

## PROFESSIONAL NEWS

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## Infrastructure for food safety and quality

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hydrocarbons, trace elements), pesticides and additives, which are regulated by the European regulations: Regulation 1881/2006 for contaminants, Regulation 396/2005 for pesticides, and Regulation 1333/2008 for additives. For addressing all these issues, analytical methods with a high degree of accuracy, precision and sensitivity, and a harmonized system for their application in analytical laboratories are required. Moreover, metrology concept must be applied to provide the basis for reliable measurements and confidence in measurement results, thus impacting the economy and society. Therefore, this pan-European Infrastructure will act in a dynamic way and its services will be adapted to the society needs to offer the best measurement results for ensuring food quality and safety.

**Key words:** METROFOOD-RI; metrology; food safety; food quality.

### Abstract

*The METROFOOD-RI is a new European infrastructure that provides high-quality services to the food sector particularly for food quality and safety. Hub and Node model is selected, with a Central Hub in Italy and a network of 48 institutes from 18 countries. The operational part of the physical infrastructure is developed through inventory of equipment, during the METROFOOD-PP project. The state-of-the-art equipment is selected for the service provision particularly for determination of the actual parameters for food safety and quality according to EU and/or National Regulations, and for that purpose is selected e.g., gas and liquid chromatography GC-MS (/MS), and/or LC-MS (/MS)) than ICP-MS (/MS), Orbitrap, TOF, Ion trap mass spectrometer (MS), laser-induced plasma spectroscopy, and others. The main parameters in estimating food quality are determination of content of proteins, fat, fatty acids, carbohydrates, fibers, vitamins, micro- and microelements and providing information about nutritional values, physico-chemical analysis, bioactive compounds, and authenticity. The most important parameters in assessing food safety are the determination of contaminants (mycotoxins, polycyclic aromatic*

### INTRODUCTION

METROFOOD-RI is a pan-European research infrastructure designed in 2015 aimed to promote scientific excellence in food quality and safety and provides metrology services regarding food safety and quality with aim of high quality of measurement results

METROFOOD-RI was cited as emerging project in the ESFRI Roadmap 2016 and 2017 completed its Early Phase upon the EU-funded PRO-METROFOOD project. During this phase, METROFOOD-RI has performed a detailed Design and Feasibility Study [1,2], including an inventory of the available facilities, an analysis of the physical-RI and e-RI services, the development of two pilot services, Data Management Plans, an analysis of users and stakeholders, a users' strategy, and ac-

cess policy, and plans for training. The infrastructure is included in the ESFRI Roadmap 2018. Currently, the METROFOOD-RI is the only active ESFRI project in North Macedonia. METROFOOD-PP project represents the "Preparatory Phase" of METROFOOD-RI that has received funding from the European Union's Horizon 2020 research and innovation program under Grant Agreement No 871073. The METROFOOD-PP project, aimed to organize the METROFOOD-RI – Infrastructure as a service-oriented organization, reaching all the agreements necessary for obtaining legal status as an ERIC (European Research Infrastructure Consortium) and ensuring the long-term sustainability [3,4].

The idea is for the infrastructure to be built on a Hub and Node model, with Central Hub placed in Italy and a network of 18 National Nodes, one for each par-

ticipating country (Belgium, Czech Republic, France, Finland, Germany, Greece, Hungary, Italy, Moldavia, The Netherlands, Portugal, Republic of North Macedonia, Romania, Republic of Slovenia, Spain, Switzerland, Turkey, and Norway). Each Node may involve many institutions and their connection at national level are in the frame of the Joint Research Unit (JRU). For example, the national node of the Republic of North Macedonia, named JRU-METROFOOD-MK, consists of two institutions recognized as institutions dealing with food quality and safety and they are the Institute of Public Health and the Faculty of Agricultural Sciences and Food.

## FOOD SAFETY & QUALITY CONTROL AND REGULATIONS

METROFOOD-RI Infrastructure aims to fill a gap in the Health & Food domain, by service provision of the food quality and safety analysis. Testing of some parameters in food is performed in order to protect the health from one side and obligation to check them according to the EU and/or National Regulations. The actual level of the parameters in the food and the amount of the food consumed by individuals is very important in terms of health protection.

One of the main substances that may be found in food and should be tested are contaminants. Pesticides are the most often contaminants that may be found in food. There are hundreds different pesticides used for crop protection. Traces of pesticides left in food are called "residues". According to the Regulation Annex 1396/2005 [5], MRLs are established for more than 1,240 pesticides [6]. The methods of sampling and control for pesticide residues determination are outlined in the EU document SANCO12571/2013 [7]. Other sources of contamination are PAHs, furans, 3-MCDP and MCDP esters that are widespread across the globe mainly due to long-term anthropogenic sources of pollution. These components possess high level of persistency because of their properties like heterocyclic aromatic ring structures, then hydrophobicity and thermostability. Maximum level is set in Regulation for contaminants in foodstuffs (EC) No 1881/2006 [8].

Other sources of contaminants are mycotoxins produced by fungi like *Alternaria*, *Penicillium*, and *Aspergillus*. The most often mycotoxins found in food and regulated by the law are aflatoxins, ochratoxin, patulin, deoxynivalenol, zearalenone, fumonisin B1 and B2, HT-2 and T-2 toxin. Maximum levels for certain contaminants in foodstuffs including mycotoxins are regulated with (EC) No 1881/2006 [8]. Commission Regulation (EC) No 401/2006 is about methods of sampling and analysis for the levels of mycotoxins [9].

Food additives provide nutritional benefits or improve food safety from the one side, but have known

or potential health risks, from the other side. Food additives must be authorized before they can be used in foods and must be included in the EU list of permitted food additives in the Regulation EC 1333/2008 [10]. Purity criteria are set in the Regulation EU 231/2012 [11].

Nutritional value and information of water, carbohydrates, sugars dietary fiber, total fat, fatty acids minerals and vitamins are important because they must comply with the national and European regulations and from the other side the information on the content of some ingredients is required and regulated by Directives relating to the labelling [12,13].

Authenticity is another huge problem of the 21st century, because of financial or economic advantages. The legal basis of food fraud is Article 8 of Regulation (EC) No. 178/2002 [14]. The most often products as a subject of fraud are e.g. olive oil, wine, fruit juices, honey and milk products, and specific regulations and guidelines exist to verify the authenticity of these products. However, for many other food items such regulations and guidelines do not exist so far.

The new generation of the tested parameters that are from the potential health risk are nanomaterials (1 nm – 100 nm). There are also specific provisions for nanomaterials for sector food, Novel Foods Regulation (EC) No 2015/2283, Food Additives Regulation (EC) No 1333/2008, Food Information to Consumers Regulation – (EC) No 1169/2011, Plastic Food Contact Materials Regulation (EC) No 10/2011, Active and Intelligent Materials and Articles Regulation (EC) No 450/2009), biocides and cosmetics (Regulation (EC) N° 1223/2009) legislation (EUNON) [10, 15, 16, 17, 18, 19].

## METROFOOD'S SERVICES

METROFOOD-RI with their facilities and human resources will offer services to all users and will have important role in filling gaps in the field of food quality and safety. The services provided by METROFOOD RI include physical (*P*-RI) and *e*-RI part, that will be active in chemical, physical-chemical, and microbiological characterization of foods, then development of new Reference Materials, experimental studies for crop production, facilities for food processing, experimental study for food storage, software development, data collection and analysis, interlaboratory testing and training.

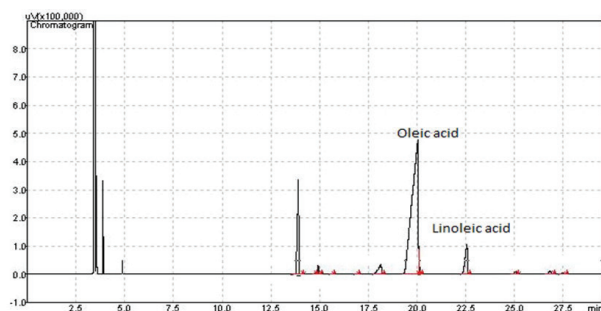
The infrastructure in the physical (*P*-RI) part includes "METRO" and "FOOD" sides. The facilities are laboratories for production of reference materials and analytical laboratories for determination of food safety and quality, experimental fields/farms for food production, facilities for food processing, storage, and preparation. Activities related to the "METRO" are development and characterization of new reference materials, and development and validation of new analytical methods and

devices. Within the “FOOD” part will be set up provision of a new data on food relating to food composition and contaminants, experimental studies for food composition in terms of geographic origin, or storage or technologies of production, experimental studies for risk assessment, studies related to the application of new technologies (i.e., nanotechnologies), etc. [20].

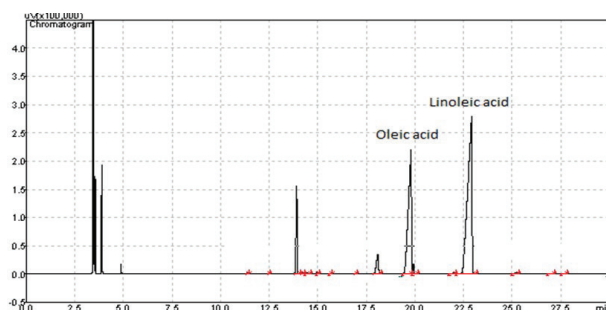
The e-RI will provide web platform for sharing information about food safety and quality. Through this platform users will have opportunity to have information about reference materials in terms of analyte and matrix, information about official method, proficiency testing, reference value, trainings and collecting information from the users about their needs [20].

METROFOOD's partners have a long background in methodology for chemical and biochemical characterization of food. They are active in analyzing presence of contaminants in food as pesticides, mycotoxins, nitrates, polycyclic aromatic hydrocarbons (PAHs), halogenated contaminants, acrylamide, furans and 3-MCDP and MCDP esters as a process contaminants, additives, melamine than GMO, amines, hormones, veterinary drug residues, nanoparticles. Determination of dry matter, water, lipid analysis, fatty acid composition, proteins and amino acids, carbohydrates, sugars (glucose, fructose, etc.), flavonoids, carotenoids, polyphenols, fiber, minerals, liposoluble and hydrosoluble vitamins and determination of nutritive value are part of the METROFOOD activity, as well. Food supplements are analyzed for the presence of some active ingredients, for example, MK-Node is active in analyzing coenzyme Q10, hesperidin, diosmin, isoflavones, quercetin, ginsenosides, hinin acid, glucosamine, chondroitin, etc. Additionally, METROFOOD is active in food authenticity and traceability as a very important part of food quality. MK-Node performs analysis on identification and quantification of presence of fatty acids with GC-FID technique in order to prove their authenticity. 1% of the analyzed oils were detected as adulated.

As it is shown on **Figure 1** the main characteristic of olive oil is higher content of monounsaturated fatty acid - oleic acid and less content of polyunsaturated fatty acids - linoleic and linolenic acids compared to other oils. In **Figure 2** is shown a clear picture of adul-



**Figure 1.** Chromatogram fatty acids in the olive oil.



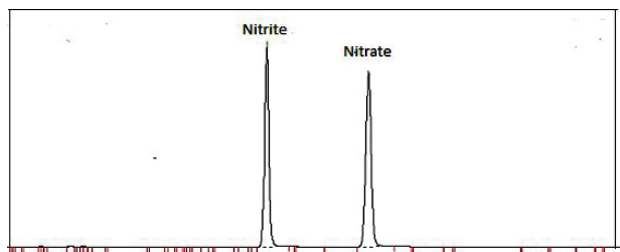
**Figure 2.** Chromatogram of fatty acids in the mix of olive oil and vegetable oils.

teration of olive oil with the sunflower oil. For determination of total fats several methods are used depending on type of fats like Soxhlet, Weibull-Stoldt or Rose-Gottlieb Method.

For mycotoxin determination the most used methods are enzyme-linked immunosorbent assay (ELISA) and high-performance liquid chromatography. MK Node has accreditation for fluorimetry determination which has the reduced time for analysis, lower cost of the fluorometer device and the lower costs of analysis.

Among the contaminants like mycotoxins, PAHs, trace elements MK-Node perform monitoring on Nitrate in Vegetables according to the Regulation 1831/2006 for contaminants.

As it is shown on **Figure 3** successful separation is achieved by reverse phase ion pair chromatography (RPIPC), on HPLC by UV – VIS Diode array detector. Numerous methods are applied for additive determination on HPLC, as well.



**Figure 3.** Chromatogram of Nitrite and Nitrate.

Expertise per food and inventory of the equipment is defined within the METROFOOD-PP project. The state-of-the-art equipment is selected for the service provision, generally gas and liquid chromatography: GC-MS (/MS), LC-MS (/MS), ICP-MS (/MS), Orbitrap, TOF, Ion trap mass spectrometer (MS), High-resolution mass spectrometer (HRMS), laser-induced plasma spectroscopy. There are also NMR instruments and equipment for molecular biology, biochemical and microbiological analysis (real-time PCR, PCR instruments, etc).



## METROFOOD'S USERS

As a user category of METROFOOD have been identified four groups: researchers, policy makers, industry, and citizens.

For research activity METROFOOD-RI will be of great scientific importance in terms of available top equipment, gain of knowledge from a colleague working in the same area of research as well as integration with the leading institutions in Europe. For policy makers and control laboratories it will enhance scientific excellence in the field of food quality and safety, thus enabling an increase in opportunities for market analyses to be carried out by laboratories. The development of new methodology of food analysis will reduce the costs of monitoring. From the industry's perspective, METROFOOD-RI with their experience and pilot plant will help in terms of how to have cheaper production of new products. From the consumers' perspective the systems for tracking the food from producer to consumer, monitoring of environmental conditions, and the system for determining the geographical origin of food will provide a comprehensive system that will fulfill buyer's wishes and needs. The improvement of chemical measurements will significantly benefit society and the economy.

More information is available at the METROFOOD-RI website where users can find dissemination materials, news related to METROFOOD-RI and crucially links to and information about any open calls that allow for engagement with the RI.

## ACKNOWLEDGMENT

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## Infrastruktura za bezbednost i kvalitet hrane

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### Kratak sadržaj

*METROFOOD-RI je nova evropska infrastruktura koja pruža visokokvalitetne usluge prehrambenom sektoru, posebno u pogledu kvaliteta i bezbednosti hrane. Uspostavljen je integrativni centar, sa sedištem u Italiji i mrežom od 48 instituta iz 18 zemalja. Tokom realizacije projekta METROFOOD-PP uspostavljena je fizička infrastruktura sa popisom opreme. Za pružanje usluga bira se najsavremenija oprema posebno za određivanje stvarnih parametara za bezbednost i kvalitet hrane prema EU i/ili nacionalnim propisima. U tu svrhu se bira npr. gasna i tečna hromatografija (GC-MS (/MS) i/ili LC-MS (/MS)), ICP-MS (/MS), Orbitrap, TOF, maseni jonski spektrometar (MS), laser-ski indukovana plazma spektroskopija i dr. Glavni parametri u proceni kvaliteta hrane su određivanje sadržaja proteina, masti, masnih kiselina, ugljenih hidrata, vlakana, vitamina, mi-*

*kro i makroelemenata i davanje informacija o nutritivnim vrednostima, fizičko-hemijske analize, bioaktivna jedinjenja i autentičnost. Najvažniji parametri u proceni bezbednosti hrane su određivanje zagađivača (mikotoksini, policiklični aromatični ugljovodonici, elementi u tragovima), pesticida i aditiva, koji su regulisani evropskim propisima: Uredba 1881/2006 za zagađivače, Uredba 396/2005 za pesticide i Uredba 1333/2008 za aditive. Za rešavanje svih ovih pitanja potrebne su analitičke metode sa visokim stepenom tačnosti, preciznosti i osetljivosti, kao i usaglašen sistem za njihovu primenu u analitičkim laboratorijama. Štaviše, koncept metrologije se mora primeniti kako bi se obezbedila osnova za pouzdana merenja i poverenje u rezultate merenja, što utiče na privredu i društvo. Stoga će ova panevropska infrastruktura delovati na dinamičan način i njene usluge će biti prilagođene potrebama društva da ponudi najbolje rezultate merenja za obezbeđivanje kvaliteta i bezbednosti hrane.*

**Ključne reči:** METROFOOD-RI; metrologija; bezbednost hrane; kvalitet hrane.