TRACEABILITY OF PROTECTED GEOGRAPHICAL INDICATION (PGI) SORRENTO LEMON BY CHEMOMETRIC ANALYSIS OF THE SOIL AND JUICE MINERAL COMPOSITION

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What is Traceability and Why is Important?

Strong connection that binds the food to its territory of origin

For consumers:
- more guarantees;
- increased food safety;
Overview of European and Italian High-Quality Food Products

European High-Quality Food Products

PDO: 1784
PGI: 1169
TSG: 59

Italian High-Quality Food Products

PDO: 3%
PGI: 11%
TSG: 9%
FOOD FRAUDS IN ITALY

In 2018, 17,500 tons of irregular agro-food products have been seized for a commercial value of over 21.8 million euros.
Analytical techniques for authentication and determination of the geographical origin of foods

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<tr>
<th>Techniques</th>
<th>Sensitivity</th>
<th>Simplicity</th>
<th>Time analysis</th>
<th>Costs</th>
<th>Reported applications</th>
<th>Compounds</th>
<th>Identification/profiling</th>
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Favourable (+), moderate (+/-), unfavourable (-) (Luykx et al., 2008).
Soils formed in different geographic areas (different soil, different environment) are different for mineral and geochemical composition.

The bioavailability of inorganic elements in soil and the chemical composition of a crop is greatly affected by soil properties, such as pH, moisture, organic matter, and clay, as well as plant requirements.
Italy is the second largest lemon fruit producer in the Europe on a cultivated surface of 23,000 ha.
As most part of high quality products, they are affected by a lot of frauds
Aims of the work

• **Discriminate** Limone di Sorrento samples multi-element fingerprinting that come from PGI area to lemon that come from two different cultivation area of Campania region.

• **Compare** multi-element fingerprinting of lemon with bioavailable element contents in the cultivation soil

• **Protect** Limone di Sorrento from frauds with lemons of other geographical origin.

4 different sampling sites:

- Limone di Sorrento PGI area
  - Massa Lubrense (MS)
  - Piano di Sorrento (PZ)
- Limone di Sorrento NO-PGI area
  - Portici (PORT)
  - Eboli (EBO).

Two depths of soil sampling
- top soils, 0-20 cm
- sub soils, 40-50 cm
• **Lemon Juices** were mineralized by acid digestion (5 mL HNO₃, 2 ml H₂O₂) in microwave.

• **Potentially bioavailable elements in soils** were extracted by EDTA 0.05 M with 1:10 soil/solution ratio.
LEMON JUICES

KMO test = 0.593;
Bartlett sphericity test, p < 0.001
**LEMON vs SOIL RELATIONSHIPS**

### Person Correlation Analysis

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<th>Fe</th>
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<th>Rb</th>
<th>Sr</th>
<th>Ba</th>
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<tbody>
<tr>
<td>Top Soil (0-20cm)</td>
<td>-0.360</td>
<td>0.800</td>
<td>-0.551</td>
<td>0.563</td>
<td>0.436</td>
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<tr>
<td>Sub Soil (40-50cm)</td>
<td>ns</td>
<td>0.799</td>
<td>-0.499</td>
<td>0.380</td>
<td>0.471</td>
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*ns not significant*
**LINEAR DISCRIMINANT ANALYSIS (LDA)**

- Based on the 10 elements
- 100% of correct classification
- The model was cross-validated with satisfactory results. (100% of correct reclassification).

\[ \lambda \text{ Wilks } 0.017 \]

p-values <0.0001
CONCLUDING REMARKS

- The results confirm multi-element fingerprinting as a valid indicator of agri-food geographical provenience. Indeed, multi-element fingerprinting was able to discriminate the “Limone di Sorrento” from lemons of the same cultivar coming from NO-PGI areas.

- The results showed a relationship between the multi-element fingerprinting of the soil and the lemon.

- This suggests that the technique might be used to protect “Limone di Sorrento” by frauds.

Future investigations including a more significant number of cases are necessary to confirm these promising preliminary results.
On going activities

- More samples and farms
- Samples from different years
- Samples at different maturation stages
- Analysis of Sr isotopic ratio \( ^{87}\text{Sr}/^{86}\text{Sr} \) in Soil (Bioavailable content) and lemon
- Analysis of essential oils in lemon peels (GC-MS and PTR-MS)
Thanks for your attention