Certified Compostable Products & the science of biodegradation

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Compost Council of Canada Workshop 2020
Rethinking plastics: Innovative plastics economy aligns with Circular Economy principles

Nutrient loop
e.g. phosphate, nitrogen, carbon

Renewable raw materials

Farming

Collection

Product

Consumer

Compost

Technical loop

Production

Collection

Reduce, Reuse, Refurbish, Recycling

Conventional and biobased raw materials

Products made of ecovio® fuel the nutrient circle: How?
Defining bioproducts: consider beginning and end of life

* Appropriate end of life for bioproducts may depend on several factors
Fossil-based, biobased & compostable polymers

Biodegradability is based on molecular structure; therefore, both fossil-based and biobased polymers can biodegrade in composting processes.

cf: Hans-Josef Endres, Technische Biopolymere, 2009 (p. 21)
Closing the loop: facilitating food residues diversion

Certified compostable polymers

Organic residues

Organics collection & Diversion

Enriching soil reducing GHG from landfill

Organics recycling

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Stewardship on biodegradability has three major components: New product developments, certifications, and stakeholder engagement

Investigation of polymer biodegradation in the environments relevant for its applications
- Dedicated research activities for water, soil, aerobic composting, and anaerobic processing conditions
- Data used for stakeholder management and standardization/certification work

Bringing together product performance and polymer biodegradability fundamentals
- Knowledge of polymer chain structure-properties relationship, facilitates the development of new tailor-made compostable products
**ecoflex® & ecovio®**

Compostable and biobased solutions for certified compostable plastic applications

- **ecoflex®** is BASF’s original PBAT and has been on the market for more than 18 years.

- **ecovio®** is the first compostable polymer with biobased content of BASF.
ecovio®: certified around the world to ensure compost and soil integrity

- **Canada**: CAN/BNQ 0017-088
- **North America**: ASTM 6400
- **Europe**: EN 13432
- **Australia**: AS 4736
- **Asia**: GreenPla
ecovio® for Certified Compostable Products

Applications:
- Compostable organic waste bags, T-shirt bags, and shopping bags.
- Food service packaging such as multilayer packaging, paper coatings for hot cups, and coffee capsules.
- Agricultural mulch films.

https://www.youtube.com/watch?v=P5L3owBT5Lk
Basic biodegradation understanding and product field evaluation are both needed to capitalize on biodegradability

**Fundamental understanding**

- Elucidating structure-biodegradability relationship
- Microbial profiling
- Enzyme characterization
- Cultivation

**Field evaluation**

- Assessing product performance in field trials
- Polymer characteristics
- Microorganisms and enzymes
- Abiotic factors

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The mechanism of biodegradation

- Mineralization by natural organisms to CO$_2$ and microbial biomass
- CO$_2$ is indicator for biodegradability measurement
- 10% of carbon is estimated to go into biomass, 90% of carbon goes in CO$_2$\(^1\)

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\(^1\) OWSnv (2016) EXPERT STATEMENT (BIO)DEGRADABLE MULCHING FILMS. (European Bioplastics e.V., [http://www.european-bioplastics.org/news/publications/].)
Fragmentation vs. biodegradation

Fragmentation:
Is the disintegration of a polymer into small fragments due to abiotic (physical) factors such as UV light or friction in fragments of different size. The disintegration can be promoted by the addition of additives (e.g. oxo or photo fragmentation).

Mechanism:
Disintegration of polymer in fragments of different sizes (e.g. micro plastic)

Biodegradation (i.e. composting):
Is an intrinsic property of a material or product to be mineralized by naturally occurring organisms into CO₂, biomass and water.

Mechanism:
Organisms colonize the surface of the polymer and eat it starting from the surface through the polymer (surface erosion). No residues remain.
Soil microbes can be seen colonizing the surface of the polymer

- Isotope labeling permitted monitoring of biodegradation
- First tracing study to show uptake of the carbon in the film by microbes
- This ensures that PBAT is not simply fragmenting into small particles

Microbial metabolism: How to show the biomass formation?

1. Microbes colonize the surface and secrete enzymes (e.g. cutinases)
2. + 3. Enzymes break down the polymer at the active site
4. Microbes digest the fragments and grow ➔ Formation of biomass from labelled carbon

- Labelled carbon
- Polymer with labelled carbon
- Fungal hypha and bacteria
- Hydrolyzed fragment with labelled carbon
- Enzyme
- Fungal hypha and bacteria with labelled biomass
Biodegradation of synthetic polymers in soils

Study from the ETH Zürich demonstrates formation of biomass from ecoflex® (PBAT)

https://advances.sciencemag.org/content/4/7/eaas9024
BASF pilot projects show how ecovio® helps to close the nutrient loop around the world
Example: compostable packaging field trial testing at composting facility

Tested at Cedar Grove
60 days active process Gore System
https://compostmanufacturingalliance.com/
Why certified compostable bags?

Makes Commercial & Residential Food Waste Collection More Efficient

- Cleaner
- Safer
- Easier
Berlin study: compostable bags made of ecovio® help increase organic waste collection

Change in amount of collected organic waste

Source: Kanthak & Adam, Waste consulting office, Berlin, 2012. Distribution of ecovio® OWB to the "project districts": 11,000 households in Prenzlauer Berg and 10,000 households in Hellersdorf and monitoring the amount of collected organic waste in the testing and reference areas.
Other certified compostable packaging applications
Recycling organics is a sustainable practice.
Certified compostable plastic applications help divert organics from landfill.
It is demonstrated innovative certified compostable plastics, even fossil-based PBAT, do biodegrade in soil, where limited control of processing conditions and less microbial activity are found compared to a composting site.
Product certification is important to ensure product biodegrades.
Certified compostable product field tests have demonstrated product biodegradability in composting sites.

Thank you
Questions?
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