

Tanning with Plant Wastes - Designing Leather to fit the Circular Economy



Dr Stefan Davis
Senior Lecturer, Leather Science

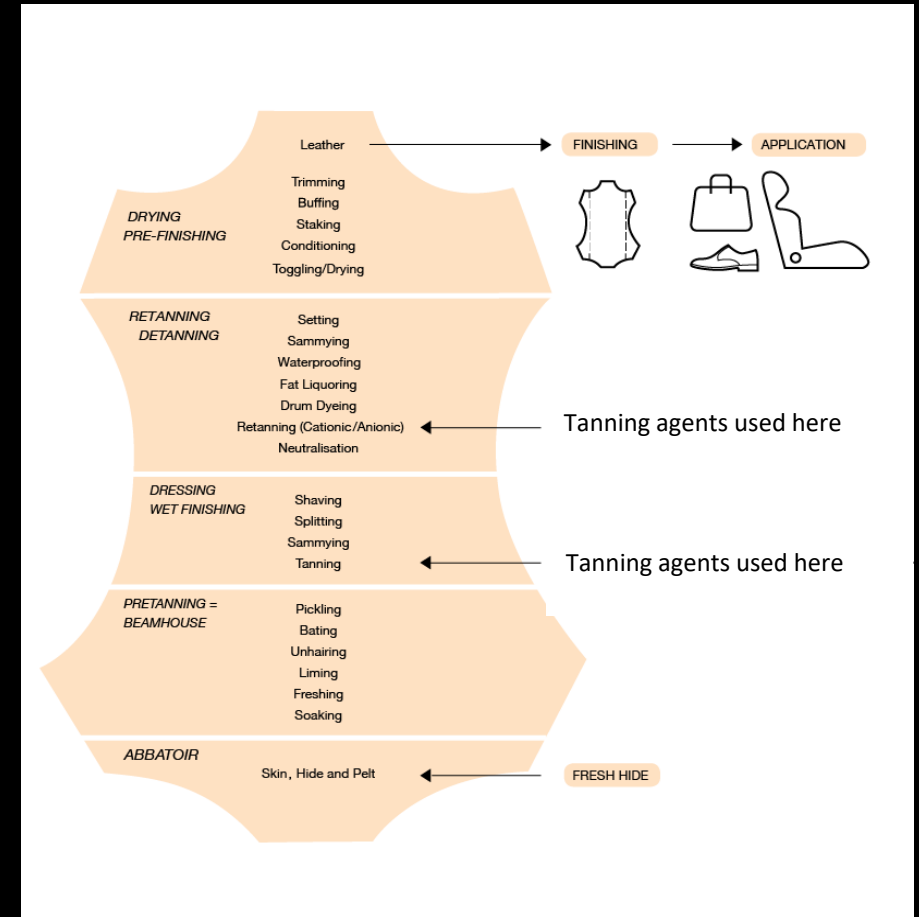
Dr Friedemann Schaber
Senior Lecturer, Product Design

Dr Anne Lama
Senior Lecturer , Leather Technology

Ashokkumar Baskar
Lecturer, Leather Technology

Introduction: Leather Manufacture

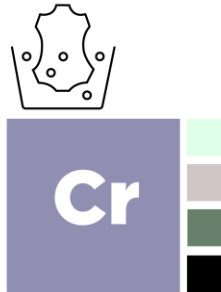
- Leather manufacture is a complex process of interconnecting steps
- Overall process can be broken down into 3 key stages
 - Removal of unwanted skin components
 - Long term preservation of the hide (tanning)
 - Addition of modifiers and coatings for specific end uses
- The chemistries employed for long-term preservation (tanning) have an uncertain future
- The use of plant tannins dates back to over 5000 years but use of current sources are unsustainable:
 - Farming of tannin crops is a large consumer of land and water
 - Forestry sources of tannins cannot replace the current demand for established chemistries



Introduction: Leather Manufacture



Modern leather manufacturing recycles over 270 million cow hides each year. Skins from cattle, goat, sheep and pig are a by-product of the food industry. Leather makes a sustainable contribution as it is durable and recyclable. Otherwise over 7 million tonnes would go to landfill, incinerated or processed into gelatine.



80% of leather is Chrome tanned. Whilst economical, the end-of-life and recovery of Chromium remains problematic. Other 20% tanning methods include synthetic (syntan), glutaraldehyde (wet-white) and vegetable tanning. Tannins extracted from plant waste are of interest to the circular economy.



Material of choice for body protection and comfort. Sustains artisan communities. However, there is a shift with 50% decline of leather use in footwear, mainly substituted by synthetics. Leather remains strong in luxury goods and is standard in premium cars.

95
mio

UK produces over 95 million cups of coffee every day



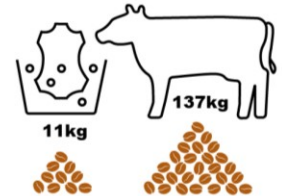
Over 500,000t of used coffee grounds per year

500,000t



The UK Leather industry produces over 16,000t of leather per year

16,000t



Extract from 11kg of coffee grounds is needed to tan a goat skin (2kg)

Extract from 137kg of coffee grounds is needed to tan a cow skin (25kg)

[1] <https://leatheruk.org/wp-content/uploads/2020/03/UK-Leather-Leather-Goods-Industry-2019-Report.pdf> [Accessed September 2021]

[2] <https://leatheruk.org/facts-and-figures/information/>

[3] Leather Naturally. <https://www.leathernaturally.org/Education/Fact-Sheets/Environment/Leather-is-a-recycled-material>

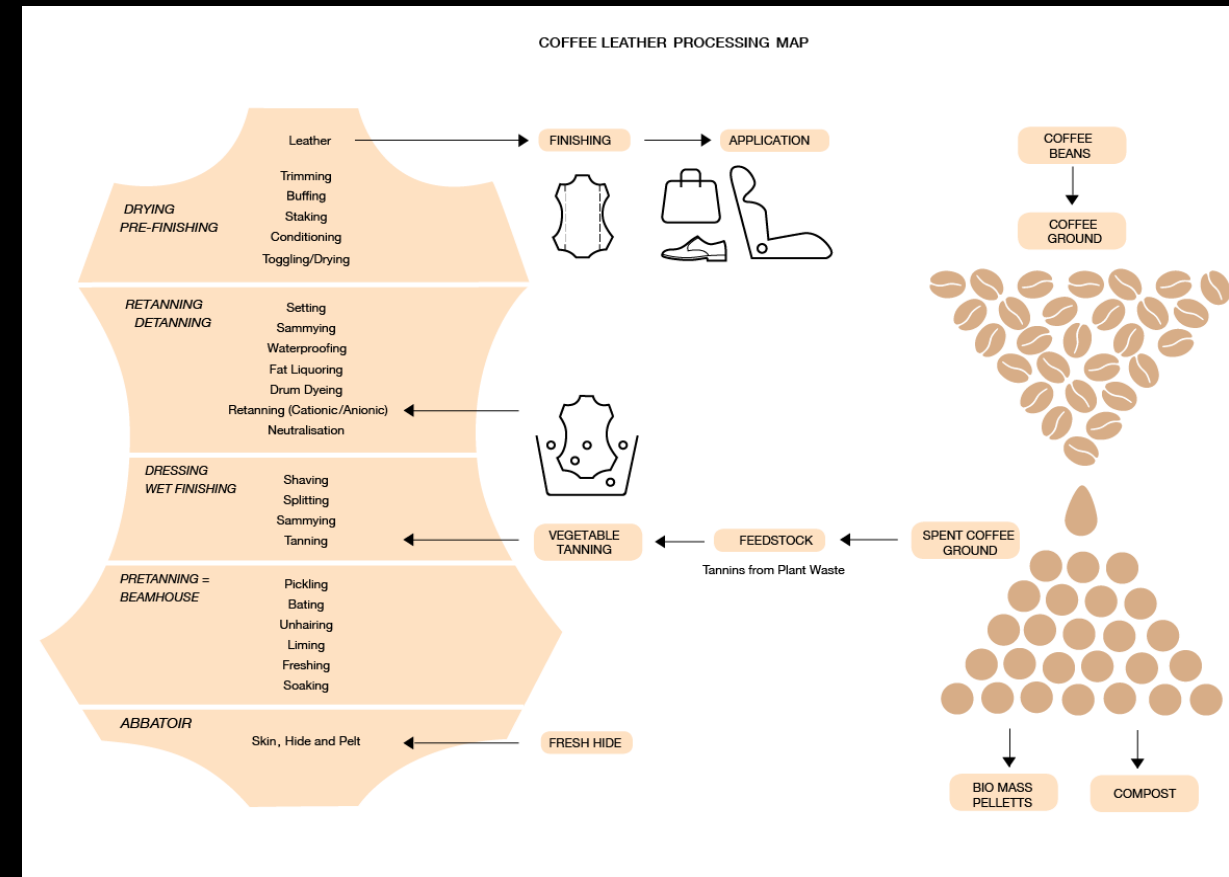
[4] Buljan, J. and Kral, I., 2019. The framework for sustainable leather manufacture, 2nd ed. Vienna: The United Nations Industrial Development Organization.

[5] <https://www.bio-bean.com/> [Accessed September 2021]

[6] Nescafe, 2020. The UK is a Nation of Coffee Lovers. In: The Grocer Fact File. [online] Available at: <https://f5f09489f4d6b22f7cfc-476354e4409503c0bf1163d0a2b97f47.ssl.cf3.rackcdn.com/161459_GRO_SEP12_D_NestleFactfile_proof.pdf> [Accessed 6 July 2021].

Project Vision

- Various plant wastes from the food and beverage industry contain tannins
- The quantities of waste available are substantial and could allow for significant quantities of tannins to be collected
- Extraction processes are simple and could theoretically be achieved within the UK infrastructure
- The depleted biomass remains uncontaminated after tannin extraction which allows for:
 - Composting
 - Biomass incineration/gasification processes
- There is potential to show waste streams from synergistic industries can help demonstrate leather's place in the circular economy.



Results

- A variety of waste streams available in significant quantities have useable tannin contents
- Waste streams considered significant enough to be suitable for industrial scale up.
- Other waste streams are being investigated at the Institute for Creative Leather Technologies (ICLT)
 - Black tea
 - Green tea
 - Hops
- Proof-of-concept pieces produced and working on process optimisation
- Extracts can be applied as a primary tanning agent or as a retanning agent

Parameters	Mimosa ME	Malt Grain Extract	Coffee Extract	Rapeseed Extract
% Tannin	70.2	13.1	21.8	16.6
% Non Tannin	22.5	71.2	35.4	7.0
% Insolubles	3.4	12.6	40.9	70.1
% Moisture	3.9	3.1	1.9	6.4



Black Tea Extract Rapeseed Meal Coffee Extract (main tan) Coffee Extract (Retan) Malt Grain Extract Rapeseed Meal Coffee Extract

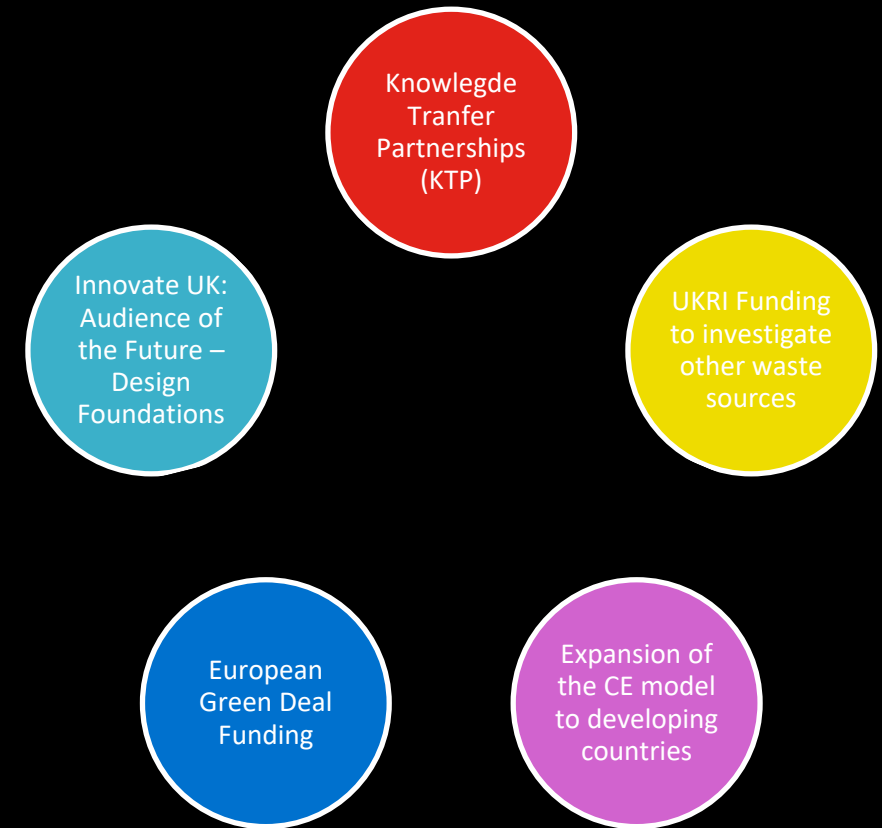
Conclusions

- Extraction and application of tannins from waste sources is achievable at laboratory scale.
- The tannins double as a colourant and effectively dyes the leather without the need for the addition of synthetic dyes
- The produced leather has imparted properties distinctive to the tanning agent used and easily adds a unique selling point
- The potential for the waste streams of other industries to convey circular economic benefits to the leather industry have been demonstrated
- Working prototype has been developed at ICLT.
 - Technology Readiness Level 3 (Proof-of-Concept)



Future Direction and Aims

- Refine the established model (TRL 3) and achieve a successful scale up to confirm TRL 5 (Pilot-scale)
- Develop new leather products to explore user acceptance and motivation.
- Demonstrate on a local scale a commercially viable, circular economic model, which rethinks leather processing using sustainably available plant-based wastes.
- Expand the paradigm to include chemistries involved in other leather processing steps
 - Oils
 - Fillers (Retans)
 - Surface Coatings
- Approach variety of funding streams to support commercialisation



Thank you for listening

