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Microplastics extraction from a sandy beach: methodology development and challenges

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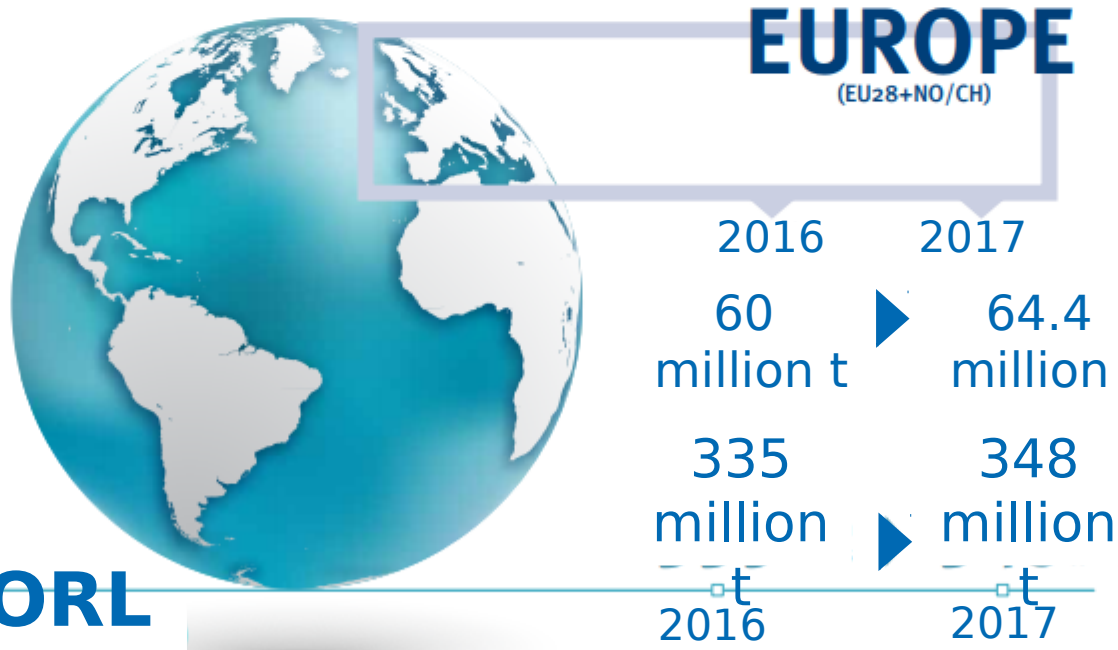
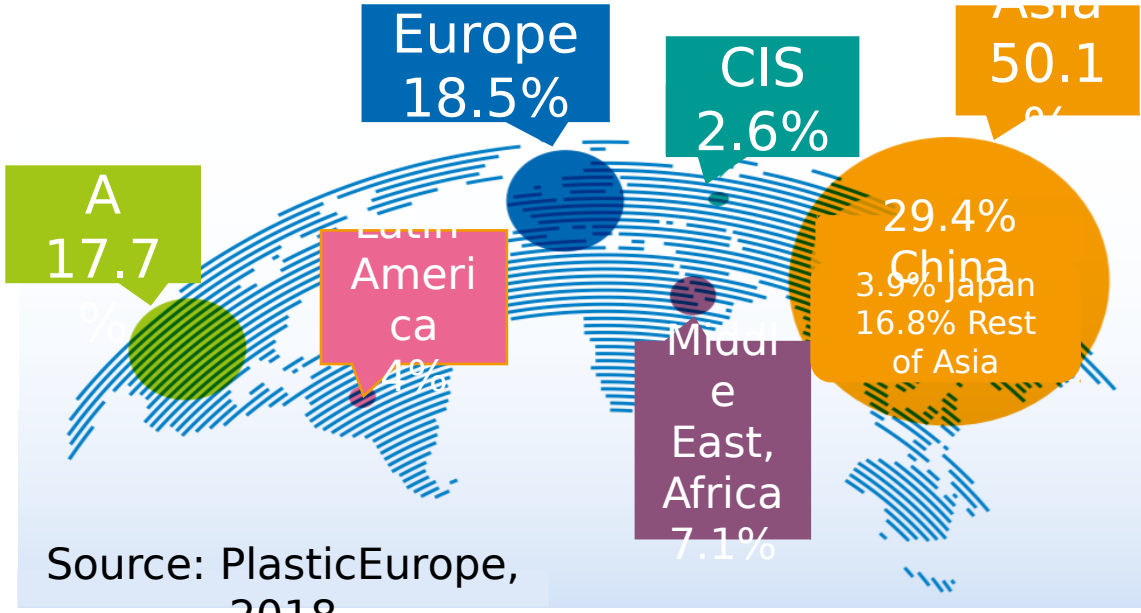
Worldwide plastic production



Source: PlasticEurope, 2018

World plastic production almost reached 350 M t

China is the largest producer of plastics



Source: PlasticEurope, 2018

Microplastics

- Small plastic pieces smaller than **5 mm** in size
- **Majority of items** in the contaminated aquatic ecosystems
- Spherical beads, films, irregular fragments, filaments, foam, granules and fibres
- Poses a threat to aquatic life:

  sorbent of toxic pollutants like HM or PCBs

  persistent

  bioaccumulation

Entering the **food chain** by ingestion by marine species

Microplastics

- The Marine Strategy Framework Directive was amended to highlight that the “composition of micro-particles (in particular microplastics) has to be characterized in marine litter and the marine coastal environment”.

- There are still **no harmonised analytical methods** for quantifying and **determining the occurrence** and composition of microplastics in those environments.

Objectives

1 - Development of an **extraction technique** for separating microplastics (**PP, LDPE, PS, PET and PVC**) from a sandy beach by using routine laboratory equipment

- using the principle of flotation and decantation process to promote the separation

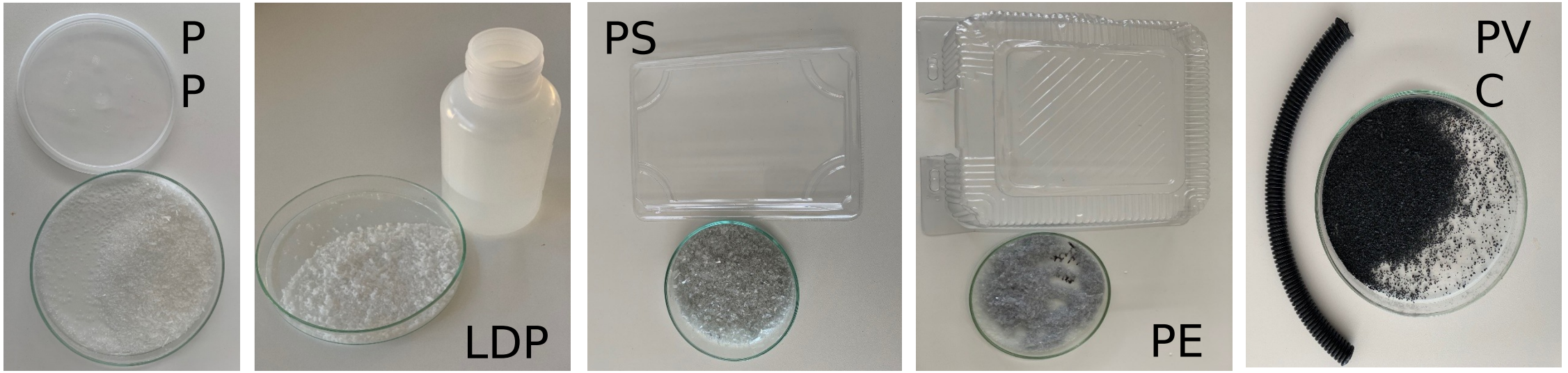
2 - Assessment of the **recovery efficiency** of the proposed method for:

i) each microplastic material

ii) microplastics fractions by size

Preparation of microplastics samples

Cutting (≈3 cm size) → Grounding in a mill → Sieving (2, 1, 0.5, 0.2 and 0.05 mm)



PP (polyproprylene), LDPE (low-density polyethylene), PS (polystyreme), PET (polyethylene terephthalate), PVC (polyvinyl chloride)

Preparation of microplastics samples

Size	Plastic material used in spiked samples (g)				
	PP	LDPE	PS	PET	PVC
> 2 mm	2.5	2.5	2.5	2.5	2.5
2 – 1 mm	2.5	2.5	2.5	2.5	2.5
1 – 0.5 mm	2.5	1.0	2.5	2.5	2.5
0.5 – 0.2 mm	1.5	0.5	2.5	2.5	1.5
0.2 – 0.05 mm	0.5	0.0	1.0	0.5	0.0
Total (g)	9.5	6.5	11.0	10.5	9.0

PP (polyproprylene), LDPE (low-density polyethylene), PS (polystyrene), PET (polyethylene terephthalate), PVC (polyvinyl chloride)

Sampling of sandy beach

Figueira da Foz, Coimbra, Portugal

3 kg of sandy beach

Dried (105 °C) and sieved (2, 1, 0.5, 0.2 and 0.05 mm)

Washing of plastics out of the sand:

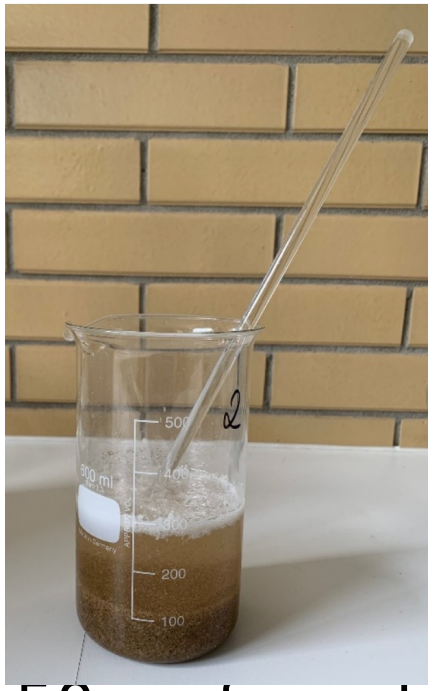
i) Stirring: sand + $ZnCl_2$

ii) Supernatant was discarded (2x)

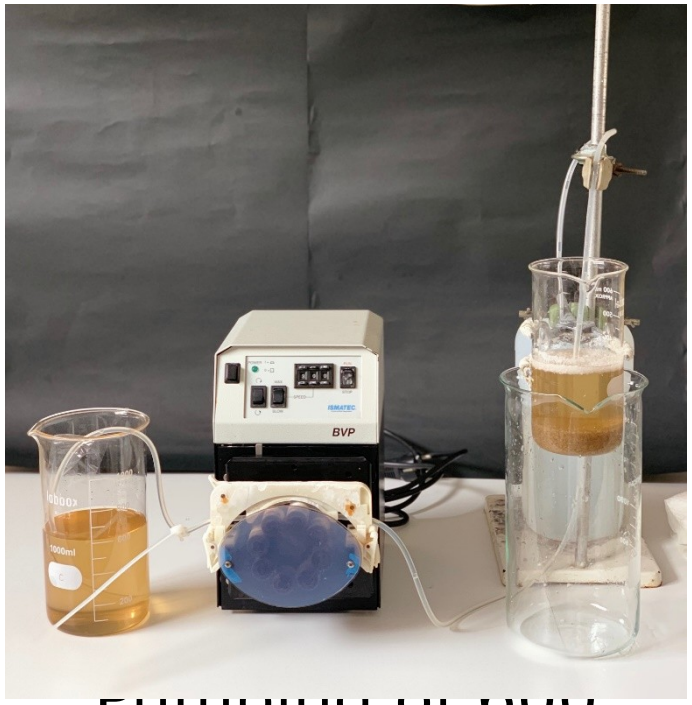
iii) Rising with 0.001 M HCl

2-1 mm: ≈2%
1-0.5 mm: 63%
0.5-0.2 mm: 35%

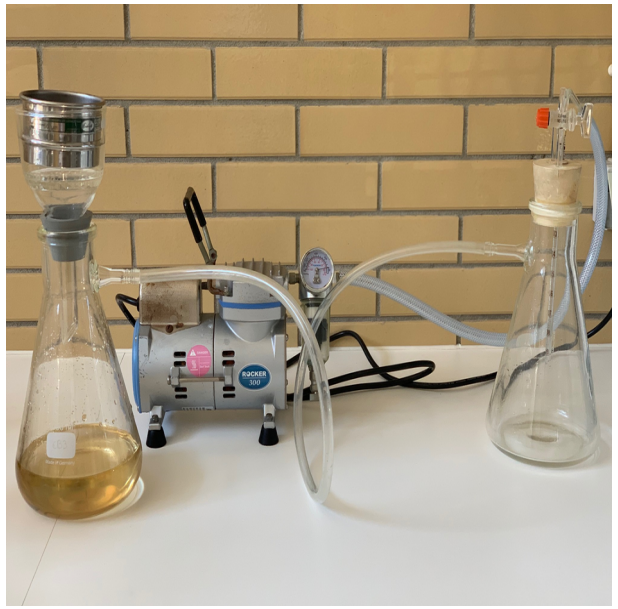
Extraction method



150 g of sand
+
microplastics
+
250mL of $ZnCl_2$



Pumping of 600 mL of $ZnCl_2$, creating an overflow of the top layer



Sieving of supernatant (0.05 mm)

Microplastics in the 0.05mm sieve

+

Sand

Extraction method

Microplastics in the sieve

↓

Rising
(0.001M HCl)

↓

Drying
(at 60°C, 48h)

↓

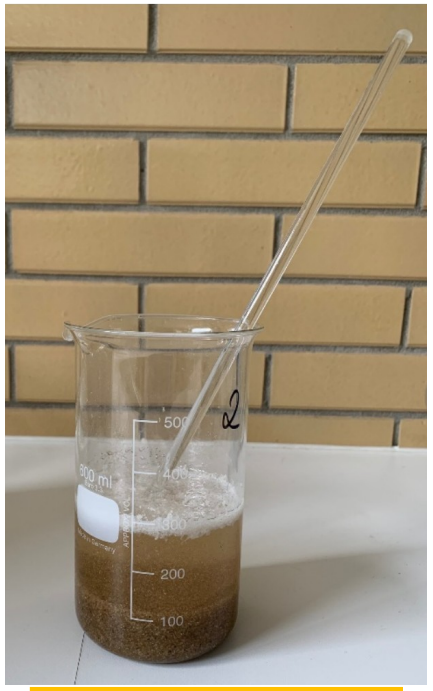
Sieving
(2, 1, 0.5, 0.2 and 0.05mm)

↓

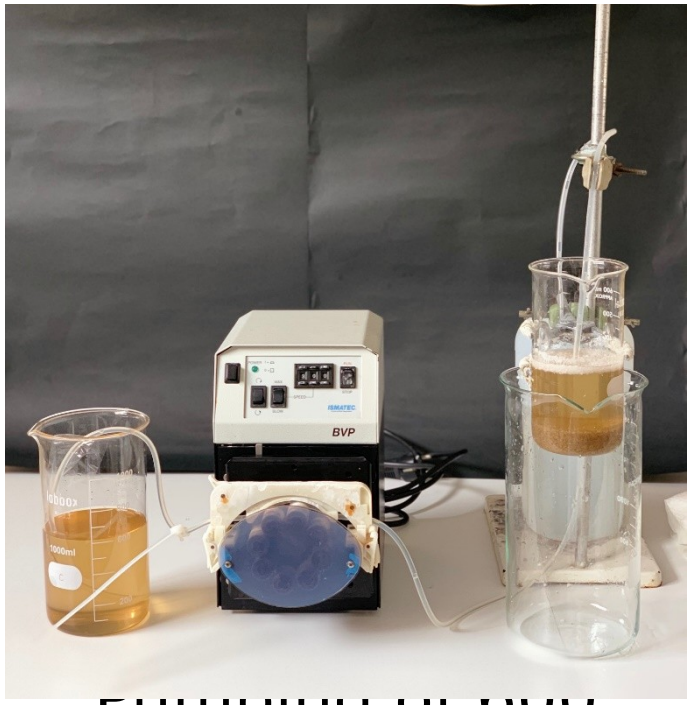
Weighing

Recovery efficiencies for the 1st flotation procedure

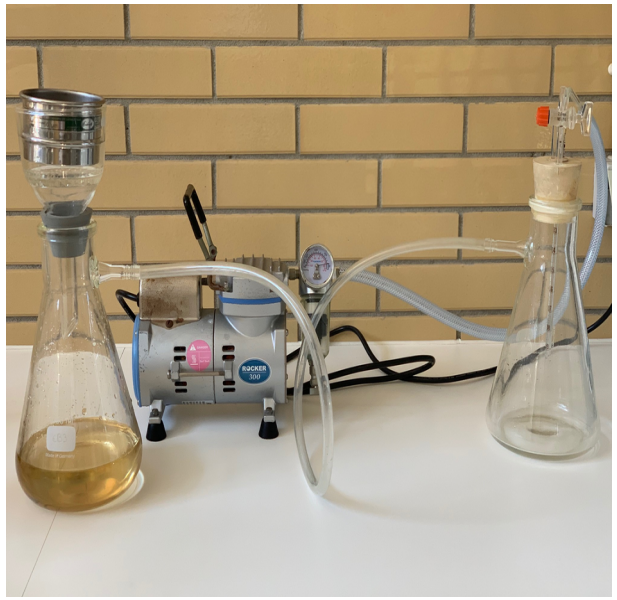
Extraction method



Sand
+
250mL of $ZnCl_2$



Pumping of 600 mL of $ZnCl_2$, creating an overflow of the top layer



Sieving of supernatant (0.05 mm)

Microplastics in the 0.05mm sieve
+
Sand

Extraction method

Microplastics in the sieve

↓

Rising
(0.001M HCl)

↓

Drying
(at 60°C)

↓

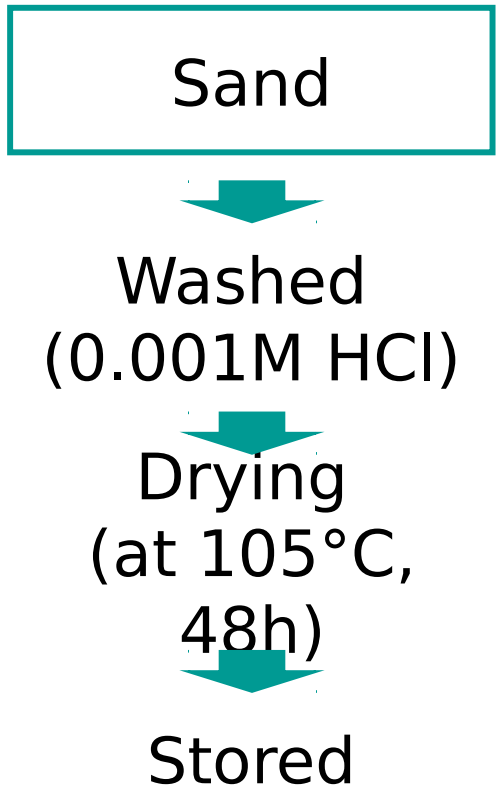
Sieving
(2, 1, 0.5, 0.2 and 0.05mm)

↓

Weighing

Recovery efficiencies for the 2nd flotation procedure

Extraction method



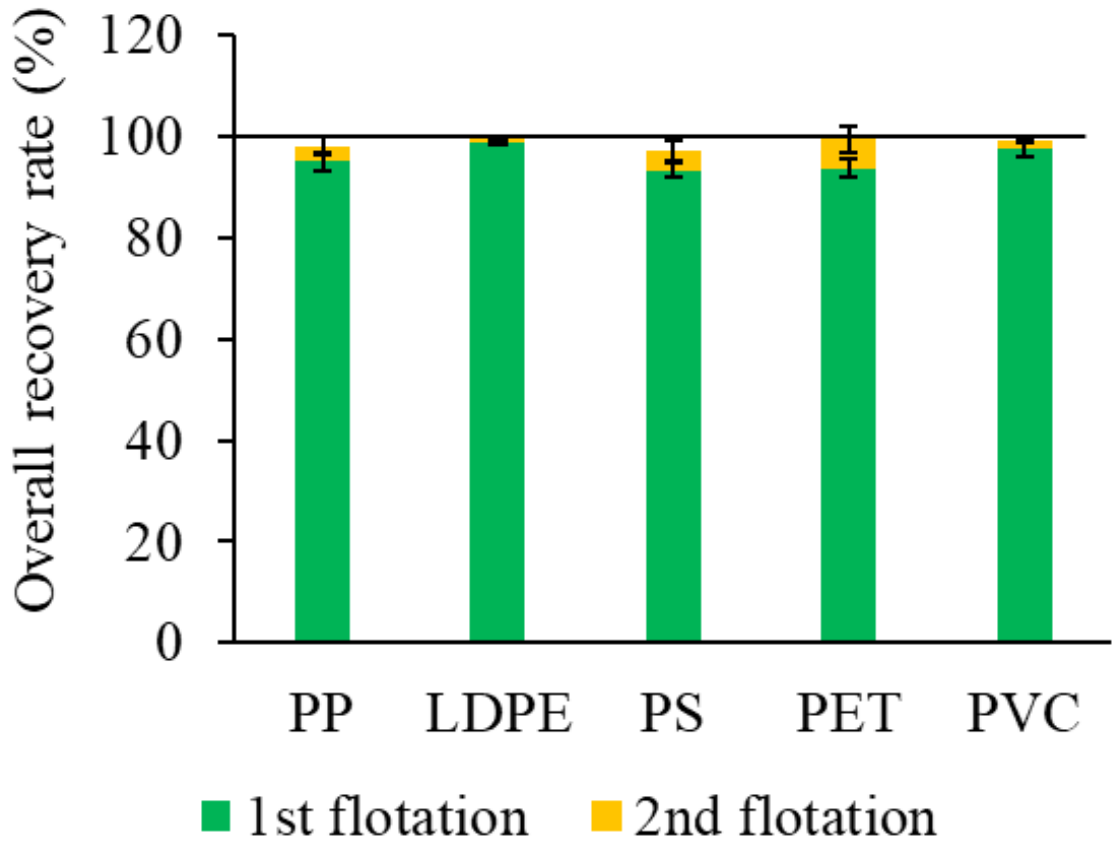
Recovery efficiencies of the proposed methodology - calculation

- $$\textit{Overall recovery rate}\ (\%) = \frac{\textit{plastic mass obtained at the end of extraction}\ (g)}{\textit{plastic mass added at the beginning of extraction}\ (g)} * 100$$

R

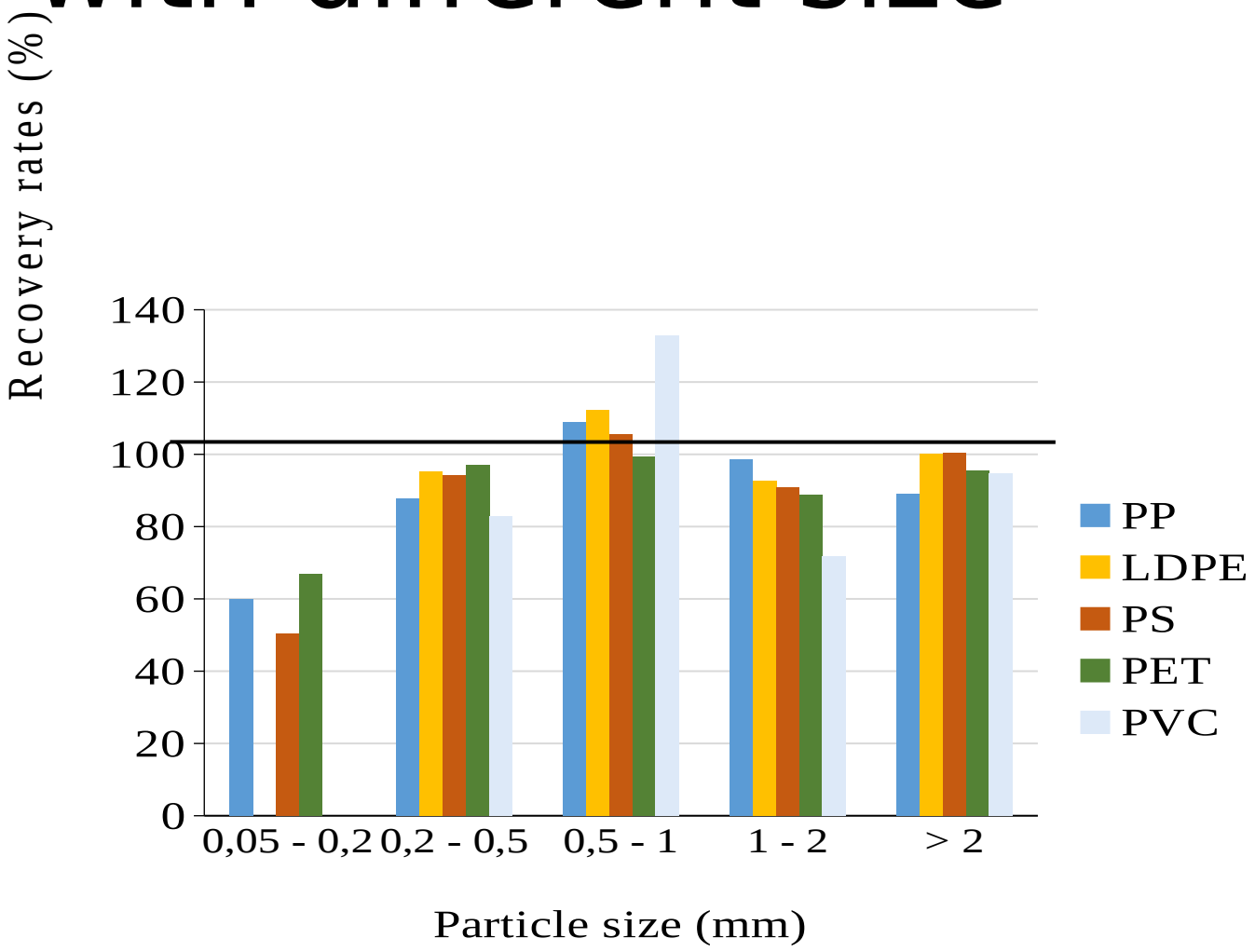
$$\textit{Recovery rate for microplastics fraction}\ (\%) = \frac{\textit{plastic fraction mass obtained at the end of extraction}\ (g)}{\textit{plastic fraction mass at the beginning of extraction}\ (g)} * 100$$

Overall recovery rates



- Range from **97 - 100%**
- PS and PP registered a slightly lower rate than LDPE, PET, and PVC (2-3%)
- **> 94%** of microplastics were extracted in the 1st time flotation
- 2nd time flotation can be eliminated

Recovery rates for microplastics with different size



- Ranged from **51 ± 8 - 133 ± 1%**

Microplastics fraction 0.05-0.2mm displayed the lowest recovery rates

PVC fraction 0.5-1mm showed a very high recovery rate (≈133%)

Challenges to overcome

- Fibres contamination from the working space

Performing of blanks to quantify the impact of it on the overestimation of recovery rates

- Presence of sand grains and unknown fragments in the extracted microplastics

Cleaning procedure of extracted microplastics:

- Stirring of the mixture of extracted microplastics with $ZnCl_2$
- Sieving and rising with 0.001M HCl

- Manual sieving of microplastics can cause an over or underestimation of microplastics mass

Automatic sieved to guaranty the same sample size

Conclusions

- The **good recoveries rates** obtained demonstrate the **potential** of the proposed extraction methodology
- There are a **few problems** that need to be **addressed in further works**
- This analytical **extraction method** can contribute **to boosting advancements for determining the occurrence of microplastics** in marine sediments.

Further works

- **Application** of the proposed methodology to **beach samples** from Angola
- Using of **Fourier Transformed Infrared spectroscopy (FT-IR)** for **identification** of microplastics material

Thank you for your attention.

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