

Deep Eutectic Solvents for Biomass Fractionation (Eucalyptus) using Microwave and Oil Bath: A Comparative Methodology Study

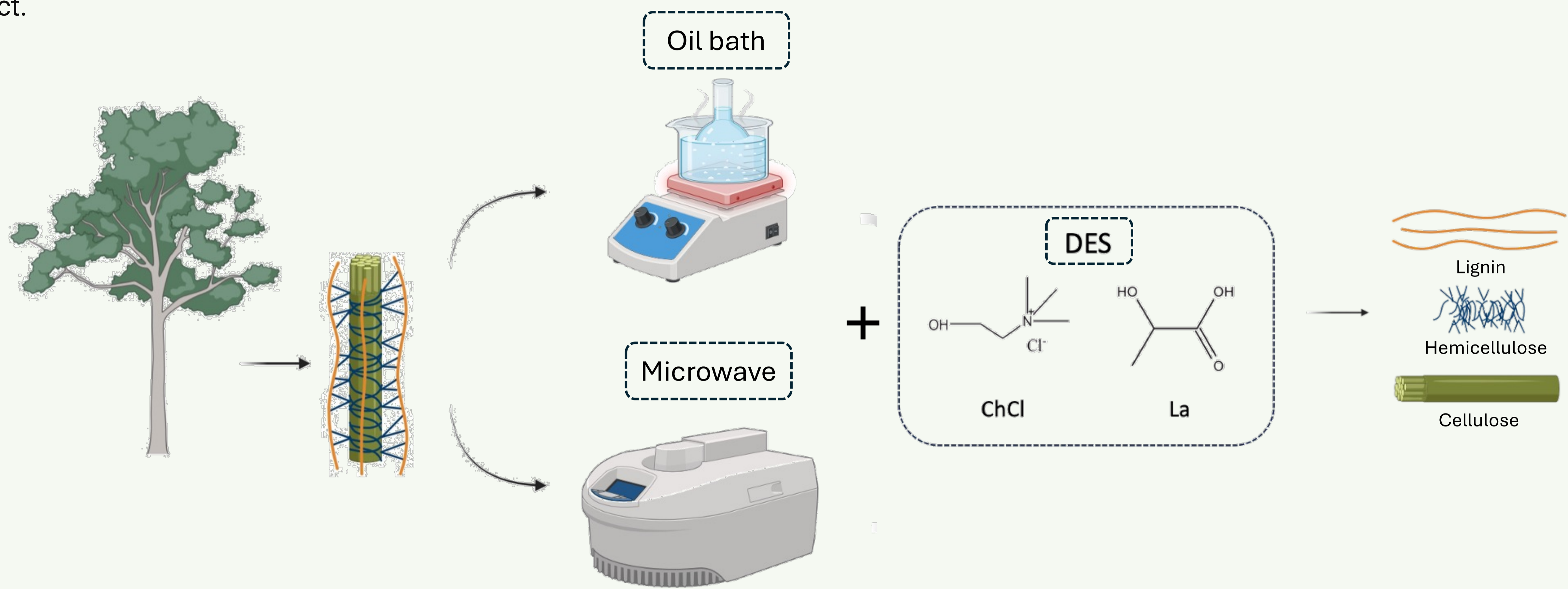


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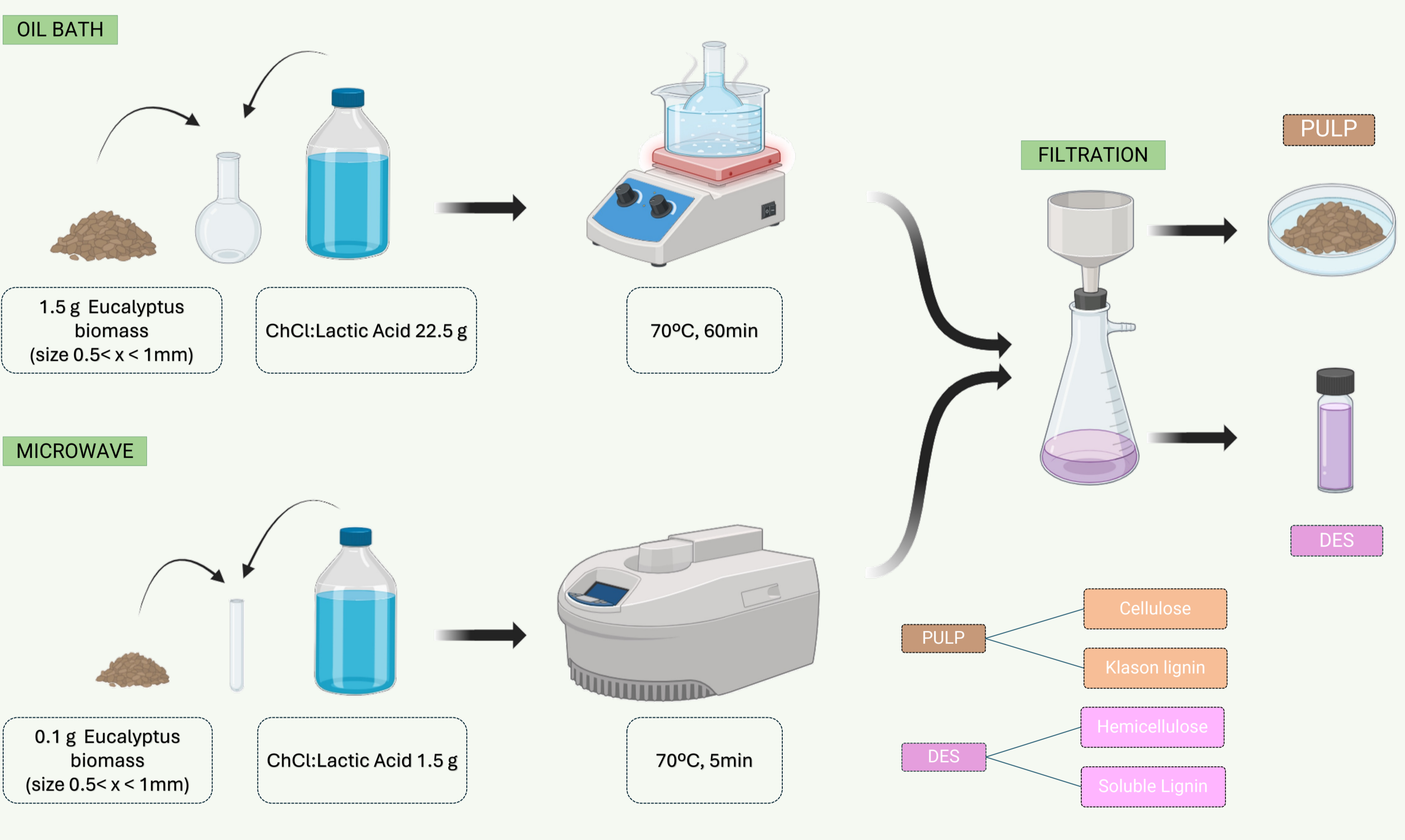


Unlocking Efficiency in Biomass Processing

Efficient and sustainable biomass fractionation is crucial for unlocking the potential of renewable resources in various industrial applications¹. Deep eutectic solvents (DES) have emerged as promising candidates for biomass breakdown, offering environmentally friendly alternatives to conventional methods². In this study, the comparative effectiveness of microwave and conventional heating techniques in conjunction with DES for eucalyptus biomass fractionation was done. The aim of the investigation is to shed light on the optimal strategies for maximizing extraction yields and product distribution while minimizing environmental impact.



EXPERIMENTAL PROCEDURE



RESULTS AND DISCUSSION

DES SCREENING

Screening was performed with DES at different pH to evaluate the lignin solubility of commercial organosolv and alkaline lignins.

The table shows that the DES with the highest solubility of organosolv lignin is ChCl: Lactic Acid, so it has been used to perform the biomass fractionation by the different methods.

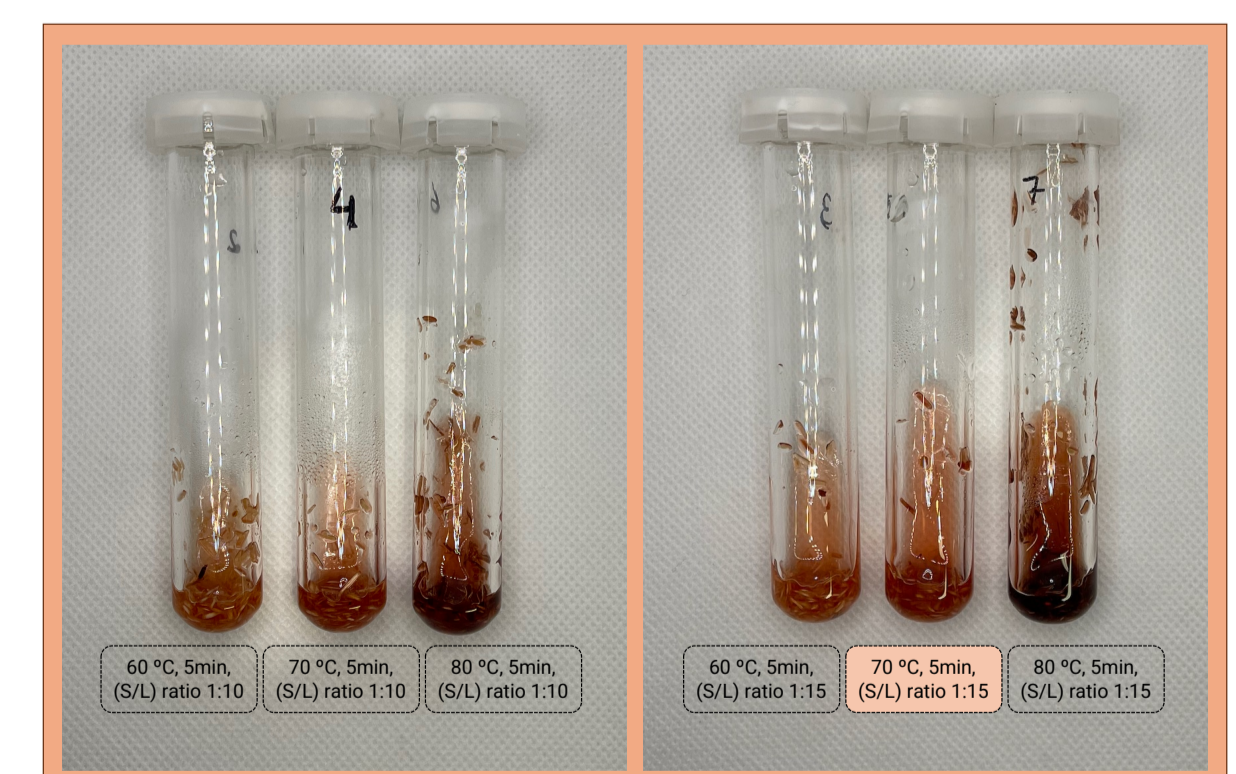
| | | Sample | Solubility (%) |
|-------------|---------------------|-------------------|----------------|
| Acidic DES | ChCl*:Lactic acid | Organosolv lignin | 97.03 |
| | | Alkaline lignin | 94.76 |
| | ChCl:Formic acid | Organosolv lignin | 95.52 |
| | | Alkaline lignin | 95.22 |
| Neutral DES | ChCl:Glycerol | Organosolv lignin | 80.00 |
| | | Alkaline lignin | 78.30 |
| | ChCl:Ethylenglicol | Organosolv lignin | 92.79 |
| | | Alkaline lignin | 91.21 |
| Basic DES | ChCl:Trietanolamine | Alkaline lignin | 56.53 |
| | ChCl:Ethanolamine | Organosolv lignin | 82.90 |
| | | Alkaline lignin | 90.30 |

*ChCl: Choline chloride

MICROWAVE CONDITIONS

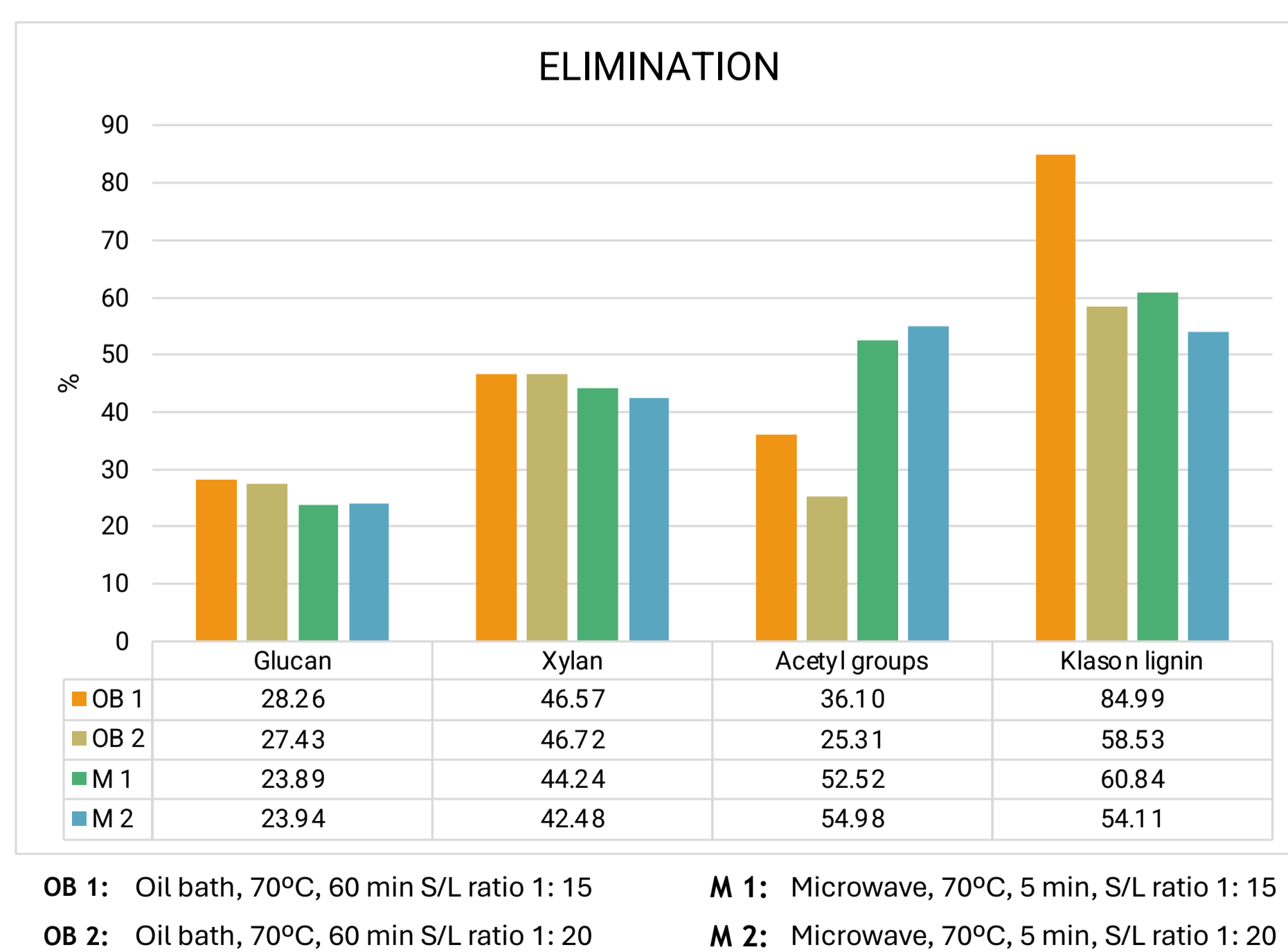
Different conditions of biomass fractionation in the microwave were studied. The variables studied were the solid-liquid ratio as well as the time and temperature of the reaction. As shown in the pictures, the colour of the solution becomes more intense the higher the ratio and the higher the temperature. The optimum temperature was considered to be 70 °C, since at higher temperatures the biomass started to burn.

| Biomass (g) | DES (g) | T (°C) | Time (min) |
|-------------|---------|--------|------------|
| 0.1 | 1 | 60 | 5 |
| 0.1 | 1.5 | 60 | 5 |
| 0.1 | 1 | 70 | 5 |
| 0.1 | 1.5 | 70 | 5 |
| 0.1 | 1 | 80 | 5 |
| 0.1 | 1.5 | 80 | 5 |
| 0.1 | 1.5 | 70 | 10 |



COMPARATIVE STUDY BETWEEN OIL BATH AND MICROWAVE

After fractionation, quantitative acid hydrolysis of the treated biomass was performed. It was determined that the percentage of Klason lignin removed from the pulp is higher with the conventional method, although the percentage of hemicelluloses was slightly higher with the microwave. With these data it can also be concluded that the optimal solid-liquid ratio for both methods is 1:15.



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CONCLUSIONS

- ✓ **High Lignin Solubility:** DES Choline Chloride and Lactic Acid (ChCl: Lactic Acid) is most effective for solubilizing commercial organosolv lignin.
- ✓ **Optimal Fractionation Conditions:** Best results for eucalyptus biomass fractionation with microwave: 70°C, S/L ratio of 1:15.
- ✓ **Efficiency of Methods:** Microwave: faster, more energy-efficient, ideal for hemicellulose removal. Oil Bath: better for Klason lignin removal but less time and energy efficient.