**Title: Exploring *Gardenia jasminoides* Seed-Derived Natural Dyes for the Development of Functional Textiles**

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**Abstract:** Natural plant-based resources are rich in bioactive compounds that offer promising alternatives for developing sustainable, functional textiles. This study focuses on the extraction and application of natural dyes from *Gardenia jasminoides* as an eco-friendly substitute for conventional synthetic dyes. The dye was extracted using methanol–water (50:50) and ethanol–water (50:50) solvent systems, alongside conventional aqueous extraction, followed by characterization through column chromatography. The characterization of the extracted powders confirmed the presence of gardenia yellow pigments with strong coloration potential. Among the tested extraction methods, ultrasonic-assisted methanol–water extraction (M.W.U.) exhibited the highest dye yield of 29.5%, followed by ethanol–water ultra-sound extraction (E.W.U.) at 24.9%, water ultrasound extraction (W.U.) at 18.35%, and the lowest yield obtained from the water-heater method (W.H.) at 18.25%. The dyed cotton fabrics were tested for color strength (K/S), CIELAB, colorfastness (washing, light, rubbing), and functional properties (antibacterial and vector protection) according to standard operating procedures. The results revealed that an optimal mordant concentration produced the maximum color strength (K/S = 1.7730), with good rubbing (4–5), washing (4–5), and light fastness (5). The dyed fabrics also exhibited excellent antibacterial activity against both *Staphylococcus aureus* and *Escherichia coli*, as evaluated by the AATCC 100 test method. For instance, the vector protection property of the cotton dyed fabrics was also excellent, as confirmed by the cage test. Overall, the use of *Gardenia jasminoides* seed-based natural dye demonstrates not only desirable coloration and functional performance but also significant ecological advantages, reducing chemical pollution and supporting the transition toward environmentally sustainable textile processing.

**Keywords:** natural dyes; ultrasonic-assisted extraction; sustainable dyeing; color fastness; antibacterial properties

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