SECOND LIFE FOR AGRI-FOOD WASTE:
TANNIN-RICH RESIDUES FOR FORENSIC FINGERPRINT DEVELOPMENT

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Can fruit and nut waste reveal hidden fingerprints?

01 INTRODUCTION

THE TRACE

Fingerprints are vital for forensic identification due to their **uniqueness and persistence**. Latent marks are invisible residues of eccrine sweat and sebaceous lipids (picked up from face or hair). **Powder dusting**, the most used technique on non-porous surfaces, relies on fine particles adhering to this moist, greasy residue.

water · amino acids · urea · lactic acid · lipids

PROBLEM

Conventional powders may contain **heavy metals** or **synthetic dyes**, raising toxicity and environmental concerns.

heavy metals · synthetic dyes · toxicity · waste

SOLUTION

Tannins are plant polyphenols that **bind and precipitate proteins**. As fingermark residue contains proteins and amino acids, tannin-rich agri-food by-products may adhere selectively to the ridges, giving a **low-cost, non-toxic powder** while **reducing agricultural waste**.

pomegranate peel · chestnut shell · clementine peel

GOAL To evaluate the efficacy of tannin-rich agri-food waste as an **eco-friendly, non-toxic powder** for latent fingerprint development, valorizing agricultural by-products.

02 METHODS

POWDER PREPARATION



Pomegranate peel
oven-dried **50 °C · 5 h**



Chestnut shell
oven-dried **150 °C · 90 min**



Clementine peel
oven-dried **50 °C · 3 h**

Peel, rinse
& chop into pea-sized pieces

→



Oven-dry
(conditions above)

→



Blend
into a coarse powder

→



Mortar & pestle
for a finer consistency

→



Sieve
for a homogeneous particle size

FINGERPRINT DEVELOPMENT PROTOCOL

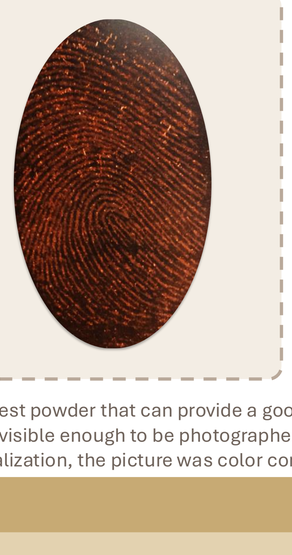
1. All surfaces were wiped with 70% ethanol
2. Fingerprint deposition on both steel and glass surfaces
3. Fingerprint revelation with squirrel hair fingerprint brush
4. Photographic register of the deposited fingerprints

All fingerprints were revealed and photographed under the same conditions

03 RESULTS

Qualitative visual assessment (0–4 scale) · target for identification in Portugal: **≥ 12 minutiae** (ACE-V)

CHESTNUT SHELL



Contrast ●●●○
Ridge definition ●●●○
Minutiae (≥ 12)
✕ not reached

Darkest powder that can provide a good contrast, and distinct ridge clarity. Was only visible enough to be photographed on the steel surface. For better visualization, the picture was color corrected (+40% brightness , +40% contrast)

CLEMENTINE PEEL



Contrast ●●●○
Ridge definition ●●○○
Minutiae (≥ 12)
✕ not reached



Strong orange-yellow contrast and some visible ridges, but not clear enough to identify minutiae, possibly due to the hygroscopic nature of fruit powders. Was visible enough to be photographed on both steel (left) and glass (right) surfaces.

POMEGRANATE PEEL



Contrast ●●●○
Ridge definition ●●●○
Minutiae (≥ 12)
✕ not reached
★ BEST RIDGES



Less intense colour but sufficient contrast, and the best ridge definition. Was visible enough to be photographed on both steel and glass surfaces. Minutiae still hard to distinguish (moisture uptake, agglomeration, large particles).

LIMITATIONS

Hygroscopicity
powders absorb ambient moisture → interparticle bridges and clumps → uneven coverage of the ridges

Particle size
blender + mortar and pestle gave varying sizes; large or irregular particles hide fine ridge detail and minutiae

Limited experimental sample size

CONCLUSION

Agri-food waste can reveal latent fingermarks.

Chestnut shells, clementine peels and pomegranate peels were explored as sustainable alternatives to conventional powders. Although they did not yet achieve the level of detail required for reliable forensic identification, the results demonstrate the potential of **valorizing agricultural waste** as a source of fingerprint development materials.

Next: calibrated particle size · moisture control · larger sample

** Images of fruit/materials are for illustrative purposes only; these were not the real fruits/materials used.*

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REFERENCES