

Biodegradability and compostability performances of new coated packaging

<u>Francesca Braca¹</u>, Agostino Bazzichi², Simone Bracaloni², Silvia Pierozzi², Fabrizia Turchi^{1,2}, Antonio Cecchi^{1,2}.

¹ARCHA Srl, via di Tegulaia 10/A, 56121, Ospedaletto (PI), Italy

²ARCHALAB Srl, via di Tegulaia 10/A, 56121, Ospedaletto (PI), Italy

Email: <u>francesca.braca@archa.it</u>

This project has received funding from the Bio Based Industries Joint Undertaking (JU) under grant agreement No 837863. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Bio Based Industries Consortium.

FINAL EVENT





Bio-based Industries Consortium





Research and development project activities:

- Ideation
- Grouping of companies and research organizations
- Drafting project proposal
- Execution of experimental activities with tests and trials
- Administrative management

The CHEMISTRY Area is divided in:

- Instrumental Analyses (GC, LC, UV FTIR ICP Spectroscopies, Calorimetry, Microscopy (MOCF-SEM))
- Desk Analyses
- On- site sampling The BIOLOGY Area mainly deals with:
- Biological and microbiological analysis on several matrices
- Food control
- Health & Safety on work
- Public Hygiene





WHAT ARE BIO-PLASTICS? Bioplastics are bio-based, biodegradable or both.



"Bio-based claims" should be backed up by sound measurements based on approved standards (e.g. EN, ISO or ASTM norms) and ideally third-party certification. They can be made by <u>indicating either the bio-based mass content or the</u> <u>bio-based carbon content as a percentage of the total carbon</u> <u>content or the material balance of a material/product</u>

Biodegradability and compostability are widely used in the bioplastics industry. Simply claiming that something is biodegradable without indicating specific standards is misleading. If a material or product is advertised as biodegradable, <u>further information on the timeframe and</u> <u>level of biodegradation, as well as the surrounding conditions should be provided</u>.



HOW AND WHAT CAN YOU CLAIM BIODEGRADABLE PLASTICS?



For certification aim, the test must be performed by OFFICIALLY RECOGNISED LABS by TÜV Austria.

RECOGNITION BY TÜV AUSTRIA

Laboratory recognition for certification schemes on compostability and biodegradability for bioplastics and components under all environments (TÜV Austria)

https://www.tuv-at.be/it/green-marks/ https://www.european-bioplastics.org/bioplastics/standards/

compasitable



Regulation EN 13432:2000

Packaging—Requirements for packaging recoverable through composting and biodegradation—Test scheme and evaluation criteria for the final acceptance of packaging





EN 13432:2000 – Main requirements EN 13432:2000 mg/kg dm 5 As Cd mg/kg dm 0,5 mg/kg dm 50 Cr tot Heavy metals **Preliminary** mg/kg dm Cu 50 Thickness and Fluorine Volatile solids mg/kg dm 0,5 Hg characterization mg/kg dm 1 Мо concentrations Ni mg/kg dm 25 mg/kg dm Pb 50 mg/kg dm 0,75 Se mg/kg dm 150 Zn mg/kg dm 100 > 90% within Components % w/w dm > 50 **Biodegradability** > 1% 6 months **OK** compost AUSTRIA INDUSTRIAL > 90% Disintegration below 2 mm **Chemical-physical** Compost **Heavy metals** Phytotoxicity composition (pH, Volatile quality concentrations tests solids, C org, N, ...)

COLUNCO FINAL EVENT



Components

> 1%

Test is performed on 3 replicates for every specimen and employs a cellulose as biodegradability positive control, a blank control containing only the inoculum and the test material;

Biodegradability

Test material can be defined "biodegradable under composing conditions" if its degradation results at least 90% in less than 6 months.

CO FINAL EVENT

ecolun

Condenser Dryer

FM

> 90% within

6 months

Climatic Chamber @

Bioreactor





CO2

Detection

IR

sensor

1st CONFERENCE ON GREEN CHEMISTRY & SUSTAINABLE COATINGS



CONFERENCE O





DESCRIPTION:

- Pieces of the plastic test material are mixed with a prepared solid matrix (synthetic solid waste and mature compost). Test is performed on 2 replicates for every specimen.
- Each reactor is placed in an air-circulation oven for 12 weeks.
- The degree of disintegration is determined after a composting cycle, by sieving the final matrix through a 2 mm sieve in order to recover the non-disintegrated residues.
- The disintegration test occurs efficiently if less than 10% of the original mass of loaded samples is above 2 mm sieve after 12 weeks.

ISO 16929 "Plastics - Determination of the degree of disintegration of plastic materials under defined composting conditions in a pilot-scale test"



INDUSTRIAL





ISO 16929 "Plastics - Determination of the degree of disintegration of plastic materials under defined composting conditions in a pilot-scale test"

Sustrate alone (55 - 58µm)



Time zero



4 weeks elapsed



8 weeks elapsed



12 weeks elapsed





90,5%



Cutin coated sustrate (60 µm)



Time zero



4 weeks elapsed



8 weeks elapsed





COUNCO FINAL EVENT





ISO 16929 "Plastics - Determination of the degree of disintegration of plastic materials under defined composting conditions in a pilot-scale test"

Sustrate alone (55 - 58µm)



Time zero



4 weeks elapsed



8 weeks elapsed



12 weeks elapsed





99%





12 weeks elapsed



8 weeks elapsed



Time zero



4 weeks elapsed

sustrate (60 µm)

Chitin coated





ISO 16929 "Plastics - Determination of the degree of disintegration of plastic materials under defined composting conditions in a pilot-scale test"

Sustrate alone (55 - 58µm)



Time zero



4 weeks elapsed



8 weeks elapsed



12 weeks elapsed



Protein coated sustrate (60 µm)



Time zero



4 weeks elapsed



8 weeks elapsed



psed 12 weeks elapsed







Compost quality Chemical-physical composition (pH, Volatile solids, C org, N, ...)

Heavy metals concentrations

Phytotoxicity tests

OECD 208 (July 2006) "Terrestrial Plant Test: Seedling Emergence and Seedling Growth Test"

DESCRIPTION:

- Tests evaluate the differences in toxic or phytotoxic potency between control compost (blank sample) and final compost obtained from the degradation of the developed materials, at two levels of concentrations
- According to EN 13432, the determination of phytotoxic effects can be performed:
 - 4germination test
 - plant growth test

<u>Requirement</u>: the germination rate and the plant biomass of both plant species, at each dilution tested, must be 90% greater than or equal to that of the control test



INDUSTRIAL



1st CONFERENCE ON GREEN CHEMISTRY & SUSTAINABLE COATINGS

Compost quality Phytotoxicity tests

Final Results – Barley

		Germination rate	Fresh Weight
	dilution	(%)	(%)
Uncoated substrate	25%	96.67	96.04
	50%	99.34	97.07
Cutin coated substrate	25%	97.99	97.43
	50%	99.67	102.2
Chitin coated substrate	25%	100.7	96.76
	50%	99.00	94.55
Dratain actated substrate	25%	100.3	94.11
Protein cotated substrate	50%	96.35	95.52

All results: > 90%



1st CONFERENCE ON GREEN CHEMISTRY & SUSTAINABLE COATINGS

Compost quality

Phytotoxicity tests



Final Results – Cress

		Germination rate	Fresh Weight
	dilution	(%)	(%)
Uncoated substrate	25%	96.92	96.03
	50%	98.59	94.25
Cutin coated substrate	25%	93.49	93.96
	50%	95.41	100.7
Chitin coated substrate	25%	96.58	101.6
	50%	100.0	104.9
Ductoin actated substants	25%	94.86	95.39
Protein cotated substrate	50%	96.82	93.40

All results: > 90%





Compost quality Chemical-physical composition (pH, Volatile solids, C org, N, ...)

Heavy metals concentrations

	MU	Compost (controll sample)	Uncoated substrate	Cutin coated substrate	Chitin coated substrate	Protein coated substrate	Reg. EU 2019/1009	D.Lgs. 75/2010
рН	-	6,11	6,43	6,7	6,51	6,18	-	6 - 8,5
Cd	mg/kg dm	< 0,1	< 0,1	< 0,1	< 0,1	< 0,2	2	1,5
Cr tot	mg/kg dm	3,88	2,58	4,27	5,10	2,70	200	-
Cu	mg/kg dm	14,8	13,5	15,3	21,8	11,8	300	230
Hg	mg/kg dm	< 0,1	< 0,1	< 0,1	< 0,1	< 0,1	1	1,5
Ni	mg/kg dm	3,14	2,28	3,40	3,40	2,43	50	100
Pb	mg/kg dm	2,97	1,90	2,38	2,89	1,75	120	140
Zn	mg/kg dm	53,8	47,3	64,1	52,7	44,1	800	500
Р	mg/kg dm	2310	1930	2220	1590	1560	-	-
к	mg/kg dm	4500	3570	4420	3710	3700	-	-
Mg	mg/kg dm	1500	1490	1720	1590	1570	-	-









COLUNCO FINAL EVENT



Substrate 2 + CHITIN









COTUNCO FINAL EVENT





CUTIN & CHITIN COATED BIODEGRADABLE FILM





1st CONFERENCE ON GREEN CHEMISTRY & SUSTAINABLE COATINGS



MAIN CONCLUSIONS

- Cutin, chitin and protein coatings applied onto biodegradable plastic don't decrease these properties of the substrate
- ✓ All coatings demontrate to be <u>FULLY BIODEGRADABLE and COMPOSTABLE under</u>
 <u>INDUSTRIAL COMPOSTING conditions</u>
- Chitin coated substrate provides the compliance with <u>HOME COMPOSTING conditions</u> (both for biodegradability and compostability)
- Cutin & chitin coated biodegradable film demonstrates to be compliant with <u>MARINE</u>
 <u>BIODEGRADATION requirements</u>
- ✓ Final validation of ECOFUNCO demonstrators in terms biodegradability and compostability in different environments is provided for the main developed coatings during the project



ECOFUNCO PARTNERS





Contacts:

Patrizia Cinelli – ECOFUNCO Coordinator patrizia.cinelli@unipi.it

> Francesca Braca – WP7 leader <u>francesca.braca@archa.it</u>

CARCHA CARCHA