# Stabilization of Water-in-Oil Emulsions Using Food Grade Materials

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## 1. Background and Aim

- Stabilization of Water-in-Oil (W/O) emulsions remains a challenging problem in colloid science.
- Polyphenols and flavonoids are a group of phytochemicals from plant based foods.
- Act as Pickering stabilizers at the oil-water interface.[1, 2]
- Irreversible adsorbed at the interface and provide a steric barrier against coalescence.[1]
- Very little work has been done on the action of these particles on stabilizing W/O emulsion.
- We propose a novel way to stabilize water droplets inside an oil phase via complex formation between flavonoids and biopolymers at the interface.

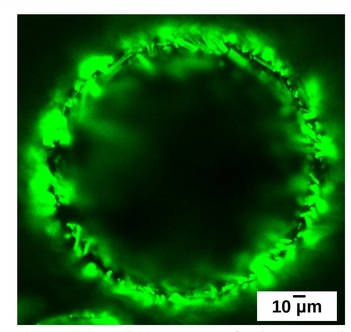



**Figure 1.** W/O emulsions (5:95 w:o ratio) stabilised by flavonoid particles.

## 2. Preparation and Characterisation Method

Flavonoids were dispersed in soybean oil. → **Flavonoid**

Aqueous phase (with or without biopolymer) was added. → Coarse emulsions (5:95 w:o ratio) were prepared.

**Aqueous Phase**

Coarse emulsions were passed through the jet homogeniser. → Water droplets were analysed using Mastersizer and/or Confocal Microscope.

## 3. Experimental Results

### 3.1. Assessment of Particles as Pickering Stabilizers

#### Contact Angle and Size of Flavonoid Particles

**Table 1.** Contact angle measurements of water and soybean oil phases on thin films of flavonoid particles.

| Phase | Contact Angle/ º |
|---|---|
| **Water** | 69.5 ± 1.6 |
| **Soybean oil** | 23.1 ± 0.7 |

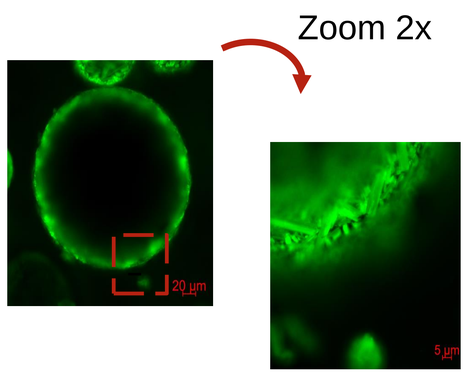



**Figure 2.** Shape and Size of flavonoid particles at the interface.

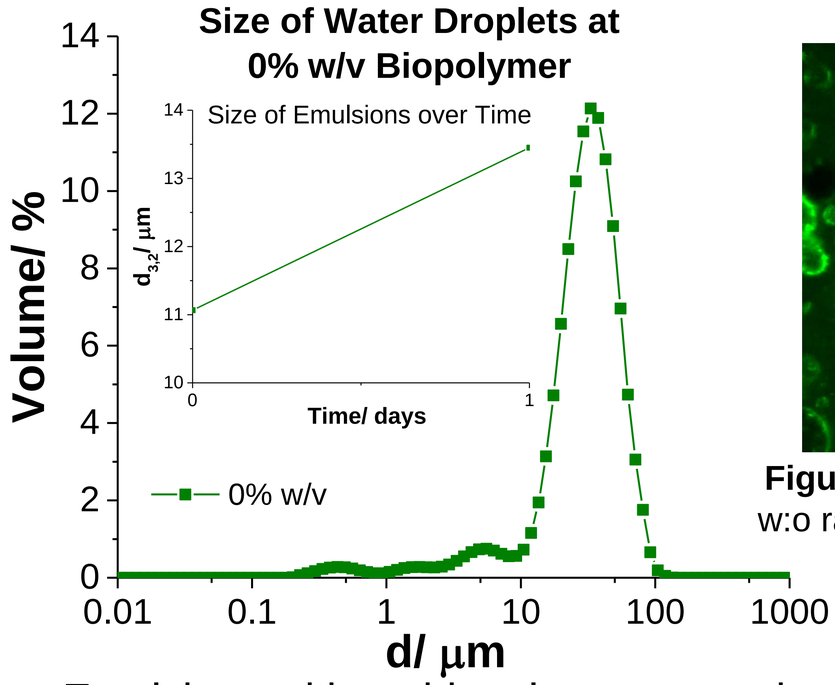
- The $\theta_w >> \theta_o$, therefore the particles can be considered as hydrophobic and stabilize W/O emulsion droplets.
- Flavonoid particles are around 4.15 µm in size ($d_{3,2}$).

#### Interfacial Tension Measurements

| Oil Phase | Aqueous Phase | γ/ mNm$^{-1}$ |
|---|---|---|
| Soybean oil | Milli-Q water | 11.4 |
| **Flavonoid** in oil | Milli-Q water | 9.2 |
| Soybean oil | **Biopolymer** Solution | 5.2 |
| **Flavonoid** in oil | **Biopolymer** Solution | 4.4 |

- No significant changes on the interfacial tension by adding flavonoid indicating a Pickering Stabilization.
- Biopolymer reduces the interfacial tension significantly.
- Adding both flavonoids and biopolymer the interfacial tension is slightly lower.

### 3.2. W/O Particle Stabilized Emulsions



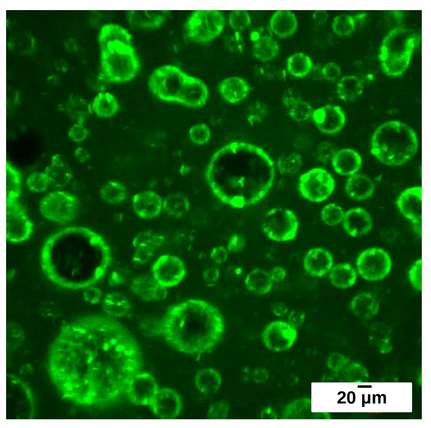
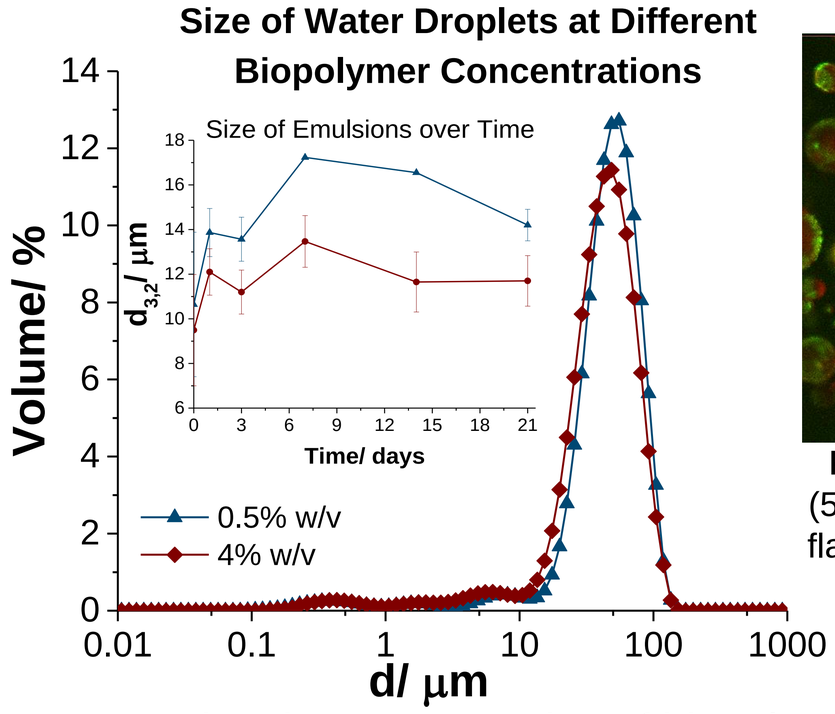




**Figure 3.** W/O emulsions (5:95 w:o ratio) stabilised by flavonoid particles.

- Emulsions without biopolymer were phase separated within 1 day.

### 3.3. W/O Particle-Biopolymer Stabilized Emulsions



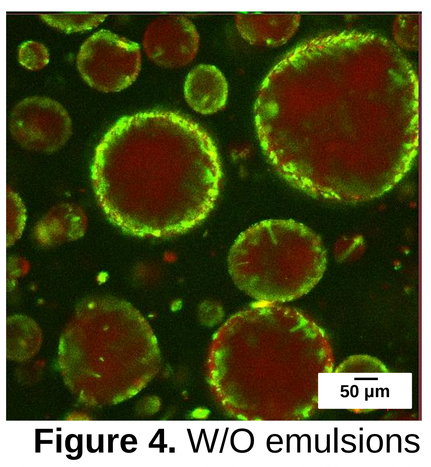




**Figure 4.** W/O emulsions (5:95 w:o ratio) stabilised by flavonoid particles and 0.5% w/v biopolymer (red-Rhodamine B dye).

- Increasing the concentration of biopolymer, an improvement on the stabilization was observed.

## 4. Conclusion and Future Work

- A novel stabilization mechanism for W/O emulsions is proposed via a complex formation of flavonoids and biopolymer.
- More work is required to identify the interactions between biopolymer and flavonoids at the interface.

**References**

1. LUO, Z. J., MURRAY, B. S., YUSOFF, A., MORGAN, M. R. A., POVEY, M. J. W. & DAY, A. J. 2011.
2. LUO, L., MURRAY, B. S., ROSS, A.-L., POVEY, M. J. W., MORGAN, M. R. A. & DAY, A. J. 2012.

**Acknowledgments**

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