

Promoting Metrology in Food and Nutrition: A Position Paper on METROFOOD-RI and its e-component

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Abstract— This position paper describes the METROFOOD-RI research infrastructure, which has been included in the ESFRI Roadmap 2018 in the domain Health and Food, with a focus on its electronic component. The Strategy Working Group and the Implementation Group in their evaluations clearly stated that the project fills a gap in the Health & Food domain and sufficiently mature to proceed with its implementation. One of the main tasks of the project is to integrate physical and electronic infrastructure based on FAIR data principles.

Keywords — research infrastructure, food, nutrition, metrology, e-services, FAIR, interoperability

I. INTRODUCTION

METROFOOD-RI “Infrastructure for Promoting Metrology in Food and Nutrition” (www.metrofood.eu) is a new pan-EU research infrastructure (RI) that aims to promote scientific excellence in the field of food quality and safety. It provides high-quality metrology services in food and nutrition [1,2], comprising an important cross-section of interdisciplinary and interconnected fields throughout the food value chain, including agri-food, sustainable development, food safety, quality, traceability and authenticity, environmental safety, and human health. With an inter- and intra-disciplinary approach the broadest concept of food integrity is addressed, and covers all aspects of the food chain from producers to consumers and is based on chemical and microbial food safety, the authenticity of food origin, and nutritional quality [3]. The agri-food sector is a strategic asset of all the European Countries and one of the largest and most important socio-economic activities, and it is vital in ensuring employment, preserving rural public goods, supplying healthy and high-quality foods, and in facilitating the integration of SMEs into the international food chain. Food

quality and authenticity have now become the focus of consumer needs all over the world, and food traceability and safety are critical factors in ensuring food quality and protecting consumer interests. Food safety, in particular, represents one of the most critical elements of public health policies at the global level. Moreover, the agri-food sector faces the challenge to provide a growing world population with healthy diets from sustainable food systems.

This paper aims to present the key characteristics of METROFOOD-RI and the development of its electronic component. The paper includes approaches to data integration and interoperability and the importance of integrating both physical and electronic components for a more effective service provision.

II. THE DEVELOPMENT OF METROFOOD-RI

METROFOOD-RI's has the mission to enhance quality and reliability of measurement results and make available and share data, information and metrology tools, to enhance scientific excellence in the field of food quality and safety and to build scientific knowledge, and to promote scientific cooperation and integration. It combines a physical distributed infrastructure (*P*-RI) and a virtual one (*e*-RI), in order to coordinate and integrate an existing network of laboratories, experimental fields/farms for crop production/animal breeding, small-scale plants for food processing and storage, kitchen-labs for food preparation. The *e*-RI will make available an access platform to share and integrate knowledge and data on metrology tools for food analysis, focusing on food composition, nutritional contents and biomarkers and contaminants. METROFOOD-RI, in full harmony with

Responsible Research and Innovation (RRI) principles [4], is intended to provide distributed services, with a plan to deliver measurement reliability, procedural harmonisation and the adoption of FAIR (*Findable, Accessible, Interoperable, and Re-usable*) principles regarding data management and service provision. The offer is addressed to a broad set of users and stakeholders, such as, public and private laboratories, and groups engaged in research activities for food data collection and measurement reliability and basic frontier research in food and nutrition; food business operators and producer associations; policy makers, and food inspection and control agencies; consumers, consumer associations and citizens.

The METROFOOD-RI Consortium includes 48 institutions from 18 European Countries, all involved in setting up the future governance structure, technical requirements, service provision and long-term scientific strategy, to realise METROFOOD-RI as ready to implement and ready to operate as a self-sustainable infrastructure. METROFOOD-RI was at first cited as “emerging” in the ESFRI Roadmap 2016, and 2017 completed its “Early Phase” upon the EU-funded PRO-METROFOOD project (Progressing towards the construction of METROFOOD-RI - GA 739568). During the early phase, the project group performed a detailed Design and Feasibility Study, including an inventory of the available facilities (physical and electronic), an analysis of the potential services, the development of two pilot services, defining the Quality Systems and Data Management Plans, a preliminary analysis of users and stakeholders, establishing the basic principles for the user strategy and access policy, and developing the training plan. The results allowed – apart from further improving the scientific excellence – to reach the appropriate maturity level in terms of organisational and managerial aspects and eventually through the ESFRI Roadmap 2018 to enter the Roadmap as a “project”. The whole timeline of METROFOOD-RI (past, present and future) includes the following phases:

Phase I – Design: 2015-2017

Phase II – Preparation: 2018-2021

Phase III – Implementation/Construction: 2022-2024

Phase IV – Operation: from 2019.

Currently, METROFOOD-RI is in the Preparatory Phase II and receives support from the H2020 INFRADEV-02-2019 CSA project. METROFOOD-PP aims to bring the project to the level of legal, financial, and technical maturity necessary for its complete implementation and operation.

III. THE CONCEPT OF THE METROFOOD-RI *E*-COMPONENT

The concept *e*-component of METROFOOD-RI is presented in Fig.1 and consists of a service-oriented architecture that provides a platform accessible to the user community (Europe and beyond) for sharing and integrating data, knowledge and information about food analysis, food composition, nutritional contents and biomarkers and level of contaminants. It will also collect the results provided by the physical component, organising and complementing them with existing data and providing data management tools. The *e*-RI

will involve integrating various data sources, and services for comparing and making interoperable food data and any other data of interest concerning the agri-food sector and human health. It will also provide metrology tools to be used for food and nutrition purposes. Besides analytical results, it will also include analytical data and information, for example, on methods, standards, best practices, and publications. During the “Phase I” a pilot system was developed and tested, which includes the following steps:

- 1) Defining a Data Management Plan for data and value documentation, data archiving and preservation (long-term storage), data exchange format, and data access and sharing policies. It also addressed details on what data are generated and collected, whether and how it will be exploited or made accessible for verification and re-use, and how the data will be curated and preserved.
- 2) Investigating relevant sources of data and information regarding analytical food chemistry and identifying specific data formats.
- 3) Specifying the various parts of the infrastructure and identifying the links between the physical and *e*-component studies in order to define procedures for integration and inter-exchange.
- 4) Implementation and testing.

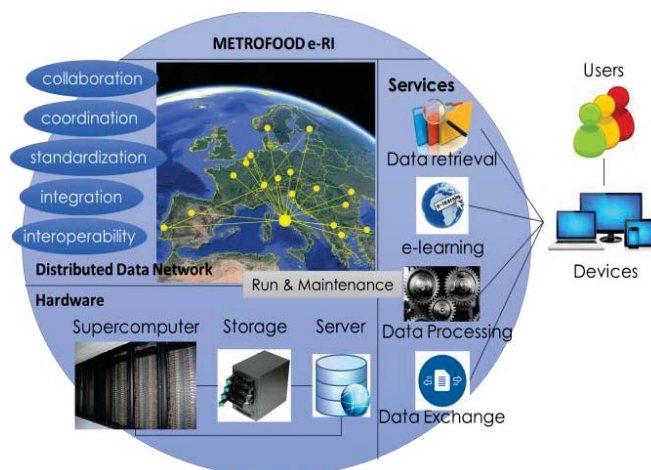


Fig. 1. Concept of the METROFOOD-RI *e*-component.

According to the European Open Science Cloud (EOSC), an *e*-RI must consist of a central platform, data and information sources, services, catalogues, search functionalities, and an authentication and authorisation mechanism. Consequently, a central METROFOOD-RI platform will be the entry point for users and provide catalogues of metadata and search functionalities to find information about the chemical, physical and (micro)biological analyses and tests related to food and nutrition. The platform will also provide catalogues of tools and services that can be (re-)used in combination with data, as well as information about access policies for databases, tools and services. The core components include the central web portal, national web portals, authentication and authorisation infrastructure and links to other *e*-RIs and platforms, as well as services such as software (desktop applications, web apps,

mobile apps), storage or computation (high performance computing or high throughput computing), data sources (unstructured, semi-structured and structured). METROFOOD will promote interoperability of food data through the development and application of a food ontology. Other core components are the directories that will list all partners, data sources, services and APIs, creating an inventory of the *e*-RI.

IV. DISCUSSION

Much progress has been made in defining the parameters that influence food quality & safety, especially for what concerns industrial processing. However, a systematic and holistic overview of the potential influencing factors all along the food chain, from primary production to final consumption, is missing and highly needed. There are also many influencing variables regarding the different sectors, e.g., the environment, climate, varieties, agronomic technologies, use of natural resources, processing and storage technologies. Often, the data, although available, are non-compatible. The possibility to connect all of the variables with specific food characteristics, such as nutritional and functional values, will favour innovation, competitiveness, and positioning on the market. The availability of such types of data will allow for the promotion of sustainability, closure of cycles and the reduction of food waste, and promote technology integration and allow for the spreading of knowledge and best practices. The challenge facing METROFOOD is the realisation of an e-infrastructure that will collect information, data and metadata related to food over its whole lifecycle, to create a system able to describe a food item and related characteristics and influencing factors.

One of the main challenges that food and nutrition research faces nowadays is the management of big data that represents the next step of data management in METROFOOD as well. New technologies are leading to an exponential increase in the volume and types of data available, creating unprecedented possibilities for generating new knowledge beneficial to society through the development of novel applications, models and systems for different classes of users (consumers, entrepreneurs, policymakers). The big data revolution will enable the rapid combination and correlation of large amounts of data.

Unfortunately, much of this data is unstructured and will require processing to extract trends and to identify gaps. Furthermore, the availability of Open Access Data platforms could permit the realisation of functional application tools for collaborative sharing and validation of technological solutions.

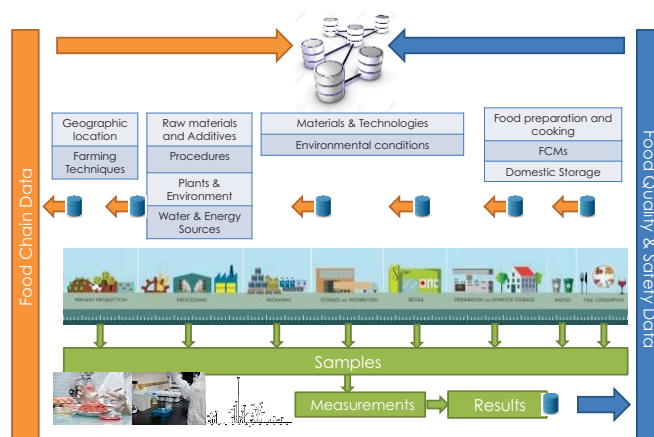


Fig. 2. METROFOOD-RI: towards an integrated data platform.

METROFOOD *e*-RI will promote higher levels of transparency across the entire food chain presented in Fig. 2 and allow the implementation of new approaches to food quality & safety, traceability and food protection, with a broader approach to food integrity, addressing multiple perspectives with regards to circularity and sustainability. It will also allow the creation and interoperability of food data, and overcome the fragmentation of food data by combining essential information about food production, diet, health, and consumer behaviour. In this way, METROFOOD can better use and re-use of the wealth of existing but scattered data. METROFOOD-RI will act dynamically by offering services in real-time tailored to the stakeholders' needs in order to offer the best solutions for maintaining food safety, quality and the traceability of products and processes.

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