PLASTIC POLLUTION: CAN THE CHEMISTRY OF MICROPLASTICS INFLUENCE THEIR ENVIRONMENTAL IMPACT?

1. The Challenge

Plastic is everywhere.

![Diagram of biodegradable vs biobased plastics]

- **Biodegradable**
  - PLA (Polylactic acid)
  - PCL (Polycaprolactone)
- **Non-biodegradable**
  - LDPE (Low density polyethylene)
  - OXO LDPE (Oxidative low density polyethylene)

Environmental factors (abiotic):
- Oxidation (UV)
- Thermal degradation

Can we mimic the formation of microplastics in the laboratory?

Artificial weathering!

2. Research objectives and methodology

**Ob1**: Artificial weathering of plastics and characterisation

**Ob2**: Link between weathering and chemical structure

**Ob3**: Environmental impact of artificial plastic fragments

3. Artificial weathering: LDPE vs. OXO LDPE

**Method**: Plastic samples subjected to different ageing conditions, via a combination of photo-oxidation (UV) and thermo-oxidation (heat) at different temperatures and different times.

**Spectra showing evolution of the carbonyl peak (C=O)**

**Carbonyl index data** (Unaged vs. 50 °C)

- **LDPE**
  - Mw = 210,374 g mol⁻¹
  - CI = 0.10
- **OXO LDPE**
  - Mw = 10,429 g mol⁻¹
  - CI = 1.70

**Changes in surface hydrophobicity by contact angle**

- Unaged LDPE: 106.65 °C
- Aged OXO LDPE: 86.30 °C

**Changes in molecular weight determined by gel permeation chromatography**

- LDPE: 50 °C
- OXO LDPE: 50 °C

The presence of a degradation catalyst in OXO LDPE results in different chemical structure and morphology being formed with artificial weathering.

4. Environmental impact of plastic fragments

**Method**: Plastic samples incubated with *Rhodococcus rhodochrous*. Graph demonstrates the amount of CO₂ released by the bacteria depending on plastic type and ageing conditions as a result of microbial assimilation.

**Experiment**

- Cultivate media and bacteria
- Incubation with plastics
- CO₂ monitoring by gas chromatography

**Graph**

- OXO LDPE (15 Cycles 60 °C) shows higher amount of CO₂ release. Unaged OXO LDPE shows the least.

5. Conclusions

- The combination of photodegradation (UV) and thermal degradation (heat) can be used successfully for artificial weathering.
- Different plastics respond differently to ageing protocols, leading to fragments with specific chemistry.
- *Rhodococcus* differentiates plastic types according to weathering conditions.
- The environmental impact of plastic fragments will be the result of close interdependence between abiotic and biotic degradation mechanisms.

References