# The Extraction of Rubrocurcumin Derivative A from Polylactic Acid

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## Introduction

The syntheses of curcumin-based colorants and rubrocurcumin derivatives (red colorants) have been successfully done by MNEXT. These different biobased colorants, including Rubrocurcumin Derivative A (RdA) (Figure 1.), have been incorporated into various polymers and have been proven to be more stable than other biobased colorants. This implementation has resulted in different questions regarding the possibilities and quality of the recycling of colored plastics. The goal of this project is to decolorize Polylactic Acid (PLA), colored with 1% (w/w) RdA (Figure 2.), using Supercritical $CO_2$ extraction and Accelerated Solvent Extraction to create a more environmentally friendly method of recycling colored plastics.

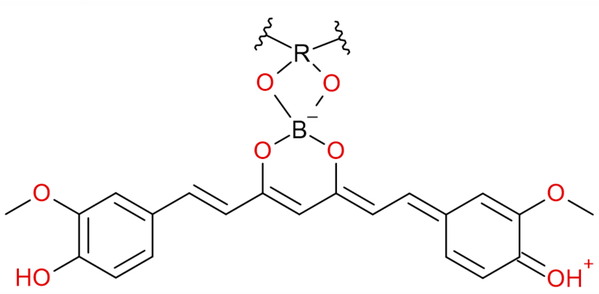


*Figure 1. Structure of RdA*

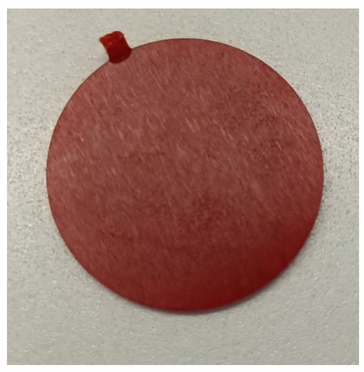

*Figure 2. PLA disc used for extractions containing 1%(w/w) RdA*

## Methodology

### Supercritical $CO_2$ –Extraction:

To test the extraction of RdA from PLA using Supercritical $CO_2$ a duplicate extraction has been done at 85°C, 350 bar for a duration of 6 hours with ethanol as cosolvent.

### Accelerated Solvent Extraction:

The Dionex ASE 350 was used to execute a Design of Experiments (DoE). Figure 3 contains a flowchart of the method used during the DoE execution. The variables used for the DoE are shown in Table 1.

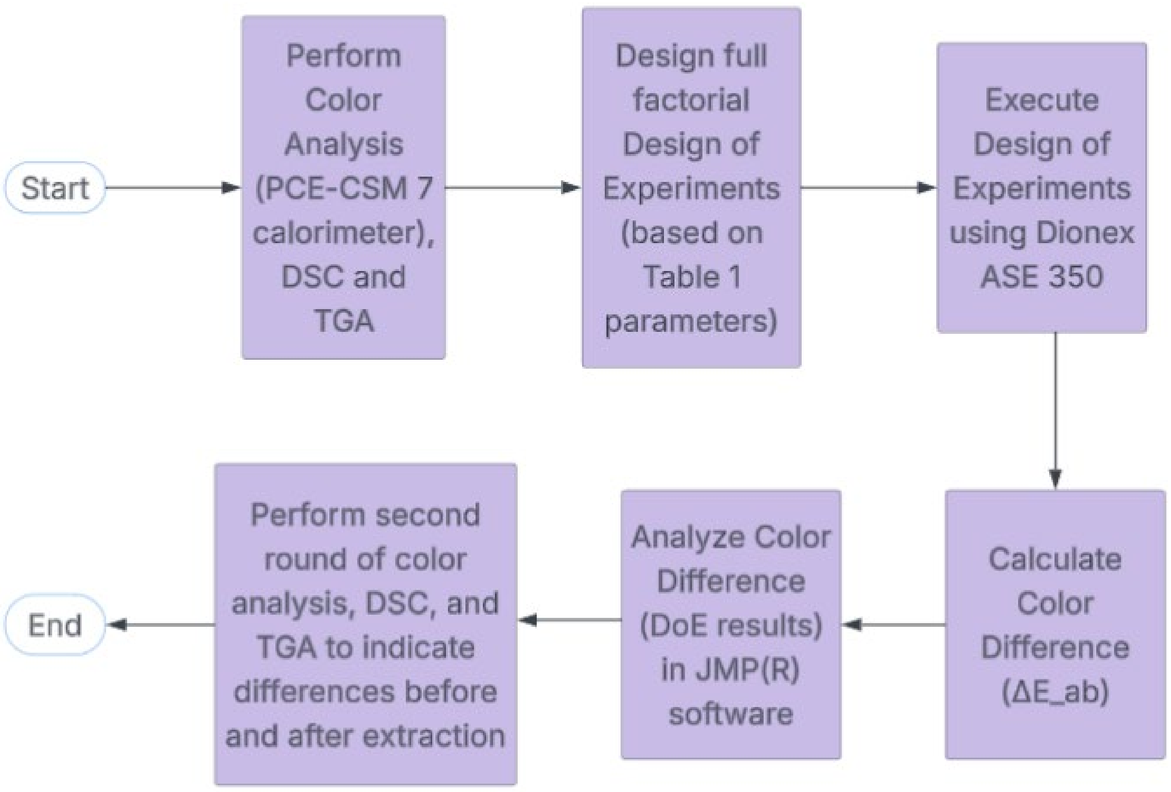


*Figure 3. Flowchart of the method used during the DoE execution*

*Table 1. Variables used during DoE execution*

| Parameter | 1 | 2 |
|---|---|---|
| Temperature [°C] | 80 | 110 |
| Solvent | MilliQ | Ethanol |
| Time [min] | 10 | 20 |
| Cycles | 1 | 2 |

## Results

### Supercritical $CO_2$ Extraction:

Both extractions at 85°C, 350 bar for a duration of 6 hours with ethanol as cosolvent. Since these are the highest settings available while still being beneficial to the environment, supercritical $CO_2$ extraction is not a viable option for the decolorization of PLA. Figure 4 shows the result of the first extraction. The solvent did not fully penetrate the disc, leaving the inside red, while the outside was visibly damaged by the process.

*Figure 4. The sample disc after the extraction*

### Accelerated Solvent Extraction:

Figure 5 shows the color difference (ΔE) per experiment that uses water as a solvent. Extractions using ethanol have not been considered since the outer layer of these extractions consisted of mostly diatomaceous earth, which has negatively affected the color measurements and have therefore been deemed untrustworthy. The patterns shown in the graph correspond with the variables shown in Table 1. Pattern 2122 shows the highest color difference with an average ΔE of 19.

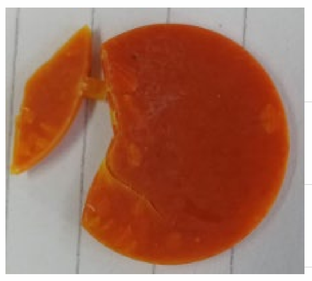

*Figure 6. A sample disc after extraction*




*Figure 5. ΔE per experiment. Experiments have been shown by giving their pattern of variables*

## Discussion and Conclusion

The decolorization of PLA containing 1% (w/w) Rubrocurcumin Derivative A using Supercritical $CO_2$-extraction is proven to be a non-viable option and should not be further investigated. Accelerated Solvent Extraction methods have not yet been successful with current parameters. However, Accelerated Solvent Extractions with water have been more successful than those with ethanol. The most successful extraction has an average ΔE of 19. Which indicates that further optimization may result in full decolorization.