Central composite design for the optimisation of silk yarn dyeing with natural extract from Melastoma malabathricum L. fruit

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Abstract

Natural dyes have gained interest in sustainable textile applications. However, the potential of Melastoma malabathricum as a silk dye source remains unexplored. Pigments extracted from M. malabathricum L. fruit using acidified methanol were used for silk yarn dyeing through the meta-mordanting process with stannous chloride (2%) as the mordant. A four-factor, face-centred composite design from response surface methodology was applied to optimise the dyeing process. The effect of extract weight, temperature, pH, and dyeing duration on colour intensity was analysed. The optimum conditions (R^2 = 0.9517) were found using 1 g of dye extract, 30 °C, pH 3, and 120 min, yielding a colour

intensity of 28.99. The ultraviolet-visible spectra indicated the highest peak absorbance of the dye bath at pH 3, aligned with the highest colour intensity. Higher temperatures and amount of dye extract increased the colour intensity, while lower temperatures and longer durations had the opposite effect. This study contributes to sustainable silk dyeing by utilising M. malabathricum fruit as a natural dye source and provides a foundation for its systematic optimisation. The findings also highlight its potential for large-scale applications, offering an eco-friendly alternative to synthetic dyes in the textile industry.

Author keywords

colour intensity; M. malabathricum; natural dye; RSM; silk yarn

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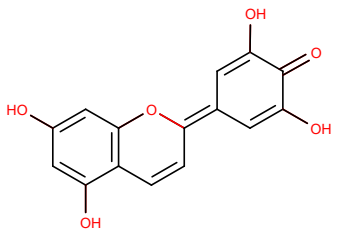

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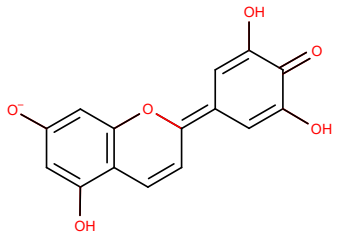

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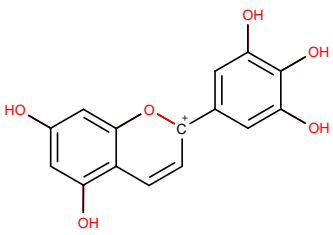

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