PhD DISSERTATION PROJECTS

Multidisciplinary Approach for Authentication and Traceability of Geographical Origin of Agri-food Products

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This PhD thesis research project is aimed at the development, testing and validation of an integrated approach for the traceability of geographical origin and the authentication of quality of agri-food products, which can be adopted in the agri-food chains, useful for the competitiveness of companies.

Approccio multidisciplinare per l’autenticazione e la tracciabilità della provenienza geografica di prodotti agroalimentari

Questo progetto di tesi di dottorato ha come obiettivo lo sviluppo, la sperimentazione e validazione di un approccio integrato per l’autenticazione e la tracciabilità della provenienza geografica di prodotti agroalimentari di qualità, adottabile nelle filiere agroalimentari, utile per la competitività delle aziende.

# **1. State-of-the-Art**

Over the last few years, the identification and certification of the geographical origin of food has gained an increasing amount of attention. Globally, large amounts of food are exchanged and transported on a daily basis, and for many consumers, geographical authentication of food is looked upon as an assurance of its quality and safety (Opatić *et al*., 2017). Therefore, the participation to protected food names (PDO, PGI, TSG) is encouraged in the EU (Luykx *et al*., 2007). The authentication and traceability of the geographical origin of agri-food products is essential to increase consumer confidence in the products and prevent fraud and counterfeiting. The main analytical methods used to implement traceability systems, have been subdivided into four groups: mass spectrometry, spectroscopic, separation, and other techniques (Luykx *et al*., 2007) (Table 1).

***Table 1***Main analytical techniques for determination of the geographical origin of food products.

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| **Principle** | **Main technique** |
| Spectroscopy | Infrared spectroscopy (IR)  Fluorescence spectroscopy  Atomic spectroscopy  Nuclear magnetic resonance spectroscopy (NMR) |
| Mass Spectrometry | Isotope ratio mass spectrometry (IRMS)  Inductively coupled plasma mass spectrometry (ICP-MS)  Proton transfer reaction mass spectrometry (GC-MS) |
| Separation | High performance liquid chromatography (HPLC)  Gas chromatography (GC)  Capillary electrophoresis (CE) |
| Others | Sensor technology  DNA technology  Sensory analysis |

These methods can analyse different characteristics of a product allowing to find markers useful for the discrimination of variety, geographical origin, and mode of production. Food traceability usually requires a multi-technique approach as single methods do not generally produce sufficiently discriminating factors (Guyon *et al*., 2020). The set of data obtained provide a characteristic fingerprinting relating to the provenance of the sample. The application of chemometrics is often required to handle the amount of data and to detect subtle differences that frequently exist between food samples (Luykx *et al*., 2007). A multi-analytical approach seems to be the most promising approach for the traceability of geographical origin and the authentication of quality agri-food products.

# **2. PhD Thesis Objectives and Milestones**

Within the overall objective mentioned above this PhD thesis project can be subdivided into the following activities according to the Gantt diagram given in Table 2:

1. **Literature review and data collection**.
2. **Food and soil sampling**.
3. **Determination of quality properties**.
4. **Near infrared spectroscopy** analysis as a quick tool to authenticate the origin and quality of agro-products.
5. **Determination of the multi-element fingerprinting** and **stable isotope ratios** (13C/12C, 15N/14N) of agro-products and cultivation soils.
6. **Analysis and study of nutritional composition (macro and micronutrients)** of fresh and processed foods.
7. **Optimization of different chemometric tools** to obtain the development of authentication and traceability models to verify and validate the quality and origins of the samples.
8. **Writing and Editing** of the PhD thesis, scientific papers and oral and/or poster communications.

***Table 2***Gantt diagram for this PhD thesis project.

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| Activity Months | | **1** | | **2** | | **3** | | **4** | | **5** | | **6** | | **7** | | **8** | | **9** | | **10** | | **11** | | **12** | | **13** | | **14** | | **15** | | **16** | | **17** | | **18** | | **19** | | **20** | | **21** | | **22** | | **23** | | **24** | |
| ***Literature review and data collection*** | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |
| ***Food and soil sampling*** | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |
| ***Determination of quality properties*** | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |
| ***Near Infrared Spectroscopy*** | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |
| ***Multi-element fingerprinting*** | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |
| ***Stable isotope profiling*** | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |
| ***Study of nutritional composition*** | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |
| ***Chemometrics*** | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |
| ***Thesis and Paper Preparation*** | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |

# **3. Selected References**

Guyon F., Vaillant F., Montet D. (2020). *Tracebility of fruits and vegetables*. Pessac Cedex, France: Phytochemistry 173, 112291.

Luykx D. M. A. M., van Ruth S. M. (2008). *An overview of analytical methods for determing the geographical origin of food products*. Wageningen, Holland: Food Chemistry 107, 897-911.

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