Extraction and Utilization of Biowaste for Sustainable Textile Dyeing

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Abstract

The textile industry is one of the largest contributors to environmental pollution due to the extensive use of synthetic dyes and their toxic effluents. At the same time, the food industry generates large amounts of by-products and waste, which are often underutilized despite their potential value. Building on this approach, the present study analyses red onion peels and beetroot waste, two abundant biowastes rich in anthocyanins and betacyanins, as sources of natural textile dyes. Pigments were extracted using three methods: boiling in water, solvent extraction with ethanol to obtain more concentrated pigments, and acidic or alkaline extraction using vinegar or sodium carbonate. Spectrophotometric analysis was performed to determine pigment yield and intensity. A comparative evaluation of the extraction methods was conducted in terms of pigment yield, color tone, and stability. The resulting extracts were applied to cotton fabrics to evaluate dye uptake and color fastness. Preliminary results indicate that both extracts produce vivid and durable shades, with slight differences between the two sources. This work highlights the potential of biowaste valorization in promoting circular economy practices and sustainable textile innovation, with future prospects for exploring nanoscale fiber–pigment interactions.

References

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