Ensuring the Integrity of the European food chain

https://secure.fera.defra.gov.uk/foodintegrity/

Food Integrity 'the state of being whole, entire, or undiminished or in perfect condition'. Assuring consumers and other stakeholders about the safety, authenticity and quality of European food (integrity) is of utmost importance for the European Agri-food economy.
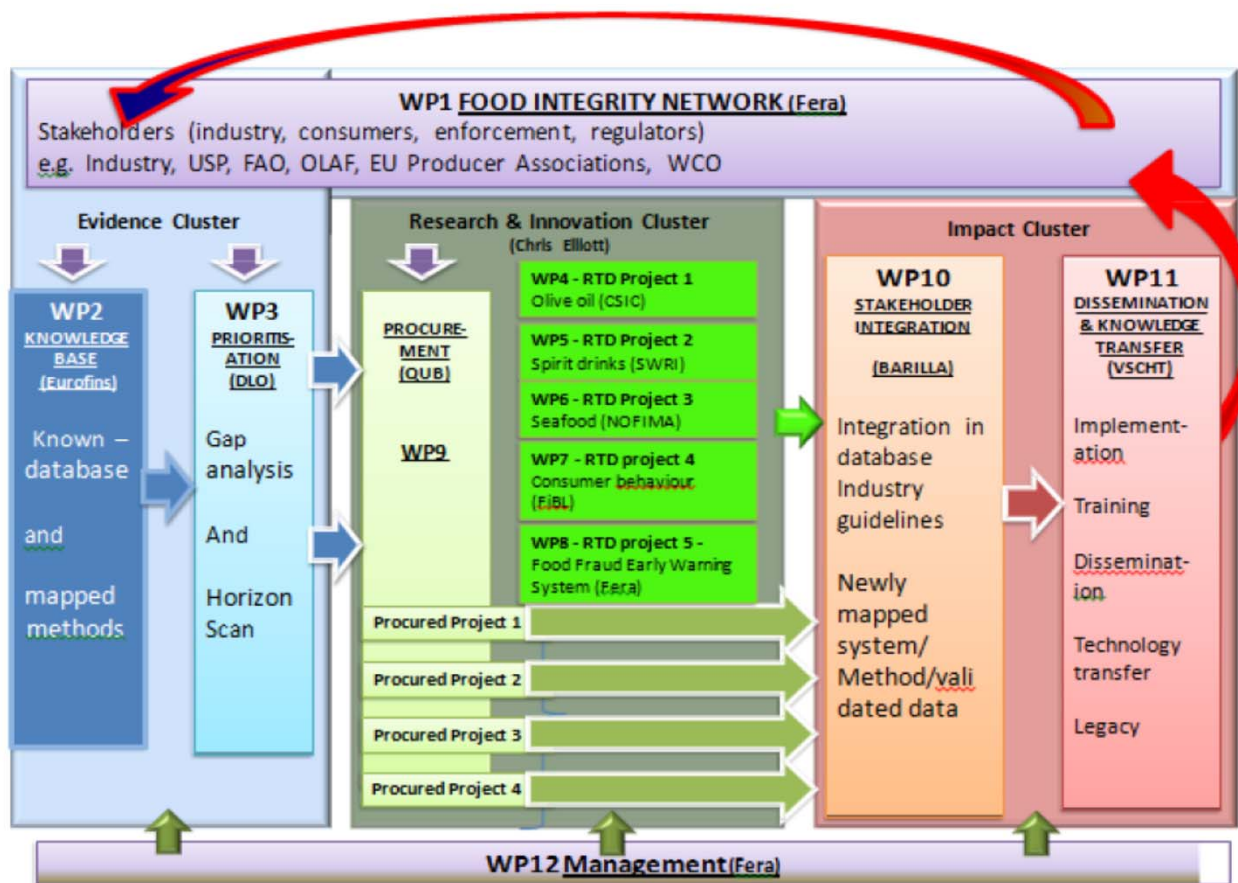
Introduction to the Food Integrity Project

Comprising 38 participants from 18 European countries and one from China, FoodIntegrity's key focus will be to consolidate, harmonise and mobilise the European capability on food authentication to ensure consumer confidence and protect European added value. The 5 year (2014 – 2018) €12M project will reduce the current barriers to data sharing and utilisation that is crucial to combating food fraud by supplying methods and tools that will address both enforcement and industry needs. The project will not only seek to enhance early warning capabilities, but working with industry, will develop methods, systems and processes that will assure the quality, authenticity and safety of the food chain so that:

1) consumer confidence is enhanced with respect to the integrity of food they purchase and
2) fraudulent products in the market place are more easily detected.

Ensuring the Integrity of the European food chain

Month	Date		Month	Date
1	Jan-14		31	Jul-16
2	Feb-14		32	Aug-16
3	Mar-14		33	Sep-16
4	Apr-14		34	Oct-16
5	May-14		35	Nov-16
6	Jun-14		36	Dec-16
7	Jul-14		37	Jan-17
8	Aug-14		38	Feb-17
9	Sep-14		39	Mar-17
10	Oct-14		40	Apr-17
11	Nov-14		41	May-17
12	Dec-14		42	Jun-17
13	Jan-15		43	Jul-17
14	Feb-15		44	Aug-17
15	Mar-15		45	Sep-17
16	Apr-15		46	Oct-17
17	May-15		47	Nov-17
18	Jun-15		48	Dec-17
19	Jul-15		49	Jan-18
20	Aug-15		50	Feb-18
21	Sep-15		51	Mar-18
22	Oct-15		52	Apr-18
23	Nov-15		53	May-18
24	Dec-15		54	Jun-18
25	Jan-16		55	Jul-18
26	Feb-16		56	Aug-18
27	Mar-16		57	Sep-18
28	Apr-16		58	Oct-18
29	May-16		59	Nov-18
30	Jun-16		60	Dec-18

INTELLI*trace* – WP 18

Improving comprehensive artificial intelligence, validation and harmonization methods as "functional bridge" between untargeted analytical approaches and food tracking/authenticity within the Food Integrity field

The gap

Topic 1. Standardization and harmonization of untargeted methods to assess food integrity

Keywords: Protocol, validation of untargeted analytical methods

Challenge: *development of a science-based, internationally accepted standardised procedure for the validation of untargeted analytical methods.*

- **Definition of performance characteristics of these analytical methods, which involve chemical/physical measurements as well as statistics**

- Efficient and standardized ways of selecting important variable/parameter combinations, minimizing noise and thereby **reducing the complexity of data** obtained **with fingerprinting methods are essential** as is the ability to **compare results between laboratories.**

...from the GAP Analysis document (Food Integrity Team)

Non targeted, often referred to as "**fingerprinting**" and "**profiling**" methods offer considerable advantages in terms of efficiency and cost effectiveness*; formal validation of these techniques will allow further implementation of these methods in practice.*

Advanced statistical approaches are poorly exploited in post analytical step of untargeted analysis

Consensus Paper / White Paper as a guideline for the stakeholders

criteria, best practices and guidelines for an effective, functional and validated application of untargeted analytical methods applied to food authentication/traceability/integrity determination.

Running title: *"Good practices and methodological guidelines for the validation and application of untargeted analysis for the food authenticity and traceability"*

FOOD INTEGRITY

Consensus Paper / White Paper as a guideline for the stakeholders

Part 1: "executive summary" on untargeted methods

Introduction to the concept of "untargeted analysis" on food; examples of case studies; state of the art; previously released guidelines

Part 2: "normalization/standardization & post-anaysis

Post-analysis approaches (linear/not linear multivariate analyses, "machine learning" approach); examples and guidelines for their application

Part 3: validation, "data quality" & "data acceptation"

Indications on how to harmonize and statistical validate the methods; description of misleading errors and re-directing actions, troubleshooting, robustness trials, recommendations on "data acceptation"

"OLD" datasets

WORKING AREA 1

- A.I. processing
- Validation

"NEW" datasets

WORKING AREA 2

- A.I. processing
- Selection of *"model performing method"*
- Validation

- **VALIDATION PROCESS, TAILORED FOR UNTARGETED METHODS**
- **WHITE PAPER (GUIDELINE)**

Step 1: normalization & data fusion

Normalization ... different technologies lead to different "data sets"

Data fusion is the process of integration of multiple data and knowledge representing the same real-world object into a consistent, accurate, and useful representation. The goal of data fusion is to combine relevant information from two or more data sources into a single one that provides a more accurate description than any of the individual data sources

Step 2: chemometric processing of big data set

- Artificial Neural Networks

- Bayesians Networks

- Genetic algorithms

- <u>other algorithms</u>...

Deep Analytics

Definition - What does Deep Analytics mean?

Deep analytics is a process applied in data mining that **analyzes, extracts and organizes large amounts of data in a form that is acceptable**, *useful and beneficial for an organization, individual or analytics software application.*

Step 3: validation of untargeted process
(comprehensive approach: analytical & post-analytical)

considering ISO, ICH, CEN, AOAC
Procedures/Guidelines...

...but:

...most guidelines are designed on "targeted" approaches

WP18 plan

1. **Advanced statistical approaches applied to "old" databases**

   - **Wheat**

   - **Honey**

2. **Advanced statistical approaches applied to "newly generated" databases**

   - **Rice**

   - **Honey**

   - **Salmon**

   - **Saffron**

RICE AUTHENTICATION

SubTask 1: geographic origin

LC-LRMS, DART-HRMS

HR-NMR

SubTask 2: variety substitution

LC-LRMS; DART-HRMS

HR-NMR

DNA: NGS; Bar coding + HRM

SubTask 1: geographic origin
SubTask 2: wild vs farmed

✓ **Protein Fingerprint**
    Lab-on-a-Chip Capillary
    microelettrophoresis
    LC-LRMS; LC-HRMS
    HR-NMR

✓ **Lipid Fingerprint**
    DART-HRMS
    GC-FID

SubTask 1: geographic origin

SubTask 2: integrity (Honey + Glucose sirups)

DART-HRMS; LC-LRMS; LC-HRMS

HR-NMR

Integrity/adulteration verification

DART-HRMS

HR-NMR

FT-IR and/or FT-NIR

FOOD INTEGRITY

FOOD SAMPLES

Untargeted Analytical approach 1

Untargeted Analytical approach 2

Untargeted Analytical approach n

DATA SET 1

DATA SET 2

DATA SET n

DATA MINING
Different approaches, combined data sets

SELECTION
performing analytical/post-analytical protocol

VALIDATION

IMPLEMENTATION

WHITE PAPER

Main (declared) interactions with FI Partners
(WP2 of Food Integrity)

NOFIMA, AZTI Tecnalia, MATIS: fish sampling / validation

JRC-IRMM: support on spiked foods preparation

VSCHT: data sets provision; DART-MS support

BARILLA: consultation on untargeted methods

ALL: interactions for the validation and the drafting of the *White Paper*

NMR Inter-Laboratory Comparisons

by Innovative Solutions S.r.l.

Call for participation OPEN

Deadline: 2016.12.11

Validating NMR methods

Comparison IS-NMR-ILC 001_2016 (Project: Re.Ge.Vi.P.)

1D ^{1}H NOESY with solvent suppression

of wine grapes juice

Validation of a combined NMR method
for analysis of wine grapes (Project: Re.Ge.Vi.P.)

Timetable

- ✔ 2016/10/24 – Start
- ✔ 2016/11/07 – 2016/12/11: Call open and registration of the participants
- ✔ 2017/01/15   : Conclusion of the stability tests
- ✔ 2017/01/31   : Publication of the "Guidelines and contract terms"
- ✔ 2017/02/01 – 2017/02/28: Sample preparation and delivery to participants
- ✔ 2017/03/01 – 2017/03/31: NMR experiment registration and results submission
- ✔ 2017/04/01 – 2017/05/31: Data elaboration and publication of the report.

www.innovative-solutions.it