

Innovative Use of Raspberry Leaf Extract as a Natural Mordant for Sustainable Leather Dyeing

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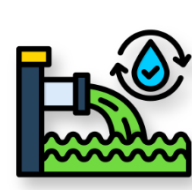
Background

Conventional leather dyeing



- Use of metallic mordants (Al, Cr, Fe salts)
- Synthetic dyes derived from petroleum
- Generates toxic effluents with low biodegradability

Environmental & health concerns



- REACH restrictions on hazardous substances
- Eco-toxicological risks of metal salts
- Increased demand for safer, bio-based alternatives

Green alternatives in leather



- Plant-derived mordants rich in polyphenols and tannins
- Raspberry leaf extract as innovative bio-mordant
- Potential to enhance interactions between dyes and collagen fibers

Sustainable mordanting strategy

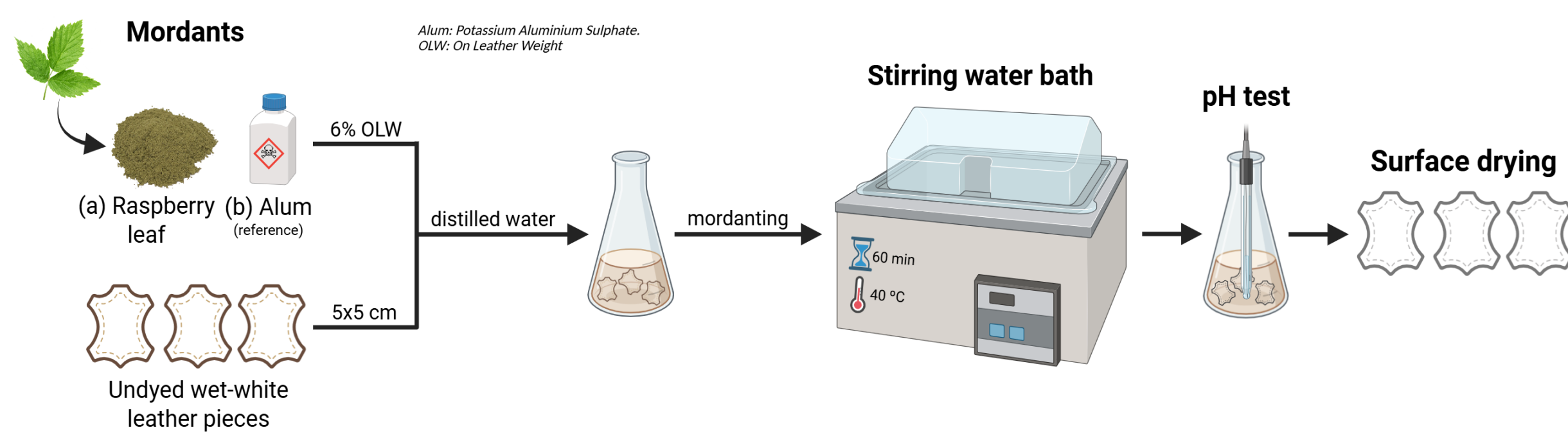


- Compared with potassium aluminium sulphate
- Combined with natural dyes from renewable plant sources
- Goal: Assess colour intensity and dye fixation efficiency

The search for safer alternatives to metallic mordants has gained relevance in the leather industry due to environmental concerns and evolving regulations, such as the **Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)**, which limits hazardous substances in manufacturing. Although **plant-based mordants rich in polyphenols and tannins** have shown promise in textile dyeing, their application to leather, especially **chromium-free substrates like wet-white**, remains limited. **Raspberry (*Rubus idaeus*) leaf extract** is a polyphenol-rich by-product with antioxidant properties, yet unexplored in this context. This study evaluates its performance as a **natural mordant for wet-white leather dyeing**, compared to the conventional metallic mordant potassium aluminium sulphate (alum), using four commercial plant-based dyes to promote **sustainable processes with comparable results**.

Methodology

Step 1 – Pre-mordant



Step 2 – Dyeing

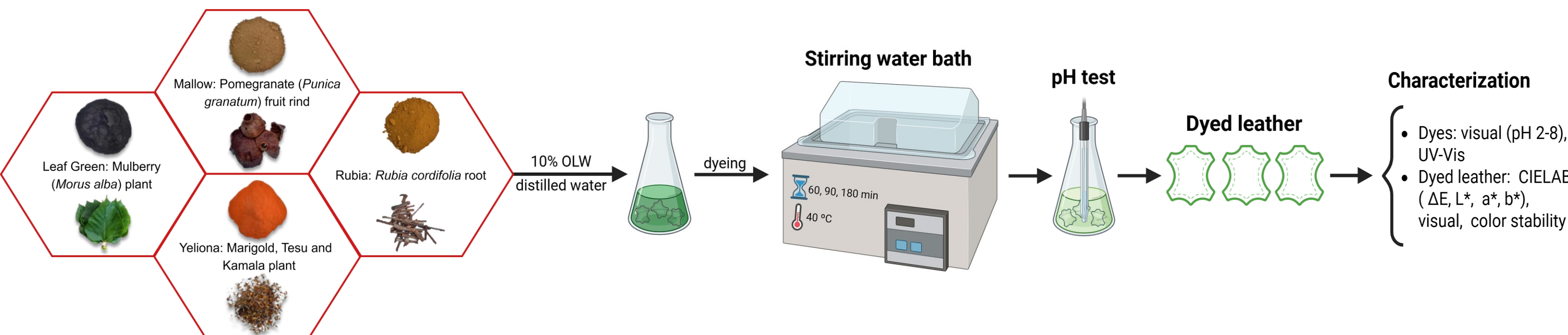


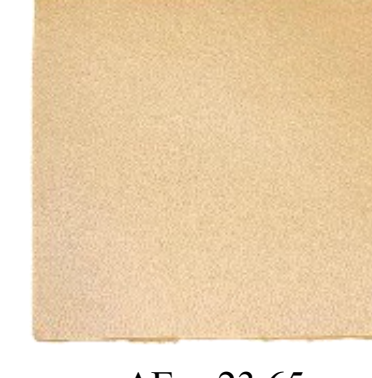

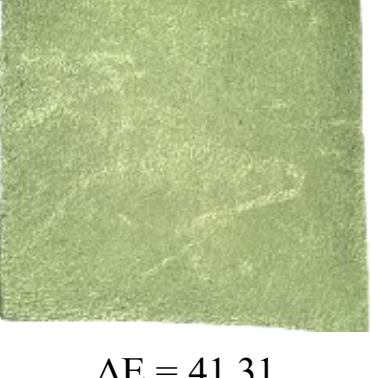
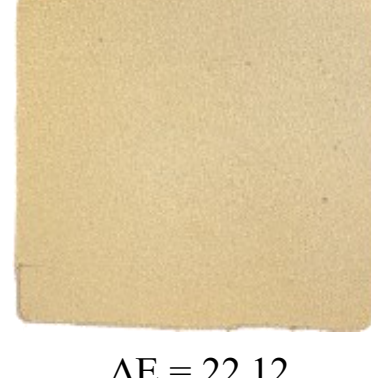
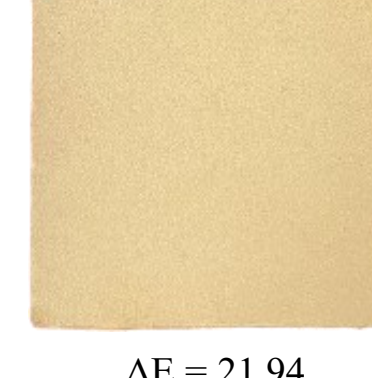



Table 1. Color difference (ΔE) of dyed leather: Raspberry leaf extract vs. potassium aluminium sulphate mordant.

Mordant	Dye			
	Leaf Green	Mallow	Rubia	Yeliona
Raspberry leaf extract	 ΔE = 23.59	 ΔE = 23.17	 ΔE = 23.65	 ΔE = 33.63
Potassium aluminium sulphate (reference)	 ΔE = 41.31	 ΔE = 22.12	 ΔE = 21.94	 ΔE = 39.37

Leaf Green

- Raspberry: Homogeneous dyeing (no staining).
- Reference: Non-uniform dyeing (severe staining).
- Key message: Raspberry extract prioritizes dyeing uniformity, eliminating defects observed with metallic mordant.

Rubia

- Raspberry: Uniform dyeing (no staining).
- Reference: Uniform dyeing (no staining).
- Key message: Both mordants achieved equivalent uniformity and color intensity, demonstrating that raspberry extract is a viable metal-free replacement for this dye.

Mallow

- Raspberry: No defects (homogenous surface).
- Reference: Localized defects (minor staining).
- Key message: Both mordants achieve comparable dye fixation, but raspberry extract ensures superior surface quality.

Yeliona

- Raspberry: Uniform dyeing (no visible defects).
- Reference: Uniform dyeing (no visible defects).
- Key message: Both mordants provide uniform dyeing, with raspberry extract yielding a matte yellow finish suitable for natural aesthetics.

Results & Discussion

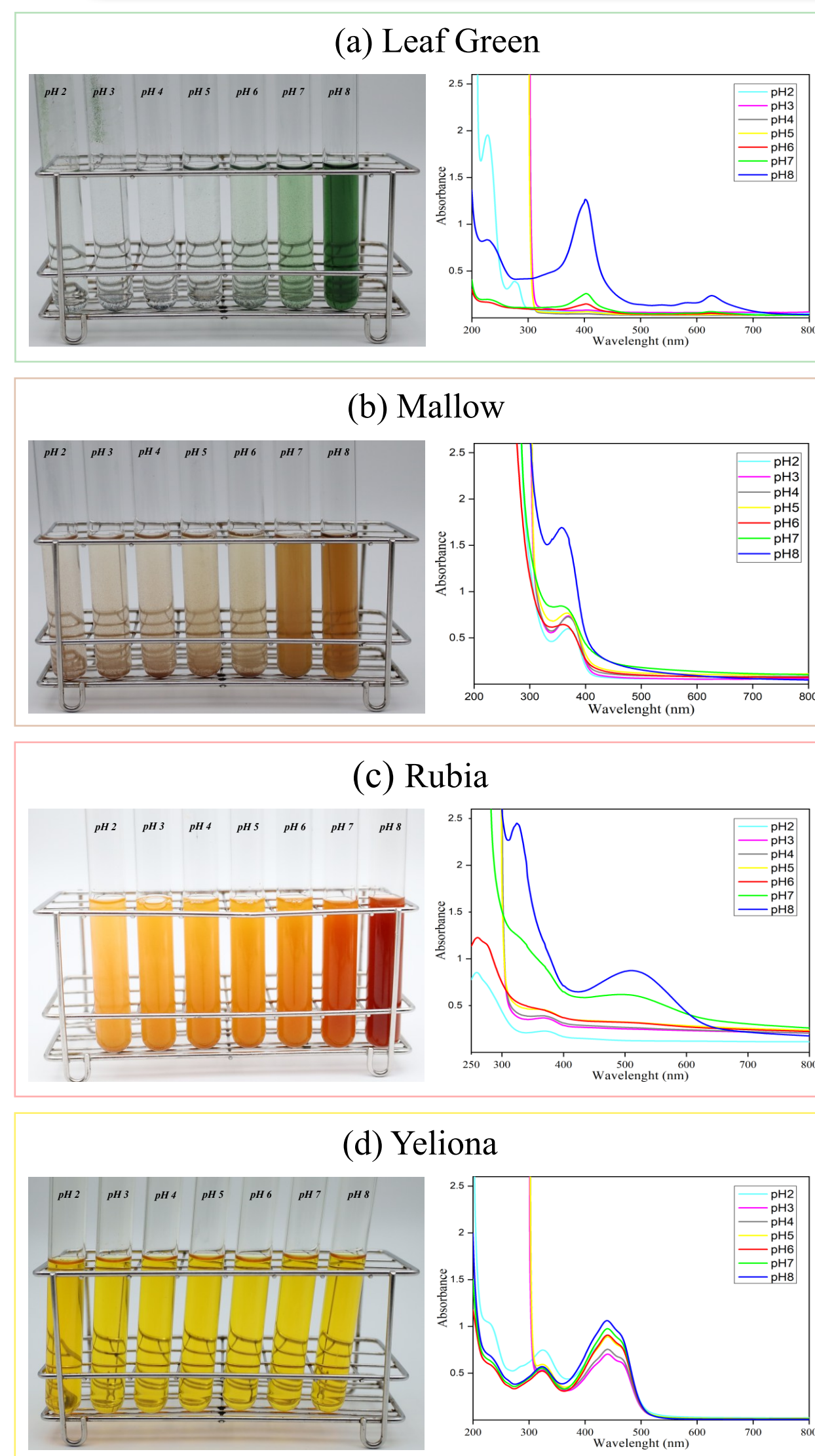


Figure 1. Dye characterization: Visual appearance and UV-Vis spectra at different pH values.

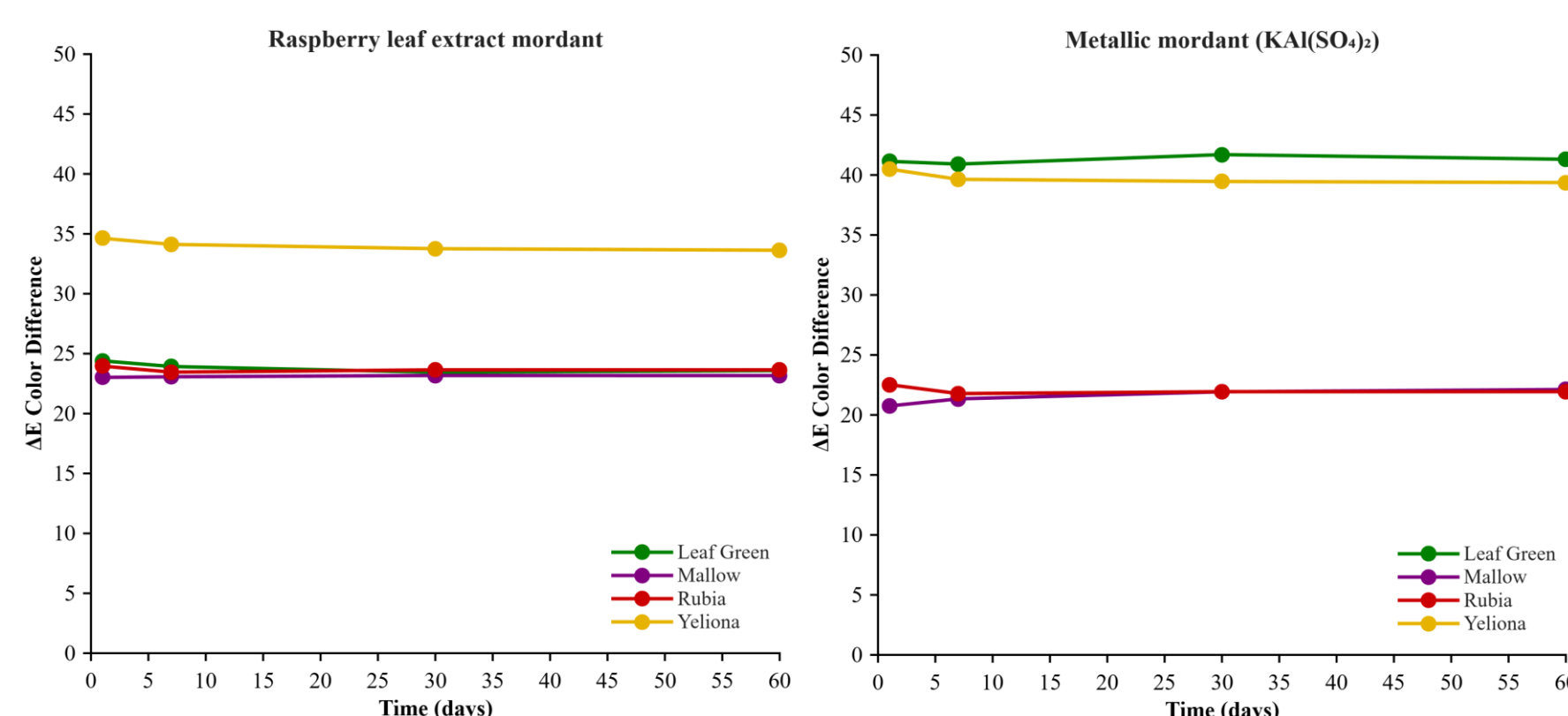


Figure 2. Color stability of dyed leather: ΔE monitoring over 60 days.

Color stability in dark storage: ΔE values remained stable over 60 days, indicating no significant color degradation. This suggests that:

- ✓ Raspberry extract may provide dye-binding efficiency comparable to metallic mordants, possibly due to tannins (e.g., ellagic acid) interacting with collagen and dyes.
- ✓ The tannin-dye-collagen complex could contribute to stability, as tannins are known to act as cross-linking agents.
- ✓ Suitable for low-light applications (e.g., interior leather goods).

Conclusions

Raspberry leaf extract provides a **heavy metal-free mordant**, eliminating pollution from metallic salts. Sourced from agricultural byproducts, it is **renewable, biodegradable, and non-toxic**, aligning with **green chemistry principles**.

The extract delivers **industrial-level dye fixation (ΔE > 20)** with **superior uniformity** compared to metallic mordants. Color stability was confirmed over **60 days in dark storage**, and it works consistently across **green, brown, red, and yellow natural dyes**.

Raspberry leaf extract is a **viable, sustainable alternative** to metallic mordants, offering **comparable color intensity, superior uniformity, and eco-friendly processing**.