Title: Fabrication of Acacia-Waste-Charcoal-Printed Cotton Fabric for the Development of Functional Textiles—A Sustainable Approach

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Abstract: he textile industry is seeking alternative coloration methods to comply with the global demands for eco-friendly and non-hazardous dyes, as synthetic colorants are costly and substantially toxic in nature, having deleterious effects on the environment as well as ecosystems. This research aimed to develop a printed functional cotton fabric using a new bio-based pigment from acacia wood waste (*Acacia nilotica*) charcoal. Acacia charcoal was ground into fine powder and added into pigment paste with polyacrylic binder and screen printed on cotton fabric, followed by drying and curing. The printed fabric was tested for color strength (K/S), colorfastness, flame resistance, contact angle (for checking the hydrophobicity), thermal insulation, and tensile strength following standard testing protocols. Using different charcoal concentrations (in the range of 0.5–5%), the samples presented light to dark gray color and the K/S value gradually increased from 1.85 (0.5%) to 12.31 (5%), demonstrating stronger color depth. The printed fabrics revealed good results in terms of color fastness ratings (washing 3–5, dry rubbing 3–5, wet rubbing 3–5), satisfactory flame resistance, good thermal insulation, and excellent hydrophobicity. The obtained results contribute to sustainable and durable textile development for achieving better performance.

Keywords: functional textiles; contact angle measurement; flame retardancy; acacia charcoal; biochar; screen printing

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