Title: Turning Cottonseed Oil into Sustainable Finishes: Hydrophobic and Wrinkle-Resistant Cotton Fabric

Authors: Taylor Kanipe[a], Luz Meza[a], Sunkyu Park[a], Hou-Min Chang[a], Matthew Farrell[b], Richard Venditti[a]

Affiliations: [a]Department of Forest Biomaterials, North Carolina State University, Raleigh, NC 27605; [b]Cotton Incorporated, Cary, NC

Abstract: Cellulose is a renewable, biodegradable material widely used in textiles and paper, but its inherent hydrophilicity reduces dimensional stability and water resistance. This study demonstrates the use of zinc chloride as a Lewis acid catalyst to covalently graft epoxidized cottonseed oil (ECSO) onto cellulose-based fabrics via epoxide ring-opening, producing hydrophobic surfaces without the use of petroleum-based or fluorinated compounds. Treatment variables (catalyst loading, reaction time, and ECSO concentration) were optimized using response surface methodology. FT-IR analysis of modified substrates confirmed new carbonyl and CH_2 signals and shifts in OH stretching consistent with disruption of cellulose hydrogen bonding and formation of new hydroxyl groups. Fabrics treated with ECSO in the presence of $ZnCl_2$ showed mass increases up to 32.6%, water contact angles of 98–132° (control 30°), and crease recovery angles up to 123° (control 98°), with hydrophobicity and mechanical improvements plateauing at higher loadings. Scanning electron microscopy revealed a coating on fiber surfaces that flattened yarns into a more cohesive layer, correlating with enhanced fabric stiffness and wrinkle resistance. These results demonstrate that $ZnCl_2$-catalyzed ECSO grafting is an effective, renewable-based method for producing hydrophobic, mechanically enhanced cellulosic materials, offering a sustainable alternative to conventional synthetic finishes. Future work is focused on developing an emulsion-based finishing technique to further the sustainability of the finishing process and decrease the use of organic solvents.

Bio: Taylor Kanipe is a Ph.D. student in the Department of Forest Biomaterials at North Carolina State University. She received her Bachelor of Science in Chemistry from Wingate University in 2022. Her research focuses on developing sustainable, bio-based finishes for cellulosic materials and alternatives to petroleum-derived coatings.