EUROPEAN COMMISSION / European Research Area / Food, Agriculture & Fisheries & Biotechnology

Functional Foods






STUDIES AND REPORTS

Interested in European research?

Research*eu is our monthly magazine keeping you in touch with main developments (results, programmes, events, etc.). It is available in English, French, German and Spanish. A free sample copy or free subscription can be obtained from:

European Commission
Directorate-General for Research
Communication Unit
B-1049 Brussels, Belgium
Fax (32-2) 29-58220
E-mail: research-eu@ec.europa.eu
Internet: http://ec.europa.eu/research/research-eu

EUROPEAN COMMISSION

Directorate-General for Research
Directorate E – Biotechnologies, Agriculture, Food
Unit E.3 – Food, Health, Well-being

e-mail: RTD-FOOD-NEWS@ec.europa.eu

Contact: Isabelle de Froidmont-Görtz

European Commission
Office SDME 08/87
B-1049 Brussels

Tel. +32 2 29 68571
Fax +32 2 29 64322
E-mail: isabelle.de-froidmont-goertz@ec.europa.eu

EUROPEAN COMMISSION

Functional Foods

Directorate-General for Research
FP7 cooperation - Food

2010

24194 EN

EUROPE DIRECT is a service to help you find answers

to your questions about the European Union

Freephone number (*):

00 800 6 7 8 9 10 11

(*) Certain mobile telephone operators do not allow access to 00 800 numbers
or these calls may be billed

LEGAL NOTICE

Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use which might be made of the following information.

A great deal of additional information on the European Union is available on the Internet.
It can be accessed through the Europa server (http://europa.eu).

Cataloguing data can be found at the end of this publication.

Luxembourg: Publications Office of the European Union, 2010

ISBN 978-92-79-14239-0
ISSN 1018-5593
doi 10.2777/85512

Functional Foods

Table of Contents

Abbreviations — 5

Preface — 6

What are functional foods? — 7

- Problems with definitions
  - Can any food be functional?
  - Working definition
- Why functional foods?
  - Awareness of links between food and health increases
  - Changes in lifestyle and the increase of chronic diseases

Health benefits of functional foods — 9

- The challenges
- Early development and growth
  - Mother's diet
  - Diet of children and adolescents
- Immune function
- Gastrointestinal health
- Mental health
- Health and well-being in ageing
- Physical performance
- Obesity
- Cardiovascular disease
  - Improving the lipid profile of the diet
  - Other diet components
- Diabetes mellitus
- Musculoskeletal disease
- Bone health

How to assess the scientific evidence for functional foods — 15

- Importance of markers
- Potential of nutrigenomics
- How should claims be substantiated? What role have EC funded projects played ?

Research challenges for functional foods — 17

Appendix 1 EC projects involving aspects related to functional foods — 18

Abbreviations

BSSL bile salt stimulated lipase

EU European Union

EC European Commission

FP5, FP6 and FP7 Framework Programme 5, 6 and 7

FMD flow mediated dilatation

FUFOSE Functional Food Science in Europe

GI gastrointestinal

HDL high density lipoprotein

LCPUFA(s) long chain polyunsaturated fatty acid(s)

LDL low density lipoprotein

MSM methylsulfonylmethane

NSAIDs non steroidal anti-inflammatory drugs

n-3 omega 3
n-6 omega 6

PUFA(s) polyunsaturated fatty acid(s)

SAMe S-adenosylmethionine

SME(s) small and medium enterprise(s)

Preface

Consumer interest in healthy eating is shifting towards the potential health benefits of specific foods and food ingredients. Moreover, scientific evidence supports the idea that some of these might have positive effects on our health and well-being, beyond the provision of basic nutritional requirements.

Research, including several projects funded by the European Commission (EC), has led to the identification and understanding of the potential mechanisms of biologically active components in food, which could improve health and possibly reduce the risk of disease while enhancing our overall well-being. This has led to the concept of functional foods that might deliver such benefits.

New promising technologies such as nutrigenomics, imaging techniques, converging technologies are increasingly being used in nutrition research. Their huge potential will be apparent in the short and medium term; this will further enable the development of foods for targeted population groups with defined risk factors or diseases such as allergy, diabetes, obesity and cardiovascular disease (CVD). Even more innovative is the possibility of merging information about the physiological responses to food with individual genetic information to design personalised food and diets. The ingenuity of food technology might also contribute to further advances in the development of food products that can support optimum health. The Seventh Framework Programme (FP7) offers many future opportunities here.

A total of 47 projects have been funded in FP5, FP6 and FP7 that address health benefits of functional foods in various areas such as obesity, diabetes, allergy, osteoporosis, mental health, cancer and CVD. These projects represent a European Union (EU) contribution of 150 million euros and involve 513 partners from research institutes, academia, industry and small and medium enterprises (SMEs). Most of the projects have their own website that can be easily accessed for further information.

This brochure gives an overview of the projects financed under FP5 within the Key Action "Food, Nutrition and Health" of the "Quality of Life and Management of Living Resources" programme, under FP6 within the "Food Quality and Safety" priority and under FP7 within the "Food, Agriculture and Fisheries, Biotechnology Theme". The focus is not on individual success stories, but rather on the approach of a programme and its instruments to contribute to achieving the aims of the European Research Area.

DG Research
Unit E.3: Food, Health, Well-being
Directorate E: Food, Agriculture and Fisheries, and Biotechnology

What are functional foods?

Problems with definitions

Can any food be functional?

Many definitions exist worldwide for functional foods, but there is no official, or commonly accepted definition.

One view is that any food is indeed functional because it provides nutrients and has a physiological effect. So, functional food should be considered a marketing term for a food whose attraction lies in its health claims and the way the product is perceived. Some even believe that, any food, if marketed appropriately, particularly with an accompanying health claim, is a functional food.

Some foods considered to be functional are actually natural whole foods where new scientific information about their health qualities can be used to proclaim benefits. Many, if not most, fruits, vegetables, grains, fish, and dairy and meat products contain several natural components that deliver benefits beyond basic nutrition. Examples include lycopene in tomatoes, omega n-3 fatty acids in salmon or saponins in soy. Even tea and chocolate have been noted in some studies as possessing functional attributes, i.e. attributes beyond the provision of traditional nutrients.

Others think that only fortified, enriched or enhanced foods with a component having a health benefit beyond basic nutrition should be considered as functional. Most definitions also suggest that a functional food should be, or look like, a traditional food and must be part of our normal diet. A functional food can be targeted at the whole population or at particular groups, which may be defined, for example, by age or genetic constitution.

Working definition

The EC Concerted Action on Functional Food Science in Europe (FUFOSE) proposed a working definition of functional food:
a food that beneficially affects one or more target functions in the body beyond adequate nutritional effects in a way that is relevant to either an improved state of health and well-being and/or reduction of risk of disease. It is consumed as part of a normal food pattern. It is not a pill, a capsule or any form of dietary supplement.

While there is increased awareness of the links between diet and disease such as certain fats and CVD, calcium and osteoporosis, fibre and gastrointestinal (GI) health, it is important, for a functional food, to identify the specific food constituents that could promote health and well-being as well as the exact conditions where they can have this beneficial effect. Practical examples of a functional food:

- a natural food such as fruit or grain which may or may not be modified by plant breeding or other technologies (e.g. lycopene-enhanced tomatoes, vitamin E-enriched vegetable oils, vitamin A-enriched rice);
- a food to which a component has been added (e.g. a spread with added phytosterols);
- a food from which a component has been removed or reduced (e.g. a yogurt with reduced fat);
- a food in which one, or several components, have been modified, replaced or enhanced to improve its health properties (e.g. a juice drink with enhanced antioxidant content, a yogurt with added prebiotic or probiotic).

Why functional foods?

The drive to develop functional foods has arisen from the growing interest in the relationship between diet, specific food ingredients and health. Healthy eating can make a key contribution to health and well-being, but busy consumers may not have the time to access their optimal diet. Functional foods can provide health enhancing ingredients in a convenient form.

Awareness of links between food and health increases

Interest in the relationship between diet, health and well-being has grown substantially in Europe, as in the rest of the developed world. Most of us know about the importance of a healthy lifestyle, including diet and its role in reducing our risk of illness and disease. Alongside growing affluence across Europe, this knowledge has allowed easier access to a safer, more varied diet, all of which should ensure longevity.

Changes in lifestyle and the increase of chronic diseases

Increased affluence and urbanisation is also linked to a lifestyle where our daily routine requires less physical activity and there is greater access to foods with higher energy densities. We now have a real challenge to balance energy intake and expenditure as more of us are becoming overweight. In 2008, across the 27 countries of the EU, 59 % of adult men and 48 % of adult women were either overweight or obese.[2]

For much of its history, nutrition science has focused on the role of essential nutrients in preventing deficiencies. However, there is now a need to ensure unaltered levels of key nutrients or functional components in the context of declining energy expenditures.

Further, the prevalence of chronic non-communicable diseases such as CVD, high blood pressure and type 2 diabetes has increased, leading to concerns about escalating costs of healthcare and reduced quality of life. Modern lifestyles and longer life are also linked to various mental health problems such as depression, poor concentration and loss of memory.

1. International Association for the Study of Obesity (IASO). Overweight and obesity in the EU 27. Available: http://www.iotf.org/database/documents/v2PDFforwebsiteEU27.pdf. Accessed 4 October 2009.

Health benefits of functional foods

The challenges

There is a strong body of science underpinning health benefits from foods. Our challenge, therefore, is to develop effective synergies between science and food product development for the benefit of the consumer. Aspects of health linked with some of the most developed aspects of nutrition science include:

- better early development and growth;
- health maintenance (e.g. immune function, gastrointestinal health, mental health, health in ageing, physical performance);
- reduced risk of obesity;
- reduced risk of chronic diet-related diseases (e.g. cardiovascular disease, type 2 diabetes and metabolic disease, musculoskeletal disease).

Early development and growth

Mother's diet

Nutrition during pregnancy and lactation can influence the short and long-term development of the child. It might even be linked to the development of conditions such as high blood pressure, heart disease and diabetes in later life.

More specifically, the course of pregnancy and childbirth and the composition of breast milk can be influenced by energy and protein intake as well as nutrients such as n-3 and n-6 polyunsaturated fatty acids (PUFAs), amino acids and micronutrients including folic acid, iron, zinc and iodine. Such nutrients may be useful as ingredients in functional foods.

Diet of children and adolescents

Diet during childhood and adolescence may have effects on some cognitive abilities as well as behaviour. Sensory, including visual, functions may also be influenced by early nutrition, particularly by n-3 and n-6 PUFAs and trace minerals such as iron, zinc and iodine.

Skeletal development during adolescence can be influenced by calcium, vitamins D and K and fluoride as well as prebiotic fructans, all of which could offer possibilities as ingredients in functional foods.

Gastrointestinal growth during the early years may be influenced by food ingredients such as probiotics and also prebiotics, such as oligosaccharides and inulin.

EARNEST

The Early Nutrition Programming Project is looking at the long-term consequences of early nutrition programming on later obesity and cardiovascular risk.

Understanding of the importance of early nutrition and the extent to which this is taken into account in infant feeding is also being investigated. The overall aim is to improve understanding of the extent to which nutritional influences in early life can programme a person's development and metabolism in adulthood. Two studies are looking at possibilities for new functional ingredients in infant formulae:

The first is a long-term study to determine the effect of functional prebiotics, more specifically of inulin-type fructans, on the incidence of infections and other immune parameters (early development of the immune system) in infants. The addition of recombinant human bile salt stimulated lipase (BSSL) to infant formulae offers the possibility of enhancing long chain polyunsaturated fatty acids (LCPUFAs) bioavailability to produce long-term health benefits and this is being tested in another study within this EU funded project.

Immune function

Immune function throughout life can be influenced by nutrition. Possible ingredients for the development of functional foods that could contribute to optimal immune response include the antioxidant vitamins, trace elements (e.g. zinc, copper and manganese), n-3 and n-6 PUFAs, l-arginine, nucleotides and nucleosides, probiotics, prebiotics and synbiotics.

TORNADO

The project (Molecular Targets Open for Regulation by the gut flora – New Avenues for improved Diet to Optimize European health) is looking at the influence of diet on the impact of gut flora and specific groups of micro-organisms on the immune system and their interaction with other organ systems. The project will allow the design of future functional foods for specific population groups of different ages in different geographical areas.

Gastrointestinal health

The GI tract is an obvious target for the development of functional foods because it acts as an interface between the diet and all other metabolic functions. GI function depends on an appropriate balance of healthy bacteria to prevent the invasion of harmful bacteria.

One of the most promising areas for the development of functional foods lies in the use of ingredients to modify the composition and metabolic activity of the gut microflora:

- probiotics;
- prebiotics;
- synbiotics (mixtures of probiotics and prebiotics).

Potential health benefits of probiotics include:

- reduced incidence or severity of GI infections;
- alleviation of lactose intolerance;
- overall improvement in gut function, including reduction in constipation as well as diarrhoea.

Prebiotics, non-digestible food components that can stimulate growth and/or modify the metabolic activity of specific bacterial species already present in the gut, might also improve gut health. They are also being evaluated for beneficial effects on the immune system and the potential to reduce risk of colon cancer. Their ability to increase production of short chain fatty acids in the colon is associated with increased absorption of minerals such as calcium and magnesium.

Dairy products, table spreads, baked goods and breads, breakfast cereals and bars, salad dressings, meat products and some confectionery items are all foods which do or might contain prebiotics.

PROEUHEALTH

The cluster aimed to evaluate the role of probiotic bacteria in our GI health and overall well-being and to improve understanding of the role of intestinal bacteria in human health and disease. Development of new functional foods incorporating probiotics could help to improve gut health in ways that are beyond the provision of basic nutrition.

Mental health

Some functional foods could potentially promote optimal mental state and mental performance and influence behaviour.

They may influence:

- cognitive performance;
- mood and vitality;
- reaction to stress;
- short-term memory;
- vigilance and attention;
- changes in memory and other mental processes during ageing.

Glucose may have a beneficial influence on aspects of mental performance, including memory and decision time. Sucrose may reduce pain perception. Caffeine can lead to improvement in cognitive performance with effects on reaction time, vigilance, memory and psychomotor performance. Cognitive performance and maintenance of mental health in older people may be improved with B vitamins.

People often find that meals high in carbohydrate are associated with sleepiness and calmness. The amino acid tryptophan can reduce the time taken to fall asleep, while tyrosine and tryptophan may help recovery from jet lag.

Several ingredients, such as n-3 fatty acids, S-adenosylmethione (SAMe) and folic acid have attracted attention as potential functional ingredients for improving depression.

NUTRIMENTHE

The project will quantify effects of early nutrition programming on later cognitive and mental disorders as well as the influence of food on mental state and aspects of mental performance such as mood, attention, motivation, effort, perception, memory and intelligence. The effects of food on mental illness will also be studied. Outcomes could have major implications for public health and policy development, and for understanding of human biology, as well as for food product development, economic progress, and future wealth creation.

Health and well-being in ageing

Now we are living longer, there is an increased prevalence of the chronic conditions of ageing (e.g. cardiovascular disease, cancer, cataract, age-related macular degeneration, Parkinson's disease, Alzheimer's disease, osteoarthritis). Such conditions, and indeed ageing itself, may put increased oxidative stress on the body. So, if we can reduce this, we can potentially delay or prevent some of these diseases.

Our bodies have several defences against oxidative stress, including:

- antioxidant enzymes;
- minerals and trace elements, such as selenium, manganese and copper, which act as co-factors for the antioxidant enzymes;
- vitamins, such as vitamins C and E, and carotenoids, all of which can act as free radical quenchers with an antioxidant effect;
- glutathione, a cysteine-containing peptide with a thiol group which acts as a reducing agent that can be reversibly oxidised and reduced.

CROWNALIFE

The project explored gut microbial population changes with age. Compared with children, adults have a larger number of different groups of gut bacteria. An intervention trial found that a synbiotic preparation (probiotic and prebiotic) can influence the gut microflora of older adults. Findings will be applied to the development of new functional foods for the health and well-being of the elderly European population.

Antioxidants naturally present in foods (e.g. vitamins C and E, carotenoids, flavonoids and other polyphenols) are potentially useful candidates for functional ingredients. Plant foods which contain these substances such as berries (e.g. cranberry, blueberry, goji, acai), mangosteen, pomegranate, tomato and grapes are now being explored by the functional food industry as potential antioxidants.

Various other ingredients are potential functional ingredients for the prevention of age-related mental changes. The n-3 fatty acids may have a role in reducing the risk of depression and the prevention of age-related dementia, while ginkgo biloba might play a role in the circulation and may help to improve memory and mental concentration.

Physical performance

Functional foods could play a key role in helping us to be more physically active. Liquid food formulae that deliver an appropriate balance of fluid, electrolytes and energy substrates in a convenient and easily digestible form can help physically active people, including athletes. Such liquid foods may also help people who cannot easily consume enough food to meet their nutritional requirements.

Specific types of carbohydrates with a range of glycaemic indices, can influence both active performance and recovery, offering potential for functional foods. Micronutrient supplementation of functional foods can also help to ensure adequate intakes during training and competition.

Other candidate functional ingredients to potentially improve physical performance include caffeine, specific amino acids, creatine and carnitine.

NUTRA-SNACKS

The project will facilitate the production of high quality ready to eat snacks and foods with bioactive plant cell ingredients and functional activity useful for promoting public health. The aim is to produce foods with a variety of activities such as anti-inflammatory, antibacterial, antiviral, antifungal and antioxidant activities for reducing the risk of disease such as cancer, hyperlipidaemia and hypertension. Ready to eat breakfast snacks and foods for those involved in sports will receive the highest priority.

Obesity

As already mentioned, obesity has become a global public health issue. In Europe the prevalence of obesity has tripled during the past two decades. More than half of all adults and one in five children are overweight or obese in the EU. The nutritional approach to weight management involves reducing energy intake, which may be achieved by reducing the energy density of the diet, reducing appetite and/or enhancing satiety or reducing fat absorption. Fat and sugar replacers are potential candidates for functional foods to reduce energy density, while foods with low glycaemic index or dietary fibre may enhance satiety.

A number of proposed functional food ingredients have been shown to act before the food is absorbed in the GI tract. These include chitosan, conjugated linoleic acid, diglycerides, medium-chain triglycerides, green tea, caffeine, calcium and capsaicin.

HELENA

The project looked at the nutritional status of adolescents, including obesity prevalence, vitamin and mineral status and immunological markers. Food choices and preferences were investigated. This project helped to understand why health promoting messages are not as effective as expected in the adolescent population. The requirements for health promoting foods were also identified and products acceptable to this population group will be developed.

Cardiovascular disease

Improving the lipid profile of the diet

Optimal heart health can be promoted by several dietary components, of which dietary fats are the best studied. Functional foods low in saturated fatty acids and trans fatty acids could help to promote optimal low density lipoprotein (LDL) cholesterol levels. Monounsaturates, such as olive oil, and polyunsaturates (e.g. linoleic and alpha-linolenic acid) can reduce plasma (LDL) concentrations, and some do this without significantly lowering the beneficial high density lipoprotein (HDL) cholesterol.

Olive oil has been the subject of many research studies for its antioxidant, anti-inflammatory and anti-thrombotic properties in reducing CVD risk. The long chain n-3 fatty acids (eicosapentaenoic acid and docosahexaenoic acid) found in fish oils can reduce plasma triacylglycerols, counteract blood clotting and promote blood vessel integrity. Functional foods enriched in these unsaturated fatty acids could reduce CVD risk.

Other diet components

Soluble fibre can influence cholesterol and lipoprotein metabolism. In particular, it can reduce LDL concentrations, particularly in people with high levels. Sources of soluble fibre currently used in functional foods include psyllium and dietary fructans (e.g. inulin, oligofructose).

Phytosterols (plant sterols and stanols) are naturally present in many fruits, vegetables, nuts, seeds, legumes, cereals, vegetable oils and other plant sources. Used as functional foods in fat spreads etc, they have been shown in numerous studies to reduce plasma LDL concentration by an average of 10 % and are thought to act by reducing intestinal cholesterol absorption.

Diets high in plant foods and rich in polyphenols have been associated with reduced risk for CVD and other chronic diseases. Possible mechanisms include their anti-inflammatory, vasodilatory, anti-platelet and antioxidant effects.

Flavonoids represent a diverse range of polyphenolic compounds, including flavonols, flavones, flavanones, flavan-3-ols, isoflavones, anthocyanins and proanthocyanidins. Found naturally in plant foods (e.g., fruits, vegetables, grains, herbs and beverages), these compounds could offer potential as functional food ingredients.

FLORA

The project (Flavonoids and related phenolics for healthy living using orally recommended antioxidants) is evaluating the beneficial effects of flavonoids and other plant phenolics on CVD and cancer. Flavonoids are present in a wide variety of foods from citrus fruits to green tea, dark chocolate and red wine. FLORA has already characterised the antioxidant and flavonoid content of a range of fruits and vegetables. Long term intake of dietary flavonoids in rats has shown that absorption of anthocyanins significantly lowers risk of heart attack; purple tomatoes have been shown to reduce risk of cancer in cancer-prone mice. In humans who smoke, orange juice has a beneficial impact on platelet function.

Diabetes mellitus

Overweight and lack of physical activity have been consistently associated with increased risk of type 2 diabetes. However, diet also appears to be important. Evidence supports the use of whole grain foods, vegetables, fruits, foods low in saturated fat and also starchy foods with a low glycaemic index. Soluble fibres with a low glycaemic index, such as psyllium and inulin, can have potential beneficial effects on glucose metabolism and insulin sensitivity.

Since compliance with dietary recommendations in diabetes is often poor, functional foods may be valuable in both treatment and prevention.

Oral amino acids included in snacks have also been studied to explore positive benefits in blood glucose control and insulin sensitivity. Spices such as cinnamon, coriander, garlic, and turmeric may also be beneficial anti-diabetic food ingredients. Chromium may be effective in optimising insulin metabolism and lowering plasma cholesterol levels. Genetics appear to have an influence, and nutrigenomic studies may help to shed light on the individuals who could benefit from additional chromium.

HEALTHGRAIN

The project aims to improve the well-being and reduce the risk of metabolic syndrome related diseases in Europe by increasing the intake of protective compounds in whole grains or their fractions. A whole grain diet seems to be protective against development of diet related disorders such as CVD and type 2 diabetes. Wholegrain cereal products have been screened for bioactive compounds including vitamins (folate, tocols, choline), phytochemicals (lignans, sterols, alkylresorcinols, phenolic acids) and indigestible carbohydrates. The aim is to produce safe and tasty cereal foods with high levels of bioactive ingredients for health.

Musculoskeletal disease

Osteoarthritis is one of the most prevalent and debilitating chronic conditions affecting older people. Pharmacological interventions such as non-steroidal anti-inflammatory drugs (NSAIDs) are associated with severe adverse effects; this creates a need for safe and alternative dietary therapies. Substances such as glucosamine and chondroitin are used as food supplements but could find application in functional foods. Evidence is also emerging for collagen hydrolysate, methylsulfonylmethane (MSM), S-adenosylmethionine (SAMe) and soybean unsaponifiables, all of which could be explored as functional food ingredients.

Bone health

Bone health is dependent on a variety of nutrients, including calcium, magnesium, vitamin D, vitamin K and vitamin C as well as trace minerals such as manganese, copper and zinc. Vitamin D is attracting attention for its role in bone mineral density and bone growth. A significant proportion of the European population has poor vitamin D status, due to lack of sunlight exposure. High fruit and vegetable intake is also associated with bone health and plant bioactive ingredients may emerge as useful ingredients for bone protection. Osteoporosis and bone fracture is a cause of considerable morbidity and mortality in older Europeans, making the search for bone protective ingredients of economic importance to the food industry and the well-being of the European population.

NUTRIDENT

The project aims to identify and investigate the effects of beverage and food components on the development of major dental diseases. Dental caries and gingivitis are the most prevalent infectious diseases and are due to the accumulation of dental plaque (a bacterial biofilm) on the tooth surface and at the gingival margin respectively. Certain beverages and foods might protect against caries and gingivitis and this project will try to identify them. Such functional constituents could be incorporated into foods and/or into oral healthcare products such as chewing gum and toothpaste.

How to asses the scientific evidence for functional foods?

Importance of markers

In some instances, it is possible to identify and measure markers of health and well-being rather than studying the disease under consideration. Use of properly validated markers demands an understanding of the mechanisms in the attainment of optimal health or disease development. Markers must be scientifically well established and chosen to reflect accurately the processes of interest. Only then can the effect of consuming a functional food on a valid proxy for the final endpoint – i.e. an improved state of health and well-being or reduction in disease risk – be studied.

Markers could be chosen to reflect:

- a key target biological function:

  e.g. Bacterial populations in the gut can be measured to demonstrate that a probiotic has successfully passed through the stomach and could potentially have a beneficial effect in the lower GI tract;

- a key stage in the development of a disease:

  e.g. Bone mineral density can be used as a marker in the study of a functional food evaluating potential benefit in reducing the risk of osteoporosis;

  e.g. Flow mediated dilatation (FMD) can be used in the study of a food component designed to improve endothelial function and so reduce the risk of cardiovascular disease.

Measurements made over the short term on carefully chosen markers can be used as an indication of effects on final health endpoints that would only otherwise be possible through long term study. Where the underlying target functions or intermediate endpoints are unequivocally linked to the risk of disease, for example, reduced serum levels of LDL cholesterol and reduced risk of heart disease, the markers are also considered to be risk factors for disease.

Development of nutritional biomarkers is a challenge. Many biomarkers have been proposed but relatively few have actually been established because of the complexity of disease mechanisms and the limited capability of a single biomarker to reflect the collective impact of multiple biochemical effects on clinical outcome.

Potential nutrigenomics

Nutrigenomics evaluates changes in gene and protein expression and metabolite pathways detected as a response to changes in dietary nutrients. Where such changes occur, markers could be identified and used to demonstrate the effect of bioactive food components on health, helping the development of functional foods that will contribute to health and well-being.

This is a rapidly emerging science but the tools to measure gene expression and metabolite production are still in the process of development. It could be some time before the science is sufficiently well advanced to allow the identification of robust markers for functional foods.

METABOLOMICS
Metabolomics, or metabolic profiling, could offer a source of novel biomarkers for nutritional studies. This technique could be used to more accurately define the molecules in foods responsible for changes in metabolic profiles. For example, the gut microflora produce significant metabolic signals that can change the profile of biofluids and this could be considered a new biomarker.

PROTEOMICS
Dietary intervention studies have used proteomics to identify changes in pathways relating to glucose and fatty acid metabolism, oxidative stress, antioxidant defence and redox status.

How should claims be substantiated? what role have EC funded projects played?

For a health claim to be truthful and not misleading to consumers, its basis and its wording must be fully consistent with scientific evidence. Guidance for substantiation of claims, the nature of the evidence to be provided and its evaluation has been developed in several countries over the past two decades.

In Europe, the Health Claims regulation[2] recognises the work of the EC Concerted Actions FUFOSE (Functional Food Science in Europe) and PASSCLAIM (Process for the Scientific Support for Claims on Foods) as valuable projects to be taken into account when assessing health claims.

FUFOSE

Functional Food Science in Europe proposed a scheme to link functional foods with markers and health outcomes and thus health claims. The project looked at six areas of science and health: growth, development and differentiation; substrate metabolism; defence against reactive oxygen species; functional foods and the cardiovascular system; gastrointestinal physiology and function; and the effects of foods on behaviour or psychological function.

PASSCLAIM

A follow-on project from FUFOSE, explored how claims might be substantiated, including the type of data needed to support them. A set of consensus criteria were produced which, if met, could give some assurance that claims made on foods can be considered valid.

2. Regulation EC No 1924/2006 of the European Parliaments and of the Council of 20 December 2006 on nutrition and health claims made on foods. Official Journal of the European Union 30.12.2006. L404/0-25

Research challenges for functional foods

Key research challenges for functional foods are the need to identify new functional food ingredients and to gain consumer acceptance of such products. In particular, research needs to:

- identify potential functional ingredients that could provide benefits in terms of health and well-being;
- identify individual biological responses to functional foods;
- define the bioavailability of functional food ingredients;
- develop appropriate biomarkers for a wider range of functional endpoints;
- develop the potential utility of nutrigenomics, bioinformatics, proteomics, metabolomics and nanotechnology in the development of functional foods;
- anticipate demand for personalised nutrition and the potential role of functional foods;
- ensure stability of functional food ingredients during manufacturing and passage through the GI tract to reach the target organ intact;
- establish Dietary Reference Intakes (DRIs) for a wider range of nutrients to enable commercial exploitation of more functional components.

Appendix 1

EC projects involving aspects related to functional foods:

Functional food has now grown into a significant area of European research. The EC supports, via its Framework Programmes, research and development in functional food through a number of different funding schemes. Details are available on the CORDIS website.

Project funded within the 4th Framework Programme:

- **FUFOSE:** Functional Food Science in Europe
  website: http://www.ilsi.org/Europe/Pages/FUFOSE.aspx

Projects funded within the 5th Framework Programme:

- **BIOCLA:** Production of CLA-enriched dairy products by natural means
  website: http://www.teagasc.ie/research/dprc/biocla/
- **CROSSENZ:** Novel cross-linking enzymes and their consumer acceptance for structure engineering of food
  website: http://www.cordis.europa.eu
- **CROWNALIFE:** Functional food, gut microflora and healthy ageing
  website: http://www.cordis.europa.eu
- **DEPROHEALTH:** Probiotic strains with designed health properties
  website: http://www.cordis.europa.eu
- **EU AND MICROFUNCTION:** Functional assessment of interactions between the human gut microbiota and the host
  website: http://www.cordis.europa.eu
- **EUROSTARCH:** Stable isotope applications to monitor starch digestion and fermentation for the development of functional foods
  website: http://www.eurostarch.org
- **FUNCLA:** Conjugated linoleic acid (cla) in functional food: a potential benefit for overweight middle-aged Europeans
  website: http://www.cordis.europa.eu
- **HTMPROT**: Hypotensive peptides from milk proteins
  website: http://www.cordis.europa.eu
- **NUHEAL:** Nutraceuticals for a healthier life: n-3 polyunsaturated fatty acids and 5-methyl-tetrahydrofolate
  website: http://www.cordis.europa.eu
- **MICROBE DIAGNOSTICS:** Development and application of high throughput molecular methods for studying the human gut microbiota in relation to diet and health
  website: http://www.cordis.europa.eu
- **OPTIFORD:** Towards an optimal strategy for optimal vitamin D fortification
  website: http://www.optiford.org
- **PASSCLAIM:** A process for the assessment of scientific support for claims on foods
  website: http://europe.ilsi.org/activities/ecprojects/PASSCLAIM/
- **PROEUHEALTH:** The Food, GI-tract Functionality and Human Health Cluster
  website: http://proeuhealth.vtt.fi/
- **PROGID**: Probiotics and gastrointestinal disorders - controlled trials of european union patients
  website: http://www.cordis.europa.eu
- **PROPATH:** Molecular analysis and mechanistic elucidation of the functionality of probiotics and prebiotics in the inhibition of pathogenic microorganisms to combat gastrointestinal disorders and to improve human health
  website: http://www.cordis.europa.eu
- **PROSAFE:** Biosafety evaluation of probiotic lactic acid bacteria used for human consumption
  website: http://www.cordis.europa.eu

- **PROTECH:** Nutritional enhancement of probiotics and prebiotics: technology aspects on microbial viability, stability, functionality and on prebiotic function
  website: http://www.cordis.europa.eu
- **SEAHEALTH:** Seaweed antioxidants as novel ingredients for better health and food quality
  website: http://www.sea-health.org
- **SENIOR FOOD-QOL:** Choosing foods, eating meals: sustaining independence and quality of life in old age
  website: http://www.foodinlaterlife.org

Projects funded within the 6th Framework Programme:

- **BIOACTIVE-NET:** Assessment and dissemination of strategies for the extraction of bioactive compounds from tomato, olive and grape processing residues
  website: http://www.bioactive-net.com
- **DIEPHY:** Dietary exposures to polycyclic aromatic hydrocarbons and DNA damage
  website: http://www.imp.lodz.pl/diephy/
- **DIOGENES:** Diet, Obesity and Genes
  website: http://www.diogenes-eu.org
- **EARNEST:** Early Nutrition Programming – long term follow up of efficacy and safety trials and integrated epidemiological , genetic, animal, consumer andeconomic research Project
  website: http://www.metabolic-programming.org/
- **FLAVO:** Flavonoids in fruits and vegetables: their impact on food quality, nutrition and human health
  website: http://flavo.vtt.fi/
- **FLORA:** Flavonoids and related phenolics for healthy Living using Orally Recommended Antioxidants
  website: http://www.cordis.europa.eu
- **GUTHEALTH SUPPORT:** Networking in Candidate countries towards Food, GI-tract functionality and human health
  website: http://www.vtt.fi
- **GUTIMPACT:** Innovations and Impact of Gut Health Foods: A Virtual Technology Platform
  website: http://www.gutimpact.net/everyone
- **HEALTHGRAIN:** Exploiting Bioactivity of European Cereal Grains for Improved Nutrition and Health Benefits
  website: http://www.healthgrain.org
- **HELENA** Healthy Lifestyle in Europe by Nutrition in Adolescence
  website: http://www.helenastudy.com
- **LIPGENE:** Diet, genomics and the metabolic syndrome: an integrated nutrition, agro-food, social and economic analysis
  website: http://www.ucd.ie/lipgene/
- **LYCOCARD:** Role of lycopene for the prevention of cardiovascular diseases
  website: http://www.ucd.ie/lipgene/
- **NOFORISK**: Qualitative risk assessment strategies for novel foods
  website: http://www.noforisk.org
- **NUTRASNACKS:** Ready to Eat Food for breakfast and sport activity with high content of nutraceutics preventing disease and promoting public health
  website: http://www.mlib.cnr.it/nutra-snacks/
- **NUTRIDENT:** Towards functional foods for oral health care – isolation, identification and evaluation of beverage and food components with anti-caries and/or anti-gingivitis activities
  website: http://www.ucl.ac.uk/eastman/nutrident/index.php
- **SEAFOOD PLUS:** Health improving, safe seafood of high quality in a consumer driven fork-to-farm concept
  website: http://www.seafoodplus.org

- **ZINCAGE:** Nutritional Zinc, Oxidative Stress And Immunosenescence: Biochemical, Genetic And Lifestyle Implications For Healthy Ageing
  website: http://www.zincage.org/home.htm

Projects funded within the 7th Framework Programme:

- **BASEFOOD:** Sustainable exploitation of bioactive components from the Black Sea Area traditional foods
  website: http://www.basefood-fp7.eu
- **COLORSPORE:** New sources of natural, gastric stable, food additives, colorants and novel functional foods
  website: http://www.cordis.europa.eu
- **FLAVIOLA**: Targeted delivery of dietary flavanols for optimal human cell function: Effect on cardiovascular health
  website: http://www.cordis.europa.eu
- **LIPIDIDIET:** Therapeutic and Preventive Impact of Nutritional Lipids on Neuronal and Cognitive Performance in Aging, Alzheimer's disease and Vascular Dementia
  website: http://www.lipididiet.progressima.eu
- **NUTRIMENTHE:** Effect of diet on the mental performance of children
  website: http://www.nutrimenthe.eu
- **TORNADO:** Diet and its effect on the development of intestinal microflora and on the immune system through the entire lifespan
  website: http://www.cordis.europa.eu

Appendix 2: Resources

DG Research
Directorate E - Biotechnologies,
Agriculture, Food
Food – Health – Well-Being Unit
European Commission
B-1049 Brussels
Belgium
Fax: +32 2 296 4322
http://ec.europa.eu/dgs/research/index_en.html

European Commission DG Research Information Centre
http://ec.europa.eu/research/infocentre/

FP5 Food, Nutrition & Health
http://ec.europa.eu/research/quality-of-life/ka1/home_en.htm

Information on FP6 Food projects
http://www.cordis.lu/food/

FP6 general information
http://ec.europa.eu/research/fp6/index_en.cfm?p=0

FP7
http://cordis.europa.eu/fp7/cooperation/food_ en.html

European Commission

Functional Foods

Luxembourg: Publications Office of the European Union

2010 — 24 pp. — B5, e.g. 17.6 x 25 cm

ISBN 978-92-79-14239-0
doi 10.2777/85512

How to obtain EU publications

Publications for sale:

- via EU Bookshop (http://bookshop.europa.eu);
- from your bookseller by quoting the title, publisher and/or ISBN number;
- by contacting one of our sales agents directly. You can obtain their contact details on the Internet (http://bookshop.europa.eu) or by sending a fax
- to +352 2929-42758.

Free publications:

- via EU Bookshop (http://bookshop.europa.eu);
- at the European Commission's representations or delegations. You can obtain their contact details on the Internet (http://ec.europa.eu) or by sending a fax
- to +352 2929-42758.

KI-NA-24194-EN-C

In the 21st century, health is no longer restricted to the absence of disease but includes optimal physical and mental well-being. Nutrition science has evolved at the same time. It has moved beyond the study of the food and nutrients required for the development, growth and maintenance of the body towards the concept of “optimal nutrition”. This is the nutrient intake to promote overall health and well-being, to improve physical and mental performance and to reduce risk of diseases such as cancer, obesity, CVD, diabetes.

Research aimed at the development of functional foods that might deliver such benefits and has been a natural consequence of this new concept. The European scientific community is working hard to identify and understand the potential mechanisms of biologically active components in food which could enhance our health and overall well-being, and possibly, reduce the risk of disease. The purpose of this brochure is to give an overview of the research carried out in this area and examples of projects financed under FP5, FP6 and FP7 in order to develop new products for the benefit of the consumer.

Knowledge - Based Bio - Economy (KBBE): http://cordis.europa.eu/fp7/kbbe/home_en.html

Publications Office

ISBN 978-92-79-14239-0

9 789279 142390