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BALL STATE UNIVERSITY

Influences of Fabric Type and Color on Post-Wash Colorfastness

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2026

Study Background

Digital textile printing offers significant advantages, including vibrant color expression and sustainable, feasible sample production. While the market has expanded to include diverse materials like jersey, stretch, and rough-surface fabrics, technical challenges persist:

Inconsistent Colorfastness: Recent research indicates that laundering durability remains a primary concern in digital printing (Bridges, 2025).
Chemical & Structural Limitations: These issues often stem from the interaction between low-viscosity reactive inks and the complex, three-dimensional porous structure of the fabric (Glogar et al., 2024).

Research Purpose & Questions

The goal of this study was to objectively measure how fabric characteristics and ink colors affect stability after wash.

Primary Objective: To quantify the color changes (Delta E 2000) in four common apparel fabrics following a standardized washing procedure.

Research Question: How do specific fabric types and ink colors (CMYK) influence colorfastness after washing?

For this **experimental** study, four distinct fabric samples were digitally printed via Spoonflower.com; colorfastness after laundering was then evaluated using a spectrophotometer.

Methodology

The study utilizes a **factorial experimental design** to analyze the relationship between material and color stability.

Experimental Variables

Independent Variable 1 (Fabric Type): Four levels chosen for their high frequency of use in the apparel industry:

- **Dogwood Denim** (100% Cotton)
- **Cotton Spandex** (93% Cotton / 7% Spandex)
- **Polyester Fleece** (100% Polyester)
- **Polyester Lycra** (88% Polyester / 12% Lycra)

Independent Variable 2 (Color): Four levels (Cyan, Magenta, Yellow, and Black).

Dependent Variable: L*a*b*color values and the resulting color difference (Delta E 2000)

Methodology

Procedure & Testing

- **Printing:** Samples were digitally printed via Spoonflower.com.

- **Treatment (Washing):** Laundering followed AATCC Methods 135-1995 (Shrinkage Test) and 124-1996 (Fabric Smoothness Test After Repeated Washing) with specific adjustments.

- **Measurement:** An X-Rite Spectrophotometer was used to measure color values at three locations on each patch both before and after washing to ensure data accuracy.

Independent Variables:
4 different fabrics with distinguishable features

DURABLE STRUCTURE

Dogwood Denim®

- 100% Cotton
- 56" wide, 11.7 oz per sq yard
- Woven, 3x1 twill weave construction
- Bottom weight, rated for residential upholstery

STRETCH RECOVERY

Cotton Spandex Jersey

- 93% Cotton, 7% Spandex
- 60" wide, 5.5 oz per sq yard
- Knit, jersey knit construction
- 4-way stretch: ≥ 50% horizontal; ≥ 50% vertical

LIGHTWEIGHT WARMTH

Polartec® Fleece

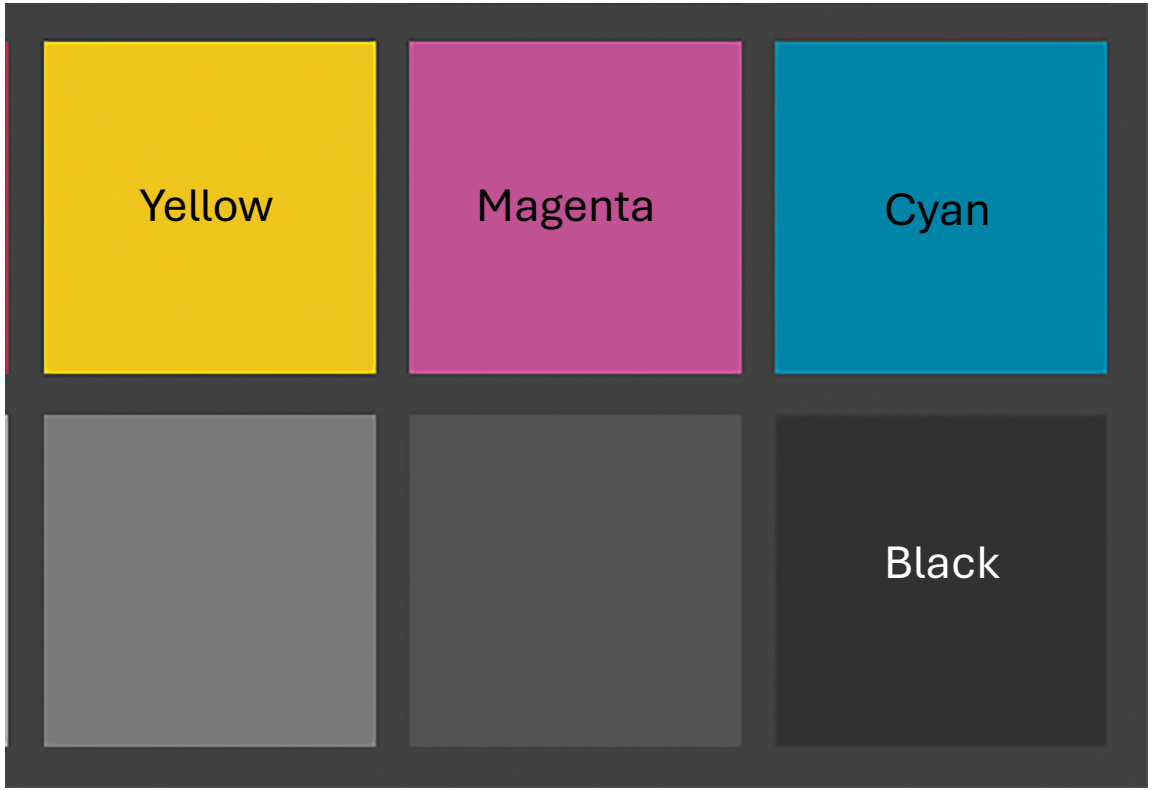
- 100% Polyester
- 56" wide, 7.4 oz per sq yard
- Knit, fleece knit construction
- Highly breathable, quick drying

SWIMWEAR READY

Sport Lycra®

- 88% Polyester, 12% Lycra®
- 56" wide, 8.5 oz per sq yard
- Jersey knit, 4-way stretch: ≥ 50% horizontal; ≥ 25% vertical
- Advanced moisture management wicking finish

Independent Variables: 4 Colors (CMYK)



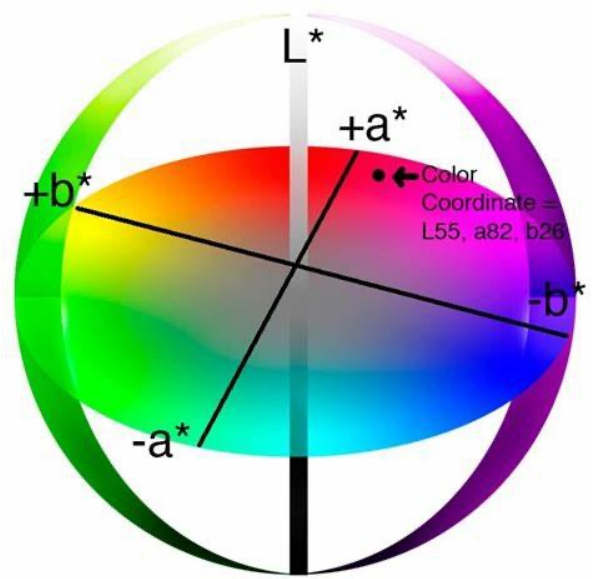
Treatment:

Washing (Laundering)

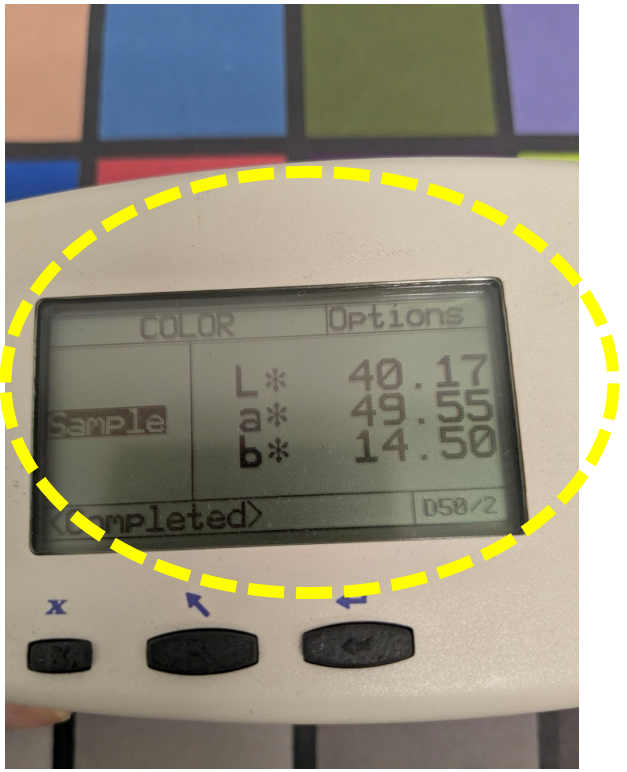
The washing method followed the washing procedure outlined in **AATCC Method 135-1995** (Shrinkage Test) and **AATCC Method 124-1996** (Fabric Smoothness Test After Repeated Washing):

1. Wash the fabric specimens in a normal washing cycle on a cotton setting with detergent;
2. Take the specimens out of the machine as soon as the final spin is completed;
3. Tumble dry the specimens but do not overdry;
4. Repeat this procedure two more times;
5. Average the score and record the results.

Dependent Variables: L*a*b* Values



Measurement Tool: spectrophotometer



Data Analysis

- L*a*b* measurements were averaged.
- Color differences (delta E 2000) before and after washing were calculated.
- Four fabrics and four colors were compared.

Dogwood Denim

	C		M		Y		K	
	Before	After	Before	After	Before	After	Before	After
L*	50.46	47.72	50.21	48.47	80.48	77.20	31.25	29.26
a*	-16.09	-15.50	47.50	46.11	5.09	7.39	0.44	0.11
b*	-22.01	-20.87	-15.46	-13.70	75.65	72.22	-0.30	-0.24

Cotton Spandex

	C		M		Y		K	
	Before	After	Before	After	Before	After	Before	After
L*	46.91	45.05	49.74	49.97	80.03	78.01	31.99	32.34
a*	-16.45	-15.25	43.28	40.94	-1.13	0.33	-1.51	-1.68
b*	-22.72	-21.46	-15.34	-14.99	59.69	56.66	-3.34	-3.44

Polyester Fleece

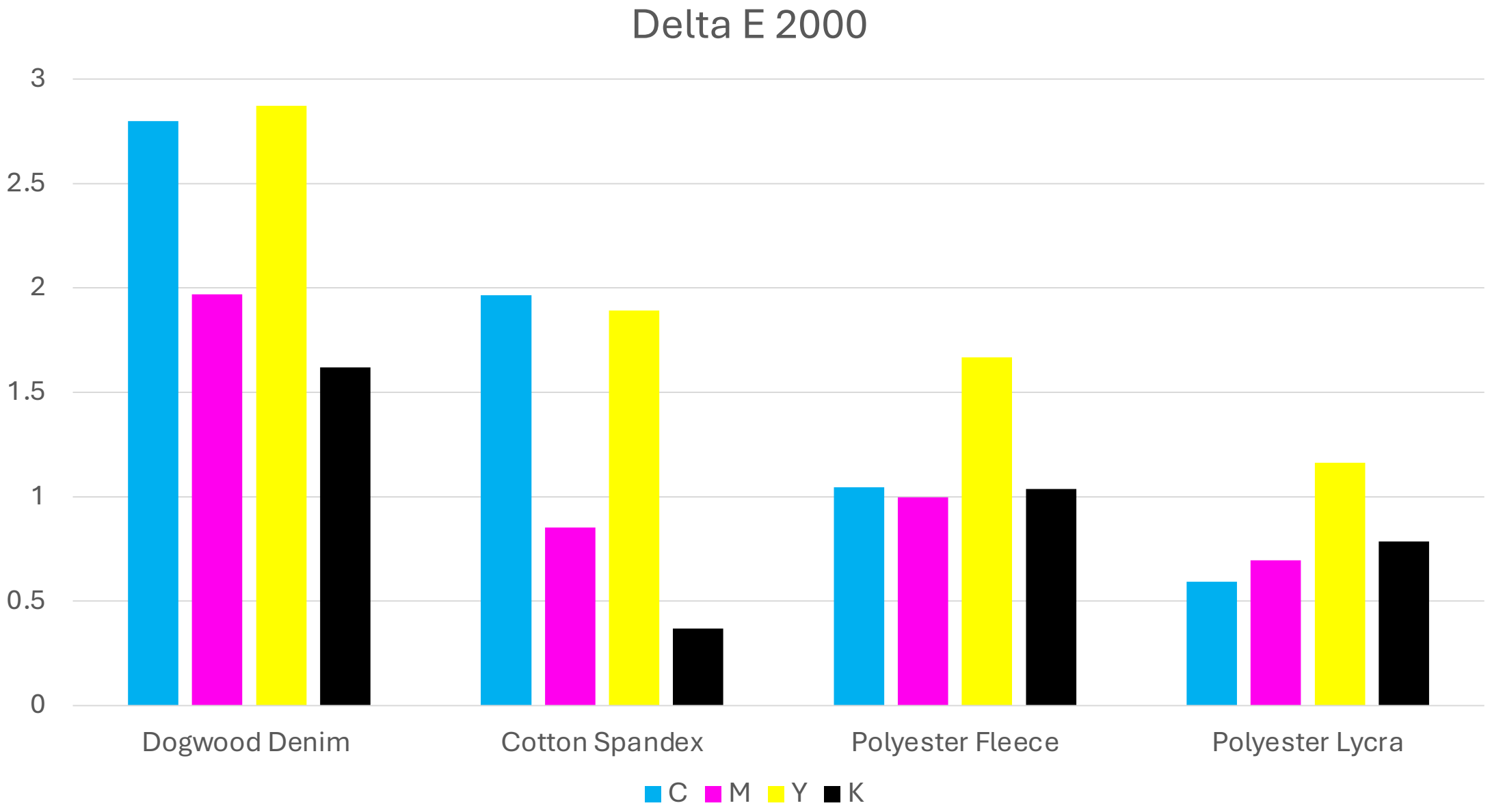
	C		M		Y		K	
	Before	After	Before	After	Before	After	Before	After
L*	47.58	48.61	45.48	46.31	77.00	75.62	28.14	28.73
a*	-18.00	-17.80	48.40	46.67	2.87	1.19	-1.76	-2.45
b*	-20.08	-19.64	-11.40	-11.55	72.67	68.78	-1.98	-2.30

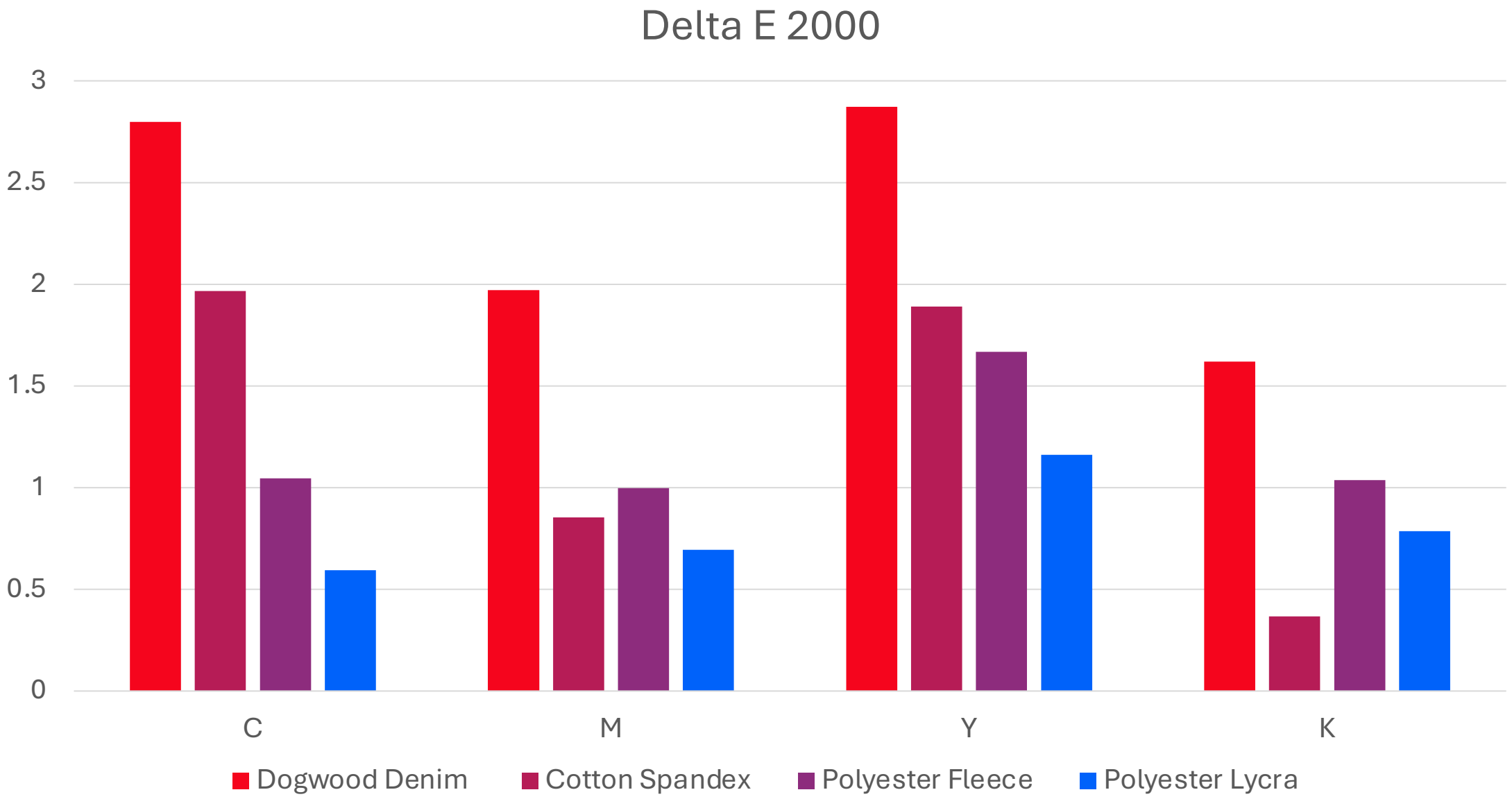
Polyester Lycra

	C		M		Y		K	
	Before	After	Before	After	Before	After	Before	After
L*	44.35	43.96	45.88	46.04	76.91	75.64	29.85	29.82
a*	-18.40	-17.78	48.98	46.87	4.61	4.24	-0.12	-0.59
b*	-15.38	-14.70	-11.34	-11.20	73.86	70.86	0.38	0.78

Delta E 2000

	C	M	Y	K
Dogwood Denim	2.798	1.97	2.873	1.62
Cotton Spandex	1.966	0.853	1.891	0.368
Polyester Fleece	1.046	0.998	1.668	1.037
Polyester Lycra	0.593	0.695	1.162	0.785


Delta E 2000
3
2.5
2
1.5
1
0.5
0
Dogwood Denim
Cotton Spandex
Polyester Fleece
Polyester Lycra
C
M
Y
K


Delta E 2000
3
2.5
2
1.5
1
0.5
0
C
M
Y
K
Dogwood Denim
Cotton Spandex
Polyester Fleece
Polyester Lycra

Conclusions

- Synthetic polyester fabrics had better post-wash colorfastness than natural cotton fabrics.
- Adding Spandex or Lycra improved post-wash colorfastness.
- For yellow color, all four fabrics had noticeable fading after wash. For cyan color, the two cotton fabrics had noticeable fading after wash. For magenta and black colors, only denim fabric had noticeable fading after wash.

Discussions and Further Study

- Digital textile printing has been recognized as a sustainable alternative to traditional dyeing and printing methods, and the use of digital textile printing is growing.

- Although challenges such as cost and colorfastness have been addressed, it offers notable advantages, including suitability for small production runs (such as sample production), fast production times, and the ability to produce photorealistic images.

- This study tested fabrics with various textures (such as twill, fleece, and cotton/polyester jersey), which demonstrated considerable color changes after washing.

- Multiple approaches can be done to compare the results such as the traditional colorfastness testing using the crock meter.

Limitations of the study

The original plan was to print the polyester (PE) fabrics using the same ink; however, the vendor did not proceed with this. This will be addressed in a further study.

References

Bridges, A. (2025). Color fastness of untreated textiles in direct-to-garment printing. *The Journal of Technology, Management, and Applied Engineering*, *1*(1). https://doi.org/10.31274/jtmae.17795

Glogar, M., Parac-Osterman, Đ., Fakin, T., & Katovic, D. (2024). The complexity of colour/textile interaction in digital printing as an integral part of environmental design. *Arts*, *13*(1), 29. https://doi.org/10.3390/arts13010029