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# ENCAPSULATION OF PHENOLIC-RICH *HOUTTUYNIA CORDATA* EXTRACT USING LYOTROPIC LIQUID CRYSTALS BASED ON PALM OILS-BASED MONOACYLGLYCEROLS

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## INTRODUCTION

Fish mint (*Houttuynia cordata*) is a well-known herb recognized for its rich phenolic content, which contributes to its antioxidant, hydrating, antimicrobial, and anti-inflammatory properties. Recently, Deep Eutectic Solvent (DES) has gained popularity in the plant extraction process due to its effectiveness, non-toxicity, and lower energy consumption. The advantages of DES are that its components, including hydrogen bond donors (HBD) and hydrogen bond acceptors (HBA), can be modified to enhance extraction efficiency. Additionally, an innovative technique known as lyotropic liquid crystal (LLC) was employed to encapsulate Houttuynia cordata extract. LLCs were created using palm oil–based monoacylglycerol (MAG). This technology achieved an encapsulation efficiency of over 75% and minimized phenolic degradation during storage.

## METHODOLOGY

- DES was formulated with Chlorine Chloride and glycerol at different ratios
- LLC was prepared by homogenizing melted MAGs with Pluronic solution
- *Houttuynia cordata* extract was ultrasonically homogenized with LLC, then quickly frozen and lyophilized to obtain encapsulated powder.

### Evaluation

- Total phenolic content (TPC) and total flavonoid content (TFC) were spectrophotometrically determined, following the methods described by Vu et.al (2025)
- Rheological properties were measured by a Brookfield rheometer (LVDVT2, USA)
- Morphology properties were analyzed by the Scanning Electron Microscope (SEM) (SU-4800, Jeol, Japan)

**Table 1.** Composition of MAG/LLC with *Houttuynia cordata* extract

| Sample | Gel phase | | % *Houttuynia cordata* extract |
|---|---|---|---|
| | %MAG (w/w) | %$H_2O$ (w/w) | (w/w gel phase) |
| A1 | 40 | 60 | 50 |
| A2 | 40 | 60 | 100 |
| B1 | 60 | 40 | 50 |
| B2 | 60 | 40 | 100 |

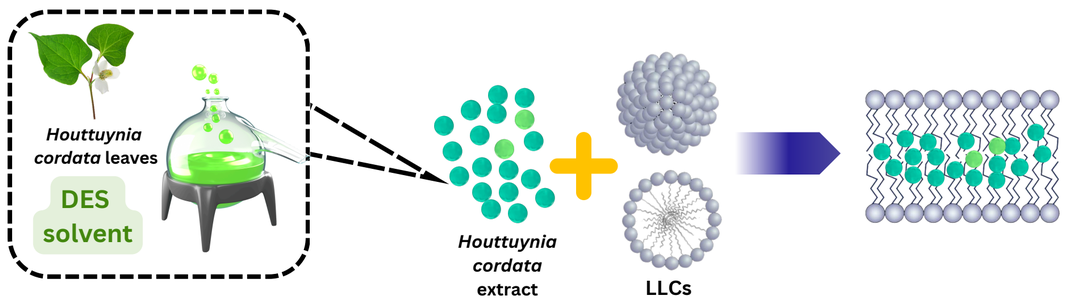


**Figure 1.** DES-based extraction and encapsulation process of *Houttuynia cordata* leaves

## CONCLUSION

- DES, composed of Choline chloride and Glycerol at a ratio of 1:5, obtained the highest phenolic content.
- LLC dispersions formulated by the mixtures of palm oil-based MAGs and water in the presence of Pluronic acid were shear-thinning fluids.
- Palm oil-based MAGs were appropriate wall materials and produced encapsulated powders with high loading capacity

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## OBJECTIVE

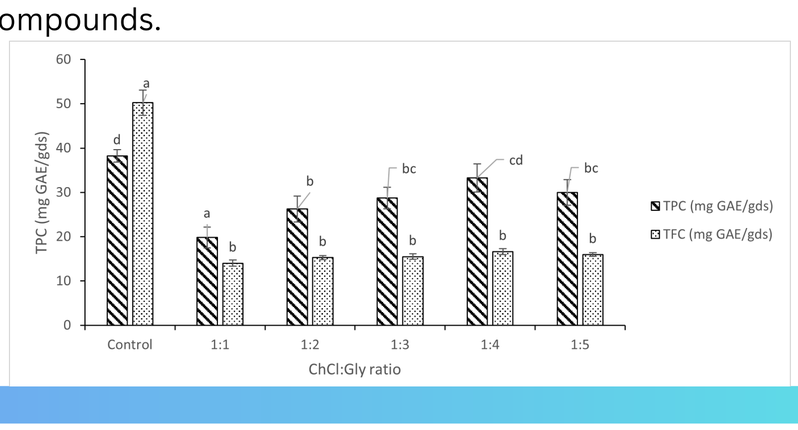
This study aimed to investigate the effect of different DES solvents on the extraction efficiency and encapsulation process with LLCs for *Houttuynia cordata* extract.

## RESULTS

### Phenolic content of *Houttuynia cordata* extract

- The maximum values of TPC and TFC of *Houttuynia cordata* extract were obtained at the DES solvent formulated with Chlorine Chloride and Glycerol at a ratio of 1:4 (Fig.2)
- Compared to the control sample using ethanol, DES solvent released fewer bioactive compounds.

**Figure 2.** TPC and TFC content of *Houttuynia cordata* extracted by different DES solvents




### Lyotropic liquid crystal characterization

- The appearance of LLCs was very limited in samples containing 40% MAG (Fig.3A). The observed amorphous structure was assumed as a mixture of cubosome and liposome. Meanwhile, the clear crystalline structures were found in the samples containing 60% MAG (Fig.3B). It could be assumed that the presence of aqueous phase at a high concentration was unfavored for the phase transition of palm stearin–based MAGs.
- Non-Newtonian flow behavior was observed in all samples. As shear stress increases, the gel viscosity decreases significantly. The reduction in the viscosity of sample B2 with the addition of *Houttuynia cordata* extract can be explained by the solvation effect of DES.

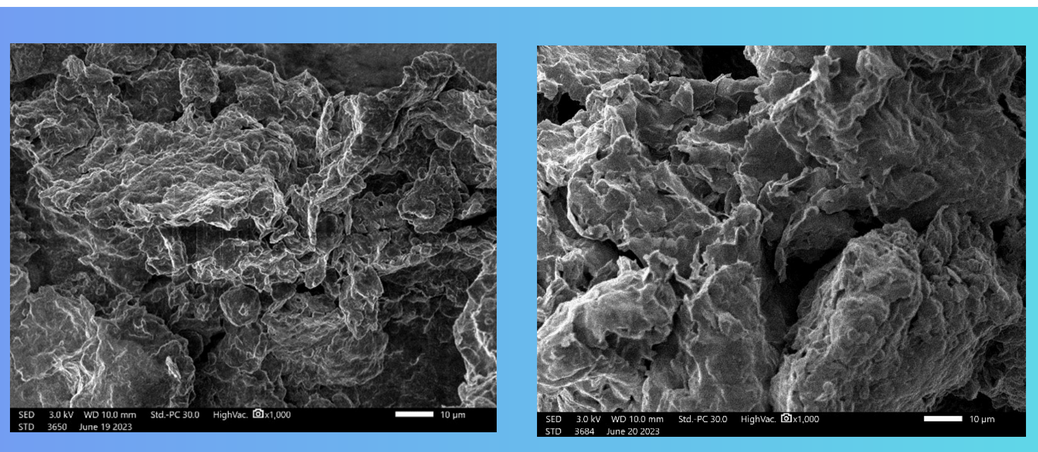


**Figure 3.** SEM morphology of LLCs: A (MAG 40%), B (MAG 60%)

### Encapsulated powder characterization

- The B samples containing MAG of 60% posed higher encapsulation yield (MEY%) compared to those with 40% MAG. Samples B1, B2 with 50%, 100% of *Houttuynia cordata* extract obtained the MEY of 82.71% and 76,43%, respectively. This phenomenon should be related to the effect of LLC composition, when plant-based extract was entrapped into the core of LLC particles during the encapsulation.

## REFERENCES

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