Designation: D6961/D6961M – 09 (Reapproved 2015)ε1

Standard Test Method for Color Measurement of Flax Fiber[1]

This standard is issued under the fixed designation D6961/D6961M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε[1] NOTE—The Terminology section was updated in accordance with D13 policy in February 2015.

1. Scope

1.1 This test method covers the instrumental color measurement of flax fiber.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D123 Terminology Relating to Textiles
D1776 Practice for Conditioning and Testing Textiles
D6798 Terminology Relating to Flax and Linen
E284 Terminology of Appearance
E308 Practice for Computing the Colors of Objects by Using the CIE System
E1164 Practice for Obtaining Spectrometric Data for Object-Color Evaluation

2.2 *Other Standard:*

AATCC Evaluation Procedure 6 Instrumental Color Measurement[3]

3. Terminology

3.1 For all terminology related to Flax see Terminology D6798.

3.1.1 The following terms are relevant to this standard: dew-retting, enzyme-retting, and water-retting.

3.2 For other textile terminology, see Terminology D123.

4. Summary of Test Method

4.1 Samples of flax fiber are presented to a color spectrophotometer. Color measurements are taken through a large aperture port 25.4 millimeter [1-in.] diameter, in order to average over the natural color variation that occurs in flax fiber. The instrument aperture is fitted with a quartz window. The window serves two functions, namely, to provide a base for compacting the sample during measurement, and to protect the instrument from accumulation of stray fiber particles. CIELAB L*, a*, and b* measurements are taken and are instrumentally calculated from tristimulus X, Y and Z data, observer function, and illuminant data.

5. Significance and Use

5.1 Few standards exist to objectively judge flax quality. Color is an important factor in the quality of flax fiber. Natural variations in raw flax fiber, various processing steps, fiber blending, and a wide range of end uses contribute to the need for a standard method of objectively measuring the color of flax fiber. Spectrophotometic data provide an accurate, precise determination of the color of flax fiber. Colorimetric data are obtained through specimen measurement by combining specimen spectral data with data representing a CIE standard observer and a CIE standard illuminant, as described in Method E308.

5.2 If there are differences of practical significance between reported test results for two (or more) laboratories, comparative tests should be performed to determine if there is a statistical bias between them, using competent statistical assistance. As a minimum, use the samples for such a comparative test that are as homogeneous as possible, drawn from the same lot of material as the samples that resulted in disparate results during initial testing and randomly assigned in equal numbers to each laboratory. The results from the laboratories involved

[1] This test method is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.17 on Flax and Linen.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Association of Textile Chemists and Colorists (AATCC), P.O. Box 12215, Research Triangle Park, NC 27709, http://www.aatcc.org.

should be compared using a statistical test for unpaired data, a probability level chosen prior to the testing series. If a bias is found, either its cause must be found and corrected, or future test results for that fiber sample type must be adjusted in consideration of the known bias.

6. Apparatus

6.1 A visible range spectrophotometer (minimum of 20-point) is recommended. Such an instrument provides greater accuracy than colorimeters, spectro-colorimeters, or 10-point color spectrophotometers.

6.1.1 *Instrument Configuration and Settings:*[4]

6.1.1.1 Either a 0/45 or a spherical instrument/specimen geometry may be used. The selected geometry should be included in the report.

6.1.1.2 If the instrument offers a choice of specular modes, measurements should be taken using the specular excluded mode.

6.1.1.3 Use the recommended CIE Illuminant D65 unless otherwise specified in a material specification or contract order. If an alternate illuminant is selected, its specifications should be included in the report.

6.1.1.4 Use the recommended CIE 10-degree observer unless otherwise specified in a material specification or contract order. If an alternate illuminant is selected, its specifications should be included in the report.

6.2 A fiber compression cell capable of applying air pressure of 206,843 Pa [30 psi] or 275,790 Pa [40 psi] is recommended for assuring consistent pressure among specimens presented for measurement.

7. Sampling and Sample Preparation

7.1 For acceptance testing, take a lot of sample from shipping containers as directed in an applicable specification, or as agreed upon between the purchaser and supplier.

7.2 Take the measurement at a minimum of five sites within a specimen and three measurements at each site. Means of the three readings constitute the site reading. For each specimen, report means of the five site readings.

7.3 *Sample Handling and Preparation:*

7.3.1 In addition to natural color variation within a sample, other variables that may influence color measurements include fiber orientation within the sample, and the relative compactness of the sample. With a flax sample there may be considerable variation in fiber orientation. Some specimens may be totally randomly oriented, while in some specimens there may be areas in which fibers are parallel. In selecting measurement sites, care should be taken to avoid areas in which there are obvious changes in fiber orientation that could result in shadows that might contribute to error in measurement.

7.3.2 Users are advised that moisture may influence color of flax and linen. Samples should be conditioned prior to measurement, as described in Practice D1776.

7.3.3 Bundles of flax fiber presented for measurement are rather open-structured, capable of being easily compacted through pressure. Care should be taken in applying the same pressure to samples during measurement, because the density of the sample may influence readings. The sample should be compressed firmly against the glass-covered aperture to assure that the entire aperture is covered by fiber. Consistency in pressure can be achieved through the use of a fiber compression cell that consists of a cup fiber specimen holder and clamp that is pressed against the specimen through application of compressed air. Air pressure of 206,843 Pa [30 psi] or 275,790 Pa [40 psi] is recommended.

8. Procedure

8.1 Specimens are compressed at a pressure of 206,843 Pa [30 psi] or 275,790 Pa [40 psi] and presented to the instrument aperture so that the entire area of the aperture is filled with the specimen.

8.2 CIELAB L*, a*, and b* measurements are taken at a minimum of five sites within a specimen, and three measurements are taken at each site. Specimens are repacked and rotated 90° between each of the three measurements taken at one site to reduce variability with respect to fiber orientation. Means of the three readings constitute the site reading.

9. Calculation

9.1 Means of the five site readings per specimen of CIELAB L*, a*, and b* are calculated. These readings indicate variation in lightness (L*), redness-greenness (a*), and yellowness-blueness (b*).

9.2 Calculations of differences in lightness, in redness-greenness, and yellowness-blueness between specimens may be reported as ΔL*, Δa*, and Δb* values. Overall color differences, ΔE*, may also be calculated , where ΔE CIELAB = $[\Delta L^{*2} + \Delta a^{*2} + \text{and } \Delta b^{*2}]^{1/2}$.

TABLE 1 Summary of precision and bias analysis for CIELAB L*

Sample	Average $\bar{x}$	Repeatability Standard Deviation s_r	Reproducibility Standard Deviation s_R	Repeatability Limit r	Reproducibility Limit R
1	59.03	2.1655	8.7004	6.0633	24.3612
2	53.24	1.0664	6.9831	2.9860	19.5526
3	51.81	2.9932	8.3534	8.3810	23.3896
4	56.23	4.3230	8.9706	12.1043	25.1177
5	58.64	1.0370	6.6149	2.9036	18.5217
6	54.81	0.3935	5.1631	1.1018	14.4568

10. Report

10.1 State that the specimens were measured as directed in ASTM Test Method D6961.

10.2 Report means of five site readings of CIELAB L*. a*, and b*.

10.3 Report instrument manufacturer and model.

10.4 Report illuminant/specimen geometry of the instrument.

[4] All available apparatus may not be suitable for this application. Apparatus considered for use in this application shall be checked for suitability in accordance with the requirement of Method E308.

TABLE 2 Summary of precision and bias analysis for CIELAB a*

Sample	Average $\bar{x}$	Repeatability Standard Deviation s_r	Reproducibility Standard Deviation s_R	Repeatability Limit r	Reproducibility Limit R
1	2.87	0.1393	0.4673	0.3902	1.3084
2	2.90	0.0854	0.4837	0.2391	1.3543
3	2.97	0.1373	0.5212	0.3844	1.4593
4	2.95	0.2137	0.5185	0.5984	1.4518
5	2.83	0.0535	0.4271	0.1498	1.1960
6	5.31	0.1764	0.7411	0.4939	2.0750

TABLE 3 Summary of precision and bias analysis for CIELAB b*

Sample	Average $\bar{x}$	Repeatability Standard Deviation s_r	Reproducibility Standard Deviation s_R	Repeatability Limit r	Reproducibility Limit R
1	12.81	0.4700	2.0691	1.3160	5.7933
2	12.77	0.1721	2.1517	0.4819	6.0248
3	11.23	0.3604	2.0252	1.0092	5.6707
4	8.69	0.7160	5.5004	2.0048	15.4012
5	12.61	0.1345	1.7626	0.3767	4.9355
6	19.33	0.6487	3.7622	1.8165	10.5341

10.5 Report instrument settings, including the illuminant, observer function, and specular mode.

10.6 Report pressure under which the specimens were compressed during measurement.

11. Precision and Bias

11.1 *Precision*—The average, standard deviation, and 95 % repeatability limit (2.8X sample standard deviation) of inter-laboratory samples tested with the same method for various flax fiber samples are shown in Table 1, Table 2, and Table 3.

11.2 *Bias*—With the limitation imposed by the lack of flax fiber color reference standards, this test method has no known bias.

12. Keywords

12.1 CIELAB; color; flax fiber