Biodegradability and compostability performances of new coated packaging

Francesca Braca[1], Agostino Bazzichi[2], Simone Bracaloni[2], Silvia Pierozzi[2], Fabrizia Turchi[1,2], Antonio Cecchi[1,2].

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

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

Email: francesca.braca@archa.it

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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:

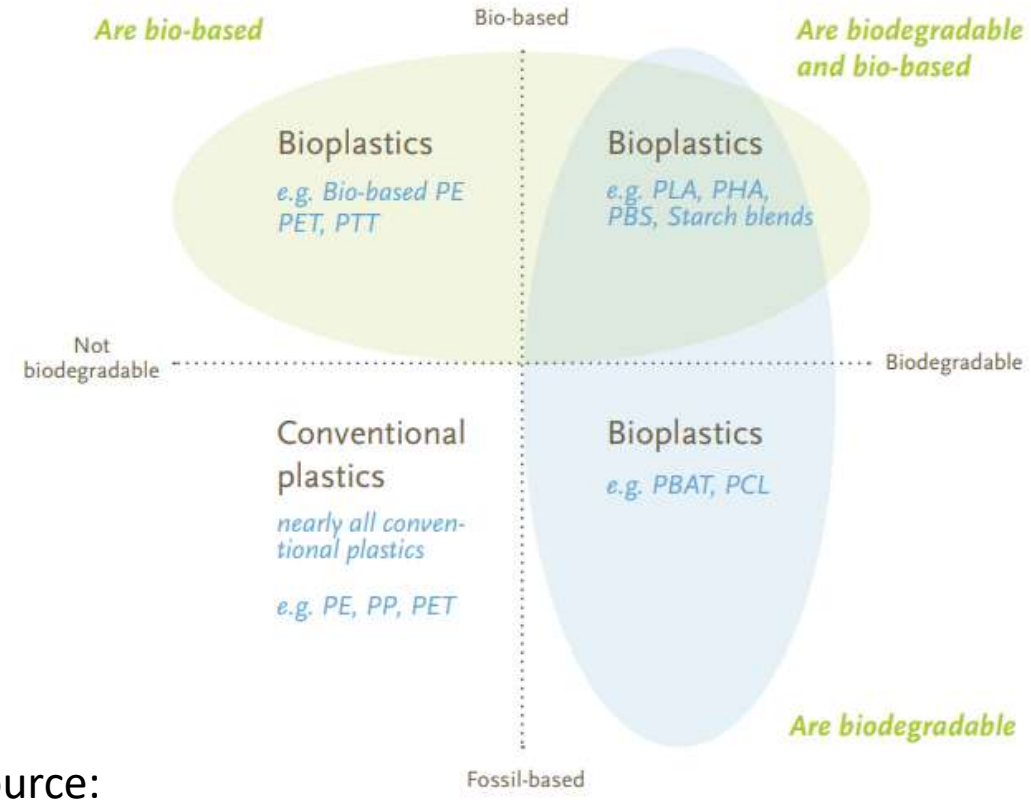
- Instrumental Analyses (GC, LC, UV – FTIR - ICP Spectroscopies, Calorimetry, Microscopy (MOCF-SEM))
- Desk Analyses
- On- site sampling

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.



Source:
European Bioplastics

"**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 **indicating either the bio-based mass content or the bio-based carbon content as a percentage of the total carbon content or the material balance of a material/product**

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, **further information on the timeframe and level of biodegradation, as well as the surrounding conditions should be provided**.

HOW AND WHAT CAN YOU CLAIM BIODEGRADABLE PLASTICS?

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

ARCHA Lab

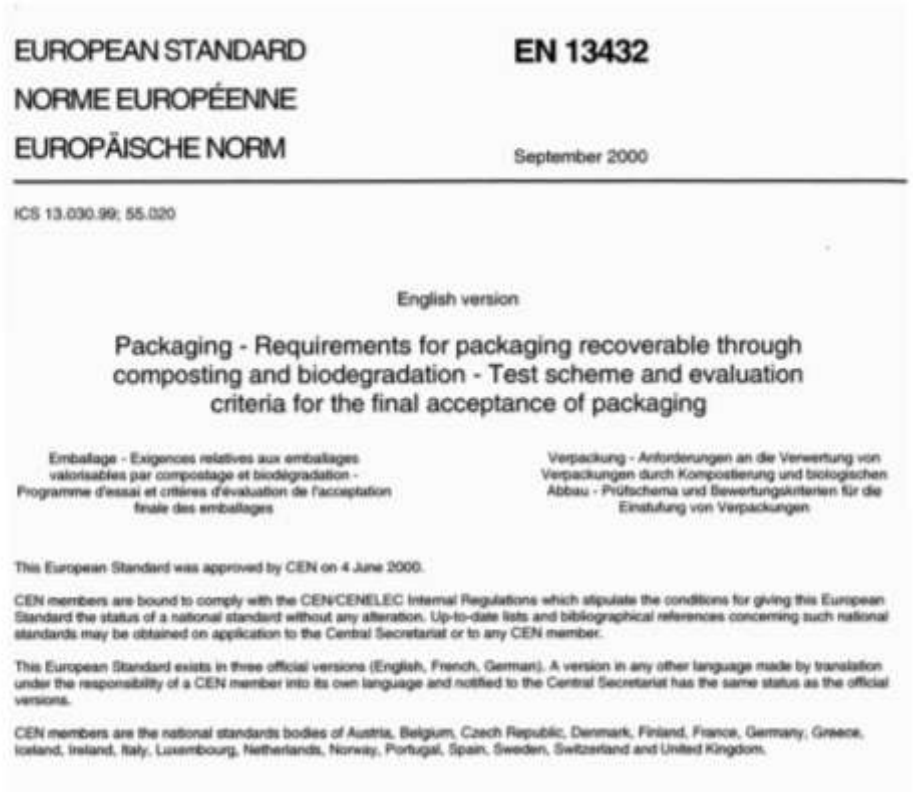
RECOGNITION BY TÜV AUSTRIA

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/

Regulation EN 13432:2000

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



EUROPEAN STANDARD **EN 13432**

NORME EUROPÉENNE

EUROPÄISCHE NORM September 2000

ICS 13.030.99; 55.020

English version

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

Emballage - Exigences relatives aux emballages valorisables par compostage et biodégradation - Programme d'essai et critères d'évaluation de l'acceptation finale des emballages

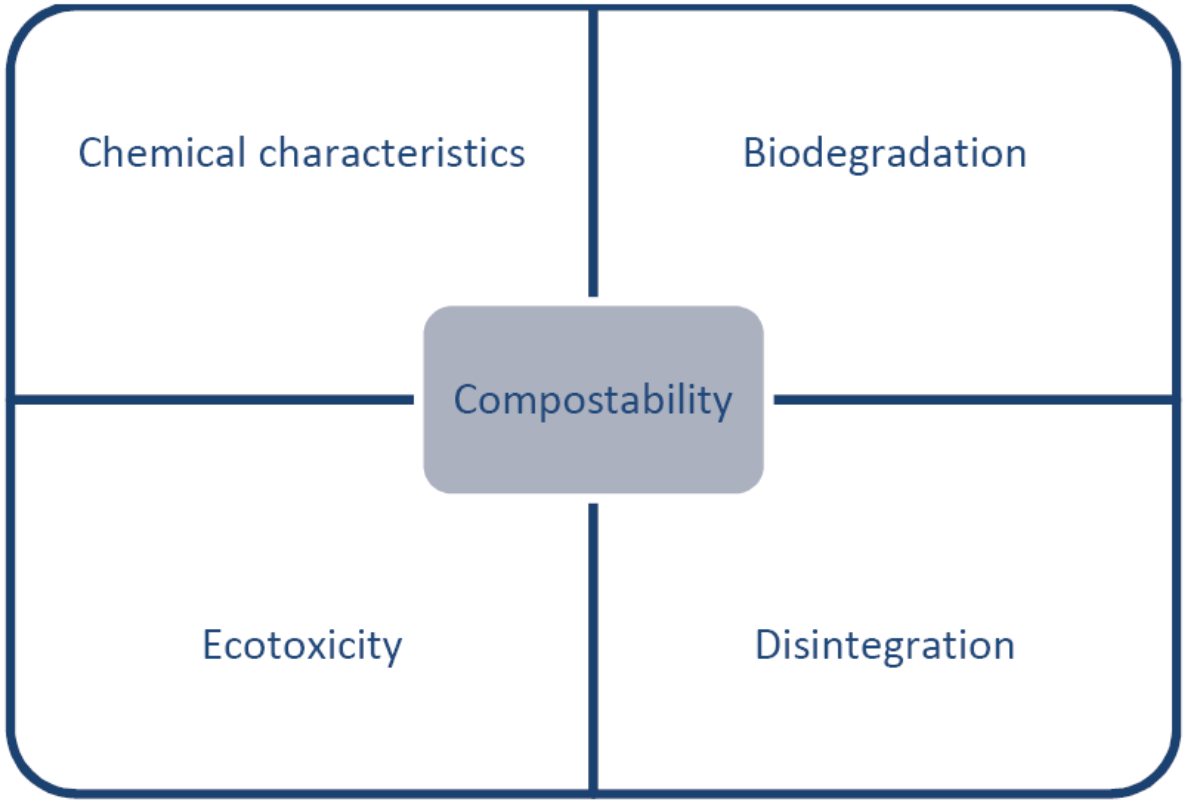
Verpackung - Anforderungen an die Verwertung von Verpackungen durch Kompostierung und biologischen Abbau - Prüfschema und Bewertungskriterien für die Einstufung von Verpackungen

This European Standard was approved by CEN on 4 June 2000.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.



EN 13432:2000 – Main requirements

Preliminary characterization → Thickness → Heavy metals and Fluorine concentrations → Volatile solids

Biodegradability → Components > 1% → > 90% within 6 months

Disintegration → > 90% below 2 mm

Compost quality → Chemical-physical composition (pH, Volatile solids, C org, N, …) → Heavy metals concentrations → Phytotoxicity tests

	MU	EN 13432:2000
As	mg/kg dm	5
Cd	mg/kg dm	0,5
Cr tot	mg/kg dm	50
Cu	mg/kg dm	50
Hg	mg/kg dm	0,5
Mo	mg/kg dm	1
Ni	mg/kg dm	25
Pb	mg/kg dm	50
Se	mg/kg dm	0,75
Zn	mg/kg dm	150
F	mg/kg dm	100
VS	% w/w dm	> 50

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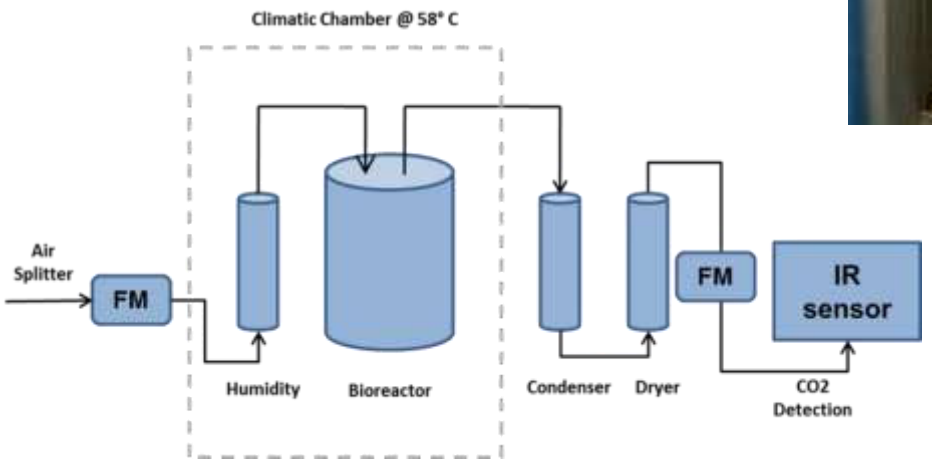
Biodegradability | **Components > 1%** | **> 90% within 6 months**

Biodegradability tests are carried according to official method ISO 14855-1
Test methods determine the degree and the rate of aerobic biodegradation of plastic materials on exposure to a controlled-composting environment

DESCRIPTION:

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



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Biodegradability | **Components > 1%** | **> 90% within 6 months**

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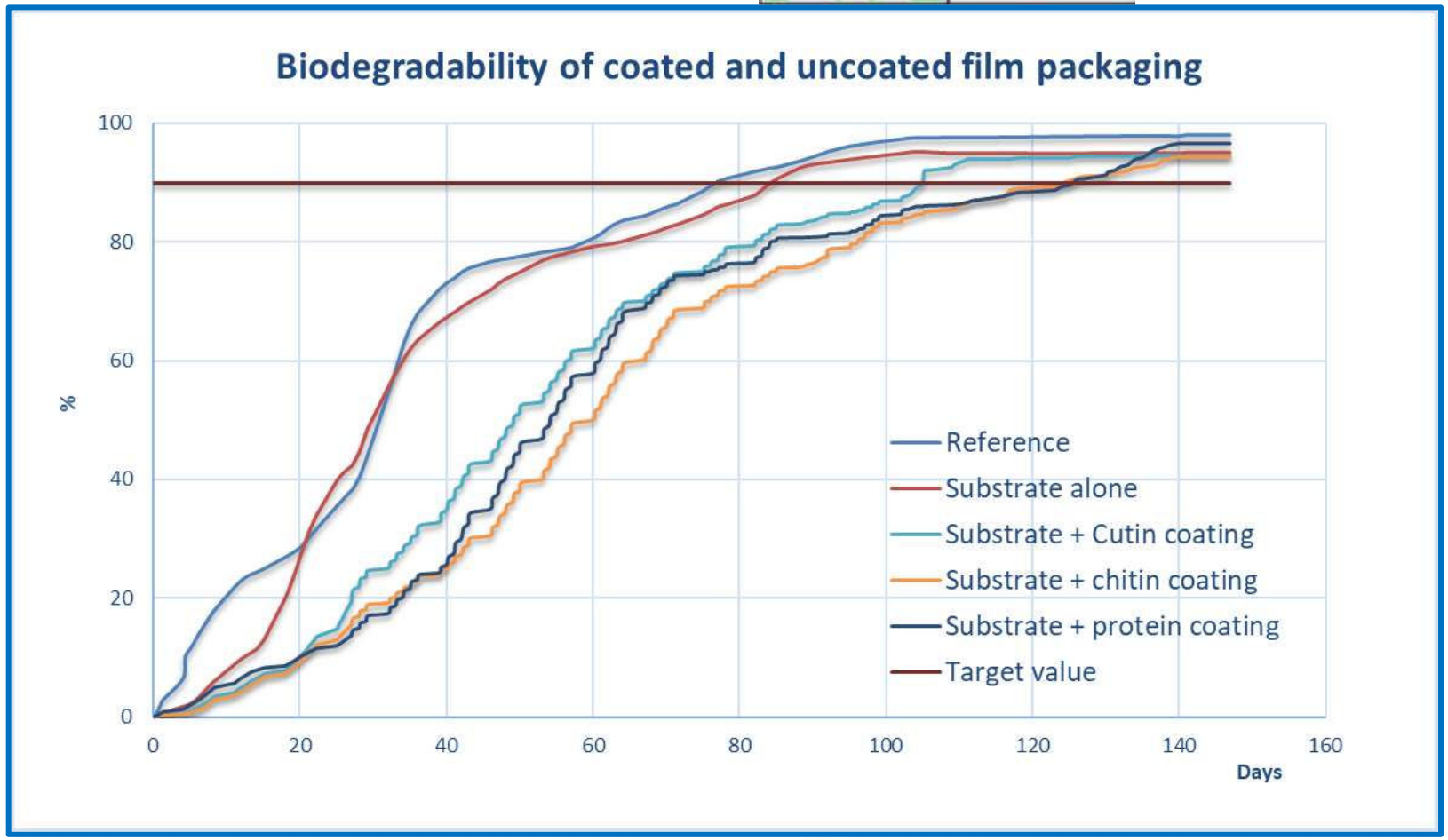
MAIN RESULTS:

- After 150 days, all tested materials are biodegradable
- Uncoated substrate = 95%
- Cutin coated substrate = 94,5%
- Chitin coated substrate = 94,3%
- Protein coated substrate = 96,5%



Disintegration | **> 90% below 2 mm**

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

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.

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Disintegration **< 10%** **above 2 mm**

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

Disintegration

100%

Cutin coated sustrate (60 µm)

Time zero

4 weeks elapsed

8 weeks elapsed

12 weeks elapsed

90,5%

Disintegration **< 10% above 2 mm**

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

Disintegration

100%

Chitin coated sustrate (60 µm)

Time zero

4 weeks elapsed

8 weeks elapsed

12 weeks elapsed

99%

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Disintegration **> 90% below 2 mm**

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

Disintegration

100%

Protein coated sustrate (60 µm)

Time zero

4 weeks elapsed

8 weeks elapsed

12 weeks elapsed

100%

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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:
  - germination test
  - **plant growth test**

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Requirement: 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

Compost quality → **Phytotoxicity tests**

Final Results – Barley

	dilution	Germination rate (%)	Fresh Weight (%)
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
Protein cotated substrate	25%	100.3	94.11
	50%	96.35	95.52

All results: > 90%

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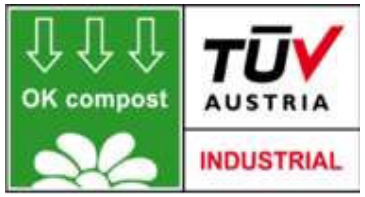
Compost quality → **Phytotoxicity tests**

Final Results – Cress

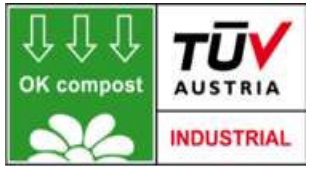
	dilution	Germination rate (%)	Fresh Weight (%)
Uncoated substrate	25%	96.92	96.03
	50%	98.59	94.25
Cutin coated substrate	25%	93.49	93.96
	50%	95.41	100.7
Chitin coated substrate	25%	96.58	101.6
	50%	100.0	104.9
Protein cotated substrate	25%	94.86	95.39
	50%	96.82	93.40

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
pH	-	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
P	mg/kg dm	2310	1930	2220	1590	1560	-	-
K	mg/kg dm	4500	3570	4420	3710	3700	-	-
Mg	mg/kg dm	1500	1490	1720	1590	1570	-	-



Substrate 2 + CHITIN

Biodegradability
(at T < 30°C)
(ISO 14855)

> 90% within
1 year

Disintegration
(at T < 30°C)
ISO 16929 or ISO 20200

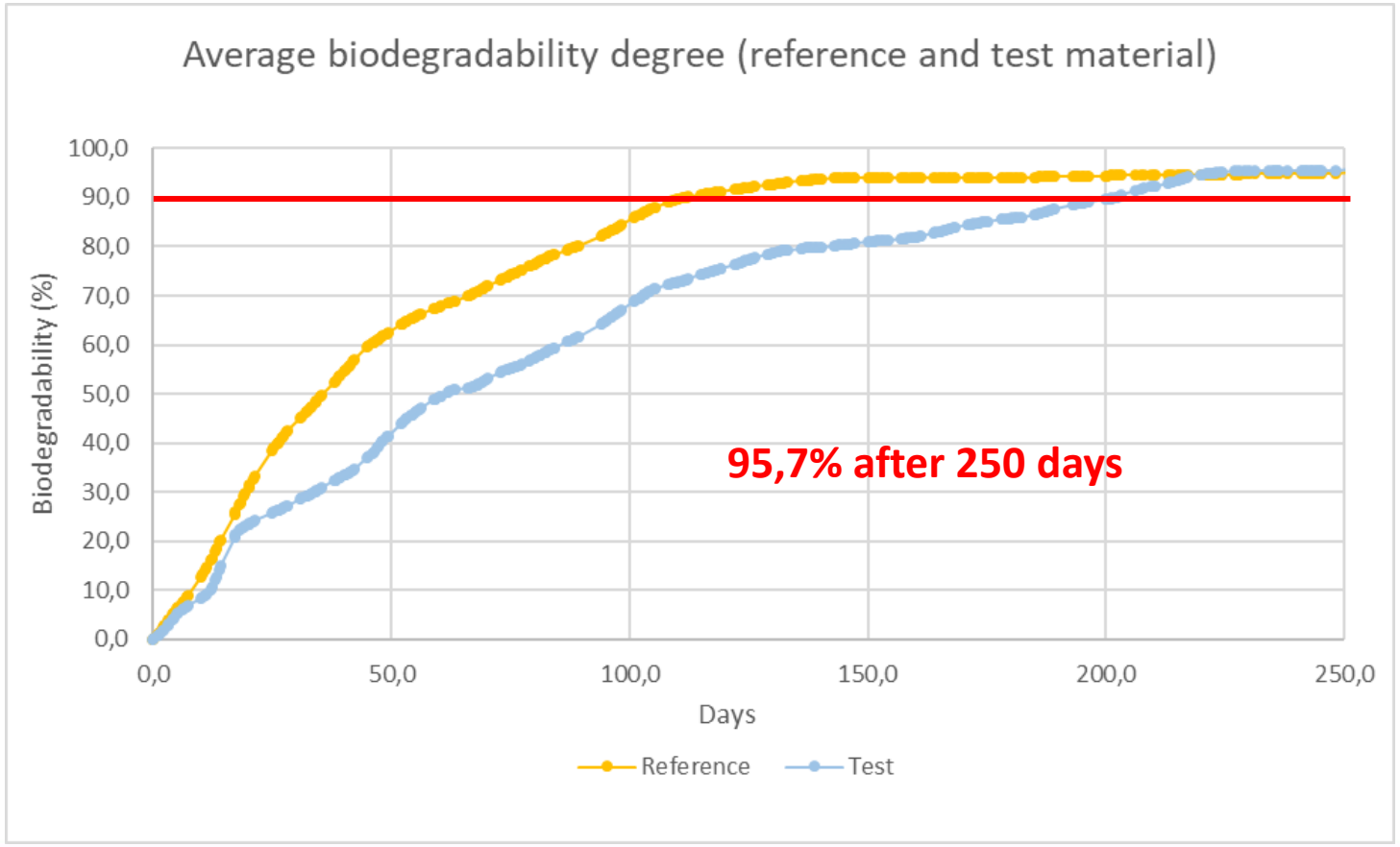
> 81% after
6 months

HOME OK compost TÜV AUSTRIA HOME

Substrate 2 + CHITIN

Biodegradability (at T < 30°C) (ISO 14855) → **> 90% within 1 year**

HOME OK compost — TÜV AUSTRIA HOME



Substrate 2 + CHITIN

Disintegration
(at T < 30°C)
ISO 16929 or ISO 20200

> 81% after
6 months

HOME OK compost — TÜV AUSTRIA HOME

TIME ZERO

15 DAYS

1 MONTH

2 MONTHS

3 MONTHS

4 MONTHS

WHAT ABOUT THE OTHER CLAIMS FOR BIODEGRADABLE PLASTICS?

SOIL — OK bio-degradable — TÜV AUSTRIA — SOIL

Biodegradability (at T 22 - 28°C) ASTM D 5988 → **> 90% within 2 year**

WATER — OK bio-degradable — TÜV AUSTRIA — WATER

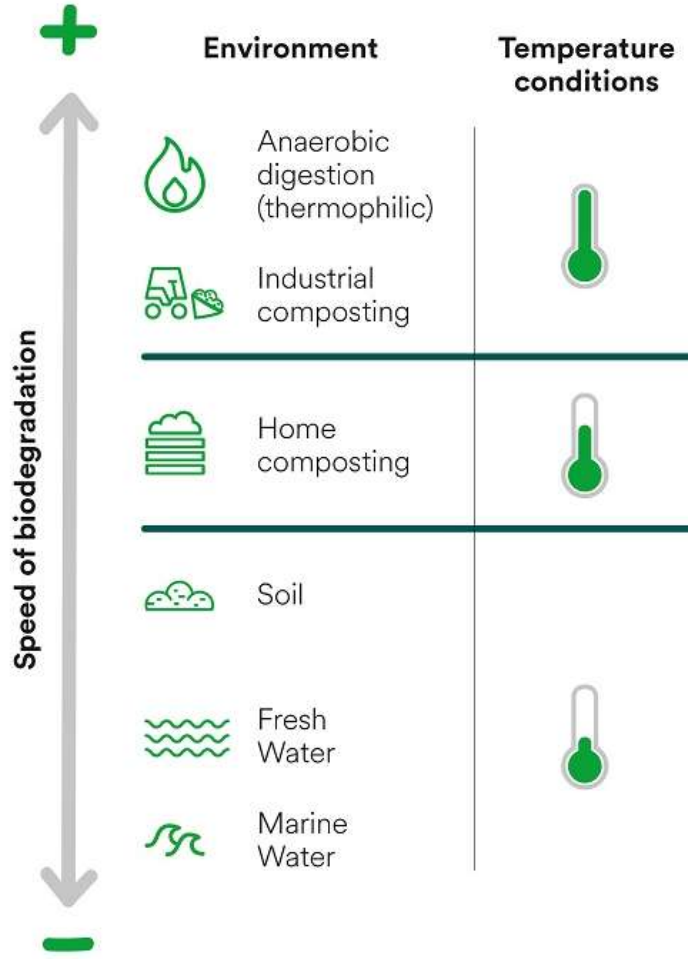
Biodegradability (at T 20 – 25°C) (ISO 14852) → **> 90% within 56 days**

MARINE — OK bio-degradable — TÜV AUSTRIA — MARINE

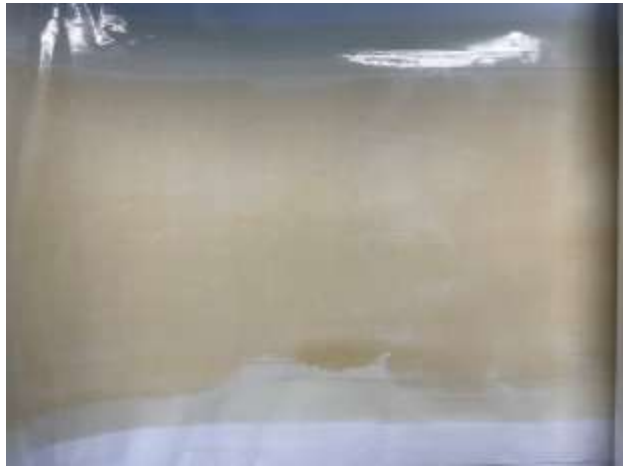
Biodegradability at < 30°C (ASTM D 6691) → **> 90% within 6 months**

Disintegration at < 30°C (ASTM D 6691) → **> 90% below 2 mm within 6 months**

Ecotoxicity with Daphnia (OECD 202)



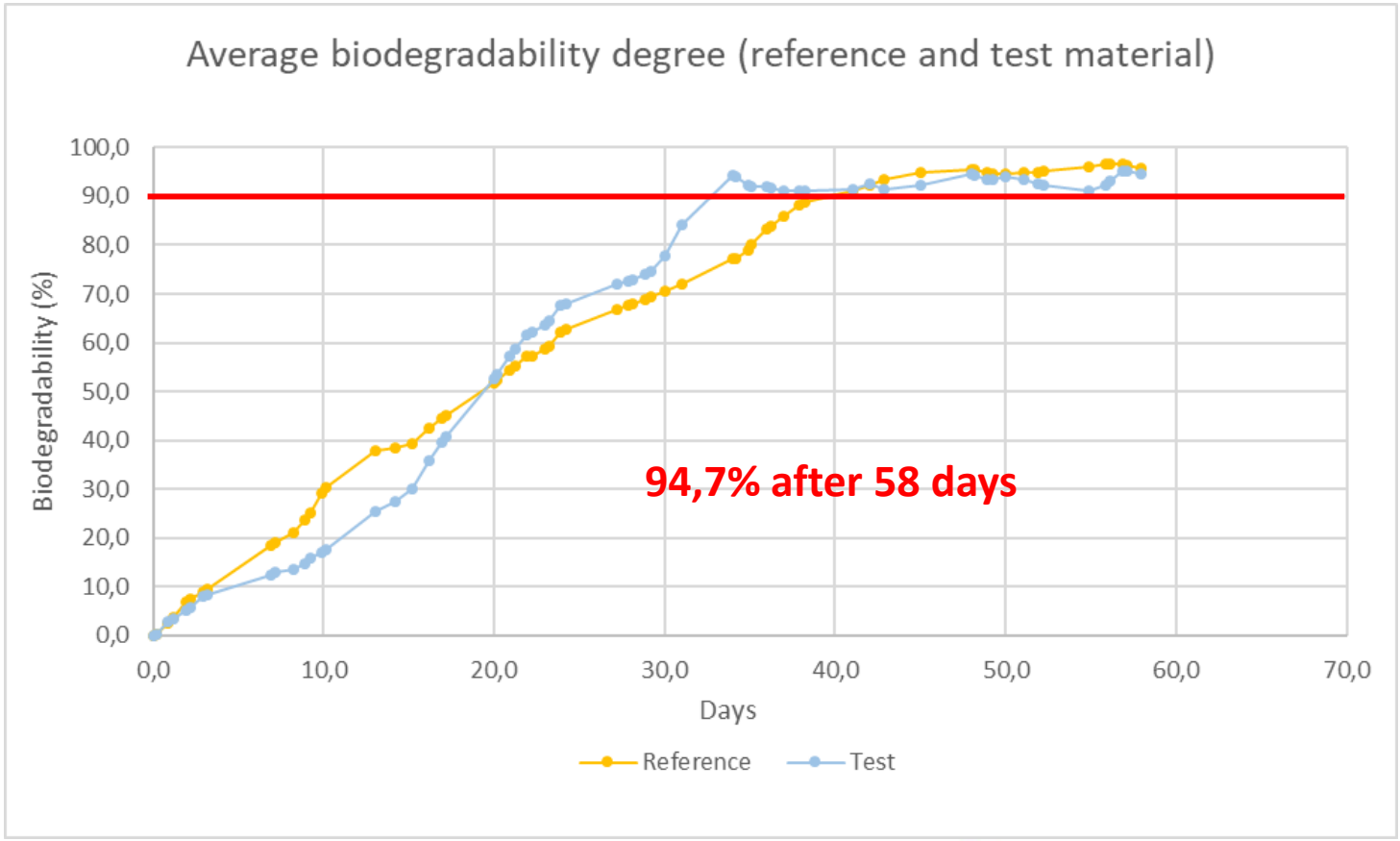
CUTIN & CHITIN COATED BIODEGRADABLE FILM



Biodegradability at < 30°C (ASTM D 6691)

> 90% within 6 months

MARINE OK bio-degradable — TÜV AUSTRIA MARINE



MAIN CONCLUSIONS

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

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TIPA
Universitat d'Alacant
Universidad de Alicante
IN SUPREMÆ DIGNITATIS
1343
UNIVERSITÀ DI PISA

Contacts:

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

Francesca Braca – WP7 leader
francesca.braca@archa.it