



ASSESSMENT OF BIODEGRADABLE PLASTIC FATE IN THE ENVIRONMENT

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INTRODUCTION

Biodegradable plastics (BPs) are proposed as possible solutions to the problem of plastic pollution.¹ Biodegradation can be defined as a system property, that depends on the specific material properties and the conditions of the environment receiving it.² Agricultural mulch films provide multiple benefits for crop production and the problem of their recovery and disposal can be solved by using BPs.³

MATERIALS

N. 3 commercial mulch films were selected and supplied by the manufacturers.

Sample code	Material composition
MF1	poly(lactic acid)(PLA)/ poly(butylene adipate-co-terephthalate)(PBAT)
MF2	Mafer-bi (Starch/PLA/PBAT)
MF3	polyethylene(PE)

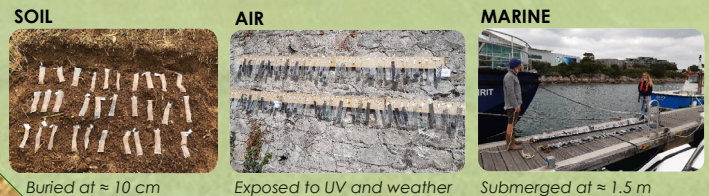
The material composition of each sample was assessed using different characterization techniques, i.e. Pyrolysis-Gas Chromatography/Mass Spectrometry (Py-GC/MS), Fourier Transform Infrared Spectroscopy (FTIR), Nuclear Magnetic Resonance Spectroscopy (NMR).

OBJECTIVES

- Investigating the environmental degradation of agricultural mulch films.
- Assessing degradation rates of the same material in different types of environment.
- Applying a combination of characterization techniques to detect and understand degradation.

DEGRADATION TESTS

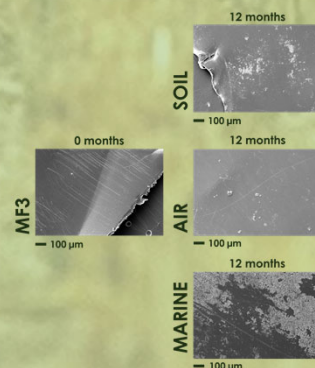
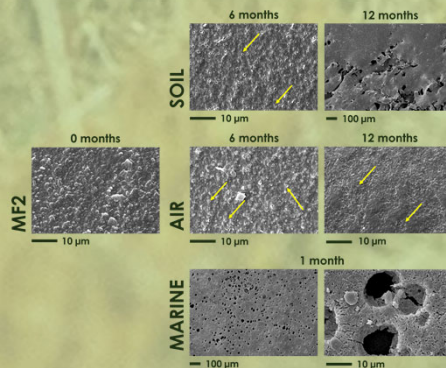
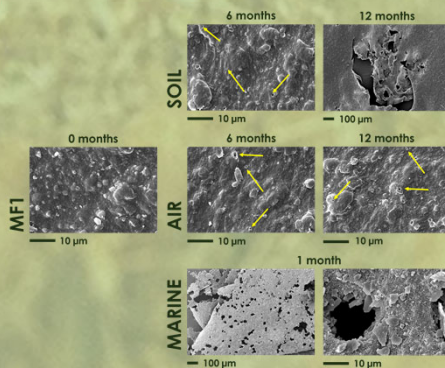
Triplicates of each sample were exposed to three different environments:



Samples were collected after 1, 3, 6 and 12 months, for a total of n. 4 time points.

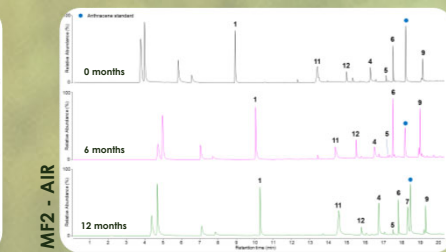
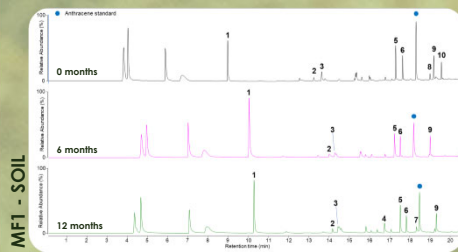
MAIN RESULTS

Morphological analysis – SEM

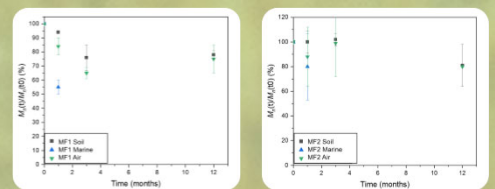


- Formation of holes and damages on the surface of all MF1 and MF2 degraded samples, visible since month 1.
- MF1 and MF2 samples completely degraded in marine environment between 1-3 months.
- No morphological changes observed for MF3 up to 12 months.

Chemical analysis – Py-GC/MS



Polymer chain analysis - GPC



- Some chain breaks observed.

Chemical analysis - FTIR

- For all samples, no relevant changes were observed in the functional groups.

Chemical analysis - NMR

- No structural changes observed.

#	Compound	Main ions m/z
1	cyclopentane	39, 41, 42, 55, 56, 84
2	3,6-dimethyl-1,4-dioxane-2,5-dion (meso form)	43, 45, 56, 144
3	3,6-dimethyl-1,4-dioxane-2,5-dion (DL form)	43, 45, 56, 144
4	3-Butenyl adipate	39, 55, 83, 101, 111, 129
5	benzophenone	39, 51, 77, 105, 152, 182
6	bis(butenyl) adipate	39, 55, 83, 101, 111, 129, 183
7	benzoic acid, 2-(1-oxopropyl)-	65, 76, 121, 149
8	1,4-dioxacyclododecane-7,16-dione	55, 71, 84, 98, 138, 166, 185
9	terephthalic acid, di(3-butenyl) ester	54, 76, 104, 121, 149, 203, 274
10	isobutyric acid, di(3-butenyl) ester	41, 55, 97, 139, 185, 239, 267
11	benzoic acid	39, 51, 77, 105, 122
12	benzoic acid, 3-butenyl ester	41, 54, 77, 105, 122, 176

- Air and soil degraded samples showed the same trend for both MF1 and MF2. Signs of PBAT degradation were detected from 6 months, and oxidation products at 12 months.
- In all the pyrograms of degraded MF1 samples, peaks 8 and 10 are absent.
- No chemical changes were observed for MF3.

SUMMARY & NEXT STEPS

- Faster degradation observed in marine environment for both MF1 and MF2. Further experiments ongoing to understand the mechanism.
- No major differences detected between soil and air degradation.
- Surface degradation and chain length changes observable from month 1, while chemical changes were observed from month 6.
- Visible leaching of additive reported for MF1.
- Degradation in the environment will be observed up to 36 months.

REFERENCES

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