COLOR, TRISTIMULUS

PRINCIPLE

When light is projected onto the surface of an opaque solid, some wavelengths are absorbed and some are reflected. The relative amounts of the various wavelengths result in the visual sensation of color. The color and brillance of a material can be determined by measuring the reflected light at specific wavelengths using a tristimulus colorimeter (Note 1).

SCOPE

This method is applicable to all unmodified and modified corn starches, corn sugars , feedstuffs and other solid products derived from corn. It does not apply to products that contain an added colorant which significantly shifts the dominant wavelength of the sample from 575 nm; nor does it apply to products containing fluorescent whitening agents (Note 2).

SPECIAL APPARATUS

1. Colorimeter, Tristimulus: Equipped with an optical sensor with a 45 degree circumferential illuminator (Note 3), and a microcomputer (Note 4)

2. Standard Calibration Plates: A black glass tile, a Japanese opal white tile (Note 5), and a standard white tile are required. These can be purchased from the manufacturer of the colorimeter.

3. Sample Dishes: Sample cups or plastic disposable Petri dishes as specified by the colorimeter manufacturer

PROCEDURE

Instrument Calibration: Calibrate the instrument daily using the standard calibration plates, following the specific manufacturer's instructions.

Sample Preparation: Grind about 50 g of sample in an appropriate grinder for about 15 seconds (Note 6). Place the ground sample in a clean sample dish, mounding the sample in the center. Gently pack the sample by tapping the mounded portion with a spoon or Petri dish cover. Wipe the bottom of the sample

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dish with a clean lens tissue to insure that it is free of starch or smudges which will cause interference.

Analysis: Put the instrument in the operating mode. Place the filled sample dish directly over the sample port, and read the color values X, Y and Z or the data calculated from the screen following the specific manufacturer's instructions.

CALCULATIONS

Equations for color calculations from X, Y, and Z (Note 7) values:

$L^* = 24.99 (Y)^{1/3} - 16$

$a^* = 107.7 [(1.02X)^{1/3} - Y^{1/3}]$

$b^* = 43.09 [Y^{1/3} - (0.8467Z)^{1/3}]$

Where:

L* is a correlate of lightness (lightness increases with the value);

a* is a correlate of redness or greenness (positive number indicates redness, negative number indicates greenness);

b* is a correlate of yellowness or blueness (positive number indicates yellowness, negative number indicates blueness).

NOTES AND PRECAUTIONS

1. This method was adopted after examination of the C.I.E. (Commission Internationale de l'Eclairage) color specification procedure which describes the primary visual stimuli: dominant wavelength, purity and luminance (luminous transmittance or reflectance). "Dominant wavelength" is that property by which the eye differentiates hue or color type. "Purity" is a measure of color concentration or saturation with respect to a pure sprectral standard. "Luminance" expresses the transmittance or reflectance of a standard light energy which is characteristic of normal perception in terms of wavelength and energy. "Luminance," sometimes referred to as brightness or brillance, is indicated on a scale between 0 and 100, representating absolute black and perfect white, respectively.

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2. Application of this method to samples containing fluorescent whitening agents will give objective values comparable to those obtained by subjective visual inspection under artificial light containing no ultraviolet energy. Such samples appear unusually bright when examined under direct or diffuse sunlight.

3. Manufacturers include Byk-Gardener (Model TCM Color Machine Senor and Colorguard System 1000), Hunter Associates (Model D25M Colorimeter) and Lovibond (Colourscan).

4. Any compatible personal computer and printer can be used.

5. Reflectance of this tile is equivalent to that of magnesium oxide, an internationally recognized standard, with an assigned 100% reflectance value.

6. When determining the brightness of a sample, grinding should be omitted, because a reduction in particle size will effectively increase its apparent brightness. Theoretically, reduction in particle size by grinding to render the sample to a workable condition and improve precision will not affect the color value of the sample.

7. The values X, Y, and Z represent integrals over the visible spectrum taking into account the relative power of the illuminating source, the reflectance of the subject and the standard observer functions $\bar{x}$, $\bar{y}$, and $\bar{z}$, which have been derived experimentally during development of color theory.

REFERENCES

Principles of Color Technology, 2nd Ed., Fred W. Billmeyer, Jr., and Max Saltzman, John Wiley & Sons, 1981

The Measurement of Appearance, Richard S. Hunger and Richard W. Herald, John Wiley & Sons, 1987

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METHOD HISTORY

Combined the Color, Tristimulus methods for Corn Starch (Unmodified) (B-14), Corn Sugar (F-16) and Feedstuffs (G-6) on 4-15-2010.

Corn Starch (Unmodified), Color, Tristimulus (B-14), Date of Acceptance 4-25-1990.

Corn Sugar, Color, Tristimulus (F-16), Date of Acceptance 4-25-1990.

Feedstuffs, Color, Tristimulus (G-6), Date of Acceptance 4-25-1990.