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SUPPLEMENT

Foreword

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In 2001, ILSI Europe arranged an international symposium on "Functional Foods, Scientific and Global Perspectives" to review the worldwide scientific developments and identify new trends in the area, as well as communication issues and regulatory developments. Before that the EU-sponsored concerted action project "Functional Food Science in Europe (FUFOSE)" had been finalised. FUFOSE worded a working definition implying that functional foods are foods with scientifically substantiated benefits for health and/or performance, above normal nutritional functions.

The next major EU-project was "Process for the Assessment of Scientific Support for Claims on Foods (PASSCLAIM)", carried out 2001–2005, defined a set of criteria for the scientific substantiation of claims. These criteria are intended to provide a guidance template to inform the evaluative and legislative process. Both FUFOSE and PASSCLAIM have been widely used and cited, and these projects have thus had a considerable impact in recent years' developments within the functional foods area.

In Europe, the Regulation (EC) on Nutrition and Health Claims made on Foods was effective by January 2007. As in most other regulations, with Japan and its "foods for specified health use, FOSHU" as a notable exception, "functional foods" is not defined as a separate category but rather in terms of health claims. Functional foods can then be regarded as food products eligible for health claims, including food supplements that are treated together with ordinary food products in the European regulation. This means that a broader category of food products than originally defined as functional foods are treated under this umbrella, which is the case also in most market analyses showing the remarkable growth potential of the functional foods sector.

With this background and the considerable developments in other parts of the world, not the least in North America and South East Asia, the present international symposium "Functional Foods in Europe—International Developments in Science and Health Claims", held in Portomaso, Malta 9–11 May 2007, turned out to be most timely. It provided an overview of the considerable scientific developments in the area, taking place at present. It also reviewed the most recent legislations in Europe and internationally which provide the platforms for further developments. The key issue of consumer understanding and confidence was addressed thoroughly.

The scientific and legislative developments provide the basis for further developments in the interest of both consumers and producers. These developments will further drive the ongoing reformulations of existing foods as well as the development of innovative products with additional benefits for consumer health, performance and well-being.

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SUPPLEMENT

Functional foods in Europe: international developments in science and health claims

Summary report of an international symposium held 9–11 May 2007, Portomaso, Malta

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Introduction

The concept of functional foods derives from the realisation that specific components of the diet have the capacity to contribute benefits beyond those of basic nutrition. The last two decades have seen the development of this concept to the point where it has aroused significantly the interest of the food industry, consumers and the regulatory authorities. The future of functional foods will depend on continued advances in nutrition science and the development of innovative technologies by the food industry. It will also depend on consumer understanding and acceptance of the concept, of products derived from its application, and on the way in which access to the market place is mediated by the regulatory environment at national, regional and global levels. The present symposium, held in Malta from 9 to 11 May 2007 and organised by the International Life Sciences Institute European Branch (ILSI Europe) in collaboration with the Malta Standards Authority, University of Malta and ILSI South East Asia, provided a forum for dialogue between stakeholders from the food industry, academia, consumer groups and the regulatory authorities. It gave an opportunity to review the current status of health claims made on foods and their scientific substantiation, to explore consumer understanding, behaviour and communication in relation to the concepts, to assess the impact of regulation on health claims and innovations in functional foods, and to discuss the future challenges and opportunities for functional foods. The conference was timely in that it followed the formal adoption of the Regulation (EC) No 1924/2006 of the European Parliament and of the Council of 20 December 2006 on Nutrition and Health Claims made on Foods [1] (hereafter referred to as the EU Regulation).

The overall chair of the symposium was Professor Nils-Georg Asp (Swedish Nutrition Foundation and Lund University, SE) and he was supported by Dr Detlef Müller (Procter and Gamble, DE), acting as overall co-chair. More than 300 experts from 45 countries participated.

The Symposium was opened by Hon. Louis Deguara, Minister of Health, the Elderly and Community Care, Malta. In doing so, he noted the need for a sound science base to underpin development of the functional foods sector and he stressed the value of collaboration between academia, the food industry, the government sector, consumer groups and the media in further exploring the potential for functional foods and their role in health promotion and disease-risk reduction.

Session I

Evolution in dietary patterns, health trends and functional foods

Professor Furio Brighenti (University of Parma, IT) chaired the session with the support of Jean-Michel Antoine (Groupe Danone, FR) as co-chair. This first session set the scene for the symposium by highlighting current health concerns in Europe—namely obesity and the diet-related chronic diseases, including heart disease, stroke, diabetes

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and cancer—and exploring the options for dietary interventions and the role for functional foods.

Professor Pirjo Pietinen (National Public Health Institute, FI) summarised the current status of health in Europe and the development in non-communicable diseases based on data from the World Health Organization (WHO). The burden of mortality in Europe is related to the chronic diseases of over-nutrition, with obesity and overweight increasing at an alarming rate and cardiovascular diseases being the principal cause of death. Raised blood pressure is the leading risk factor, while elevated blood cholesterol, high body mass index and excessive alcohol consumption are additional diet-related risk factors. There is a wide variation in life expectancy in Europe, which currently mirrors the prevalence of cardiovascular diseases, rather than obesity, and reflects the inequalities between the countries of Europe. Inequality, particularly in socio-economic status, within countries also has an impact on obesity and chronic disease, prevalence being higher in poorer communities. Probable dietary determinants of disease are a too high intake of fat (high energy density) and saturated fat and a too low intake of fruits and vegetables. There is particular concern about the rising prevalence of obesity and related type 2 diabetes in children, and there is a need to break the cycle of deprivation of low income, poor diet, lack of physical activity, psychiatric problems and reduced ability to care for children. Thus, WHO has developed the European Charter on Counteracting Obesity that outlines policy tools to address this issue through actions for all stakeholders. Finally, Professor Pietinen called for the support of the research community to provide a strong science base for action.

Although better diet and safe food have contributed to increased average life expectancy in Europe, there are some unfavourable trends in terms of food availability and eating habits. The potential for dietary intervention to contribute to further improvements in health was explored by Dr Nynke de Jong (National Institute for Public Health and the Environment—RIVM, NL). She described a conceptual framework and methodology to assess and weigh positive and negative health effects of population dietary interventions. A measure of disease impact, used by WHO and researchers alike, is the disability-adjusted life year (DALY). DALY is a summary measure of early death (years lost) and years lived with a disease burden. Using the DALY as a scoring system, it proved possible to calculate that the positive impact of dietary change such as reduced saturated fat consumption and increased fish intake can, by far, outweigh the negatives of well-established food safety concerns such as microbial contamination and food allergy. In addition, Dr de Jong recommended risk–benefit analysis of functional foods, showing, in the case of benefit, that it is possible to measure the benefits of functional foods, such as those containing cholesterol-lowering phytosterols, in well-designed post-marketing cohort studies.

Professor Nils-Georg Asp (Swedish Nutrition Foundation and Lund University, SE) referred to functional foods as denoting positive nutrition. Functional foods may have optimised nutrient content, or may offer additional benefits in terms of health, well-being and physical or mental performance. Although there have been many attempts to define functional foods, for example under the ILSI Europe Functional Food Science in Europe (FUFOSE) project [2], there is no single, accepted definition; however, in general it is true that functional foods are those for which health claims are made. The EU Regulation defines nutrition claims and health claims, the latter including both claims for the function of nutrients and other substances as well as claims for disease risk reduction. Codex Alimentarius (Codex) Guidelines have slightly different, but overlapping, categories. In the development of lists of health claims, Professor Asp pointed out the difference between claims that can be used for a range of food products fulfilling certain compositional criteria, sometimes referred to as "generic claims", and product-specific or innovative claims that rely primarily on intervention studies with the product. He stressed the importance of communicating health claims in the context of the diet, and the need for consumer relevance as well as consumer understanding. Allowing health claims that are scientifically substantiated can stimulate product development and may assist in consumer education, as well as improve health, well-being and performance.

In the discussion session there was clarification that the EU Regulation regulates claims not foods. Hence, if the food composition and science provide appropriate support, any food, including a traditional food, can bear a claim. There was a comment about the cost of functional foods and it was pointed out that the investment to develop and produce such foods is high. However, the proportion of consumers that choose functional foods may be quite small; 2–5% in the case of foods containing phytosterols in the Netherlands, even though re-imbursement of costs is available from health insurers in that country. It was noted in relation to life expectancy that for older people to be moderately overweight is positively related to longevity.

Session II

Scientific substantiation of claims on foods

The session was chaired by Professor Gerhard Rechkemmer (Federal Research Center for Nutrition and Food, DE) and co-chaired by Dr Anne Franck (Raffinerie Tirlemontoise—ORAFTI, BE). The objective of this part of the

programme was to compare the different approaches taken around the world to formalise the scientific substantiation process and to learn the latest thinking from the European Food Safety Authority (EFSA), currently preparing its guidance for the submission of dossiers on health claims in the EU.

The Chair of the PASSCLAIM Consensus Group, Professor Peter Aggett (Lancashire School of Health and Postgraduate Medicine, UK), described the outcome of the EU Concerted Action, "The Process for the Assessment of Scientific Support for Claims on Food" (PASSCLAIM), which was co-ordinated by ILSI Europe in 2001–2005. The key output from the programme was a set of criteria for the scientific substantiation of claims [3]. These criteria relate to the characterisation of the food or food component, appropriate methodology for human studies, the use of markers, and to the evaluation and use of the totality of the data (both published and unpublished) in weighing the evidence. The PASSCLAIM criteria provide a guidance template to inform the evaluative and regulatory process; they do not establish the validity of the claim. The process of evaluation must be applied on a case-by-case basis with an intelligent interpretation of the evidence, its consistency and coherence, its plausibility and its biological relevance — including instances where there are gaps in knowledge. An intelligent approach is also needed for the re-evaluation of claims. Expanding on the original project, Professor Aggett explored the notion of causality and also the use and interpretation of markers, as well as the difficulty of interpreting the complex link between markers and the causal pathway. In many cases, single components might influence several outcomes while, in others, single outcomes might be influenced by several components.

Outlining the current thinking of the US Food and Drug Administration (FDA), Professor Joanne Lupton (Texas A&M University, USA) noted that, in the USA as in most countries, it is the health claims rather than the foods that are regulated. She pointed out that functional foods were currently regulated as conventional foods (not as supplements), but that the FDA was conducting a public consultation prior to considering legislation on functional foods. US health claims are essentially the equivalent of disease-risk reduction claims in Europe and require "significant scientific agreement" (SSA) prior to publication of their approval in the Federal Register. Qualified health claims are those that do not reach the level of SSA but are nevertheless used under enforcement discretion, which means that the FDA advises against enforcement action being taken against the claim. The process of evaluation of all these claims is the same, whether qualified or not or whether applied to conventional (or functional) foods or to supplements. The important features of the process for the scientific substantiation of health claims in the USA are firstly that the food or food component is defined and, secondly, that the specific statement or claim is evaluated. In reviewing the evidence, the FDA ensures that all relevant studies are identified, rather than relying on the petitioner's dossier. Human studies in non-diseased populations are the most relevant, and markers need to be those approved by the FDA or the National Institutes of Health (NIH). The totality of the evidence is rated for strength, extent and consistency, and a recommendation made. Beyond the regulation of health claims, the safety of functional foods and appropriate vehicles for health claims are topics worthy of further consideration.

Dr. E-Siong Tee (ILSI Southeast Asia, MY) described ongoing efforts to harmonise scientific substantiation of claims across Southeast Asia. Between 2000 and 2006, ILSI Southeast Asia organised a series of workshops to inform all stakeholders of international developments in the science and regulation of functional foods and health claims and to provide them with a platform to discuss the scientific basis of the regulation of nutrition labelling and health claims in Southeast Asia. Considering the countries of the region and also Japan and China, there is a varied approach to the regulation of functional foods and claims, with Japan undoubtedly having the most comprehensive system—the so-called FOSHU (Foods for Specified Health Use), a system that requires pre-marketing approval of health claims on a food-by-food basis. Qualified health claims have been admissible since 2005, recognising the importance of informing consumers about emerging evidence. The ILSI workshops have also prepared guidance on the scientific substantiation of health claims drawing on the work of PASSCLAIM and Codex. Once again, well-designed human intervention studies and the use of appropriate markers are emphasised. Evaluation of the safety of foods carrying health claims is also part of the procedure for scientific substantiation, but only where the target group, level of intake or potential interaction with other nutrients so warrants, otherwise standard food safety procedures apply.

Dr. Pilar Rodriguez Iglesias (European Food Safety Authority—EFSA, IT) affirmed the mission of EFSA with respect to nutrition and the role of the Panel on Dietetic Products, Nutrition and Allergies (NDA panel). The mandate of the NDA panel under the EU Regulation on Nutrition and Health Claims made on Foods falls under two main headings: firstly, the setting of nutrient profiles, and secondly, the scientific substantiation of health claims. In relation to the latter role, the first task for EFSA is to provide guidance on the content and preparation of dossiers to be submitted under Article 14 of the Regulation (claims for a reduction in disease risk and claims related to children's development and health) [4]. The European Commission will also consult EFSA as it prepares a list of

claims based on generally accepted scientific evidence under Article 13 of the Regulation. EFSA will also need to evaluate dossiers submitted for new or proprietary claims that also fall under this Article. EFSA may be consulted on other matters under the EU Regulation where their independent scientific opinion is required.

Professor Rolph Grossklaus (Federal Institute for Risk Assessment—BfR, DE) spoke in his capacity as chair of the Codex Committee on Nutrition and Foods for Special Dietary Uses (CCFNSDU). As part of its key role in protecting the health of consumers and ensuring fair trade practices in the global food market, Codex adopted revised Guidelines for Use of Nutrition and Health Claims in 2004. Several proposed draft recommendations on the scientific substantiation of health claims have been considered and amended by the CCNFSDU in recent years but the work is not yet complete. The current work draws on the work of FUFOSE and PASSCLAIM and also on that of WHO and FDA. Given the important role of Codex in food safety, the draft recommendations place importance on circumstances where additional evaluation of safety or nutritional safety needs to be considered. High quality human intervention studies are the prime evidence needed to substantiate claims but there is recognition that, in some cases, only observational studies may be available and that emerging evidence is also important. Animal and in vitro studies will also be evaluated as part of the totality of the evidence. The strength of the evidence depends additionally on the consistency and reproducibility of results. It has been suggested that the recommendations should include re-evaluation of claims after a certain time period, as well as in cases where new data call the validity of claims into question.

During the discussion, a question was raised about new evidence that might question the veracity of an approved claim. In fact, options for re-evaluation are built into most schemes and, in the case of the Codex draft, a timed re-evaluation is recommended. It was suggested that it may be important to consider public health relevance as well as biological relevance and consumer relevance. However, a public health benefit may not imply a positive benefit for the individual consumer who is relying on the health claim to guide choice. The importance of risk–benefit analysis was noted, particularly in regard to emerging science. At a more basic level, it was debated whether, if the removal of a component leads to a benefit, this could result in a health claim. In the USA, the legislation does not allow for such claims, but elsewhere it would seem that such claims can be made if they can be substantiated. The challenges for small and medium sized enterprises (SMEs) may be considerable in meeting the requirements for scientific substantiation and so the audience was made aware of a network called FunctionalFoodNet [5] that could be helpful to SMEs.

Session III

Regulatory issues of functional foods

Regulatory matters related to functional foods were addressed by four speakers in a session chaired by Professor Peter Biacs (Hungarian Scientific Society for Food Industry, HU). The co-chair was Dr. Michele Kellerhals (Coca-Cola European Union, UK). Key features of the EU Regulation were outlined and a perspective was provided on certain aspects of implementation including those related to transitional measures, compiling the lists of health claims and nutrient profiling. In addition, the concept of risk–benefit assessment of functional foods was introduced.

It was the task of Basil Mathioudakis (European Commission, BE) to provide a perspective on the EU Regulation on Nutrition and Health Claims made on Foods that came into force in January 2007. The primary aim of the Regulation is to provide a high level of consumer protection, but it must be recognised that the inclusion of claims about a reduction in disease risk was a substantial regulatory step for the EU. With the exception of those substantiated on the basis of proprietary data, the Regulation makes approved claims open to use by all operators. Claims based on proprietary data are reserved for the exclusive use of the owner of the data for a period of 5 years unless, in the intervening period, they are independently substantiated on the basis of data from alternative sources. Mr. Mathioudakis emphasised that restrictions on the use of claims are not related to good or bad foods but are, in the case of nutrient profiles for example, to counterbalance strong promotional activity. There is considerable work for all stakeholders around implementation of the EU Regulation. This especially relates to nutrient profiles and to the list of claims under Article 13 as well as some interpretational issues, particularly concerning the categorisation of claims into nutrition claims, health (function) claims or disease risk reduction claims. In the case of the latter, grading of evidence, wording of claims and consumer understanding are all complex issues. Transitional arrangements, particularly those that concern claims about child development and health, remained to be clarified at the time of the symposium.

Challenges around establishing the list of claims based on generally accepted scientific evidence under Article 13 of the EU Regulation were discussed by Noel Griffin (Food Standards Agency—FSA, UK). In some senses the task is difficult because most countries have no national list; nevertheless, there are many claims on the market and, in the case of the UK, these claims will form the basis for the list. The UK Voluntary Joint Health Claims Initiative evaluated a number of claims on several foods, as well as

statements on micronutrient function that can be considered for inclusion on the national list. A template has been provided for submission of claims to the FSA [6]. There is a large burden on regulators to succeed in this process and the UK believes continuing consultation with all stakeholders, both nationally and across the EU, is a key to a successful process. The national role should be to exclude spurious references and to ensure that there is adequate science for review (if needed) by EFSA. There is an opportunity for the EU Regulation to help inform and educate consumers as well as to provide protection.

Professor Gérard Pascal (National Institute for Agronomic Research—INRA, FR) addressed the important topic of risk–benefit analysis in evaluating functional foods. He described the evolution of the definition of risk from a narrow, strictly quantitative concept to a broader approach that embraces the concept of societal acceptance of risk. Also important is the ability to communicate that acceptable risk does not mean zero risk. The safety of functional foods must be equivalent to the safety of normal foods—that is, the functional food must be capable of providing its specific benefits without appreciable risk. For micronutrients and micro-components, classical toxicological testing can be applied. However, macro-components and whole foods have always posed a challenge to the toxicologist and, in this case, substantial equivalence and history of safe use are important criteria. Novel approaches for comparing beneficial and adverse effects on the same scale of measurement have been proposed and are being debated in several fora. In the future, other risks and benefits (economic, commercial, environmental, ethical, etc.) should be assessed from a scientific point of view. These assessments may be used by risk managers to define, after a discussion with all stakeholders, what is socially acceptable.

The last speaker in this session, Professor Albert Flynn (University College Cork—IE), dealt with the topic of the nutritional impact of functional foods and the role of nutrient profiling. He stressed that his observations were made in a personal capacity rather than in his role as chair of the EFSA Panel on Dietetic Products, Nutrition and Allergies (NDA). It is important in developing nutrient profiles that the specific objectives of the exercise (in this case ensuring that health claims do not mislead) are taken into account. The nutrient profile of an individual food does not have to match the nutrient profile of a balanced diet, and the level of usual intake needs to be taken into account. Professor Flynn explored the advantages and disadvantages of setting a profile that applies to all foods or setting profiles per category. Regarding the nutrients to be addressed, the EU Regulation is not prescriptive, so only nutrients that are pertinent need to be addressed. There are several different possible bases for a threshold approach or for scoring nutrient content as well as the option to apply these per 100 g, per portion or per 100 kcal. EFSA NDA will provide guidance to the European Commission on these scientific principles and also on the tricky operation of testing and feasibility of the proposed scheme. Given its potential complexity, it is comforting to know that the scheme does not need to be communicated as such to the consumer.

In the discussion session, a question was asked about whether it was still the current view that new claims under Article 13.5 of the EU Regulation could not be submitted until 2010, as indicated in the EFSA pre-submission guidance. Mr. Mathioudakis confirmed that there was a legal basis for this view because of the word "addition" in the text (i.e. the list must be in existence before it can be "added to"). Mr. Griffin stated that if a Member State received a dossier, it was bound to act in accordance with the Regulation and forward the dossier to EFSA. In answer to a question on probiotic claims, panel members indicated that criteria such as number of live cells would need to be met, as well as there being a need for evidence of a modification to the type or metabolic activity of the gut microflora. It was confirmed that front-of-pack labelling schemes that were making nutrition or health claims would need to be notified by Member States and comply with the EU Regulation. EFSA confirmed that it would be publishing population reference intake (PRI) values for macronutrients, but would not be working on related labelling values such as guideline daily amounts (GDAs) or reference labelling values (RLVs).

Session IV

Consumer perspective: behaviour, understanding and communication

The session on consumer perspectives was chaired by Professor Diána Bánáti (Central Food Research Institute—KEKI, HU) and co-chaired by Reg Fletcher (Kellogg, IE). Five speakers presented different aspects of the current state of knowledge on how the form in which information is presented to consumers influences their perception of functional foods, their understanding of the health messages conveyed and the dietary choices they make.

Jens Lönneker (Rheingold GmbH, DE) presented findings from studies of how consumers' perception and behaviour is affected by information on aspects of food composition associated with health. Aspects reported included the presence or absence of preservatives, low glycaemic impact, low fat content, low calorie content and the presence of probiotics. Observations on consumers' receptiveness to sport-related communications and to retail environments were also reported. At a superficial level,

consumers respond positively to brands that eliminate food additives or that are formulated to meet concepts of health and well-being. However, such brands may generate underlying concerns associated with doubts about the hedonistic quality of the product and with loss of consumers' own control over their responses and dietary choices. In addition, consumers' perception of what it takes to achieve a state of health and well-being is often counterbalanced by their desire for pleasure and the excitement that comes with the taking of risks. Unease in the face of information overload and a desire for stability/familiarity at the point of sale also motivate consumers' purchasing choices in ways that may run counter to the pro-active use of health messages in connection with branded products. Ultimately, consumers' decisions are determined by a balance of influences relating to health and lifestyle, which may appear contradictory.

An industry perspective on the marketing of functional foods was presented by Dr. Edward Fern (Nestlé, CH). Dr. Fern's principal proposition was that, with the possible exception of foods for special health use (FOSHU) in Japan, functional foods are not perceived by consumers to be a coherent category of foods. Rather, they are seen as the moving edge of an evolving spectrum of food products in which traditional foods are under continual development with the aim of providing dietary choices leading to benefits beyond simple nutrition. In this context, the challenge in the development and marketing of functional products lies in the possibilities for adding functionality to traditional foods in such a way that they retain their appeal as a source of pleasure. The challenge must be approached simultaneously from the four aspects of food quality, nutrition science, regulatory oversight and consumer expectation. Science and regulatory oversight must work together to ensure the credibility of any claims for health benefits within a framework capable of communicating legitimate health messages to consumers. Nutrient profiling arguably has a role in underpinning that credibility. Outside the special confines of "FOSHU" foods, successful functional food products are likely to be those that are presented to consumers in a form that meets their expectations with respect to traditional food characteristics, and that communicate the additional health benefits consumers can expect to obtain in a context to which they can relate.

Professor Ulrich Oltersdorf (Federal Research Centre for Nutrition and Food—BFEL, DE) described the challenge of communicating knowledge generated by nutrition science to consumers in a form that has practical effect in influencing their dietary habits. Modification of dietary behaviour to produce successful health outcomes must be effective in modifying habitual, everyday behaviour rather than behaviour responding to discrete, episodic events. Such behaviour is controlled by two principal influences, one relating to metabolic input/outputs and the other to information input/outputs. Professor Oltersdorf's further discussion addressed the information input/output domain in which dietary behaviour is shaped by many factors ranging from sensations, through feelings and emotions, to habitual physical actions such as walking and eating. These many inputs are assimilated by a system that develops over an individual's lifetime and that is itself susceptible to societal and cultural influences. External messages relating to nutrition are received into an individual's acquired pattern of attitudes, beliefs and trusts and will be treated accordingly. Planned interventions have the potential to direct changes in nutritional behaviour but their effective design requires a systematic knowledge of the way individuals' behaviour responds to communication about nutrition. Research is required to develop a comprehensive model of nutrition behaviour in order that more effective nutrition communication can be formulated.

Further aspects of consumer understanding of nutrition communication, with a particular focus on information provided on food packs, were discussed by Professor Hans van Trijp (Wageningen University, NL). Claims on food packs provide a valuable source of information but the information always comes to consumers within a context that influences the effectiveness of the communication. When the claims are scientifically justified and the information is correctly understood and used by consumers, the interests of all stakeholders (policy makers, industry and consumers) are best served. Assessment of the effectiveness of on-pack communications presents methodological problems, but it is clear that the extent to which information is assimilated is influenced greatly by consumers' regional origins and societal and demographic characteristics. Consumer understanding is limited by the availability of nutritional knowledge and the facility to appreciate complex information, with the result that claims and information may be misinterpreted. The EU Regulation on Nutrition and Health Claims made on Foods requires claims to be understood by the average consumer, but there is as yet no consensus about how compliance with this requirement is to be assessed. The ILSI Europe Consumer Science Task Force has proposed a stepwise approach for gathering evidence to allow assessment of the comprehensibility of claims [7] but, within the EU, the responsibility for making the assessment will fall to the EFSA. Issues that remain to be addressed include the need to develop a pragmatic approach that recognises the need to balance scientific certainty against practical limitations in consumer science, the difficulties inherent in basing judgements about post-market effectiveness on information limited to the pre-market situation, and agreement of an appropriate standard of evidence.

Professor Peter Biacs (Hungarian Scientific Society for Food Industry, HU) presented an assessment of the part

played by considerations of health in determining consumers' choices of foods. Although an appreciation of the role of diet in maintaining health is growing, it remains at a relatively low level at present. In a recent study in Hungary, the term "functional" in relation to food was found to be unknown to a large majority of consumers. Consumer surveys indicate that awareness of the role of nutrients in health and well-being varies across age groups. While older age groups recognise the role of calcium-rich foods in the maintenance of bone health, younger age groups are less aware of a possible positive role for antioxidant-rich foods in combating cardiovascular disease and cancer. An increased awareness of the value of diet to health can be achieved through a three-step approach in which foods are enriched with a nutritionally valuable component, the nutritional benefit of enrichment is established and, eventually, the role of a nutritionally enriched food in disease-risk reduction is demonstrated. An example of such an approach was presented in the context of marketing communication by the dairy industry in relation to the presence of calcium in dairy products, the role of calcium-rich foods in the maintenance of bone health and the possibility that the risk of osteoporosis may be reduced by regular consumption of milk and dairy products. Market research indicates a potential for future interest in functional foods by a wide group of consumers.

During discussion, interest focussed on the extent to which consumers are influenced in their dietary choices by the quality and the quantity of information presented on packs. The two aspects were seen as closely related. While superficially a larger quantity of information may lend greater credibility to the content of the information, at another level consumers are deterred by large amounts of information and so are likely to disregard it. Similarly, information that remains static over time ceases to be seen by consumers and so flexibility in the wording of claims may be important if the information they contain is to be refreshed and kept current in consumers' perception. Although "traffic-light" systems, GDAs and logos provide frameworks that can assist consumers in making sense of complex information, if there is no agreement on the thresholds and bandings they are based on, they become sources of confusion rather than of enlightenment. Despite care taken in the wording of health claims, evidence suggests that consumers do not distinguish between disease-risk reduction and disease prevention. As far as the underlying consumer science is concerned, assessment of the extent to which labelling information is used and understood is hampered by the limited methodologies available for this purpose. Also, there is a need to develop a more complete model of human nutrition behaviour so that the influence of communication on food choice can be better understood.

Session V

Roundtable discussion: different strokes, different visions: where lies the future of functional foods?

An opportunity for an overarching discussion about the future for functional foods was provided by a session in which a panel comprising Professor Joanne Lupton, Basil Mathioudakis, Dr. Edward Fern and Professor Nils-Georg Asp was invited to respond to debating points from the floor of the symposium. Alex Puissant (BE) acted as moderator for the session.

Overall, the panellists considered the prospects for the future of functional foods to be positive in a context where a developing science base provides the means to extend the range of familiar food items by addition to, or enhancement of, existing functionality. The present working definition of functionality is likely to provide continuing grounds for discussion since it presently relies on the concept of basic nutrition for its point of departure and, as nutrition science evolves, so will the concept of basic nutrition. However, the discussion may prove academic in the European context since the EU regulatory framework subsumes the issue into the more general one of food labelling and of claims made on all foods in relation to nutrition and health. The issue becomes one of the validity of the claim made about a food, rather than whether or not the food falls within the notional category of "functional". Where national and regional frameworks differ from that of the EU, the definition of functionality may remain an issue for scientific and legal discussion.

A question arose as to whether the burden of proof imposed by the EU Regulation for establishing the validity of a claim presents a barrier to entry into the market for SMEs and therefore disproportionately favours large business operators. Panellists felt that this was not the case, pointing to the fact that there are examples of innovative activity in the sector on the part of SMEs. Furthermore, all authorised claims, other than those dependent on protected proprietary data for their substantiation, will be available for use by SMEs. It was also pointed out that a counterbalancing disincentive exists for large enterprises in the form of risk to the image of established brands where claims might prove not to be supported or where product performance fell short of expectations. In addition, by establishing a Community procedure for the evaluation of claims and a register for those assessed to be valid, the Regulation provides an even playing field for all operators, reducing the possibility for large business operators to gain credibility for claims solely from their larger market presence.

There was discussion about the value of "traffic-light" systems as a means of conveying nutritional information in the face of evolving nutrition science. As knowledge

about the impact of intakes of macronutrients on health increases, the thresholds and bands forming the basis of any system may be adjusted up or down and the resultant changes to the labelling indicators will be confusing for consumers. A proposal for revised EU nutrition labelling rules is anticipated by the end of 2007. It remains to be seen how it will address the use of traffic-light or similar systems of nutrition signalling in Europe. Nevertheless, however, addressed in the short term, the issue will remain pertinent since continuing evolution of nutrition science is inevitable and, clearly, desirable.

Concern was expressed that the process of evaluation foreseen for the initial list of health claims ("Article 13 claims") during the introduction of the EU Regulation will be overwhelmed by the volume of information that will need to be assessed. In response, it was pointed out that the information will be provided in a structured format that will facilitate its assessment and that single datasets may provide the support for several claims, thus reducing the multiplicity of primary reviews that will need to be conducted. While acknowledging that significant resources will be required to evaluate the information, confidence was expressed on the part of the EU Commission that the procedure foreseen is sustainable.

There was discussion about the infrastructure necessary to advance the development of functional foods proactively. Development of EU funding proposals in support of research into food functionality is foreseen as a possibility, for example within the European Technology Platform "Food for Life", which was launched in July 2005 as part of the European Food Industry's input into the EU Seventh Framework Programme (FP7). Subject to compliance with the provisions of the EU Regulation on Novel Foods and Food Ingredients [8], the EU regulatory environment controlling nutrition and health claims does not place limitations on the nature of the sources of functional components that may be used and, in this sense, can be regarded as supportive. The view was expressed that the establishment of dietary reference intakes (DRIs) for a wider range of nutrients would enable the commercial exploitation of a greater number of functional components. It was pointed out that many functional components are not nutrients in the conventional sense and that DRIs would not be applicable. However, it was suggested that, in the light of developing functional food science, evolving perceptions might indeed make it appropriate to consider them as such. The development of appropriate markers for a wider range of functional end-points was also cited as something that would facilitate advancement in the field.

While there was recognition that the EU Regulation does much to minimise the risk to consumers in relation to false and misleading claims, the question was raised about whether it could do more to encourage improvement in the health quality of foods. In response, it was pointed out that the Regulation does seek to remove disincentives, for example by providing protection for proprietary data generated in support of claims. However, the driver of the market is ultimately the consumer and the greater part of the incentive to develop food functionality must come from consumer demand.

It was suggested that, by maintaining a prohibition on claims for disease prevention, the EU Regulation unduly restricts the development of functional foods. In response, it was said that the present regulatory environment reflects the current societal perception of the distinction between foods and medicines. A change in EU law would in principle be possible, but it would require a consensus amongst all stakeholders that food has a legitimate role as medicine. At the present time such a consensus is not apparent.

The relationship between functional foods and dietary supplements was discussed. One consequence of not recognising functional foods as a separate category in food law is to include them in the same category as dietary supplements for the purpose of control. Yet the circumstances of use of the two, including the greater possibility of health risk from product over-use in the case of supplements, could be very different. Likewise, the functional performance of an active component could be different in the presence or absence of a food matrix. In EU law, the two categories will be treated equally from the perspective of nutrition and health claims and this may be regarded as a strength since it will ensure that the validity of any claims will be judged on a consistent basis. This will benefit both consumers and the credibility of the claims themselves.

The question of health risks from functional foods is a separate issue from that of the regulation of nutrition and health claims. In the EU, as in most other regulated systems, general food law requires that all foods are safe in use. However, it was felt that there are special considerations for functional foods, where arguments in support of their use are predominantly based on expectations of improvement in the health of those who consume them on an individual basis, without any countervailing assessment of their impact on public health overall. Against this background, it was agreed that there are strong arguments for conducting risk–benefit analyses in connection with the use of functional foods. On the part of the Commission, it was said that the responsibility for conducting any post-market surveillance within Europe would fall to the authorities of the Member States.

The difficulty of establishing consumer understanding of health claims, in advance of gaining market approval, was discussed. The difficulty arises not only because data from a real market situation are not available at that point in time, but also because consumer awareness of how dietary inputs might influence a particular aspect of health is

lacking when products designed for the purpose are not present in the marketplace. There are strong arguments for allowing claims onto the market place as a means of educating consumers about the benefits that functional foods may bring. It was agreed that the requirements of the EU Regulation concerning consumer understanding would need to be interpreted flexibly if the Regulation is not to function in an unduly obstructive fashion. It might, for example, be appropriate to interpret the "average consumer" as being representative of the target group for a functional food, where awareness of the relevant health issue is initially likely to be higher, rather than representative of the population overall, where initial awareness is likely to be low. It was also agreed that the introduction of particular health claims into the market place needs to be supported by parallel programmes designed to educate consumers on the issues concerned if a favourable impact on consumers' nutrition behaviour is to be maximised, always provided that consumers are not encouraged to use dietary means as alternatives to the proper medical management of health problems where this is appropriate.

In their closing remarks the panellists agreed that:

- The EU Regulation represents a positive contribution to the future development of functional foods in Europe
- Continued research in the field of food functionality will be important in sustaining the current upward trend in development
- Education will be important in raising consumers' awareness of the potential benefits to be gained
- Nutrition and health claims have a part to play in the process of education

Session VI

Future of functional foods: challenges and opportunities

The final session of the symposium addressed future challenges and opportunities for functional foods. It was chaired by Professor Albert Flynn (University College Cork, IE) and co-chaired by Dr. Hans Zevenbergen (Unilever, NL). The session provided an opportunity for expert speakers to map out how the future of functional foods might be affected by evolving consumer perceptions, the application of personalised nutrition and emerging technologies. The possibilities for financial support from the European Community for future research into functional food science were also described.

Possible future societal perspectives on functional foods were presented by Claude Fischler (National Centre for Scientific Research—CNRS, FR). Although at present functional foods have an indeterminate and rather variable identity in popular perception, Dr. Fischler pointed out that, historically, there has long been an association between health and the diet in general. The development of a discrete, popular identity for functional foods in the future will likely require consumers to confront three fundamental concerns that shape their attitude to food. First, consumers have a tendency to prefer naturalness in their foods and will form negative associations in response to triggers that have unnatural connotations. Second, to an extent that varies with their cultural background, they find the concept of food incompatible with the concept of medicine. Third, they are risk-averse and are likely to perceive "active" components as associated with risk. In addition, food has become trivialised. The main challenge for the future in finding a favourable identity for functional foods may first be to re-establish the perceived value of food in general by improving its quality with regard to both taste and nutritional value. However, in circumstances where obesity is increasingly seen as the major issue for health, any attempt by the food industry to create a perception of added value in the market for food may raise issues of trust in the minds of consumers that will make the task difficult for the industry to achieve.

Professor Mike Gibney (University College Dublin, IE) addressed the future role of functional foods in an era of personalised nutrition. Possibilities for dietary interventions exist because genetic variation, in the form of polymorphisms, results in discrete groups of individuals with particular traits that may influence their susceptibility to disease and that can be identified by DNA analysis. In principle, identification of such polymorphisms can serve as the basis for targeted dietary advice aimed at reducing disease risk or optimising health and well-being. Implementation of such advice has been termed "personalised nutrition". In practice, with a few exceptions, the precision with which such advice can be targeted is limited because the identification of polymorphisms likely to respond to intervention, and the individuals who possess them, is itself of limited precision. Where advice can be precisely targeted, the complexity of the dietary combinations necessary to meet population requirements is prohibitive. In order to satisfy consumer demand for variety, total diet formulations would have to be so numerous as to be impracticable on a commercial scale; alternatively, they would have to be so limited as to be unpalatable to consumers on a regular basis. While functional foods may have the potential to offer solutions to meet individuals' needs for personalised nutrition, the complexities of implementing personalised nutrition would appear to make realisation of the potential impracticable for the foreseeable future.

Peter Brown (Kraft Foods, USA) described the likely impact of emerging technologies on food from the perspective of the possibilities, the needs and the risks and

benefits. The impacts of nano-, digital and biomolecular technologies were considered with some indicative examples of the ways each might be used. Examples included the use of nanotechnology in the decontamination of water from groundwater sources, the application of digital technology to the use of information in food distribution, storage and preparation, and the use of biomolecular technology in cell-based, receptor-mediated functional assays to improve the taste quality of foods. While these technologies have the potential to contribute to the increased safety, convenience, quality and nutritional value of the food supply, and to the application of personalised nutrition in the pursuance of health, they must be adequately managed to ensure human and environmental safety and the privacy of the individual. If they are to be commercially viable in their application to food, they must be implemented in ways that are acceptable to consumers. This means that their application must be transparent to consumers, enabling them to make informed, personal choices.

Financial support for research into functional foods under the EU Commission's Seventh Framework Programme (FP7) was the subject of a presentation by Isabelle de Froidmont-Görtz (European Commission, BE). The European Community is committed to support health-oriented nutrition research. Research in functional food science has been a continuing recipient of funding from the EU Framework Programmes from 1989 onwards. Support amounted to €2 million under the Second Framework Programme, rising to €60 million under the Sixth Framework Programme. It is a candidate for support under the activity "From Fork to Farm: Food, health and well-being" of the Food, Agriculture, Fisheries and Biotechnology (FAFB) Theme within FP7. The FAFB Theme has been allocated a total budget of €1.935 billion over the lifetime of FP7, which runs from 2007 to 2013. There are two activity areas of relevance:

- 2.2.1 Consumer perception and attitudes towards food, understanding societal trends, cultural aspects of food, determinants of food choice
- 2.2.2 Nutrition, diet-related diseases, nutrigenomics, interaction between nutrition, physiological and psychological functions, food development (dietetic, functional, personalised foods)

Functional Food Science is also a candidate for support from FP7 under the European Research Area networking activity (ERA-NET).

Closing remarks and end of symposium

The overall co-chair, Dr Müller, briefly summarised some key messages from the presentations, concluding:

- Functional foods are a reality
- Functional food science is established and progressing rapidly
- Food manufacturers know how to translate the science into real products
- Regulatory frameworks are in place, but need to be implemented with due regard to practical realities
- There needs to be a better understanding of what motivates consumer choice if messages about healthy food choices are to be communicated in ways that result in changes in nutrition behaviour

In bringing the symposium to a close, the overall chair, Professor Asp, re-stated the view that the EU Regulation now in place provides a platform for the development of foods providing healthier choices for consumers that will further drive the ongoing reformulation of existing food products and the development of innovative products in the interest of consumer health and well-being, as well as in the interest of business opportunities. He proposed that further research is needed to explore diet/health relationships, to identify and validate surrogate markers of effect and, finally, to substantiate the health effects of diets, foods, food products and food components.

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SUPPLEMENT

Codex recommendations on the scientific basis of health claims

Rolf Grossklaus

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Abstract
Background Within the framework of Codex Alimentarius, attempts are being made at international level to establish guidelines for use of nutrition and health claims. An important issue that has to be addressed is the process of scientific substantiating of claims on foods.
Objective To provide an insight into the current step procedure of the proposed draft recommendations on the scientific basis of health claims. These Codex recommendations are intended to facilitate governments' own evaluation of health claims made by the industry.
Methods Review of comments of governments, observers and non-governmental organizations (NGOs) and relevant references to the proposed draft recommendations of the last sessions of the Codex Committee on Nutrition and Food for Special Dietary Uses (CCNFSDU). A literature search was performed using the PubMed database.
Results/Conclusions Several proposed draft recommendations on the scientific substantiation of health claims have been considered and amended by the CCNFSDU in recent years but the work is not yet complete. The current work draws on the work of FUFOSE and PASSCLAIM and also on that of WHO and FDA. Given the important role of Codex in food safety, the draft recommendations emphasize circumstances where additional evaluation of safety or nutritional safety needs to be considered. High quality human intervention studies are the prime evidence needed to substantiate claims but there is recognition that, in some cases, only observational studies may be available. Animal and in vitro studies will also be evaluated as part of the totality of the evidence. It has been suggested that the recommendations should include re-evaluation of claims after a certain time period, or if new evidence calls into question the scientific validity underpinning the claims. Setting out a common approach for the substantiation of health claims is an important step in the use of health claims around the world. There is a need to reflect emerging as well as consensus science. The substantiating evidence should be proportionate to the claim. Further progress in the elaboration of this relevant Codex text is needed to reach consensus.

Keywords Guidance for governments · Scientific substantiation · Health claims · Totality of evidence

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Background

More and more foods bear health claims. There are diverse approaches to regulate the market. No scientific consensus exists on how to substantiate health claims on food. The scepticism of consumers regarding functional foods resides mainly in the veracity of health claims and in the low and often inadequate control of their claimed properties [3, 23, 25]. Many countries throughout the world, including Canada, China, Japan, Korea, Australia and New Zealand, the USA and the European Union are in the process of establishing regulations to control the use of health claims on labels [5, 21, 24, 26, 30, 33, 36,

40]. It is important that health claims should provide truthful and non-misleading information to aid consumers in choosing healthful diets, that they should be supported by a sound and sufficient body of scientific evidence to substantiate the claim and reinforced by specific consumer education.

Why is Codex interested? International standardization is a key issue for a homogenous and legally transparent market, and steps taken by FAO/WHO Codex Alimentarius are important. The international guidelines and standards developed by the Codex Alimentarius Commission (CAC) perform an important advisory role in establishing and developing national regulations and standards and are central to protect the health of consumers and to ensure fair practices in global food trade [27, 35]. Therefore, during its 22nd session in 2000, the Codex Committee on Nutrition and Foods for Special Dietary Uses (CCNFSDU) initiated work on the establishment of scientific criteria relevant for the justification of health claims at the request of the Codex Committee on Food Labelling (CCFL) [25]. Meanwhile, the revised guidelines for use of nutrition and health claims, prepared by the CCFL, were adopted by the Codex Alimentarius Commission (CAC) during its 27th session in 2004. The CAC has considered three types of health claims: "nutrient function claims", "other function claims" and "reduction of disease risk claims" [10].

In the last few years, several proposed draft recommendations on the scientific basis of health claims have been considered and amended by the CCNFSDU, but this work has not yet been finalized [7, 8, 11–13]. The Committee agreed that the proposed draft recommendations, when finalized would be included, as an Annex in the guidelines for use of nutrition and health claims.

Objective

The purpose of this paper will be to provide an insight into the current step procedure of the proposed draft recommendations. It will also discuss the comments at step 4 for further consideration at the next session.

Methods

Review of comments of governments, observers and non-governmental organizations (NGOs) and relevant references to the proposed draft developed at the last sessions of the CCNFSDU. A literature search was performed using the PubMed database.

Results and discussion

Proposed draft annex to the Codex guidelines for use of nutrition and health claims: recommendations on the scientific basis of health claims

Scope

It should be pointed out that these recommendations are intended to help governments evaluate the health claims used by industry. They address the nature and the quality of the scientific evidence supporting these claims. They are not intended for the complete evaluation of the safety and the quality of a food, for which relevant provisions are laid out by other Codex standards and guidelines or general rules of existing national legislations.

Whether a health claim should be granted pre-market approval or how responsibilities are shared between competent authorities and industry in the provision and updating of scientific evidence are issues that are beyond the scope of this paper. Generally, the procedural and organizational issues should be left for the competent national authorities to decide upon.

The objective of the proposed draft recommendations on the scientific basis of health claims is to give guidance for the assessment of the scientific evidence used in support of health claims. By establishing common criteria for such assessment, these recommendations will lead to harmonization of the requirements for scientific substantiation of claims around the world [22].

Safety as a prerequisite for all foods [2] is addressed by existing Codex standards or guidelines and by national legislations. Therefore, the sole task of the proposed draft recommendations was to define criteria for the scientific substantiation of claims, and only the safety issues directly related to the claims required specific consideration [7]. As regards the strength of evidence to justify health claims, these recommendations should focus on procedures for the review of scientific evidence for substantiation of health claims [9]. It was proposed to delete the definition section as the guidelines for use of nutrition and health claims [10] did not refer to properties in the definition of health claims and this would ensure consistency of the Annex with the guidelines. The phrase "food or food constituent" should be used throughout the text [13].

Specific safety concerns

- When a claim is made about a food or food constituent, the amount recommended should not expose the consumer to health risks and the known interactions between the constituent and other constituents should be considered.

- The expected level of consumption should not exceed relevant upper levels of intake for food constituents.
- The exposure assessment should be based on an evaluation of the distribution of usual total daily intakes for the general population [16] and, where relevant, those for vulnerable populations groups.
- It should account for the possibility of cumulative intake from all dietary sources, and of nutritional imbalance due to changes in dietary patterns in response to consumers' information laying emphasis on the food or food constituent.

Consideration of safety concerns is separate from consideration of the totality of evidence to substantiate a health claim. Governments should favour a risk analysis approach that can determine whether safety considerations might restrict the range of foods that are eligible to carry the claim. It is not necessary to detail the safety considerations in this Annex, as jurisdictions would apply their own approach to risk analysis [8, 12].

Evaluation of the scientific evidence used to support a health claim

Nature, quality, and scope of the evidence

Regarding nature, quality, and scope of the evidence, CCNFSDU proposes that the following criteria should be applied in identifying, categorizing, and evaluating relevant studies:

- The scientific studies should provide adequate characterization of the relationship between the food or food constituent and the health effect. Relevant studies include those that use appropriate measurements for the food or food constituent and health endpoint, those that do not have significant study design flaws, and those that are applicable to the population targeted by a health claim.
- The totality of the evidence should be reviewed, including evidence to support the claimed effect, evidence that contradicts the claimed effect, and evidence that is ambiguous or unclear.
- Health claims should primarily be based on evidence provided by well-designed human intervention (clinical) studies. A well-designed randomized, placebo-controlled clinical trial may demonstrate a causal relationship between a food or food constituent and a health endpoint.
- Observational studies should provide information about an association, but not causation.
- Animal model studies and in vitro studies may be provided as supporting the knowledge base for the food or food constituent—health effect relationship, but they should not be considered sufficient per se to substantiate any type of health claim.
- The methodological quality of each type of study should be assessed, including study design and statistical analysis. For example, human intervention studies should include an appropriate control group; they should describe the background diets of the study groups and other relevant aspects of their lifestyles; they should be of an adequate duration, and they should assess the influence of the food matrix and total dietary context on the health effect. Statistical analysis of the data should be conducted with methods recognized by the scientific community as being appropriate for such studies, and with the proper interpretation of the concept of "statistical significance".

The CCNFSDU [7] was not able to discuss the relevance of the PASSCLAIM criteria for the scientific substantiation of health claims [2, 5] in detail. It was suggested that sufficient time be allowed for discussion of this agenda item at the next session.

Some Members have suggested a basic scheme as broadly applicable. It is made up of three steps:

(1) Define a physiological or behavioural endpoint (biomarker); (2) define an enhanced component of the diet and (3) monitor the relation between the two. Some delegates consider that the definition of all three types of health claims could accommodate well-established biomarker endpoints as the health effect. They support text such as that provided by the United States in relation to biomarkers:

> Biomarkers might be used as an indicator or predictor of a disease or health-related condition or as an indicator of a body function. A relevant biomarker would be a well-defined and validated biological, physiological, clinical or epidemiological indicator for which there is agreement among the qualified scientific community on the relationship between the biomarker and the disease.

This concept was also suggested by the EU Concerted Action on Functional Food Science in Europe (FUFOSE) [6, 14]. However, it is only justifiable when based on appropriate, validated markers of exposure, enhanced function or reduction of risk of disease. Currently, the numbers of biomarkers that fulfil these criteria are relatively small and potentially limiting [29, 37]. Then again, there was no final decision to consider whether this approach should be used as the main basis of the recommendations [8, 9].

Evaluation of the total body of relevant evidence

In evaluating the strength of the evidence, CCNFSDU is of the opinion that consideration should be given to the type,

quantity and quality of relevant human studies, and to the consistency and reproducibility of their results.

For example:

- Evidence based on human intervention (clinical) studies should demonstrate a consistent association between the food or food constituent and the health effect, with little or no evidence to the contrary.

Based on this evaluation, a government can determine if and under what circumstances a claimed health relationship is substantiated, and how the claim can be communicated in truthful, accurate and non-misleading language.

In one delegate's opinion, the sources and nature of the evidence may be different, but the scientific standard for the process of substantiation of all health claims should be the same. The substantiation of health claims should be carried out on a case-by-case basis and the degree of substantiation and the sources and nature of the supporting evidence should be proportionate to the type of health claim and take into account the totality of the available evidence and the weighing of the evidence.

Human studies are accorded greater weight than animal or in vitro studies, and human intervention studies have greater weight than observational studies. However, it is important to include text which states that the substantiation of a health claim can be demonstrated on a case-by-case basis by a number of different sources of evidence and types of studies and designs, and that methodological soundness overrides any hierarchy of studies, given that scientific validity depends not only on the appropriateness of study type but also on the quality of its design, execution and analysis [8]. Scientific bodies or independent expert bodies are likely to assess the totality of available data and weight of evidence, as shown in Table 1.

However, these factors should be not used as strict rules. For example, the absence of a dose–response relationship does not prove that an association is not causal; in some situations, a threshold effect exists and no dose–response relationship would be expected [25].

Table 1 Factors likely to be taken into account for the assessment of the totality of available data and weight of evidence (Adapted from Aggett et al. [2])

- Persuasiveness of each relevant study
- Consistency of results across different studies
- Consistency among various populations and within them
- Magnitude of the effect
- Strength of the association
- Dose–response relationship
- Temporal relationship
- Biological plausibility
- Specificity of the effect
- Statistical validity

Some delegations support the articulation of a specific standard/strength/grade of evidence in these recommendations rather than requiring jurisdictions to make their own determination [29]. Such an approach would contribute to a similar global standard of supporting evidence for health claims appearing on foods traded internationally. The WHO Technical Report on Diet, Nutrition and the Prevention of Chronic Diseases provided criteria to describe the strength of scientific evidence. They were based on the criteria used by the World Cancer Research Fund, but have been modified by the Expert Consultation to include the results of controlled trials where relevant and available. There are four grades of evidence: 'convincing', 'probable', 'possible' and 'insufficient'. These definitions have been specified for observational/epidemiological studies, although they need to be developed to cover the interpretation of other human studies and areas of supporting evidence, including animal and in vitro studies.

Determining the weight of the evidence as a whole requires an assessment of the persuasiveness of each relevant study [31]. The overall assessment, however, should be the application of the scientific judgement and critical interpretation of the data as a whole (totality of evidence). The WHO framework provides a good starting point from which to forge consensus on an agreed strength of evidence [38, 39]. Some delegations and observers therefore support the idea of establishing the standard of evidence at the level of 'convincing' [8]. In their view, a 'convincing' standard of evidence (or significant scientific agreement) is needed to offer reasonable certainty that any health claim is unlikely to be contradicted in the future by new evidence [7, 17]. The Committee discussed that the WHO definition of a 'convincing strength of evidence' should be amended[1] to allow for the possibility of the totality of evidence comprising observational evidence only, as this could be particularly relevant for the relationship between health and a particular diet/food group. In addition, some observers expressed their support for a system of grading of evidence (published or not, peer-reviewed or not) reflecting the strength of the evidence, the degree of certainty, or the balance of probabilities that there is sufficient evidence supporting a claim between a food or food constituent and

[1] The following language was suggested: "Convincing evidence – There are consistent associations between the diet, food or food constituent and the health effect, with little or no evidence to the contrary. There should be a substantial number of human studies of acceptable quality, preferably including both observational and experimental studies and preferably conducted in different population groups. Any intake response relationships should be supportive of a causal relationship and the relationship should be biologically plausible. Supporting evidence sources should be consistent with the findings of human evidence" [7].

a health benefit and that the claim is truthful, accurate and not misleading.

There is also a need to define the term 'significant scientific agreement' and 'generally accepted scientific data' as used by governments in new laws in such a way as to take account of emerging science in addition to well-established consensus science [25].

"Significant scientific agreement" exists when the validity of the relationship is not likely to be reversed by new and evolving science, although the exact nature of the relationship may need to be refined over time. Furthermore, although significant scientific consensus or agreement is not consensus in the sense of unanimity, it represents considerably more than an initial body of emerging evidence. Because each situation may differ with the nature of the claimed food or food constituent/disease relationship, it is necessary to consider both the extent of agreement and the nature of the disagreement on a case-by-case basis. If scientific agreement were to be assessed under arbitrary quantitative or rigidly defined criteria, the resulting inflexibility could cause some valid claims to be disallowed where the disagreement, while present, is not persuasive. Significant scientific agreement cannot be reached without a strong, relevant, and consistent body of evidence on which experts in the field may base a conclusion that a food or food constituent/disease relationship exists. There is considerable potential for incorrect conclusions if only preliminary evidence (emerging science) is available for review [17].

A guidance document for the industry, which is to be read in conjunction with the new Regulation (EC) No 1924/2006 of the European Parliament and of the Council of 20 December 2006 on nutrition and health claims made on foods, has been developed by the European Food Safety Authority (EFSA) and its scientific Panel on Dietetic products, Nutrition and Allergies (NDA Panel) [15]. It is in line with the principles laid down in the proposed draft Recommendations, notably on the following key points:

(a) Information on the characteristics of the food, or food constituent for which a health claim is made.
(b) Target population for the intended health claim.
(c) Systematic and comprehensible review of the totality of the data from studies in humans addressing the relationship between the consumption of the food/constituent and the claimed effect (data from studies in animals or model systems may be included only as supporting evidence).
(d) Data from intervention studies in humans should be organised according to a hierarchy of study designs, reflecting the relative strength of evidence which may be obtained from different types of studies.

Table 2 Ranking of the type of research supporting efficacy (in descending order of persuasiveness) (FDA [20])

- Randomized, controlled clinical trial
- Cohort (longitudinal) studies
- Case–control studies
- Cross-sectional studies
- Uncontrolled case series or cohort studies
- Time-series studies
- Ecological (cross-population) studies
- Descriptive epidemiology
- Case reports

The US Food and Drug Administration (FDA) has ranked the persuasiveness of the type of research supporting efficacy, as shown in Table 2.

The FDA accepts all types of data in support of a health claim. But animal and in vitro studies alone would not adequately support a health claim. Human data are required. Among the human studies, the FDA considers "interventional" studies, i.e., randomized, controlled clinical trials, to represent the gold standard. Furthermore, the FDA has never approved a claim based on meta-analysis alone; such analyses are regarded as corroborative but not as alternatives to primary data [20, 36].

The FDA has also developed a draft system of evaluating qualified health claims as guidance for the food industry and for its own bodies [18, 30, 32, 36]. According to the interim procedures, the degree of qualification needed and the level of evidence supporting a health claim will be judged by the following rating system:

- A: significant scientific agreement exists—no qualifications are necessary
- B: the evidence is not conclusive
- C: the evidence is limited and not conclusive
- D: there is little scientific evidence supporting the claim

The types of studies supporting claims will be rated:

- Type 1: randomized controlled intervention trial
- Type 2: prospective observational cohort study
- Type 3: non-randomized intervention trial with concurrent or historical control
- Type 4: cross-sectional study, case study

The strength of the total body of scientific evidence will be rated according to:

- Quantity: the number of studies and number of individuals tested, weighted by study type and quality
- Consistency: similarity of results from high quality studies of design types 1 and 2
- Relevance: magnitude of effect (observed in high quality studies of design types 1 and 2), and

consideration of whether the effect is physiologically meaningful and achievable [19].

This new approach to health claim approval will undoubtedly open the door for many more claims than are currently in use [31]. PASSCLAIM did not consider regulation or classification of claims as well as "qualified" claims[2] [1, 2, 28, 29]. The examples given here can only provide information to member states about how to regulate health claims.

Special cases

Although high quality of scientific evidence should always be maintained, it is the opinion of the Committee that substantiation may take into account specific situations, such as:

- The totality of evidence may only comprise observational evidence.
- 'Nutrient function' claims may be substantiated on the basis of generally accepted authoritative information that has been verified and validated over time.
- One could also use consensus reports or evidence-based dietary guidelines, provided that these reports/guidelines have been prepared by an authoritative body, that they meet high scientific standards; that they are relevant to the claim as well as to the population in question and that they are up-to-date.

Step-by-step process

It is possible to broadly outline a process for the substantiation of health claims by national or supranational competent authorities that takes into account the general principles for substantiation. Such a process would typically include the following steps:

1. Identify the standard of evidence for substantiation and other national policies for health claims.
2. Identify the proposed relationship between the food or food constituent and the health endpoint for a health claim.
3. Identify appropriate measurements for the food or food constituent and the health endpoint.
4. Identify and categorize all the relevant studies.
5. Assess and interpret each relevant study.
6. Evaluate the totality of the evidence across studies and determine if and under what circumstances a claimed relationship is substantiated.

In order to substantiate a 'reduction of disease risk' claim, which offers the highest 'degree of promise' in the Codex guidelines, a rigorous step-by-step evaluation of the available evidence should be required according to the outline given above. Although stringent standards of scientific evidence should always be maintained, substantiation may be achieved through simplified processes for categories of claims with a lower 'degree of promise'. One could also use consensus reports or evidence-based dietary guidelines, provided that these reports/guidelines have been prepared by an authoritative body, that they meet high scientific standards that they are relevant to the claim as well as to the population in question and that they are up-to-date. A systematic approach for the whole process of scientific substantiation of health claims with particular reference to the grading of evidence is demonstrated in Fig. 1.

Established or proposed health effects can be classified as 'convincing' in case of consensus or acceptance by official independent scientific bodies or independent expert bodies. Evidence based on epidemiological studies showing consistent associations between exposure and disease risk reduction, with little or no evidence to the contrary, can also be classified as 'convincing'. The available evidence is based on a substantial number of studies including prospective observational studies and where relevant, randomized controlled trials of sufficient size, duration and quality showing consistent effects. The association should be biologically plausible. The health effects can be classified as 'probable' if the scientific evidence in support of the effect outweighs the evidence against. Possible evidence in this case includes evidence based on epidemiological studies and showing fairly consistent associations between exposure and reduction of risk of disease, but where there are perceived shortcomings in the available evidence or some evidence to the contrary, thus precluding a more definite judgement. Laboratory evidence is usually supportive. Again, the association should be biologically plausible. In case of contradictory or inconsistent results, or data based upon small studies, or in vitro studies only, effects can be classified as 'insufficient' [17, 28, 34]. Overall, the totality and coherence of published and unpublished evidence should be considered. Assessments for substantiation need expert judgement, weighting of the strength of the claim, and intelligent use of the criteria applied on an individual basis with respect both to gaps

[2] In the USA "unqualified" health claims (also referred to as "authorized health claims") must be supported by significant scientific agreement among qualified experts that the claim is supported by the totality of publicly available scientific evidence for a substance/disease relationship. In comparison, "qualified" health claims are supported by scientific evidence, but do not meet the significant scientific agreement standard. As a result, to ensure that they are not false or misleading to consumers, they must be accompanied by a disclaimer or other qualifying language to accurately communicate the level of scientific evidence supporting the claim. Both unqualified and qualified health claims may be used on conventional foods and on dietary supplements [20].

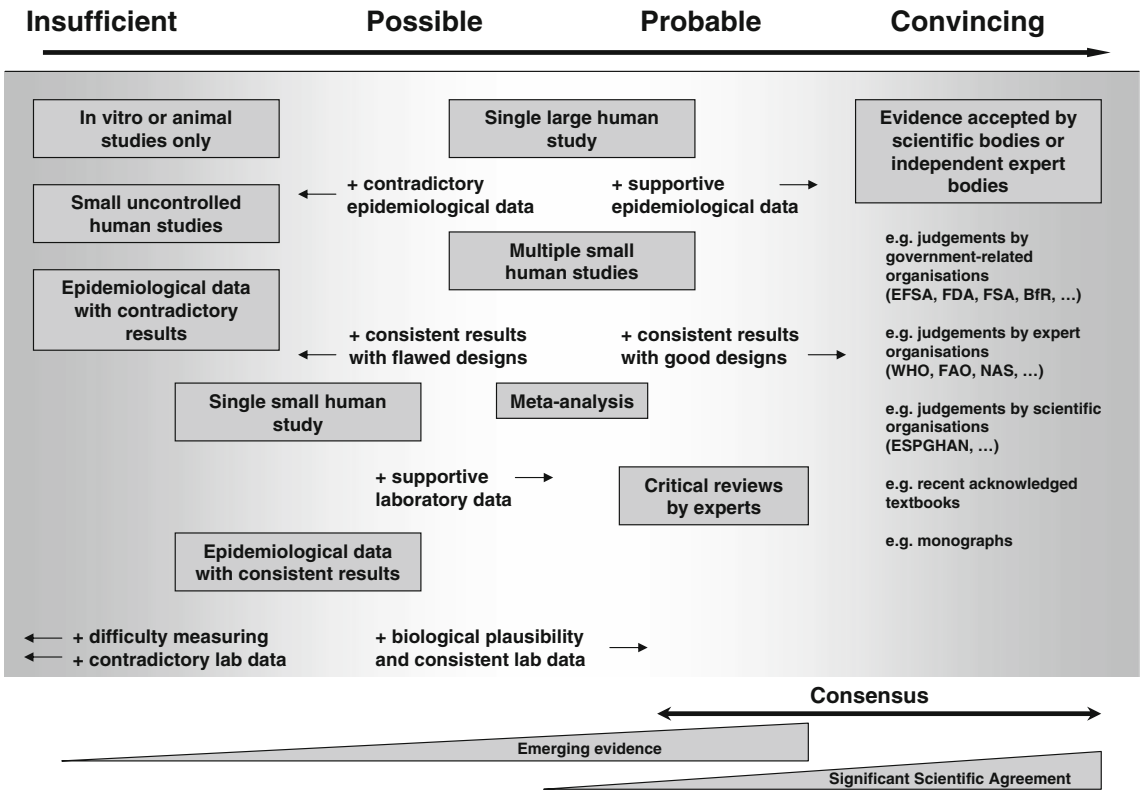

Fig. 1 Systematic approach for the grading of evidence in support of a health claim. Adapted from [17, 28, 34]

in knowledge and to any need for new knowledge and data [1].

Re-evaluation

There is consensus that health claims should be re-evaluated after a certain period of time or following the emergence of significant new evidence that has the potential to alter previous conclusions about the food or food constituent—health relationship. In view of the frequency with which new evidence might emerge, a review may be unnecessary if the new evidence is unlikely to change the claim. Health claims should be re-evaluated if new evidence calls into question the scientific validity underpinning the claim.

Conclusions

These Codex recommendations are intended to assist governments by facilitating their own evaluation of health claims. Setting out a common approach for the substantiation of health claims is an important step in the use of health claims around the world. Health claims need to reflect emerging as well as consensus science. The substantiating evidence should be proportionate to the claim. This paper also highlights issues that are emerging and will require consideration and dialogue in the forthcoming session of CCNFSDU. Further progress in the elaboration of the respective Codex document is needed to reach consensus.

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SUPPLEMENT

The Process for the Assessment of Scientific Support for Claims on Food

Peter J. Aggett

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Abstract The concerted action "The process for the assessment of the scientific support for claims on foods", PASSCLAIM, proposed criteria that could provide an international yardstick for the harmonised transparent assessment of evidence submitted to support a claim for a food or food component. The evidence would be systematically appraised against specific criteria: namely, (1) a characterisation of the food or food component to which the claimed effect is attributed; (2) human data, primarily from intervention studies that represent the target populations for the claim; (3) a dose response relationship; (4) evidence allowing for confounders such as lifestyle, consumption patterns, background diet and food matrix etc.; (5) an appropriate duration for the study; (6) a measure of compliance; (7) adequate statistical power to test the hypothesis. Validated and quality assured markers of intermediate or final outcomes could be used when ideal endpoints are not easily accessible for measurement as long as their relationship to the development of the principal outcome relevant to the claim is well characterised and substantiated. The overall coherence and totality of published and unpublished evidence should be considered in the process. Assessments for substantiation claims need expert judgement, weighting of the strength of the claim, and intelligent use of the criteria applied on an individual basis with respect both to gaps in the knowledge and to any need for new knowledge and data.

Keywords Diet · Claims · Food and health · Markers · Health claims · Biomarkers

The ILSI (Europe) coordinated European concerted action on Functional Food Science in Europe (FUFOSE) which ran between 1995 and 1997 developed a working definition of functional foods and reached a consensus on the scientific evidence needed to demonstrate that such specific foods or food components actually had positive or beneficial affects and physiological functions by enhancing or sustaining systemic biochemical and physiological functions, reducing the risk or delaying the onset of disease, and improving well-being and psychological function, either separately or in any combination of these [1]. It was appreciated that such benefits need to be shown to be genuine. This is the essence of evaluative and evidence based science whether it is in nutrition or in any other discipline exploring the outcomes and responses to intakes of exogenous compounds.

FUFOSE critically assessed the science base required to demonstrate that specific foods or food components positively affect target functions in the body. It did this from a perspective of needing objectively demonstrable functional outcomes, rather than speculative submissions supporting products based on evidence created by extrapolating from generic evidence and weak epidemiological associations, perhaps bolstered by eager advocacy. FUFOSE reached a consensus on how specific functional claims might be explored and justified, and identified areas in health and well-being that might benefit from targeted scientific approaches to the generation and evaluation of functional foods. The concerted action produced the familiar "egg

On behalf of the EU PASSCLAIM concerted action.

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diagram" (Fig. 1) showing a chain of markers of exposure, body burden, intermediate effects and the final beneficial outcome. This emphasised the interrelationship of markers of exposure and effect, their mechanistic connections and their associated dose response relationships. This highlighted the strategic use of a series of valid and quality assured markers to create an objective evidence base for the justification of health claims [3].

A claim has been defined by the Codex Alimentarius in 1979 as "any representation which states or implies that food has certain characteristics relating to its origin, nutritional properties, nature, production, processing, composition, or any other quality" [1, 3]. The current situation relating to the types of claims that may be made is a principal focus of this meeting so I would just comment that at the time when the PASSCLAIM activity was evolving the categories of claims were broadly seen as addressing "what the product contains: for example nutrient content claims (low-fat, fat-free, low sugar, source of fibre, high fibre, high protein, high in vitamins, high in minerals etc.), or what the product does expressed in relation to a well-established end function which would perhaps be the basis of a generic functional claim, or a claim for enhanced function, or a reduction of disease risk.

PASSCLAIM had three basic objectives [1]; these were to

1. evaluate critically existing schemes that assess scientific substantiation of claims
2. produce a generic guidance tool for assessing the scientific support for health claims for foods
3. establish criteria which can be used to explore the links between diet and health.

The Concerted Action drew on and critically evaluated investigative studies that were used to underpin existing claims, and, also, current practice and regulatory and advisory processes for evaluating and approving claims.

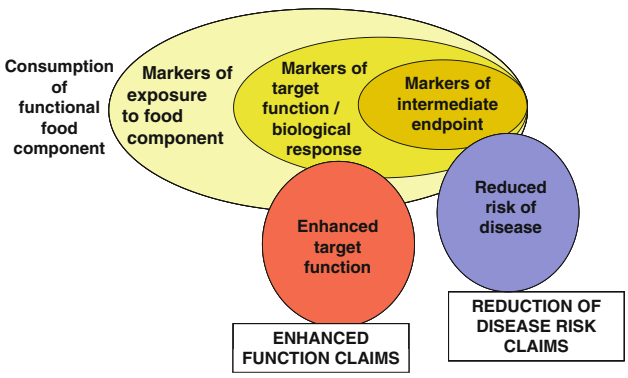

Fig. 1 The FUFOSE strategic scenario of markers for use in the scientific support of claims for foods [3]

The activity collated potential types of claims and described the scientific support needed and evaluated the relevance of this. Drawing on this practice, and on the concepts developed as part of FUFOSE, the activity assessed the use and validation of markers. From this it developed a list of criteria that could be used to evaluate any database being submitted for the substantiation of claims. In the first set of activities three thematic working groups explored actual and potential claims on their evidence base in (1) diet related cardiovascular disease [4], (2) bone health and osteoporosis [5] and (3) physical performance and fitness [9], and a fourth thematic group reviewed existing processes for claims and their review and regulation [8]. The experience and recommendations of these four groups were then applied to derive an interim set of criteria for the evaluative framework. This and the lessons learnt from the first activities were then applied by four further thematic working groups that are considered (1) insulin sensitivity and diabetes mellitus [7], (2) diet related cancer [6], (3) mental state and performance [10] and (4) gastrointestinal function and immunity [2]. After a second plenary meeting a consensus group prepared a final report which was refined after a third plenary meeting [1].

Overall the PASSCLAIM exercise represented an effective precompetitive collaboration involving representative stakeholders involving 45 participants from Universities or Research Institutes, 63 from the Food Industry and 83 from consumer and public interest groups, and regulatory and legislative authorities.

The PASSCLAIM criteria for the scientific substantiation of claims are listed in below [1]:

(1) The food or food component to which the claimed effect is attributed should be characterised.
(2) Substantiation of a claim should be based on human data, primarily from intervention studies, the design of which should include the following considerations:
    (a) Study groups that are representative of the target group
    (b) Appropriate controls
    (c) An adequate duration of exposure and follow-up to demonstrate the intended effects
    (d) Characterisation of the study group's background diet and other relevant aspects of lifestyle
    (e) An amount of the food or food component consistent with its intended pattern of consumption
    (f) The influence of the food matrix and dietary context on the functional effect of the component
    (g) Monitoring of subjects' compliance concerning the intake of the food or food component under test.

(3) When the true endpoint of a claimed benefit cannot be measured directly, studies should use markers.
(4) Markers should be: biologically valid in that they have a known relationship to the final outcome, and have a known the variability within the target population; methodologically valid with respect to their analytical characteristics.
(5) Within the study the target variable should change in a statistically significant way and the change should be biologically meaningful to the target group consistent with the claimed to be supported.
(6) A claim should be scientifically substantiated by taking into account the totality of the available data and by weighing of the evidence.

There are some basic assumptions which provide the context for the application of these criteria. These are; that the foods and food components for which a claim is made should comply with existing legislation (for example those relating to safety); that they would and should be consumed as part of a healthy diet; that the regulatory environment should reflect and accept the evolving science base, and thus be prepared to take into account new scientific developments as appropriate; and that any claim should reflect its scientific basis and be understandable to consumers and not mislead them.

The pathway and markers shown in Fig. 1 summarises the evidence based approach to nutrition and metabolism [3]. It demonstrates that the desirable outcome may be removed both in time and in terms of the physiological and biochemical mechanisms from the consumption of the food component. This, in turn, would necessitate the use of intermediate or surrogate markers as for the potential "outcomes". The identification of these intermediate markers requires an informed insight of the relevant mechanisms and an intelligent selection and evaluation of an appropriate marker from what might be a large number of candidate markers. Therefore, the validation and quality assurance of any selected marker is particularly important if it is going to contribute to the substantiation of the claim and not be misleading both to the investigators and to consumers [1, 3].

The criteria reflect an appreciation that any claim for a food or food ingredient or dietary supplement should be based on evidence derived principally from human studies that represent expected use of the product in the context of a usual diet. Studies in animal models may underpin the mechanistic plausibility and any claimed causal association, as well as informing the identification and validation of intermediate markers for use when ideal endpoints are not accessible. Even so, data from animal models are not substitutes for human based data with clear dose–response relationships with outcome markers that have a proven validity and quality assurance in humans. As such, markers could be used for many biomedical outcomes, including mental and physical performance, and mental health and well-being [1, 10].

The evidence in support of the claim can come from many sources and ideally it should build a portfolio that substantiates an objective and verifiable case. Thus epidemiological or natural surveillance data can be used to demonstrate associations, identify markers, characterise study populations and to generate hypotheses. Data derived from studies on animal models can, as has been said, be supportive in generating hypotheses and associations, and through the exploration of mechanisms, can enable the identification of markers processes and intermediate outcomes. A claim can not be based solely on data from animal studies, or on in vitro or molecular investigations, or on observational or anecdotal information which would be unlikely to be substantiated without any intervention study. However, all this information overall can provide a sound background or platform for the definitive study that would substantiate the claim. Thus although observational human studies would be unlikely to justify a sound claim, their data would help characterise potential participants for the definitive interventional studies and they would also identify possible beneficiaries for the claimed effect, and, additionally provide clues about suitable candidate outcomes and potential surrogate markers.

The portfolio of evidence collectively should provide evidence of consistency of results across the various categories of evidence and methodologies. It should be evident that valid dietary methods have been used to monitor intakes and exposure to the food or food component in question, and that compliance has been good. Clear dose response relationships or threshold exposure for effects, between intakes of food and food components and the effects should be apparent, and in general the data should show biological plausibility. Importantly, given the variance of intake data and of the chosen outcomes it should be evident that the intervention studies have been appropriately randomised and have sufficient power.

All appropriate data should be included in the portfolio of evidence. Selective presentation and inclusion of studies in a portfolio is only acceptable if this is done transparently on the basis of the quality of the data, rather than on the nature of the study outcomes. Essentially, all published studies should be reviewed as part of the portfolio and, ideally, any relevant unpublished data, including those that are being withheld from publication for reasons of confidentiality should also be considered. However, this would be difficult to enforce and would probably remain an ideal rather than a definite requirement for any portfolio of evidence.

The PASSCLAIM criteria were drawn up as a yardstick or a gold standard. The activity consensus deliberately avoided setting up any algorithm or scoring system that might enable a quantitative expression of the strength of the scientific evidence submitted in support of a claim. It was felt that the criteria could serve as a universal standard that would enable international and interagency harmonisation and transparency of approaches to establishing claims. Given the relatively uncompromising standards set by the criteria it is probably best left to competent authorities who can on a case-by-case basis perform a risk–benefit analysis of any portfolio for a claim. Thus the PASSCLAIM consensus has made no recommendation on how a claim based on the evidence should be weighted; i.e. graded as "convincing", "probable", "possible" or insufficient, or graded on a scale from A to D. The flexibility of any system to allow or qualify claims should lie with the competent authorities acting on the advice of its stakeholders as part of a risk–benefit analysis of the claim. The criteria offered by PASSCLAIM provide a basis of scientific integrity. Even though the criteria applied specifically to the assessment of a portfolio of submitted evidence and are not meant to provide a template for a research strategy if any product, it was appreciated and hoped that those who are responsible for compiling and acquiring the scientific support for claims would be able to use the criteria as a guide.

It is envisaged therefore that the advisory and regulatory process for the review of scientific portfolios will need informed scientific advice to support an intelligent interpretation of the evidence and its ambiguities and uncertainties, and to enable a transparent extrapolation, or otherwise, of data to other age and gender groups. Such expert evaluation would be needed to advise on whether or not claims have drawn on the full spectrum of scientific data, whether or not the portfolio shows the best of current knowledge, the totality, consistency and complementarities of existing evidence, and to decide whether or not questions that the submission may leave unanswered need to be answered by additional research, or whether the overall evidence compensates these gaps.

PASSCLAIM did not consider how agencies would pass the assessment into national or supranational decision making processes. Nevertheless the criteria would enable any other stakeholders that might be engaged at this stage to understand the nature of the scientific evaluation of the evidence submitted to support the claim. Thus overall the criteria should facilitate and enhance the efficiency of regulatory review, evaluation and feedback to all involved not least those seeking approval for a claim.

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Conflict of interest statement The author declares no conflict of interest.

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SUPPLEMENT

Scientific substantiation of claims in the USA: focus on functional foods

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Abstract Although functional foods are currently regulated the same as conventional foods by the US Food and Drug Administration (FDA) there is some concern that they should not be. One concern is whether functional foods can/should carry the same type of health and nutrition labeling claims as conventional foods. For example, the type of nutrient content claim that describes a level of the nutrient such as "good or excellent source" presents a problem for functional foods since these claims relate back to a standard value for nutrients (the daily value or DV). At this time the bioactive or functional components in a functional food do not have daily values so they could not take advantage of this type of claim. Structure/function claims are also at issue since they are required to relate to the food's attributes of taste, aroma, and nutritive value, rather than attributes of functionality (which would pertain to functional foods). There appear to be three categories of issues concerning the regulation of functional foods: safety; efficacy; and their effect on the overall diet. Since bioactive components can be synthesized or extracted and concentrated, the concern is that the amounts of these substances in functional foods might reach levels which are actually injurious to health or they may negate beneficial effects of substances in the same food. Most people/organizations consider that functional foods need to document their functionality. This means that unlike conventional foods, all functional foods, by definition, would have to apply for a health claim. Finally, the long term overarching concern is what will be the impact of a functional food-driven market on overall health. It is of interest to see how the regulatory environment for functional foods evolves in the next few years and what impact that environment has on the future of these foods.

Keywords Functional foods · Efficacy/safety · Heath claims · USA

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Introduction

There is no FDA regulatory policy specific to functional foods. Rather they are regulated under the same framework as conventional foods. Whether or not there should be a separate policy for functional foods was the subject of an FDA sponsored public hearing held December 5, 2006 and a request for comments on Conventional Foods Being Marketed as "functional foods" [5]. The FDA Hearing and request for comments was, in part, a response to a number of key reports on functional foods including "Improvements Needed in Overseeing the Safety of Dietary Supplements and 'functional foods'" from the General Accounting Office (GAO) [17]; an Institute for Food Technologists (IFT) report titled "Functional Foods: Opportunities and Challenges" [13]; a report from the Functional Foods Committee of the International Life Sciences Institute (ILSI) [14]; and a citizen petition from the Center for Science in the Public Interest (CSPI) [1].

FDA does not have a formal definition of a functional food, but for the purposes of its public hearing it adopted the definition used in the IFT report, which is "food and food components that provide a health benefit beyond basic

nutrition…" [13]. If a product makes a statement on the food label that is related to health and nutrition, that statement is subject to regulation or enforcement discretion by FDA. One could argue that functional foods, by their very name, are implying a health claim or a structure/function claim and as the GAO report stated, FDA should "ensure that functional foods provide the functions that they claim" [17]. This report will focus on the types of health related statements that might pertain to functional foods; how these statements are evaluated by FDA; and the major issues involved in determining whether functional foods should be considered differently from conventional foods and supplements.

Types of health related statements that might pertain to functional foods

There are generally four types of claims related to health and nutrition in labeling including dietary guidance; nutrient content claims; structure/function claims, and health claims [8]. Each type of claim will be discussed below together with its potential relationship to functional foods.

Dietary Guidance [2] Dietary Guidance statements cannot contain information linking a food or substance to a disease or health related condition (those are Health Claims). Instead, dietary guidance statements focus on general patterns of food intake to promote health. They most often refer to a category of foods such as fruits and vegetables. They can be made without FDA review or authorization. It is difficult to conceive of a functional food making a dietary guidance statement.

Nutrient content claims [3] A nutrient content claim may describe the level of a nutrient or dietary substance. If a claim describes the level of a nutrient as being high or low or a "good source" then it needs to conform to the criteria for that specific nutrient content claim. Most nutrient content claims are compared to a standard for that nutrient (the daily value or DV). For example, the DV for dietary fiber is 25 g/day and a good source is considered 10% of that value (2.5 g) whereas an excellent source is 20% of that value (5 g/day). Of interest, and the subject of considerable controversy, is that there are no daily values for foods or functional components in foods. This means, for example, that there is no daily value for "whole grain." Although a food label can state the amount of whole grain in a product it cannot indicate that it is a good or excellent source of whole grain. The same would hold true for the bioactive components of functional foods (except for traditional nutrients) in part because there is no DV for these substances. Thus nutrients in conventional foods but not bioactive compounds in functional foods may make these types of nutrient content claims in which values are compared to a standard.

Structure/function claims [7] These claims describe the role of substances that affect the normal structure or function in humans. The example that is frequently provided is "calcium builds strong bones." Conventional foods and functional foods may not be viewed the same way with respect to structure/function claims. For example, for a food to bear a structure/function claim or a health claim the claim is required to be related to the food's attributes of taste, aroma, and nutritive value. If the claim is not based on the product's "food" attributes it may be classified as a drug. Although "nutritive value" has been rather broadly interpreted by FDA, the IFT report argues that this approach is too restrictive and does not allow for claims based on the food providing a functional or physiological effect [13]. This appears to place a functional food in a hybrid category with some characteristics of food and some characteristics of drugs.

Health claims [4] One outcome of the way that FDA exercises its oversight on health claims is that it allows foods (including dietary supplements) to bear certain science-backed claims about reducing disease risk in their labeling without being regulated as drugs. All health claims must be about reducing the risk of a disease or health-related condition, not treating, mitigating, or curing diseases. If statements are made about treating a disease they are considered drugs, not foods. FDA exercises its oversight on health claims in three ways. (1) FDA issues a regulation for claims which involve significant scientific agreement (SSA). If the strength of the relationship between the substance and decreased risk of a disease reaches the level of significant scientific agreement (SSA), The Nutrition Labeling and Education Act of 1990 (NLEA) [16] provides for the FDA to issue regulations authorizing health claims. Guidance for Industry on the significant scientific agreement standard is available online [11]. (2) FDA prohibits or modifies, by regulation, a health claim that is submitted based on an authoritative statement from a scientific body of the US government or the National Academy of Sciences. See guidance for this at [6]. (3) FDA issues a letter of enforcement discretion for qualified health claims. For information on qualified health claims for which FDA has issued a letter of enforcement discretion, see [10]. The evaluation process is the same for conventional foods and functional foods. Letters of enforcement discretion lay out agency thinking and criteria for health claim evaluation. They are available on the FDA CFSAN website at [10].

How health claims are evaluated by FDA

A new "guidance for Industry titled "evidence-based review system for the scientific evaluation of health claims" has recently been released by FDA [9]. This draft guidance represents the agency's current thinking on the scientific evaluation process for health claims. Although evidence-based reviews differ from each other, they all have certain aspects in common. These include: definition of the question/statement; collection of all relevant studies; evaluation of the type of study (randomized clinical trial versus observational study); evaluation of the quality of the study; and a rating of the strength of the entire body of evidence. The initial question is very important since it sets the criteria for the type of evidence that is pertinent. Typically the question takes the form of "Does substance '*x*' reduce the risk of disease '*y*' in (name the population). To answer that question requires defining the substance, defining the disease, and defining the target population. Relevant studies must test "substance *X*" rather than a mixture. For example, if the question is "Does eating fish reduce the risk of coronary heart disease"? then the appropriate studies would be on fish intake; if the question were "Do omega 3 fatty acids reduce the risk of coronary heart disease"? then the studies considered should deal with intake of omega 3 fatty acids. Relevant studies would concentrate on those done in humans in non-diseased populations. Animal studies, in vitro studies, review articles and meta analyses would be used as background information but not as part of the evidence based review with few exceptions. What constitutes a "non-diseased population" is not entirely clear. For example, in the US, 2/3 of the adult population is overweight or obese. Are overweight or obese individuals considered a healthy non-diseased population? Similarly, many individuals have some degree of insulin resistance; as individuals age, hypertension is more the norm than an example of a "diseased population." If a case can be made, based on the evidence, that a disease progression is part of a continuum and that those individuals to the greater disease progression end of the continuum react to diet in the same way as do those further to the left on the continuum then data from individuals with hypertension or elevated cholesterol or a higher than desirable body mass index may be considered in the evidence-based review with an appropriate explanation.

The type of study design is an important consideration in determining the strength of the evidence, and here the concept is to minimize bias. A randomized clinical trial is rated more highly than a prospective cohort study which in turn is rated more highly than a cross sectional observational study. Also important is the appropriate choice of surrogate markers as substitutes for a disease endpoint. Many studies do not have the disease of interest as the endpoint for the study. Instead surrogate markers of that disease are used. The markers must be accepted by FDA and NIH as markers, and justified. For example, an intervention that decreases the level of LDL cholesterol is considered a surrogate marker for decreasing the risk of CHD. If the diet intervention for the study affects the rest of the diet, then a highly rated study would characterize the rest of the diet. For example, a low fat intervention would have to mean that as fat was decreased something else must be increased. That "something else" would have to be defined. Other quality factors include the type of population in which the study is performed. If that population is very different from the one for which the proposed health claim is made, it would not be highly rated. Studies done in populations with substantial evidence of malnutrition, or very different rates of disease, or differences in genetic backgrounds known to affect outcomes would be "downgraded" accordingly. All excellent intervention studies have a control group that does not receive the intervention, not just measurements on groups before and after an intervention with no control group. It is always possible (and sometimes highly likely) that a factor independent of the intervention could cause the outcome, rather than the intervention. Finally, there should be no key differences between the control and test groups (e.g. more smokers in one group vs. the other; differences in age or gender between groups). The study must be long enough to observe the effect being tested, and the food/substance needs to be characterized. Appropriate statistical methods are important. For example, the use of paired *T* tests for multiple endpoints is not accepted. And, for epidemiological studies it is always necessary to control for the known confounders. The final decision on the strength of the evidence between the food or substance and decreased risk of the disease or health related condition is a combination of the overall quality and quantity of the data. The benefit of the intervention and the consistency of the findings are considered. The end result of using an evidence-based review system is a statement linking a substance to a disease/health-related condition with a ranking as to the scientific evidence behind that statement. It should be a clear and transparent demonstration of which research studies were evaluated to provide the ranking combined with evidence tables showing the rigor of the evaluation. Trained scientists should come to similar conclusions using the same data base.

Major issues involved in determining whether functional foods should be considered differently from conventional foods and supplements

Do functional foods need to have their own category? Currently, functional foods are regulated the same as conventional foods with no different requirements. Some

have argued that there is a need for a separate category for functional foods [13]. The major arguments revolve around issues of safety and efficacy, and the effect of a diet high in functional foods on human health.

Safety A manufacturer who wants to add a new additive to a food must first prove that it is safe and that there is a reasonable certainty of no harm under the substance's intended conditions of use [15]. Typically an "additive" for a conventional food is there for its benefit to the food itself (e.g. to prevent oxidation, to aid in emulsification, etc.). With functional foods the "additive" may be there as a concentrated source of a bioactive component at levels higher than typically found in conventional foods. Thus, even though "functional foods" are being considered as conventional foods, they may differ in this regard and the "intended use" could be different also. At what point might we be concerned about an upper level of a functional component? Generally, we are not concerned about eating too much of a substance from a conventional food, but when substances are extracted and concentrated in functional foods this may become an issue at some level. Some argue that we should not have to concern ourselves with "side effects" of our foods and we might have to consider such effects from functional foods. Therefore functional foods should be regulated differently from traditional foods.

Efficacy The beneficial effects of traditional nutrients in conventional foods have been well described as have their interactions. This is not true for most bioactive compounds in functional foods. It is also not known how high amounts of one bioactive component added to a food may affect other nutrients in that food. Nor is there a good literature base on the bioavailability of most functional food ingredients when these substances are added to different types of foods. If a functional component is synthesized or extracted from a plant, for example, does it produce the same physiological response as if it were endogenous to that food?

Overall effect of functional foods on health Currently, FDA states that it "regulates conventional foods being marketed as 'functional foods' under the same regulatory framework as other conventional foods [2]. Perhaps that statement should be modified to explain that conventional foods are not required to have a health claim, but it appears that it would not be possible to market a food as a "functional food" unless there was a claim concerning its function. In addition to having to satisfy all the criteria of a particular type of claim, a functional food would have to meet the qualifying criteria for a product for amounts of fat, saturated fat and sodium, and perhaps for "positive" nutrients, just as a conventional food with a health claim would have to meet. Unless a conventional food bears a health claim it does not need to meet these qualifying criteria. It would also seem that for a food to be called "functional" it would have to contain a reasonable amount of the functional component, just as a conventional food needs to contain a set amount of the substance that is the subject of the claim. Finally, what effect will an increased emphasis on functional foods have on recommendations and consumption patterns of conventional foods? Will a diet of foods fortified with functional ingredients have the same overall benefits to health as consuming a diet high in fruits, vegetables, lean protein sources, low or non-fat dairy products and whole grains as recommended by the Dietary Guidelines [12]? It will be interesting to see how the future of functional foods plays out from a regulatory viewpoint in the next few years, particularly as the EU establishes their regulatory environment. Most important to evaluate will be the effect of the regulations on research, product innovation, and human health.

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SUPPLEMENT

Safety impact—the risk/benefits of functional foods

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Abstract It is amazing to see how much the approach of the food risk analysis evolved in the recent years. For half a century and the birth of the risk assessment methodology in the food domain, only no appreciable health risk was considered acceptable by the manager. This is the vocabulary used in the case of a voluntary, deliberated human action, as the use of food additives (definition of ADI). In the case of risks not resulting from such an action, as that of the presence of contaminants, the risk assessor allocates provisional tolerable daily, weekly or monthly intake that are the basis for regulation. This vocabulary is in agreement with the objective which consists in approaching closer possible of the zero risk which is the wish of a majority of the consumers. Some years ago, the risk managers insisted to obtain from the assessors as often as possible a quantitative risk evaluation. More recently even, the managers would like to decide on the basis of a balance of risk and benefit acceptable for management purposes. Finally, they hope that general principles and tools will be available for conducting a quantitative risk-benefit analysis for foods and food ingredients. What is possible in the case of functional foods (FF)? Based on the definition of FF proposed in the programme FUFOSE, one has to distinguish between different situations in order to assess the risk: that of a micro-, that of a macro-component or that of a whole food. These situations have been clearly described in the document resulting from FOSIE. The standardized methodology relevant to assess micro-components is not well adapted to the assessment of whole food. Concepts of substantial equivalence and of history of safe use could be useful tools in this case. However, quantitative risk assessment remains a very difficult exercise. If a process for the assessment of health benefit of FF has been proposed as an outcome of the PASSCLAIM action, the quantification of this benefit needs adequate tools. An EFSA scientific colloquium on "Risk-Benefit Analysis of Foods" organized in July 2006 concluded that the risk-benefit analysis should mirror the current risk analysis paradigm and that its assessment should be performed with common scales. Disability adjusted life years (DALYs) or quality adjusted life years (QUALYs) have been proposed as some of these common scales. However, the meeting "concluded that the data available to undertake a quantitative risk-benefit assessment may be too scarce". Because it was considered that it was premature to formulate guidelines on good risk-benefit analysis practice and it is now time to "learning by doing", a reference to the upcoming ILSI Europe project BRAFO was done. All these aspects are discussed, in particular in relation to the specific case of FF.

Keywords Functional foods · Safety · Risk · Benefits

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Introduction

In a special issue of the British Journal of Nutrition [15] untitled "Functional Foods: Scientific and Global Perspectives", M.B. Roberfroid wrote in 2002 "Being foods, functional foods need to be safe according to all criteria

defined in current food regulations. …But that regulation does not concern nutritional properties or physiological effects of these novel foods. It is strictly a safety regulation. The requirement for safety is a prerequisite to any functional food development. Indeed the risk versus benefit concept, that is familiar to pharmacologists developing new drugs, does not apply to functional foods, except, maybe, in very specific conditions for diseases risk reduction when the scientific evidence is particularly strong."

This position with respect to the evaluation of the risks/benefits ratio of functional foods (FF) evolved during the last years to become a more systematic waiting.

In the same way, and since approximately the same amount of time, the vocabulary used for the communication of the result of risk assessment evolved considerably.

We more closely will examine this evolution in a first part of this paper. We will be interested then in the risk assessment in the specific field of functional foods. Finally we will see what can be implemented to evaluate their benefit.

Risk assessment: an evolution in the vocabulary used

It was in September 1955 that a joint FAO/WHO conference was held in Geneva, the main conclusion of which was to recommend to the Directors General of the two agencies that regular meetings be called of a joint committee of FAO/WHO experts to study the toxicological problems raised by the use of additives in foods. The JECFA (Joint FAO/WHO expert committee on food additives) was born. During its second meeting in June 1957, a chapter in the final report was included on "Evaluation of concentrations probably harmless to man". One member of JECFA, present in all these crucial first meetings, the French Pr. R. Truhaut, who believed that one cannot prove absolute non-toxicity, but only a very high degree of innocuousness, talked in terms of an acceptable daily intake for human [16]. For this reason, R. Truhaut was considered as the "Nestor" of the acceptable daily intake (ADI) concept [18]. A definition of ADI was later published by WHO in 1987 [19]: "Acceptable daily intake: an estimate by JECFA of the amount of a food additive expressed on a body weight basis that can be ingested over a lifetime without appreciable health risk (standard man = 60 kg)". From this definition, one can conclude that they are experts of JECFA who decide what is an appreciable health risk and what is acceptable for the consumers.

R. Truhaut was also instrumental in the application of the ADI concept to the specific case of pesticides in the first meetings of the Joint FAO/WHO experts committee on pesticide residues (JMPR, inaugural meeting in 1963). This concept applies thus to substances (food additives, pesticides) deliberately used and authorized by regulation. It is the reason why in the JECFA glossary of terms (IPCS Risk Assessment Terminology, http://www.who.int/entity/ipcs/food/jecfa/glossary.pdf), the ADI definition became "An estimate of the amount of a substance in food or drinking water, expressed on a body-weight basis, that can ingested daily over a lifetime without appreciable risk (standard human = 60 kg). The ADI is listed in units of mg per kg of body weight."

A comparable toxicological approach was then adopted by JECFA in the case of contaminants present in food, but the vocabulary could not obviously be the same one as for authorized substances. Thus, JECFA proposed in the case of contaminants with no cumulative properties to fix "provisional maximum tolerable daily intake" (PMTDI). In 1972 at its 16th meeting JECFA proposed to fix, for cumulative heavy metals (Hg, Pb, Cd) "provisionally tolerable weekly intakes" (PTWI). For contaminants with very long half-life in the human body, a "provisional tolerable monthly intake" (PTMI) could be allocated.

Also in the case of contaminants, it is clear that for JECFA they are experts who decide of what is tolerable.

In 1978 and 1980, the US Food safety council published a draft then a final report untitled "Proposed system for safety assessment" [11, 17] in which it is very interesting to read: "the word safe is here interpreted to mean presenting socially acceptable risk under expected conditions of consumption" and "the word accept may or may not include some form of restricted use rather than unlimited consumption". One can find in the report a comment on the "Choice of Societal Risk Level":

- We have attempted to give procedures which separate statistical and biological judgement from societal judgement;
- A major element in this judgement will be the choice of an allowable level of risk, P_0. The choice of $P_0 = 10^{-6}$ for potential cancer risks (one extra cancer from a particular chemical per one million persons exposed over a 70-year lifetime) by the Commissioner of the FDA was made after much discussion;
- It nevertheless seems to us that its value should not be fixed in advance for all agents and that its choice must depend on the value to society of the agent involved;
- It is incumbent upon those using the decision tree to do the necessary risk-benefit analysis by setting upon a value of P_0 and…"

Thus, for the US Food Safety Council, it is the Commissioner of FDA (a risk manager) who decides of the societal allowable level of risk, taking into account in particular the result of a risk-benefit analysis. It is, however, difficult to quantify the level of risk for human

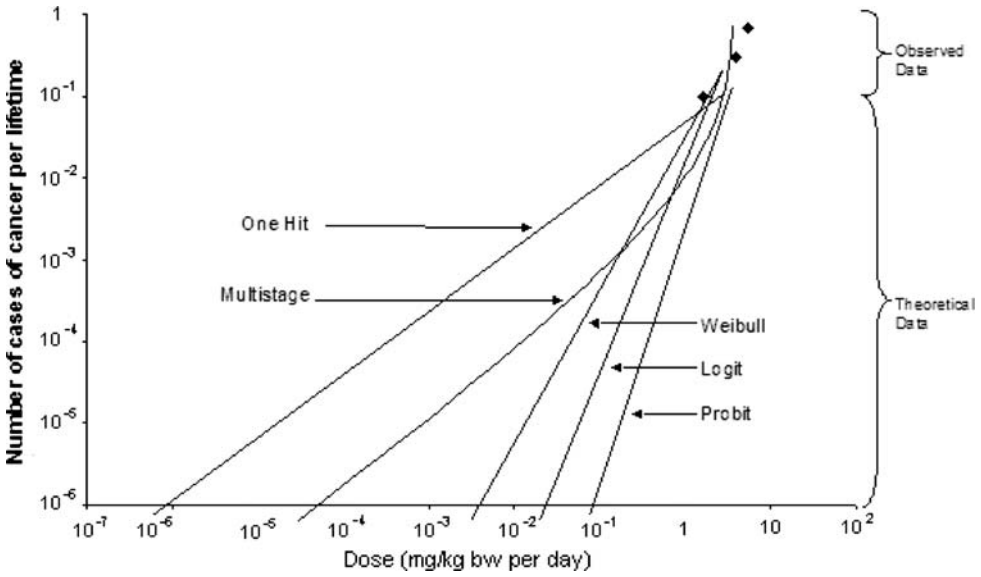

Fig. 1 Low dose extrapolation from animal carcinogenicity data using various models. Figure reproduced and modified from the Guidance on a strategy for the risk assessment of chemical carcinogens of the UK Committee on Carcinogenicity of chemicals in food, consumer products and the environment. Adapted from [3]

consumers by extrapolation from animal experiment taking into account the levels of exposure, the result depending on the model used for extrapolation. A good example (Fig. 1) was published by the UK-COC in 2004 [3].

Even if the question of carcinogenic effects of FF does not arise, the example of risk assessment and management of substances which are both genotoxic and carcinogenic is interesting because it shows how the scientific approach and the vocabulary used evolved during the last years. Because of the above mentioned difficulties, unlike the previous American quantitative approach, the approach was appreciably different in the majority of the European countries. In an opinion from the EFSA Scientific Committee [7] on "A harmonized approach for the risk assessment" the committee said "In many countries and especially in the EU, the advice given by the risk assessor has been to reduce the exposure to such substances to a level that is as low as reasonably achievable. However, it is recognized that such advice does not provide risk manager with a basis for setting priorities for action". Therefore, the Scientific Committee recommends using an approach known as the margin of exposure (MOE). It recommends the use of the benchmark dose (BMD) to obtain the MOE. The benchmark dose is a standardised reference point derived from the animal data by mathematical modelling within the observed range of experimental data. It uses all of the information obtained over the range of doses from the experiment. The Scientific Committee recommends the use of the BMDL10 (benchmark dose lower confidence limit 10%) which is an estimate of the lowest dose which is 95% certain to cause no more that a 10% cancer incidence in rodents (Fig. 2). The Scientific Committee notes that the benchmark dose approach can also be applied to human data when available.

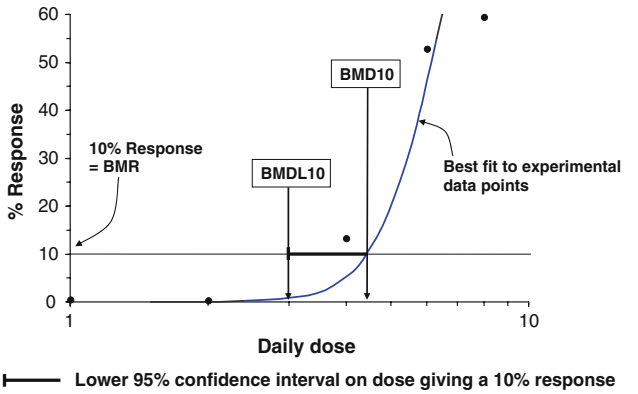

Fig. 2 Hypothetical dose response data illustrating the concepts of BMR, BMD and BMDL for a 10% incidence response above the control

Margins of exposure, calculated for different substances and intake scenarios can vary broadly. A small margin of exposure represents a higher risk than a larger margin of exposure. Consequently, the risk managers can use this information for priorities setting. This approach is now in process of harmonization at the international level.

This is one of the examples which show that experts' committees are more and more aware that their role consists in supplying to the risk managers scientific elements to help them to make management decisions, but that their mission does not consist in deciding on what is or not acceptable by the citizens. Thus, EU scientific steering committee (SSC) concluded in an opinion on "Harmonisation of risk assessment procedures" [10] that attention needs to be given to various approaches for the formal contextualisation of risk, e.g. by:

– comparison with possible replacements,
– risk ranking,
– risk/benefit assessment.

So the vocabulary used to estimate the risks evolved as well as the spirit in which is realized this evaluation. If until the end of the 80s, the experts who are the risk assessors or the civil servants who are the risk managers decided of what is acceptable in terms of health risks, without clear information of the citizens, for many hazards, particularly novel sources, a transparent risk-benefit analysis is now much needed. Assessment of the benefits needs to be carried out with the same rigour and expression of uncertainties as risk assessment [10].

This is a general survey of the evolution of risk assessment, but what is the situation in the case of FF?

The specific case of functional foods

To approach this question, I am going to adopt the working definitions of FF given in the Consensus Document of the concerted European action FUFOSE [5]: "a functional food can be:

– a natural food,
– a food to which a component has been added or has been removed by technological or biotechnological means,
– a food where the nature of one or more components has been modified,
– a food in which the bioavailability of one or more components has been modified,
– or any combination of these possibilities.

Functional foods must remain foods and they must demonstrate their effect in amounts that can normally be expected to be consumed in the diet: they are not pills or capsules, but part of a normal food pattern".

As a consequence of these elements of definition, the safety issues of FF could be summarized to the safety assessment (or the risk assessment) of foods or of food components, in other words:

– of low molecular weight micro-components which could be essential nutrients or not,
– or macro-components (nutrients or not) or whole food.

In the case of micro-components which are not essential nutrients, the classical methodology designed for food additives and contaminants should be applied for their safety assessment, with special attention to the safety factor. A complete survey of the hazard characterisation of chemicals in food was made on the occasion of the European concerted action FOSIE (Food safety in Europe), including a description of the context in which this methodology has to be applied [2].

In the case of micro-components which are essential nutrients (for example vitamins or trace elements) a novel approach has been proposed by an expert group of the ILSI Europe's Addition of Nutrients to Food Task Force, to compare beneficial and adverse effect across intake levels [14]. The model can provide advice for risk managers in a form that will allow the risk of deficiency or the risk of not experiencing the benefit to be weighted against the risk of toxicity. Using this approach, risk managers will be able to define ranges of intake based on a balance between the risk of deficiency (or lack of benefit) and toxicity. This case is representative of FF to which a component has been added.

The risk in the case of macro-components or whole food is more difficult to assess with the traditional approach and is different in many aspects from the one of food additives or contaminants. Dybing. [6] have clearly identified these differences from the report of a JECFA consultation [13]:

Additives/contaminants

- Simple, chemically defined substance
- Low proportion in the diet (usually less than 1%)
- No nutritional impact (with few exceptions)
- Specific route of metabolism, often simple to follow
- Acute effects obvious

Food

- Complex mixture
- High proportion in diet, high intake (often >10%)
- Nutritional impact possible depending on dose
- Complex metabolism with interactions
- Acute effects difficult to produce (usually absent)

The term "Wholesomeness" rather than safety better describes the evaluation of whole food; it encompasses several considerations, including toxicology, nutrition, microbiology and environmental effects. Macronutrients and whole foods present a special case because the quantities that may be ingested by consumers and because nutritional considerations are normally an essential part of safety evaluation. The current performance of the safety assessment of whole foods is mainly based on the protocols for low-molecular-weight chemicals such as pharmaceuticals, industrial chemicals, pesticides, food additives and contaminants. However, these protocols have limitations for testing of whole food. This primarily results from the fact that defined single substances can be dosed to laboratory animals at very large multiples of the expected human exposure, thus giving a large margin of safety. In contrast foodstuffs are bulky, lead to satiation and can only be included in the diet at much lower multiples of expected human intakes. When testing whole foods, the possible

highest concentration of the food in the laboratory animal diet may be limited because of nutritional imbalance of the diet, or by the presence of compounds with a known toxicological profile and the doses that can practically be applied cannot, in general, encompass the required uncertainty factor of 100.

The design of the study should be adapted from the OECD 90-day rodent toxicity study. The precise study design has to take into account the nature of the food and the characteristics of the new trait(s) and their intended role in the food.

Due to the limitation of the current risk assessment approach in the design of animal feeding studies and higher possibility of nutritional impact on overall diet, new strategy and concepts have been proposed in order to overcome these difficulties:

- the core of the present process of safety assessment of whole foods and macro-nutrients is based on a comparative principle, whereby the food being assessed is compared with one that has an accepted level of safety often based on "history of safe use" [4]. This is the concept of "substantial equivalence" [13]. In order to applied the concept of substantial equivalence, chemical and physical data for both the test material and the reference food or ingredient need to be available. However, there is often very limited information, e.g. on natural variation of plant components due to climatic influences or due to plant varieties [6]. Such chemical characterisation have advanced in recent years thanks to considerable progresses in analytical chemistry compared with the methods in use when early novel foods such as single-cell proteins were evaluated in the 1970s;
- in addition to the substantial equivalence concept application, nutritional testing and tolerance studies are necessary to ensure that the nutritional status of consumers is not jeopardised by substitution of existing foods of known nutritional value with new food with less known nutritional or anti-nutritional effects.

How to assess the risk-benefit ratio of functional foods?

Even if Dybing et al. [6] wrote on the occasion of the program FOSIE "But functional foods are notable in that an effect on "function(s)" in human is desired; this implies a degree of specificity (benefits without hazards) not sought for traditional food products", we saw that M. B. Roberfroid anticipated that it would be recommended to take into account the ratio risks/benefits in the case of FF leading to a disease risk reduction.

In line with the SSCs recommendation to take into account this ratio, EFSA organised a colloquium on "Risk-benefit analysis of foods: methods and approaches" in July 2006 [8]. The background was (announcement of this meeting) described as follow "The assessment of risk to human health of food substances or nutrients is usually conducted independently of possible health benefits. Furthermore, different scientific approaches are used to estimate health risks and health benefits of foods, food ingredients and nutrients. When a food or a food substance is associated with both potential health risks and benefits, and particularly when the levels of intake associated with risk and benefit are close, there is a need to define an intake range within the balance of risk and benefit is acceptable for risk management purposes. However, there is currently no agreement on the general principles or approaches for conducting a quantitative risk-benefit analysis for food and food ingredients. One of the main challenges of such an exercise is to define a common scale of measurement for comparing the risks and the benefits".

A "process for the assessment of scientific support for claims on foods" has been proposed as an outcome of the PASSCLAIM European concerted action [1]. This project builds on the principles defined within the previous EU project FUFOSE and delivers criteria to assess the scientific support for claims on foods. PASSCLAIM project focussed on beneficial effects of foods and foods components on health. Safety was not a consideration in the data supporting the scientific validity of claims but was as mentioned, the subject of the programme FOSIE. The discussion of both projects underlined the need to look at risks and benefits associated with a given food product or product modification. However, the quantification of the risks and benefits needs adequate tools.

Amongst conclusions of the EFSA Colloquium, the following possible common scale measures were mentioned:

- Incidences;
- Disability adjusted life years (DALYs);
- Quality adjusted life years (QUALYs). Like DALYs these are quantitative, but are still based on a number of assumptions and are more difficult to quantify than DALYs;
- Days of work lost;
- Cost in money. Requires equal cost structures across countries/world and is difficult to communicate. In practice it requires assumptions about costs of human life loss or about cost of changes in quality of life which are highly controversial.

The concept of QUALYs has been used extensively in medical technology assessment and in health economics to optimise decision making. It has been adopted as a basis for public health policy in a few countries, such as the Netherlands [12].

As a result of the EFSA Colloquium, a project for a Specific Support Action to investigate the Risk-Benefit Analysis for Foods (BRAFO) was elaborated and proposed to the FP6. It was accepted in 2007; one of its objectives is to test the developed methodologies including QUALY and DAILY-like methodologies, on selected case studies (folic acid, oily fish, fat replacement agents and heat processing of foods).

Conclusions

We limited ourselves in this review to the case of FF which meet the working definition proposed in the consensus document resulting from the project FUFOSE: FF are foods.

The case of food supplements and plant and herbal extracts is more controversial. The toxicological risk is indeed bigger with products for which there is no physical limitation in the exposure. With a food, there is a maximal quantity of its constituent, which a consumer can ingest because of the physical bulking effect of the food matrix. Such a limitation does not exist with supplements or herbals and the risk of an excessive exposure is then bigger. In addition, the bioavailability of the components of these products is higher than that of the same components inside a food matrix, leading to higher toxico-kinetics parameters.

Furthermore, if the concepts of substantial equivalence and of history of safe use can often apply to FF, in reference to food consumed in countries having an epidemiological surveillance system capable of discovering the deleterious effects of certain food, the concept of history of safe use can apply much more with difficulty for products coming from countries in which the epidemiological data are non-existent or non-credible. An ancestral consumption is not a sufficient assurance of safety!

On the basis of our definition of FF, the evaluation of their safety is relatively easy and can be decomposed into various situations:

- FF differs from a current food because it contains a substance added in relatively limited quantity. It is "substantially equivalent" to the normal food with the exception of this substance:
- If this substance is present in other current foods or present in bigger quantity than in the same current food, it is advisable to make sure that on the basis of the toxicological knowledge, a sufficient safety factor exists;
- If this substance does not exist naturally in current foods, it must be evaluated as any substance intentionally added to food or resulting from authorized treatments (vitamins, minerals, trace elements, food additives, pesticide residues…). FF becomes then a Novel Food and recommendations were proposed for its evaluation [9][1];
- FF is not "substantially equivalent" to a normal food because its composition is different from any food usually consumed with a new or intentionally modified primary molecular structure; it is a Novel Food and we are returned to the previous case.

They are the most delicate cases, because as it was underlined, there is no totally satisfying protocol to evaluate the safety of a food.

In every case, it is recommended when possible, to realize a quantitative risk evaluation or at least to place the risk on a scale which allows the risk manager to compare it to the others food.

In the case of FF, this recommendation is going to be difficult to implement because of the already evoked difficulties of the risk evaluation. A post marketing monitoring (PMM), which cannot be considered as an element of risk evaluation a priori, can, however, consolidate the premarketing risk assessment.

The research for a common scale of measurement of risks and benefits allowing estimating a ratio risks/benefits, can then appear as illusive. It is advisable to wait for the results of the program BRAFO, to know if the wishes of the risk managers can be satisfied. Science cannot always satisfy the managers (and the consumers) wishes!

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[1] Part I: Recommendations concerning the scientific aspects of information necessary to support applications for placing on the market of novel foods and novel food ingredients (Opinion expressed on 7 June 1996).

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Conflict of interest statement The author declares no conflict of interest.

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SUPPLEMENT

Consumer understanding and nutritional communication: key issues in the context of the new EU legislation

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Abstract
Background Nutrition communication by means of nutrition and health claims and otherwise, holds the potential to contribute to public health by stimulating informed healthier food choices and enhanced health-focussed competition in the market place, provided that the health messages are trustworthy (i.e. scientifically substantiated) and correctly used and interpreted by the consumer. Not surprisingly, these two considerations constitute the cornerstone of the new EU legislation on nutrition and health claims, in which evidence for consumer understanding of nutrition and health claims is a new requirement.
Aim of the study To review some of the key issues in consumer understanding of nutritional communication as a basis for reflection on the consumer understanding element of the new EU legislation on nutrition and health claims.
Conclusions There is a need for more methodologically advanced research in consumer understanding of nutrition and health claims as a basis for truly assessing the real-life use of such information and its actual effect on consumer food choices. Such approaches are pertinent in light of the evaluation and approval process of (new) nutrition and health claims as required under the new EU legislation on nutrition and health claims.

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Keywords Consumer understanding · Nutrition and health claims · EU legislation · Nutrition communication

Introduction

Nutritional communication, including the sharing with consumers of information on the nutritional properties and associated health effects of food products [28] has become a very relevant issue in today's food markets where foods are increasingly being positioned and marketed on the basis of their (positive) contribution to a healthy diet and a healthy lifestyle [1, 21]. Nutritional communication is an important tool for reducing the information asymmetry between the consumer and other stakeholders such as food companies, NGOs and governments [26]. Such information asymmetry exists because knowledge on nutritional content and potential health effects of food products resides in the expert domain of nutritional sciences and cannot be directly perceived nor verified by the individual consumer. Rather this so-called credence quality [4] of the food needs to be communicated to make it accessible as an information cue in the consumer's search and selection process of food products [5]. Without such communication much of the nutrition and health information would remain hidden to the consumer and hence have no impact on actual informed choices.

Effective communication draws heavily on the extent to which message(s) are adequately understood by the receiver. This also holds for nutritional communication. However, a large number of factors combine to determine the extent to which the consumer decodes the message as was intended by the sender. As a consequence the meaning that the receiver extracts may easily go beyond the literal meaning of the message and even the intended meaning.

In the context of nutritional communication three factors that affect effective communication deserve specific attention.

1. Specific nutritional knowledge is often lacking with consumers. Much of the nutritional information is based on specialist knowledge residing in the area of nutritional sciences. Effective decoding and adequate understanding of nutritional information requires a certain level of nutritional knowledge on the part of the consumer. Without such background knowledge there is a danger that any (more detailed) communication will not reach the target audience or may be misinterpreted. Interpreting nutritional information in relation to health requires knowledge on the products attributes and its benefit [28]. Knowledge on nutrients is at best superficial, with the concept of calories being relatively well understood but much less so for other nutrients [11]. This limited knowledge favours simple and straightforward nutritional messages as more detailed (and probably more scientifically correct) information may be less meaningful to consumers and further increase the chances of misinterpretation.
2. Many food choice decisions are examples of low involvement decisions with limited time and effort spent on information processing. Whereas knowledge determines the consumer's *ability* to process nutritional communication, much of the research shows that *motivation* to process information may also be a limiting factor in the case of food products. Many food choices are of a low involvement nature and characterised by very limited effort invested into information processing. For low involvement decisions, i.e. those that do not typically involve high levels of perceived personal relevance and risk of wrong decisions, consumers have a tendency to revert to peripheral or heuristic processing rather than more central detailed processing [18]. The implication is that consumers tend to base their choice on superficial, simple to interpret cues rather than the more detailed information.
3. Consumers are active processors of information not passive receivers. The decoding process of nutritional information is far from a linear process. Rather, the information is actively processed by consumers in constant interaction with other external information (e.g. brand name, packaging, endorsement etc.) and with internal knowledge representations already present in memory. As a consequence external information (such as nutritional) may be "enriched" as a consequence of (spontaneous) associations that are co-activated in the brain (so called spreading activation). This process of "filling in" the information from (in-) accurate inferences may again add to the probability of nutritional information being misinterpreted well beyond its factual and even intended meaning (see also [15]).

It is against this background that consumer understanding of nutritional information needs to be understood. On the one hand it is necessary that the information is cognitively processed by consumer at least to some degree. But on the other hand it should not be "over-processed" in the sense that consumers build associations that would not be justified by the literal or intended meaning of the nutritional information/claim.

More recently, the issue of consumer understanding of nutritional information has received considerable policy interest. It takes a prominent position in the New EU Regulation on Nutrition and Health claims [7], adopted in January 2007, where it is defined as a prerequisite in the claim approval process, next to scientific substantiation of the claimed benefit. From a consumer protection point of view, this is an important milestone in nutrition and health communication at the European level. But at the same time, it raises the issue of what adequate consumer understanding constitutes and how it should be operationalised.

The aim of this paper is to provide a succinct overview of the state of the art in consumer understanding of nutrition and health information in the context of the new EU Regulation. The paper will be based on a number of recent studies and reviews both in the areas of nutritional labelling [3, 11, 24], nutrition and health claims [25, 30] and consumers' use of nutritional labels in general [5]. It will focus on four specific issues:

1. the importance of nutrition communication from the perspective of various stakeholders involved,
2. a brief overview of the current knowledge in how consumers process and handle nutritional information
3. the position of consumer understanding in the new EU regulation on nutrition and health claims
4. the implications of the new regulation for consumer understanding research in health claim substantiation

Finally, we discuss some specific research needs in the field of consumer understanding in relation to nutrition and health claims.

The importance of nutrition and health information to different stakeholders

As argued before, nutritional communication aims at reducing information asymmetry on nutritional features and health effects, that consumer cannot verify from personal consumption experience. To form personal beliefs

about health (and other credence qualities), consumers can revert to one of two belief formation processes [9]. They might accept information from others (known as "information belief formation") in which case he/she would either rely on informants (such as relatives, experts, consumer organisations or brand manufacturers) or alternatively rely on nutritional information cues on the pack (such as endorsements, logos etc.). Trust and confidence in the informants and the information they provide is a prerequisite for the informational belief formation process to be effective. A second process often used by consumers is "inferential belief formation" in which case the consumers uses his/her own rules of thumb, often based on subjective knowledge, to infer the level of healthiness of a food product. Cues from which such inferences are made can be diverse to include health claims, colour of the product, brand name, etcetera.

For *consumers*, nutritional information is important as it provides them with an information cue that can guide their decision process. Nutrition information on pack can be a very effective cue, provided that the information is correct, complete and trustworthy. If so, this information is indispensable for consumers' informed choices in which nutritional quality is taken into account. However, in final choice the nutritional information is traded off against other product perceptions (such as taste, price and convenience), implying that the informed choice is not necessarily the healthy choice.

For the *food industry*, nutritional labelling is important too as it provides an opportunity to communicate to consumers that their products are of good nutritional quality. This provides them an opportunity to make visible their corporate social responsibility through the process of "be good and tell it". In addition, given the consumer and public interests in the diet-to-health link, nutritional labelling may provide the food industry with a tool for differentiation and hence to achieve competitive advantage from consumer preferences.

For *policy makers*, reliable nutritional labelling plays a key role in reducing information asymmetry, so as to ensure transparency in the market and enable consumers to execute their right to know. By regulating nutritional information they ensure that consumers can make an informed choice which in turn will hopefully stimulate more healthy diets among consumers. Finally, ensuring a fair system of nutritional labelling regulation will support innovation and stimulate fair competition in the food industry [7].

The objectives of these three stakeholder groups will converge, provided that the health information is justified scientifically and correctly understood and used by the consumer. Not surprisingly, these are also two important pillars underlying the new EU regulation [7]. It takes into about both the coding (scientific justification) and the decoding (consumer understanding) of the nutrition and health claims.

Nutritional information from a consumer information processing point of view

From a consumer point of view, for nutritional information to have an impact on consumer decision making there needs to be some level of processing of the information. Such information processing goes through a series of stages, for which various models have been proposed in the communication and marketing literature (see [15]). These models vary in the number and naming of the different stages. An integration of these models in the context of nutritional information has recently been provided by Grunert and Wills [11] which provides a very useful structuring device for the research on nutritional information (see also [13]). We use a similar structure along the phases of (1) presence and interest, (2) attention and perception and (3) interpretation and understanding.

Presence of nutritional information is of course a necessary prerequisite for information to be processed. Although accidental exposure to such information may in itself already trigger a processing of the information, exposure to information will be enhanced if the consumer has a level of *interest* in it, stimulating the consumer to actively search for exposure. However, exposure itself is not a sufficient condition for information processing as much of the information in the environment is ignored by consumers. The information needs to be *attended* to to be brought into the perceptual system allowing further processing. Once the information is attended to, the consumer will start a process of assigning meaning to the information (*perception*). This elaboration on information will form the basis for *interpretation* and *understanding* of the nutritional information. Based on such subjective (mis-)understanding the consumer may decide to *use* or ignore that information in the decision whether or not to buy the product. When interpreted and understood correctly, the use of the nutritional information will lead to an informed and (hopefully) healthier choice. The whole process, is likely to differ between different consumers types (segments) and as a function of the information content and the format in which it is provided. But neither labelling formats nor individual differences between consumers are the focus of this paper.

A concise review of existing knowledge on consumers and nutritional information

As several excellent recent reviews (e.g. [3, 5, 11, 31]) of consumer science on nutritional information are available,

we will restrict ourselves here to just a brief review of key findings. The reader is encouraged to consult the relevant references for further detail.

Presence and interest

Nutritional information on pack and in advertising is widely available (e.g. [2, 12, 16]), although this may vary considerably between product categories and countries [12, 30]. Back of pack nutrition facts panels appear on many of the packaged foods, although in Europe only mandatory if a nutritional or health claim is being made for the product. Several initiatives are currently ongoing (see [6]) in moving some of the relevant back of pack nutritional information front of pack, such as through GDA (developed by IGD), Traffic Lights (supported by FSA), My Choices logo [8], Green Keyhole [14], other food information programmes [22] and front of pack calorie labelling [24]. Overall, presence of nutritional information seems not a limiting factor in nutritional communication on pack and the problem is probably more one of information abundance rather than information shortage.

A consistent finding in most of the consumer research has been that consumer *interest* in nutritional information is high. This is also evidenced by the fact that health has become the key driver of the world's fastest growing food and beverage categories [3]. Thanks to advancement of the nutritional sciences and public health communication efforts, the diet and health link generates high awareness among consumers and is even increasing. However, many of these studies also reveal that nutritional information is not THE most important information cue to consumers [7]. A cross-culturally consistent finding is that taste, price, naturalness and absences of pesticides are considered by consumers of greater importance than health information. Interest for nutritional information tends to be higher among women, parents and older consumers and consumers in North/Central Europe tend to be more interested [6, 7].

Attention and perception

Attention and perception has been explored from two different streams of research. Many survey studies [11] reveal that about 40% of consumers typically report to use nutritional information before purchasing. But an important question of course is to what extent survey methodologies provide a reliable insight into attention and perception. Observational studies, not relying on consumers' self-expression of general attitudes and behaviours towards nutritional labelling paint a different picture. They reveal that in store, consumers spend very limited time on food selection and think-aloud protocols (where consumers think aloud on the consideration they make in selecting products in store) find very low levels of search and consideration of nutritional information (e.g. [19]). As a field experiment on a nutritional intervention in store, one study [23] showed that only 50% of consumers had noticed the intervention and only 25% had noticed that the intervention involved nutritional labelling. This finding shows that many consumers simply do not attend to the information provided. Another study conducted by Kellogg's (reported in [11]) using tachistoscopic research in which consumer are very briefly exposed to food packaged with labels showed 3–4% of the respondents noticed the label with a 1 s exposure and 20% noticed the label after 2 s exposure.

There exists a clear need for more research on consumer attention and perception to nutritional information in more market-relevant conditions as attention may be an important bottleneck in the further processing of nutritional information. Such research should have to rely on experimental and behavioural observation methods rather than purely on survey research.

Understanding is the crucial part of consumer information processing of nutritional information. There is no precise and agreed upon definition of what understanding is in the context of nutrition and health information. But clearly, understanding requires a reference base with the consumer from his/her nutritional knowledge. Unfortunately, detailed nutritional knowledge is often lacking with consumers. Consumers seem to have a basic awareness of calories but much less so for other nutrients [11]. Also, they lack the specific knowledge on daily dietary needs for nutrients. As a result of this limited knowledge, consumers get easily confused by detail and scientific wording of the nutritional information [30]. Also, many consumers seem sceptical about commercial health claims [30].

Understanding of nutritional information and health claims is a dynamic process. As consumers are active information processors, rather than passive recipients of the information, the meaning assigned to nutritional information may easily go beyond the literal (or even intended) meaning conveyed in the nutritional claim [15]. This is largely due to the fact that the human memory is organised as an "associative network" of interlinked information items. Much of this information can be accessed spontaneously, with little mental effort, a process known as "spreading activation". In the context of nutritional information this implies that simple nutritional messages (e.g. with extra vitamin C) may automatically trigger other (subjective) knowledge (e.g. helps prevent flu, reduces risk of cancer etc.). Consumer decoding of nutritional messages depends to large extent on whether these subjective inferences are correct or not. Seminal work by Roe et al. [20] has identified four important potential misinterpretation effects in nutrition and health claims. The *positivity* bias

implies that the presence of a claim in itself can already lead to a more positive interpretation of the product carrying the claim, almost irrespective of the content of the claim. In other words, the consumer will infer that because of the fact that the product carries a health claim, it must be a healthy product. But more specific effects may also occur. The *halo* effect implies that the fact that the product is claiming to be good in one specific nutrient (e.g. is low in cholesterol) is taken by the consumer as evidence that the product will likely be good on some other nutrients too (e.g. is also low in total fat), even though such relationship need not exist nor is implied by the claim. The *magic bullet* effect extends this even further in which case the consumer assigns inappropriate health benefits to the product because of the claim. Finally, there may be an *interactive* effect in which case the presence of a health claim may obstruct consumers' further search for other information, such as back of pack. In those cases, the information is taken for granted without being verified or qualified against other available nutritional information.

One consistent finding in this research (e.g. [29, 30]) is that consumers prefer simple and easy to understand information on the front of the pack, with more detail being provided back-of-pack. Although Roe et al. [20] find that front of pack nutritional information truncates search of back of pack information in actual shopping situations, other studies that have taken a more experimental approach show that this is probably mainly due to lack of motivation to search further, rather than inability to do so. These studies (e.g. [10]) suggest that consumers are capable of integrating both streams of information and even to identify inconsistencies between what is communicated front-of-pack and back-of-pack.

In sum, the process of information processing of nutritional information is a multistage process where at each of the steps information may be lost or incorrectly interpreted. As a result, the understanding of the information is problematic from a public health perspective (reducing information asymmetry) and also from a consumer perspective (reliable information cues for informed choices). Consumers see claims as useful information, but are sceptical about commercial claims [30]. They prefer to receive the information in a simple format and wording [24], with more detail available back of pack [29]. They are easily turned off by scientific wording and long claims and they do not seem to differentiate between different types (e.g. content claims vs. health claims) of claims [25, 30]. By and large, this illustrates the dilemma in nutritional communication. The information needs to be scientifically correct which will probably require long and complex wordings, and on the other hand it needs also be understandable to the consumer, which will require very simple messages. This balance between the two conditions is addressed in the new EU regulation on nutrition and health claims to which we turn next.

Consumer understanding in the new EU Regulation on nutrition and health claims

The new EU Regulation on nutrition and health claims [7] adopted early 2007 complements the Directive on general labelling provisions contained in Directive 2000/13/EC on general labelling provisions which prohibits the use of information that would mislead the purchaser or attribute medicinal properties to food. In doing so it makes explicit provisions for the level of consumer understanding which we will summarise in this section before we turn to the implications for consumer understanding research.

As a general principle for all claims (article 3), "the use of nutrition and health claims shall not be false, ambiguous or misleading". But article 5.2. extends this in stating that "the use of nutrition and health claims shall only be permitted if the average consumer can be expected to understand the beneficial effects as expressed in the claim". Health claims (article 13.1) will only be allowed if "they are (1) based on generally accepted scientific data, and (2) well understood by the average consumer". Similarly for reduction of disease risk claims, an initial judgment will come from the Authority that (article 16.3) "shall give advice on whether the proposed wording of the health claim is understandable and meaningful to the average consumer".

The new regulation further defines the target population of the average consumer. It takes as a benchmark (article 15 of preamble) "the average consumer, who is reasonably well- informed and reasonably observant and circumspect, taking into account social, cultural and linguistic factors as interpreted by the Court of Justice". Additionally, this article states that "The average consumer test is not a statistical test. National courts and authorities will have to exercise their own faculty of judgment, having regard to the case-law of the Court of Justice, to determine the typical reaction of the average consumer in a given case."

Consumer understanding is a new element in the regulation, and by January 19 2013 at the latest, the European Commission will submit to the European Parliament and evaluation report on "the evolution of the market in foods in respect of which nutrition or health claims are made and on the consumers' understanding of claims, together with a proposal for amendments if necessary".

In sum, there is quite a bit of attention for the actual consumer understanding of nutrition and health claims in addition to their scientific substantiation. This is an important good, as in the end all sincere stakeholders will benefit from a market in which available health claims are

scientifically correct as well as effectively communicated to consumers. This will ensure transparency, facilitate informed choice and create a level playing field as a basis for fair competition and, given the consumer and public interest for food and health, also further stimulate healthy innovation in the food and drink industry.

One important condition for this situation to arise is an agreed upon definition and measurement approach to what is consumer understanding of nutrition and health claims. The ILSI Consumer Science Task Force has made a first attempt in exploring the implications for consumer research to which we will turn next.

Consumer research approaches to verify consumer understanding

Consumer understanding of nutritional and health claims poses a number of new challenges to the food consumer science community. Leathwood et al. [15] recently reflected on what could be considered adequate evidence for consumer understanding of nutritional information. Taking a consumer processing of nutritional information perspective, they argue that a useful operational definition of consumer understanding would be that from the nutritional information provided "the consumer makes inferences that are justified by the objective content of the claim without significant embellishment of exaggeration". Because in market situations consumers use multiple information cues in addition to the sheer nutritional information, inferences may be influenced by other communication elements in the environment of the claim such as the packaging and/or endorsements, so understanding of the claim needs to be tested in context [15].

Adequate testing of consumer understanding is a complex issue for a number of reasons. A major complication comes from the fact that such testing is to be executed a priori (i.e. before approval and launch). At that point in the innovation process, it is unlikely that the full marketing mix of the product has already been developed. At best, the new health product can only be tested as a prototype or mock up of what the product as marketed would look like. Second, particularly for new health claims it is quite unlikely that a substantial level of consumer understanding will exist before the full communication mix has been developed. Often, health claims can actually play a role in generating awareness on a new diet–health relationship. In that sense, the upfront requirement of consumer understanding could actually work against substantive innovation in the food and beverage industry. Further, although it is do-able to define the target population a priori, it is much more difficult to define the actual user group a priori as also non-target group members may decide to adopt the product. Finally, because consumer understanding is not a well delineated dependent variable and consumers are active information processors, it may always be possible to find an inaccurate inference in any specific study which would formally lead to rejection of the null hypothesis (no inferences that are not justified by the claim). As a consequence, what is needed at this stage is a pragmatic (rather than ideal) approach with an agreed level of consensus among key stakeholders, which is scientifically justifiable as well as do-able for food operators at the early stage of the new product development process.

After reviewing four prominent methodologies of consumer research (qualitative research, quantitative research, experimental research and econometric analyses from panel data) on their strength and weaknesses in relation to the objective of measuring consumer understanding of nutrition and health claims, Leathwood et al. [15] propose a four step approach (1) Identify and define the consumers to be recruited, in terms of the target group of intended consumers, (2) define the food—claim—presentation combination to be tested, in terms of a mock up or detailed concept of the appropriate food and packaging, (3) identify the range of consumer interpretations with the claim, though qualitative research techniques such as in-depth interviews, and (4) quantify the accuracy of consumers' understanding of the claim, through quantitative research on consumer interpretation of the claim in his/her own words (see [15] for more detail).

An important aspect of the methodology is that each of the steps needs to allow for replication and validation. For that reason, at all stages it is crucially important that the test conditions (e.g. characteristics of the target group, sample size, stimulus material, procedure for presenting and testing, etc.) are made explicit and ideally would be agreed upon a priori. Over time, the methodology will have to be further refined both in terms of methodological approach as well as agreed standards of what constitutes an adequate level of evidence. As a first start, the analysis could focus on the percentage of consumers that can outline the beneficial effects of the product with health claim in their own words. This would require a content analysis of spontaneous associations (classified for justified and unjustified spontaneous associations) and probably a statistical analysis of rating scales on which the consumer indicates which benefits are associated with the health product. At this stage there is no scientific evidence for what would be a reasonable benchmark and this will have to be developed over time when experience with the approach is building up.

Conclusion and future research needs

This paper has addressed selected issues in consumer understanding of nutrition and health claims. More detailed

information can be found in several recent reviews in relation to health claims [30], nutritional labelling both back of pack and front of pack [3, 11], as well as on consumer use of nutritional information more generally [5]. In line with a recent WHO analysis [12] most of these reviews conclude that despite progress, there is still a shortage of research on understanding how consumer interpret, understand and use health claims in real life. Developing such better understanding has become more urgent in light of the new EU legislation on nutrition and health claims which incorporates consumer understanding as one of the criteria for approval [7]. Key learnings from the existing literature are that there is widespread self-stated interest in nutritional information, but that knowledge and lifestyle factors limit consumers in using the information in detail. Consumers prefer simple and trustworthy information over scientific detail, although such detail is welcomed on back of pack as a means of potential verification and reassurance. Due to lack of knowledge and motivation misinterpretation and over-generalisation is likely to occur but there exists limited quantitative insight into the degree of misperception.

Regarding front of pack labelling (see [6] for an overview), there is still a debate going on on the preferred format in which this simplified information should be made available to consumers. This topic has not been addressed in this paper as there still is no general consensus reached (see [11]. From a consumer understanding perspective there is an urgent need to solve this discussion, as multiple schemes (with diverging criteria underlying them) are likely to further confuse the consumer. Also, there is a need for pan-European validation of consumer preferences for front-of-pack labelling as much of the current research evidence may be country specific.

Methodologically, the research field of consumer understanding of nutrition and health claims is in strong need for further development, particularly at the interface with public policy. Research in this field almost exclusively depends on self-reported attitudes and behaviours, in terms of "how interested are your in…", "do you usually read or use", "how important is nutritional information in your product choices" etcetera. Although such self reported opinions provide valuable insights into consumers basic attitudes toward nutritional information, they likely suffer from so called social desirability bias as the validity of these measures relies on an unrealistically high level of assumed introspection on the part of the consumer. By explicitly confronting consumers in the response task with the stimulus at hand, existing research often imposes forced exposure and information processing. As in real life situations, consumers are much more distracted and time pressured it is questionable to what extent these findings have external validity for actual food choice situations. There is a strong need for experimental and observational research on consumers' attention and perception processes. Finally, much of the current research evidence comes from qualitative research, often conducted in one country only which may cast doubt on the replicability and generalisability of findings. When the purpose is to understand consumer understanding of nutrition and health claims, there is an urgent need to complement this type of research with behavioural and observational studies both at the supermarket shelf and at the dinner table.

Ultimately, the proof of the pudding is in the eating and this also holds for food products with health claims approved under the new regulation. This should encourage outcome based studies in which from scanner and purchase data the true effect of the nutrition and health label regulation is evaluated in terms of its main objectives: (1) has it increased the share of healthy food choices among consumers, (2) has it stimulated health innovation, and (3) through changes in food choices has it had a significant impact on public health. Each of these questions will hopefully receive due attention when the effects of the new regulation will be reviewed in the year 2013.

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SUPPLEMENT

Emerging technologies and perspectives for nutrition research in European Union 7th Framework Programme

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Abstract Nutrition trends in Europe are driven by taste, health and convenience. The possibilities of research using new technologies and tools such as nutrigenomics, imaging techniques, nanotechnology, bioinformatics, cognitive sciences, innovative processes are very promising to support these nutrition trends and in particular their health aspects. This is supported by European Union research. The opportunities offered in the 7th Framework Programme (FP7), among other innovations, will contribute to the general aim of improving nutrition policy as well as improving products from the food industry in accordance with the Lisbon strategy to create employment and improve the quality of life of the European citizens.

Keywords Functional foods · Framework Programmes · European Commission

Introduction

"Tell me what you eat, and I will tell you what you are" wrote a French gastronome Brillat-Savarin in his 19th century tome of "The physiology of taste". This phrase underlines the importance of nutrition in later life. The latest research on early programming shows that the influence of nutrition starts from an early stage and continues throughout life [6, 7].

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Again according to Brillat-Savarin, "The discovery of a new dish confers more happiness on humanity, than the discovery of a new star". That reminds us that we should not forget that food is more than the product itself. Food is more than buying, preparing and eating food. Food is pleasure. Food is social contact, health and well-being. Consumers, governments and the food industry have started to understand this and recognise the need for action in order to change the current situation i.e. the increase of diet-related diseases in Europe.

Achieving good health for all means, not just reacting to ill-health, but proactively promoting health, preventing diseases and helping people make healthy choices. Good food is the major source of health throughout life.

New challenges for food research

In the last decades, food has become very abundant with a lot of different products in Europe and other parts of the industrialised world. This could be perceived as progress; however, coupled with our increasing sedentary lifestyles, rapid cultural changes, increasing urbanisation and dietary changes, it has generated a huge increase in the morbidity of several chronic diseases, such as obesity, diabetes, and cardiovascular diseases.

In Europe today, six out of the seven most important risk factors for premature death (blood pressure, cholesterol, Body Mass Index, inadequate fruit and vegetable intake, physical inactivity, excessive alcohol consumption) relate to how we eat, drink and move [10]. The basic problem is relatively easy to identify and is a combination of unhealthy diets (too high in fats, sugar and salt) usually coupled with a lack of physical activity [4].

What are the challenges for the future? Why do we have to move from curative to preventive health care? The reason is manifold: the growing and ageing population; the increase of several chronic diseases; the limited resources of raw materials; energy and water and therefore the need to develop a sustainable economy built on bio-based processes. Ageing and obesity are two examples illustrating the necessity to move from the curative to the preventive health care.

Obesity

Obesity is one of the most serious public health problems in Europe as it significantly increases the risk of many chronic diseases such as cardiovascular diseases, type 2 diabetes and certain cancers. The increase of childhood obesity is particularly worrying, as it is also a strong predictor for adult obesity. Knowing that lifestyle factors, including diet, eating habits, levels of physical activity as well as inactivity, are often adopted during the early years of life, the best time to address the problem is during early life and even pregnancy [3].

Ageing

The proportion of elderly people over 65 years in Europe is currently around 25% and this is predicted to increase to 40% by 2030. The paradox is that people want to live longer but without getting old. However, the decline of mental health function, cardiovascular health, digestive health, bone density, immunity and muscle mass is still unavoidable. Therefore, the best way to ensure successful ageing is to prolong the active years. Good nutritional health is essential to maintain good health, prevent functional decline and improve quality of life. The influence of diet on the ageing process such as energy intake, protein glycation and antioxidant intake needs to be further studied. It is clear that new foods could be designed to satisfy the elderly specific nutritional needs (e.g. nutrient-dense, rich in taste, familiar foods, available in convenient, easy-to-open packaging and reasonably priced) [9].

These two examples show that instead of being reactive after the problems have occurred; there is a need to invest more into prevention in the future. Both healthy food and a healthy lifestyle are necessary to improve the quality of life for a longer period.

The evolution of food research

The nutrition science of today has evolved from the classical concept of preventing nutrient deficiency diseases to the concept of optimal nutrition. This latter concept aims at optimising the nutrient intake to promote overall health and well-being, to improve the physical and mental performance and to reduce the risk of diseases such as cancer, obesity, cardiovascular diseases and diabetes. Scientists seek to identify and elucidate the mechanisms of interaction between diet, genes and environment and the synergies between the different components contained in food and their impact on health.

Functional foods offer a great potential for improving health and helping to prevent chronic diseases of the European citizens. Providing scientific evidence that substantiate the health benefits of these products helps to protect the consumers, encourages the innovation of new industrial products by food manufacturers wishing to use health or nutrition claims, and ensures a fair trade. Research collaboration between different disciplines such as nutrition, food technology, cognitive and health sciences provides the scientific basis for successful development of functional foods [8].

New technologies and tools such as nutrigenomics, imaging techniques, nanotechnology, bioinformatics and cognitive science are very promising and are increasingly being used in medicine, the environment, agriculture and livestock research. A convergence of these interdisciplinary activities is a key aspect in Food R&D to improve the quality and safety of foods. Emerging and converging technologies are considered as a highly innovative research area for a European approach. The potential of these new technologies to have an impact on the food sector should be further investigated to generate in the short- and medium-term innovative processes, tools and methods that can be applied along the food chain from the raw material to the final product. The near future will see the commercialisation of personalised nutrition providing food with improved health attributes. Development of foods and nutraceuticals for targeted groups with defined risk factors or diseases (e.g. allergy, diabetes, obesity, cardiovascular diseases) linking diet to treatment will be designed. Even more futuristic, individual genetic information together with the physiological response to food will be compiled to design personalised food and diet.

7th Framework Programme (FP7) [2]

In the past Framework Programmes, the European Commission financed a significant number of projects in the nutrition area addressing issues such as obesity, diabetes, allergy, osteoporosis, nutrigenomics, functional foods, etc. [1, 5]. In the FP7, food research will find its place within the specific programme on collaboration, Theme 2 “Food, Agriculture and Biotechnology”. The overall objective of this theme is to build a “European Knowledge Based

Bio-Economy" by bringing together science, industry and other stakeholders, in order to exploit new and emerging research opportunities that address social, economic and environmental challenges in agriculture, food, forestry, aquaculture, and fisheries. The challenge is thus to correctly manage our biological resources and use them for the sustainable production of safe, healthy and diversified food and bio-based materials for industry and energy.

The main research priorities proposed by the FP7 for the pillar 2: "Fork to farm: Food, health and well-being" are the following:

- Consumer, societal and health aspects of food, behavioural and cognitive sciences.
- Nutrition and diet related diseases.
- Innovative food and feed processing technologies.
- Improved quality and safety, both chemical and microbiological, of food, beverage and feed.
- Environmental impacts on food chains and of food chains including the concept of traceability.

The FP7 offers further opportunities in nutrition science. This will involve the development and application of nutrogenomics and systems biology and the study of the interaction between nutrition, physiological and psychological functions. The ingenuity of food technology in food formulation and production will contribute to further advances in the nutrition area. This will increase the opportunities for providing products that will support optimum health.

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