Bio-based Coated Yarns: Turning Waste into High-Value Sustainable Textile

Augusta Silva*[1], Jéssica Antunes[2], Ashly Rocha[2], Carla Silva[3], Sandra Ventura[4], Agostinho Afonso[4], and João Abreu[4]

[1]Centro Tecnológico Industrias Têxtil Vestuário Portugal – Portugal
[2]Centro Tecnológico Industrias Têxtil Vestuário Portugal – Portugal
[3]CITEVE – Portugal
[4]TÊXTEIS PENEDO – Portugal

Abstract

The textile industry is increasingly prioritising sustainability through the adoption of environmentally responsible manufacturing processes and the integration of bio-based materials to replace fossil-derived resources. Although textile coating is recognised as a sustainable finishing technology, most commercial coating formulations remain predominantly fossil-based.

This work presents the development of an innovative bio-based coated yarn composed of organic cotton coated with a water-based formulation incorporating organic and mineral industrial by-products as functional and colouring components. The formulation includes pine bark, cork industry residues, bacterial fermentation pigments, natural pigments, and biomass boiler ash, replacing conventional fossil-based polymers, additives, and dyes while promoting circularity and resource efficiency.

Research and development were carried out at laboratory scale by CITEVE and subsequently industrially validated at CORK-A-TEX, the only company worldwide producing cotton yarns coated with industrial by-products. The process involved residue micronisation, optimisation of particle size distribution and dispersion using bio-based binders and additives, continuous yarn coating, and industrial validation using conventional textile production equipment.

Laboratory characterisation confirmed stable processing behaviour and full compatibility with existing coating technologies. The coated yarns exhibited excellent mechanical integrity, high tensile strength, abrasion resistance, and structural stability. Fastness testing demonstrated high resistance to washing, rubbing, water, and light exposure, confirming compliance with conventional textile performance requirements.

Compared with a conventional fossil-based paste-coated yarn, the developed solution demonstrated clear technical and environmental advantages. Industrial-scale Life Cycle Assessment (LCA) identified a 16.4% reduction in greenhouse gas emissions (kg CO eq/kg). Fossil raw material consumption decreased by 43.5%, while bio-based ingredient content increased by 86.7%, incorporating 3% (m/m) cork powder into the final coating formulation. Water use efficiency improved by 88.2%.

*Speaker

The coated yarn achieved Technology Readiness Level (TRL) 8, demonstrating validated performance under industrial operating conditions. Demonstrator jacquard fabrics confirmed successful incorporation of cork residues while maintaining the functional and aesthetic requirements for home textile applications.

Overall, this work demonstrates a scalable bio-based coating technology based on industrial residue valorisation, enabling the production of high-performance coated yarns with reduced environmental impact and supporting the transition towards circular, resource-efficient, and sustainable textile manufacturing.

Keywords: coated yarn, bio, based coating, textile bio, coating, biobased polymers, waste valorisation, pine bark, cork, waste, bacterial fermentation pigments, sustainability, circular economy.