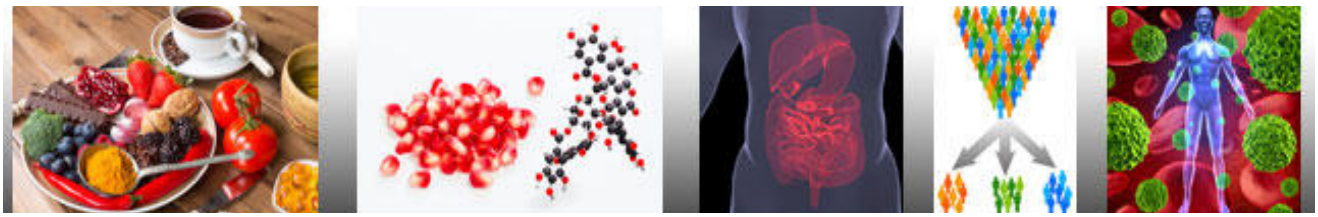
# SATELLITE SYMPOSIUM OF ICPH 2015

## 1st COST Action POSITIVe SCIENTIFIC WORKSHOP

## October 26 – 27th, 2015, Tours (FRANCE)



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POSITIVe

# COST Action POSITIVe (FA1403)

## WELCOME TO THE 1st Scientific Workshop Organized by:

COST Action FA1403 (2014-2018)

**Interindividual variation in response to consumption of plant food bioactives and determinants involved (POSITIVe)**

The COST Action POSITIVe FA1403 has been launched in December 2014. Currently POSITIVe involved over 70 research institutions from 31 European countries.
The objective of this European network is to structure a multidisciplinary and multisectorial network to address inter-individual variation in bioavailability and physiological responses (bioactivity) to consumption of plant food bioactives in relation to cardio-metabolic outcomes. A better understanding of the factors responsible for this interindividual variation will help to ensure an optimal integration of plant food bioactives in future personalized nutrition strategies.
The aim of this COST symposium is to raise awareness of the scientific community to the importance of this inter-individual variation by reviewing the state of the art and presenting perspectives in this emerging field.
Thank you for being there.
We hope that you will enjoy this POSITIVe's symposium!

**Christine Morand**,
Chair of FA1403 POSITIVe

**Francisco Tomas-Barberan**,
Co-chair of FA1403 POSITIVe

More information about POSITIVe can be found at: http://www6.inra.fr/cost-positive

## ORGANIZING COMMITTEE OF 1st POSITIVe WORKSHOP

- Dr. Christine MORAND - **Chair** (INRA - Clermont-Ferrand, France)
- Pr. Francisco TOMAS-BARBERAN - **Vice-Chair** (CSIC - Spain)
- Dr. Maria-Teresa GARCIA-CONESA (CEBAS-CSIC - Spain)
- Dr. Claudine MANACH (INRA - Clermont-Ferrand, France)
- Dr. Dragan MILENKOVIC (INRA - Clermont-Ferrand, France)
- Dr. Laurent-Emmanuel MONFOULET (INRA - Clermont-Ferrand, France)
- Vanessa BOISSERY (INRA - Clermont-Ferrand, France)

**Acknowledgement**
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**COST** (European Cooperation in Science and Technology) is a pan-European intergovernmental framework. Its mission is to enable break-through scientific and technological developments leading to new concepts and products and thereby contribute to strengthening Europe´s research and innovation capacities.
*Detailed information about the COST office can be found at http://www.cost.eu/*

**COST is supported by the EU Framework Programme Horizon 2020**

## PROGRAM

| Monday, 26th October 2015 | |
|---|---|
| 2:00 – 3:00 p.m. | *Welcome* |
| 3:00 – 3:15 p.m. | Introduction of the COST Action POSITIVe<br>**Dr. Christine Morand** (INRA-Clermont –Ferrand, France) |
| 3:15 – 4:15 p.m. | Interindividual differences in polyphenols gut microbiota metabolism. Can they affect human health?<br>**Prof. F.A. Tomás-Barberán** (CEBAS-CSIC, Murcia, Spain)<br><br>Single nucleotide polymorphisms associated with carotenoid bioavailability<br>**Dr. Patrick Borel** (INRA, Marseille, France) |
| 4:15 – 4:30 p.m. | *Coffee Break* |
| 4:30 – 6:00 p.m. | Variation in vascular response to cocoa flavanol intake according to age and sex<br>**Dr. Ana Rodríguez-Mateos** (University of Dusseldorf, Germany*)*<br><br>From inflammaging to healthy aging: is epigenetics the key to personalized medicine or dietary health recommendations?<br>**Prof. Wim Vanden Berghe** (University of Antwerp, Belgium)<br><br>Genetic polymorphisms and response to polyphenols/ Mediterranean diet<br>**Prof. Dolores Corella** (University of Valencia, Spain) |
| **Tuesday, 27th October 2015** | |
| 9:00 – 10:45 a.m. | Interindividual differences in metabolism of plant food bioactives: impact on dietary recommendations<br>**Prof. Joanna Lampe** (Fred Hutchinson Cancer Research Center, Seattle, USA)<br><br>From pathways to networks: A cofactor-protein interactome as a model for plant bioactives<br>**Dr. Jim kaput** (Nestle Institute of Health Science, Switzerland)<br><br>Food4Me and personalised nutrition<br>**Dr. Eileen Gibney** (UCD, Institute of Food and Health, Dublin, Ireland) |
| 10:45 – 11:00 a.m. | *Coffee Break* |
| 11:00 – 12:00 a.m. | Round table with all speakers “The future for plant food bioactives in personalized nutrition” *Chairman*: **Prof. F. Tomás-Barberán** |

# SPEAKERS' BIOGRAPHY AND ABSTRACT

## Prof. Francisco TOMÁS BARBERÁN - Co-Chair of the COST Action POSITIVe

*Department of Food Science & Technology, CEBAS-CSIC, Murcia, SPAIN*

Prof. Francisco Tomás-Barberán got his PhD in Pharmacy at the University of Valencia. He has carried out research in laboratories from England (Reading), Switzerland (Lausanne), France (Lyon), and the USA (Davis) and is co-author of more than 300 publications in scientific journals in the areas of Phytochemistry, Agricultural Chemistry, and Food Science and Nutrition. These articles have been cited over 12000 times. His main interest is deciphering the role of phenolic phytochemicals on food quality and health. His current research aims to the identification of those food constituents that provide health benefits, the mechanisms by which they exert their effects, their bioavailability and efficacy in humans and the role of gut microbiota on polyphenols metabolism and interindividual variability. His research has also been concerned with the transference of scientific results to industry and he has registered 6 patents of which 3 have been licensed and derived products are actually in the market.

***Lecture title*:**
**Interindividual differences in polyphenols gut microbiota metabolism. Can they affect human health?**
E-mail Francisco Tomás Barberán: fatomas@cebas.csic.es

***Abstract***
Polyphenol intake is associated with health effects in humans. Clinical studies, however, often lack significance due to the large inter-individual variability in the effects observed. In many cases, gut microbiota metabolites of dietary polyphenols have been identified as responsible for the biological effects observed. Poorly absorbable polyphenols are metabolized by gut microbiota into metabolites that are generally better absorbed and often show relevant biological activities (interaction with estrogen receptors; anti-inflammatory). This has been demonstrated for isoflavones, lignans, flavanones, ellagitannins and proanthocyanidins. Recent evidence shows that this can also be significant for stilbenes and flavonols. Gut microbiota polyphenol metabolism depends on different factors, but differences in the composition of the gut microbiota that colonize the human gut can have relevant effects on polyphenol metabolism and therefore in the final biological effects observed. Therefore, volunteer stratification by gut microbiota composition (enterotypes) and urinary phenolic metabolite profile (metabotypes) can shed light on the inter-individual differences observed after dietary interventions with polyphenol-rich food products or nutraceuticals.

## Dr. Patrick BOREL - WG1 member of the COST Action POSITIVe
## *INRA, Faculty of Medicine de la Timone, Marseille, FRANCE*

Dr. Patrick Borel obtained his PhD in Molecular Biology at Marseille University in 1988 and since he has published various highly cited papers on the metabolism of carotenoids and vitamin E in humans and on factors that modulate their bioavailability. He works for INRA in a join research unit with INSERM (the French national institute of health and medical research) and Aix-Marseille University. The research unit, NORT ("Nutrition, Obesity and Risk of Thrombosis") is located at the Faculty of Medicine de la Timone in Marseille (France). Since 2002, Dr Borel leads the research group "Bioavailability of fat soluble micronutrients" composed of various experts on lipid micronutrients, postprandial lipid metabolism, cellular and molecular biology and genetics. He is member of the scientist board of the nutrition department of INRA and vice-chairman of the SFVB (Société Francophone Vitamines & Biofacteurs ; French society on Vitamins). In 2002 he won the research award on vitamins research from the CEIV (Centre d'Etudes et d'Information sur les Vitamines; the French centre for information on vitamins). He is currently focused on the identification of intestinal proteins involved in the absorption of these compounds and has carried out a clinical trial showing the inter-individual variability in carotenoid and vitamin E bioavailability in association with combinations of single nucleotide polymorphisms.

***Lecture title*:**
**Single nucleotide polymorphisms associated with carotenoid bioavailability**
E-mail Patrick Borel: Patrick.BOREL@univ-amu.fr

***Abstract***
Carotenoids are plant bioactives assumed to participate in the beneficial effects against degenerative diseases attributed to plant products. Their absorption efficiency is very variable among individuals. We hypothesized that this is due, at least in part, to genetic variations between individuals. We thus dedicated a clinical study to identify minor genetic variants associated with carotenoid bioavailability. Healthy male adults (n=40) consumed, at a minimum of 3 weeks intervals, 2 meals that contained either tomato purée (as a source of lycopene and β-carotene) or a lutein supplement. Volunteers were genotyped using whole-genome microarrays. Carotenoid concentrations were measured in plasma chylomicrons isolated at regular time intervals over 8 h postprandial. Partial Least Squares (PLS) regression was used to identify combinations of single nucleotide polymorphisms (SNPs) associated with the variability in carotenoid levels (AUC of the postprandial chylomicron carotenoid concentration).

The carotenoid responses were highly variable among the subjects (CV = 105 % for β-carotene, 75 % for lutein and 70 % for lycopene) and were significantly correlated with fasting plasma carotenoid concentrations. PLS models, which included between 12 and 16 genes and between 25 and 29 SNPs, explained a significant part (69% to 73%) of the variance of the carotenoid responses. Combinations of SNPs are associated with interindividual variation in carotenoid bioavailability which apparently affects the long term carotenoid status. Our results allow us to propose genetic scores that may predict the ability of a subject to accurately absorb these plant bioactives. This is a first step toward personalize recommendations in carotenoid intake.

## Dr. Ana RODRÍGUEZ MATEOS – WG2 leader of the COST Action POSITIVe

***Division of Cardiology, Pulmonology & Vascular Medicine, University of Dusseldorf, GERMANY***

Dr. Ana Rodríguez Mateos received her PhD and conducted her postdoctoral studies at the Department of Food and Nutritional Sciences of the University of Reading in the UK, where she began to investigate the absorption, metabolism and excretion of dietary flavonoids and their impact on vascular function in Professor Jeremy Spencer's research group. Her research included development and validation of analytical methods for the identification and quantification of polyphenol metabolites in biological fluids using liquid-chromatography and mass spectrometry; design and undertaking of randomized controlled trials investigating the effects of polyphenol-rich foods on cardiovascular function and investigations on mechanisms of action using animal and cell models. Currently, she works as a research leader at the Univ. of Dusseldorf and her main research interests include investigating the factors affecting the bioavailability and bioactivity of dietary polyphenols, such as food matrix, processing, age or sex, and their mechanisms of action in the vascular system.

***Lecture title*:**
**Variation in vascular response to cocoa flavanol intake according to age and sex**

E-mail Ana Rodríguez Mateos: Ana.Rodriguez-Mateos@med.uni-duesseldorf.de

***Abstract***

Flavanols, including (**–**)-epicatechin, and their related oligomers, the procyanidins, are plant-derived compounds that occur in substantial amounts in certain food and beverages, including apples, tea, berries wine, and cocoa-derived products. In recent years, several human intervention studies have demonstrated improvements in accredited surrogate markers of cardiovascular disease (CVD) risk (such as blood pressure, endothelial function or blood lipids) following the consumption of flavanols. However, it remains to be fully established whether or not currently available data can be extrapolated into wider populations, and studies aimed at investigating inter-individual differences in the biological response to flavanols are necessary to evaluate the applicability of current data in the larger population-based context of health and nutrition. Within the European Union funded project Flaviola, we carried out several randomized controlled trials aiming to assess the variability in vascular response to the consumption of cocoa flavanols according to sex and age in healthy individuals. Our data demonstrate that cocoa flavanol intake exerts beneficial effects of various accredited CVD risk markers in healthy men and women across all the ages and groups investigated. Furthermore, the intra- and inter-individual variability of the absorption, distribution, metabolism and excretion (ADME) of flavanols is relatively low, and while small differences in the ADME of flavanols were identified as a function of age and sex, in general, flavanols were absorbed, metabolised and excreted in a similar fashion across healthy study populations.

## Prof. Wim VANDEN BERGHE - WG2 member of the COST Action POSITIVe
***Department Biomedical Sciences, University Antwerp, BELGIUM***

Prof. Wim Vanden Berghe (Univ. Antwerp, Belgium) holds a PhD degree in Chemistry-Biotechnology from the University of Ghent (LEGEST, UGent, Belgium). He received postdoctoral training at the Nuclear Signalling Lab of Prof. Mahadevan (Oxford, UK, 2000) and at the Department of Biochemistry lab of Prof. Hapgood & Prof. Louw (Stellenbosch, South Africa, 2001). Currently, he is professor of Epigenetic Signalling (PPES) and his research focuses on crosstalk of kinases and hormone signalling with epigenetic reprogramming in cancer-inflammation, CVDs and neuroplasticity in response to medicinal phytochemicals.

*Lecture title*:
**From inflammaging to healthy aging: is epigenetics the key to personalized medicine or dietary health recommendations?**
Email Wim Vanden Berghe: wim.vandenberghe@uantwerpen.be

***Abstract***
The progressively older population in developed countries is reflected in an increase in age-related chronic diseases (metabolic syndrome, diabetes, cancer, dementia, etc). The heterogeneity in aging and associated disorders has been ascribed to genetic, environmental and socioeconomic factors with a common denominator: the inflammatory response. Chronic low-grade systemic inflammation and immunosenescence are intertwined in the pathogenesis of aging also defined as 'inflammaging'. Pharmacological drugs acting against individual targets usually cannot cure or prevent complex inflammaging diseases. Combination therapies or "polypharmacological" drugs that impact multiple targets are better at controlling complex diseases, less prone to drug-resistance and constitute the standard care in many therapeutic areas. Human diet has a major influence on the development and prevention of age-related diseases. Most plant-derived dietary phytochemicals and nutrients modulate multiple biological processes via oxidative stress, inflammatory signalling, metabolic pathways and bioenergetics.

Epigenetic instructions modify the DNA, affect the amounts of proteins/RNAs synthesized by the cell dynamically anticipating to environmental factors (diet, stress, lifestyle, pollution) throughout life. Our health/disease state relies on a balance between genetic ("nature") and epigenetic ("nurture") instructions. Increasing evidence reveals that nutrition can cause reversible epigenetic modifications (acetylation, methylation, etc.) of histones, DNA and RNA, resulting in adaptive health beneficial or detrimental responses. Remarkably, humans present a broad range of responses to similar dietary challenges, due to genetic and epigenetic modulations of genes/proteins involved in the metabolism and distribution of the dietary constituents and/or differences in gut microbiome compositions. Results will be presented from in vitro/in vivo studies with natural bioactives from various plants and their anti-inflammatory, cardioprotective, or cancer chemopreventive properties. Difficulties and challenges of dietary recommendations for healthy aging will be discussed with respect to highly variable interindividual (epigenetic) diet responses.

## Prof. Dolores CORELLA - Invited speaker
***University of Valencia and CIBER OBN, SPAIN***

Dr. Dolores Corella is a full Professor of Preventive Medicine and Public Health since 2009. She has also been Director of the Genetic and Molecular Epidemiology Laboratory since its creation in 1998. Since 2003, Dr. Corella has participated in the PREDIMED Study (PREvention with DIEt from the MEDiterranean sea) as principal investigator and from 2006, in the Physiopathology of Obesity and Nutrition department (CIBER). Her studies have generated more than 270 papers in peer-reviewed journals. Dr. Corella's interests are focused on the study of genetic and epigenetic determinants of cardiovascular diseases, diabetes, obesity and other cardiovascular risk factors. She has developed research methodology for analysing gene-environment interactions. Within the gene-environment interaction study, gene-diet interactions have constituted the main research line giving rise to the development of Nutritional Genomics. She has collaborated with Dr. Ordovás at the Human Nutrition Research Centre in Boston in various studies focused on the analyses of gene-diet interactions including the Framingham, GOLDN, PREDIMED and BPRHS studies. Currently, she is also studying how to integrate 'omic' technologies (genomics, epigenomics, transcriptomics, etc) into the field of the Mediterranean diet and obesity and cardiovascular-related diseases.

*Lecture title:*

**Genetic polymorphisms and response to polyphenols/Mediterranean diet**

E-mail Dolores Corella: Dolores.Corella@uv.es

***Abstract***

Mediterranean diet (MedDiet) is rich in fruits and vegetables, olive oil, nuts, legumes, whole-wheat bread and fish. This food pattern is very rich in polyphenols. In the PREDIMED (PREvención con DIeta Mediterránea) Study, a large, parallel-group, multicentre, randomized, controlled 5-year feeding trial aimed at assessing the effects of the MedDiet on the primary prevention of cardiovascular disease (n=7447 high cardiovascular risk participants), the polyphenol content of the diet was assessed and related to cardiovascular incidence and mortality, showing favourable effects. Furthermore, gene-diet interaction analyses investigating the whole dietary intervention patterns (MedDiet groups versus the control group) revealed an important genetic heterogeneity in the response to the MedDiet both in determining intermediate and final cardiovascular disease phenotypes (stroke incidence, myocardial infarction and cardiovascular death). Among the most relevant genetic variants related to the heterogeneity in the response to the MedDiet intervention are the TCF7L2-rs7903146 polymorphism (that interacted with the MedDiet on fasting glucose and lipids at baseline and modulated the stroke risk); the MLXIPL-rs3812316 (that interacted with adherence to the MedDiet in determining fasting triglycerides at baseline and with the dietary intervention on myocardial infarction risk); and the microRNA-410 target site polymorphism (rs13702T>C) in the 3'untranslated region of the LPL gene that modulated the effect of the MedDiet on fasting triglycerides and stroke risk. All these results support an important influence of the genotype in determining the response to the MedDiet on cardiovascular-related outcomes.

## Prof. Joanna LAMPE - Invited speaker
***Fred Hutchinson Cancer Research Center, Seattle, USA***

Prof. Joanna Lampe is a Full Member and Associate Division Director in the Public Health Sciences Division at Fred Hutchinson Cancer Research Centre and a Research Professor in the Department of Epidemiology at the University of Washington in Seattle, USA. She received her PhD in nutritional sciences, with a minor in biochemistry, from the University of Minnesota and trained as a post-doctoral fellow in epidemiology at the University of Minnesota before joining the faculty at Fred Hutchinson Cancer Research Centre in 1994. Dr. Lampe's research focuses on the effect of diet constituents on cancer susceptibility in humans and the effects of genetic variation on response to diet. Her group uses controlled dietary interventions to evaluate cancer biomarker-response to diet and specific phytochemicals. In addition, her group studies the modifying effects of the gut microbiome on diet and disease risk. Dr. Lampe's research has been supported by the US National Cancer Institute for the past 15 years and she has published over 200 papers related to diet and human health. In 2014, Dr. Lampe received the American Society for Nutrition's Mary Swartz Rose Senior Investigator Award for research on the safety and efficacy of bioactive compounds for human health.

***Lecture title:***
**Interindividual differences in metabolism of plant food bioactives: impact on dietary recommendations**
E-mail Joanna Lampe: jlampe@fredhutch.org

***Abstract***
Plant-food bioactives constitute a range of chemical structures that are metabolized to varying degree by human and gut bacterial enzymes. Disposition of phytochemicals, like that of drugs and other xenobiotics, involves absorption, metabolism, distribution, and excretion. Many plant bioactives are glycosides or other conjugates, and in order to be absorbed, need to be hydrolysed by brush border membrane-bound β-glucosidases (e.g., lactase phlorizin hydrolase) or bacterial β-glucosidases in the lower small intestine and colon. Absorbed aglycones undergo first-pass metabolism in gut epithelium or liver, being conjugated with glutathione, glucuronic acid or sulphate. Conjugates excreted in bile are deconjugated by bacterial β-glucuronidase and undergo further bacterial metabolism and enterohepatic recycling. Numerous genes encoding for enzymes involved in phytochemical disposition are polymorphic; thus, human genetic variation may contribute to interindividual differences in exposure and biologic response to these compounds. Bacterial metabolism of plant-food bioactives also varies among individuals, such that differences in gut bacterial communities influence exposure. Recent studies suggest that phytochemical modulation of microbial activity, despite exerting responses at the level of the gut and distant from target tissues, may also be important for disease risk. General recommendations encouraging populations to consume diets rich in vegetables, fruit, whole grains, legumes, and nuts provide a foundation for improving health, but do not necessarily assure adequate exposure to these bioactive compounds by the majority of individuals. Ongoing research to better characterize factors contributing to actual exposure or to site of action of plant-food bioactives will further assist in optimizing dietary recommendations and health-promoting strategies.

## Dr. Jim KAPUT - WG2 member of the COST Action POSITIVe
***Nestle Institute of Health Sciences, Lausanne, SWITZERLAND***

Dr. Jim Kaput currently works as the Head of the Clinical Translation Unit at Nestle. He's got his PhD at the University of Colorado in Biochemistry and Molecular Biology and is an expert in Translational Genomics and Personalized Nutrition for Health Care. His research focuses on human genetics molecular studies and association with the diet.

***Lecture title:***
**From pathways to networks: A cofactor-protein interactome as a model for plant bioactives**
E-mail Jim Kaput: James.Kaput@rd.nestle.com

***Abstract***
Among the great successes of the 20$^{th}$ century science was the elucidation of highly detailed metabolic maps of cellular biochemical reactions. The utility of these maps was confirmed in 1941 by the groundbreaking Beadle and Tatum's study on *Neurospora* auxotrophs. Their experimental protocol was designed to identify individual genes responsible for the metabolism of a metabolite. Their success was a major contributor to the idea that single genes could have significant effects on biological processes. The modern era of transgenic and knockout technologies has extended the single gene – single chemical approach not only to metabolism but also to developmental processes. These achievements resulted, however, in an almost exclusive focus on reductionist approaches to study complex biological processes that cannot be understood by analysing single pathways that occur in interacting systems. The technological limitations that limited more comprehensive analysis of metabolism are being overcome with the development of high throughput methods for analysing multiple metabolites, proteins, nucleic acids and by capturing more environmental data.

Complex strategies and computational methods are needed for analysing and translating these data to knowledge. Using publically available data, we conducted a network-based analysis of proteins that bind to cofactors and then functionally analysed modules of the interactome which linked biological processes to combinations of micronutrients and minerals. The pipeline and methodologies for the cofactor-protein interactome are now being applied to polyphenols. The integration of data from single biochemical reactions into a systems view is an important step that may provide strategies for targeted nutritional interventions aimed at improving health and preventing diseases.

## Dr. Eileen GIBNEY – Co-leader WG2 of the COST Action POSITIVe
***Institute of Food and Health, University College Dublin, IRELAND***

Dr. Eileen Gibney is a lecturer in Human Nutrition at the University College of Dublin. She is an active member of the UCD Institute of Food and Health, and a Registered Nutritionist. She graduated with a degree in human nutrition from the University of Ulster at Coleraine, she then obtained her PhD from the Dunn Nutrition Unit, University of Cambridge in 2001. Her current research interest lie in the molecular aspect of nutrition and disease, an area of nutrition research called Personalised Nutrition. Dr Gibney has successfully obtained funding for several research projects including 'Examination of the effect of genotype (PTC/PROP) on fruit and vegetable intake in children' (www.ucd.ie/foodandhealth/projects/geneticsofhealthyeating/) and more recently is involved in both the National Adult and Nutrition Survey (NANS) and National Phenotype Database (www.ucd.ie/JINGO) in Ireland. Eileen is a PI on the FP7 funded food4me project (www.food4me.org), which examined opportunities and barriers to personalised nutrition.

***Lecture title:***

**Food4Me and personalised nutrition**

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***Abstract***

With the mapping of the human genome sequence in 2000 many were hopeful about the ability to plan dietary recommendations based on an individual's genetic profile. However, the promise of personalized nutrition (PN) has failed to develop as a commercial service, and matching dietary advice to genetic profiles has proven difficult. The fundamental question remains, "how can we best use our current understanding of food, genes, and physical traits to design healthier diets tailored for each individual?". To further these investigations, the Food4Me team gathered an international group of experts to survey the current knowledge of PN, and to explore the application of individualised nutrition advice. Within the Food4Me project a Proof-of-Principle (PoP) RCT on the implementation of PN was completed. The RCT was a four arm, internet-based, 6-month study conducted across seven European countries, which compared the effects of different levels of PN on health-related outcomes. The RCT was designed to mimic a real-life internet-based PN service and to provide an insight into the effectiveness of PN advice compared with non-personalised "one size fits all" recommendations. The study demonstrated that PN advice is effective in improving dietary behaviours compared with conventional, population-based advice. There was no evidence that adding phenotypic or genotypic data to the information used to develop and deliver PN advice enhanced the effectiveness of the intervention based on analysis of current eating habits. PN advice delivered via the internet offers promise as a scalable and effective route to improving dietary behaviours, which may have important public health benefits.