Compostable materials in real world settings

Aotearoa New Zealand is on a journey towards a productive, sustainable and low-emissions bioeconomy.

Within the Government's emissions reduction plan are actions to support New Zealanders to reach our emissions and sustainability goals.[1]

One way to reduce emissions is to make it easier to reduce waste and manage it responsibly.

As more people strive to live eco-friendly lives, understanding how to properly dispose of compostable packaging has become increasingly important.[2] Single-use compostable food packaging, contrary to public understanding, is not widely composted in Aotearoa. In addition, food waste going to landfill, often found in combination with the packaging, is a problem due to the production of methane as waste breaks down. Methane is one of the major greenhouse gases produced in Aotearoa.

Scion is working together with Te Pūtea Whakamauru Para the Waste Minimisation Fund to improve understanding about how to dispose of compostable materials. Achieving this ensures Aotearoa will be better placed to meet its sustainability goals.

For single-use packaging to be certified as compostable, it undergoes testing in a laboratory setting according to relevant standards. But are the conditions used in this testing comparable to real-life composting of this type of packaging?

The difference between how compostable materials disintegrate in laboratory-based compostability testing and in the 'real world' was investigated in a practical study of composting systems across Aotearoa in 2021.

Both Industrial composting facilities and home-based composting systems were included in the study. The findings from the Industrial testing are discussed below.

Methods

Six single-use compostable products were tested at five different Industrial composting facilities throughout Aotearoa. Both fibre-based and plastic-based compostable products were included. All materials were previously certified as compostable according to the relevant standards. As part of this study, they were also re-tested against the compostability standards. The research focused on the disintegration of the material within the compost.

In addition to the distinct testing, other compostability testing requirements are:

- The presence of certain harmful chemicals in the test materials (such as heavy metals, or PFAS – forever chemicals).
- Biodegradation (the ability of a material to break down in a compost all the way to carbon dioxide and water).
- Compost quality (producing compost that is not toxic to plants or worms after test material disintegration).

Because the test materials have all passed laboratory testing, they have already been proven to pass these compostability requirements. The big question is, will they disappear/disintegrate in a real compost? A full description of the research methodology is available in the full report – details to request the report are at the end of this document.

Disintegration results

The research revealed variability in disintegration across and even within sites. While all the materials were technically compostable according to laboratory testing, the conditions at each facility significantly impacted their disintegration rates. Factors such as time, temperature, mixing protocol, and shredding timings played a role, with moisture content emerging as a critical element.

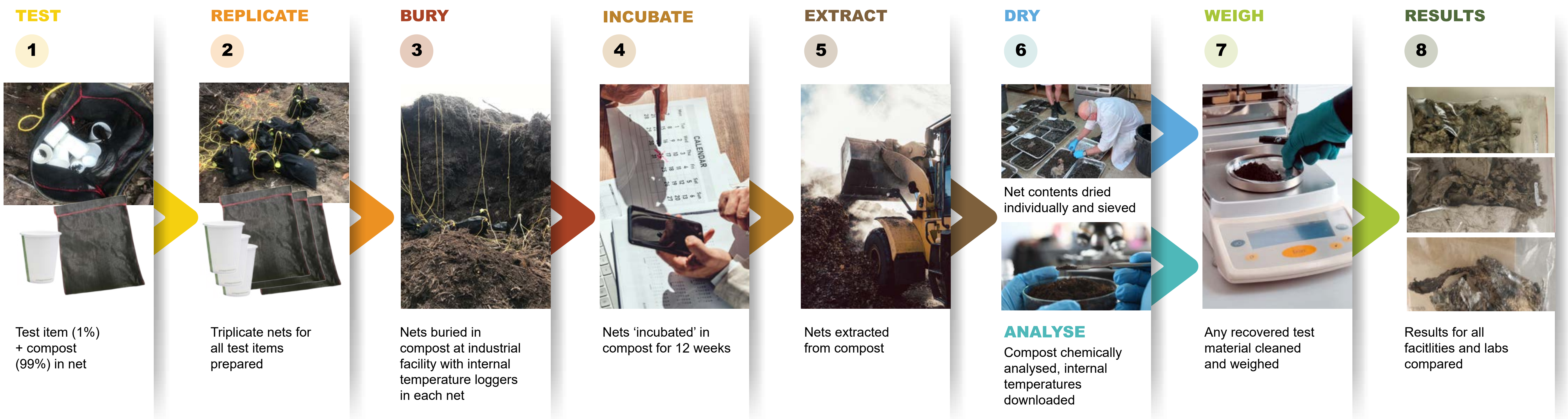


Image 1: *Testing the real-life compostability of compostable materials.*

Image 2: *Six different compostable products were tested in the trial. From top left: hot cup lid, cold cup, takeaway tray, hot cup, bin liner, and meat bag.*

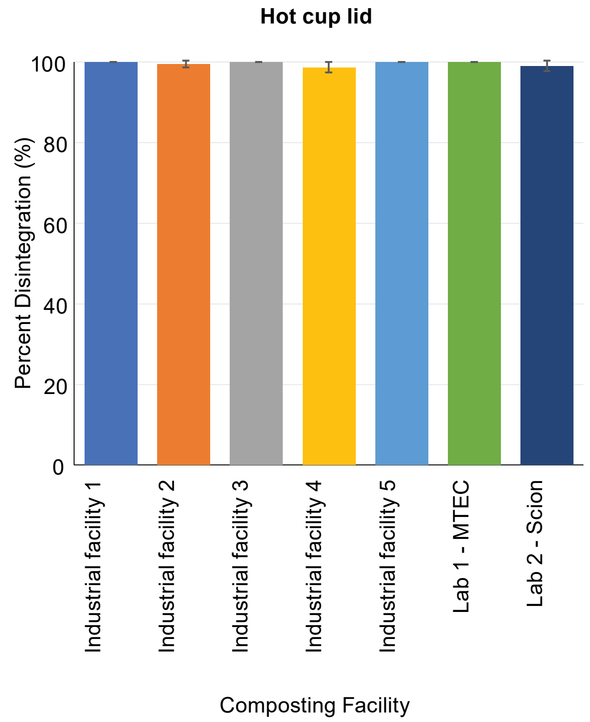
Image 3: *Comparison of disintegrated material 0% disintegrated (top) versus 99% disintegrated (bottom).*

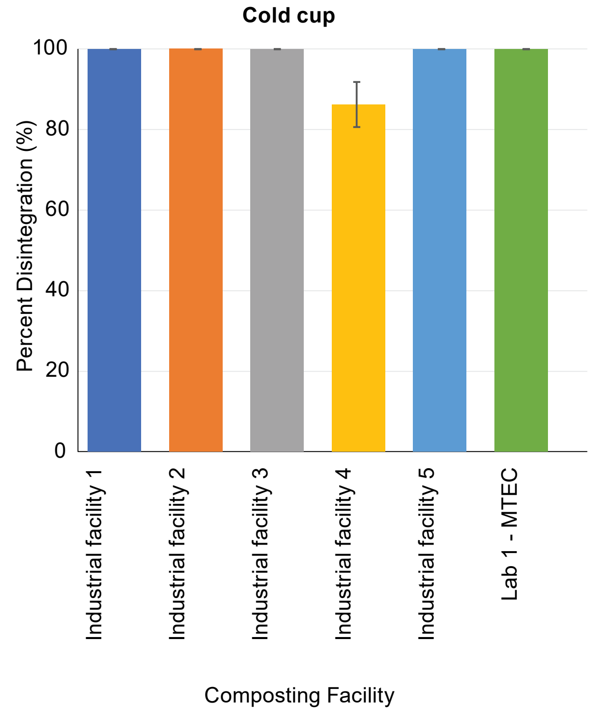
Six single-use compostable products were chosen for the trial, as shown in Image 2. The compostable products were either fibre-based (takeaway tray and hot cup) or plastic-based (bin liner, hot cup lid, cold cup and meat bag).

Materials are considered to have passed the test if they reach a threshold of 90% disintegration in the compost pile. Generally, compostable plastic materials disintegrated faster than compostable fibre-based materials.

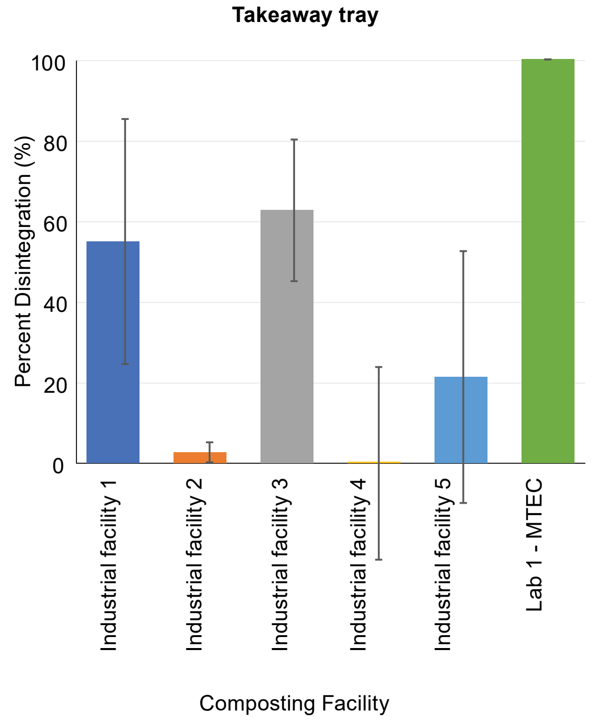
Some materials such as the hot cup lid and cold cup disintegrated at all of the industrial composting sites, where others (hot cup and take-away tray) failed to disintegrate at any of the sites tested. See Appendix 1 for the full list of disintegration percentages.

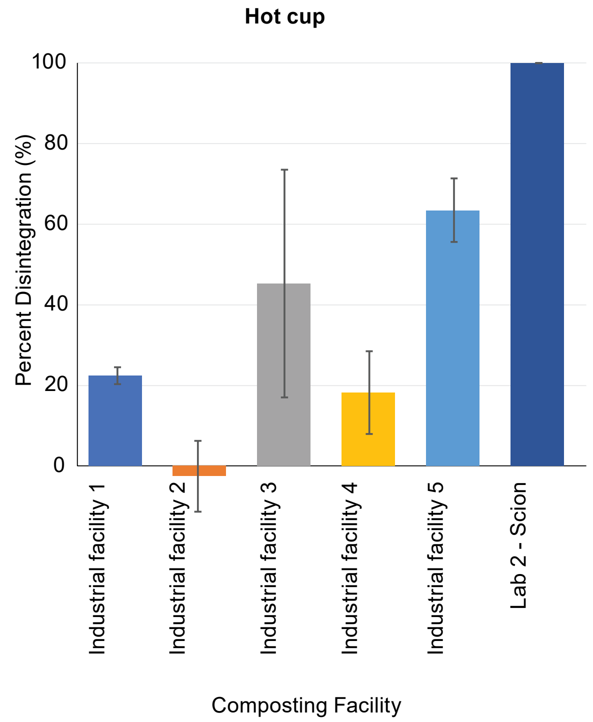
Out of the six products we tested, the hot cup lid reached the threshold of 90% disintegration at all five testing sites, in the independent laboratory and Scion laboratory. The cold cup also successfully disintegrated at all five facilities (within error), and in the laboratory setting.



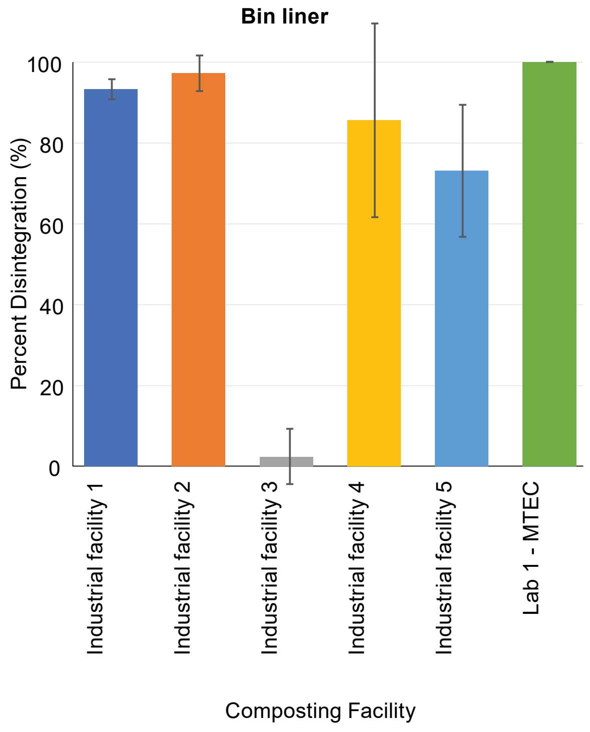


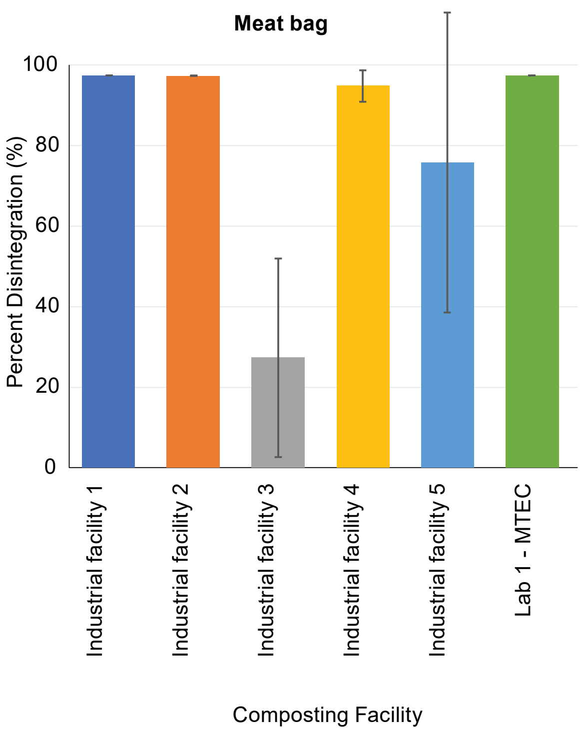
At the other end of the spectrum, the takeaway tray and hot cup only reached compostability threshold in a laboratory setting, with maximum disintegration in the composting facilities of around 60%.





The bin liner and the meat bag were very similar: both failed to disintegrate at one or two of the facilities but successfully disintegrated at the other test facilities, and in the independent laboratory.





Composting conditions

Processing conditions at the facilities had a large influence on the results. Each facility has its own process where shredding, mechanism of turning and aeration, holding period (before composting begins), duration of composting, and moisture content differs. Three types of aerobic composting systems were included in the trial: windrows, agitated tunnel, and aerated static pile.

It was found that if the compost is too dry then nothing biodegrades and the converse if it is too wet the compost becomes anaerobic (an environment where bacteria essential to the degradation process largely produce methane).

Moisture content was the key factor in the variable composting results between the Industrial facilities. At facility 3, where incomplete disintegration was observed, the compost was notably dry, with an initial moisture content of 26%, compared to 55% for facility 2. A subsequent trial investigating variation in moisture content between laboratory-scale composting reactors showed that composting failed when the compost's initial moisture content was 33%. Moisture content of around 55% was shown to be optimal, with some test material disintegration also observed at 73% moisture content.

Temperature also plays an important role in the composting process. During normal composting, a temperature increase is generated by the microbes metabolising the raw compostable materials. Some materials require heat to break down. If a compost pile gets too hot, the type of microbes in the compost changes, but if the compost is too cold, some materials will not break down. The internal temperatures of the compost piles were monitored in this trial, as well as the daily external temperatures.

The research highlights concern among New Zealand composting facilities, as laboratory tests don't always accurately replicate real-world composting environments. In addition to moisture and temperature as already discussed, differences were seen for real-life composting timeframes. These tend to vary upon season; for example during Spring, Industrial facilities see shorter times for composting as this is a time when garden waste generation is high, and demand for compost is also high.

Conclusions

In this trial we found that the plastic-based packaging material disintegrated better than the fibre-based packaging in an Industrial composting setting.

Although composting conditions, processes and weather varied across all the composting sites, this trial showed that moisture content was the biggest single contributor to successful composting.

The ultimate goal of this study supports the shift in Aotearoa towards a sustainable bioeconomy. The desired outcome is that more compostable materials will reach compost piles when appropriate, such as when they are contaminated with food. However, it is important to remember that it is the food residues that provide nutrients for the composting process, not the packaging so it is important to use compostable packaging wisely. Helping manufacturers, retailers and consumers understand what products are packaged in, and how accurate the compostability claims are, is important. There is a place for both recyclable and compostable materials, and at the end of their life being disposed of correctly, and reaching the appropriate facilities, is paramount. Compostable and recyclable waste that ends up in landfill, which contributes to emissions, in Aotearoa, is what we are working towards reducing.[3]

Recommendations

From this composting trial, Scion recommends that Industrial composting facilities:

- Monitor and control for moisture content within the compost.
- Incorporate a shredding step in the composting process.

Other factors for Industrial composting facilities to consider:

- Monitor internal compost temperature.
- Allow enough time for compostable packaging materials to fully degrade.

Scion and Te Pūtea Whakamauru Para the Waste Minimisation Fund are focused on accelerating New Zealand's transition towards a low emissions and low waste circular bioeconomy.

Te Pūtea Whakamauru Para the Waste Minimisation Fund is open year-round and is focused on initiatives that make the greatest impact. This fund also provides support for local councils to develop and implement kerbside collection, and organic processing facilities.[4]

As the only certified compost testing facility in Australasia, Scion continues to explore the complexities of compostable packaging, aiming to contribute to a more sustainable future.

Compostability testing at Scion

In 2022, Scion opened a new, purpose-built pilot-scale disintegration testing facility to complement our biodegradation testing facility at our Rotorua headquarters. This laboratory facility is designed to conduct disintegration and biodegradation testing for commercial clients, expanding our capabilities to test a wider range of standards.[5]

Appendix 1

Table 1: *The percentage disintegration of all test materials at all test sites.*

Test material	Test site	Disintegration (% ± Std. Dev.)
Hot cup lid	Industrial facility 1	100 ± 0
	Industrial facility 2	100 ± 1
	Industrial facility 3	100 ± 0
	Industrial facility 4	99 ± 1
	Industrial facility 5	100 ± 0
	Lab 1 - MTEC	100 ± 0
	Lab 2 - Scion	99 ± 1
Cold cup	Industrial facility 1	100 ± 0
	Industrial facility 2	100 ± 0
	Industrial facility 3	100 ± 0
	Industrial facility 4	86 ± 6
	Industrial facility 5	100 ± 0
	Lab 1 - MTEC	100 ± 0
Takeaway tray	Industrial facility 1	55 ± 30
	Industrial facility 2	3 ± 3
	Industrial facility 3	63 ± 18
	Industrial facility 4	0 ± 24
	Industrial facility 5	21 ± 31
	Lab 1 - MTEC	100 ± 0

Test material	Test site	Disintegration (% ± Std. Dev.)
Hot cup	Industrial facility 1	22 ± 2
	Industrial facility 2	-3 ± 9
	Industrial facility 3	45 ± 28
	Industrial facility 4	18 ± 10
	Industrial facility 5	63 ± 8
	Lab 2 - Scion	100 ± 0
Bin liner	Industrial facility 1	93 ± 3
	Industrial facility 2	97 ± 4
	Industrial facility 3	2 ± 7
	Industrial facility 4	86 ± 24
	Industrial facility 5	73 ± 16
	Lab 1 - MTEC	100 ± 0
Meat bag	Industrial facility 1	100 ± 0
	Industrial facility 2	100 ± 0
	Industrial facility 3	28 ± 25
	Industrial facility 4	97 ± 4
	Industrial facility 5	78 ± 38
	Lab 1 - MTEC	100 ± 0

References

[1] https://www.environment.govt.nz/assets/publications/Aotearoa-New-Zealands-first-emissions-reduction-plan.pdf

[2] https://www.plastics.org.nz/environment/compostable-packaging

[3] https://pce.parliament.nz/publications/biodegradable-and-compostable-plastics-in-the-environment

[4] https://www.environment.govt.nz/what-you-can-do/funding/waste-minimisation-fund/

[5] https://www.scionresearch.com/__data/assets/pdf_file/0006/66156/Compostabilty_testing_infosheet.pdf

About Scion

Scion is the Crown research institute that specialises in research, science and technology development for forestry, wood and wood-derived materials, and other biomaterial sectors.

Scion's purpose is to create economic value across the entire forestry value chain, and contribute to beneficial environmental and social outcomes for New Zealand.

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