the proportion of the Primaries or by mixing equal parts of a Primary and an adjacent Binary, new hues can be formed. Thus a mixture of three parts yellow and one part red equals yellow-orange, while a mixture of three parts red and one part yellow gives red-orange. Likewise three parts of red and one of blue gives red-violet and three parts of blue and one of red gives blue-violet. In a similar manner with blue and yellow, blue-green and yellow-green are formed. It is evident, also, that by combining yellow and yellow-orange, yellow-yellow-orange will be formed. Theoretically, there is no limit to the hues that can be produced, but practically there is a limit, for the distinction between the tones of a color similar to the closely adjacent hues is too slight for the untrained eye to grasp. Thus the difference between a light tone of yellow-orange and yellow-yellow-orange is very slight. The twelve hues shown in chart VII[1], the three Primary, the three Binary and the six Secondary and Neutral Gray with their tones, brilliant and grayed, afford as minute a differentiation of color as the ordinary mind can grasp.

It is evident that nothing approaching a complete color scheme is feasible, but a serviceable selection of type colors would be practicable.

In such a color chart proposed for the U. S. Pharmacopœia, the twelve hues and neutral gray could be arranged in thirteen columns and a fourteenth column could be used to gather into one place the various tones of "brown." The so-called brown tones are scattered through the yellow-orange, orange and red-orange columns. There should be about ten tones of each hue, part brilliant and part grayed. This would give 130 color tones, every one of them produced scientifically and properly named. The range of color is complete. The division into hues and tones could be made finer, but it is here fine enough for all practical purposes.

Some of the advantages of such a chart may be stated as follows:

First—It supplies a standard color *nomenclature;* a nomenclature adopted and used wherever color is scientifically considered. This nomenclature is also generally used in the schools in connection with color and art work. Also, it is gradually being adopted by color makers to replace the cumbersome color nomenclature that has been built up by color manufacturers.

The color nomenclature of the U. S. P. IX cannot be considered scientific though in most cases it is fully descriptive. For instance in the monograph on Aloe, the following color terms are employed:

Yellowish brown, 3 times	Yellowish, 2 times
Blackish brown, 3 times	Pale yellow
Dark brown	Greenish yellow
Reddish brown, 5 times	Bright yellow
Deep reddish brown	Purplish red
Light brown	Deep red
Purplish brown	Deep rose
Greenish	Orange
Green	Olive-black

A second great advantage of such a chart is that it supplies a standard color *guide.* While it may be true that persons with a color training would know just what was meant by deep rose, there are many readers of the U. S. P. including myself who are not so well trained. For instance the color produced in making the test for emodin in Aloe is named as deep rose. My results, uniform with many samples of Aloes, was a pink. Lighter red in the color chart almost exactly matched the color produced in this reaction. If a color chart were in U. S. P. IX and the color in the test had been named according to the chart, I would have known at once whether the results of my test were at the U. S. P. standard.

Finally, we need a standard color nomenclature and a standard color guide because color terms are so extensively used in the Pharmacopœia and color descriptions are of such great importance. As a student of the Pharmacopœia for a number of years, I have appreciated as most of you do that color terms are not rare in the U. S. P., but I had no conception until after investigation how *numerous*, *varied* and *important* color terms are in pharmacopœial description. Do you know that color terms are used 3,000 times in U. S. P. IX? In the first 50 pages of descriptive text, 84 color terms are employed a total of 302 times.

In conclusion permit me to reply to a few of the criticisms offered against the introduction of a color chart into the U. S. P.

Question.—Can lithographed charts be printed in large quantities so that all the charts will have the same intensity of color?

Answer.—The chart proposed for the U. S. P. will be made from paper dyed in liquid dye in a vat, sufficient paper being dyed at one time with the one lot of color to supply all the copies of this revision that can possibly be sold. After each color has been thus dyed into paper, small rectangles will be cut, very much as labels are cut and each rectangle of colored paper will be mechanically attached in its proper place to the heavy paper used for the chart. There can be no question about the absolute uniformity of colors in every chart, even though 100,000 or 200,000 be prepared.

Question.—Will the colors not fade?

Answer.—The colors are as permanent as can be obtained. They might fade with long exposure to sunlight. However, the chart should be bound into the book and sufficient exposure to cause fading of the colors will be a rarity. There is much more likelihood of their becoming soiled by constant use. Provision will be made for the purchase of additional charts by those who need them.

Question.—Is color of sufficient importance to warrant this innovation?

Answer.—The use of color terms 3,000 times in U. S. P. IX certainly indicates that color descriptions are of value.

Question.—Should color be made a criterion of vegetable drugs? Do not drugs vary much in color without affecting their value or virtue? Is color a true index to quality?

Answer.—Color is just as valuable a criterion of the identity, purity and value of vegetable drugs as is size, shape, external markings, structure, odor or taste. If it is desirable to eliminate the descriptions of drugs entirely then color description might also be eliminated. Even then, however, about two-thirds of all color terms now employed in the Pharmacopœia are used in connection with the chemical monographs. Hence even with the elimination of all vegetable drugs a color chart would still be desirable.

Question.—Will it not be difficult to exactly match the colors?

Answer.—It will, but an approximate match is better than no match at all.

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