Cultivating Sustainability: Extracting Curcuminoids from *Curcuma Longa* using a Green Approach

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1. INTRODUCTION

Industries significantly impact the environment through their use of energy, water, and resources, as well as their resource exploitation methods. The current linear economic model, which follows a take-make-dispose approach, has led to a global waste crisis. Transitioning to a circular economy is essential to address this issue. Industries face major challenges in downstream processes, such as extraction and purification, which constitute up to 80% of operational costs. Conventional high-resolution methods, though common, are expensive, capacity-limited, and can compromise process precision due to diffusional spread. An alternative is the use of aqueous two-phase systems (ATPS), specifically aqueous micellar two-phase systems (AMTPS), for biomolecule separation. AMTPS require only a surfactant and water or an aqueous solution, with phase separation induced by temperature changes. There is also a growing demand for curcumin, known for its benefits as a natural colorant and its anti-inflammatory, antioxidant, analgesic, and anticancer properties. Turmeric, which contains curcumin, also includes demethoxycurcumin and bisdemethoxycurcumin.

2. EXPERIMENTAL SECTION

To develop the curcuminoids extraction and purification from *Curcuma longa* utilizing micellar solutions, this work was structured into two interconnected and sequential steps: solid-liquid extraction (SLE) followed by liquid-liquid extraction (LLE). This approach aims to minimize solvent consumption, namely in LLE, where purification is accomplished using micellar two-phase systems (AMTPS). The quantification of curcuminoids and the contaminants in the supernatant post-SLE, as well as in each phase post-LLE, is conducted through UV-VIS spectroscopy and HPLC.

3. RESULTS

3.1. OPTIMIZATION OF SLR AT A FIXED EXTRACTION TIME

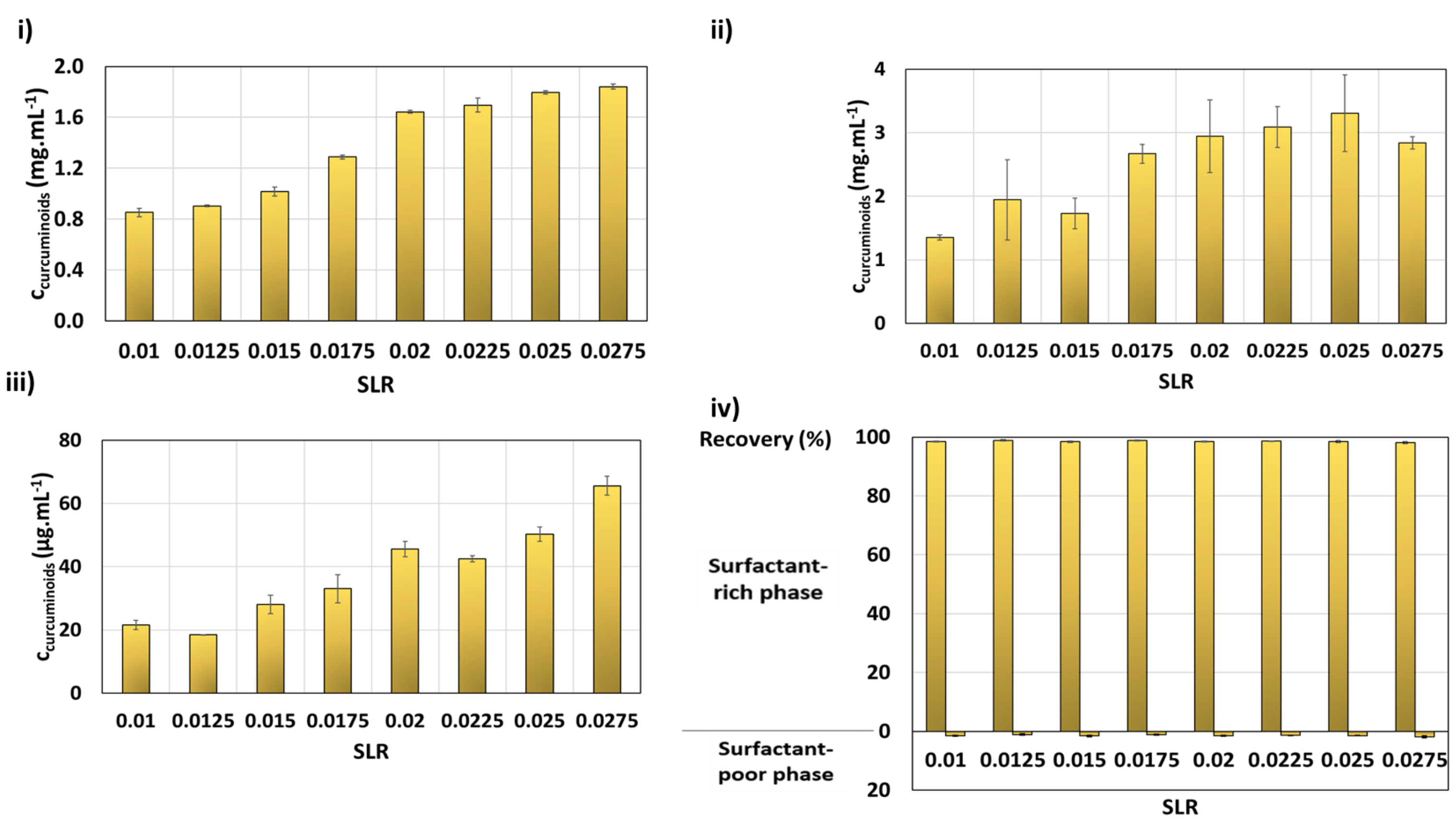

Fig.1: Curcuminoids' concentration in i) the supernatant obtained with SLE, ii) the surfactant-rich phase, iii) surfactant-poor phase, and iv) curcuminoid recoveries in both phases

- ➡30 min extraction
- ➡LLE performed above T_{cloud}
- ➡Growing curcuminoid trend
- ➡SLR 0.025
- ➡Recovery over 90%

3.2. CENTRIFUGATION TIME OPTIMIZATION

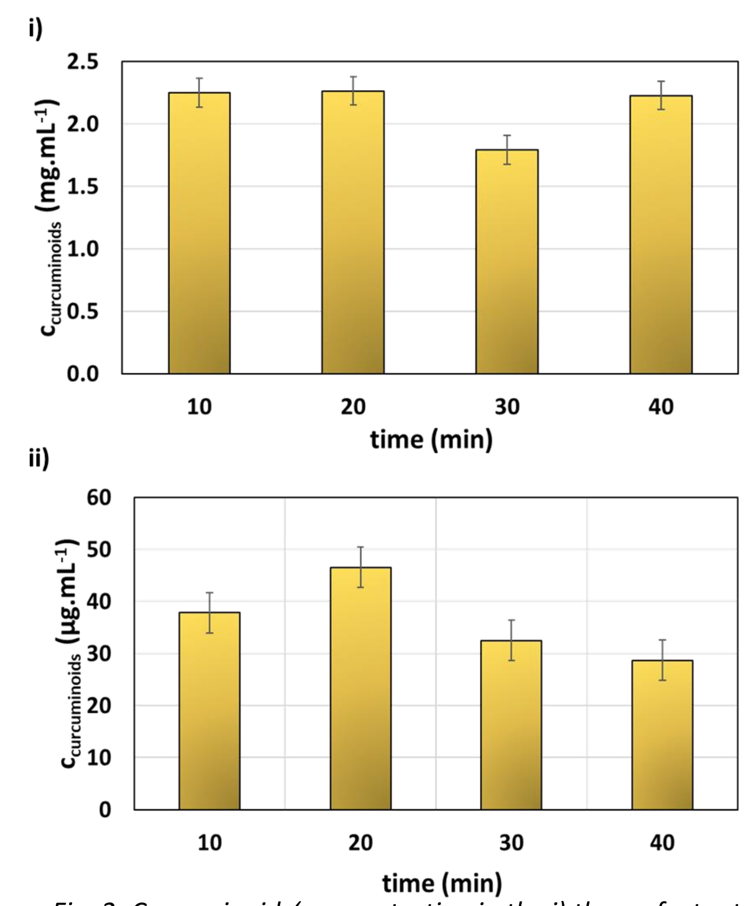

Fig. 2: Curcuminoids' concentration in the i) the surfactant-rich phase, and ii) surfactant-poor phase

- ➡Centrifugation in the LLE does not significantly impact the extraction
- ➡20 minutes of centrifugation

3.3. EXTRACTION TIME OPTIMIZATION WITH THE MOST PROMISING SLR

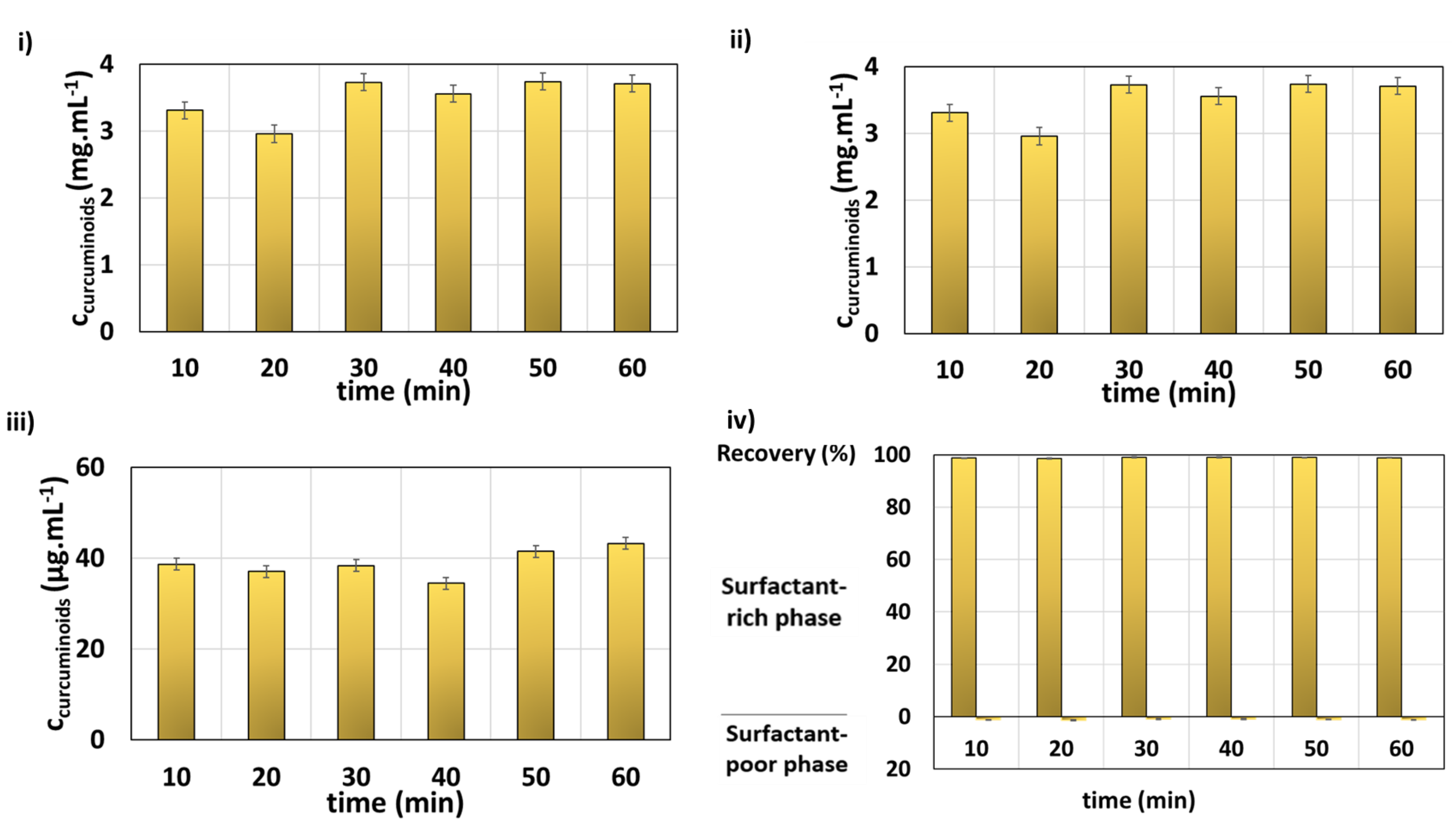

Fig.3: Curcuminoids' concentration in i) the supernatant obtained with SLE, ii) the surfactant-rich phase, iii) surfactant-poor phase, and iv) curcuminoid recoveries in both phases

- ➡Growing curcuminoid trend
- ➡30 min extraction time
- ➡Recoveries over 95 %

3.4. HPLC METHOD OPTIMIZATION

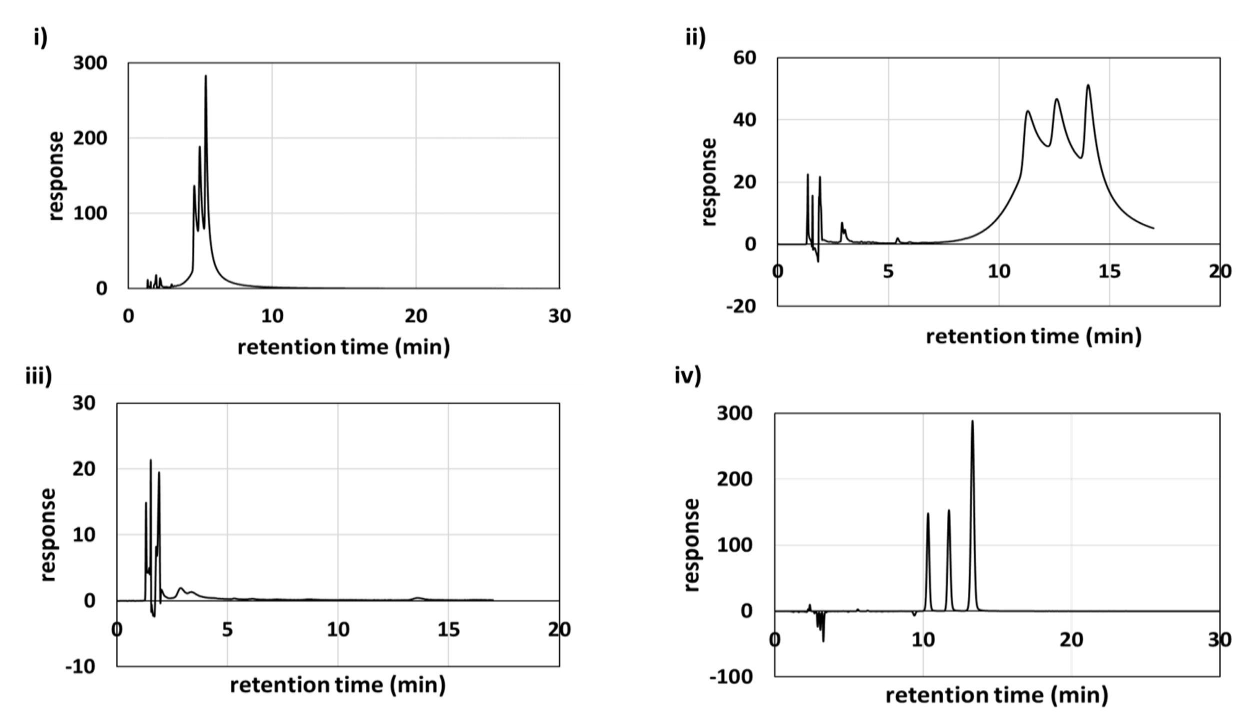

Fig.4: Chromatograms of i) the surfactant-rich phase using method no.1, ii) method no.2, iii) and iv)

- ➡Quantification of individual curcuminoids
- ➡6 different methods were tried out
- ➡Last method as presented in Fig.5 iv) results in three divided, sharp peaks

4. CONCLUSIONS

This study focused on optimizing the extraction and purification of curcuminoids from *Curcuma longa* using eco-friendly micellar solutions. The research employed SLE and AMTPS processes, emphasizing the individual optimization of each parameter.

Acknowledgments
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