**European Cooperation in Science and Technology**
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**Secretariat**
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**Brussels, 2 July 2010**

**COST 4134/10**

**MEMORANDUM OF UNDERSTANDING**

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| Subject : | Memorandum of Understanding for the implementation of a European Concerted Research Action designated as COST Action : The application of innovative fundamental food-structure-property relationships to the design of foods for health, wellness and pleasure. |

Delegations will find attached the Memorandum of Understanding for COST Action FA1001 as approved by the COST Committee of Senior Officials (CSO) at its 178th meeting on 25 May 2010

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**MEMORANDUM OF UNDERSTANDING**

**For the implementation of a European Concerted Research Action designated as**

**COST Action FA1001**

**THE APPLICATION OF INNOVATIVE FUNDAMENTAL FOOD-STRUCTURE-PROPERTY RELATIONSHIPS TO THE DESIGN OF FOODS FOR HEALTH, WELLNESS AND PLEASURE.**

The Parties to this Memorandum of Understanding, declaring their common intention to participate in the concerted Action referred to above and described in the technical Annex to the Memorandum, have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of document COST 4159/10 "Rules and Procedures for Implementing COST Actions", or in any new document amending or replacing it, the contents of which the Parties are fully aware of.

2. The aim of the Action is to apply the principles of food structure and material science to the design of innovative new foods with health benefits and optimal sensory characteristics.

3. The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at EUR 88 million in 2010 prices.

4. The Memorandum of Understanding will take effect on being accepted by at least five Parties.

5. The Memorandum of Understanding will remain in force for a period of 4 years, calculated from the date of the first meeting of the Management Committee, unless the duration of the Action is modified according to the provisions of Chapter V of the document referred to in Point 1 above.

## A. ABSTRACT AND KEYWORDS

The food industry is constantly challenged to meet consumer demands for new food products that are safe, convenient, affordable, pleasurable and healthy. The approach of many companies to product development is largely empirical in nature which compromises opportunities for truly innovative, healthy products. An understanding of fundamental structure–function relationships of food components is key to the design of new foods. This material science area is well researched. However ingredient formulation and production processes also have a major role in commercial food development and their impact on food structure is poorly characterised. Furthermore the influence of structure and physical properties on the nutritional and health inducing properties of foods (e.g. bioavailability/efficacy of nutrients/ bioactives) has received very little research. This Action will create an interdisciplinary team to apply the fundamental structure-properties knowledge of multiphase-foods (foams, emulsions) to real food systems, with a view to designing end-products with good sensory quality and health benefits. The Action will create an expert network to bridge the gap between material scientists, food technologists and nutritionists. The Action will seek to holistically train young researchers and provide industry with the expertise to design truly innovative pleasurable food products with real health benefits for consumers.
**Keywords:** material-science, food-structure, food-formulation and processing, design of innovative-healthy-foods

## B. BACKGROUND

### B.1 General background

There is an unprecedented interest in health and well-being. The food industry is faced with the challenge of producing quality food products that are convenient, shelf-stable, have health benefits and above all good sensory attributes. In addition there is a limit to the premium which consumers will pay for a product with 'added health benefits', so the use of cost-effective ingredients and technological processes is of paramount importance to the industry. Many food companies try to meet the challenge of designing healthy food using a trial and error approach; hence empiricism is the driver of innovation due to lack of technical 'know how'.

Many of the foods with health benefits launched to date, involve the addition of bioactive components (e.g. probiotics, prebiotics, peptides, polyphenols) that may have health benefits as an individual ingredient. However the physiological efficacy of these bioactives is often impaired when they are incorporated in food matrices and undergo typical food processing regimes. In essence when incorporated in food, the bioactives may provide no real health benefit to consumers or may impact negatively on the sensory properties of foods (e.g. milk peptides impart very bitter flavours) reducing their appeal to consumers.

Food structures could however be designed to protect labile bioactives, enhance their sensoric quality and ensure delivery of the bioactives to the targeted physiological site. Development of such 'intelligent' food structures would require the integration of a number of scientific disciplines including, material science, food physics, food chemistry, food engineering, process technology, food formulation, sensory analysis, nutrition and medicine**.** This fully integrated approach typically does not feature in food design. This COST Action will use this approach as a design tool for creating innovative products with real health benefits.

Foods tend to be complex materials comprising many components that are often and exist as separate phases hence the foods are termed ‘multi-phase’ systems. Foams and emulsions as multi-phase food systems attract much interest as matrices for ‘healthy’ products. For example filling an emulsion with air provides opportunities to reduce the fat content while maintaining the quality of a full fat equivalent. This COST Action will focus on the development of ‘healthy’ multiphase systems. The well established principles of structure-function design will be applied to model multiphase systems. To ensure the structure-function relationship is robust enough for industrial product design, an integrated approach will be taken which will expose the systems to formulation and production processes representative of those used commercially. Maintaining the stability, sensory properties and health inducing properties of the matrices will be central to the Action.

**Wider relevance**

The current buoyant global market for foods with health benefits is predicted to grow even further in the next 5 years. The design of foods based on integrated scientific principles provides an excellent template for food innovation and industrial competiveness. Availability of uniquely designed convenient foods with health benefits may lead to increased consumption of healthier food which in the long term may play a part in contributing to a healthier society and reducing health care costs.

**Why a COST Action?**

To realize the aims of the action will require a multidisciplinary approach. Each of the disciplines listed above are well established in their own right, however this COST Action will harness the strengths of scientists who already have/had funded research in each of the key disciplines. This will lead to a better understanding of the influence of food processing and formulation on the physical and sensory properties of foods and ultimately the health benefits of foods. A COST Action provides a very appropriate mechanism to integrate current knowledge and create a new interdisciplinary programme that will act as a pipeline for the discovery of innovative healthy products. No other programmes currently exist to cover the aims of this COST Action.

**Advantages of a COST Action**

The Action will provide the perfect forum for the interdisciplinary exchange required to integrate fundamental and applied sciences into an innovative approach to the design of healthy foods of high sensory quality. It will promote discussion and transfer of data between European groups, avoid duplication of research in different European countries and assist in the co-ordination of nationally funded research. It will be ideal for the mentoring of young scientists, exposing them to a holistic approach to innovative food product design and helping them embrace entrepreneurship.

## B.2 Current state of knowledge

**Previous research**

Over the past decade there has been considerable research in the area of developing foods with health benefits or what are termed 'functional foods'. For the most part the research has focused on the isolation of food components with potential health benefits, these are termed 'bioactives'.
The work has focused on the isolation, preparation and characterisation of the bioactives (milk derived peptides, oligosaccharides, polyphenols, omega 3 fatty acids), followed by for the most part by *in vitro* studies and in some case *in vivo* studies to establish health benefits/effects such as immunomodulation, decreased hypertension, lower cholesterol, improved gut health and satiety regulation. Although the bioactives are designed for food use, the work has been largely of a biochemical nature. There is a lack of research on the food processability of bioactives, their incorporation and stability in foods, their impact on the structure and sensory quality of food and very importantly their physiological efficacy when incorporated in foods. This may partly explain why despite the large body of research on health inducing bioactives there are relatively few commercial food products with scientifically proven health benefits.
The creation of multiphase systems to target the delivery of drugs to treat human disease has received some attention. However the nature of the material used would not be permitted in foods and the cost of the materials is prohibitive from a food application perspective.

**Current state of the art**

In recent years the techniques available to characterize the chemical and physical properties of foods at micro, meso and macro levels have advanced considerably. In the case of many food components good structure-function relationships have been clearly established which is very valuable in designing tailor-made foods to meet consumer demands. Such basic information is useful to predict the quality, shelf stability, processability and transport properties of foods. Previous European research projects have focused primarily on aspects of food structure and functions:

- FP 5 "Novel cross-linking enzymes and their consumer acceptance for structure engineering of foods";
- FP 6 – NMP "New controlled release systems produced by self-assembly of biopolymers and colloidal particles at fluid-fluid interfaces";
- FP6 – Food "Nutritional and Structural Design of Natural Foods for Health and Vitality" (End Date**:** 2010-04-30.

Currently many members of the COST Action are conducting research in the area of food structure and function. However there is very little research relating the structure of food to the physiological efficacy of bioactives incorporated in food matrices. There have many advances over the past decade in process-structure-function relationships of foods and food constituents and there has been particular activity in the area of Novel processing. Members of this COST Action have explored the use of Novel processes to improve production efficiency, the safety, stability and sensory quality of food. Interacting food polymers to entrap and target the delivery of food bioactives in the human gut is also a current activity of the Action group: the complexity and the lack of understanding of the underlying fundamental physical principles of release processes, has impeded the progress in the design of new encapsulating devices useful for food matrices.
It is necessary to further our understanding of all of these individual areas and most importantly interrelate and integrate the activities to deliver healthy pleasurable foods.

**How the Action will be innovative**

A substantial body of the research activity on healthy foods has focused on relatively simple substitution of food components (e.g. replacement of fat with water) to improve the nutritional profile. Another approach has been to focus on the biochemistry of bioactive components. This research has not been representative of the full processing pipeline required to prepare safe, shelf-stable foods with health benefits.

This Action will take a truly holistic and collaborative approach to the design of new healthy foods. Combining the expertise from the scientific disciplines of material science, food physics, food chemistry, food engineering, process technology, food formulation, sensory analysis, nutrition and medicine will result in a truly innovative approach to the design of foods that will provide consumers with a pleasurable but healthy eating experience.

## B.3 Reasons for the Action

There is increasing evidence to suggest a direct link between diet and health. Consumers have embraced this message resulting in a demand for food with health benefits beyond its normal nutritive value. Consumer's acceptance of food is however first and foremost governed by the sensory attributes of foods – no health benefit will compensate for a non-pleasurable eating experience. Price and convenience will also influence purchase of healthy food products. In addition, the companies must act within a very strict legislative environment. For example in Europe foods with claimed health benefits can only be approved for sale, if efficacy of the health benefit has been proved scientifically to the satisfaction of EFSA. It is attractive for companies to try and gain a share in a global functional foods market estimated at a value ~$129 billion or $34 billion in the European market but technically it is very challenging to produce health inducing foods particularly for SMEs.

The aim of this Action is to harness scientific data currently available in separate disciplines and research groups and combine it in a truly collaborative approach to ensure the 'whole' is greater than the 'sum of the parts'. It will lead to synergy between research groups and avoid duplication. It is expected that the Action will:

- advance the scientific and the technological knowledge required to create innovative pleasurable healthy foods;
- provide a template for the development of healthy foods that can be transferred to industry to increase their competitiveness;
- lead to a greater choice of healthy products for consumers to enjoy;
- increase consumption of healthy foods leading to a healthier society.

### B.4 Complementarity with other research programmes

This Action aims at improving knowledge transfer across the pipeline of discovery of new food products. A key focus will be the optimisation of internal and external contacts and cooperation. The Action identifies the need for an effective integration of strategically-focused, trans-national, concerted research in the food science, food engineering and nutritional science to deliver innovative, novel and improved food products to satisfy consumer needs and expectations. The outputs of this Action will therefore be linked to other complementary programmes that will facilitate the exchange of information. This will assist in the dissemination of tools for designing new food for health, wellness and pleasure to the European Food producers.
This main challenge of the Action fits with the prioritised research activities defined by the ETP FOOD FOR LIFE. In particular, ETP Key Thrust 1 (Improving health, well-being and longevity, a priority research challenge in Food Quality and Manufacturing research) maps well to the research criteria defined in the Action. This is the research required to achieving breakthroughs in nutritional and food science and food technology, which will subsequently be implemented in food products.
Several partners have links to the following current and/or planned European research projects of relevance:

- NOVELQ project "Novel processing methods for the production and distribution of high-quality and safe foods" (EC Integrated Project, contract no. FOOD-CT-2005-015710) (http://www.novelq.org/Default.aspx ) , whose main objective is to develop and successfully demonstrate novel processing technologies for improved quality food.

- DREAM EU-Project 2009-2013 “Design and development of realistic food models with well characterised micro- and macro-structure and composition” (http://dream.bf.uni-lj.si/home/) that will develop realistic, physical and mathematical food models for use as standards to be exploited across all major food categories to facilitate development of common approaches to risk/benefit assessment and nutritional quality in food research and industry.
- HEALTHGRAIN EU-Project 2005-2010 “Exploiting bioactivity of European cereal grains for improved nutrition and health benefits”( http://www.healthgrain.org/pub/) , an Integrated Project of the European Union's Sixth Framework Programme "Food Quality and Safety" activity, that aims to improve wellbeing and reduce the prevalence of the insulin-resistance syndrome in the European population by increasing the intake of protective whole-grain components.
- COST 928-V: “Control and exploitation of enzymes for added-value food products” (http://virtual.vtt.fi/virtual/cost928/ ), whose objective is to develop novel enzymes and tailored bioprocessing technologies for especially cereal, berry, fruit and vegetable and proteinaceous (dairy, meat, fish) food raw materials in order to obtain higher-quality food products.
- EUREKA 3694 ‘Propocream The development of the multifunctional cream from natural products’ (http://www.eurekanetwork.org/project/-/id/3694), that aims to create environmentally friendly semi solid preparation from natural ecological sources.
- FP6 – ‘ProSafeBeefAdvancing Beef Safety and Quality through Research and Innovation’ (2007-2012) (http://www.prosafebeef.eu/asp/), whose objective is to make it possible to increase the safety of beef and beef products by the science-based development (along the total beef chain) of novel tools and intervention strategies as well as consumer focused innovative beef products thus invigorating the beef sector.

There may be possible liaisons and interaction with:

- ISEKI-FOOD 3 'Innovative Developments and Sustainability of ISEKI-Food' **(**https://www.iseki-food.eu/drupal/ **)-** 142822-LLP-1-2008-PT-ERASMUS-ENW, its main objectives are to contribute to the realisation of the European Higher Education Area in the field of Food Studies and to work towards the network sustainability. A deliverable of the project is to support a Special Interest Group on: "Food Structure and Physical Properties".

## C. OBJECTIVES AND BENEFITS

### C.1 Main/primary objectives

The main objective of the Action is to apply the principles of food structure and material science to the design of innovative new foods with health benefits and optimal sensory characteristics. More specifically it will seek to: 1) apply principles of fundamental structure-properties relations to the development of innovative model multiphase systems to enhance their stability, sensory properties and their ability to effectively deliver bioactives with health benefits; 2) examine the influence of formulation and process technology (conventional and novel) on the model systems with a view to designing real foam-like and emulsion-based foods tailor made in terms of their health and sensory properties.

### C.2 Secondary objectives

The secondary objectives will be to:

- collate previously obtained results and transfer of technology from several disciplines (physical sciences, material science, food formulation, food engineering, food chemistry and nutrition) that had previously worked for the most part independently on multiphase food structure-function-process-formulation–nutrition-health benefits;
- transfer of technology to industry and training of SME staff;
- increase cooperation in the delivery of undergraduate and graduate food science.

## C.3 How will the objectives be achieved?

The objectives will be achieved by establishing a truly collaborative forum for scientists that currently work in independent fields relevant to the design of innovative healthy food products. Through organized workshops, summer schools and conferences the Action participants will be able to have fruitful interactions/collaboration and disseminate their expertise. Short term Scientific Missions (STSMs) focused on Early Stage Researchers will be organized to enhance collaborations. There will be a continuous exchange of information within and between Working Groups (WGs) to ensure the continuous integration of the work programmes. There will be a strong emphasis on technology transfer; training programmes will be established to ensure the outcomes of the Action can be successfully transferred to Industry. Activities and achievements will be disseminated via websites and press publications.

## C.4 Benefits of the Action

The Action will:

- encourage innovation by providing a template for the development of pleasurable foods with health benefits;
- increase the competitiveness of the European food industry. This will ultimately benefit consumers and increase their choice of healthy affordable food;
- widen the availability of attractive healthy food may encourage a healthier diet and ultimately decrease diet related diseases and associated medical costs;
- develop young scientists with an entrepreneurial culture with technology transfer skills;
- transfer research skills between different scientists active in the Food and Health field which will accelerate research in this area;
- facilitate the sharing of teaching strategies and experiences in food related undergraduate and graduate programmes;
- strengthen dialogue with end users and ensure research activities are appropriate to their needs;
- identify future research needs.

### C.5 Target groups/end users

The Action is aimed at:

- Scientists and students researching/teaching in the area of Food, Diet and Health
- Food Companies
- Entrepreneurs
- Consumers with an interest in health and well being
- Policy makers – national and international

## D. SCIENTIFIC PROGRAMME

### D.1 Scientific focus

**Research Tasks**

This COST Action seeks to co-ordinate the activity of scientists from distinctly different disciplines, to create an innovative design tool for the development of new food products with health benefits**.** The interdisciplinary scientific team will collaboratively engineer solutions for fundamental issues. This will pave the way for innovation and increased competiveness for the European Food Industry. This fully integrated research programme is a novel approach to food product design. The participants have identified 4 key research priorities. A Working Group (WG) will be established for each of the 4 focus areas and strong links and inter relationships will be established between the four groups which will be as follows:

- enhancing analytical and modeling techniques to characterise the structure and physical properties of foods;
- elucidating structure-property functions and designing model multiphase systems;
- designing innovative everyday foam- and emulsion-based foods with optimal sensoric quality and health benefits;
- training and technology transfer.

A brief description of each of the focus areas is as follows:

1. **Enhancing analytical and modeling techniques to characterise structure and physical properties of foods**

The key criteria governing the technical success of a new food product i.e. sensory quality, processability and stability are dictated by the structure of the food. Therefore fundamental measurements that would lead to an understanding of how food components interact with each other to form complex food structures, would be of great value in the design of new foods. Developing such a suite of fundamental tests will be the focus of the first task of this Action. More specifically it will focus on the analytical and modeling techniques available to characterise the structure and physical properties of foods at different levels of the hierarchic scale i.e. micro- to macro- level. Current protocols for the evaluation of food physical properties and food structure assessment (rheological, physico-chemical, geometrical, surface, electric, and optical properties) will be evaluated for further developments. The 'analytical techniques' activity will be supported with an innovative chemometrical modeling approach to data treatments. This will enhance the quantity and quality of information generated. This modeling aspect will allow an integration of the wealth of data that already exists for each of individual physical properties but has yet to be collated and applied to real food systems.

2. **Elucidating structure-property functions and designing model multiphase systems**

The second focus area will involve understanding structure-property functions and designing model multiphase food system. Most foods are quite complex systems comprising a number of components, which may exist as different phases within a food. This Action will focus specifically on food emulsions and foams (liquid and solid foams). Foams and emulsions represent the underlying structure of many foods (e.g. soufflés, ice cream, dressings, spreads, solid foams like bread). However due to large interfacial/surface tensions between phases (e.g. oil and water, gas and solid or liquid continuous phases), they are metastable systems. They present a notorious challenge for stabilisation, particularly at industrial production level.

The programme is based on the characterization and full description of the performances of the selected food model systems by means of their physical, chemical, physico-chemical and transport properties on the basis of their nature of composite materials made of a dispersed phase (gas, liquid) and a continuous medium (liquid, solid). Transfer of fundamental knowledge on material properties will be successively used to design stable emulsion systems and foam-like real foods.

The first aspect of this task will be to explore opportunities to develop new techniques to stabilise emulsions and foams (e.g. microbubbles in food foams or air filled emulsions to reduce fat while maintaining the quality of the full fat equivalent). This will involve determining how molecular interfacial behaviour can explain bulk functional behavior (i.e. foam and emulsion stability). For example in the case of proteins, their adsorption and re-configuration at the interface will be related to interfacial tension, interfacial rheology, adsorbed layer dynamics and ultimately foam and emulsion properties.

A second aspect of this task will be to develop foams and emulsions as innovative structures for the delivery of bioactives (e.g. prebiotics, peptides) with health benefits. The objective of this task will be two-fold:

- emulsions/foams will be designed to protect the bioactives against what are often quite harsh processing regimes used in the food industry;
- emulsions/foams will be created to 'entrap' bioactives that will only be released at the targeted physiological site e.g. release in the small intestine rather than the mouth/stomach.

In the first part of this task the food polymers (e.g. proteins and carbohydrates) most suitable for interacting and protecting selected bioactives will be identified and their physical properties will be compiled. The nature of polymers selected will be dependent on their ability to act as a suitable dispersion/dispersed phases, their interfacial behaviour and their affinity for a specific bioactive.

The ability of the assembled matrix to protect the bioactivity against processing parameters (e.g. heat, shearing, acidic/ionic conditions) in model systems will be assessed. Similarly polymer system for the creation of emulsions will be designed to protect the bioactives from release in the mouth and the harsh conditions of the stomach. The methods by which the bioactives can be released in a controlled manner in the intestine (e.g. via ionic exchange) will be determined. In summary transport phenomena of bioactives in multiphase systems will be studied and their release described as a diffusion-controlled phenomenon.

3. **Designing innovative everyday foam- and emulsion-based foods with optimal sensoric quality and health benefits**

Task 2 will deal with model food systems. However if the Food Industry is to meet consumer demand for pleasant tasting convenient foods with health benefits, they need to be able to translate information from model foods to real food systems. Understanding the impact of structure-function relationships on health aspects of real food systems will be the focus of task 3. This will involve examining the influence of food formulation (i.e. range of ingredients used in food recipes) and food processing on the properties of foam and emulsion based foods containing bioactives. Both traditional and emerging thermal and non thermal novel processing methods will be examined. Emerging technologies (e.g. high pressure processing, pulsed electric fields ohmic heating, microwave and radio frequency technologies) may have an important role to play in optimizing health benefits and sensory attributes that are often compromised by conventional food processing. This task will lead to the design of innovative everyday foam- and emulsion-based foods with optimal sensoric quality (appearance, aroma, taste, acoustic, tactile, kinesthetic) and health benefits. Activities will focus on elucidating the impact of food ingredients in combination with processing on food structure and ultimately the sensory and health benefits of the food. Consumer perception of new real multiphasic products will be evaluated. Currently there is a complete lack of information on the structural changes occurring when real foods are processed using manufacturing conditions. This is particularly the case for emerging technologies. Very valuable information will be generated as most multiphase foods shows metastable within the window of heat, shear and mass transfer imposed by many of process events incurred in real food manufacturing processes. Elucidating the causes of the instability and the loss of bioactivity will assist in formulating solutions.

4. **Training and technology transfer**

Research in the area of food diet and health can only be of true value, if ultimately the consumer and the public in general, reap the benefits of the outcome. In many instances important research advances are not utilized to their full advantage from a society perspective. This often occurs due to poor technology transfer between research institutions and industry. Against this background the Action will include a fourth task that will focus on training and technology transfer. The objective of this task will be to ensure that the Action is focusing on topics relevant to the stakeholders and that the outcomes of the Action are most effectively transferred to industry. Effective technology transfer will enhance the competitiveness of European research in the food area and strengthen companies' capabilities to sustain innovation in European food production. This Action will focus on developing research and industrial partnerships and encourage personnel transfer between academia and industry and *vice versa*. STSMs will provide postgraduate and postdoctoral researchers with relevant interdisciplinary skills and help create a culture of innovation and entrepreneurship. The task will promote a European annual summer school for PhD students on food product design and innovation. An important aspect of the task will be to train specialized technology transfer Mediators. These Mediators will translate the scientific outcomes of the work packages in a manner that is accessible to industry especially SMEs. To develop this training WG contact will be made with the licensed Foundation for Training. Organization financial support for the initiative will be sought from industry.

**Structure and flexibility of plan**

The frame of the work plan will be sufficiently flexible to permit the inclusion, at the implementation stage, of disciplinary perspectives and activities not foreseen during this preparation of the proposal. Partners will aggregate in WGs according to their main competences; there will be open access to new partners entering during the course of the Action.

**Achieving the plan**

The objectives of the Action will be achieved by bringing together scientists from several disciplines (physical sciences, material science, food formulation, food engineering, food chemistry and nutrition) and companies of different food sectors. The participants have previously worked for the most part independently but have in-depth experience and access to the relevant technologies in their respective fields. The scientists have external funding for research in their areas which also supports graduate studies. Young scientists associated with these funded research activities will play an integral part in this Action. New developments in the field are expected to be achieved by building a platform for exchange of data between all the scientists. There will be continuous interactions with the food industry to ensure the scientific focus is relevant to their needs and that the outcomes of the Action are effectively transferred to industry.

## D.2 Scientific work plan methods and means

**Work plan**

The programme will start with the following activities:

- a database on the current research of the partners on food structure, food physical properties foams and emulsion-based-foods (already constructed for this proposal) will be updated and expanded. A database on partner laboratory facilities that has also been assembled for this proposal will be further refined;
- specific work plans will be established and partners will be assigned to working groups and tasks in accordance with their competences;
- an invitation will be issued to all partners to plan new PhD theses centered on themes of food material science for the design of new food products with health benefits.

The four tasks described in section D1 including subtasks and deliverables that will be developed by four Working Groups (WGs) are as follows:

WG 1 will develop task 1:

‘‘Analytical and modeling techniques to characterise structure and physical properties of foods’’
Sub-tasks of WG1 are:

1.1 Evaluating current protocols for the analysis of food physical properties and food structure assessment (rheological, thermal, physico-chemical, geometrical, surface, electric, and optical properties) with a view to combing techniques to give more in depth analysis.
1.2 Applying innovative chemometrical models to physico-chemical-structure data to enhance quality of multivariate information achieved.

Deliverable:
Co-ordination and integration of top advances in EC research in the fundamental characterization of the physical properties of foods. This will lead to the optimization of analytical techniques to characterise factors influencing food structure from micro to macro level.

WG2 will develop task 2:
“Elucidating structure-property functions and designing model multiphase systems
– foams and emulsions ”
Sub-tasks of WG2 are:

2.1 Characterising the relationship between the physical properties of polymers, the structure of foams and emulsions and ultimately stability /shelf-life of the multiphase systems.
2.2 Development of novel strategies for stabilisation of emulsions and foams.
2.3 Designing foam and emulsion structures to protect and deliver bioactives to their targeted physiological site.

Deliverable:
The integration of data from physical chemistry and multi-phase structure structure to design emulsions and foams with enhanced stability capable of effectively protecting and delivering biactives with health benefits.

WG 3 will develop task 3:

"Designing innovative everyday foam- and emulsion-based foods with optimal sensoric quality and health benefits"

Sub-tasks of WG3 are:

3.1 Establishing the effects of structure-function-formulation-processing on sensory and health related aspects of multi-phase food.

3.2 Establishing the influence of food ingredients on the properties and stability of model multiphase food systems.

3.3 Determining the influence of traditional and emerging thermal and non thermal technologies on the properties and stability of multi-phase systems.

Deliverable:

A tool to predict the impact of food ingredients and processing on the structure of multi-phase foods and the sensory and health benefits of the foods.

WG 4 will develop task 4:

"Training and technology transfer"

Sub-tasks of WG 4 are:

4.1 Training: promotion of the exchange of young researchers throughout STSMs; organize a European annual summer school for PhD students; creating a culture of innovation in participating research groups; organizing a training programme for specialised technology transfer mediators.

4.2 Technological Transfer: building a database capturing the themes, competences and outcomes of the Action. Creating and implementing strategy for technology transfer and dissemination of the innovative outputs of the Action to industry.

Deliverables:

- Creation of an innovative culture for scientists including students
- Databases on the integration of physical properties of foods – food structure – food processing and formulation – sensory properties and health benefits of foods.
- Trained technology transfer mediators
- Young researchers with a broad skill base relevant to effective career development in the European Research Arena.

**Integration of work plans**

A key aspect of the workplan will be the integration of all 4 Work Groups; an approach which is truly innovative. This will involve extensive co-operation between researchers and collation of data. Through this co-operation, the Action will seek to optimize undergraduate and graduate food science and nutrition programmes. This will help to increase the competitiveness of EC students in the food and health area. The engineering based approach focusing on fundamental material science, as described in the work plans, will allow relationships to be established between the structure of food and its properties/functions. This in turn will provide a means of predicting how to combine food components and processes to create the desired end structure.

The overall deliverable of the work plan will therefore be an innovative design tool for creation of healthy pleasurable foods that is readily translated to Industry.

## E. ORGANISATION

### E.1 Coordination and organisation

The overall project coordination will be entrusted to a Management Committee (MC) which includes up to two representatives from each COST Party of the Action.
The MC will:

- facilitate the communication among the different partners and modules;
- be responsible for the development and coordination of the activities of the WGs;
- coordinate the timetable of activities;
- coordinate interaction between the Action and the research community participating in other complementary research programmes;
- assist the coordinator in the allocation of financial resources;
- supervise the preparation of general reports of the WGs, and approve the technical reports of the different activities;
- prepare the general activity reports and other deliverables to be submitted to the COST Commission.

The MC will assume the following rules of procedure:

- an Editorial Committee (EC) and its Leader Person will be appointed and will be in charge for science dissemination;
- in order to reduce overall costs, the MC will elect a Steering Committee (SC) of eight persons (MC Chair, MC Vice-Chair, WGs Leaders, Leaders of the EC) who will coordinate the work of the Working Groups and other elements of the programme. The SC will meet at least twice per year to:
  - oversee the activities;
  - supervise the work, re-evaluate the work programme when needed;
  - monitor the financial budget;
  - supervise educational exchanges *via* STSMs;
  - supervise the implementation of a training-summer-school to aid dissemination of the findings of the Action amongst young scientists;
  - supervise the technological transfer of the Action deliverables.

The MC will meet early in the life of the Action to plan the initial programme and elect the Chair, the Vice-Chair, the Steering Group, the Leader and Vice-Leader of the EC, an STSMs coordinator and vice-coordinator and Leaders and Vice-Leaders of the WGs.
The MC will meet at least once per year in conjunction with a WG meeting.
An external Scientific Advisor with recognized authority in the field will be appointed, who will have access to the Action website and have the responsibility for contextualizing the Action outcomes from an international perspective. The Advisor will be invited to the MC meetings. E-communication within Committees and the Steering Group will be encouraged by using an agreed server.
Important milestones are crucial to monitor the direction of the Action. These are as follows:

- updating and maintaining a database (that has been already partially drawn up) on the current research activities of the partners on foams and emulsion-based-foods structure, physical properties, sensory studies, processing regimes, formulation studies, data modeling, delivery of bioactives and laboratory facilities. This will be available electronically via an already existing interactive web platform. The web based service will be accessible to members of the network, registered EC industries, SMEs, research centers, other registered users;

- scheduling and definition of the main operative details for a European annual summer school addressed to PhD students on food product design. The scientific content will annually reflect advances of the Action (12 months);
- formation of an appropriate interface network of food engineering / food material science and nutrition experts to focalize the future scientific and dissemination direction of the Action. E-publication of conclusions (24 months);
- organisation of a training-school aimed to develop specialised technology transfer Mediators (36 months);
- a preparatory platform for future coordinated research activities in the frame of EC Programs (48 months).

## E.2 Working Groups

The scientific program, that accounts for four tasks (as described in D1 and D2), will be developed by four working groups (WGs). Each of the WGs will elect a Steering Group (SGWG) including: a Leader, a Vice-Leader with responsibilities for each WG's subtasks. The SGWGs will meet twice a year and the WGs at least once a year.

WG 1 will develop task 1: Analytical and modeling techniques to characterize structure and physical properties of foods" and will be organized in two sub-tasks.

WG 2 will develop task 2: "Designing model multiphase systems –foams and emulsions" and will be organised in three sub-tasks.

WG 3 will develop task 3: Designing innovative everyday foam- and emulsion-based foods with optimal sensoric quality and health benefits" and will be organized in three sub-tasks.

"WG 4 will develop task 4: "Training and technology transfer" and will be organized in two sub-tasks.

Close interaction between WGs will be encouraged to stimulate problem solving, due to the diversity of expertise and experiences of the Action members.

In order to permit a systematic monitoring of the progresses of WGs activities and a matching with Action milestones, performances indicators for each of the WGs will be defined:

- items uploaded to the website;
- access to the WGs activities by external targeted audience from academy and food producers;
- scientific publications in international and national journals.

### E.3 Liaison and interaction with other research programmes

As mentioned earlier (B4) active collaboration with other COST Actions and other European research programmes will be encouraged. Some experts who have already expressed interest in participating in this Action also participate to some of these programs and will be therefore will have the responsibility of developing links. Complementarity will be monitored to ensure synergies. Leaders of Research Programmes or COST Actions with complementarity to the present Action will be invited to conferences and meetings for exchange of information and will be invited to link their web pages to the Action's web site. The Action plans to invite Early-Stage Researchers to join the annual summer school for PhD students on food product design.

### E.4 Gender balance and involvement of early-stage researchers

This COST Action will respect an appropriate gender balance in all its activities and the Management Committee will place this as a standard item on all its MC agendas.
This Action will also be committed to a considerable involvement of Early-Stage Researchers (ERSs). This item will also be placed as a standard item in all MC agendas.
The Action will develop a gender action plan to promote gender equality in all forms within the network. An effort will be made to maintain a good gender balance in the elected leading team members of the COST Action. Each of the participating institutions will be requested to comply to an appropriate gender balance in recruiting its personnel for the participation in the Action.
The Action will also place a high priority on the evolvement of ESRs in all activities in order to ensure the project successfully contributes to capacity building within European Science. There will be a particular focus on building the capacity to exploit the research findings to all stakeholders in the food development chain.

To involve ESRs, the Action intends to undertake the following activities:

- ESRs will be encouraged to participate in workshop and conferences, including help to plan and organizing such events. ERSs will also benefit from the provision of funds enabling a selected number to attend organized workshop and conferences, with the aim of facilitating new research networks;
- ESRs will be encouraged to join the WGs. There will be an ESR representative to the MC. This role will be undertaken for one year, such that four young researchers will pursue valuable managerial experience by the Action;
- The Action will use STSMs to provide postgraduate and postdoctoral researchers with relevant interdisciplinary skills. Gender balance will be observed in STSMs;
- An annual training school will be organized for PhD students to aid the dissemination of the findings of the Action among this group of young scientists. Links will be established with ISEKI_Food (Integrating Safety and Environment Knowledge In Food towards European Sustainable Development - http://www.iseki-food.eu/) network that contributes to the European Higher Education Area (EHEA) in the field of food studies by internationalization and enhancement of quality, and with EFCE (European Federation of Chemical Engineering) - Section on Foods that organizes an annual European Workshop on Food Engineering and Technology in cooperation with EFFoST, the European Federation of Food Science and Technology offering a forum for young PhD-students to present their ongoing research and to discuss it with people from academia and industry (http://www.efce.info/Working_Parties_and_Sections-111843/Sections/Food/European_Food_Workshop.html).
- ESRs will participate in the training-school aimed at developing specialised technology transfer Mediators.

## F. TIMETABLE

The duration of the Action is four years. It will begin with the kick-off meeting; all named participants will be invited. It will finish with a summit conference where all Working Groups will present their results.
Each year there will be at least two meetings of the SC and WGSGs with meetings of the MC and WGs coinciding with an annual conference.
Years 2, 3 and 4 will see exchanges of personnel using the STSMs instrument and implementation of the Summer School for PhD students. The third year will also see the organization of a Training-School for technology transfer mediators.
The Action website will be generated the first semester and will be updated every trimester.
Reports will be generated at the end of every year.

The timescale is shown in the table.

| | YEAR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 |
| | kick-off | 6m | 12 m | 6 m | 12m | 6 m | 12 m | 6m | 12m |
| **Positions appointment** | x | | | | | | | | |
| **MCSG meeting** | x | x | x | x | x | x | x | x | x |
| **WGSGs meeting** | x | x | x | x | x | x | x | x | x |
| **WGs meeting** | | x | | | x | | x | | x |
| **Financial budget** | | x | | x | | x | | x | |
| **Finantial actual** | | | x | | x | | x | | x |
| **Web site** | | x | x | x | x | x | x | x | x |
| **STSMs** | | | | | x | | x | | x |
| **Summer School** | | | | | x | | x | | x |
| **Annual Conference** | | | x | | x | | x | | |

| Milestones | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Annual report** | | | x | x | x | | |
| **Final report** | | | | | | | x |
| **Final conference** | | | | | | | x |
| **Other** | **M0** | **M1** | **M2** | **M3** | **M4** | | **M5** |

M0: Publication of members of WGs, their Chair persons and WGSGs

M1: Database on current research of partners on food design for wellness and pleasure

M2: Plan for the annual European Summer School for PhD students

M3: e-publication of communication of the virtual community of food scientists, food engineers and nutritionists

M4: Training school for technological Mediators

M5: Preparatory platform for future coordinate researches in the frame of EC Programs

## G. ECONOMIC DIMENSION

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest: Austria, Croatia, Denmark, Finland, the Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Lituania, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovenia, Spain, Sweden. On the basis of national estimates, the economic dimension of the activities to be carried out under the Action has been estimated at 88 Million € for the total duration of the Action. This estimate is valid under the assumption that all the countries mentioned above but no other countries will participate in the Action. Any departure from this will change the total cost accordingly.
In addition, the following non-COST country has expressed its interest to participate: Chile

## H. DISSEMINATION PLAN

### H.1 Who?

The target audiences are:

- food research and business communities involved in the disciplines of food engineering and food material science, nutrition, food and health;
- national entities in charge of implementing technology transfer;
- scientific communities interested in new food products/ingredients with improved wellness impact on consumers;
- consumers associations;
- industrial food companies concerned with production of emulsion- and foam-based foods;
- early stage researchers in food engineering and technology;
- decision makers of guidelines for food engineering studies in European Community;
- columnist opinion makers;
- gastronomy opinion makers

In order to serve the purposes of the Action, a forum of universities, research institutions and food companies will be established and supported by networking with institutions and existing organized groups that share similar field if interest. Scientific organizations already contacted include: EFCE-Food section (European Federation Chemical Engineering – Food Section), IFA (ISEKI – Food Association). Establishment of a long-lasting information exchange will be pursued. The MC will establish specific subtasks in WG, to deal with particular subjects rising from advising and assisting activities of these external networks. They can act as external consultants for special purposes. Other liaisons with other complementary research programmes (B4) will be encouraged with the perspective of exchange of information.

**H.2 What?**

Scientific and technical knowledge generated by this COST Action will be:

- disseminated by posting on the Action's web site: publications, WGs reports, guidelines and the Final Report with suggestions for further coordinated research. Some documents will only be accessible via a password protected area of the site. There will be links from other websites - some are identified in section B4 and E3- and from websites of the participants. Users of this service will be members of the Action, registered EC industries, registered SMEs, research centers;
- presented at International Conferences in order to promote the European know-how and expertise in the area. The major annual event of the Action will be the Annual Workshop, in which also key international experts in the field will be invited as speakers, when appropriate;
- original research results obtained will be published in international peer-reviewed journals as joint papers between the participating universities or institutes. Special emphasis will be put on encouragement of paper submission by the partners taking part in an STSM;
- teaching materials and teaching methods will be developed by a joint academic and industry panel and will constitute the basis for the planned Summer School on food design for PhD students in food engineering and technology;

The Public Awareness of the new concepts for designing foods for health, wellbeing and pleasure will also be addressed in order to increase the public acceptance of the developed technologies. A virtual community of experts in food engineering/science and food nutrition will be developed to promote communication to the general public. This will focus on disseminating the impact of food material science/food engineering on the sensoric quality and health benefits of food. User friendly documentation e.g. dedicated newsletters will be prepared for consumers and interested groups/associations. Contacts with policy makers and stakeholders will also be made.
Specific information schemes will be designed for specialised groups like food researchers and food producers**.** Synergies between academic research/education and industry will be promoted by Technological Transfer strategies that will be managed by WG4. Private companies will be invited to the Action conferences and workshops and a training school will be organized with the industrial support.
During the Action novel foods/ processes will be developed for the food industry. As the practical research is funded by both national and EU-funded projects, the resulting intellectual property rights are owned by the respective projects. However, if novel inventions arise from the collaboration with private companies, issues will be discussed separately and specific agreements will be made.

**H.3 How?**

Communication including Technology Transfer and Training will be key elements in supporting an effective strategy for affirming the effectiveness of the Action for innovation in product design.
In order to obtain the most significant impact from the project activities, the dissemination plan will include:

- creation of a web-based service with an interactive blog site to disseminate the outcomes of the Action to members of the network, registered EC industries, SMEs, research centers. The role of the service will be to manage the web communication of the outputs from the Action, to serve the needs of the participants and to host a communication network. The website will be hosted at an appropriate web platform from an institution which supports the Action. A close collaboration with the WGs will be established together with a close work with the management of the Action to develop the dissemination and publication strategy;

- specifically designed seminars and research workshops twice a year. Professional bodies will be encouraged to attend these events. Coordinators of complementary research programmes will be invited also;
- contacts with media via press offices and communication services of each participating institution and trade associations;
- dissemination of results in local and international journals;
- participants that are involved in teaching activities will provide information about the project to their students.

Powerful and innovative supports for the dissemination of the new conceptual tool for food design will be:

- the exchange of PhD students and early stage researchers (STSMs);
- training of technology transfer specialists aimed at spreading the innovation culture in the food design and the possible interactions between food products, health and wellbeing.

Since a relevant number of the results achieved by the Action (data, general information, conceptual tools) will be posted on the public area of the Action's website, and therefore will be in the public domain, no specific provision is made to protect intellectual property. However COST Action members will be able to update and access some working documents via a password protected website section. It is expected that academia will use the outputs from the project to further their research and aid the submission of applications for funding of innovative research goals.
It is also expected that large dimension industries and SMEs will introduce product innovations through the action of this project advisors. For planners, the final report will provide a valuable resource for their activities. WGs reports will be distributed to relevant bodies and leaders of other complementary programmes will be invited to Action's general meetings. These actions will contribute to dissemination of results.
The Editorial Committee (EC) of the MC will supervise the dissemination strategies and will take lead in publishing and distributing a E-newsletter that will contain relevant links to complementary programmes achievements to date, plus details on future events with details on how to register.