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Rapport final projet OPTIFEL - Optimised food products for elderly populations

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PROJECT FINAL REPORT

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1. Final publishable summary report

1.1 *Executive Summary*

WP1

Experimental evidences showed the effect of ageing on the capability of elderly in dealing with food, including package opening/handling, sensory discrimination (e.g. differences between autonomous and dependant elderly), biting force etc. Eating capability assessment can be used to choose the food of just-right texture and desired oral processing properties. A set of guidance about food packaging design for elderly and baseline environmental impacts for Optifel systems was established.

WP2

WP2 produced a software tool for calculating the necessary nutrient composition for the concepts of model products for the given target group (dependent elderlies needing fortified food) upon eating in specified cook-and-serve systems. WP2 also collected the specific needs of the elderlies for nutritional and sensory properties and produced guidelines for the industry. The guidelines give recommendations for nutrients to be fortified and instructions for sensory properties.

WP3

Food prototypes, based on fruit and vegetables, which met safety and nutritional requirements, food preferences (taste and texture) and constraints for elderly people were prepared using conventional and new technologies. They included soft-solid and liquid concepts enriched with proteins, minerals and vitamins. Industrial scenarios were simulated for production and distribution of the prototypes. A full approach of a week meal was developed under the OPTIFEL TOOL KIT concept.

WP4

Optifel prototype foods enriched with proteins, vitamins and minerals were characterized for sensory properties, nutritional values, safety, environmental and cost performance. Usage conditions (delivery system, storage, reheating and serving) that maintain protein digestibility, vitamin stability, reduce microbial risk and optimize environmental and cost performance, were identified. New scientific knowledge was obtained on these issues and published.

WP5

The enriched recipes produced in Optifel project were assessed by autonomous elderly to select the most appreciated one in each product category. Those selected recipes were then tested as part of a full meal (in comparison with non-enriched versions) by elderly living in nursing homes or benefiting from food services. The products were well appreciated and allowed to increase the proportion of elderly reaching a recommended protein intake at lunch.

WP6

The knowledge produced within the OPTIFEL project was disseminated through an active website (www.optifel.eu), synthesized in guidelines addressing the food and care industries (<http://www.optifel.eu/food-for-elderly/guidelines/>), and in seminars dedicated to food for seniors, one of them including a culinary demonstration. Further the results were presented in 137 trade fairs, scientific congresses, media (newsletters, interviews, press) and in 27 scientific publications.

1.2 Summary description of project context and objectives

The European population has been ageing since the 50s and prospects show that this trend will be increasing in the next decades with a peak in 2040. Facing this problem in a decent while economically-efficient way is a challenge posed to almost all European countries (EIP Active and Healthy Ageing). Malnutrition, which particularly affects older people, costs European healthcare systems similar amounts as obesity and overweight, and is a major determinant in accelerated loss of autonomy and adverse health outcomes. However up until now, elderly denutrition is fought at the quantitative level by elderly food pyramid-based prescriptions or food supplements.

The aim of Optifel is to fight the onset of elderly malnutrition by achieving a paradigm shift: rather than remedying elderly nutritional deficiencies, the project will contribute to fight appetite loss with attractive and nutrient-dense food products designed to meet the nutritional needs, sensory expectations and physical constraints at the level of end-products as well as preparation and delivery. To design the products Optifel will map all the relevant information on elderly's needs, expectations, capabilities of handling and manipulating product and packaging, and acquire data on the evolution of taste sensitivity (for attractiveness) as well as physical capacities (ease of chewing, ease of opening) with ageing. This will provide data to guide further product development and contribute to design a new generation of varied and tasty food products for elderly and thus help improve life quality and pushback hospitalisation. Optifel will test the developed concepts using fruit and vegetable as a base.

The specific objectives of OPTIFEL are:

- To bring new knowledge on elderly's sensory expectations and physical constraints, and in particular on food preference, integrating sensory, physical, cultural and personal factors. Concerning physical constraints, we plan to better understand the food properties that impact on mastication and swallowing, in relation with evolution of physical capacities, and to design packaging taking into account ease-of-opening and legibility. A specific item concerns the environment and costs assessments of the existing solutions for meal delivery.
- To provide tools for categorization of elderly according to their eating capability and/or sensorial discrimination, enabling food manufacturers to produce foods tailored to particular segment of elderly population. Furthermore, the observed relationship between hand and orofacial muscle strengths might offer caregivers a safe and reliable method to assess and eating capability of elderly using non-invasive hand gripping force measurement for assessment.
- To synthesize existing and new knowledge on nutritional requirements, texture, packaging and environmental costs in guidelines adapted for the food industry, and use these guidelines to design adapted products, delivery and preparation solutions.
- To elaborate adapted products, using fruit and vegetable base, with enrichment in proteins and in vitamins and minerals. This will also allow to better understand the impact of food processes, including innovative processes such as high pressure and ohmic heating, on texture and nutritional qualities of fruit and vegetable foods.



- To validate these products from production to the individual plate, taking into account the sensory qualities, nutritional content and digestibility, microbial safety and environmental and cost performance.
- To test selected products with seniors, either able to come at the lab for a preference assessment, or with decreased autonomy, using meals-on-wheels or in retirement homes.

The results of the project will be disseminated at three levels: to the general public, through a dedicated website and communication, to scientific community through articles, and to the food science and catering communities through design of courses and presentations at professional fairs.

1.3 Description of the main S&T results/foregrounds

WP1 User specifications

Objectives

The first part of OPTIFEL was concerned identification of preferences and needs, and their evolutions with ageing. This workpackage aimed to collect, refine and formalise the needs and expectations of European elderlies in terms of food sensory and nutritional quality, texture, cognitive and biomechanical ergonomics of packaging, preparation convenience and environmental requirements. Its specific role in the project was to provide the fundamental understanding of the capability and needs of elderly people to decide the way forward for food product design. The evolution of strength and dexterity of elderlies, the ease-of-opening individual packaging and the evolution of grip-strength will be taken into account to study the adequacy between physical abilities and packaging solutions.

Approach

WP1 combined different approaches: analysis of literature data concerning nutritional needs, a survey of user needs and preferences addressing elderly and care-givers, focus groups, collection and exploitation of data for environmental and cost performance, and experimental studies. A major survey was carried out for eating behaviour, preference, special needs for elderly; with a standard questionnaire translated into different languages. This survey was conducted in parallel by task participants across different countries. Experimental studies were used to assess physiological and physical capabilities of elderly people, including chewing/swallowing capability and detecting taste and sensory flavour changes. Focus groups and experiments of opening strength and torque were used for the packaging study.

Preferences of elderly for fruit and vegetables

Besides a literature review on nutritional needs of elderlies, a major achievement was a face-to-face survey of preferences concerning fruit and vegetables, and food products from fruit and vegetables, allowing to assess common aspects and cultural differences. This survey included 490 elderlies and 45 care-caterers and was carried out in France, Finland, United Kingdom, Poland, Spain and Turkey, involving 8 of the project's partners and a common (translated) questionnaire. Three groups of elderlies (age between 65 and 95 years) were identified for the survey (**Figure 1**): Category 1: Elderly people who need help for food purchase, Category 2: Elderly people who need help for both food purchase and meal preparation (one helper at home, meal delivery), Category 3: Elderly people who live in nursing homes and require all time care.

Eating capability

In study with 61 young adults and elderly in UK and Spain, it was further demonstrated that dental status was the key determining parameter in distinguishing bite, oral processing time, number of chews, and liking. Trials including real foods of different texture or gels with more or less complex structures indicated that the perceived difficulty to eat a given food is related to its residence time in the mouth. Elderly perceived those food as difficult which resided in the mouth for a longer time. From a food design point of view, it was elucidated that not only the consistency (hardness) of food structure but also the heterogeneity of the matrix affected food oral processing behaviour (number of chews and time in mouth). Overall EC holds potential choosing the food of just-right texture and desired oral processing properties (chew cycles, swallowing time).

Sensory discrimination and preferences

On a parallel stream, it was critical to identify the sensory (taste) discrimination capability of elderly population using 328 subjects in France, Spain and Poland (**Figure 2**). It was worth noting that there was no difference between France and Poland when people performed the olfactory tests (categorisation, discrimination, detection). About gustatory tests (detection), Polish people had higher performances than French ones in detecting sugar and malic acid. Results on taste discrimination in purees showed that at an individual level, dependent elderly people (living in nursing homes) failed more often in discriminative tasks, compared to young adults and autonomous elderly people. Moreover, at group level, young adults and autonomous elderly were able to make a difference between 2 products based on 1) a variation of +1 g/100g of sugar at a low level of acid (4.71g/kg) or at a high level of acid (6.71 g/kg); 2) a variation of +0.25 g/kg of malic acid at a low level of sugar (16 g/100g) or at a high level of sugar (24 g/100g). At group level, the dependent elderly living in nursing homes were only able to make a difference between 2 products based on a variation of at least +4 g/100g of sugar at a low level of acid (4.71g/kg). About apple purees liking, independent living elderly preferred sweet apple purees with a low acid level (4.71 g/kg) compared to sourer ones. They liked sweet purees (20 & 22 g/100g). Dependent elderly people living in nursing homes preferred the sweetest apple puree (28 g/100g of sugar) among the three less acidic samples selected for this specific population.

Easy-opening packaging

Qualitative focus group discussions were carried out in Switzerland, Spain and Finland (62 elderly subjects) to understand needs for easy opening and legibility of packaging. The findings derived from the qualitative analysis were compared with quantitative measurements of the opening forces (e.g. peeling force, can opening force, torque to open packaging) obtained from the 10 selected commonly used packaging systems to retrieve comprehensive information on the specific packaging needs of European elderly ageing population. Packaging systems “PET bottle with a larger screw cap and a peelable aluminium foil with tab underneath”, “stand-up pouch with a small perforation on each side”, “container with aluminium foil lid” and “thermoformed tray easy to open” were qualified for the elderly market. Furthermore, labelling needs sufficient font size (> 1.5 mm), familiar and sans serif characters, clear contrasts and a structured layout. Elderly perceived cans as the most difficult package to open and in majority; they do not use special tools to open packages.

Baseline environmental and cost performance

From the baseline life cycle analysis, it can be suggested that manufacturing had lesser environmental footprints than the other stages as it is much more optimized, and so is distribution. The packaging impacts in general are strongly dependent on the product as they vary as a function of the packaging type and quantity. The most important conclusion was that food transportation is in general much more optimized for elderly at nursing homes than that for elderly at private

homes. Considering the impacts on climate change, if the distance from centralized kitchen to private homes is long, it is preferable for elderly at private homes to go to supermarket to buy the ready meal and cook it at home. For elderly at nursing homes, in term of both impacts on climate change and life cycle costs, it is always preferable to deliver the food directly from producers (or through intermediates).

In summary, this work package provided a comprehensive collection of needs, expectations and capabilities of European elderly in terms of food sensory and nutritional quality, fruits and vegetable and their cooking preference, texture, packaging, preparation convenience and environmental requirements, therefore providing a solid base for other WPs for food design.

WP2 Functional requirement specifications

Objectives

The objectives of WP were two-fold: the first one was to synthesize the data collected from WP1 and from national authorities in a series of functional (i.e. quantitative) guidelines, which can then be used by food industries and care-catering to design food for elderly, and the second was to use these functional guidelines, in addition to a market study and creativity of the project's participants to imagine product concepts.

Approach

WP2 relied on synthesis of literature, project's results, marketing and creativity sessions (organised during one of the project's meeting), followed by integration of the data relying on the expertise of OPTIFEL's partners for a critical viewpoint.

Nutritional guidelines

Averages for recommended nutrient concentrations were first calculated and tabulated in the draft guidelines. **A software tool** was developed for calculating personal nutrient needs based on a meta-analysis done to collect the existing data on the effects of processing and preparation on nutritional quality. The software tool calculates the necessary nutrient composition before preparation for a given target group (dependent elderly population needing fortified food) upon eating in a specified cook-and-serve system. For draft guidelines recent literature concerning elderly nutrition and expectations of food sensory quality was reviewed. Revised tables of draft guidelines, renewed literature review and concept product evaluations were compiled to final guidelines containing recommendations for nutrients to be fortified and instructions for sensory properties and packaging.

(Appendix 1: Guidelines).

Nutritional recommendations are presented in Table 1. Fortification to Content 2 (**Table 1.**) is highly recommended for **calcium, vitamin D, vitamin E, folate and vitamins B6 and B12** for both men and women. Fortification is recommended for all products intended for meals-on-wheels services, nursing homes, hospitals, because malnutrition and risk of malnutrition are common. For the other nutrients (Mg, K, Fe, Zn, I, Mn, Mo, Cr, and vitamins A, C, B2, niacin, pantothenic acid), fortification is not de rigueur (necessary) because the intake levels are within $\pm 5 \%$ of recommendations. Among elderly living in nursing homes deficiencies have been found also for these other nutrients. For those elderly this need is often fulfilled using special foods for medical purposes (clinical food products). Fortification is not recommended for P and Na, as the average intake is high.



Taste and colour guidelines

In general, the elderly like fruit and vegetable foods but cultural differences are still great. Thus no universal texture or taste requirements can be set for their foods. There is a real need for more research to develop instrumental methods linked with sensory properties for food product design.

Functional and ingredient guidelines are presented in Appendix 1.

The elderly are a very inhomogeneous group of consumers. They have the normal variation in food preferences, based on local, traditional and cultural habits – a variation typically found in middle-aged and younger consumer groups, too. In addition, due to the age-related changes in physical ability, illnesses, medications and mental status, they have different capabilities to handle and open the food packages and eat foods, and also sensory food preferences may change. Although sensory capabilities decrease during aging, it seems to have only minor effects on food liking in healthy elderly. Textural properties become more important determinant of the actual food intake. On the other hand, older adults with poor appetite may have specific food preferences. They like meals and snacks with high oro-sensory **variation** and high colour variation.

Tailoring would improve the palatability of the food and thus the nutrient intake would be secured.

Fruits and vegetables provide natural and recognisable aroma and colour compounds, which improve pleasantness and palatability. By ageing, the importance of sensing different textures, flavours and colours is not reduced, thus the foods and meals for the elderly should provide sensorial experiences. As the personal variation is large, there is no common scale for saltiness, sweetness, sourness and bitterness.

Despite of the variations, common features can be found, considering fruits and vegetables consumption in European countries. Vegetables are preferred as soups or plain cooked. The preferred vegetables and fruits vary somewhat, but same major, common crops are liked. According to the Optifel Survey (WP1), the most liked/ less disliked vegetables and fruits are almost the same in the participating countries, and illustrated in a graphical form (**Appendix 1**).

Food texture guidelines

The foods should contain structural elements, referred as “soft solids” in Optifel project. No literature data was found on textural requirements of food for the elderly, especially to measure both texture and liking of real food items. The only guideline found in the literature search was for consistency of tailored foods for dysphagia patients and other persons having condition difficult to swallow (presented in a table in the Guidelines, **Appendix 1**).

The above consistency guidelines are valid mainly for foods intended for hospitals and other special diets, but useful also for product development of foods intended for the elderly living still in community but needing already services.

Some research groups have published vocabularies, which could be used to describe the food preferences in texture, taste, flavour and aroma. After more examples of sensory evaluation conducted by elderly are available, the present subjective and objective analysis data could be combined and be more useful as a guide for food development for elderly. Elderly are involved as panellists in different countries during Optifel project, and useful data will accumulate - especially on the preferences of elderly towards different structures of fruit and vegetable-based foods. The present published data can be delivered by request. So far we are not able to give any instrumental or physical quantity values for food.

General advice for designing food for elderly (or other dependent people) having decreased eating capabilities are: the solid pieces should be soft enough to be mashed with tongue and if the components must be milled, they should be served separately to maintain at least part of mouth-watering appearance. Sticky and adhesive foods are not suitable for elderly having eating difficulties. Hard, fibrous and dry foods may be difficult to swallow and increase risk of choking. In the Optifel



study, D1.3, a wide variation was found in tongue pressure. Again, different elderly groups need different product design.

One has to bear in mind that the elderly consumers who participated Optifel Surveys and evaluated the test products, had, in average, a good health status, compared with the average elderly population in the nursing homes (especially related to severity of dementia and other memory problems). According to caretakers and caterers interviewed the food for dependent elderly should be well-cooked, tender and soft: it has to be easy to eat. In addition, food for elderly should be simple, traditional, designed with the elderly's taste in mind, taste as home-made and contain ingredients they know. The number of the personnel interviewed was low, and it is impossible to estimate if the results are representative to general situation.

Packaging guidelines

Guidelines for food packaging are given in Appendix 1.

The community living elderly prefer packages they can reuse, and recycle. Most elderly find present packages difficult to open without tools. The opening itself should be suitable in size, permitting the use of the hand muscle forces most effectively, depending on the type of the opening. Examples can be found in Appendix 1. The site to open and the date of expiration should especially be clearly marked. Packaging information should be printed using at least a font size of the lower case letters of 1.5 mm. The color contrast of text is a critical factor. Dark colors on a white background are easy to read. Matt material, such as the paper label on the jars, is preferred.

Product concepts

Benchmarking sessions did show that plenty of products exist already on the market, but many of them need further development of taste and texture or adaptation to the specific needs of seniors. **Six preferred product concepts** and six reserve concepts were described (2+2 for categories functional drinks, soft solids and mixed fruit and vegetables. Concepts are listed in the Table 2.

WP3 Design and processing of novel food products

Objectives

WP3 had a central role in the project as it was the WP in which the preferences and needs, identified in WP1 and sifted through WP2 to (semi-)quantitative descriptions, were actually translated in food products, some of which were selected for characterisation in WP4 and a few were produced on a large scale for sensory assessment by seniors. The objective of WP3 was to design food prototypes and packaging fulfilling the specifications provided by WP1 and WP2. For this, the functional requirements from WP1, translated in product concepts in WP2, were analysed in terms of production flow charts. First experimental productions were tested for apple and carrot products to select food prototypes and their stabilization process. Shelf life were confronted to data (time/temperature) collected for meals in nursing homes and meals-on-wheels. Texture of pureed fruit and vegetable products were studied as a function of particle proportion and size to elaborate a functional model.

Approach

Definition and development of the pre-treatments and of stabilisation treatments for the making of soft-solids and functional liquid prototypes were carried out taking into account that products obtained should have enhanced sensory properties.



Sensory, nutritional and microbiological evaluation of the impact of pre-treatment, packaging and stabilisation process (alternative and conventional process) in apple and carrot based products were studied for all prototypes. Flow charts showing pre-treatments and stabilisation treatments have been made for the low pH (<4.5) and high pH (≈ 6.0) products and some of the results were presented in MS5 and MS6.

Processing choices were dictated by the products physico-chemical characteristics and in particular their pH. With a low pH, apple products stabilisation process such as HPP has proven to be an interesting alternative and two food prototypes (Apple purée and Apple pieces with watermelon texture) have been designed and developed to be tested in WP4. Apple purée has been done with Golden delicious variety, samples have been sent to Agroparistech and WUR for rheological and pectin's texture analysis. In parallel IO have worked on apple purée treated by thermal processing to enhance sensory properties by the introduction of natural ingredients (dried micronized apple skins and red coloured dried fruit).

For carrot product the high pH (≈ 6.0) has given inconsistent microbiological results and HPP has been discarded, only high pasteurisation done by thermal processes (Ohmic heating, autoclave and microwave) can give the appropriate microbiological safety. Microwave technology has been also discarded due to problems with packaging. WUR has evaluated the impact of processing on the pectin's texture. A third product concept called "Healthy Confectionary" based on Apple purée was also developed but no selected for final testing because of their limited shelf life.

Sweet food products enriched in minerals and vitamins

Five sweet food concepts enriched or not with a mineral and vitamin supplement MV2 and designed by CENTIV.

The first product is an apple purée made from Golden delicious variety with ascorbic acid, enriched with 0.25% and 0.50% MV2 and treated by HPP. With a treatment of 600 MPa during 3 min, the product can reach a shelf-life of 45 days at 8°C. With the addition of MV2, the nutritional content is greatly improved but 45 days was judged insufficient for a full production for WP5, so the product was dismissed for consumer tests. The relationships between the purées's structure (proportion and size of particles, viscosity of the serum) were studied in order to identify potential action points to tailor purées texture.

The second product is an apple dessert made from Golden delicious apples enriched with fibres, psyllum husk and pineapple aroma. From sensory evaluation, 4 formulations including additional apple fibres, black carrot juices and MV2 were tested. The product was pasteurized by autoclave in glass jar and has a shelf life of 4 month with a refrigerated storage at 8°C. This product was tested in WP4 and WP5 T5.2.

The third product is a Healthy confectionary based on apple purée. In order to create a candy-like product, safe and tasty, numerous trials were carried out. Finally, with a pasteurization we were able to have a product safe at ambient temperature with a water activity of 0.85. This innovative product could be a source of fibre and protein due to the incorporation of inulin, gelatine and agar-agar. However the shelf-live was still too short and the product was not retained for final testing.

The fourth product is apple pieces with watermelon texture, which have been tested with Golden delicious, Fuji, Pink lady, Gala and Granny Smith varieties. Granny Smith and Gala have been rejected and Golden delicious Pink Lady or Fuji have been selected for further tests.. The product is 1/8 apple pieces immersed in apple juice liquid in a ratio 40% apple pieces and 60 % juice, packaged in a vacuum pouch. The product was pasteurized by HPP at 450 min during 5 min to achieve a shelf life of 30 days and to modify the texture. This innovative product was tested in WP4.

Savoury food products enriched in plant proteins



Solid-soft products were enriched with proteins and the conditions were explored for their sensory characteristics, nutritional composition and safety in order to propose 2 to 3 food prototypes for evaluations in WP4. The effort have been concentrated on designing and developing products enriched with plant proteins, mainly from pea and wheat.

Carrot base purées were formulated incorporating a mixture of 5 to 10% proteins. This addition of mostly insoluble proteins had a marked impact on product texture, which limited the processes that could be used for stabilisation due to poor flow properties. Stabilization processes were ohmic heating, tubular heating and autoclave. Initially some texture problems arose with the use of ohmic heating and the formulation and preparation of the product had to be reworked. Tubular heating could only be used with the carrot purees with low levels of protein enrichment. The carrot purée was produced for further microbiological, sensory and nutritional analysis by WP4 in order to have an acceptable recipe that can be sent to WP5 partners. For such product, the shelf life is 3 month stored at 6°C.

CP did the formulation of the culinary aid enriched in protein products. The chosen formulations intend to match the taste of elderly from North and South Europe. The product was packaged in a T-shape pouch or glass jars of 110 to 150g and sterilized by autoclave. Work have been also undertaken to fulfil an industrial production in task 3.5.

In parallel other small production were done to assess the digestibility of proteins (pea, wheat and microalgae) in apple and carrot purée treated by autoclave and high pressure processing. Mineral and vitamin supplement was introduced in the healthy confectionary to enhance their nutritional properties.

Enriched drinks for the elderly marked

The objective was to create enriched fruit and vegetables liquid prototypes. The final recipes of two food concepts, apple smoothie and concentrated soup, were established.

Apple smoothie formulations were selected after sensory testing. Products incorporate rose juices, blueberry and the mineral and vitamin supplement MV2. The product was packaged in glass bottle with large screw-cap and sterilized by UHT. Other technologies based on microwave were tested but did not bring any substantial improvement over the more conventional system. HPP pasteurization was also tested at pilot plant level in Spain but not under industrial conditions in Poland. It resulted in shorter shelf-life so that the product would not be used in the final testing. At last, four recipes were selected for further analysis in WP4 and WP5.

Vegetable concentrated soup based on carrot and parsley, enriched in protein was used as prototype to test the different stabilisation technologies, ohmic heating and autoclave. Results were encouraging for the ohmic heating but autoclave was much better for large production for WP5 partners. Therefore, CP has formulated different soups (tomato soup, 7 vegetables soup and potato and leek soup) enriched in protein (5% and 7.5%) packaged in T-shape pouch of 70g and sterilized by autoclave. Samples were delivered to task 5.2 for testing.

Development of whole meal solutions/presentation.

The activities have been concentrated mainly on the definition of the whole meal solution related with the meal on wheel concepts. The solution is the OPTIFEL Tool kit, a concept refined in different meetings held in 2015 and 2016. The basic ideas are: the recipes can be easily cooked at home; all ingredients are already prepared; the ingredients just have to be assembled and reheated if necessary. The benefit for elderly of such tool kit should be, no or little shopping, already prepared ingredients easy to cook, variety of recipes that match nutritional needs.

Presentation was in two boxes: one for stable products and other for the refrigerated ones. Products developed in Optifel could be used as well as others available in the market. The whole idea was



presented in Deliverable D3.8. Also tests were done on packaging in order to improve their suitability for elderly or to improve their resistance to some pasteurization treatment such as HPP.

An online calculator has been developed by CENTIV, which allows nursing homes calculating nutritional needs of elderly on a personalized level. The next logical step is the development of a calculator for caterers (meals on wheels), however, this being a far more complex issue. The D3.8 shall serve as a conventional guideline for a later development of the OPTIFEL Tool Kit Calculator (OTKC).

The use of the Optifel Toolkit reduced sensitively the transportation, but increased the impacts of packaging production and end-of-life. With the packaging considered in this study, the Optifel Toolkit had higher climate change impacts than the delivery via centralized kitchens.

Reducing the weight of packaging in the Optifel Toolkit will allow to reduce the climate change impacts, making this scenario comparable to the traditional one in terms of environmental impacts. Based on these results the setup of the OPTIFEL Tool Kit may be improved to support elderly people through whole meal solutions as optimal as possible in order to counteract malnutrition but also promote the maintenance of their independence.

Production of prototypes and small series.

One of the tasks of this WP was to provide products to be tested to the two downstream workpackages. Task 3.5 has been focused in the production of large batches of products for testing in WP4 and task 5.2. In November 2015 a short list of 19 different products was done and the production of such large amount of food prototype was undertaken by the technical centres and SMEs involved in the task. In agreement with WP5 partners the logistic of movement of the products pallet was done and products arrive safely in the facilities of the 5 partners involved in task5.2. Works was also carried out to prepare the production and logistic to match the needs of WP5 partners for task 5.3 and 5.4. The movement and temperature of products was monitored using dataloggers.

At last production conditions was presented to QUANTIS for a LCA evaluation of the production of products used by WP4 and WP5 partners. In parallel on some of the products (broth with meat balls, apple purée and apple pieces) not selected for analysis in WP5 work has been carried out to implement an industrial production. Apple purée and Apple pieces were not selected because of their short shelf life and also for the second because it did not match sensory expectations from WP4 analysis.

The result was the development of 19 food prototypes concepts, including optimization of formulation, process, and packaging. Pilot and industrial scale production for concentrated soups, enriched carrot purée, enriched culinary aids, smoothies, apple dessert.

Experiments conducted in WP3 (Tasks 3.1, 3.2 and 3.3) allowed to select food concept products based on fruit and vegetables. Using three preservation technologies (HPP, ohmic heating and autoclave) these products had undergone detailed investigation in WP4 and WP5 from partners of OPTIFEL project (**Table 3**).

For the first product concept, apple purée with fibres (psyllium husk and/or dry apple fibers) and vitamin supplement, ‘Golden Delicious’ apple was chosen considering its availability for partners from Spain (IRTA) and Poland (IO). For the second product, apple wedges with watermelon texture, different cultivars (Golden Delicious, Gala, Pink lady or Fuji) were chosen for further testing in WP4. However, the results obtained showed that this product was not appropriate for the consumer study in WP5. Carrot purée samples and concentrated soups were also produced and tested in WP4 and WP5 and autoclave and ohmic heating technologies were applied. In addition, several recipes of culinary aids were tested. Apple smoothie prototype was also produced and tasted. Deliveries from the companies where products are produced until their final destination (institutions) of the selected



products were monitored in order to know the time-temperature variables and costs related with these transports.

In addition, costs related with the preparations of prototypes under industrial conditions were also calculated to know the feasibility of this production. In most cases, main cost are related with the staff cost. For this reason, the optimization of the human resources involved in the preparation of the samples should be optimized. Regarding the logistics (**Figures 3, 4 and 5**), data from food miles (international transport) and local chain (domestic transport) were also gathered and the complexity of this part is clearly pointed out.

Results from the trial of local chain showed the positive effect of the treatment of marinated chicken samples by HPP from a safety and sensory point of view. This product can be integrated in the concept of OPTIFEL tool kit (Task 3.4).

WP4 Impact of food storage and preparation of food product properties

Objectives

WP4 aimed at assessing the prototype food products developed in WP3, for their sensory properties, their nutritional value, their microbial safety and their environmental and cost performance. The assessment considered the formulation (in particular the nutritional fortification), the processing and packaging of the prototype foods designed in WP3, as well as the impact of products usage conditions (delivery, storage, reheating and serving). Among products from WP3, WP4 proposed the final selection to be tested by elderly consumers in WP5.

Approach

Concerning nutritional value, the focus was put on vitamin C and folates stability and on proteins digestibility. Vitamin C and folates are sensitive to heat degradation according to the scientific literature and fruits and vegetables represent an important source of these vitamins. Proteins studied were those used for nutritional fortification (pea and wheat proteins) and the question was the impact of processing and reheating on their digestibility. A sensory profile of the Optifel prototype foods was done by a trained sensory panel with a particular focus in the impact of proteins fortification. Microbial safety was assessed on non-sterilized Optifel products, considering as the most relevant hazard the bacterial pathogen *Bacillus cereus*, because its spores resist the heat treatment applied during processing and some cold tolerant strains can multiply in the product during refrigerated storage. Environmental and cost performance was assessed on the basis of products composition, processing, packaging and on several scenarios of usage.

Selection of prototype foods for WP5

The final selection of Optifel products for WP5 was made in a stepwise approach in the course of several Optifel consortium meetings (**Figure 6**). The selection procedure was based on the purpose of Optifel to design new foods fortified in vitamins and proteins that could be used as normal dishes in normal meals, and that should not look as the food supplements currently available on the market. Then, a benchmarking session and the feasibility constraints identified in WP3 permitted a first choice of product concepts. The testing (sensory, vitamins, microbiology) of these concept and the constraints of WP5 gave the final list of prototype foods (**Table 4**). The range of prototype foods includes a vitamin rich drink for breakfast and all the dishes of the main meal (starter, main dish, side dish, dessert), expect meat (chicken dices), bread and cheese that can be purchased as usual.

Sensory profile

The use of proteins in carrot purée and soup has a huge impact on the sensory characteristics compared to the heating treatment tested. Aroma had to be improved towards “cooked” and “carrot” notes. However, in purées adding proteins prevented exudation. In soups, sensory impact of proteins



addition was the least in a mixture of 7 vegetables. For the products for which time of storage was evaluated, only slight modifications of the sensory properties were observed. For culinary aids, reheating with pieces of chicken in pan, saucepan and Actifry (SEB) showed that Actifry permitted the best reproducibility of sensory profiles.

Nutritional value

During cold storage of heat treated products, no degradation of vitamin C and folates was observed. On the contrary, vitamin C and folates rapidly declined in high pressure treated apples, presumably because degradation enzymes were not inactivated. For this reason high pressure treated products were not selected for WP5.

Vitamin C degradation depends on pH, temperature and oxygen availability. In model solution, in perfectly stirred conditions, with a homogeneous distribution of compounds and oxygens in the solution, kinetics of vitamin C degradation were acquired in malate buffer (20 mM, pH 3.8, representative of apple purées), at temperatures (50 - 90 °C) and oxygen partial pressures (10 - 30%). Kinetics degradation constants were calculated and used to build a simulation tool [available on internet](#). Examples of results obtained are shown in **Figure 7**. The food simulator considers both the aerobic (diketogulonic acid pathway) and the anaerobic (furfural pathway) degradations. In non-stirred solutions or purées, no degradation of vitamin C was observed in absence of oxygen. Presence of oxygen in the headspace, over the solutions or purées surface permits vitamin C degradation, at a rate that depends on oxygen availability in the solution/purée. In particular, degradation rate did not increase when temperature got over 60°C, presumably because oxygen got less soluble.

Concerning folates, the vitamer naturally present in fruits and vegetables, 5-methyltetrahydrofolate, was very sensitive to degradation but could be preserved either by eliminating oxygen or by adding ascorbic acid in the purees. Folic acid, the vitamer commonly used for food fortification, appeared stable during reheating of purées, without stirring.

The common reheating methods (microwave, hot bath) did not markedly impact the concentrations of ascorbic acid and 5-methyltetrahydrofolates in the purées. The innovative reheating method (Actifry) did not lead to marked vitamin loss but did lead to water loss i.e. concentration of the products.

Digestibility of the proteins added to the products was verified. Pea protein had significantly higher rate of digestion than wheat protein. In wheat protein digestibility, the pH or the processing did not have significant influence. The re-heating increased the extent of protein digestibility due to unfolding of globular structure. Food matrix does not seem to influence the results of theoretical digestibility, so proteins added in apple and carrot are equally digestible.

Microbial safety

For the pasteurized Optifel products, the heat treatment was not sufficient to kill spores of *B. cereus*. During storage, if present, psychrotolerant strains of this pathogen can multiply at temperatures higher than 5°C (for instance 4 log₁₀ in 100 hours à 8°C, at pH 7), reaching within a few days numbers of *B. cereus* unacceptable for consumers safety. However, without oxygen, growth was not observed at 8°C and started at temperatures higher or equal to 10°C. The emetic toxin cereulide was produced by some strains of *B. cereus* at 8°C in presence of air, but at concentrations too low to represent a risk for consumers. At 10 °C, the amount of cereulide produced after 8 days could represent a risk. During durability studies, no *B. cereus* was detected in the samples of Optifel prototypes stored at 6°C for 2 months.

The *B. cereus* vegetative cells, grown from spores during storage, are very heat sensitive and can be rapidly killed by reheating (for instance 0.4 min at 60°C permits a million-fold reduction). However, cereulide is known to be very heat resistant. Therefore, food reheating can permit a risk reduction, only if storage conditions have not allowed for cereulide production (e.g. below 10°C).



During serving, spores that have not germinate during cold storage (e.g. from mesophilic strains) could multiply once the reheated food has cooled down to below the maximum growth temperature. In a nursing home, the time of food serving and consumption by active elderlies was short enough to prevent multiplication of *B. cereus*. However, the frailest elderlies took longer time to eat.

Environment and cost performance

The environmental and cost performance assessment includes the ingredients and packaging production as well as distribution and use of the Optifel prototypes. The study assesses three scenarios for usage of the prototype foods:

- Scenario 1: Optifel prototype delivered to nursing homes. The product is delivered to nursing homes from producers directly (or through intermediates) and heated on site;
- Scenario 2: Optifel prototype delivered to centralized kitchen which distributes the meals to elderly and nursing homes. The product is delivered from producers directly; the product is heated in a centralized kitchen and delivered hot to nursing (Scenario 2.1) or private homes (Scenario 2.2);
- Scenario 3: Optifel prototype delivered to supermarket: Elderly pick up the product themselves at supermarket (going by car, public transport or foot) and heat it at home.

The stages that most impact on climate change are (**Figure 8**):

- Raw ingredients supply: the ingredients cultivation (fertilisers and pesticides use and production, yield, diesel for farming activities) contributes mostly to this indicator.
- Packaging production: type and weight of the packaging affect climate change. The prototypes using the glass bottle, instead of the pouch, have the highest impacts because they use higher quantities of packaging per 100 g of prototype.
- Delivery to elderly and use stage: Transport of food to nursing homes or elderly homes is the most impacting stage. In particular, transport by van is the stage that mostly contribute to climate change impacts of scenario 2.2. and 2.1. Impacts for transport at ambient temperature (prototypes 4 and 5) are lower than impacts for refrigerated transport.

Results for costs performance are in line with climate change since the most impacting stages in terms of costs are raw ingredients supply, packaging (in particular glass bottle) and delivery to elderly and use stage.

A qualitative social LCA on the Optifel prototypes has also been undertaken, showing that no significant negative impact within the Optifel boundaries has been identified.

WP5 Product acceptance at homes and nursing houses

Objectives

The objective of WP5 was to ascertain the products designed and produced with the OPTIFEL approach did fulfil their aims in terms of appreciation and improved food intake (in particular calories and proteins) by elderly. WP5 focussed on the evaluation of elderly acceptance, enjoyment and satisfaction (taste, texture, portion size, willingness for repeated consumption etc.) as well as caregivers' opinion. This was done across a wide range of senior's dependency, from autonomous elderly able to come to the laboratories for preference tests to appreciation by dependent seniors benefiting from meals-on-wheels or community restaurants and seniors in nursing homes.

Approach

The approach in WP5 relies mostly on preference and consumption assessment, using either classical tools from hedonic sensory analysis or quantitative consumption data coupled with questionnaires. The preference tests performed by autonomous elderly were used to choose the best appreciated products for dependant elderlies, taking into account also countries' preferences.



Preference tests

Three types of products were enriched in vegetable proteins (wheat and pea): soups, culinary aids and carrot purees. Two fruit products were enriched in fibres, vitamins and minerals: apple dessert and smoothies. For each type of product, there were variants with different levels of proteins (5% or 7.5%) or different flavors. The task 5.2 of OPTIFEL aimed to select the enriched products to be tested during the clinical study (T5.3 and T5.4) in comparison to the standard without proteins or fibres minerals and vitamins. Hedonic tests were conducted in France, Finland, Poland and Spain and elderly consumers were asked to score their liking for each variant, choose the best and the worst among the variants and tell if they could envisage these products as part of their meals or not.

In France, Finland and Poland, the most liked recipe of soup was Tomato soup while it was the seven vegetables soup recipe which was the most liked in Spain. The Basquaise culinary aid was consensual in the four countries where it was tested, as the carrot puree with 5% of proteins and cooked aroma. AD2 dessert was the most liked recipe, with no significant difference with AD1 in Spain. The apple rose MV2 smoothie was the most liked in France and well accepted in Poland and was finally chosen for the “repeated exposures study”.

Food intake and appreciation by seniors

Setting and participants: Different places with dependent populations were studied; 18 nursing homes in Poland, Finland, Spain, France and Germany, 10 meals on wheels companies in Finland, Spain and France, 6 community centres in UK, Spain and France. In total 233 nursing home’s elderly participants (176 women, 57 men; mean age 83.8 ± 8.0 years), 56 meal on wheels ‘elderly participants (30 women, 26 men; mean age 83.1 ± 6.8 years), 67 community centre’s elderly participants (47 women, 20 men; mean age 79.8 ± 9.0 years). *Intervention:* Each participant was offered four meals one day a week corresponding to one control condition and one experimental condition (+91 kcal and 22.6g of protein) with one repeated session; meal including soup, chicken with culinary aids, carrots purée, bread, dairy products and desserts.

Dietary intake was weighted at the end of each meal. Energy and macronutrient intake was calculated using the composition of all products. Hunger and desire to eat ratings were asked before lunch and liking of each experimental dish and hunger rating was asked after lunch. Difference in calories and protein intake were evaluated using paired t-tests.

Results: Amount of food ingested is not significantly different between meals tested whatever the population but energy intake was significantly higher with the enriched conditions (+50.5 kcal in nursing home population, +42.6 kcal in meal on wheels population and +58.6 kcal in community centre population) with also a higher proteins contents ingested (+14.6 grams, +12.6 grams and +12.6 grams respectively). At the end of the enriched meal more elderly reached a protein intake level of 0.4 g/kg/lunch than the control meal (82.1% vs 42.2% in nursing home population, 89.0% vs 65.8% in meal on wheels population and 93.5% vs 82.6% in community centre population). The enriched recipes were well appreciated in the study.

Conclusion: Adding plant protein enriched foods in a meal can help to increase amount of proteins and calories ingested in institutionalized elderly. Additional large clinical trials with long-term interventions are needed to establish the benefits of these types enrichment in older people at risk of malnutrition.

Appreciation of vitamin-enriched fruit smoothies

Fighting elderly’s malnutrition leads scientists and industrials to develop enriched products whose sensory properties are not familiar. In our case, a smoothie, enriched in vitamins and minerals, has been developed. The products itself does not belong to the familiar repertory of the elderly and first hedonic evaluations (D5.2) showed that it was a little accepted but did not get high liking scores. The



objective of the study was to test a methodology to increase the acceptance and the consumption of such new products with dependent elderly people. A repeated exposures methodology was set up in nursing homes in two countries: France (n=64) and Poland (n=66). The subjects were divided in two sub-groups: 63 in the control group and 67 in the experimental group. They all received a bottle of smoothie in the morning in their bedroom at the first session and consumption, desire to eat, liking and hunger were measured. At the last session, 10 weeks later, all subjects followed the same procedure. In between, only the experimental group received a bottle of smoothie once a week in the morning during 8 weeks. The results show that there is no difference between control group and experimental group. The weekly exposition of the products did not increase liking or intake. However, when dividing experimental subjects according to their intake evolution throughout the weeks, we discovered that some of them keep a high intake during the survey, those who liked the most the product at the beginning (n=25), some of them get tired of the products and their consumption falls (n=24), and the last group, who started with a small intake and a low liking, consume more and more throughout the weeks (n=18). This variability is frequent in the elderly and shows that for a part of the elderly population who does not accept the new product at the first taste, it is worth presenting it several times to make it accepted.

Opinion of nursing and catering staff on the OPTIFEL products

The development of products especially for elderly people is needed in order to improve food intake and particularly protein contents to be accepted by elderly people but also by the professional staff who are in charge of this population. The objective of this study is to know the opinion of staff working in nursing home and catering concerning the Optifel products tested in targeted population living at home with meals on wheels and living in nursing home. Questionnaires with visual analogic scale in face to face were used. A total of 47 professional working in meals on wheels companies or in nursing home were recruited (20 in France, 22 in Poland and 5 in Finland). Between the middle and the end of the elderly population studies, professional staffs were questioned on what they thought about the products tested by the residents in nursing home or customers in meals on wheels. The 5-point scale (Yes (1), Probably yes (2), Probably no (3), No (4) and not at all (0)) was used to know if the enrichment with proteins or with vitamins and minerals were a good for elderly people, if this product is a good way to cook tasty dishes, if smoothie in individual bottles is a convenient way to present a healthy snack, and if packaging of products will be easy to open. The enrichments with proteins in soup and in culinary aids seemed to be a good way for 57.5% and 70.2% respectively but only 40.4% found a good way in the carrot purée. Concerning the enrichment with vitamins and minerals, 55.3% and 57.5% of professional found that it was a good way for the apple purée and the smoothies respectively proposed to elderly population. The culinary aids seemed to be very interesting way for 70.2% of professional.

Adding enrichment with protein or vitamins and minerals in conventional food seem to be a good issue for the professional staffs in charge of elderly people.

WP6 Dissemination and technology transfer

Within the framework of the Optifel project, dissemination activities targeted 3 different audiences: the general public, stakeholders in the food and care industry and scientific community.

To communicate with the **general public**, our main tools were the Optifel [website](#) and the newsletters. Since its launching the 1st January 2014, nearly 5000 internet users visited the website, mainly from France, Spain, Finland, UK, Switzerland, USA, Poland and Germany. The most visited pages were the project page and science page including the list of publications (Source: Google Analytics).



A newsletter has been disseminated every 6 months from May 2014 to October 2016 to inform about the news, results, recipes and innovations related to food for elderly. At the same time, press releases were sent to media professionals. Optifel newsletters are all available in the Science tab of the project website: <http://www.optifel.eu/science/>

The project was also presented to general public during the Paris International Agricultural Show in 2017.

To reach the **stakeholders** in the food and care industry, a professional seminar “Which foods for which seniors?” was held in April 2016 in Avignon (France). A similar event including culinary courses was organised in Barcelona (Spain) in December 2016. A web TV about “Health and nutrition in catering: new constraints” was also organised during the international fair SIRHA in January 2017.

One of the highlights is the development and layout of Optifel guidelines. Indeed, Optifel partners have developed a practical specification to food industry, based on the project findings and including information about product development for the elderly. These guidelines include 3 sections: **Nutritional** guidelines, **Functional** guidelines and **Guidelines** for Packaging.

This 4-page document has been distributed during the final conference and is available online.

Awareness of Optifel project results in the food industry has also been raised by means of presentations at commercial fairs. OPTIFEL project partners have been presenting to different commercial fairs, which are listed below:

- Health & Food Days, La Rochelle – France 2014
- SIAL, Paris – France 2014
- EU Open Doors Days, Brussels – Belgium 2014
- MDD Expo, Paris – France 2016
- Expo Milano, Milan – Italia 2015

Regarding **scientific community**, the results of Optifel project have already been the subject of numerous communications to congresses and publications. List of posters, orals and scientific papers will be regularly updated on the website: <http://www.optifel.eu/fr/science/results/>

Last but not least, the **final conference** of project Optifel was held on the 1st of February 2017, in Paris at the auditorium of Business France (77 Boulevard Saint Jacques 75 014 Paris, France). The seminar had asset the results of the project and explain to what extent they are transferable to food industry, meals-on-wheels, catering services and health professionals.

This final event embodies the end of an original concept, which was melting taste, pleasure and nutritional profile in the perspective to create food products giving back to older people the pleasure to eat.

1.4 Potential impact, the main dissemination activities and exploitation of results

WP1

WP1 has evolved in parallel of, on the one hand, an increase of the understanding of real needs, expectations and capabilities of European elderlies, and on the other hand, provided clear guidelines towards tailored food provision for elderlies. The categorization of elderlies based on their physical and oral capabilities using appropriate identification of quantitative tools rather than age is a major advancement for food provision of elderly of just-right texture.

Results of WP1 research for which appropriation by stakeholders can have practical interest are:

- Hand-grip strength is an adequate proxy for mastication strength, and together with the complementary information on dental status this can be used to predict eating capability. This provides caregivers with a reasonably easy and quick state-of-the-art quantitative methodologies to measure elderlies' individual eating capability:
- Experiments with complex model foods and real products with wide range of textures indicated that perceived difficulty to chew is not directly related to instrumental texture. This can help industries to design food tailored for elderlies with appropriate food types (fruits and vegetables), nutritional and textural properties
- The most preferred species and type of preparations for fruit and vegetables were identified, as well as their variation across Europe. The discrimination abilities of seniors are not impaired, but preference for sweeter products was identified among the frail elderlies. This gives opportunities to the food industry in developing food products (using identified most preferred fruits and vegetables) with right sensory qualities (sugar, sour) to ensure pleasure in eating for elderly people who are at risk of malnutrition
- Recommendations in terms of package design, torque and tearing strength as well as labelling legibility were formulated. This can help industries to develop the right food packaging for easy opening and legibility for elderly food products

As a whole, WP1 has helped to take a key step further to not only understand the needs and expectations of European elderly population in all the stages of eating, but also provide clear guidelines to food industries for tailored food product development for European elderlies, which might help to tackle the malnutrition issues in Elderly population and associated health costs.

The key dissemination activities included 3 oral presentations at large-scale public dissemination event targeted at end-users at the Final OPTIFEL Conference in Paris (2017) with media coverage by Food Navigator (<http://www.foodnavigator.com/Policy/Age-does-not-determine-eating-capability-but-can-affect-flavour-perception-say-researchers>), several oral and poster presentations in relevant European and International conferences (2014-17), such as, 1st Food for Elderly Conference in China, 4th Oral Processing Conference in Switzerland, 7th Euro Sense Conference in France, 7th International Symposium on Food Rheology and Structure in Switzerland, Nutrition Society-Royal Society of Medicine Joint meeting in UK, 16th Food Colloids Conference in Netherlands, 11th Pangborn Sensory Science Symposium in Sweden beside local events in respective European countries. Besides dissemination among public, scientific and industrial audience, results were published as 10 research outputs (8 peer-reviewed publications, 1 book chapter and 1 conference proceedings). :

WP2

The industry has now guidelines (on OPTIFEL's website: www.optifel.eu/food-for-elderly/guidelines/) for food product development for dependent elderly. Due to tailored products the nutritional status and quality of life of the focus group will improve and as a consequence a decrease in health care costs could be expected.

The guidelines are published on the project webpage on several languages. The results were presented in the international public conference and in several national events.

The guidelines and nutrient calculator were exploited in Optifel product development, and part of the model products were well accepted both in the groups of independent and dependent elderly. Thus they serve already as good models for industry. Some further recommendations were given for products needing further development. Guidelines are now ready to be adapted in the food industry. Further the product concepts which were described but not elaborated are available to the industrial partners of the project for further development.

WP3

The **potential impact** of the work carried out in WP3 has three levels: the project's participants, nutrition of seniors and food industry as a whole.

There is a **direct socio-economic impact** for the industry partners which were involved in the project. They have acquired new know-how in formulation and texture adaptation, which they can now directly use to produce food (including ingredients, processes and technologies) for elderly people. Knowledge generated in the WP3 and the production of food prototypes under industrial conditions represents a further step for food industry because they can apply directly the developed processes in the project adapting this to the particularities of each company. This means that industries could increase their offer leading to a better position in the market. This point could also be related with the number of employees that companies could sustain.

The second impact concerns the knowledge on development of **products for the elderly people** which fit their needs and demands, and is both more far-reaching and diffuse. Because of the improvement of their nutrition and the presentation of food with convenient packaging, seniors could remain at home for a long time and this fact, in turn, increases their well-being and quality of life and decreases health expenses. This information could also provides a general framework which can be applied for other kinds of foods; for this reason, the potential effect could be extended to all agribusiness chain.

WP3 thus provides guidelines to design future food products that reach the same specifications in terms of eating pleasure and nutritional contributions, as well as guidelines on distribution. Optifel also address cook-serve stage, with a simulator of vitamin loss and proposed solutions to mitigate the effects of cooking and reheating on food quality and safety.

WP3 provides attractive and nutrient-dense, fruit and vegetable-based, food solutions for the elderly. These food solutions have been validated for attractiveness, packaging, nutrition, microbial safety, texture and means of delivery. Detailed product concepts were described within the consortium for further use by participants for new products and product lines. Options for personalisation and preparation have been conceived. These products will allow nutritional status to be better maintained while providing pleasure, and help prevent malnutrition. Specifically enriched foods were available with sensory and use characteristics such that they can be used as part of a meal. Equipment for food preparation with adapted ergonomics and meeting the technical specifications elaborated for nutrition preservation and microbial safety were designed.

The third concerns specifically **processing of fruit and vegetables**, for which product development opportunities are high and OPTIFEL explored systematically a number of strategies notably for texture modification.

New knowledge acquired in the fields:

- New knowledge on the textural specification for foods that are easy-to-chew and safe to swallow, while avoiding the “baby-food” effect, as well as on the relation between physical capacities and eating capacities of elderly.
- Food science and food processing: The impact of innovative and conventional technologies on fruit and vegetable-based products was better understood, allowing manipulation of texture and improved preservation of nutrient content. The basis for texture variation in pureed fruit and vegetables, including the evolution of pectin and the impact of particles, was better understood. Knowledge-based recommendations for better preservation of vitamin contents and protein digestibility while maintain food safety during re-heating of plant-based foods was also proposed.

Expected impact is thus three-folds:

- New knowledge in food science, specifically on processing of fruit and vegetable.
- Tools available to the stakeholders for conception of products adapted for elderly and their distribution; adoption of these guidelines is expected to contribute to competitiveness of the European food industry by facilitating their product development, and to a decrease in malnutrition in the European population.
- Actual products that can be proposed to seniors for increased food pleasure and better nutrition. This will have a direct economic impact on participating businesses and a long-term effect on reduction of malnutrition.

Dissemination of the results:

- Dissemination of the results to the scientific community (scientific publications, presentations at international conferences and workshops,..)
- To introduce the project to the general public in terms of stakes, prospective, threats and solutions

WP4

WP4 contributed to the development of new food products, enriched in proteins, vitamins and minerals, designed for elderlies. The specific impact of WP4 was to demonstrate the sensory quality, nutritional value and microbial safety of the product, in conditions of usage representative of real conditions. This proves the feasibility of the Optifel project concept: combatting nutritional deficiencies in elderlies through enriched real foods that can be part of a normal meal, served in normal conditions.

Potential impacts of the scientific results from WP4 can be summarized as follows.

- Recommendations for food processors, nursing homes and meal on wheels companies to optimize their environmental and cost performance (for instance for nursing homes, preparing food on site instead of using a central kitchen providing meal for several nursing homes).
- New knowledge on the sensory impact of food enrichment with proteins, the effect of the proteins concentration and the food matrix.
- New knowledge on the stability of vitamin C and folates. In particular it is very interesting that these vitamins are more stable than expected in real foods, showing that the benefit of vitamin enrichment will not be lost during usage of the products.
- Demonstration that pea and wheat proteins have a good digestibility when added in real foods, whatever the process and reheating applied.



- Definition of the conditions for storage, reheating and serving that permit a safe usage of the Optifel food.

Dissemination of WP4 activities towards the scientific community was done through publications in international peer reviewed journals (6 articles published so far).

Dissemination towards the industry and scientific community was done through oral and poster presentations in meetings gathering representatives of both communities (approximately 14 presentations).

Results from WP4 were presented, among results from other WPs, at the final seminar of the project which gather a broad audience of journalists, professionals of the elderly sector, industries and scientists.

Knowledge acquired in WP4 on degradation of vitamin C was made available through a simulation tool freely accessible.

WP5

Potential impact:

Enrichment with plant protein in familiar food can be an effective and attractive solution to increase food intake and protein intake of older adults and alternative for oral nutritional supplements (ONS).

The main dissemination activities and exploitation of results

The results of WP5 have been presented in 2016 in scientific congress in France, Montpellier to Journées Françaises de Nutrition, in oral presentation in Paris.

In the next months, articles are going to be written by partners:

- article with common results about all dependent population by CHUD
- article about smoothie by ESA
- Finnish partners want to write an article with specific Finnish data by HAMK and MTT
- French partners want to write an article with French dependent population CHUD and ESA

WP6

The expected result of the dissemination WP of OPTIFEL is to broadcast major outputs of the project at the widest audience possible. Throughout the project, we kept on diversifying the communication tools and channels of dissemination (organisation of professional dissemination days, participation to commercial fairs, guidelines dissemination during final seminar, etc.). All the partners were involved in dissemination activities.

The optifel.eu website with its numerous contents, posts and news was an excellent channel for propagating information, not only on the project itself but also on the general topic of food and nutrition for the elderly. Other ways of communication used (twitter, newsletters, press releases, communication at specialised congresses...) yielded also excellent results.

Our main dissemination activities:

- Organisation of the Fruit and Vegetable Processing conference showing active participation of the consortium. The Symposium gathered 210 researchers and students from all over Europe, with strong contingents from Italy, Spain and Poland in addition to the more local French participants. A conference ("Fruit and Vegetable Processing: An integrated view on sustainability and impact on quality, safety and consumer" <https://colloque.inra.fr/fruitvegprocessing2016>) was organised April 4-6 in Avignon. It was followed by a day dedicated to presentation to



stakeholders of the constraints for food appropriate for seniors, co-organised with other French projects on similar topics.

- Development of concrete guidelines for food and care industry which have been layout by graphic designers. Updated French and English versions of guidelines are now available on the website: <http://www.optifel.eu/food-for-elderly/guidelines/>
- Other translations are expected in Spanish, Finnish, German, Polish, Swedish and possibly Turkish

- Definition of a concept of culinary training courses for the cooks in the care-catering and care industry. This concept was put into practice during a dissemination day organized in Barcelona by the Spanish partners (culinary demonstration led by a chef - Photo gallery X). Beyond the improvement of theoretical knowledge, this applied training aims to promote beneficial changes in professional practices to improve food for elderly.

- Optifel Final conference
The seminar gathered participants from all over Europe (UK, Poland, Finland, Belgium, Spain...) in addition to the more local French participants. Overall, more than 100 people registered for the conference. Many companies in the agri-food, catering and healthcare sectors were represented: Laboratoire PYC, Bonduelle, LDC, Floréale, Mc Cain, Sodexo, Api Restauration, Saveurs et Vie, Nutriset...
Tasting of the innovative products developed in the framework of Optifel was organised to show different solutions tailored to elderly population in terms of taste, texture, nutritional composition and packaging.

- A video about the Optifel final conference is public on Youtube, and will be also posted on Optifel website:
<https://www.youtube.com/watch?v=44gAYQP9uE0> (full version)
This 10-minute video includes interviews with the coordinator Catherine Renard and other scientific and industrial partners.
https://www.youtube.com/watch?v=ldUz1K48_Js (short version)

1.5 Project website

<http://www.optifel.eu>