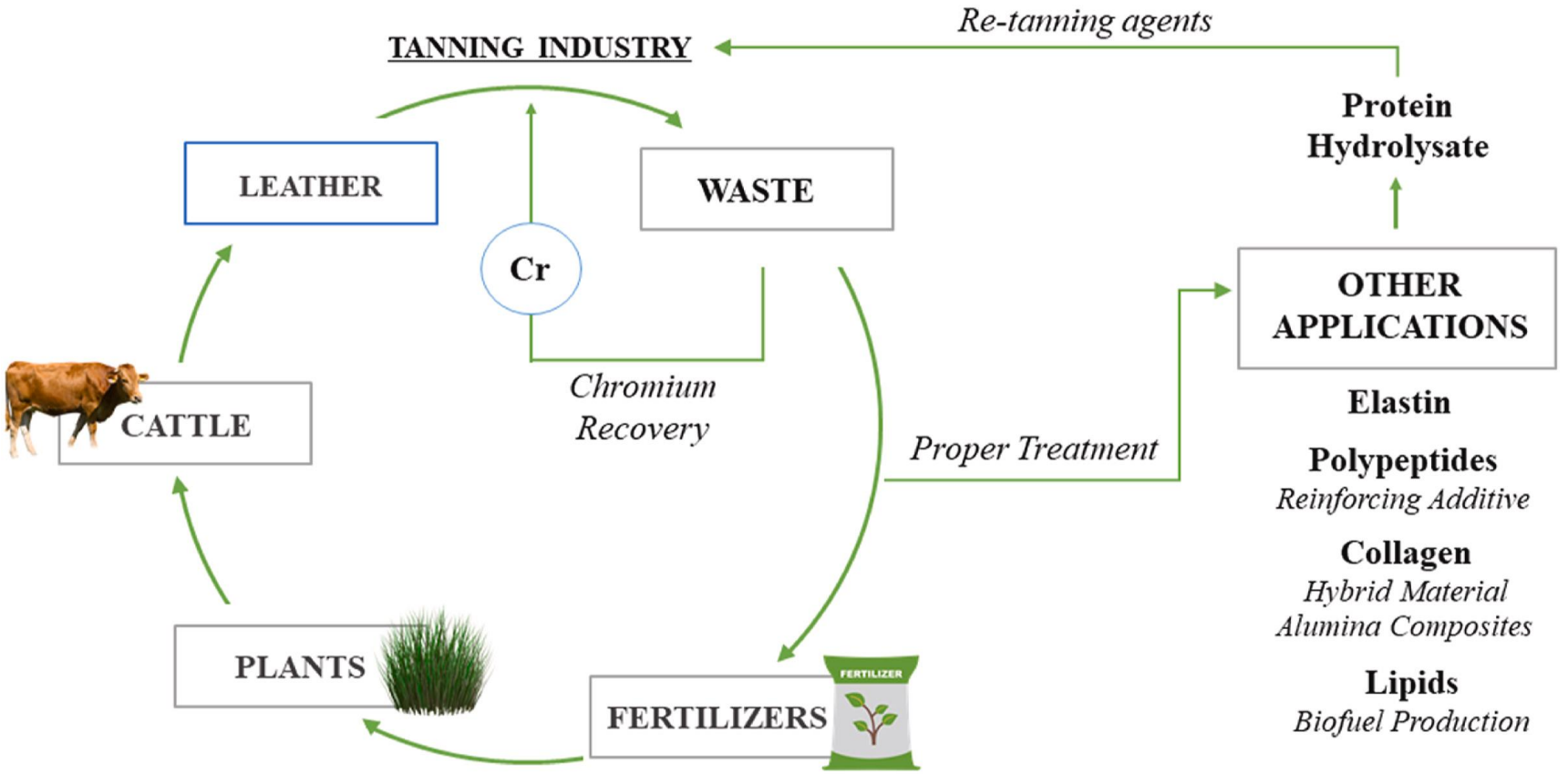
Leather Disintegration Test

Dr Ying Ju

Outline

- Leather Waste
- Tanning Chemistry
- ISO 20200
- Experiment



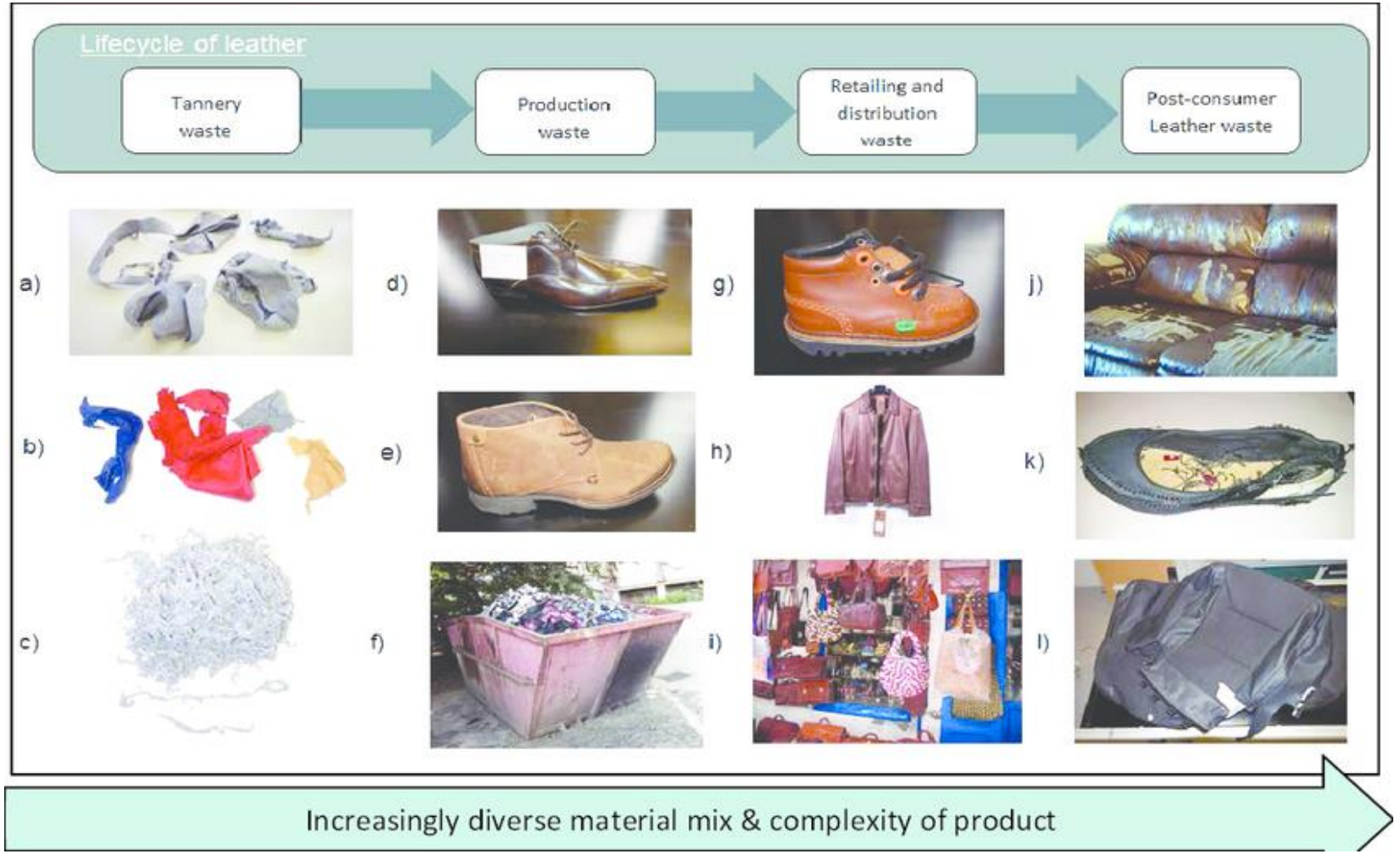
Circular economy in the tanning industry.

Chojnacka, K., Skrzypczak, D., Mikula, K., Witek-Krowiak, A., Izydorczyk, G., Kuligowski, K., ... & Kułażyński, M. (2021). Progress in sustainable technologies of leather wastes valorization as solutions for the circular economy. *Journal of Cleaner Production*, *313*, 127902.

Leather Waste

“one metric ton of raw material is converted into only 200 kg of usable leather product + 250 kg of non-tanned solid waste + 200 kg of tanned waste and 50,000 kg of wastewater effluent.”

Sivaram, N.M. and Barik, D. (2019). Toxic waste from leather industries. In D. Barik (Eds), Energy from toxic organic waste for heat and power generation (pp.55-67).

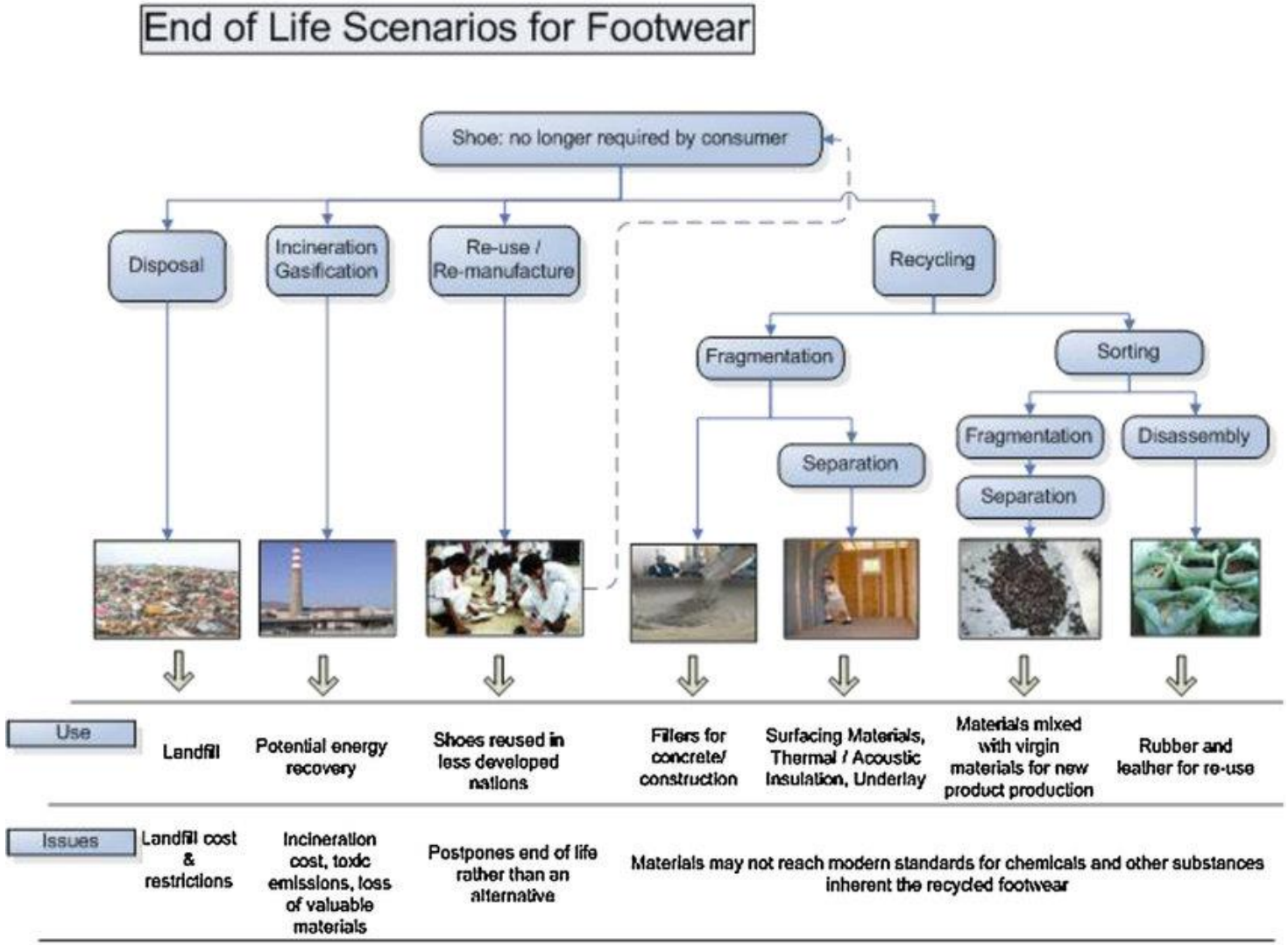


The lifecycle of leather and the waste associated with each stage.

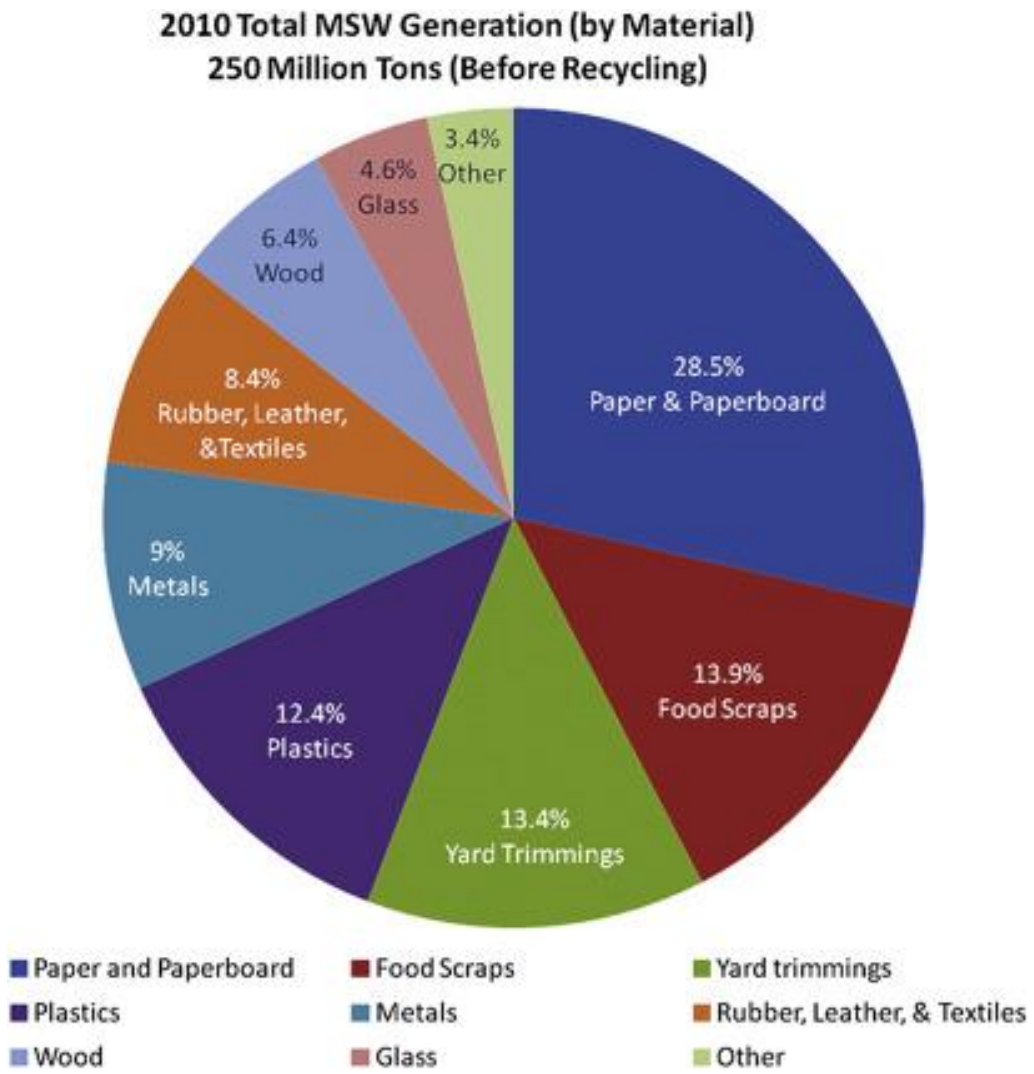
T, Pringle., M, Barwood., and S, Rahimifard. (2016). The challenges in Achieving a Circular Economy within Leather Recycling. *23rd CIRP Conference on Life Cycle Engineering (CIRP), 48*, 544-549.

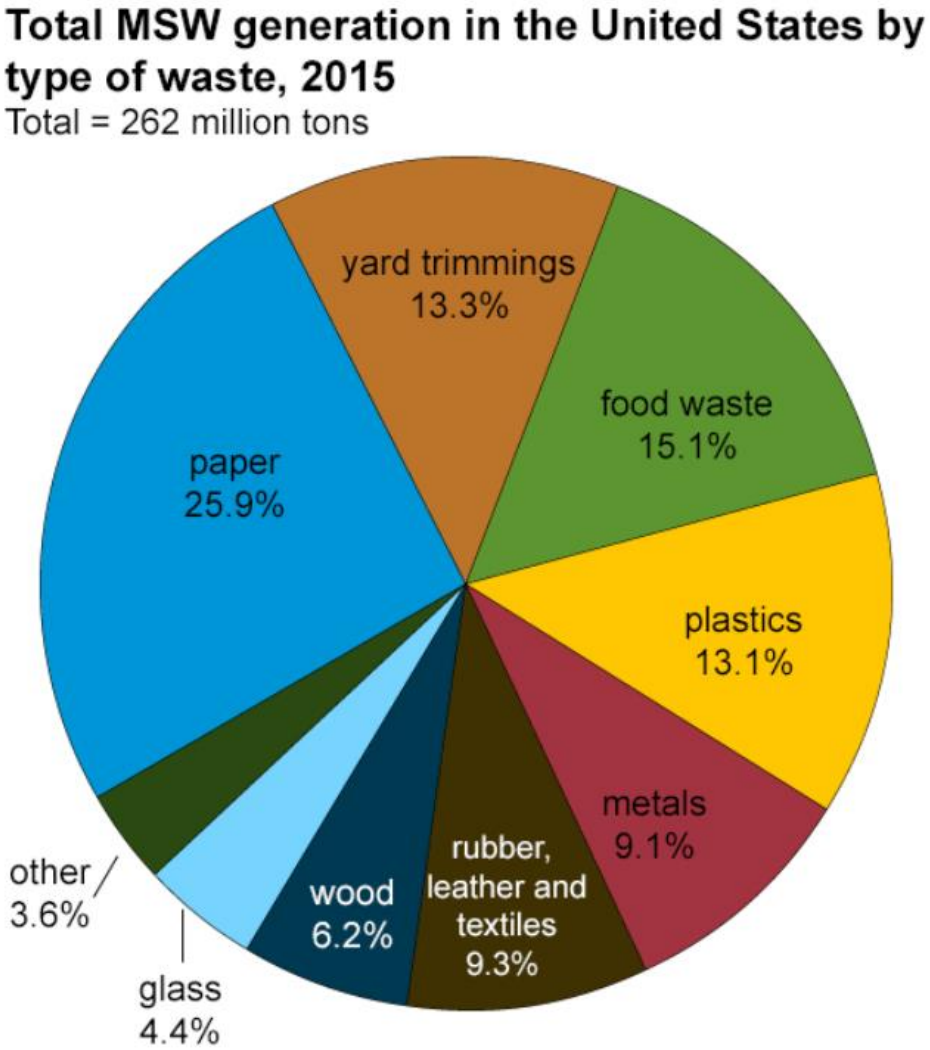
Recovery of leather waste throughout lifecycle.

T, Pringle., M, Barwood., and S, Rahimifard. (2016). The challenges in Achieving a Circular Economy within Leather Recycling. *23rd CIRP Conference on Life Cycle Engineering (CIRP), 48*, 544-549.



Lee, M.J., and Rahimifard, S. (2012). An Air-based automated material recycling system for postconsumer footwear products. Resources, *Conservation and Recycling, 69*, 90-99.



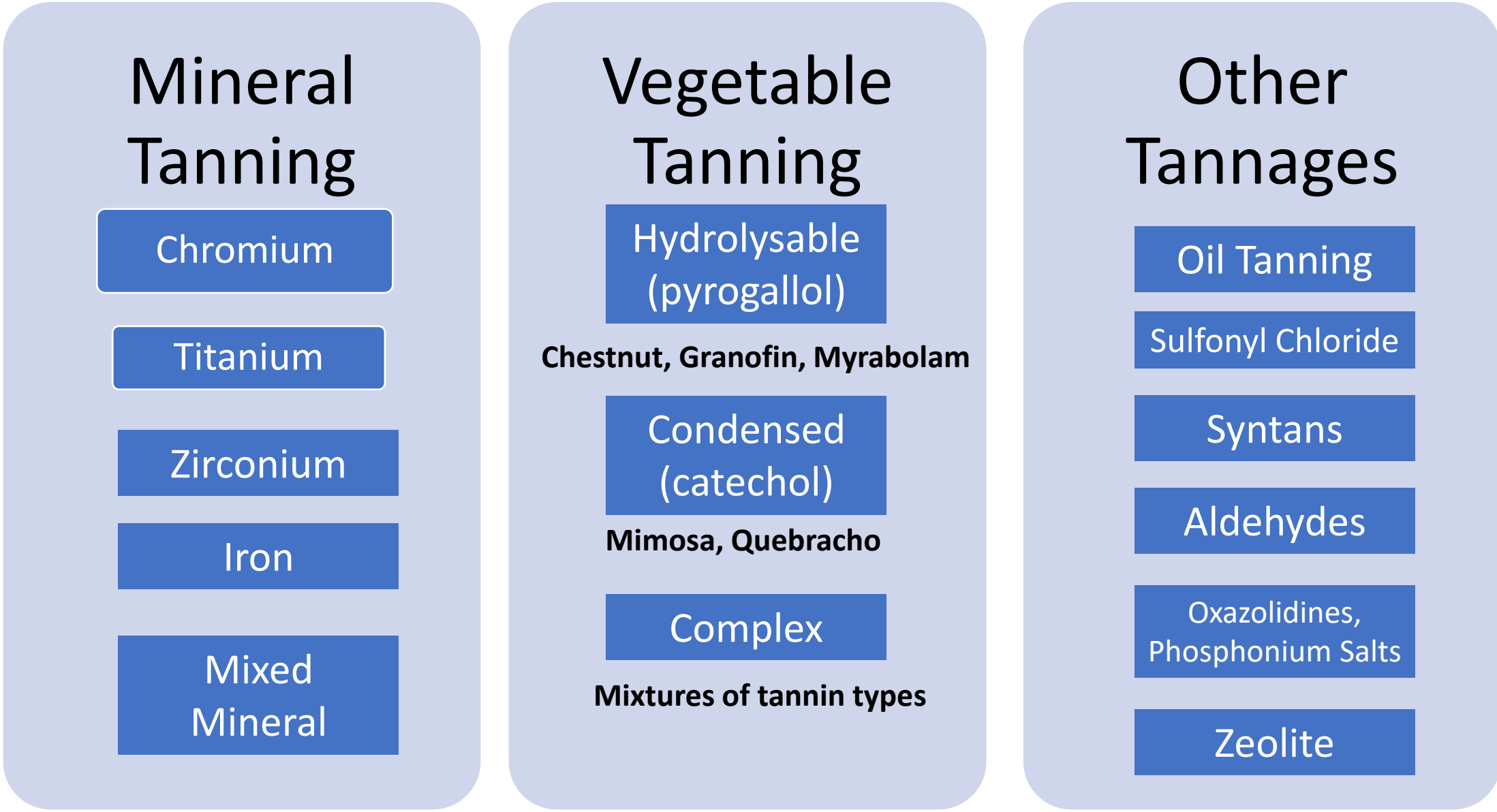


Rao, M.N., Sultana, R. and Kota, S.H. (2017). Municipal Solid Waste. In Rao, M.N., Sultana, R. and Kota, S.H. (Eds.), *Solid and Hazardous Waste Management Science and Engineering* (pp.3-120).

Waste-to-energy from municipal solid wastes report released. (2019). Retrieved from https://content.govdelivery.com/accounts/USEERE/bulletins/25b3acc

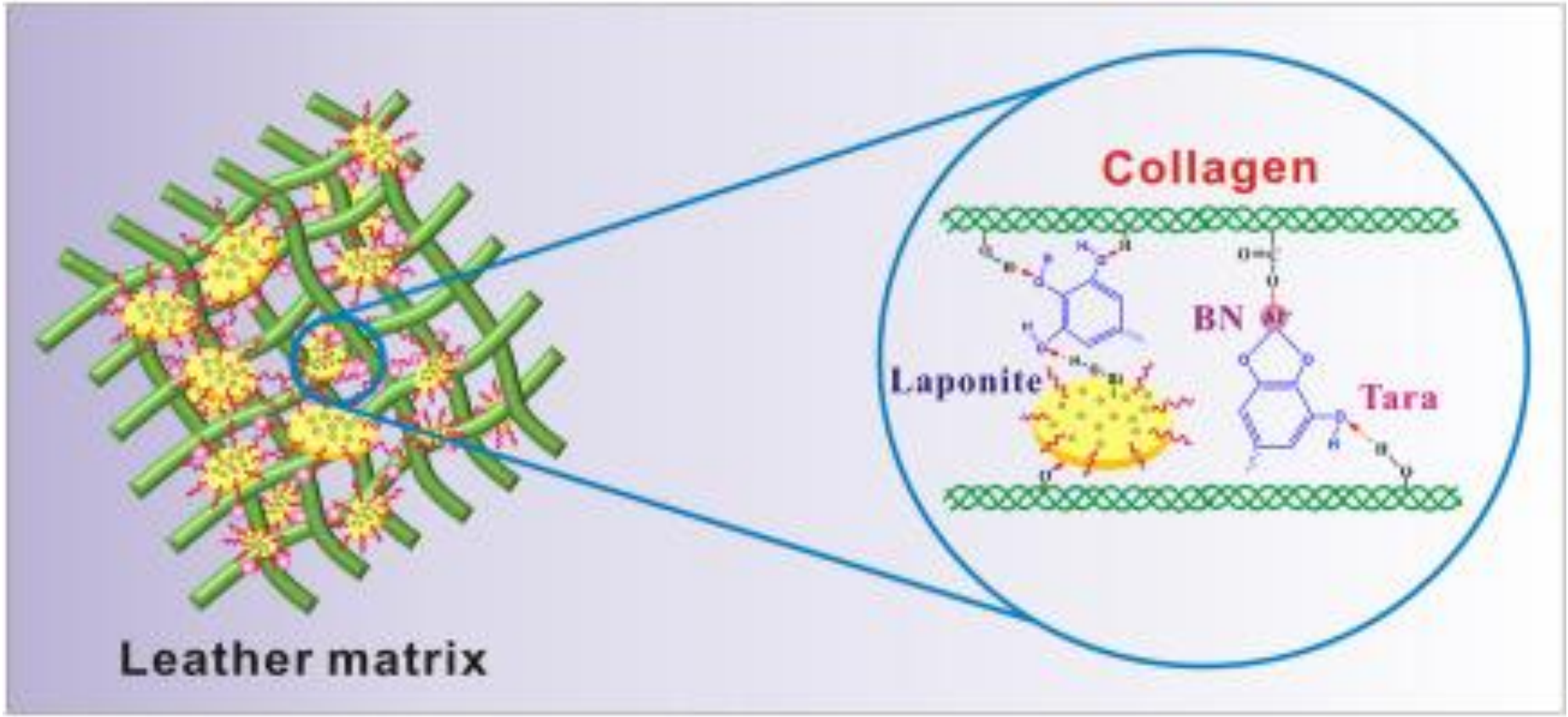
Outline

- **Leather Waste**
- ✓ ***Tanning Chemistry***
- ISO20200
- Experiment



Tanning Chemicals' Options

Covington, A.D. (2009). *Tanning Chemistry - The Science of Leather.* Cambridge, UK: The Royal Society of Chemistry.



Illustrator about tanning agents react with leather matrix.

Shi, J., Zhang R., Mi Z., Lyu, S., and Ma, J. (2021). Engineering a sustainable chrome-free leather processing based on novel lightfast wet-white tanning system towards eco-leather manufacture. *Journal of Cleaner production, 282*.

Outline

- Leather Waste
- Tanning Chemistry
- ✓ ***ISO 20200***
- Experiment

International standards----Integration Test

- ISO 20200 Plastics
  Plan Response testing and Weed Tests: ***WRAP 3.0, OECD 301 and ASTM E1963.***

- ASTM D6400 Standard Specification for Compostable Plastics

- GB/T 19277-2002

- BS EN 13432

International standards----Biodegradability Test

Aqueous medium	Solid medium
ISO 20136	BS EN 13432
	ISO 14855-1
	ASTM D5338
	GB/T 19277-2002
	ASTM D6400
	DB/T 505-2020
	GB/T 28018-2011

Testing information is cited from https://www.eurofins.com/textile-leather/services/testing-services/disintegration-biodegradability/ and https://www.respirtek.com/biodegradability-testing/.

ISO 20200:2015 Experimental Procedure

- Test material preparation

Thickness of test material	Dimensions of pieces (mm)
<5 mm	25 × 25 × original thickness
>5 mm	15 × 15 × thickness

Sawdust
Rabbit food
Ripe compost
Corn starch
Cane sugar
Cooking oil
Urea

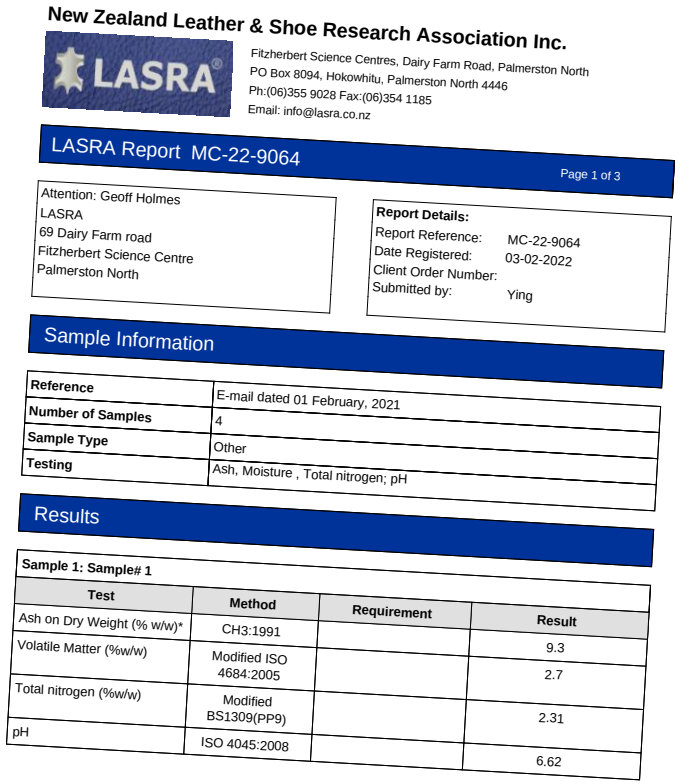
- Start-up of the test

- **Thermophilic incubation period (high temperature)**

- Mesophilic incubation period (at room temperature)

Lasra Test Report

- ✓ Sample material supplied
- ✓ A reference to ISO 20200
- ✓ Sample material assessment
- ✓ Artificial solid waste composition
- ✓ Analysis results of the ripe compost & the artificial solid waste
- ✓ Composting reactor
- ✓ Conducting the test – period and processing
- ✓ **Observations during the composting with photos**
- ✓ Degree of decomposition
- ✓ Proof of the validity of the test
- ✓ Analysis results of the sieved compost



New Zealand Leather & Shoe Research Association Inc.

LASRA

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Email: info@lasra.co.nz

LASRA Report MC-22-9064 Page 1 of 3

Attention: Geoff Holmes
LASRA
69 Dairy Farm road
Fitzherbert Science Centre
Palmerston North

Report Details:
Report Reference: MC-22-9064
Date Registered: 03-02-2022
Client Order Number:
Submitted by: Ying

Sample Information

Reference	E-mail dated 01 February, 2021
Number of Samples	4
Sample Type	Other
Testing	Ash, Moisture , Total nitrogen; pH

Results

Sample 1: Sample# 1

Test	Method	Requirement	Result
Ash on Dry Weight (% w/w)*	CH3:1991		9.3
Volatile Matter (%w/w)	Modified ISO 4684:2005		2.7
Total nitrogen (%w/w)	Modified BS1309(PP9)		2.31
pH	ISO 4045:2008		6.62

Guidance is available from LASRA regarding sampling; results can only apply to samples as received. Opinions and interpretations, where these are expressed, are outside the scope of the laboratory's terms of accreditation. This information is provided for, or at the request of members in accordance with the Rules of the Association and without liability and may only be reproduced in full.

Outline

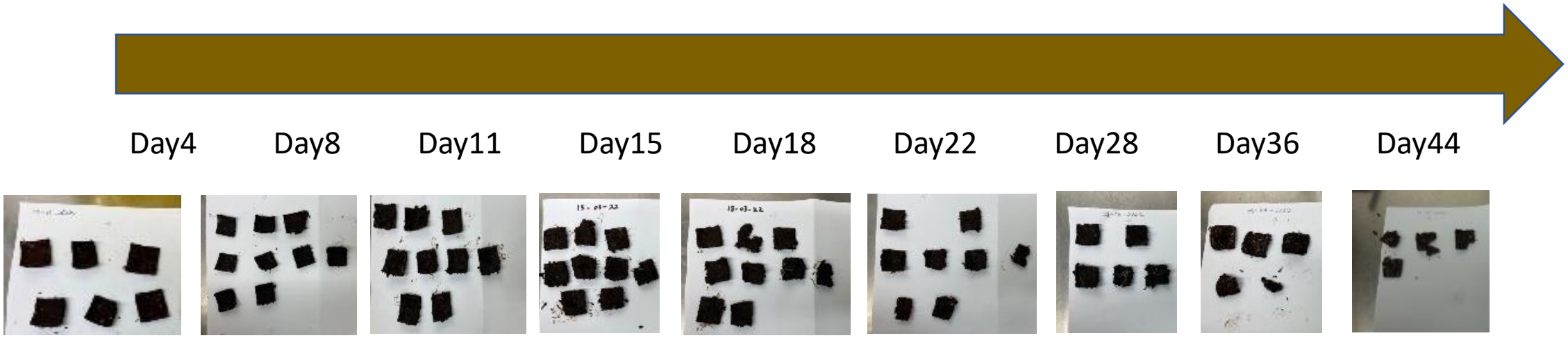
- ➢ Leather Waste
- ➢ Tanning Chemistry
- ➢ ISO 20200
- ✓ ***Experiment***

Goals

- To study the rapid composting performance of leathers that tanned by different tanning agents using ISO 20200.

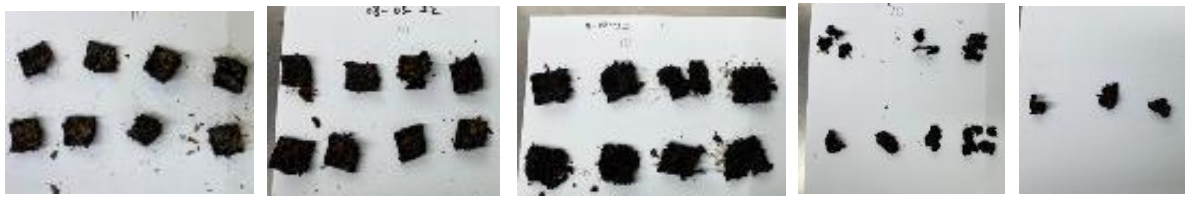
- We seeks to understand the underlying mechanism of leather composting as a practical guide to tanners.

Pine bark tanned leather



Mimosa tanned leather

Day4 Day8 Day11 Day15 Day18 Day22 Day28 Day36 Day44



Fully decomposed

Polycarbamoyl sulfonate tanned leather

Day4 Day8 Day11 Day15 Day18 Day22 Day28 Day36 Day44

Fully decomposed

Zirconium tanned leather

Day4 Day8 Day11 Day15 Day18 Day22 Day28 Day36 Day44

Fully decomposed

Chromium tanned leather

Day4 Day8 Day11 Day15 Day18 Day22 Day28 Day36 Day44

Fully decomposed

Disintegration Days and Index

	Pine bark tanned leather	Mimosa tanned leather	Polycarbamoyl sulfonate tanned leather	Zirconium tanned leather	Chromium tanned leather
Days	44	22	11	11	11
Index	4	2	1	1	1

Degree of decomposition/Disintegration

Sample	Initial dry matter of the sample in g	Rest dry matter of the sample after sieving in g	Decomposition degree
Pine bark tanned leather	7.4	1.0	86.5
Mimosa tanned leather	6.8	0	100
Polycarbamoyl sulfonate tanned leather	7.0	0	100
Zr tanned leather	7.0	0	100
Cr tanned leather	6.8	0	100

Conclusion

- Decomposition rates of leathers samples differ.
- Pine bark tanned leather is the most resilient.
- Even though pine bark and mimosa are both of condensed vegetable tannins, they react differently with leather matrix.
- “The valuable biochemicals in the pine bark extract offering antioxidant, antibacterial and waterproofing properties that may hinder the biodegradability efficiency.” (SCION: **Bark biorefinery progress,** Scion - Bark biorefinery progress (scionresearch.com).

Future work

- To generate a decomposition rate matrix for all the different tanning agents and processes used by industry partners.

- To carry out the short-term toxicity exposure screen by observing tiger worms' mortality rate and other indexes.

- To study the toxicity by measuring seed germination rate and root development in the post-composting mixture.

1st Step for the toxicity screen

✓ Worm farm

✓ Compost undergoes thermophilic incubation


Thank You

Appendix Terms and Definitions

- Disintegration: Physical breakdown of a material into very small fragments.
- Composting: Aerobic process designed to produce compost.
- Compostability: Ability of a material to be biodegraded in a composting process.

➢ Disintegration Testing

- ISO 20200: Designed specifically for plastic materials, this test method enables the determination of the degree of disintegration and provide an indication of the likelihood of a plastic to disintegrate when placed in a compost environment.

- ISO 20200 Modified: leather industry and other industries can use the modified method by substituting the plastic test substrate with a leather or textile.

- ISO 20200 Supplementary Testing: Additional compost nutrient and toxicology testing can be performed on completion of the ISO 20200.

ISO 20200 Supplementary Testing:

- EcoTox Testing: Evaluate the end compost of ISO 20200 analysis measuring 200+ components quantitatively including (but not limited to): Metals, Volatile Organics, Phenols, Chlorinated Hydrocarbons, Petroleum Hydrocarbons, Nitrogen and other pesticides etc.

- Plan Response testing and Weed Tests: Taking ground up substrates and incorporating them into soil growth media at known concentrations, official cultivars of crop or non-crop plants are then planted in these soils to check weed propagules or bio-enrichment or bio-suppression by the material constituents. Methods available include: ***WRAP 3.0, OECD 301 and ASTM E1963.***

➢ Biodegradability Testing

- ISO 20136: leather-specific method, to determine degradability by microorganisms. Leather grindings ae exposed to an inoculum in an aqueous medium and the rate aerobic biodegradation of hides and skins (tanned or not tanned), through CO_2 production (via collagen degradation) is determined.

- BS EN 13432 Packaging. Requirements for packaging recoverable through composting and biodegradation.

- ISO 14855-1 Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions-Method by analysis of evolved carbon dioxide-Part1: General method.

- ASTM D5338 Standard Test Method for Determining Aerobic Biodegradation of Plastic Materials Under Controlled Composting Conditions, Incorporating Thermophilic Temperatures.

➢ Biodegradability Testing

- GB/T 19277-2002 Determination of the Ultimate Aerobic Biodegradability and Disintegration of Plastic Materials Under Controlled Composting Conditions—Method by Analysis of Evolved Carbon Dioxide.
- BS EN 13432:2000 Packing requirement for packing recoverable through composting and biodegradation.
- ASTM D6400 Specification for labelling of plastic designed to be aerobically composted in municipal or industrial facilities.
- DB/T 505-2020 General requirement for biodegradable plastic shopping bags.
- GB/T 28018-2011 biodegradable plastic refuse sack.

Testing information is cited from https://www.eurofins.com/textile-leather/services/testing-services/disintegration-biodegradability/ and https://www.respirtek.com/biodegradability-testing/.