



Breaking it Down: Cotton's Biodegradability in Various Environments



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Breaking it Down: Cotton's Biodegradability in Various Environments











Biodegradability of Cotton and Polyester in Soil

Disposing of old clothes...

What's the problem?

- ❑ The average American discards about 70 pounds of clothing per year¹
- ❑ Of that only about 10 pounds are donated
- ❑ The remaining 60 pounds end up in landfills
 - ❑ 327 million people in the US
 - ❑ 20 billion pounds of textile waste goes to US landfills each year



1. Council for Textile Recycling, 2014

Recycling Options

- ☐ Donation
 - ☐ Charities
 - ☐ Retailers
- ☐ Municipal recycling programs
 - ☐ Sort through the waste
 - ☐ Creates different streams
 - ☐ Convenience



What happens to fabrics in a compost pile?



- ☐ Today's landfills are good at preserving things.
- ☐ Little air, water, sunlight and bacteria available.
- ☐ How well would natural soil break down garments?
- ☐ Could back-yard composters convert their fabrics to soil?

Three biodegradation methods have been explored...

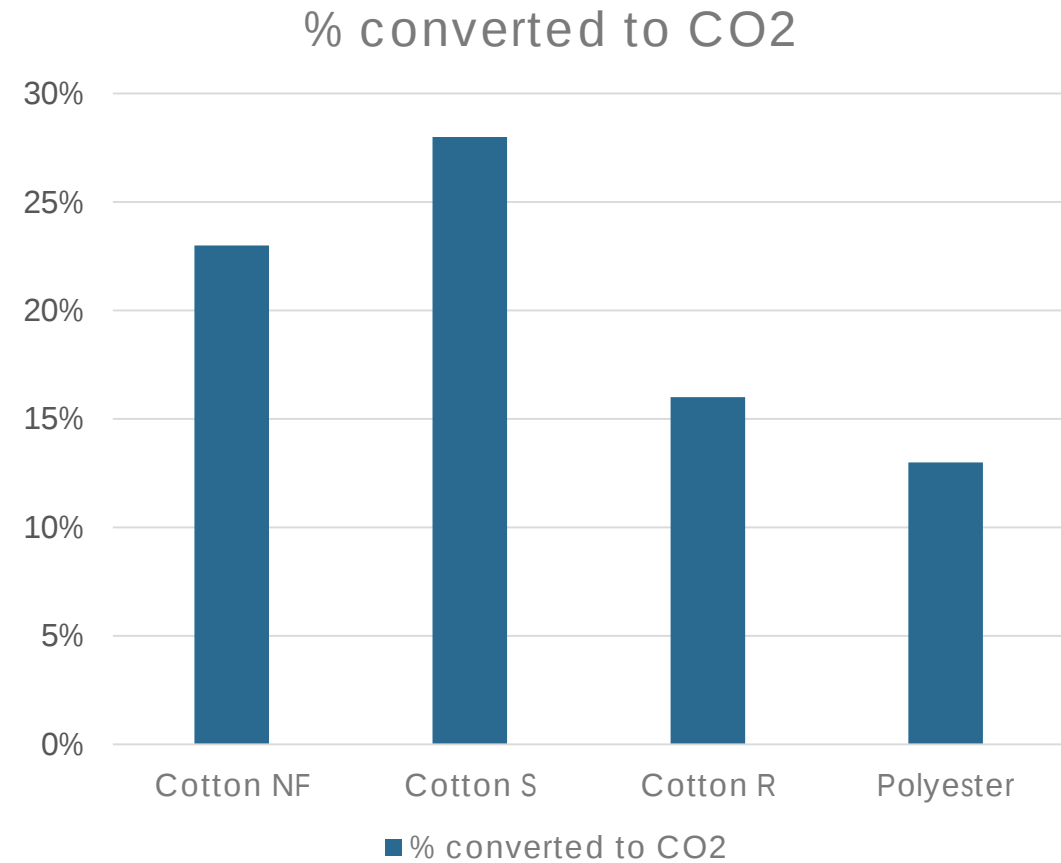
- ❑ ASTM D5988-03
 - ❑ Standard Test Method for Determining Aerobic Biodegradation in Soil of Plastic Materials or Residual Plastic Materials After Composting
- ❑ Composting in winrows at Cornell University
- ❑ ASTM D6400 Compostable Product Test
 - ❑ Controlled temperature, moisture level, carbon:nitrogen ratio
 - ❑ Compost bin was used

Design of Trials One and Two

ASTM D5988-03 and Composting

- ☐ Fabrics Evaluated
 - ☐ 100% cotton jersey, scoured and bleached, no finish
 - ☐ 100% cotton jersey, scoured and bleached, softener only
 - ☐ 100% cotton jersey, scoured and bleached, resin plus softener.
 - ☐ 100% polyester shirt
- ☐ Fabrics were laundered 30 times before testing
 - ☐ D5988-03 measures the generation of CO₂
 - ☐ In composting, weight loss is measured
 - ☐ Fabrics were exposed for 90 days

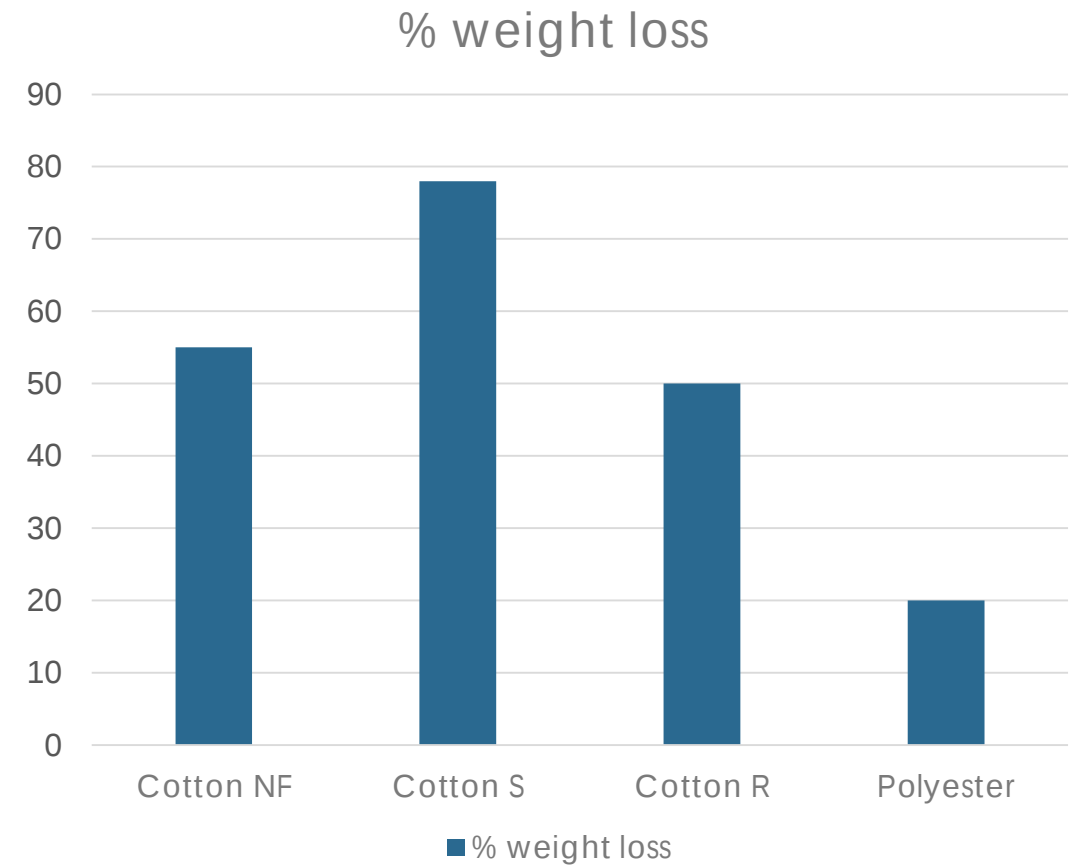
Results of ASTM D5988-03



Degradation of Fibers in Compost



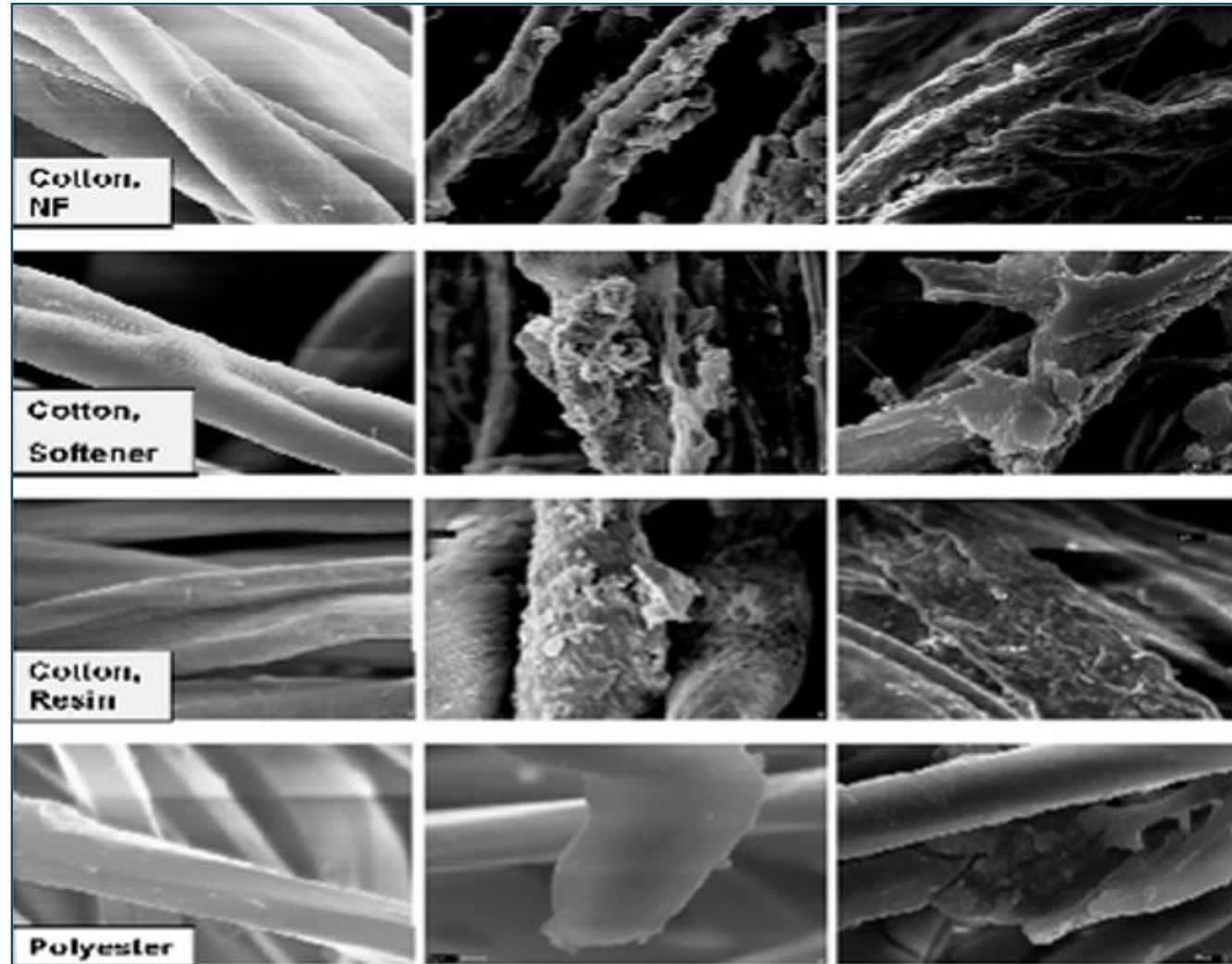
Cornell University composting facility



Degradation in Soil

0 Days

90 Days



Design of Trial Three

ASTM D6400 (Biodegradability Testing in Compost)

- ☐ Fabrics Evaluated
 - ☐ 100% cotton jersey, scoured and bleached, softener only
 - ☐ 100% cotton jersey, scoured and dyed black, plus softener
 - ☐ 100% recycled polyester shirt
- ☐ Fabrics were laundered 30 times before testing
- ☐ Carbon-to-nitrogen ratio of 30:1
- ☐ Moisture content 45–50%
- ☐ Fabrics were exposed for 12 weeks (84 days)

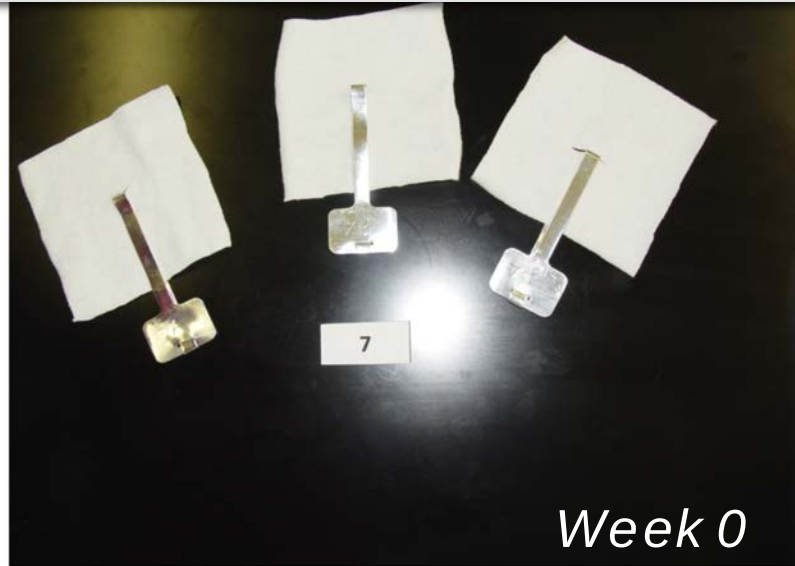
Recycled Polyester T-Shirt



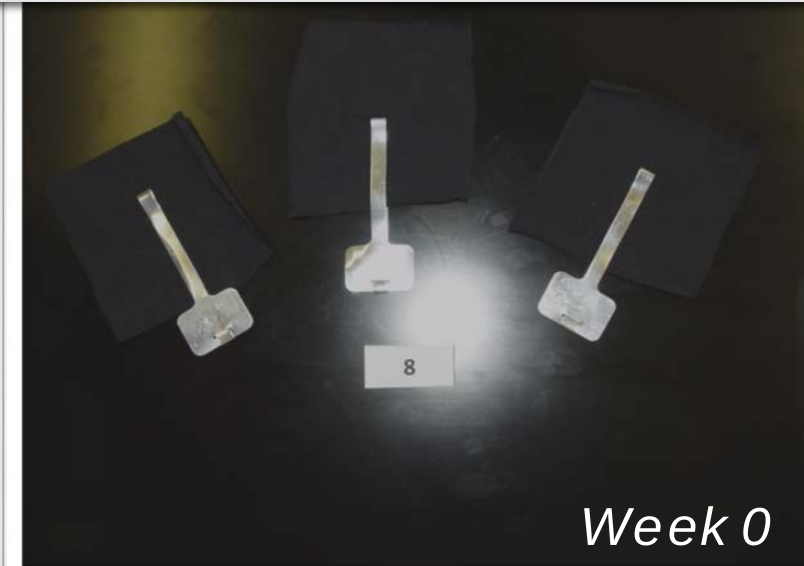
Week 0 Compost Bin



Cotton Jersey, Bleached, Softened



Cotton Jersey, Dyed Black, Softened



Recycled Polyester T-Shirt



Week 6

Week 6 Compost Bin



Cotton Jersey, Bleached, Softened



Week 6

Cotton Jersey, Dyed Black, Softened



Week 6

Recycled Polyester T-Shirt



Week 12 Compost Bin



Cotton Jersey, Bleached, Softened



Cotton Jersey, Dyed Black, Softened





Biodegradability of Wet Wipes

Cotton Nonwoven
Degradation in Soil

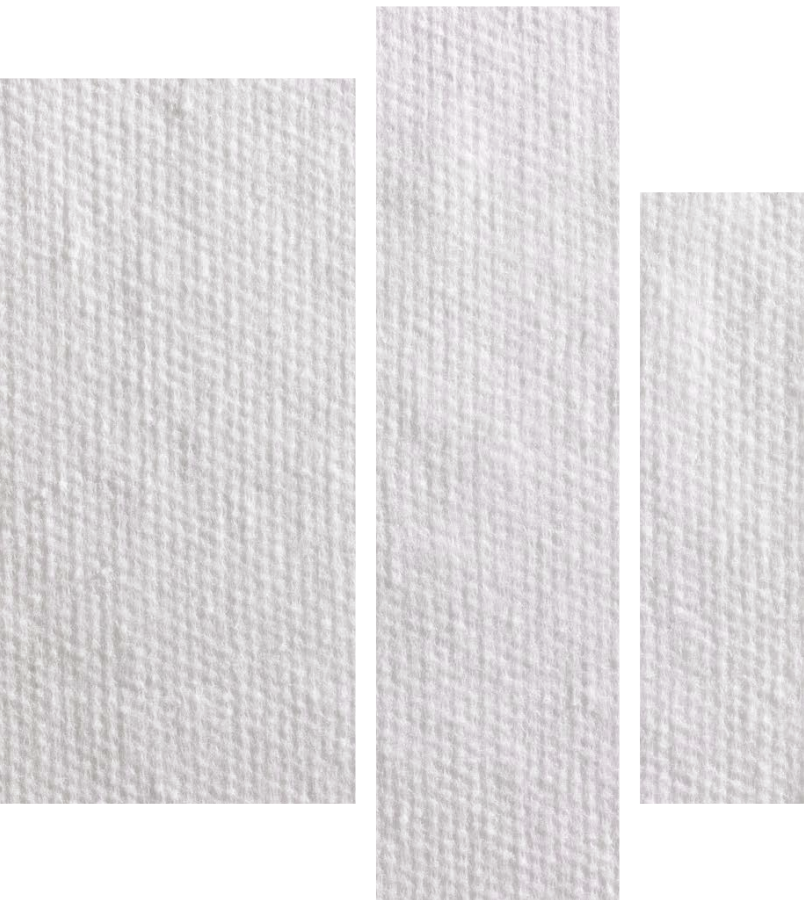
Methodology

- ❑ ASTM D-6400
 - ❑ Standard Specification for Labeling of Plastics Designed to be Aerobically Composted in Municipal or Industrial Facilities
- ❑ Materials tested
 - ❑ Spunlaced nonwovens
 - ❑ 100% virgin cotton
 - ❑ 100% virgin cleaned cotton
 - ❑ 100% purified cotton
 - ❑ 55% purified cotton/45% PP

Methodology

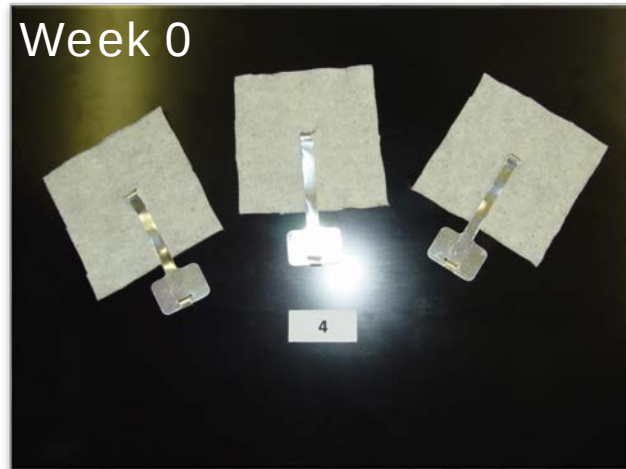
- ❑ Samples were prepared, weighed, and placed into an active compost vessel
- ❑ Every 2 weeks, samples were removed from the compost vessel, dried, weighed, and photographed
- ❑ Average percent biodegradability was calculated for each sample
- ❑ Biodegradability was accomplished at 90+% mass loss
- ❑ 100% cotton nonwovens biodegraded 90+% within 4 weeks



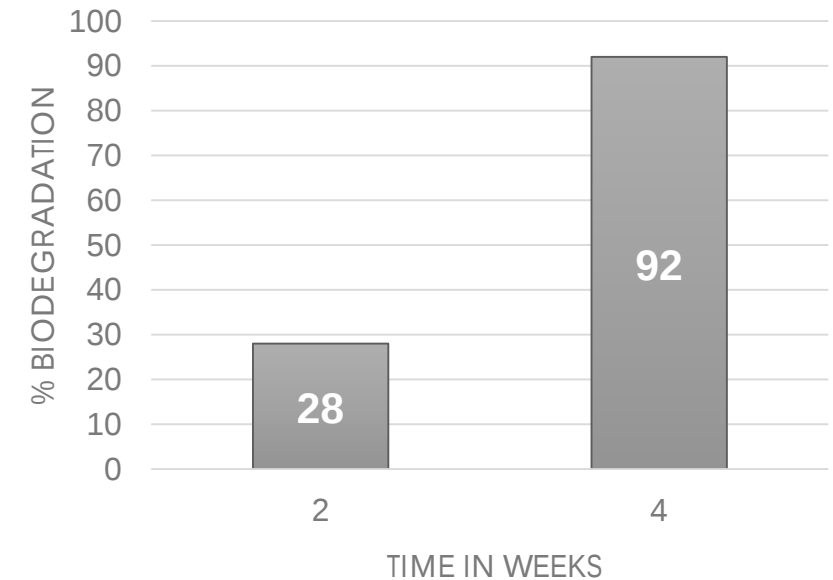


Nonwoven Results

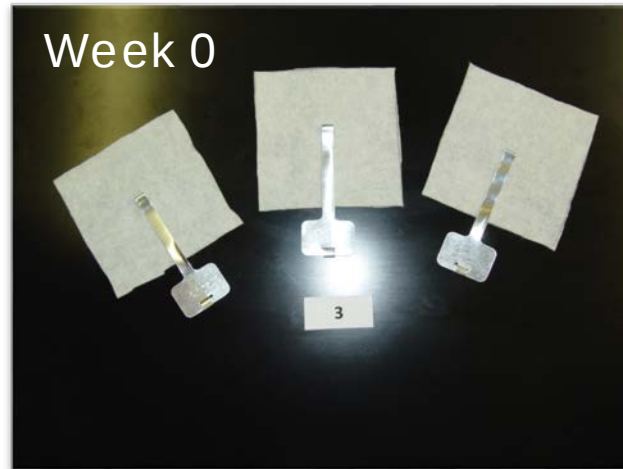
100% Virgin Cotton Composting (ASTM D6400)



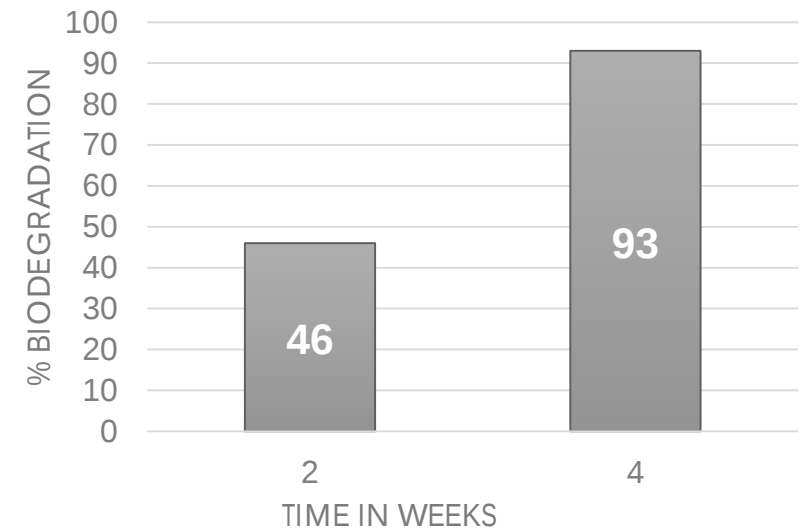
Sample #4



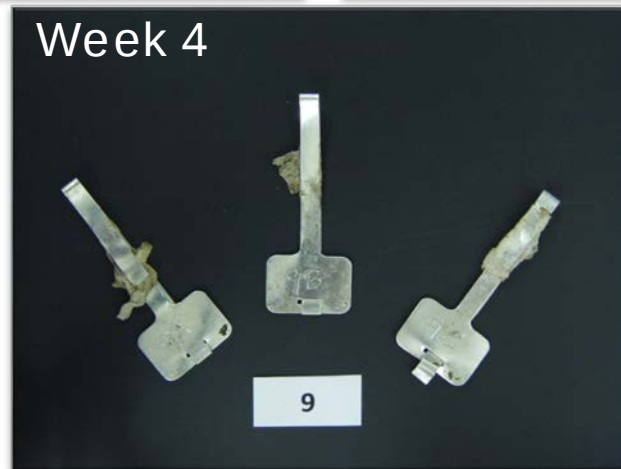
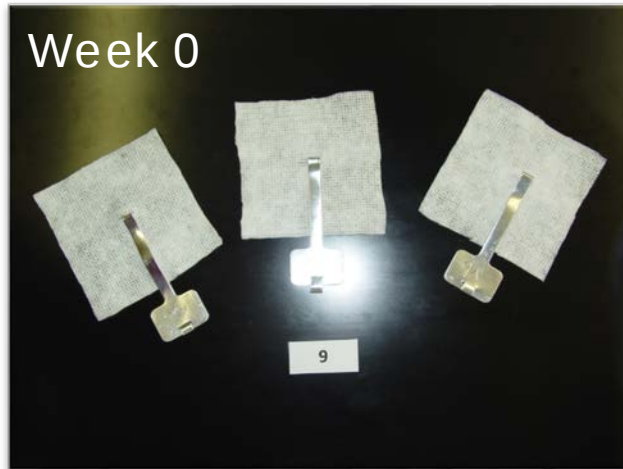
100% Virgin Cleaned Cotton Composting (ASTM D6400)



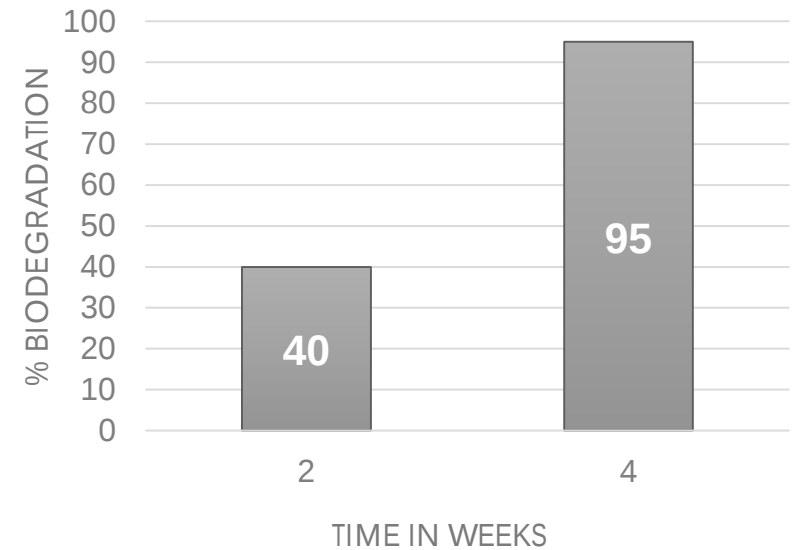
Sample #3



100% Purified Cotton Composting (ASTM D6400)

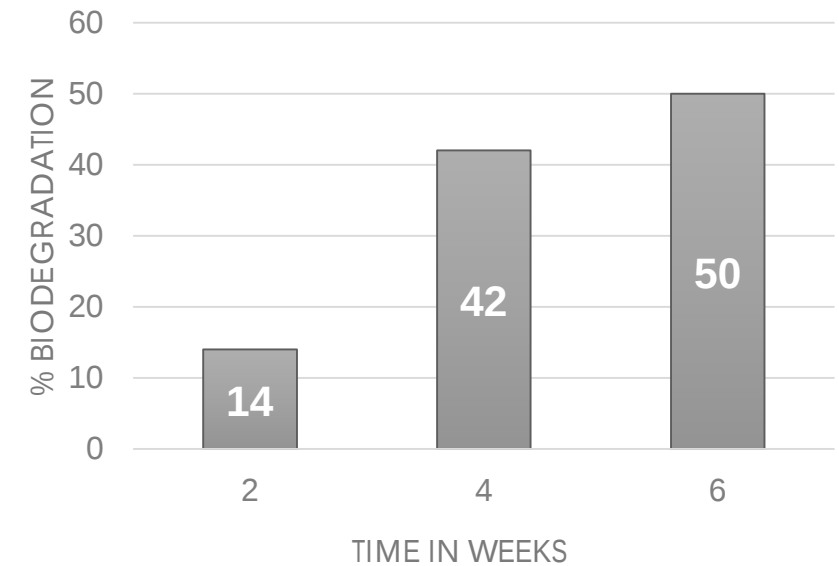
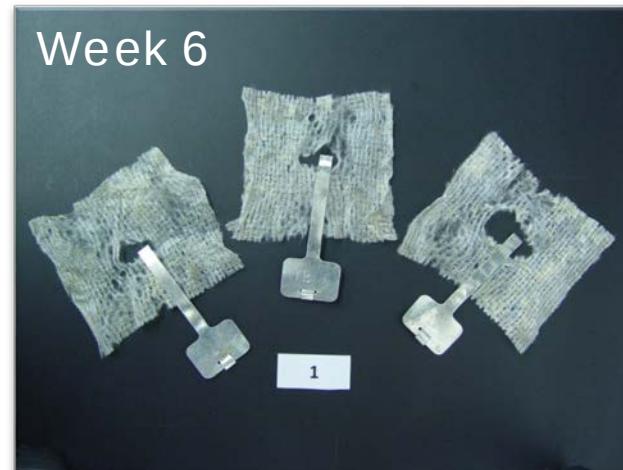
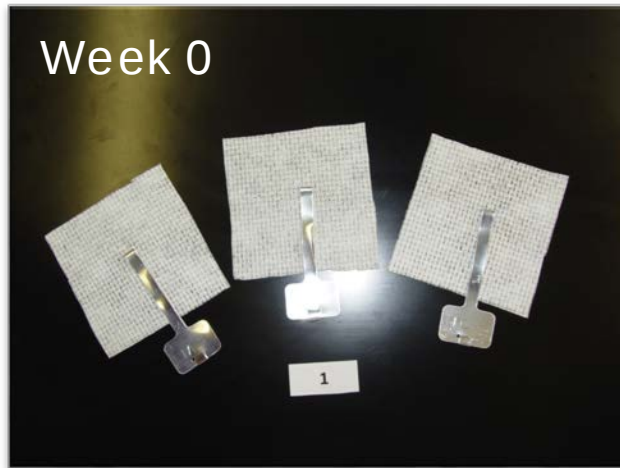


Sample #9



55% Purified Cotton/45% PP

Composting (ASTM D6400)



Sample #1



Conclusions

- ❑ Cotton wipes biodegrade quickly in a composting container
- ❑ 100% cotton: 92 – 95% in four weeks
- ❑ Blend: Cotton biodegraded; Polypropylene did not



Biodegradability of Wet Wipes

Flushability

Methodology

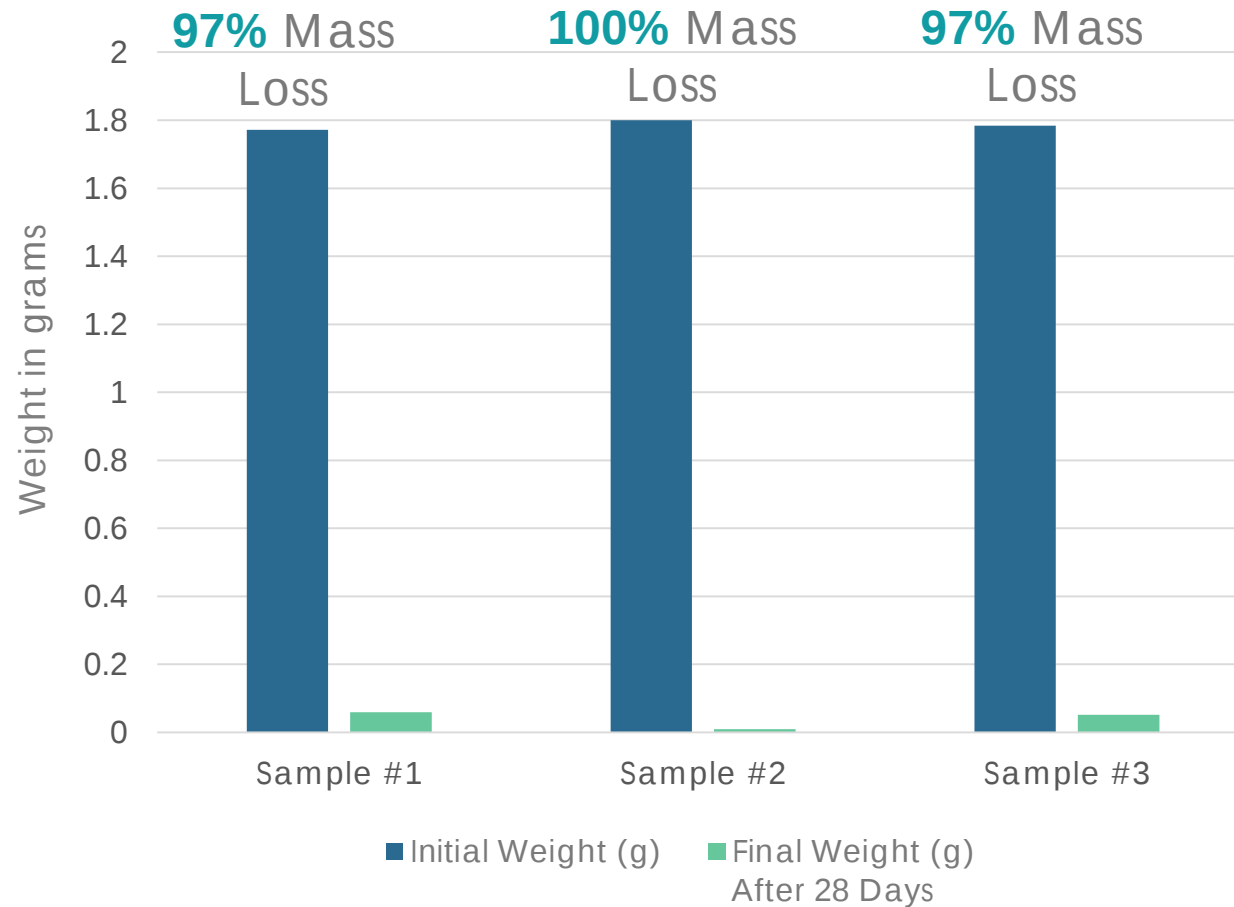
- ❑ Followed Guidelines for Assessing the Flushability of Nonwoven Disposable Products
 - ❑ INDA/EDANA
 - ❑ Developed as standards for the industry to produce wet wipes that can be marketed as flushable to consumers
- ❑ 2 Test Methods:
 - ❑ Aerobic Biodegradation (FG505)
 - ❑ Anaerobic Biodegradation (FG506)
- ❑ Materials Tested
 - ❑ 60 gsm nonwovens measured at approximately 2 grams per sample



Results

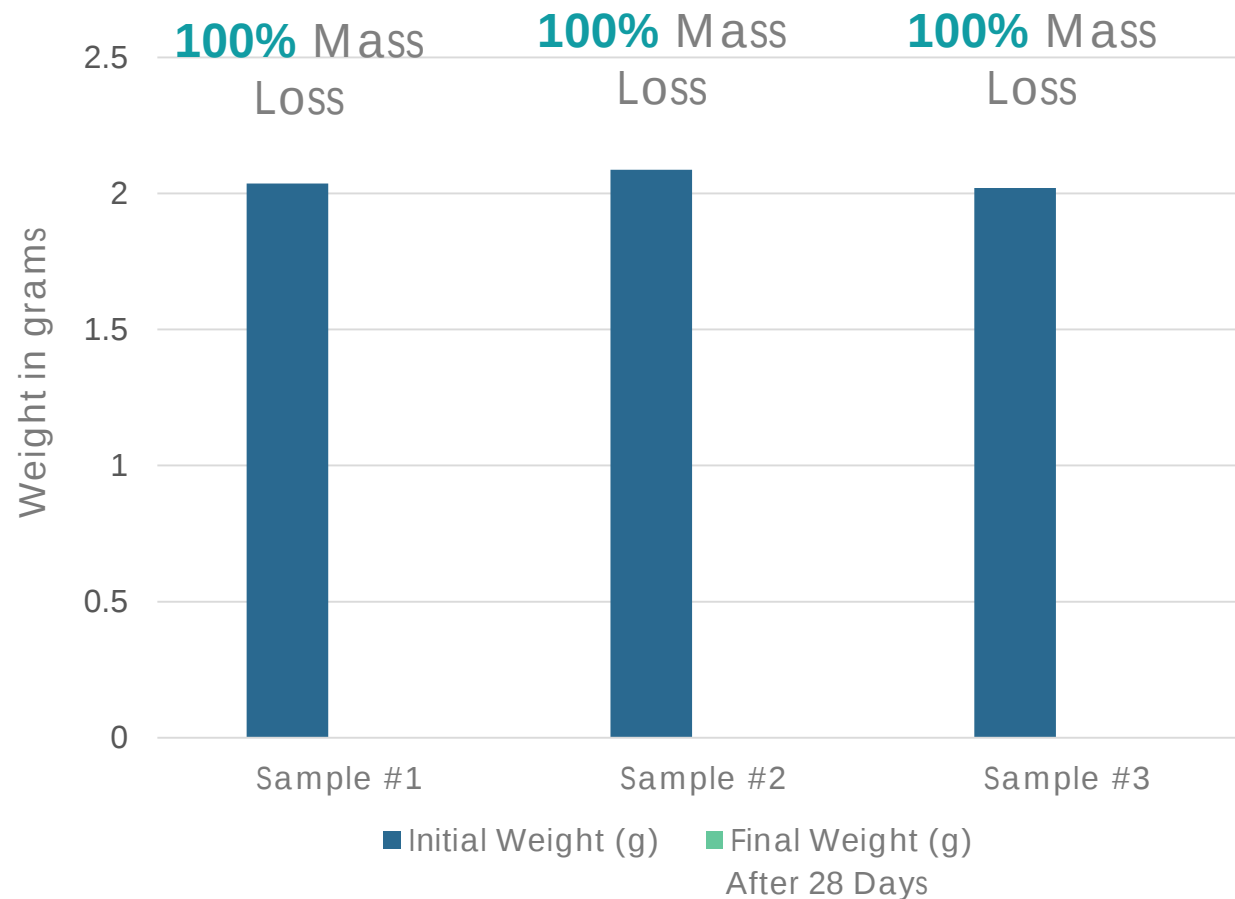
Virgin Cotton

Aerobic Biodisintegration (Sewer System)



Purified Cotton

Aerobic Biodegradation (Sewer System)



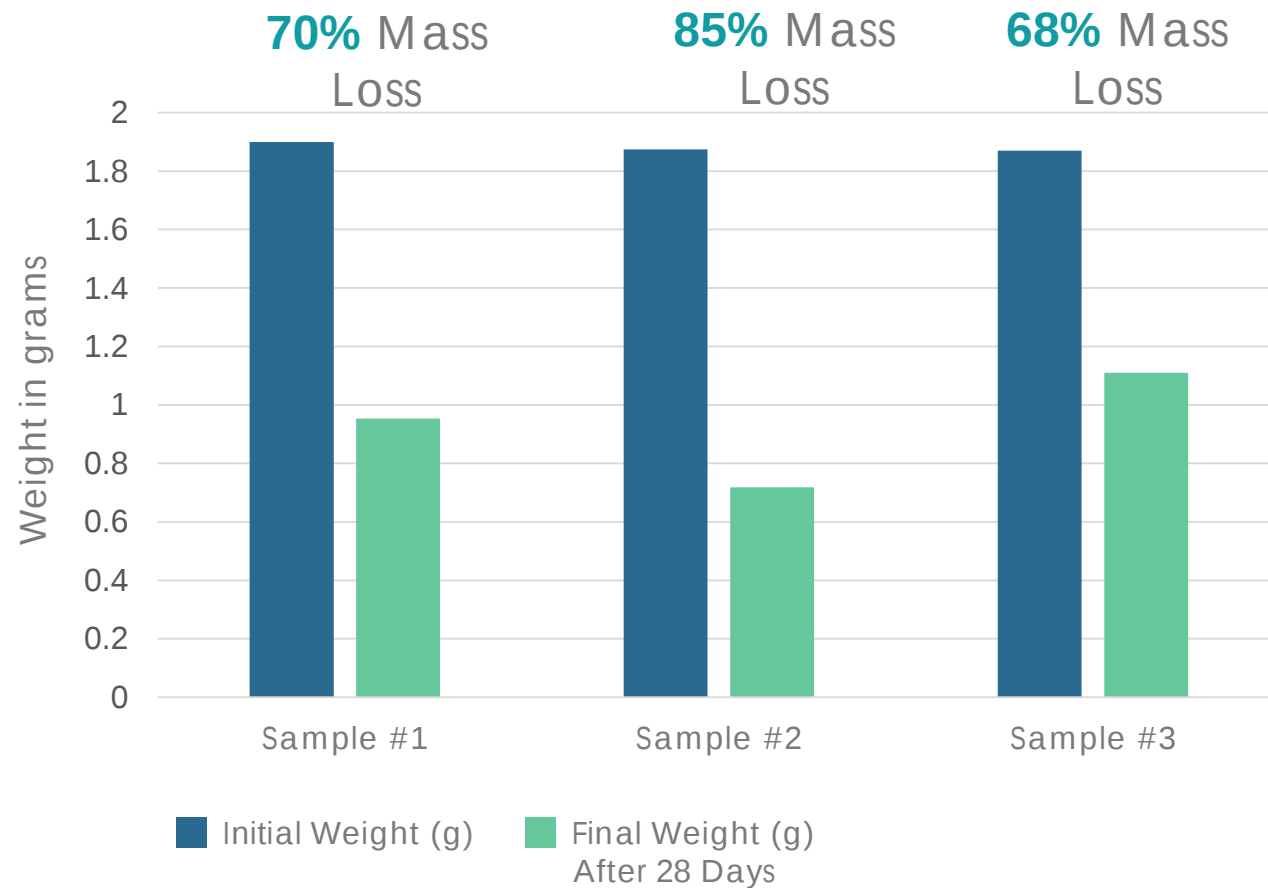
28 Day Test

Minimum required mass loss: **95%**

Average mass loss: **100%**

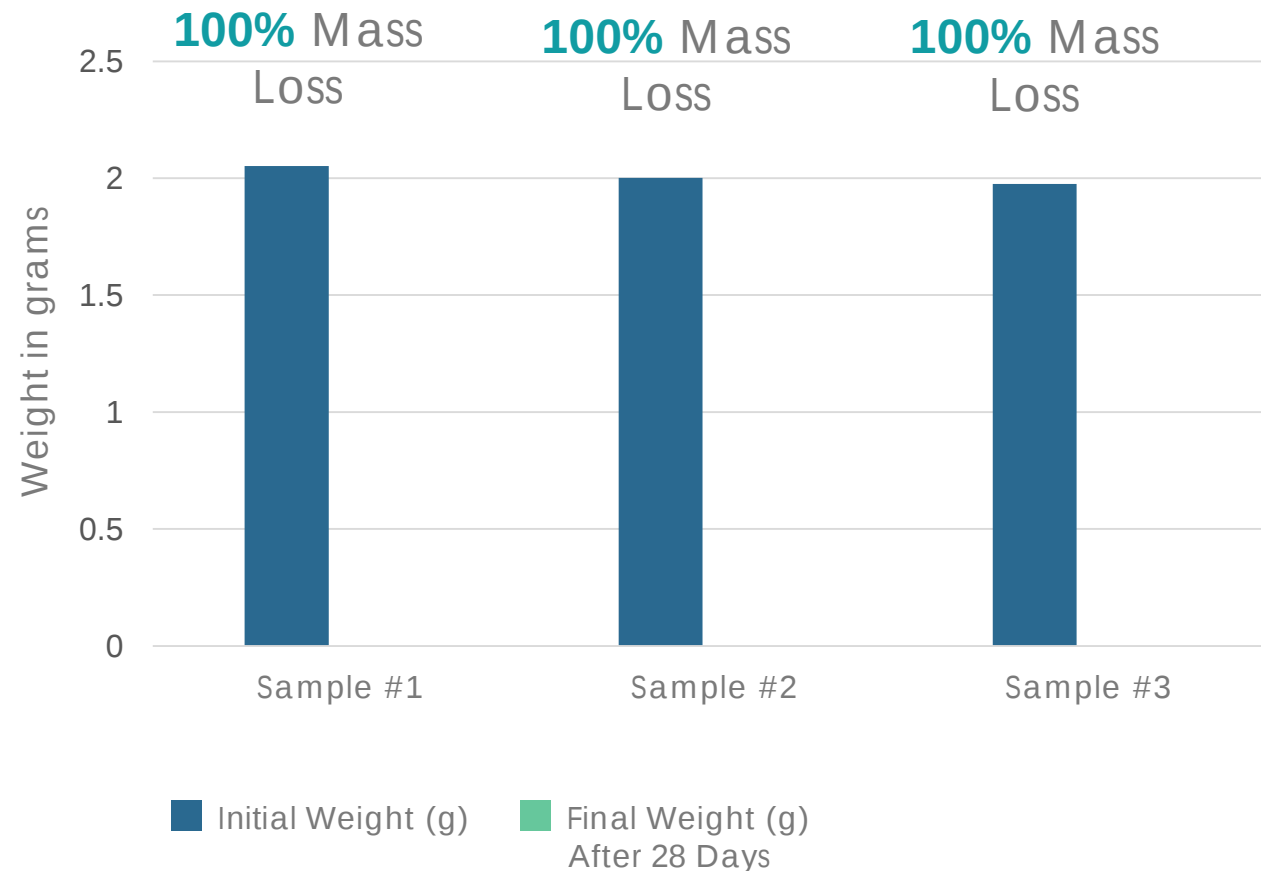
Virgin Cotton

Anaerobic Biodisintegration (Septic System)



Purified Cotton

Anaerobic Biodisintegration (Septic System)



28 Day Test

Minimum required mass loss: **95%**
Average mass loss: **100%**



Conclusions

- ❑ Similar results to the composting test
- ❑ Purified cotton biodegraded faster than the virgin cotton
- ❑ Cotton – An example of the cycle of nature



Thank You



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