Assessment of pork authenticity by means of multi-element analysis

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1. OVERVIEW
The mineral content of pork tissues was estimated to establish the pig provenance. ICP-OES and ICP-TOF-MS techniques were employed for the determination of both macro and micro-elements. ICP-TOF-MS proved to be a fast and high-sensitivity instrument for quantifying the lowest concentrations of metals. Linear Discriminant Analysis (LDA) showed that Mg, Zn and Pb could trace the origin of pork samples.

2. INTRODUCTION
Nowadays authenticity is a basic attribute for food. Analytical methods supporting documental traceability are helpful to guarantee food authenticity, including origin. The objective of this work is to check the possibility to distinguish fresh hams originating from pigs differing for animal type, breeding conditions, origin and diet through a multi-element analysis. This study represents a first step for tracing the provenance of pork samples.

3. METHODS

SAMPLES
12 samples of domestic Heavy Pig, bred in Northern Italy (A)
7 samples of Nero di Parma, a local breed of black pigs, reared in the province of Parma (B)
8 samples of foreign pork, bred in Germany (C)

Muscle samples were taken from the outer section of Biceps femoris muscle in fresh hams

MINERALIZATION
About 1 g of minced muscle was mineralized in triplicate with 4 ml of HNO3 in a microwave-assisted digestion system UltraWAVE (Milan, Italy).

MULTI-ELEMENT ANALYSIS
Macro-elements by ICP-OES (MPX-Vista, Varian)
Ca, Mg, Na, K, P, Fe, Cr, Ni, Mn and Zn

Micro-elements by ICP-TOF-MS (Optima 9500, GBC)
Li, Al, V, Co, Cu, Ga, As, Rb, Sr, Mo, Ag, Cd, Cs, Ba, Ce, Ti, Pb and U

DATA ANALYSIS
Statistical analyses (SPSS Statistic, V22.0) were performed on data normalized to dry matter content.

Chemometric methods: Univariate analysis of variance (One-Way ANOVA), Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA). PCA was used as method for selecting a suitable number of variables for LDA.

4. RESULTS

One-way ANOVA and Tukey post-doc test

<table>
<thead>
<tr>
<th>Element</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mg</td>
<td>1090</td>
<td>969</td>
<td>994</td>
<td>0.003</td>
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<tr>
<td>Na</td>
<td>1938</td>
<td>2376</td>
<td>1065</td>
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<tr>
<td>K</td>
<td>13253</td>
<td>13044</td>
<td>12405</td>
<td>0.003</td>
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<tr>
<td>P</td>
<td>8574</td>
<td>7610</td>
<td>8001</td>
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<tr>
<td>Fe</td>
<td>20.3</td>
<td>30.4</td>
<td>16.6</td>
<td>0.000</td>
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<tr>
<td>Mn</td>
<td>224</td>
<td>283</td>
<td>232</td>
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<tr>
<td>Zn</td>
<td>80</td>
<td>120</td>
<td>62</td>
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<tr>
<td>Co</td>
<td>2.48</td>
<td>3.50</td>
<td>2.92</td>
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<tr>
<td>Cu</td>
<td>1718</td>
<td>2070</td>
<td>1743</td>
<td>0.007</td>
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<tr>
<td>Pb</td>
<td>4.75</td>
<td>18.9</td>
<td>10.2</td>
<td>0.012</td>
</tr>
</tbody>
</table>

Different colors
significant differences between samples (p<0.05)

Mean values of Mg, Na, K, P, Fe and Zn (in mg/Kg of d.m.) and of Mn, Co, Cu and Pb (in ug/Kg of d.m.)

Fe and Zn allow to discriminate samples belonging to the three groups

Principal Component Analysis (PCA)

PCA was performed, based on the elements which proved to be discriminant in one-way ANOVA. 3 components extracted accounting for 82.7% of total variance (PC1 = 47.8%, PC2 = 23.0%, PC3 = 11.9%) Variables less related to each other (Pearson r<0.65)

Na, Mg, Co, Cu, Zn and Pb

Submitted to Stepwise LDA analysis

Linear Discriminant Analysis (LDA)

Simplified Discriminant Function

F1=−4.387+0.010∙Mg+0.097∙Zn−0.742∙Pb

5. CONCLUSIONS
Mg, Zn and Pb resulted as the most important variables for the discrimination of pig type. A higher number of samples will be analysed in the future to build a reliable model for assessing pork authenticity.

References