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SPECIFICATIONS ON THE e-RI CORE COMPONENTS

Project	METROFOOD-EPI – *METROFOOD-RI Early Phase Implementation*
Grant Agreement n.	101130162
Call	HORIZON-INFRA-2023-DEV-01
Due date	Month 10 – October 2024
WP – Task	WP3 – Task 3.2
Lead Beneficiary	PMT PL
Type	R - Document, report
Dissemination Level	PU

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1. Executive Summary

METROFOOD-RI - *Infrastructure for Promoting Metrology in Food and Nutrition* (www.metrofood.eu) is a distributed RI aimed to promote scientific excellence in the field of food quality and safety. It provides high-quality metrology services in food and nutrition, comprising an important cross-section of highly interdisciplinary and interconnected fields throughout the food value chain, including agrifood, sustainable development, food safety, quality, traceability and authenticity, environmental safety and human health. It combines a Physical-RI (P-RI) and an electronic-RI (e-RI) for open data deposition, access and processing. The P-RI coordinates and integrates an existing network of state-of-the-art facilities including: in the "Metro" side, laboratories for the full chemical, physical-chemical and microbiological characterisation of foods and any matrix of interest in relation to the agrifood (e.g., environmental matrices from the agroecosystem of production, feeds, food contact materials, etc.), and plants for Reference Material (RM) development and production; in the "Food" side, experimental fields/farms for crop production and animal breeding, small-scale plants for food processing and storage, kitchen-labs for food preparation, and "demo" sites for direct stakeholder engagement (e.g., to run Living Labs). The e-RI consists of a service-oriented electronic architecture providing an accessible platform for sharing and integrating data, knowledge and information on metrological tools for food analysis and for facilitating the availability and use of agrifood data to the user community. The e-RI collects, integrates and makes the P-RI results open and interoperable, organising and complementing them with existing data and providing tools for various uses of the data, even promoting their interoperability and the integration with data arising from other existing networks and infrastructures. METROFOOD-RI users are individuals, teams or institutions who are foreseen to use the services of the RI. Four main user categories have been identified as follows: Researchers and academic communities; Policy makers/food inspection and control agencies; Food business operators (FBOs); Consumers/citizens.
METROFOOD-RI is structured according to a *Hub & Nodes* model. The Central Hub (CH) will be the statutory seat of the ERIC and will represent the heart of the strategy, coordination, communication and administration of METROFOOD-RI, coordinating the overall infrastructure and managing the central e-portal, which will give access to all the resources and services of the infrastructure. The CH will act as a coordinating European layer across all National Nodes (NNs), while the NNs will represent the operational sites of the infrastructure. The distributed nature of METROFOOD-RI facilitates collaborative research and service provision, leveraging the strengths and capabilities of diverse national institutions.

METROFOOD-EPI (GA 101130162) is the Horizon Europe funded project supporting the Early Phase Implementation of METROFOOD-RI. Its overarching mission is to advance the building process of METROFOOD-RI as infrastructure consolidated for its full implementation and ensure an effective start of the operational phase.

This document describes the specification of the e-RI core components for the CH. It serves Objective 2 of the METROFOOD-EPI project, i.e. *specify the technical implementation of the RI as service-oriented.* It focuses on the e-RI core architecture components, with the focus to produce user requirement specifications describing the requested functionalities and defining the user interfaces for the apps (UI/UX) and ICT technical details for their implementation. In the first part, the methodology of gathering potential users' opinions is presented: a survey was used where potential users could see either descriptions of the planned apps or links to existing apps; they were asked

different questions concerning the apps. The next part describes the gathered feedback and presents user requirements specifications for new apps that was created based on existing descriptions of planned apps and the opinions of potential users. Third part presents feedback and possible improvements that can be included in pilot apps created in the previous projects done as part of METROFOOD-RI. Final chapter presents the conclusions gathered and planned next steps.

2. Introduction

Since the design and early steps of METROFOOD-RI, the e-component of the infrastructure was planned. In particular, during the H2020 funded projects supporting the Early Phase (PRO-METROFOOD, GA 739568) and the Preparatory Phase (METROFOOD-PP, GA 871083), multiple e-components were planned, described, or even implemented. Figure 1 shows an overview of the core e-components of the CH that were identified, while the green tick-boxes indicate which components are already up and running. This overview serves as a "map" to see where a user requirement specification could be specified (apps without green tick-box) and where user feedback could be collected (apps with green tick-box) in order to gather information how to fit the users' needs better in those apps.

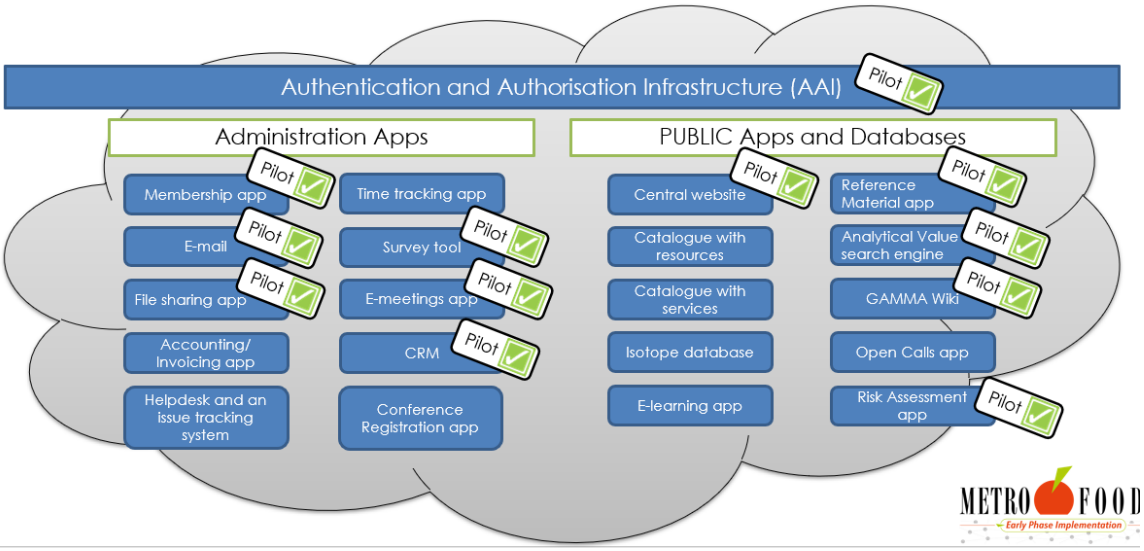

Figure 1 – e-Component of METROFOOD-RI

As presented on Figure 1, the apps in METROFOOD-RI are divided intro Administration Apps (used internally to support the management of the RI) and Public Apps and Databases (publicly available, presenting the work of the RI and service provided). The focus of this deliverable is on the Public Apps and Databases, with an exception for Conference Registration App, which is classified as "Administration App" and for which a specification was also prepared, as this will not be only used internally, but to register people outside of the Consortium for events. Accounting, helpdesk and time tracking tools weren't included considering that they will be used by the CH, that it has been stated to be hosted at the premises of the ENEA Casaccia Research Center (Rome) and it is under evaluation the possibility to use the tolls already used and maintained by ENEA. As for the helpdesk, it was also non considered since at the beginning it will be based on an e-mail address (support@metrofood.eu) and contact form implemented in the infrastructure's website (hosted and maintained by ENEA). A dedicated helpdesk tool is instead under testing and evaluation in the frame of the HEu EOSC-Beyond project (GA 101131875) in collaboration with the university of Karlsruhe (KIT) as they offer this as a service for any organisation and within the European Open Science Cloud (EOSC).

In order to gather opinions about both already existing and planned public apps, representatives of the NNs and Partner Institutes were asked to fill out a survey regarding e-needs, as well as provide feedback and ideas regarding specifications of the e-RI core components. The survey was prepared during multiple meetings among the partners in charge for coordinating the technical implementation of the METROFOOD e-RI (namely, PMT, PMT PL and JSI), to also support the definition of the e-needs implementation concept and not require project partners to provide the same information multiple times.

The preliminary specifications of some of the components that are still to be created for METROFOOD-RI that were prepared during the Preparatory Phase, specifying the architecture of the e-RI as well as identifying and classifying some of the resources that are still to be created in METROFOOD-RI, were updated and re-used in the survey to describe the applications such as Catalogues, Open Calls, or e-learning App (Annex 1). This with the purpose to let participants know how the apps should work and to gather feedback. For existing applications, like Authentication and Authorisation Infrastructure (AAI), Central Website, Reference Material app, Analytical Value search engine, GAMA Wiki, and Isotope database respondents were provided with links and asked few questions, focused to know their opinion about the tool, how often they use it, and if they would like to change the tool to something else.

Inputs collected were then analysed and elaborated to define user requirement specifications (presented in section 4) and collect feedback for pilots (presented in section 5). Moreover, preliminary user requirement specifications for new applications and updates of existing applications were created. Wireframes, which are rough schematic representations on how user interfaces should look like were created using Balsamiq software and are also included in section 3. Wireframes do not follow the style guides of METROFOOD-RI but are used to visualise user interfaces to users and help in UI/UX design. All the apps specified in section 3 will implement the METROFOOD-RI style guideline and design requirements.

In particular, user requirements specifications for the following planned components were created:

i) Catalogues
ii) e-learning app
iii) Open Calls app
iv) Access Portal
v) Conference app

Additionally, possible updates for the pilot versions of the following public apps created previously were defined:

i) AAI
ii) Central website
iii) Reference Material app
iv) GAMA Wiki
v) Isotope database
vi) Search&Compare app

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3. User Requirements Specifications

3.1. Catalogues

Catalogues list resources that METROFOOD-RI provides, with detailed descriptions and metadata to help users with searching the resources that interest them. It contains both physical and e-facilities, as well as services of METROFOOD-RI. The Catalogues are to be publicly available and, in connection with Access Portal, is to provide users with the possibility to access the resources. In general, the feedback on the description provided in the survey was positive and it was rated as very comprehensive and clear enough. Some ideas for additional features to be included in this software were collected, such as:

1. Including photos and pictures in addition to text for a catalogue item
2. Including, besides the contact person, a list of main people working in the facilities (or supporting the specific service provision)
3. Including a place where users can ask questions, share experiences, and collaborate
4. Allowing users to request additional resources not currently available in the Catalogue
5. Alerting users about newly added resources that match their profile or previous searches
6. Including an interactive map showing information on the NNs
7. Including different formats of the datasets
8. Integrating NNs' catalogues with the central ones

Based on the responses above, User requirement specification for the Catalogue was prepared, as specified hereinafter.

In the app, different types of resources will be available. A "resource" can be understood as an already existing resource, a service, or an access to a facility.
Each type of resources will be a separate catalogue, with separate search functionalities. Using the search functionality will not require a user to login, however separate terms and conditions may be applied to get access to the resource - those will be defined with information from the Access Portal. Resources with such terms and conditions would require users to create an account, but it will be also possible to create resources available to all users without logging in.

Figure 2 shows an example of a search functionality for e-services. There is a search field and different dropdown boxes facilitating search. Once the user clicked on the search button, the results will be presented as shown in Figure 3. Each result will have a title, description and some categorisation and more information can be opened to see more details.

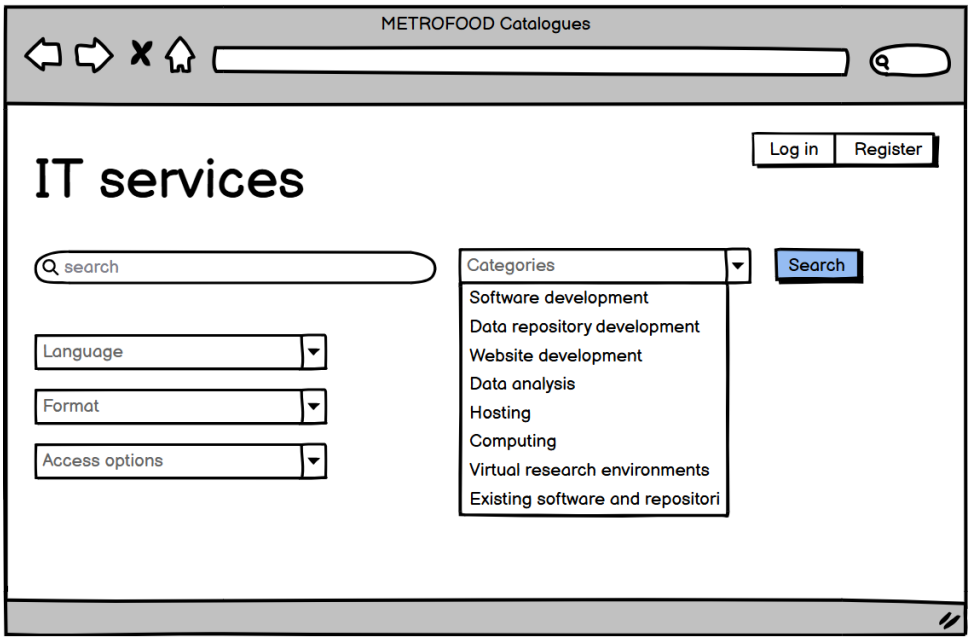


Figure 2 - Wireframe presenting searching in ICT resources

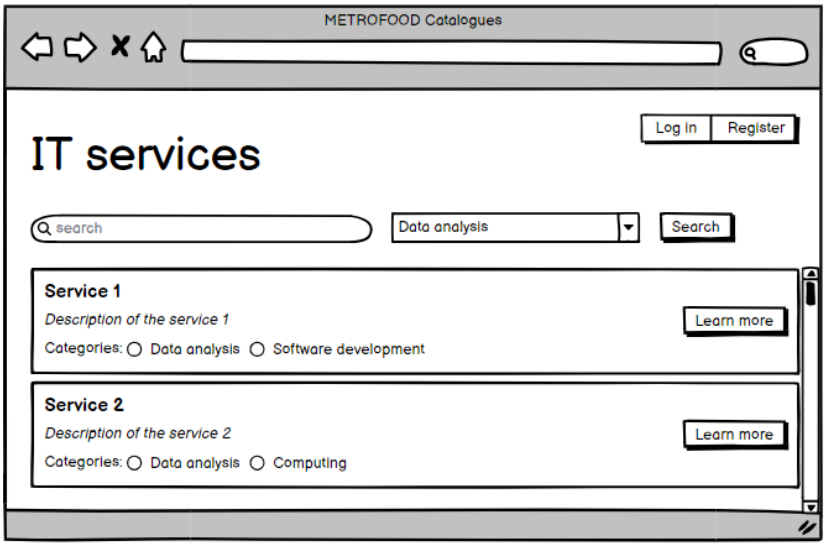


Figure 3 - Wireframe presenting searching results in "Data analysis" category

A resource can be created and modified in an editor panel by a user that has the permission to create new resource (resource owner). Only the administrator user of METROFOOD ERIC (i.e., of the CH) will be able to edit all resources and only the admin user can approve new resources.

Each resource can be described by a list of fields, with a possibility to also add pictures. Contact information of a person responsible for a resource will also be included, with a possibility to add more contact people during the creation of a resource. Figure 4 shows an example of what details will be provided for service entry.

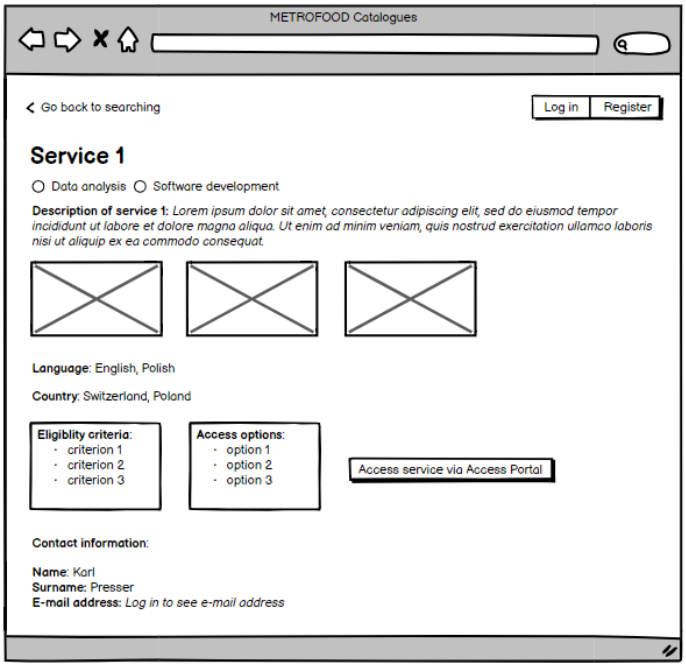


Figure 4 - Wireframe of exemplary resource page from "Data analysis" category

The fields planned for resources connected to laboratory or plant work are:

1. name
2. description
3. pictures
4. language
5. country
6. access options.

The fields planned for ICT resources are:

1. name
2. description
3. pictures
4. language
5. access options.

The fields are planned for advisory resources (e.g. help with regulatory compliance or expertise) are:

1. name
2. description
3. pictures
4. language
5. access options.

The fields planned for software are:

1. name
2. description
3. pictures
4. licence
5. language
6. format
7. files
8. technology stack
9. access options.

The fields planned for repositories are:

1. name
2. description
3. pictures
4. licence
5. language
6. countries
7. format
8. size
9. starting year of data collection
10. ending year of data collection
11. files
12. access options.

The fields are planned for learning materials are:

1. name
2. description
3. pictures
4. language
5. format
6. files
7. access options.

In all cases, it will be possible to upload data files in multiple formats.
Additionally, each resource may be assigned categories to help with the search, as filtering using the provided categories will also be possible. Multiple categories may be assigned to one resource thus increasing the findability of the resource.
Each logged in user will be able to request a resource that is not currently available in the Catalogues. Information about such a request will be sent to the CH, which will contact the a facility that may fulfil such a request or by answering that it is not possible to fulfil the request in METROFOOD ERIC, see Figure 5 and Figure 6.
Logged in user will also be able to rate the resources. Additionally, a comment field under each resource will be implemented, so that logged in users can give feedback.

Figure 5 - Wireframe of requesting a resource option below the searching results

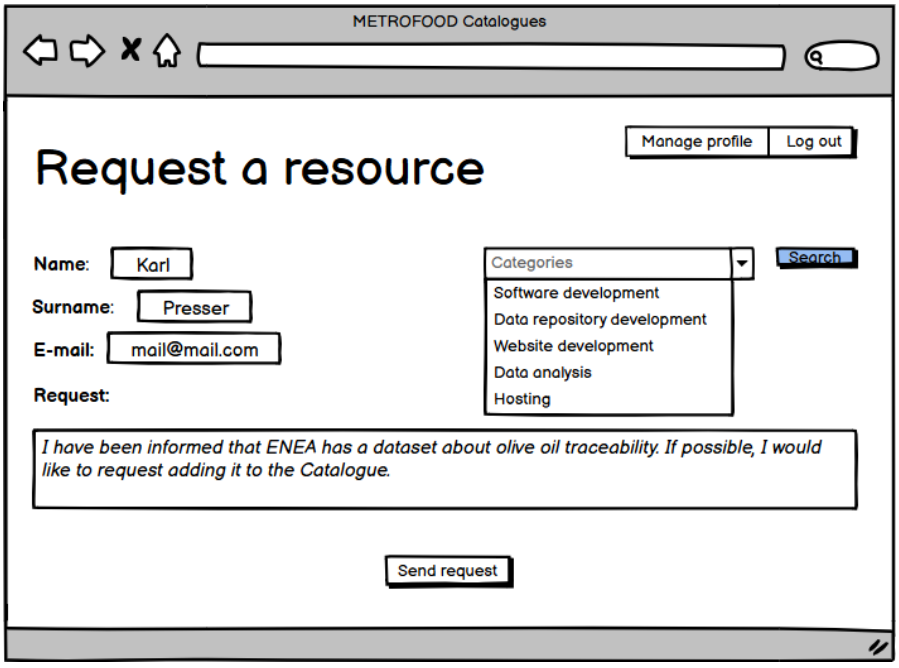


Figure 6 - Wireframe of a form to request a resource

All catalogues created within METROFOOD-RI should be inter-linked to enable switching between resources and catalogues. User statistics about logged in users and not logged in users will be collected (e.g. number of users, country of the user, etc.).

3.2. E-learning app

The e-learning app is a modern Learning Management System (LMS) designed to provide high-quality education and training resources. In the app, different types of learning resources will be available. A "learning resource" can refer to an existing course, tutorial, assessment, or educational material.

In general, some feedback disclosed the need to create such an application, as METROFOOD community has a lot of training and learning materials to be shared. Some ideas for features to be included in this software were collected, such as:

1. Including pre-recorded presentations
2. Including materials for consultation
3. Providing certificates or badges for completing courses
4. Including a place where users can interact
5. Implementing feedback-gathering feature
6. Including a list of training options, and a list of specific expert groups
7. Exploiting -IT platform that is being developed or integrating with it

Based on the responses above, user requirement specification for the e-learning app was prepared, as specified hereinafter.

Each type of learning resource will have its own separate catalogue with its own search functionality. Accessing the search functionality does not require users to log in, but certain resources may have specific access requirements (e.g., paid access, completion of prior courses). Log-in will be necessary only for then accessing the resources. Figure 7 illustrates an example of the search functionality for e-learning modules. The interface includes a search bar and various dropdowns for filtering by subject, level, language, and more.

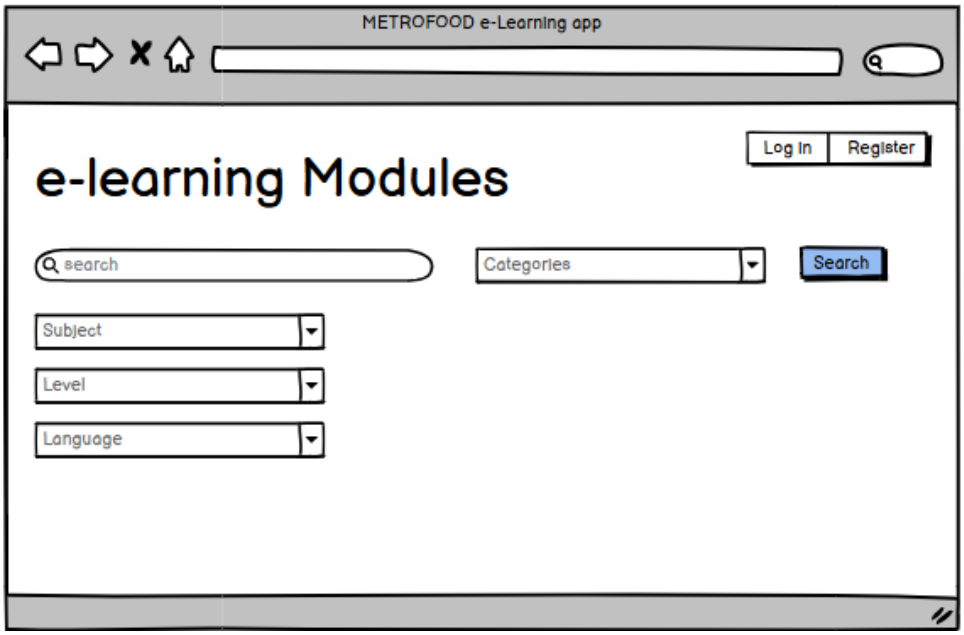


Figure 7 - Wireframe of searching in e-learning App

Upon clicking the search button, the results are displayed as shown in Figure 8. Each result will display the course title, a short description, and categories, with the option to click for additional details such as syllabus, instructor, and course prerequisites.

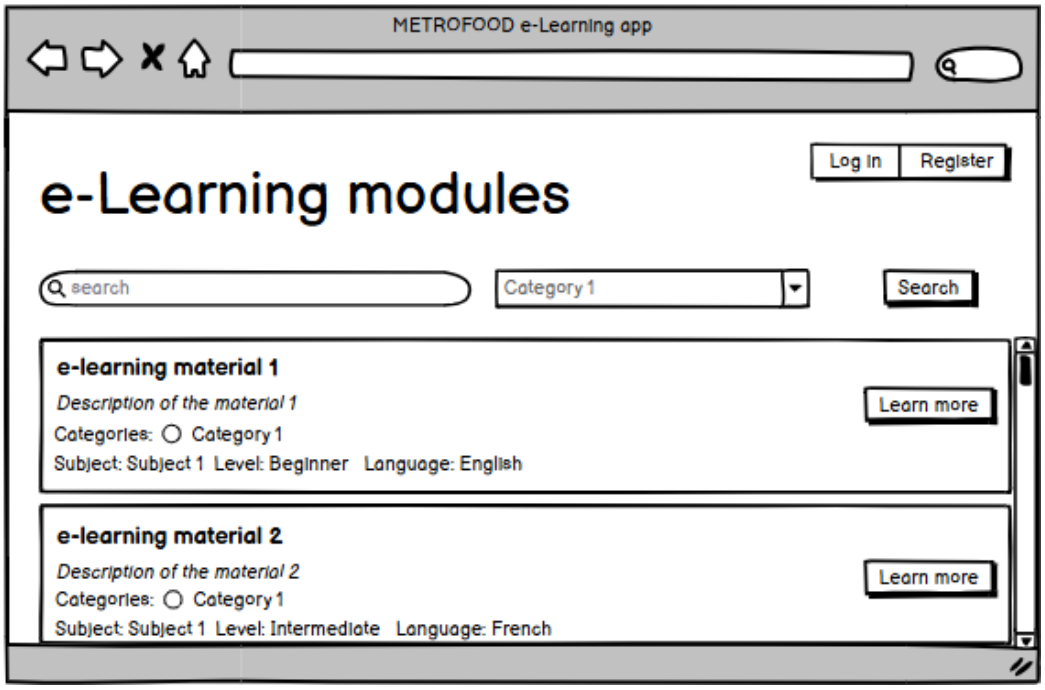


Figure 8 - Wireframe of search results in e-learning App

Learning resources can be created and edited in an admin panel by authorized users (course creators). Admin users (platform administrators) will have the ability to manage all resources, including approving or rejecting newly created courses before they are published.
Each learning resource will have a set of fields to provide a structured description, with options to upload images and additional files (e.g., lesson plans, exercises). Contact information for the instructor or course coordinator will also be included, with the ability to add more contacts if necessary. Figure 9 demonstrates an example of a detailed course entry.

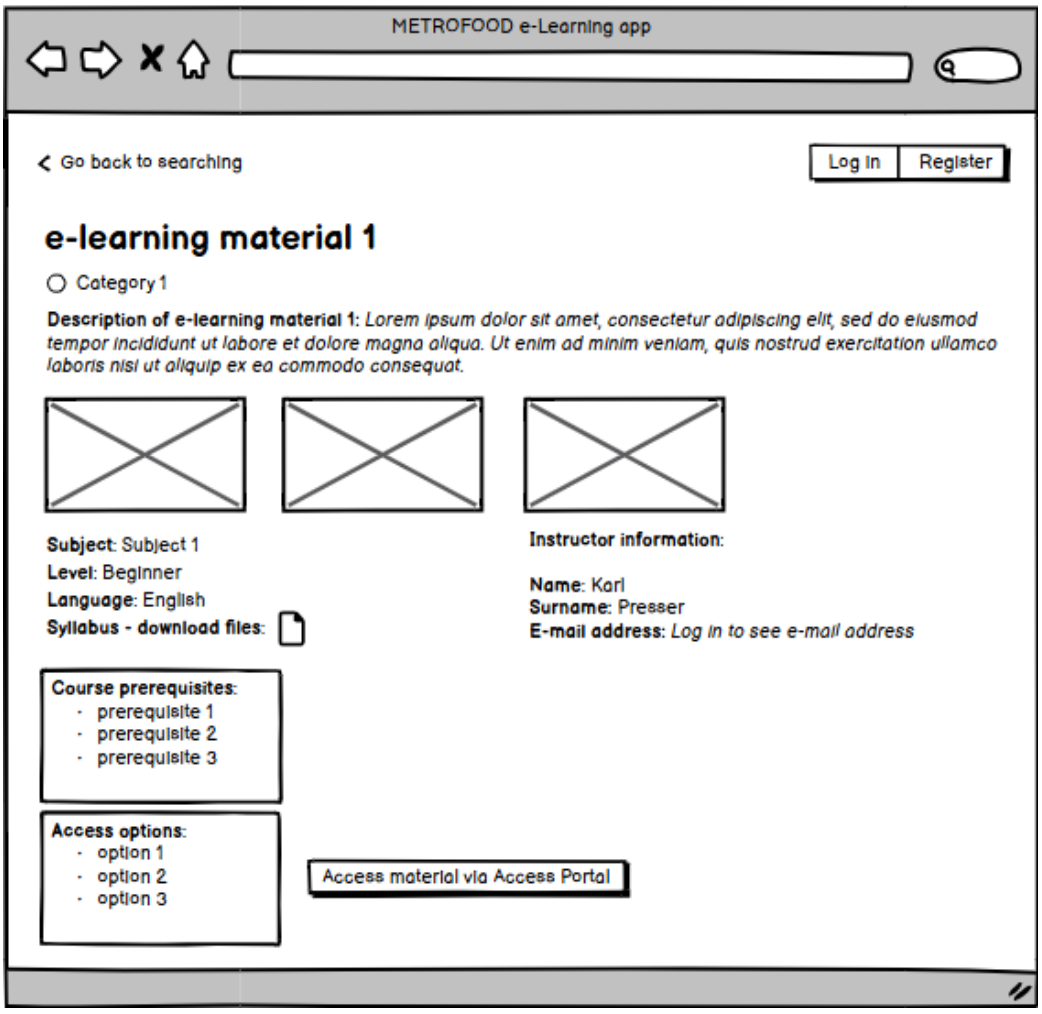


Figure 9 - Wireframe of a detailed entry in e-learning App

The e-learning app will be capable of hosting Massive Open Online Courses (MOOCs), targeted at three main user groups:

1. Academic staff (teachers, researchers, and PhD students)
2. Companies operating in the agrifood sector
3. End users (general public).

These MOOCs will include videotaped lectures with multimedia content such as handouts and self-assessment tools like multiple-choice tests. The platform will provide advanced technologies, such as virtual classrooms, for an engaging and interactive learning experience.
The e-learning app shall be used also for training the internal staff of the infrastructure (both the CH and NNs), to be used for upskilling of human resources.

The fields planned for Online Courses are:

1. Course Title
2. Course Description
3. Instructor Information

4. Images
5. Language
6. Duration
7. Course Level (e.g., Beginner, Intermediate)
8. Prerequisites
9. Access Requirements

The fields planned for Tutorials are:

1. Title
2. Description
3. Author Information
4. Images
5. Language
6. Format (video, text, interactive)
7. Files (e.g., code examples, reading materials)
8. Access options

The fields planned for Assessments/Quizzes are:

1. Name
2. Description
3. Duration
4. Number of Questions
5. Language
6. Difficulty Level
7. Access Requirements
8. Passing Criteria

The fields planned for Learning Materials (PDFs, Guides) are:

1. Title
2. Description
3. Author Information
4. Language
5. Format
6. Files
7. Access Options

The fields planned for Webinars/Workshops are:

1. Title
2. Description
3. Instructor Information
4. Date and Time
5. Duration
6. Registration/Access Requirements
7. Platform (Webex, Zoom, Teams, etc.)

For all types of resources, it will be possible to upload files in various formats (PDF, video, etc.). Additionally, each resource can be categorised (e.g., by subject, level, or format) to enhance searchability.

Registered users will have the option to request new courses or learning materials that are not currently available in the catalogue. Requests will be sent to the platform's admin team, who will handle inquiries and provide feedback regarding the possibility of adding the requested resources.
Users will also be able to rate courses and provide feedback through a comment section available under each course description. These ratings and comments will help improve the quality of learning resources on the platform.

User statistics, such as the number of users, their activity levels, and country of origin, will be collected for both logged-in and non-logged-in users. These insights will help improve the overall platform and tailor content to user needs.

3.3. Open Calls app

As METROFOOD-RI will have different open calls, they should be available for interested parties online. Therefore, a dedicated app allowing for creating calls, their management and rating by CH, as well as filling them out by external users, shall be created.
Some ideas for features to be included in this software were collected, such as:

1. Making the survey as user-friendly as possible
2. Integrating the app with Access Portal
3. Providing customisable templates for different types of call
4. Providing training for the creation process
5. Including automated notifications to alerts users about deadlines, new calls, etc.
6. Maintaining and archive of past calls and training sessions that the user can search through
7. Integrating social media sharing features
8. Including possibility for the partners to express their interest in specific calls
9. Including visual and eye-catching elements on the website

Based on the responses above, the following user requirement specification for the Open Calls app was prepared.

This web app will allow the CH service officer, along with open call managers, to create open calls and allow applicants to apply for these open calls. The app will contain a database with all applications and will allow the open call manager and reviewers to manage and analyse these applications.
The main goal of the app is to allow a non-IT person to easily create an open call form. The app will contain multiple templates for different types of open calls (e.g. administrative calls, service provision calls, project partnership calls, training sessions), which the call manager will be able to fill out and add some information. The creator will be able to include files and pictures in the call.
Figure 10 shows the starting page of the open call app where the different types of calls can be seen.

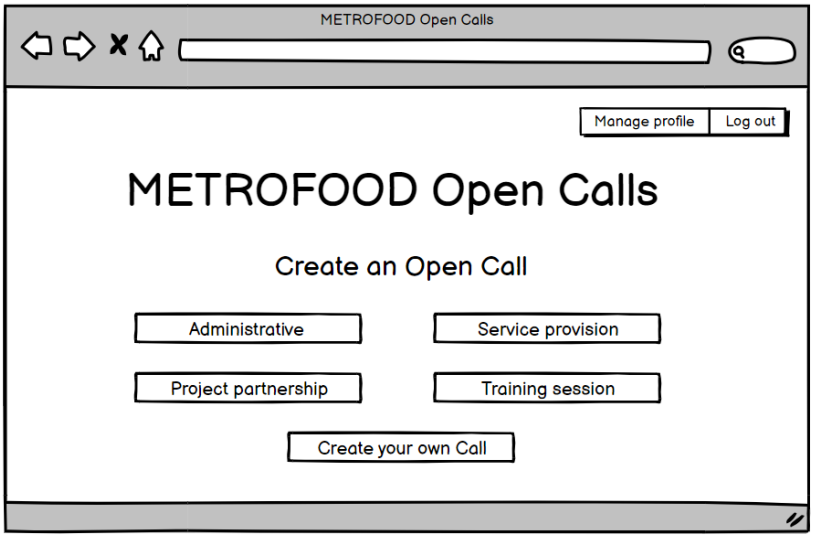


Figure 10 - Wireframe of page with different Open Call templates

The fields planned for each call are:

1. Name
2. Surname
3. E-mail
4. Professional designation
5. Sector
6. Affiliation
7. How did you hear about this Open Call?
8. Proposal title and acronym
9. Persons involved in the proposal, their affiliations and roles
10. Proposal description
11. Proposal objective
12. Timeline and workplan
13. Expected outputs
14. Ethical and safety concerns
15. Background and publications
16. Additional information
17. File upload

Additionally, necessary agreements and consents will be included.

Before the call if published, it should be checked and approved by another person and therefore open calls need a status plan. A status plan defines what statuses an open call can have and how to get from one status to another. In the first version, three statuses were identified: The status “New” indicates that an open call is being prepared and checked and is not yet published. As soon as it is ready, the status “Published” indicates that the call is now online, and users can apply. Once the deadline is over, the open call changes automatically into the status “Closed” indicating that no more applications are

allowed, and the open call is no longer online. It will be possible to jump from each status into another which allows maximal flexibility.
All past calls will be saved and available for the managers to see for reference and historical data.
A published call will also include functionalities to easily publish information about the call on social medias. Additionally, there will be a comment section to ask questions and express interest in the calls as shown in Figure 11.

Figure 11 - Wireframe of a published Open Call with comments section

Candidates must create an account in METROFOOD AAI to fill out the call. In this way they also get access to other METROFOOD e-services.
When the call candidate fills out the form, the data will be saved. If the candidate fills out only part of the form, this part will be saved, and the user can come back later to continue.
If an open call foresees that a proposal document should be uploaded, e.g. a pdf document, then the application form will allow to upload documents.

If a certain service offered in the Catalogues is associated to an Open Call, the user can search for it and select it.

The open call manager will be able to see the user applications, can see the filled forms and will be able to download the files that applicants uploaded, see Figure 12. The open call manager can then assign applications to evaluators and the evaluators will be able to see applications that are assigned to them.

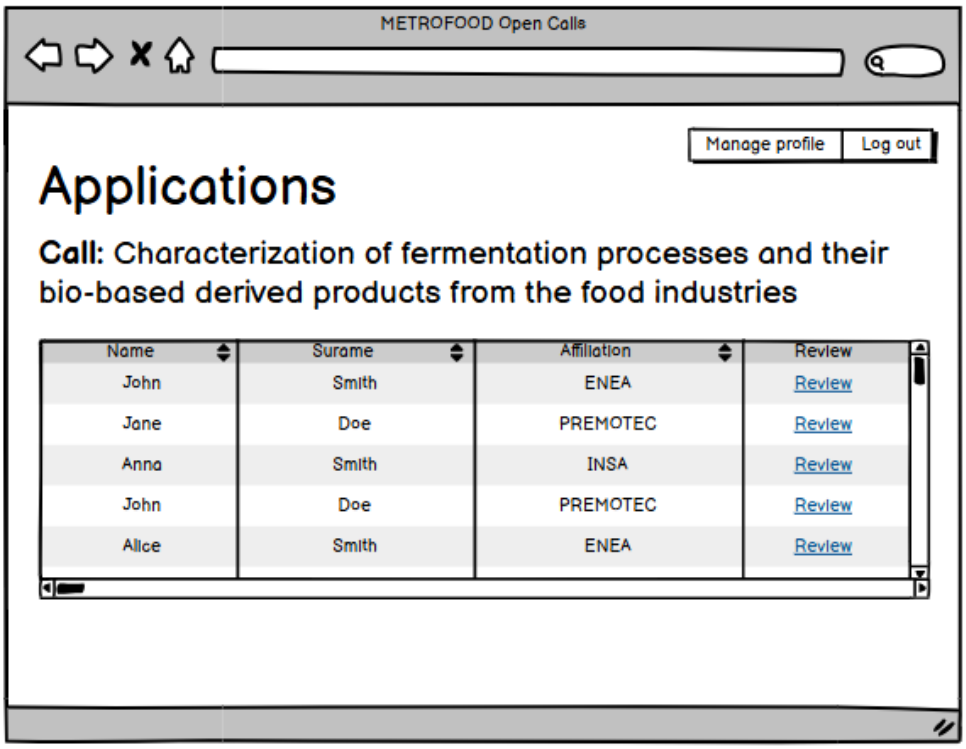


Figure 12 - Wireframe of applications table with possibility to download files with application

The open call manager will define evaluation questions or evaluation criteria and the rating schema (for example 1-5). The evaluator should then evaluate each question or criteria using the rating schema. A reviewer should add a general comment as well as comments for each question or criteria. Figure 13 depicts an example of two questions and three rating schemas on excellence, impact and implementation.
For the final rating, which is presented to the user, two options should exist:

1. The open call manager can generate automatically an average of the reviewers' ratings and needs to summarise the comments or
2. The final evaluation is done as group where rating and comments are evaluated in evaluation meeting (like how Horizon evaluations are done)

Finally, a decision (accepted or rejected) must be made and stored. The open call app should then allow to generate an acceptance or rejection letter/notification with the rating and comments.

From the user's perspective, any access granted to services and resources of METROFOOD-RI will be visible in the Access Portal.

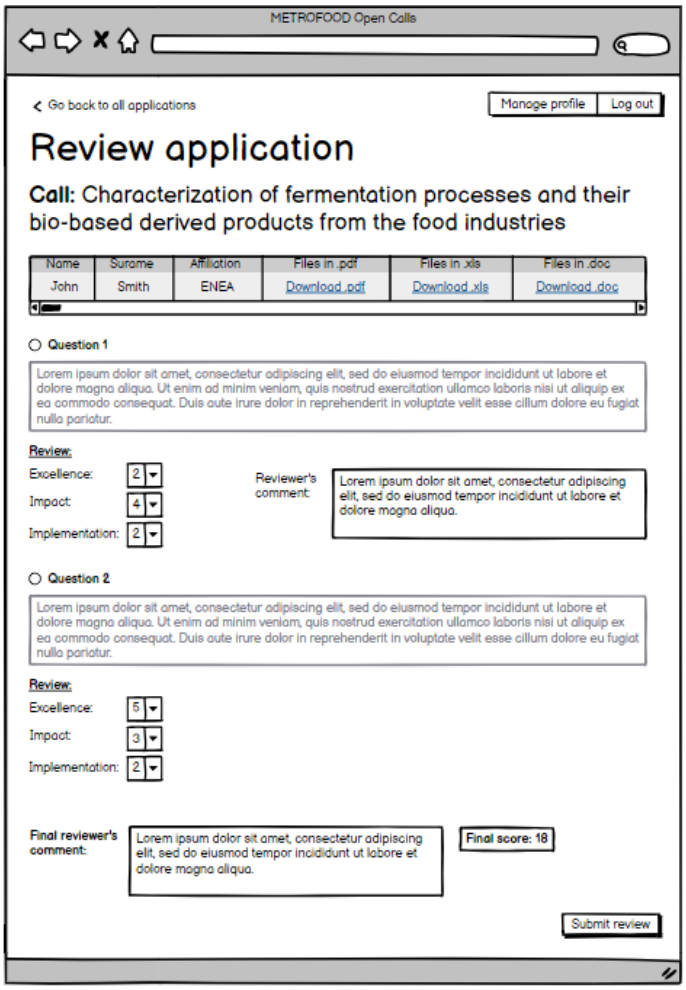


Figure 13 - Wireframe of reviewing panel

3.4. Access Portal

Access Portal will be the place where a user can see granted access to METROFOOD-RI services and resources. If the granted access is an electronical service or resource, e.g. access to a restricted dataset or access to e-learning module, then the user can access it from the Access Portal. The access portal will contain access to services and resources from the catalogues, e-learning, and open calls that were granted. In the analogy of an online shop, the access portal would be the place where bought items can be seen and from where these items can be accessed. An example is reported in **Figure 14**.

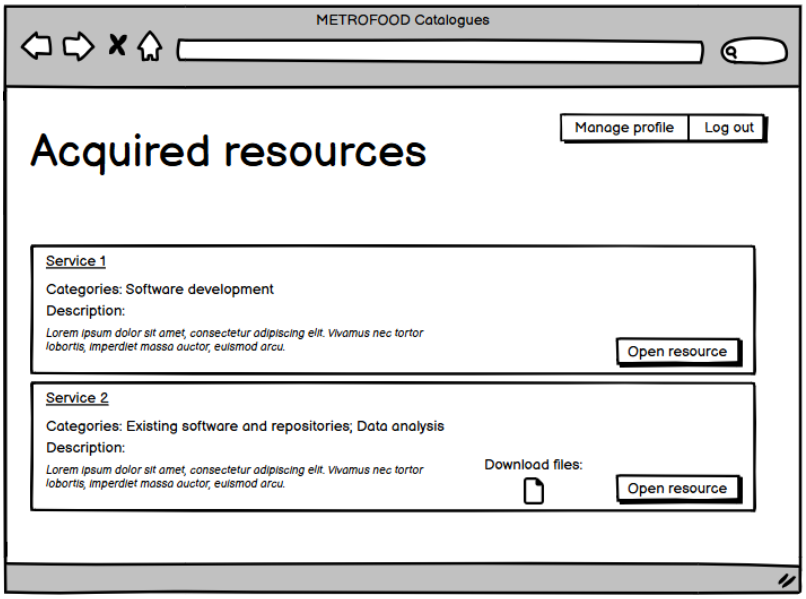


Figure 14 – List of services user has access to

Five different "use cases" have been identified for access to services and resources:

1. Services which are available upon application to Open Calls.
2. User asks for a service or resource in the Catalogues or e-Learning App and access is provided via the CH in the Access Portal (e.g. upload a file on Access Portal or provide login on Access Portal).
3. User asks for a service or resource over the Catalogues or e-Learning app. Through the Access Portal and via e-mail, an offer will be provided to the user. If the user accepts the offer, the user can get access to the services or resources. The app will allow the Service Officer of the CH to manage the access provision, including reporting and – in case of paid services – the payment procedure.
4. Services and resource which are available to registered users ("wide access").
5. User asks for a special service which does not exist in the Catalogues, or which is different to an existing service in the Catalogues. This request will be stored in the Access Portal, and, under the coordination of the Service Officer, a service provider will be identified then defining a tailored offer for the user. The user will be then put into contact with the Access Manager of the facility(ies) identified to provide the service (outside of the Access Portal), but then the user will have to close the request in the access portal, accepting it or not. If the proposal is accepted, then the service provision will be managed like the ones for the services already included in the Catalogues.

The Access Portal will facilitate providing the access to the services and resources from the METROFOOD's side, accommodating each use case connected to the Access Portal above. It will also allow the users of the Catalogues to see which resources they have access to.

3.5. Conference app

The conference app, called "Confi", provides a platform for event managers to onboard users and let them register for events. It is possible for the organiser to individually prepare a form for the participants to fill in during registration. This might include relevant information like allergies, food preferences, language request or additional information like which workshops they want to attend.

Figure 15 – Confi app – main view

The organiser can:

1. View events

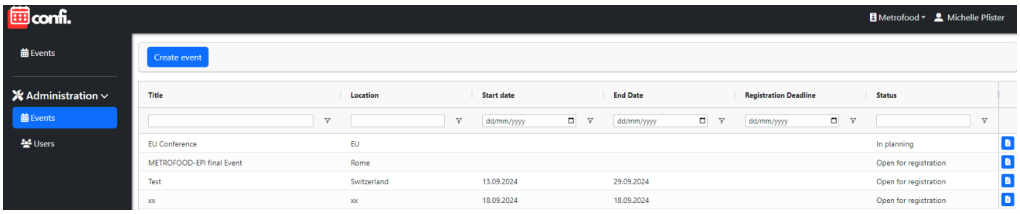


Figure 16 – Confi app – viewing events

2. Create and manage events, including e.g.: title, location, schedule, details (including creating a bespoke form), or uploading documents for participants (e.g. agenda, flyers, practical information)

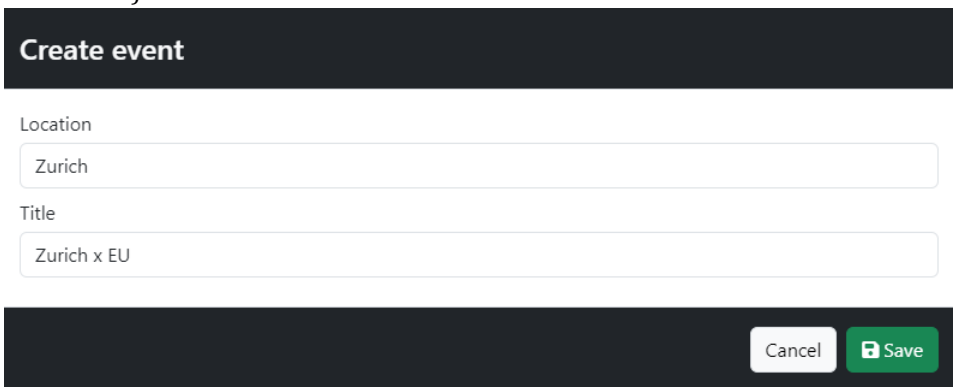


Figure 17 – Confi app: event creation – adding location and title

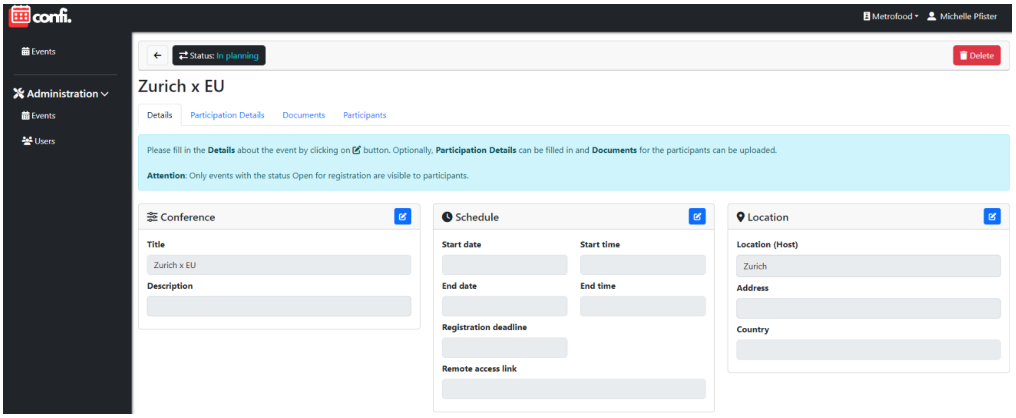


Figure 18 – Confi app: event creation and management – providing details about schedule and location

3. View Participants (with possibility to send email to selected participants)

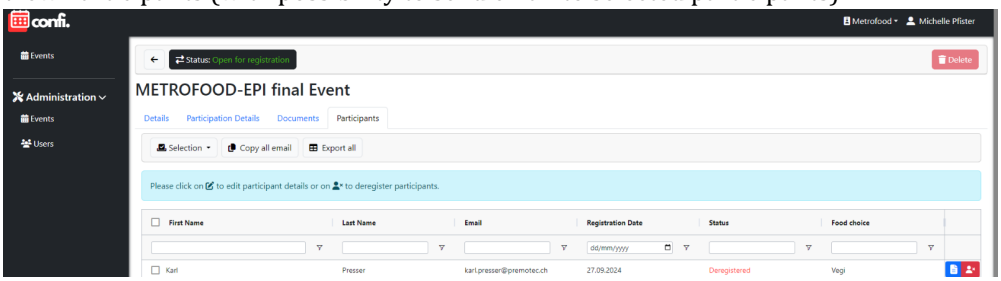


Figure 19 – Confi app: event creation – viewing participants

4. Invite users
5. Export data like list of all participants of an event as excel file
6. Change participants details (for example manually deregister them if necessary)

The participants can:

1. Register for an event
2. View events where they are registered, including provided documents (for example the slides from the presentation)
3. Fill in other details requested by the organiser.

The data is securely being managed as the users log in with their Keycloak login in the METROFOOD-RI's AAI.

4. Feedback for Pilots

4.1 AAI

AAI (Authentication and Authorization Infrastructure) in the context of METROFOOD-RI is a set of protocols that allows user to use the same password and login in different systems – a single sign-on (SSO) system. Thanks to that, users do not have to create and remember multiple login details. METROFOOD's AAI is available under:
https://aai.metrofood-services.eu/auth/realms/metrofood/protocol/openid-connect/auth?client_id=account.

The AII resulted as "easy to use," "useful to manage account's details and control accesses". As for changes, there was an idea for some updates, e.g., including more information related to the account, such as a link to the organisation website or other forms of contact (presented on Figure 20).
Two additional fields are proposed to be added to the current version of AAI:

1. Organisation
2. Alternative form of contact

Both of the fields would not be mandatory, as this information is not necessary to set up an account.

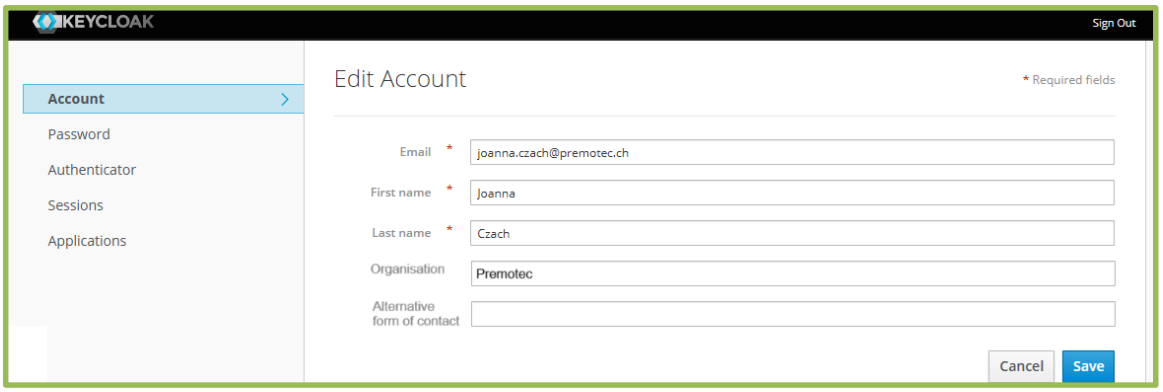


Figure 20 - Proposition of additional fields in AAI

4.2 Central website

METROFOOD-RI website is the main entry point for METROFOOD-RI stakeholders. It is available under the https://www.metrofood.eu/ address. The website contains information about METROFOOD-RI, consortium and projects behind it. It is filled with news, dissemination material, information about Open Calls, and contact information.

Feedback gathered in the survey was rather positive and website was rated as informative, well structured, and easy to navigate. However, some respondents pointed out the necessity to update the design to have more "modern" feel and it should compile and classify information in a more practical way. As central website is currently under re-built and should be finished by the end of the METROFOOD-EPI project whole feedback was passed to the team that is working on that. Such an activity is part of WP6 – *Dissemination, outreach and community engagement*.

4.3 Reference Material app

Reference Material app (RM-app) presents information of the production of Reference Materials (RMs) for the agrifood sector worldwide. There are two search modules (basic and advanced) that allow users to look for RMs based on e.g., Matrix, Parameter, or Producer (see Figure 21). It was created during METROFOOD-PP by PMT and ENEA. Access to the app is restricted only to the users with a login. The app can be found under https://rm.metrofood-services.eu/.

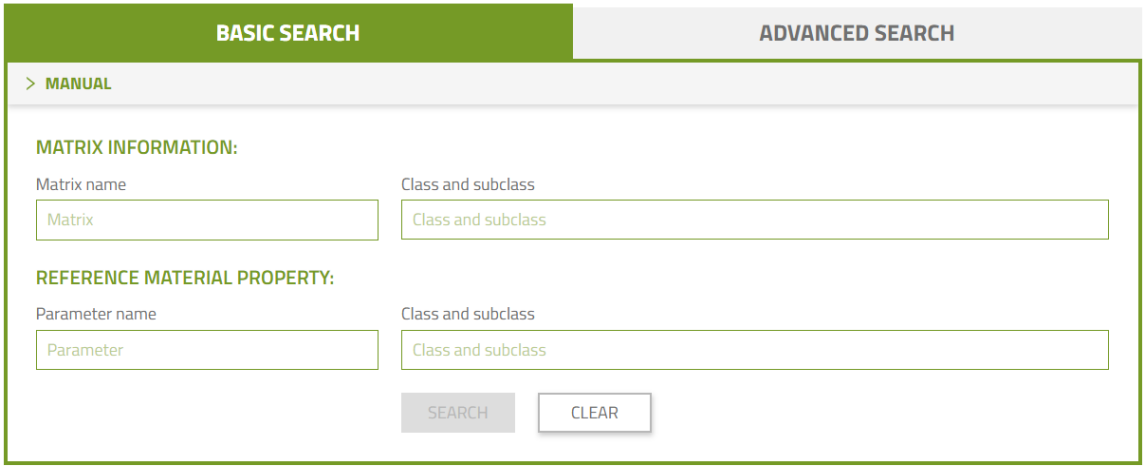
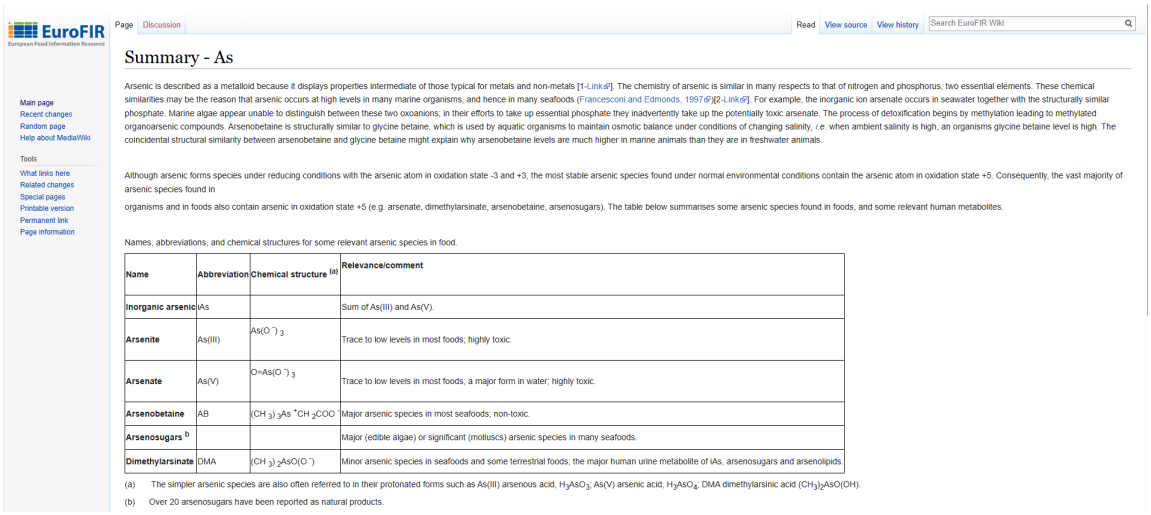


Figure 21 – Search module of RM-app

Feedback gathered from the survey was mostly positive, concentrating on user-friendliness and intuitiveness. However, it was mentioned that some information is missing, and an update of the app is needed. An idea for an automatic update was also presented, especially considering that in fact update on the data provided by the app is a crucial, critical aspect also for its proper effectiveness. Additionally, it is planned to extend the app to also include proficiency testing, and reference and official methods, ideally giving the possibility to the users to find with a single search all the information about the matrix-analyte combination they are interested in. and include more information for matrix and more parameters)

4.4 GAMA Wiki

GAMA (Guidelines for Assessment of Methods of Analysis) Wiki is a tool created in EuroFIR and TDS-EXPOSURE projects. PRO-METROFOOD project migrated it into the Wikimedia tool, which is used by Wikipedia. GAMA Wiki presents analytical methods, reference materials and proficiency testing schemes for listed target analytes. It contains guidelines that can assist compilers when evaluating methods of analysis and can also be used as a reference points when evaluating the accuracy of routine methods. It can be found under https://eurofir-wiki.metrofood-services.eu/index.php/GAMA_Guidelines_for_Assessment_of_Methods_of_Analysis.



EuroFIR
European Food Information Resource

Page | Discussion | Read | View source | View history | Search EuroFIR Wiki

Main page
Recent changes
Random page
Help about MediaWiki

Tools
What links here
Related changes
Special pages
Printable version
Permanent link
Page information

Summary - As

Arsenic is described as a metalloid because it displays properties intermediate of those typical for metals and non-metals [1-Links]. The chemistry of arsenic is similar in many respects to that of nitrogen and phosphorus, two essential elements. These chemical similarities may be the reason that arsenic occurs at high levels in many marine organisms, and hence in many seafoods (Francesconi and Edmonds, 1997)[2-Links]. For example, the inorganic ion arsenate occurs in seawater together with the structurally similar phosphate. Marine algae appear unable to distinguish between these two oxoanions; in their efforts to take up essential phosphate they inadvertently take up the potentially toxic arsenate. The process of detoxification begins by methylation leading to methylated organoarsenic compounds. Arsenobetaine is structurally similar to glycine betaine, which is used by aquatic organisms to maintain osmotic balance under conditions of changing salinity, *i.e.* when ambient salinity is high, an organisms glycine betaine level is high. The coincidental structural similarity between arsenobetaine and glycine betaine might explain why arsenobetaine levels are much higher in marine animals than they are in freshwater animals.

Although arsenic forms species under reducing conditions with the arsenic atom in oxidation state -3 and +3, the most stable arsenic species found under normal environmental conditions contain the arsenic atom in oxidation state +5. Consequently, the vast majority of arsenic species found in

organisms and in foods also contain arsenic in oxidation state +5 (e.g. arsenate, dimethylarsinate, arsenobetaine, arsenosugars). The table below summarises some arsenic species found in foods, and some relevant human metabolites.

Names, abbreviations, and chemical structures for some relevant arsenic species in food.

Name	Abbreviation	Chemical structure [a]	Relevance/comment
Inorganic arsenic	As		Sum of As(III) and As(V).
Arsenite	As(III)	$As(O^-)_3$	Trace to low levels in most foods; highly toxic.
Arsenate	As(V)	$O=As(O^-)_3$	Trace to low levels in most foods; a major form in water; highly toxic.
Arsenobetaine	AB	$(CH_3)_3As^+CH_2COO^-$	Major arsenic species in most seafoods; non-toxic.
Arsenosugars [b]			Major (edible algae) or significant (molluscs) arsenic species in many seafoods.
Dimethylarsinate	DMA	$(CH_3)_2AsO(O^-)$	Minor arsenic species in seafoods and some terrestrial foods; the major human urine metabolite of iAs. arsenosugars and arsenolipids.

(a) The simpler arsenic species are also often referred to in their protonated forms such as As(III) arsenous acid, H_3AsO_3; As(V) arsenic acid, H_3AsO_4; DMA dimethylarsinic acid $(CH_3)_2AsO(OH)$.

(b) Over 20 arsenosugars have been reported as natural products.

Figure 22 – Arsenic page on GAMA wiki

The survey results were mostly positive – the tool was considered useful and effective. However, there are areas for improvement and updates, e.g., some links are broken. As data belongs to EuroFIR, the feedback was forwarded to the organisation and it has been planned to set a dedicated collaboration between METROFOOD-RI and EuroFIR in order to implement those improvements.

4.5 Isotope database

The IsofoodTrack database (http://isofoodtrack.ijs.si) has been developed at the JSI to structure analytical data on stable isotopes of light elements and elemental composition in a way that enables further processing using statistical and machine learning methods, Geographic Information System applications, and modelling. The main page is presented on Figure 23.

The main purpose of IsofoodTrack is to provide a tool for combating food fraud and ensuring food safety and integrity. Among the techniques available, stable isotope fingerprinting are leading the way of establishing the authenticity and geographical origin of food products. This choice is based on the fact that distribution of stable isotopes of carbon (12C, 13C), nitrogen (14N, 15N), sulfur (32S, 34S), hydrogen (1H, 2H), and oxygen (16O, 18O) is influenced by fractionation processes linked to local climate, geology, and soil characteristics. These processes result in varying rates of isotope transfer from natural sources such as water, soil, and the atmosphere to plant or animal tissues. For example, the ratio of stable isotopes in water (2H/1H and 18O/16O) can provide critical information about local precipitation, surface water, and groundwater, which are influenced by factors like latitude, altitude, distance from the sea, precipitation levels, and evapotranspiration. The verification of regional origin becomes even more effective when combined with elemental composition profiles. To determine authenticity, a suitable reference dataset of analysed authentic products is required. This dataset should include samples representative of a wide range of geographical, seasonal, dietary, and production conditions. Authenticity is assessed by comparing the values found in commercial samples with the limits estimated from the reference dataset, using a suitable statistical model to evaluate the best fit.

Currently, only a few databases cover a wide regional distribution of isotopic signatures, with the European wine database being the most developed. Therefore, the IsoFoodTrack was developed

database and implemented as an openly available PostgreSQL database. Its underlying schema is flexible, accommodating growing metadata or analytical results requirements without the need for frequent modifications. Additionally, it complies with the ISO-FOOD ontology[1], supporting semi-automated integration with data from other relevant sources, and is openly available through the NCBO BioPortal. Currently, the IsoFoodTrack database contains data on the stable isotopes and elemental composition of various products, including oils (argan, olive oils), milk and dairy (cow, sheep, goat milk), meat (Iberian pig and Tunisian lamb), spices (saffron), and truffles, primarily from the Mediterranean macro-region. The nomenclature of the elemental components complies with the CEN Standard of food data.

The database is managed by the IsoFoodTrack database management system (DBMS), a user-friendly web-based tool that offers convenient data handling features, such as data compilation, grouping, aggregation, visualisation, and analytics. In addition to basic data grids, geographic maps are used to present data with isoscapes - an innovative approach that allows users to visualize and understand trends, outliers, and patterns in the IsofoodTrack dataset (presented on Figure 24). An isoscape, derived from the words “isotope” and “landscape,” provides a spatially georeferenced representation of the distribution of isotopic compositions (generally of light elements). These maps are generated by incorporating isotopic data into geographic maps.

The IsoFoodTrack tool supports advanced analytics based on statistical and explainable machine learning approaches, enabling the development of discriminant models to differentiate selected food commodities based on species using elemental and stable isotope data. Machine learning (ML) is a branch of artificial intelligence (AI) that enables systems to learn and improve from experience without being explicitly programmed. The ML component accepts the food's isotopic composition as input and predicts its geographical origin. Additionally, it offers explanations about which specific isotopes serve as indicators for that geographical origin, with the aim to raise the trust in the AI generated suggestion.

Initially developed during the European project RealMed (REALMed Project, 2024[2]), the IsoFoodTrack database and DBMS are currently being upgraded in METROFOOD-EPI to support science, industry, citizens, and policymakers in combating food fraud, particularly in the seafood sector. The plan is to enhance the IsoFoodTrack database and its supporting tool by incorporating new data for commodities relevant to the interests of the METROFOOD community. As new data analysis methods are developed, the IsoFoodTrack user interface will also be enhanced to visualise the resulting insights.

[1] Tome Eftimov, Gordana Ispirova, Doris Potočnik, Nives Ogrinc, Barbara Koroušić Seljak (2019) ISO-FOOD ontology: A formal representation of the knowledge within the domain of isotopes for food science, Food Chemistry, Volume 277, Pages 382-390, ISSN 0308-8146, https://doi.org/10.1016/j.foodchem.2018.10.118.

[2] REALMed Project. (2024, 09 30). *REALMed Project*. Retrieved from https://realmedproject.weebly.com/

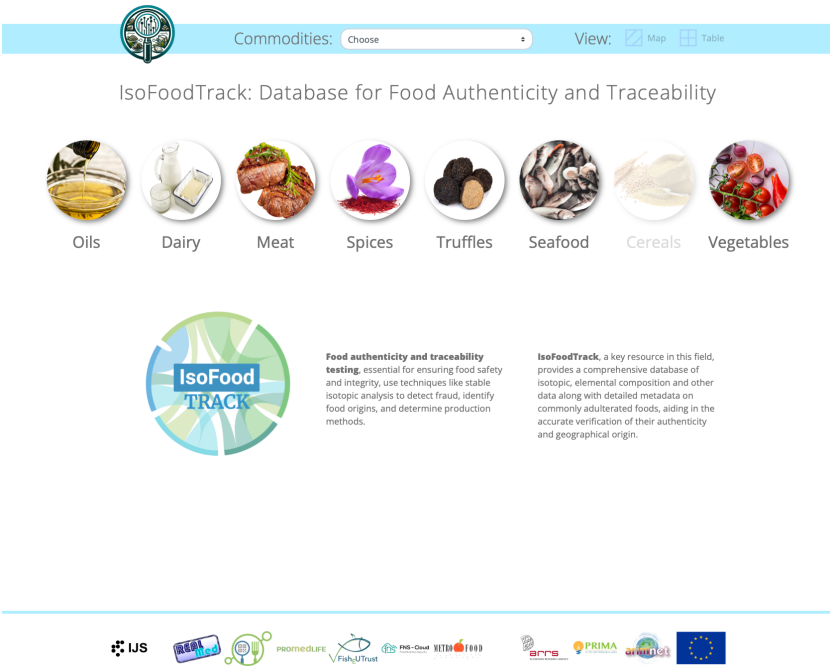


Figure 23 - IsoFoodTrack

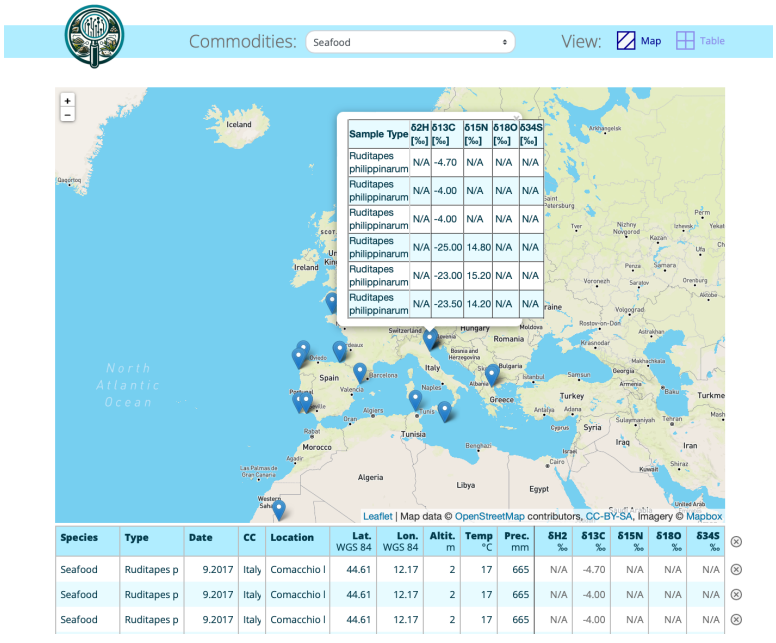


Figure 24 - IsoFoodTrack visualisation model

4.6 Search&Compare app - METROFOOD Data Repository

A pilot version of the Search&Compare app (Analytical Value search engine for foods) was developed during PRO-METROFOOD project. The Search&Compare App was created to allow users to search data in different FoodCASE databases, including only analytical results and no metrological data in the version created in PRO-METROFOOD. There are two search options – searching by food name and by analyte value. Additionally, it is possible to filter by datasets. After the search, all the results are presented together as a food list with English Name, Original Name, Country (marked as a flag), dataset and institute. After clicking on the food, analyte values are presented to the user, including information about the value, value type, unit, matrix unit, as well as detailed information about the analytical method. Additionally, a possibility to compare different foods' analyte values exists (Figure 20).

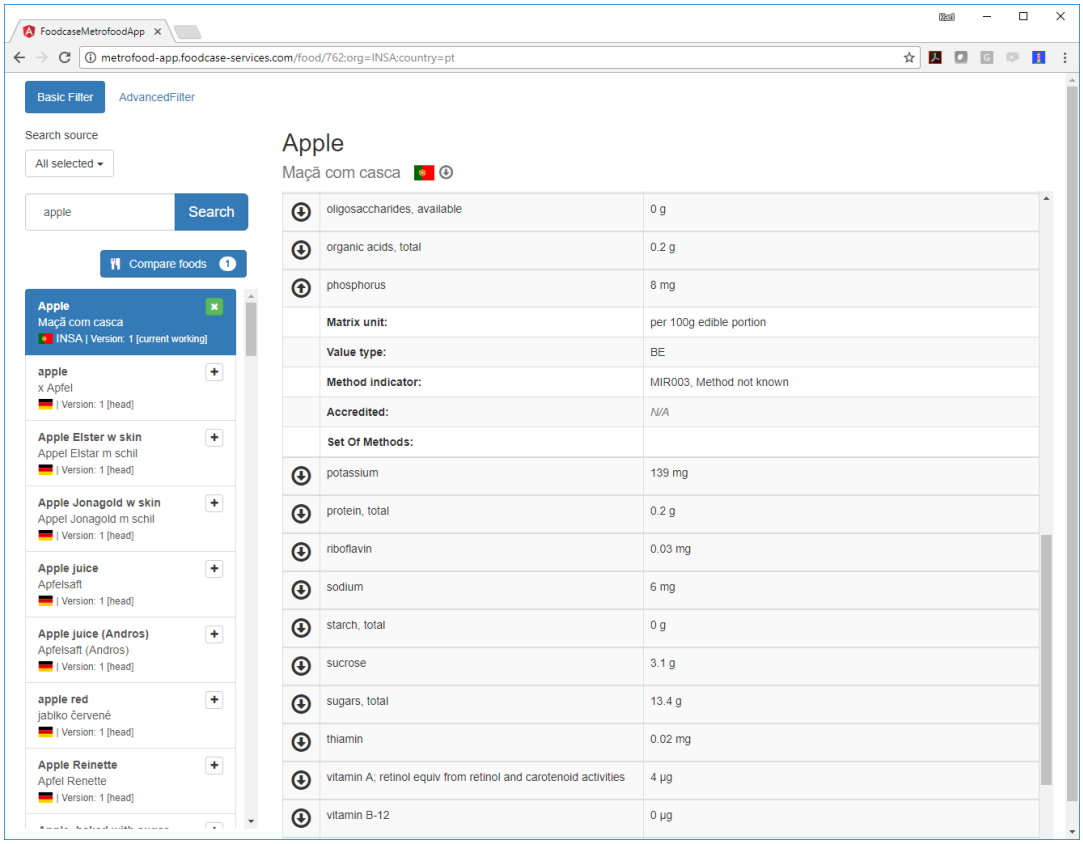


Figure 25 - Search&Compare App in intermediate state where an apple search was performed over two datasets

Particularly during the activities performed for service provision in the Preparatory Phase and in METROFOOD-EPI, the need to store, manage, and share analytical data became apparent. With this reference, to update the Search&Compare app could represent a useful solution. Such an update should include: adding raw data section, separate repository for specific classes of data in relation to different analytical approaches (e.g., proteomics data, metabolomics data, etc.) including spectra and diagrams. Data would have to be imported into FoodCASE and the software would also need to be updated to include the necessary changes.

5. Conclusions and plans for the next steps

Since the inception of METROFOOD-RI, multiple e-components were either planned, designed, or already created. During the future work, some e-components must be implemented (Catalogues, e-learning app, Open Calls app, Access Portal, Conference app) and this deliverable serves as a first specification, including both previous plans for the apps, as well as current feedback from the partners. Users feedback about the plans for those e-components was gathered from the National Nodes using a surveys. Their notes and ideas were included in the specifications of those new tools. To help with the understanding of the functionalities, wireframes of the planned apps were included. Those specifications serve as an important step in understanding the needs of the RI and will be used in the future for the implementation of the apps.

Additionally, several public pilot apps should be updated, as they serve an important function. Feedback about those was also gathered using a survey and examples of possible updates were described in this document.

Furthermore, there are also non-public administration apps (e.g. Membership app), for which updates should also be considered, as they are being used by the partners. Possible linkage between all e-components should be analysed in order to keep the information only in one place and allow to easily find it between different sources.

Feedback from the users should be considered especially important, as they are the specialists that will be using and supporting the e-components. Connections between different components and activities in all METROFOOD-RI projects and more in general in all infrastructures' activities must be maintained and supported, as they provide important information that must be included in e-components. Additionally, gathering feedback from outside of the Consortium should also be considered, e.g. from users of the Public Apps and Databases or people using the conference app to register for METROFOOD-RI's events.

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List of abbreviations

AI – Artificial Intelligence
AAI - Authentication and Authorization Infrastructure
CH – Central Hub
DBMS - Database Management System
E-RI – Electronic Research Infrastructure
EC - European Commission
ENEA - Agenzia Nazionale per le Nuove Tecnologie, L'energia e lo Sviluppo Economico Sostenibile
EOSC – European Open Science Cloud
ERIC - European Research Infrastructure Consortium
FBO – Food business operator
GA – Grant Agreement
GAMA - Guidelines for Assessment of Methods of Analysis
H2020 – Horizon 2020 Framework Programme
HEu – Horizon Europe
ICT – Information and communications technology
JSI - Institut Jozef Stefan
KIT – University of Karlsruhe
LMS - Learning Management System
METROFOOD-EPI – METROFOOD-RI Early Phase Implementation
METROFOOD-PP – METROFOOD-RI Preparatory Phase
METROFOOD-RI – METROFOOD Research Infrastructure
ML – Machine Learning
MOOC - Massive Open Online Course
NCBO - National Center for Biomedical Ontology
NN – National Node
P-RI – Physical Research Infrastructure
PDF – Portable Document Format
PMT – Premotec GmbH
PMT PL – Premotec Poland
PU – Public
RI – Research Infrastructure
RM – Reference Material
UI – User Interface
UX – User Experience