CSA JPI HDHL 2.0

Evaluation of Joint Funding Actions

Food Processing for Health (FP4H)

Content

1 Introduction and aims

Monitoring and evaluating of JPI HDHL activities is highly important to measure the success, concrete outcomes and impact of the JPI HDHL and to allow for continuous improvement and development of this initiative. Therefore, these activities are an integral part of the work plan of the current Coordination and Support Action (JPI HDHL CSA 2.0).

The evaluation activities continuously performed by JPI HDHL include:

- Monitoring and evaluation of the processes and general performance of JPI HDHL → Report on the third and fourth Process evaluation of JPI HDHL (CSA Deliverable D6.1, D6.4)
- Evaluation of the funding activities of JPI HDHL → Report on the evaluation of JPI HDHL funding activities (CSA Deliverable D6.2, the present report)
- Monitoring and evaluation the activities of JPI HDHL not related to funding → Report on the evaluation on the progress of the alignment activities (CSA Deliverable D6.3)
- Overall evaluation of the impact of JPI HDHL → Report on the evaluation of the impact of JPI HDHL (CSA Deliverable D6.5)

These tailored activities focus on different aspects of JPI HDHL presented in the consecutive published Implementation Plans (IP) and will result in publically available reports like this one.

The main aim of this report is to evaluate the monitoring data of the funded research in JPI HDHL in relation to the respective aim of the call and the IP and to analyse the output, outcomes and impact of JPI HDHL funding activities (both on call and project level). The results of the evaluations will allow the fine-tuning, refining and planning of new activities for the following IP to reach the expectations of all stakeholders and fulfill the JPI HDHL objectives. The evaluation will also assist in raising awareness for the activities performed under the umbrella of JPI HDHL and provides the basis for the communication and dissemination of JPI achievements.

2 Approach for the evaluation of the JFA

The evaluation is based on comparison of the objectives of the IPs and the outputs/outcomes of the different funding activities of the JPI HDHL. In addition, the Scientific Advisory Board (SAB) and Stakeholder Advisory Board (SHAB) of the JPI HDHL have been involved in the evaluation process. The evaluation of the Joint Funding Actions builds on the related work packages in the ERA-Net ERA-HDHL, in particular WP 7, dealing with monitoring and communication of the additional transnational JFAs and their results.

The present report includes evaluations of all JFAs implemented by the JPI HDHL in 2015 and earlier:

- Determinants of Diet and Physical Activity Knowledge Hub (DEDIPAC KH, 2013)
- European Nutritional Phenotype Assessment and Data Sharing Initiative (ENPADASI, 2014)
- Biomarkers for Nutrition and Health (BioNH, 2014)
- Food Processing for Health (FP4H, 2014)
- Malnutrition in the Elderly (MaNuEl, 2015)
- Intestinal Microbiomics (IM, 2015)
- Nutrition and Cognitive Function (NutriCog, 2015)

2.1 Methods

For this report a 'Framework for the evaluation of JPI HDHL joint funding activities' (see Annex) has been developed by the task leader and agreed with the other involved CSA partners.

In a first step, relevant indicators have been collected and defined (see chapter **2.2 Indicators** for details). Based on these indicators the required data from the funded projects have been collected systematically in form of project reports and oral presentations at the project symposia (see chapter **2.3 Monitoring** for details). If necessary, further questions were addressed to the coordinators of the research consortia. In parallel, other necessary data and information (call documents, call statistics, etc.) have been collected from the respective Call Secretariats. In addition, the success and impact of funded projects has been assessed by experts (previous or former SAB and SHAB members) based on final project reports and symposia. For the experts' assessment a specific short evaluation questionnaire, based on the elaborated indicators, has been developed. This template asked the respective expert for a short written assessment of the funded projects based on 3-4 leading questions after the attendance of the final symposium and/or reading of the final report.

The actual evaluation has then been performed by the task leader by analysing the different data available following the evaluation framework and afterwards agreed with the other involved CSA partners.

2.2 Indicators

The indicators used in this evaluation report have been developed in a designated task force by several CSA partners in a separate task (Subtask 6.1.1 Definition of performance indicators) within the CSA JPI HDHL 2.0. Two different types of indicators on have been defined, general and specific indicators, comprising outcome, output and impact level:

(1) General indicators for all JFAs

To enable the comparison between joint funding actions (at least with JFAs using the same funding instrument) a set of general indicators for all JPI HDHL JFAs has been developed. These general indicators can be grouped into six overarching categories comprising several more specific indicators: Alignment of national funding, Involvement of national scientific communities, Collaboration, Capacity Building, Data and Knowledge Sharing, and Impact.

(2) Specific indicators for each respective JFA

Since the aims and objectives differ greatly between the various JFAs, the definition of specific indicators was necessary to evaluate the success of a JFA in itself and not only in comparison to other JFAs. To evaluate the success of each JFA separately, specific indicators following from the corresponding Strategic Research Agenda and IP as well as the call text as of each JFA have been developed.

2.3 Project Monitoring

The comprehensive monitoring of the output and outcomes of the running and finished funded projects builds the basis for the performed evaluations. The systematic and structured collection of data from all funded projects has mainly been organized within a designated work package of the ERA-Net ERA-HDHL (WP7). The monitoring activities within ERA-HDHL comprised the monitoring of

the progress and the results of the research projects of the non cofunded JFAs implemented as part of ERA-HDHL, as well as the previous calls implemented through the IP 2014-2015.

Data from all funded projects have been collected in accordance to the indicators defined in WP6 of the CSA JPI HDHL 2.0. This comprises data both on call and project level:

(1) Call level:

For each Joint Funding Action, the funding organisation responsible for the Joint Call Secretariat (JCS) of a JFA was in charge of the statistical analysis of the call results based on the elaborated indicators (see 2.2). In particular the geographic distribution of the scientists applying to the call, the discipline and the type of organisation, the amount of funding requested per partner/consortium and the transnational cooperation has been analysed.

(2) Project level:

The follow-up of funded projects was taken care of by the respective JCS. For each funded project, annual scientific progress reports and one final report have been collected.[1] Project coordinators were asked to submit the respective scientific reports for the joint project, on behalf of the whole consortium to the respective JCS based on a pre-defined template including the specific indicators (see 2.2). Since 2019, these reports are collected using an online submission tool.

For the calls launched 2015 and later, the progress of ongoing JFAs has also been monitored by two status symposia organized by JPI HDHL. One status symposium has been held during the runtime of the projects (midterm symposium) and one just before the project is about to finish (final symposium). The main purpose of these symposia is to provide the JCS, the Call Steering Committee and members of the former Scientific Evaluation Committee (SEC) as well as representatives from SAB and SHAB with an update on the progress of the research projects. The presentations by the project coordinators and partners PIs are followed by a plenary discussion with questions from the audience.

For most of the earlier calls (DEDIPAC, ENPADASI, FoodBall/BioNH, MaNuEl) a final conference has been organized by the consortia itself without participation of SAB, SHAB or former reviewers.

[1] The data collection for the specific indicators as part of the final report was not possible for the first three JFAs (DEDIPAC, ENPADASI & MaNuEl) since the specific indicators have only be defined after the projects where finished. The project coordinators have been contacted retrospectively to answer those indicators.

3 JPI HDHL Joint Funding Action: Food Processing for Health (FP4H)

3.1 Aim of the call

In the Strategic Research Agenda of the JPI HDHL the important link between diet, food processing and health was highlighted. The topic "Food Processing for Health" has been described as a joint action in the Implementation Plan 2014-2015 that "will help **innovative product development** whilst also **providing the basis for approved health benefits**. The increased knowledge in nutrition and the rapid development of new technologies are a **unique strength for European researchers and industry** alike. Processing technologies, such as bioprocessing, can support formation of desired components with the food matrix including health-promoting components".

The main objective of the Joint Action "Food Processing for Health (FP4H)" was to support multidisciplinary transnational research consortia with innovative and scientific approaches to address the following:

Mechanistic research on the preservation and/or the enhancement of health promoting properties of food as a result of food processing

- Food processing for matrix stability and controlled digestibility, bioavailability, bioaccessibility and bioactivity of food compounds
- Food structures for appropriate bioavailability of nutrients and bioactives
- Optimize food processing for quality and safety

Important for the call was the cognizance of sustainability, retention or improvement of quality, consumer acceptance and affordability. Furthermore, the research on the food-health relationship should result in better standards, harmonized methods, databases and better coordinated research activities.

3.2 Peer-review Procedure and Results

The FP4H Joint transnational call was launched on 1st of April, 2015 and was coordinated by the Call Secretariat DAFM (Department of Agriculture, Food and the Marine Agriculture House, Ireland). The implementation process was organized by a postal and a panel review. In the postal review each eligible submitted proposal was evaluated on basis of the evaluation criteria as published in the call text by three international experts according to their expertise in the substantive area of the proposed research. In the panel review, 6 international experts discussed the inputs of the postal peer reviews, the overall merit and priority of proposals. Evaluation criteria were

(1) relevance to the aims of the call,
(2) scientific excellence of the proposal,
(3) feasibility of the project,
(4) quality of the transnational collaboration,
(5) international competitiveness and
(6) transnational impact.

The panels ranked the proposals and made recommendations for proposals to be considered for funding by the Call Steering Committee (CSC). Out of 12 submitted full proposals, 11 were eligible and 3 proposals were recommended by the evaluation panel for funding. The chair of the evaluation panel indicated that the call was a great opportunity for experts in food processing and in nutritional science to collaborate in a novel and meaningful way to develop new research proposals. However, it

looked like the call has not reached the scientific field like the other joint actions of the JPI HDHL which might be due to the selected topic. ccording to the ranking list established by the evaluation panel and the available funds, the CSC agreed to fund, the two consortia, **ProHealth** (Innovative processing to preserve positive health effects in pelagic fish products) and **LONGLIFE** (Food fermentations for purpose: health promotion and biopreservation) on October 27th 2015.

Aim of the **ProHealth** consortium was the development of a comprehensive toolbox of optimised existing and novel technologies for developing healthy, high quality, safe and sustainable fish products from pelagic fish species. The consortium was coordinated by Prof. Turid Rustad (Norwegian University of Science and Technology) from Norway.

The goal of **LONGLIFE** was to advance knowledge on the fate and function of food ingredients to advance fermented functional food design. The consortium focused on innovative processing of the food substrates milk, cereals and meat and was coordinated by Prof. Catherine Stanton (Teagasc Food Research Centre) from Ireland.

ProHealth and **LONGLIFE** started in March 2016 and should have ended in March 2019. This is the case for **LONGLIFE, ProHealth** got a cost-neutral runtime extension of 2 month and finished end of May 2019.

3.3 Evaluation Results

3.3.1 General Indicators

3.3.1.1 Alignment of national funding

8 JPI HDHL partner countries (Belgium, Germany, Ireland, Italy, The Netherlands, Norway, Poland, Romania) and 10 funding organisations participated in the call. The total *in cash* budget committed by the participating funding organisations for FP4H was 4.6 Mio €. In addition, Italy provided 137.215 € *in kind* budget.

3.3.1.2 Involvement of national scientific communities

3.3.1.2.1 Participation of national scientific communities

In response to the call, 12 full-proposals were submitted involving 50 PIs (principle investigators). The two consortia, **ProHealth** and **LONGLIFE**, were composed of 10 PIs from 5 JPI HDHL partner countries. In addition, a Romanian research group was participating in LONGLIFE in kind.

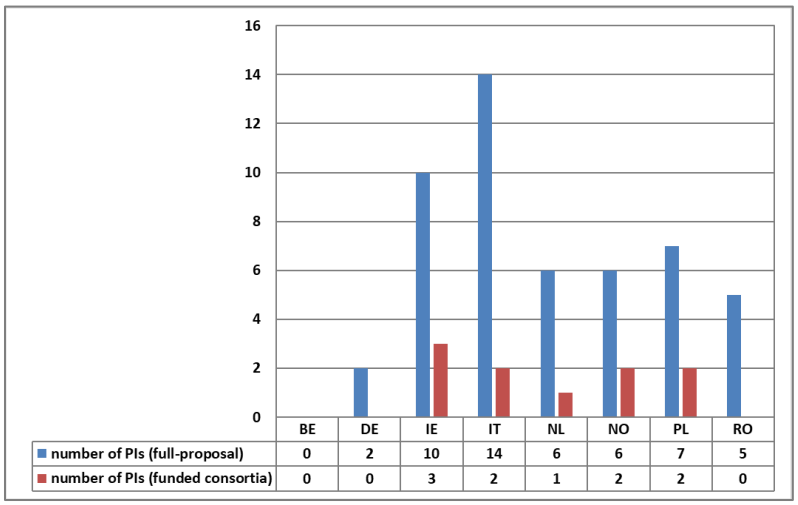

Figure 1: Numbers of PIs per country in the implementation of FP4H

With 5 female and 5 male PIs in the funded consortia, the distribution of the sexes was equal. A list of all FP4H partners in both funded projects can be found in Annex 1. The division of the PIs per country applied and accepted for funding respectively are depicted in fig.1. Belgium, Germany and Romania were the three countries which had no PIs in the funded consortia.

3.3.1.2.2 Distribution of national funding

Like all subsequent joint funding actions implemented by the JPI HDHL, the funding of FP4H was organized as „virtual common pot", meaning that each country and/or funding organization finances the activities of the respective national scientists.

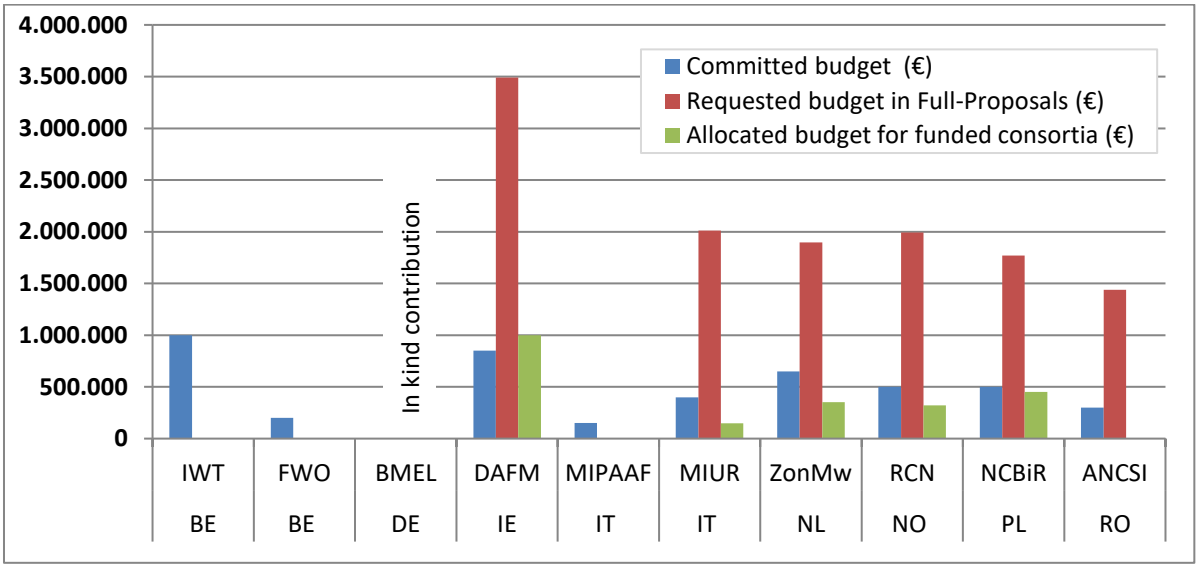

Figure 2: Committed, requested and allocated funding budget of FP4H consortia, distributed by countries.

The total committed budget for all proposal submitted for the FP4H call was 4.6 Mio € *in cash*. As shown in fig. 2, the requested budget for most of the countries was substantially higher compared to the committed budget reflecting the large interest of the research community on the released call. In total all proposals together requested 12.6 Mio. €. For the two recommended consortia, the allocated budget was 2.5 Mio €, which is 55.8 %[2] of the initially committed budget of 4.6 Mio €. The largest amount of *in cash* money was allocated to applicants from Ireland and Poland. At the end, there were no Romanian research groups who requested funding to participate in the funded consortia. The projects were led by a Norwegian coordinator (**ProHealth**) and an Irish coordinator (**LONGLIFE**).

The **ProHealth** consortium consisted of **5 PIs/groups of PIs** from 4 countries (Ireland, Norway, Poland and Italy) and was funded with 0.9 Mio €. Additionally, the Italian partner provided 74.000 € *in kind* budget. **LONGLIFE** consisted of **5 PIs/groups of PIs** from 4 countries (Ireland, The Netherlands, Italy and Poland) and received 1.7 Mio € and the Italian partner allocated 63.125 € *in kind* budget. Furthermore, **LONGLIFE** had two collaborators from New Zealand and Romania.
All PIs in the two consortia were from academic and health research institutions. Partners from the industry were not represented in **ProHealth** or **LONGLIFE** but during the runtime several collaborations with the industry were initiated.

3.3.1.3 Success of implementing collaboration

The main objective of the FP4H call was to support multidisciplinary transnational research consortia with innovative and scientific approaches to address mechanistic research on the preservation

[2] It was the first and until now the only time that more funding was available then projects recommended for funding.

and/or the enhancement of health promoting properties of food as a result of food processing. The two consortia were supported under the umbrella of the FP4H call; however, the research was conducted independently from each other with no planned collaboration between the two consortia. None of the FP4H consortia collaborated with a consortium funded by the JPI HDHL.

The partners of LONGLIFE at the Netherlands Organization of Applied Scientific Research (TNO) set up a large consortium with 8 industrial partners using fermentation as technology to produce different functional ingredients. The consortium mainly comprised of multinational companies. In 2019 a collaboration was initiated with the Horizon 2020 project SMART PROTEIN.

The success of the established collaboration on transnational and scientific level is being assessed in the following subchapters.

3.3.1.3.1 Interdisciplinary collaboration

The 5 partners of the **ProHealth** consortium were experts in food science, biochemistry, functional genomics, nutrition, processing technologies and consumer studies. All partners were academic research groups, but the results were presented directly to the industry (see section "scientific output"). The obtention of basic results and its use for the development of new products including consumers' acceptance clearly reflects an interdisciplinary approach.

The **LONGLIFE** consortia consisted of 5 partner and 2 collaborators from academic research institutes. They supported the project with expertise in the field of biochemistry, biotechnology, food science, nutrition, microbiology and engineering. The intensive collaboration with the industrial partner from CULTURED supported the interdisciplinarity and transfer of the results into future foods.

3.3.1.3.2 Transnational collaboration

The 5 partners of the **ProHealth** were located in 4 European countries (Italy, Poland, Ireland and Norway). The transnational composition of **ProHealth** is depicted in Fig. 3. With 2 partners, Norway was the strongest represented part in the consortium.

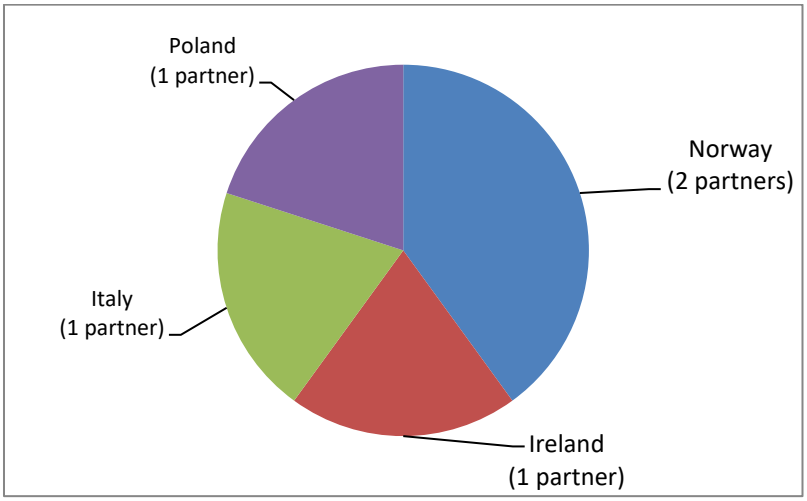

Figure 3: Transnational composition of ProHealth

The strength of the Norwegian partners (one was the coordinator) was also represented by the distribution in the single work packages (WP) and the task as coordinator. Norway, was involved in 3 work packages dealing with a technological toolbox for developing healthy, high quality, safe and sustainable fish products (WP2), optimized technologies for preserving quality and health beneficial components (WP3), and the combination of the research outcomes to present new knowledge and

results to relevant audiences (WP5). The Polish partner was responsible for the consumer studies (WP1) and Italy worked on the bioactivity and bioavailability of the healthy components (WP4). Ireland worked together with Norway on WP2.

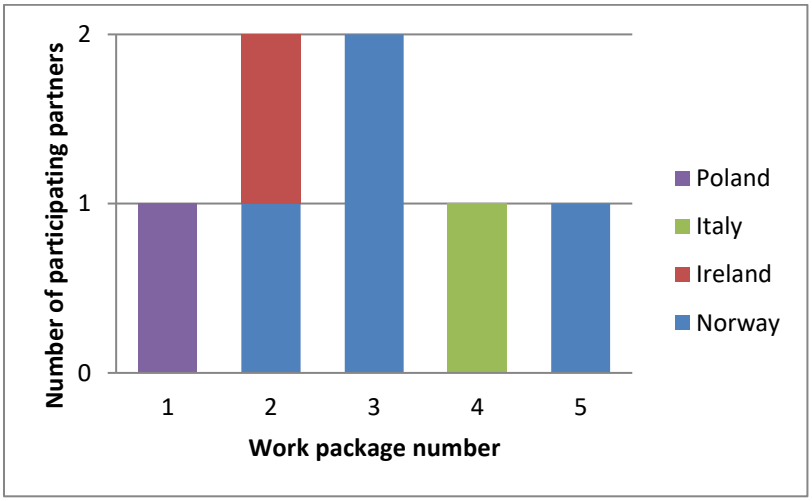

Figure 4: Number of participating ProHealth partners in work packages

LONGLIFE consisted of 5 partners and 2 collaborators from 6 countries (Ireland, Poland, Italy, The Netherland, Romania and New Zealand). The transnational composition of **LONGLIFE** is depicted in Fig. 5. With 2 partners, Ireland was the strongest represented part in the consortium.

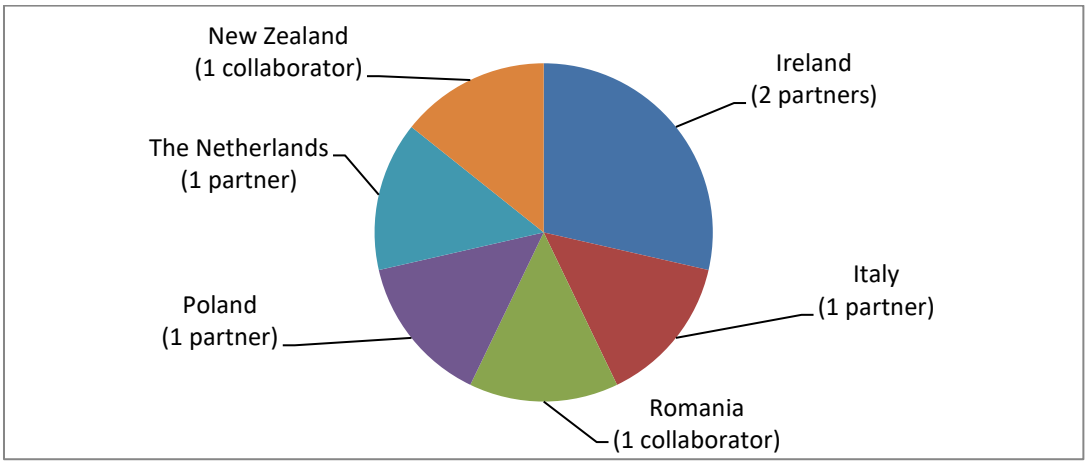

Figure 5: Transnational composition of LONGLIFE

Compared to the distribution of the partners in the corresponding work packages, the **LONGLIFE** consortium showed a very strong transnational collaboration. The partners of the consortium closely collaborated in WP 1 (selection and characterisation of functional microbiota), WP 3 (fermented and product prototype development), WP 4 (bioavailability/digestibility assessment of prototype products) and WP 6 (exploitation and dissemination). The Netherlands took over WP2 dealing with the physical treatment of bran pre-fermentation to enhance bioavailability and bioaccessibility of bioactives and nutrients. One Irish partner as coordinator was responsible for WP 5 (project coordination and management).

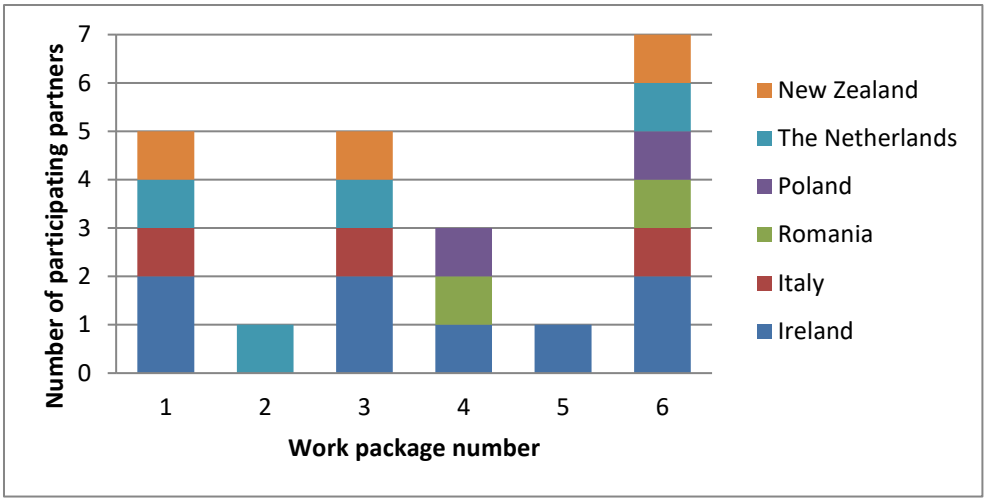

Figure 6: Number of participating LONGLIFE partners per work package.

3.3.1.3.3 Intensity of Collaboration

The partners of both consortia intensively collaborated with each other. During the 3 years funding **ProHealth** organized 9 project meetings including 7 physical meetings in Dublin, Gdynia and Lisbon as well as 2 telephone conferences. Furthermore, the consortium met at the JPI HDHL midterm symposium in Brussels 2017, attended the JPI HDHL conference in 2019 and the JPI HDHL final symposium 2019. However, no lab visits or student exchanges were organized during the funding period. The **LONGLIFE** consortium met 7 times physically, organized 1 telephone meeting and attended to the JPI HDHL conference in 2017 and 2019. Four master students got the chance of a 6 to 7 months lab exchange and 4 PhD students visited other labs for 1 month up to 2 years. In 2018, a seminar on dietary fibres and health (in Dutch) was organized where 23 industrial companies and small and medium-sized enterprises (SMEs) participated. Finally, the participation of 3 to 6 partners in 4 WPs is also an indicator of a strong collaboration between the partners (see Fig. 30)

3.3.1.4 Success of scientific collaboration

3.3.1.4.1 Scientific Output

16 publications were released during the runtime of the **ProHealth** consortium and **LONGLIFE** published 10 scientific papers. Both consortia presented their work and results at symposia and conferences. **ProHealth** presented 19 times orally to scientists and industrial companies. Furthermore 8 poster presentations were given mostly to the industry and scientists but also one time to students. Additional dissemination of the work took place by presenting results on the webpage of the partner Teagasc (Ireland) and a blog post on “Gemini.no”. The result of the **LONGLIFE** consortium were presented by 11 posters to the scientific community and 16 oral presentations to scientists, the industry, students, pharmacists and brewers.

3.3.1.4.2 New funding obtained

The **ProHealth** consortium applied to the Norway-Poland funding program as well as for a project under BluBio Cofund. However, they did not receive funding from these applications at the end. Some partners of the **LONGLIFE** consortium established a new project financed by H2020 (SMART PROTEIN).

3.3.1.5 Involvement in other JPI HDHL activities

The two consortia participated, as previously described, on the JPI HDHL conferences, workshops and symposia. No further cooperation was established within the JPI HDHL framework.

3.3.1.6 Capacity Building

Both consortia generated new positions. **ProHealth** generated 6 new positions including 3 Master students, 1 PhD student and 2 Post-docs. The **LONGLIFE** consortium generated positions including 4 Master students, 4 Post-docs and 1 research assistant within their project. No further training activities were provided for young scientists either in **ProHealth** nor in **LONGLIFE**.

LONGLIFE established a biobank of food grade lactic acid bacteria (LAB) and characterized the antimicrobial and antifungal activity, exopolysaccharide (EPS) and polyol production, and proteolytic activity.

3.3.1.7 Data and Knowledge Sharing

The **ProHealth** consortium did not handle the data according to the FAIR principles since it was not yet part of the JPI HDHL policy. The publications are saved at institutional repositories however the data are not stored in any repository at all.

The **LONGLIFE** research project contributed to sustainable data and research infrastructures (RI) by endorsing the co-innovation approach maximizing synergies between the research centers and industries acting as supplier and user of RI. By this, the consortium planned to address new markets for functional foods, promote commercial applications of processes or prototypes by industrial investment as well as facilitate commercial exploitation. Furthermore, the consortium strongly supported open access data, a better link with the industry and prioritized a multi-level approach (national, European and international level) by working with high rated research centers. The **LONGLIFE** consortium indicated to have used the FAIR principles by having published several results which are online accessible and further manuscripts are in preparation.

3.3.1.8 Impact

3.3.1.8.1 Contribution of the projects to the coordination/harmonization of research activities

Both consortia worked on the enhancement of recipes for the development of healthy foods. The **ProHealth** consortium intensively studied different processing technologies for the production of pelagic fish products that are healthy, safe, with good sensory properties and preserved bioactivity and bioavailability of healthy nutrients. The project used high pressure processing, plasma technology, sous vide cooking and superchilling to increase the shelf life of the products and studied the effect of these methods on the retention of valuable nutrients (lipids and proteins). The increased knowledge on the mechanisms underlying the preservation technologies should improve these methods by optimizing process parameters.

The **LONGLIFE** project worked towards developing safer, and healthier fermented foods using novel bacterial isolates which can be applied to improve food functionality and shelf life. New bacterial strains for the development of meat (e.g. salami), bakery (e.g. biscuits) and dairy products (e.g. yoghurt) were identified and the results were broadly disseminated.

3.3.1.8.2 Contribution to Public Health

The **ProHealth** consortium performed a consumer survey in the 4 participating countries (Norway, Poland, Italy and Ireland) to understand preferences when choosing fish products with focus on label information and evaluated the acceptance of developed prototypes. Interestingly, consumer attitudes differed between the different countries regarding fish consumption and fish products. However, all consumers understood, that diet is a main factor determining a healthy life and eating less processed food will increase health. Altogether, there was a negative perception of industrial produced food. This knowledge was used to develop prototypes (fish cakes and canned products)

with increased healthiness. For this pelagic fish (e.g. mackerel) was chosen which is rich in omega-3 lipids (EPA and DHA) with documented beneficial effect against coronary heart diseases, easily digestible proteins and vitamins (E and D) The developed fish cakes supplemented with 25% and 50% mackerel had consumer acceptability not lower than the currently produced white fish cakes made from haddock. Furthermore, it turned out that using fresh raw fish for canned products are better accepted than frozen raw material. The increase knowledge on consumer attitudes towards pelagic fish will enable further development of new and improved consumer friendly products made from pelagic fish. The results of the study are interesting not only for the scientific community, but also for the industry as well as consumer (adolescent, adults and seniors).

The **LONGLIFE** consortium was highly interested to disseminate their results to industrial partners but also to brewers, pharmacists and students because antioxidant actions of wheat bran and the future use of the identified bacteria in oat wort-based beverages. Especially the results from meat and biscuit production are of interest for industrial partners. The most promising products are planned to be used in future clinical trials however further research will necessary beforehand. Since a healthy diet is important for each age, no specific target group was mentioned by the consortium.

3.3.1.8.3 Activities towards innovation

The **ProHealth** consortium developed prototypes with a high content of pelagic fish which found good consumer acceptance. The storage of raw fish material can lead to microbial contamination. Therefore, **ProHealth** tested optimal processing technologies to transfer healthy pelagic fish raw material into healthy and safe pre-prepared food product. High pressure processing, plasma technologies, sous vide and superchilling was used to increase the shelf life but also to change lipid and protein composition preserving the healthy components of pelagic fish. Fish cakes where 25% and 50% of white fish were replace with mackerel were developed as well as canned products from sprat and herring. It needs to be highlighted that there was no industry involvement. It is not mentioned so far if the developed model products will be produced in large scale in the future.

The **LONGLIFE** consortium develop innovative processes for transforming food substrates (milk and cereals) into fermentates, using novel strains of lactic acid bacteria (LAB) and yeasts to produce value-added fermented liquids and powders, and long-fermented sourdough bread with improved health benefits, improved organoleptic qualities and extended shelf-life. The consortium worked on the basis of sustainability by using superheated steam processing as a new technology for the pre-treatment by-product ingredients such as bran because of the antioxidant activity. Thank to this novel technology, novel products like biscuits were developed with 30% less sugar. Together with the industrial collaboration partner Barilla **LONGLIFE** identified benchmark and pilot bakery product recipes and processes. Newly identified bacteria strains were used to develop a salami with reduced nitrate concentration. However, the prototypes were developed without any further support of an industrial partner. However, LONGLIFE can provide a selection of LAB starter culture for the application at commercial scale that are able to improve nutritional properties in cereals and dairy.

3.3.1.8.4 New strategies/applications to reduce incidence of diet related chronic diseases

The obtained knowledge by the **ProHealth** consortium how biologically active components in pelagic fish will be better preserved during processing and storage and will support the development of healthier food and thereby a healthier diet of the consumer. Increase consumption of healthy pelagic fish (rich on omega-3 fatty acids) might decrease the development of cardiovascular diseases. The results of the consumer acceptance can be furthermore used for campaigns to increase fish consumption.

The **LONGLIFE** consortium modified recipes for the production of salami and biscuit products. By using a new developed starter culture cocktail a prototype of salami was developed with reduced nitrate concentration. Since nitrate is a carcinogenic compound, nitrate reduction will improve food safety. Sugar reduction in biscuit products were achieved by fermented bran. Wheat and oat bran showed antioxidant properties which could be even enhanced when treated with superheated steam. Sugar and nitrate reduction and antioxidant properties of ingredients will support the production of healthy products and will result in a healthier diet. Furthermore, the **LONGLIFE** consortium demonstrated that fermented dairy products could bring cardiovascular benefits for consumers compared to the milk counterparts. Reduction of sugar content and nitrate could have reducing effect of the development cardiovascular diseases as well as cancer.

The results of both consortia are of large interest for the development of new food products but at this time point they didn't indicate clear mechanisms how these products can reduce diet-related chronic diseases. However, in long term, products based on the obtained results of both consortia have the potential to reduce chronic disease.

3.3.1.9 Experts' assessment on general aspects and the specific aims of FP4H

For external evaluation of **ProHealth** and **LONGLIFE** one experts from the Scientific Advisory Board (SAB) and one expert from the Stakeholder Advisory Board (SHAB) have answered general questions regarding the project.

1. *Contribution of the JFA to fill relevant research gaps in the field*

Both experts agreed that there is a lack of knowledge on the effect of food processing on the quality and sensory parameters and health benefits of processed food. The two projects showed the potential but also the challenge to connect the development of health products with the validation of health aspects of such products. Nevertheless, the experts had the opinion that the investigated food examples in both consortia came from the most relevant food groups of Europe. They both highlighted that the projects contributed to improve the availability of healthy and diverse foods by analysing the interaction between processing of foods using different techniques (e.g. heat treatment, high pressure pasteurization and many more), including consumer studies to identify motivation for consuming fish and other healthy food and collaboration with the food industry to make sure that the results can reach the market.

2. *Contribution of the JFA to better coordination and collaboration*

From the experts' view, the projects in the frame of this JFA are the first step into interdisciplinary collaboration between process and product development and the validation of their health effects. The newly formed consortia consisted of researchers from several disciplines generating a new network for food behavior, food processing and microbiology. However, one expert mentioned that more funding and further collaboration between food and health research is still need and that the JPI has the best capabilities to support this.

3. *(Future) Impact of JFA results for changes/improvement in the food and/or public health sector*

Table 1: Impact of funded projects

Results of JFA have or will generate	**End of the project**	**In the coming years**
New suitable strategies	**expert 1**: yes, e.g. use of EPS cultures **expert 2**: no comment	**expert 1**: no comment **expert 2**: no comment

Recommendations	**expert 1**: probably not **expert 2**: no comment	**expert 1**: no comment **expert 2**: no comment
Applications	**expert 1**: new product ideas both dairy, meat and fish **expert 2**: usable LAB strains for fermentation available to create new healthy food products based on cereals, meat and dairy products; for preservation of fish products new technology concepts are available	**expert 1**: will continue in the future **expert 2**: industry might produce a large variety of tasty, stable and bioactive foods using fermentation of milk, meat and cereals; new approaches for the stabilization of fish products without damaging the healthy ingredients
Product to reduce the incidence of chronic diseases	**expert 1**: still to be validated but potential to improve the health profile of some products, like reducing nitrates in meat or sugar in yogurts **expert 2**: first indication to enable sugar reduction in fermented cereal products and salt reduction in bread and sausages	**expert 1**: to be expanded in the future **expert 2**: the results of the projects might contribute in longer terms on a reduction of high consumption of salt and sugar, if new products might be produced by industry
Induce changes/improvements in the food and drink sector	**expert 1**: yes, see comment before **expert 2**: new technologies available for further research in the food and drink sector.	**expert 1**: to be expanded in the future **expert 2**: new technologies available for industrial use in the food and drink sector.
Induce changes/improvements in the public sector	**expert 1**: probably not **expert 2**: no comment	**expert 1**: no comment **expert 2**: see above

Furthermore, one expert mentioned that projects in this area are likely to generate new products and processes that are very important to improve the nutritional profile of many products.

4. Any other comment on this funding measure:

One expert stated that this research area requires better integration with other JPI areas and competences. In the view of the expert this might be extremely complex but very important for improving the research. The other expert stated that this kind of funding activities combined the benefits of European and local funded projects in the member states. The research groups showed a higher binding and commitment to the national funding agencies compared to their project coordinator that's why the strength of international collaboration can be combined with better controlling from national funding agencies.

5. *Did this project successfully characterise novel food processing technologies and their effects on the fate of food products and/or its constituents in the human body?*

Both experts agreed, that the **ProHealth** consortium investigated novel technologies like high pressure pasteurization, fast chilling, cold plasma and sous vide to optimize the quality of fish

products and to increase the retention of healthy ingredients such as omega3 fatty acids. Furthermore a consumer survey in four countries showed interesting results regarding the need and interests for this type of products. However, one expert mentioned that the health effects of fish are not always clear and further communication activities are needed.

The **LONGLIFE** consortium focused on novel strains of lactic acid bacteria (LAB) to produce added value products (e.g. bread, dairy and meat). From the experts view the consortium investigated the fermentation procedure with LAB and successfully identified and quantified the influence on quality parameters (e.g. extension of shelf-life of milk, salami with no nitrites, bread and biscuits with lower sugar content).

6. *Did the project generate substantial progress on the characterisation of structure-function relationships of food and its ingredients in relation to health?*

The **ProHealth** consortium had a clear focus of processing using different technologies to preserve pelagic fishes like super chilling, high pressure or sous-vide. That's why one expert did not see that characterization of structure-function relationships of food and its ingredients in relation to health was part of the project. The other expert mentioned that the obtained results did not lead to understand the effects of processing on fish quality and on the bioactive compounds associated with health benefits like in fresh fish.

One expert mentioned that in cooperation with the Wageningen University Research (WUR) and Barilla, the **LONGLIFE** consortium produced cereal products using LAB. By this, it could be demonstrated that LAB bacteria can produce compounds like EPS and lower for example the sugar content. However, the expert still sees the challenges to maintain the bread quality since sensory properties of the developed bread product was remarkably different from the commercial reference. The other experts did not see a substantial progress since consumer studies would have been required however this was not possible in the given time frame and finances of the project.

7. *Did the projects appropriately consider the broader context of food processing research (for example aspects like sustainability, food quality, consumer acceptance, affordability)?*

The experts agree that the process to produce fishcakes in the **ProHealth** project is a good opportunity to formulate new product or to increase the quality of fish products by reducing the oxidation and the formation of histamine. One expert mentioned that the results of the *in vitro* studies were not available and it was unclear, which bioactive compounds have been tested. The other expert sees the aspect of sustainability covered by using new technologies to reduce food waste and highlighted the consumer study to reveal new information about consumer behavior concerning fish products.

Both experts agreed that the **LONGLIFE** consortium very well approached the broader context of food processing in terms of quality. It could be demonstrated how metabolites from LAB can influenced the growth of unwanted microorganisms and the shelf life of the developed foods. Furthermore, sensory parameters like flavor, taste and appearance had been investigated to increase consumer acceptance. However, the other expert mentioned that the health aspects still have to be demonstrated.

8. *Any other comments on the projects*

The experts stated the **ProHealth** results are an important research area and in consideration of the budget, the outcome is remarkable in amount and quality. One expert further mentioned that good based scientific results are still needed regarding omega-3 lipids (EPA and DHA), protein and protein digestion as well as vitamins (E and D).

Both experts agreed that the research of **LONGLIFE** consortium was a very relevant and well-coordinated and that the amount and quality of the results are remarkable.

3.3.2 Conclusions

New methods for food processing are needed to produce healthy foods which support the diet of the population resulting in health benefits. For these reasons, the JPI HDHL call "Food processing for Health" was launched with the aim to fund mechanistic research on the preservation and/or the enhancement of health promoting properties of food as a result of food processing. Furthermore, it should be focused on the cognizance of sustainability, retention or improvement of quality, consumer acceptance and affordability. The call was an opportunity for to combine food processing and nutritional science. However, the evaluation panel criticized the overall rather low scientific quality of the submitted proposals. This was also reflected by funding of only two consortia and only of 55.8% of the initially committed budget being spent. This could be an indicator that more funding activities are necessary to support the further development of this field.

The two consortia investigated a broad range of food groups which are most relevant in Europe. They used new technologies like sous vide, superheated steam processing or fermentation (new bacterial strains) to improve fish, meat, bakery and dairy products. By this they were able to increase the quality, shelf life but also the health effects of the product by e.g. reduction of the sugar and nitrate amounts. The sustainability aspect was considered as well by processing of poorly used by-product ingredients such as brans. During the development of the food prototypes consumer acceptance was evaluated by **ProHealth** by to generated attractable and healthy products. Both consortia presented their results especially to industrial partners. So far, no end product ready for the market could be developed indicating the need of further results to convince industrial partners. Therefore, further work especially in close collaboration with industrial partners will be necessary in the future to transfer the results of food processing research into the industry to develop healthy foods supporting a healthy life of the population.

3.4 Annexes

3.4.1 Annex 1: List of FP4H partners

Due to data protection regulations the list of FP4H partners was removed.

3.4.2 Annex 2: Used data sources

Call Text "Joint Action 2: Food processing for Health (FP4H)" published via https://www.healthydietforhealthylife.eu/index.php/call-activities/calls/98-calls-site-restyling/518-fp4h-2015

FP4H proposals from ProHealth and LONGLIFE submitted by 15th of July 2015.

FP4H final report from ProHealth and LONGLIFE submitted on 31.08.2020 and 26.04.2019, respectively.

Written feedback to final report from FP4H from one Scientific Advisory Board members and one Stakeholder Advisory Board member.

3.4.3 Annex 3: Overview on general indicators

	ProHealth	**LONGLIFE**
4.1.1 Alignment of national funding		
- Number of countries/partners participating in the call	6 countries and 10 funding organizations	
- total committed budget	4.6 Mio €	
4.1.2 Involvement of national scientific communities		
- Number of submitted pre/full-proposals per country/funding organisation	12 full-proposals (11 eligible proposals)	
- Number of accepted proposals per country/ funding organization	3 consortia recommended for funding 2 consortia funded	
- Committed budget per country	4.6 Mio € in total	
- Budget requested /allocated per country	12.6 Mio € requested/ 2.5 Mio € allocated in total	
- % of the total budget spent	55.8 % (2.5 Mio € spent in total)	
-Committed budget per consortium	**ProHealth**: 0.9 Mio€	**LONGLIFE**:1.7 Mio €
- Number and type (Research/SME/Large industry) of organisations/teams in the funded consortia	5 partners (all from research institutes and academia)	5 partners (all from research institutes and academia)
- Gender of Coordinators and PI's	100% female coordinators; 50% female and 50% male PI's	
4.1.3 Success of implementing collaboration		
- Interdisciplinary collaboration		
Number of disciplines per consortium	**ProHealth:** 7	**LONGLIFE:** 7
list of disciplines	food science, biochemistry, functional genomics, nutrition, processing technologies and consumer studies	biochemistry, biotechnology, food science, nutrition, microbiology and engineering
- Success of transnational collaboration		
Number of new collaborations with academia	**ProHealth**: 0	**LONGLIFE**: 1
Number of collaborations with other JPI funded projects	**ProHealth**: 0	**LONGLIFE**: 0
- Number of project coordinators/partner per country	**ProHealth**: see Figure 3 and 4	**LONGLIFE**: see Figure 5 and 6
- Intensity of Collaboration		
Number of Meetings	**ProHealth**: 7 physical meetings and 2 telephone conferences	**LONGLIFE**: 7 physical meetings and 1 telephone conference
Number of mobility/lab visits within a consortium	**ProHealth**: 0	**LONGLIFE**: 8 lab exchanges (4 master students and 4 PhDs)

4.1.4 Success of scientific collaboration		
- Number of new publications related to the project	**ProHealth**: 17	**LONGLIFE**: 10
- Number of presentations related to the project	**ProHealth**: 19 oral and 8 poster presentations	**LONGLIFE**: 16 oral and 11 poster presentations
- New funding obtained	**ProHealth**: 0	**LONGLIFE**: 1
4.1.5 Involvement in other JPI HDHL activities	**ProHealth**: none	**LONGLIFE**: none
4.1.6 Capacity Building		
- Training activities	**ProHealth**: none	**LONGLIFE**: none
- New jobs/positions generated in the project	**ProHealth**: 6 positions (3 master students, 1 PhD student and 2 Post-docs)	**LONGLIFE**: 9 positions (4 masters and 4 PhD students, 1 research assistant)
- Use of existing tools and/or development of new capacities or resources (e.g. a transnational database, biobanks, animal models, cohorts)	**ProHealth**: 0	**LONGLIFE**: biobank of LAB starter cultures
4.1.7 Data and Knowledge Sharing		
- Use of existing data: Has existing data been used / pooled for the project?	**ProHealth**: 0	**LONGLIFE**: 0
- Has the consortium used samples from existing cohorts and / or other epidemiological studies?	**ProHealth**: 0	**LONGLIFE**: 0
- To perform the project, have you used samples (omics-based) from bio-bank or/and other disease register sample collections?	**ProHealth**: no	**LONGLIFE**: no
- FAIR-Data principles: Has the data generated in the project made available by following the FAIR principles?	**ProHealth**: no	**LONGLIFE**: yes
4.1.8 Impact		
- Contribution of the project to the coordination/harmonization of research activities (standardisation of methods and protocols, data harmonisation, data and knowledge sharing)	**ProHealth**: high pressure processing, plasma technology, sous vide cooking and superchilling to increase the shelf life and retention of valuable nutrients (lipids and proteins) in fish products	**LONGLIFE**: novel bacterial strains for reduction of nitrate, sugar and increase of shelf life
- Activities towards innovation	**ProHealth**:	**LONGLIFE**:
New industry collaboration	**ProHealth**: no	**LONGLIFE**: large consortium of 8 industrial partners (CULTURED (TNO/WUR))
Development of new methods/research tool/products	**ProHealth**: Fish cakes with 25% and 50% mackerel replacement	**LONGLIFE:** prototype of salami reduced nitrate, biscuits with 30% less sugar
Patents: number and geographical scope	**ProHealth**: 0	**LONGLIFE**: 0
- Contribution to public health	**ProHealth**:	**LONGLIFE**:
Target groups	**ProHealth:** consumer, industry, academia	**LONGLIFE:** consumer, industry, brewer, academia

Interaction with End-Users (e.g. consumers, patients in intervention studies)	**ProHealth**: consumer acceptance of prototypes tested	**LONGLIFE**: consumer acceptance tested, planned application of new products in clinical trials
- New strategies/applications to reduce incidence of diet related chronic diseases)	**ProHealth**: no	**LONGLIFE:** no