



# Workshop on risk-benefit assessment on foods

## Book of Abstracts



21<sup>st</sup> & 23<sup>rd</sup> May 2018 | Lisbon, Portugal

National Institute of Health Dr. Ricardo Jorge



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## Welcome message

Dear Participants,

On behalf of the RiskBenefit4EU team, we are very pleased to receive you in our beautiful city of Lisbon, to participate in the "Workshop on risk-benefit assessment of foods", held on the 21st and 23rd May, 2018, at the National Institute of Health Doutor Ricardo Jorge (INSA).

This Workshop aims to gather researchers, academia, and industry and health professionals to discuss the latest updates related to risk-benefit assessment of foods and its importance for food safety and nutrition. It includes two days sessions with keynote lectures given by renowned scholars on the area of food safety, risk assessment and risk-benefit assessment providing a scenario of national and international ongoing activities on these areas. A videoconference with the European Food and Safety Authority (EFSA) will also promote the discussion on these issues.

The balance between risks and benefits is of interest to food authorities developing food policy and consumer advice, to business developing new food products, and to consumers considering dietary changes.

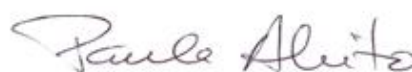
This workshop is organized within the EFSA Partnering Grant Project RiskBenefit4EU "Partnering to strengthen the Risk Benefit Assessment within EU using a holistic approach" (GP/EFSA/AFSCO/2017/01-GA02), coordinated by INSA. It aims to strengthen the EU capacity to perform risk-benefit assessment of foods.

We wish you an excellent Workshop!

On behalf of the RiskBenefit4EU team,



José Maria Albuquerque,  
Member of the Executive Board of the  
National Institute of Health Doutor  
Ricardo Jorge, I.P.



Paula Alvito,  
Scientific Researcher at Food and Nutrition  
Department,  
National Institute of Health Doutor Ricardo  
Jorge, I.P.



## Programme

### Monday, 21<sup>st</sup> May

9h00	Registration
9h30	Opening session <i>Dr. Fernando de Almeida (President of INSA)</i> <i>Dr. Pedro Portugal Gaspar (General Inspector of ASAE)</i> <i>Dr. Graça Mariano (Sub-General Director of DGAV)</i> <i>Dr. Sofia Mendes de Sousa (DGS)</i>

#### **Session I: Is risk-benefit assessment an important tool for food safety and nutrition?**

Chair: Jeanne-Marie Membré (INRA)

09h45	What is risk analysis in food safety and nutrition? From risk assessment to risk-benefit assessment <i>Filipa Vasconcelos (ASAE)</i>
10h15	Introduction to risk-benefit assessment (RBA) of foods <i>Lea Jakobsen (DTU)</i>
10h45	Risk-benefit assessment in Europe <i>Géraldine Boué (INRA)</i>
11h15	<b>Coffee-break</b>
11h45	European ongoing activities related with RBA of foods <i>Sara Monteiro Pires (DTU)</i>
12h15	Discussion
12h30	<b>Lunch</b>

## Session II: Risk assessment versus risk-benefit assessment – Portuguese reality

Chair: Maria Antónia Calhau (INSA)

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|-------|--|
| 14h00 | Which consumption data are needed to perform risk-benefit assessment?<br><i>Duarte Torres (UPorto)</i>   |
| 14h15 | Children exposure assessment to food additives: an exploratory study<br><i>Elsa Vasco (INSA)</i>   |
| 14h30 | Risk assessment of foods consumed by children – a case study<br><i>Ricardo Assunção (INSA)</i>   |
| 14h45 | Effect of selected food components on effectiveness of dietary exposure mitigation to chemical contaminants<br><i>Isabel Castanheira (INSA)</i>  |
| 15h00 | Evaluation of the benefit/risk associated to the consumption of seaweeds based on the bioaccessibility of antioxidant compounds and contaminants<br><i>Maria Manuel Gil (MARE, IPLeiria)</i> |
| 15h15 | An overview of the risk-benefit assessment associated to contaminants and nutrients intake through seafood consumption: case studies<br><i>Cláudia Afonso (IPMA)</i>                         |
| 15h30 | Discussion   |
| 15h45 | <b>Coffee-break</b>  |

## Session III: Risk-benefit assessment – future perspectives

Chair: José Maria Albuquerque (INSA)

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|-------|---|
| 16h15 | RiskBenefit4EU – project presentation<br><i>Paula Alvito (INSA)</i>                                       |
| 16h35 | Future perspectives and opportunities in risk-benefit assessment of foods<br><i>Géraldine Boué (INRA)</i> |
| 16h50 | Discussion  |
| 17h15 | Closing session<br><i>President of INSA</i>   |

## **Wednesday, 23<sup>rd</sup> May**

### **Session IV: Risk-benefit assessment – EFSA perspectives**

Chairs: Paula Alvito (INSA) and Géraldine Boué (INRA)

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|-------|--|
| 10h00 | Welcome and introduction<br><i>Paula Alvito (INSA) and Géraldine Boué (INRA)</i>   |
| 10h15 | Risk-benefit assessment in the EU perspective<br>EFSA's guidance on uncertainty in scientific risk assessment<br>Questions and discussion<br><i>Hans Verhagen (EFSA)</i> |
| 12h00 | Concluding remarks   |



## Speakers

### Cláudia Afonso

Cláudia Afonso, BSc in Marine Biology (UAlg), MSc in Pharmaceutical Sciences, specializing in Quality Control and Food Toxicology, and PhD in Pharmacy (FFUL). She is a Post-doc researcher at DivAV of the Portuguese Institute for Sea and Atmosphere, I. P. (since 2000) and at CIIMAR. Her main scientific research focuses on quality and safety, an area where she has developed research activities with a view to upgrading and qualifying fisheries and aquaculture products. Particularly, her work has encompassed risk-benefit assessment, bioaccessibility of nutrients and contaminants, nutrition and toxicology and, more recently, bioprospection of compounds from marine resources. She is co-author of 38 articles published in peer-reviewed journals and 4 book chapters, being supervisor of undergraduate, master and PhD students. She has participated in 15 national and international R&D projects and conferences (more than 80 oral or poster presentations) (Orcid: 0000-0002-5717-818X).

He is researcher at the Group of Nutrition and Obesity Epidemiology – Epidemiology Research Unit, Institute of Public Health University of Porto (ISPUP). He has participated in the National Food and Physical Activity Survey (IAN-AF), funded by EEA Grants (000088SI3), between 2014 and 2017, and in the project CFT/EFSA/DCM/2012/01 Support to national dietary surveys in compliance with the EFSA Guidance on General principles for the collection of national food consumption data in the view of a pan-European dietary survey, funded by EFSA, between 2013 and 2017. He currently coordinates the University of Porto participation in the projects NEWFOOD – Food Technologies Valorization (NORTE-01-0246-FEDER-000043), RiskBenefit4EU – Partnering to strengthen the risk-benefit assessment within EU using a holistic approach (GA/EFSA/AFSCO/2017/01 – GA02) and Dose-response relationships in health risk assessment of nutritional and toxicological factors in foods (GA/EFSA/AFSCO/2017/01 – GA09). He got a PhD degree in Chemical and Biological Sciences and Engineering (2010) and a Master degree in Bioprocess Engineering (2005) by the School of Engineering of the University of Minho. In 2000 he graduated in Nutritional Sciences by the Faculty of Food Science and Nutrition of the University of Oporto.

### Duarte Torres

Duarte Torres is assistant professor at the Faculty of Food Science and Nutrition of the University of Oporto, teaching Food Toxicology, Food and Meals Composition, and Innovation. He is member of the Scientific Committee of the Master in Food Service Management and Vice-Chairman of the Scientific Board of the Faculty of Food Science and Nutrition of the University of Oporto.

### Elsa Vasco

Elsa Reis Vasco is Health Researcher on the Monitoring and Surveillance Unit and on the Chemistry Laboratory of the Reference Unit of the Food and Nutrition Department of the Portuguese National Institute of Health in Lisbon. She has got her degree on Biology at the University of Lisbon in 1991 and the PhD in Chemical Engineer at the Technical University in 2002. Her main scientific areas of

research are Food Chemical Analysis (implementation and development of methods for food chemical analysis, to determine food additives, nitrates and vitamins), Analytical Quality (implementation of analytical quality assurance systems in the scope of accreditation by ISO 17025), Chemical Occurrence Data, Risk Assessment and Total Diet Studies. She is responsible for the Design for implementing a system for monitoring the intake of food additives in Portugal.

### **Filipa Vasconcelos**

Currently, Deputy General-Inspector of the Technical Area of ASAE - Economic and Food Safety Authority of Portugal, EFSA national representative (alternate member) in Focal Point networks and Advisory Forum, and member of the Communications Experts Network (CEN). More than 20 years of experience in Agro-Food Inspection; Senior Inspector of ASAE's Higher Inspection Career, Coordinator of the Department of Studies and Planning of the Food Area (NEPAA/GTP); Head of the Inspection and Internal Affairs Department (GIAI) and Chief-Inspector of the Santarém Delegation from the South Operational Unit of ASAE. Active participant in the organization of national and international events and Scientific Research Projects in the area of Communication and Risk Assessment in the food chain. From 1995 to 2006, at the (IVV) Vine and Wine Institute, she coordinated the Technical Control and Inspection Department of Santarém, she was the Head of Wine Inspection Department, and she was integrated at the Project Team responsible for the development of the SIVV - Vine and Wine Information System. Participation as Expert of the European Commission (DG-AGRI), integrating the Commission

agents Specific Body for the Wine Sector (CASC), having carried out missions in the UNITED KINGDOM (2003) and HOLLAND (2003); participation by the DG-ELARG in the Peer Review missions of the candidate countries for EU enlargement, namely: Slovenia (2002), Hungary (2002), Bulgaria (2003, 2004, 2005 and 2006) as well as in the missions to the Balkans in the Former Yugoslav Republic of MACEDONIA (2005) and in the Republic of Croatia (2005). Graduate in Technology of Agro-Food Industries and Management; Postgraduate in Viticulture & Oenology; Postgraduate in Quality Management and Food Safety, and Postgraduate in Public Management.

### **Géraldine Boué**

Géraldine Boué is a lecturer-researcher in food safety, risk assessment and food processing. She is working at SECALIM, a research unit of INRA and ONIRIS at Nantes in France. Her background is in food science and engineering and she has a PhD in risk-benefit assessment in foods. Her research activities are mainly in risk-benefit assessment in foods and microbiological risk assessment.

### **Isabel Castanheira**

Principal Researcher at National Institute of Health Doutor Ricardo Jorge. Head of Laboratory Reference Materials for Food and Nutrition. Chairperson of IMEKO Technical Committee for Metrology in Food and Nutrition). Co-supervisor of PhD thesis and master thesis focus on food characterization. Research

member of several European research projects. Reviewer of scientific articles in indexed journals mainly first quartile (Scimago rank). Author of more than 100 scientific papers in various areas, from metrology to food. Participating in international collaborative studies focusing on certification campaign of values assigned to certified reference materials. She has interests in analysing and studying the content of classical nutrients and contaminants of emerging concern in food products in terms of the comparability and reliability of the measurement values. Her activities in these research projects consider aspects of the traceability routes to SI units involving intermediate reference points which are identified and developed through state of the art analytical methods such as HPLC-ICP-MS, LC-MS or GC-MS.

University of Portugal for research on Microbial Predictive Modelling in foods. She is currently a Professor of Food technology and Risk Assessment at the Polytechnic Institute of Leiria and also a researcher at MARE-IPLeia, with experience in mathematical modelling and seafood technology. She has been involved in a number of national research projects (as principal investigator) and international research projects dealing with modelling of food quality and safety of thermal technologies (predictive microbiology), seafood innovation with specific focus on quality of seafood, quality assessments and how processing influence seafood quality and preferences. She has also particular interest in evaluation of the benefit/risk associated to the fish and seaweeds consumption.

## **Lea Jakobsen**

Lea Jakobsen is a Post-doc researcher at the Risk-Benefit Research Group at the National Food Institute, Technical University of Denmark. She has a background in food science, and her research focuses on developing methods to estimate the burden of disease of chemical hazards, toxicological risk assessment and risk-benefit assessments.

## **Maria Manuel Gil**

Maria Manuel Gil holds a BSc in Food Engineering from College of Biotechnology, Catholic University of Portugal. She was awarded his PhD also at College of Biotechnology, Catholic

## **Paula Alvito**

Paula Alvito, PhD Biology, EUROTOX Registered Toxicologist ERT (2017). Integrated member of Centre for Environmental and Marine Studies, University of Aveiro, Portugal (2016). Dr. Alvito has focused her research interests on food safety and food toxicology, namely, mycotoxins mixtures occurrence, toxicity, risk assessment and bioavailability. Reviewer of peer review journals on food safety. Member of the editorial board of World Mycotoxin Journal. She participates in international associations and networks on food safety (Cost Action Infogest, ImParas), collaborates in international projects (RiskBenefit4EU, EFSA; HBM4EU, Horizon 2020; Total Diet Study Exposure, 7FP) and national ones (MYCOMIX 2012-15), teaches in MSc programs and supervises PhD and MSc Thesis. She also coordinates the organization of new national and international scientific

meetings (ICFC15, 17) concerning food contaminants challenges, symposiums and summer courses within international projects.

## **Ricardo Assunção**

Ricardo Assunção, DVM, post-graduated in Quality Management and Food Safety, obtained his PhD in Veterinary Sciences. Currently, Ricardo is Post-doc researcher at Food and Nutrition Department of National Institute of Health Dr. Ricardo Jorge (INSA, Lisboa). His main research activities include food safety and public health, with particular interest in health risk assessment, food toxicology and health impact assessment of food contaminants, with special emphasis for the interaction between food contaminants and gastrointestinal system.

## **Sara Pires**

Sara Pires is a senior researcher at the Risk-Benefit Research Group at the National Food Institute, Technical University of Denmark. Her main research areas are burden of foodborne diseases, control and prevention of foodborne diseases, and risk-benefit assessment of foods. She currently coordinates the Danish initiative to estimate the burden of food-associated diseases.

## **Session I:**

**Is risk-benefit assessment an important tool for food safety and nutrition?**

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## What is Risk Analysis in Food Safety and Nutrition? From Risk Assessment to Risk-Benefit Assessment

Melo de Vasconcelos, Filipa<sup>1</sup>

<sup>1</sup>ASAE – Autoridade de Segurança Alimentar e Económica, Lisboa, Portugal

Email address: [fmvasconcelos@asae.pt](mailto:fmvasconcelos@asae.pt)

“Risk” means a function of the probability of an adverse health effect and the severity of that effect, consequential to a hazard. Zero Risk is considered as almost impossible to achieve.

The classical concept of **Risk Analysis**, according to the international organizations and the European Food Law means a process consisting of three interconnected components: Risk Assessment (RA), Risk Management (RM) and Risk Communication (RC).

**RA** stands for a scientifically based process, consisting in four steps: hazard identification, hazard characterization, exposure assessment and risk characterization.

Risk-benefit analysis (**RBA**) is a relatively new approach based on the comparison matrix of the risk of a situation to its related benefits, making the match of identification and characterization of the correspondent negative and positive aspects and effects.

Exposure to personal risk is assumed as a daily challenge in our lives. Most of people consent that some benefits are achieved only if we incurring in some sort of risk, even that the sensation of a controlled situation isn't more than a felling.

As noted by Dutch Health Council, policy-making is not a scientific but a political and legislative process. RBA provides scientific information that can be used as a basis for policy-making. In this way, Food Safety Authorities (FSA) must balance their action to provide food consumers protection as well as the correspondent assurance on the global fair trade. Should FSA integrate in their management measures a balance response aiming to achieve the compromise between the risk acceptable given the correspondent benefits??

## Introduction to risk benefit assessment of foods

Lea Sletting Jakobsen<sup>1</sup>, Sofie Theresa Thomsen<sup>1</sup>

<sup>1</sup>National Food Institute, Technical University of Denmark, Denmark

Email address: [leaja@food.dtu.dk](mailto:leaja@food.dtu.dk)

Food is a basic requirement providing nutrients for a healthy life. At the same time, consumption of unhealthy and unsafe foods is the cause of many diseases. Therefore, an integrated assessment that evaluates both the beneficial and adverse health impact of food consumption is needed: risk benefit assessment of foods (RBA).

RBA is a multi-disciplinary research field combining data and methodologies from toxicology, microbiology, nutrition and epidemiology, and fits into the large domain of research in food safety and nutrition, which has a focus on the human health impact of food consumption. The process of an RBA is similar to the process of a traditional risk assessment applied in chemical toxicology and microbiology, in which the initial step is the formulation of the risk benefit question (RBQ). RBAs provide evidence on the overall health impact of decisions regarding food consumption, both from a consumer and public health management point of view, and the value of RBA is evident from the broad range of RBQs that may be posed.

RBA can be performed on three levels of aggregation: the component (e.g. a micronutrient), the food (e.g. fish) and the diet. Each level of aggregation has different demands and may require different methods. Besides, the RBA may be qualitative or quantitative. A qualitative assessment focuses on the overall balance between the risks and benefits, whereas the quantitative assessment informs on the size of the overall health impact. Both the level of aggregation and whether an assessment is qualitative or quantitative depend of the RBQ.

In this presentation, we shortly present the overall methodology used in RBA. We then justify the place of RBA in food safety and nutrition by giving an overview of the possible RBQs to be asked; where they belong at the level of aggregation and how qualitative and quantitative assessments may be useful in a management perspective.

## Risk-benefit assessment in Europe

Boué Géraldine<sup>1</sup>, Membré Jeanne-Marie

<sup>1</sup>SECALIM, INRA, Oniris, Université Bretagne Loire, Nantes, France

Email address: [geraldine.boue@oniris-nantes.fr](mailto:geraldine.boue@oniris-nantes.fr)

Risk-Benefit Assessment (RBA) of foods gained particular attention in Europe since the beginning of the 21st century. The objective of the presentation will be to introduce what has been done so far in RBA from a European perspective. That will be based on a review that has been updated in April 2018 (Boué et al., 2015). RBA has emerged with the initiative of the European Food Safety Authority (EFSA) that have settled down RBA basic principles (EFSA, 2006; EFSA, 2010). This important step was followed by few European projects (BRAFO, QALIBRA and BEPRARIBEAN) that have built the foundation of the RBA methodology (Boobis et al., 2013; Hart et al., 2010; Hoekstra et al., 2012; Tijhuis et al., 2012; Verhagen et al., 2012).

To date, about 100 RBA case studies were performed in the food safety and nutrition area, mainly in European research centers. Main topic of interest has been the RBA of fish consumption (72 studies in 102 studies) considering nutritional compounds (e.g. fatty acids DHA and EPA), chemicals (e.g. methylmercury, dioxins and PCB) and occasionally microbiological hazards (e.g. *Listeria monocytogenes*). Other topics were investigated such as the use of intense sweeteners, the consumption of fruits and vegetables, different cooking practices, food fortification, etc.

It is now well established that a RBA starts by defining the question related to the case study (a diet, a food or a food compound), the (sub)population targeted, and different scenarios of consumer exposure to be assessed (reference and alternative scenarios). Then, similarly to traditional risk assessment, each risk and benefit is individually assessed (in microbiology, chemistry and nutrition) for different scenarios. This step is followed by an integration / comparison of all risks and benefits in order to predict the overall health impact.

Different ways of integrating / comparing risks and benefits were used as it seemed impossible to converge toward a unique approach. The most common option was based on a comparison of consumer levels of exposure with regard to safety reference levels such as TWI (Tolerable Weekly Intake) in chemistry and RDI (Recommended Daily Intake) in nutrition. Another option was to compare the change in endpoint trends like the increase of number of deaths due to a risk with the decrease of number of deaths thanks to a benefit. Alternatively, the use of a composite metric like the DALY (Disability-Adjusted-Life-Year) was used to convert all risks and benefits into a same metric and then to provide a comprehensive assessment of the consequences of a disease by integrating the quality of life lost and premature death.

To conclude, the state of art has highlighted that RBA is now a well-established area of research and a promising tool to increase the comprehensiveness of evaluation for balanced public health interventions in food.



## European ongoing activities related with RBA of foods

Pires, Sara

<sup>1</sup>National Food Institute, Technical University of Denmark, Denmark

Email address: [smpi@food.dtu.dk](mailto:smpi@food.dtu.dk)

Risk-benefit assessment (RBA) of foods is a relatively new discipline that is increasingly used to inform food safety policies or to provide dietary advice based, with the ultimate aim of preventing food-associated diseases and promoting wellbeing of consumers. It has evolved substantially during the progress of several national-level and international projects in the last decade, with the development of RBA methodologies, establishment of inter-disciplinary collaboration, and awareness of its utility by governments and international authorities. Still, several challenges remain. These include data and knowledge gaps, methodological limitations, lack of harmonization of concepts and new research questions and agendas.

Several research groups and national authorities with Europe currently allocate resources to address these challenges and expand the application of RBA of foods. Ongoing activities lead to promising developments, which are equally evident in terms of data collection and analysis and of method development. As examples, RBA methods are evolving to move from considering the health impacts of consumption of a single food to the ones of dietary patterns; to account for the variation in the population in terms of susceptibility or dietary preferences; and to expand to including non-health impacts such as sustainability and economy. And in addition to projects at the national level, a recent collaboration platform has been formed – the *Risk-Benefit Assessment International Network* -, and international organizations such as the European Food Safety Authority are supporting the discipline's development by funding activities and raising awareness.

We will share ongoing research on RBA, present current progress in methodologies and applications, discuss how to further develop and optimize RBA, and present our arguments to increase collaboration internationally.

## **Session II:**

### **Risk assessment versus risk-benefit assessment – Portuguese reality**

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## **Which consumption data are needed to perform risk-benefit assessment?**

Torres DPM<sup>1,3</sup>, Carvalho C<sup>2,3</sup>, Lobato L<sup>2,3</sup>, Severo M<sup>2,3</sup>, Correia D<sup>2,3</sup>, Lopes C<sup>2,3</sup>

<sup>1</sup> Faculty of Nutrition and Food Sciences, University of Porto, Portugal, <sup>2</sup> Faculty of Medicine, University of Porto, Portugal, <sup>3</sup> Epidemiology Research Unit, Institute of Public Health, University of Porto, Portugal

Email address: [dupamato@fcna.up.pt](mailto:dupamato@fcna.up.pt)

The lack of data related to intake of foods, nutrients, chemical hazards, pathogens, and dietary habits is one main challenge in risk-benefit assessment.

The National Food, Nutrition and Physical Activity Survey, 2015-2016 (IAN-AF) aimed to collect representative nationwide and regional data (from 3 months up to 84 years of age) on individual food consumption. Participants were selected by multistage sampling, using the National Health Registry as the sampling frame. Data collection, during 12 months, was harmonized according to European guidelines (EU-MENU, European Food Safety Authority [EFSA]). Dietary assessment was performed using 24-hour recalls (two nonconsecutive, 8-15 days apart) or food diaries in the case of children aged <10 years, complemented with a food propensity questionnaire; physical activity data (International Physical Activity Questionnaire [IPAQ], the Activity Choice Index [ACI], and 4-days physical activity diaries); sociodemographic data, and other health-related data were also collected.

The 24-hour recalls were conducted using an electronic tool – the eAT24 module. This module allows to collect food consumption data and to describe consumed foods according to the system FoodEx2. Portion sizes estimation included a digital food picture book, which was developed including 1048 food photos and 39 photos of household measures.

The actual Portuguese food consumption data can be matched with datasets on nutrient composition of foods, chemicals and microbials occurrence in foods, among other datasets, to estimate the distribution of exposure, where any percentile of interest can be calculated. The average contribution of each food or food category to the total exposure can also be estimated.

## Children exposure assessment to food additives: an exploratory study

Ana Calmeiro<sup>1</sup>, Paula Alvito<sup>1,2</sup>, Elsa Vasco<sup>1</sup>

<sup>1</sup>Food and Nutrition Department, National Institute of Health Dr. Ricardo Jorge, Lisboa, Portugal <sup>2</sup>  
Centre for Environmental and Marine Studies, University of Aveiro, Aveiro, Portugal

Email address: [elsa.vasco@insa.min-saude.pt](mailto:elsa.vasco@insa.min-saude.pt)

**Introduction/Aim:** The increase of processed products in children's diet has been accompanied by an increase in the consumption of food additives, which could be associated with the prevalence of overweight and childhood obesity constituting a health threat. Food additives are regulated by European directives requiring each additive to be subjected to toxicity tests in order to establish an Admissible Daily Intake (ADI) and Maximum Permitted Level (MPLs) in different foodstuffs and the monitoring of the intake of these additives by member states. The present exploratory study aimed to i) evaluate the exposure of Portuguese children, from 0 to 3 years of age, to food additives, ii) to study its association with age, sex, body mass index and iii) to identify main food categories contributing to food additives exposure.

**Methodology:** The exploratory study, included in the MONITADITIVOS project, was conducted using food consumption, anthropometric, clinical and demographic data obtained from the MYCOMIX Project. The OPEN Portugal platform allowed the computerization of Portuguese children food consumption data collected using a 3 days food diary. All food items selected were grouped and organized into categories according to FoodEx2 and the foodstuffs consumed by children containing food additives were identified, as well as, the food additives themselves. Thus, taking into account the consumption of these foodstuffs and the corresponding MPLs, the daily intake of each food additive was estimated, which compared to the ADI, allowed an assessment of the exposure of children for each food additive studied. The intake of food additives was related to sex, age and body mass index by statistical analysis.

**Results:** From 103 children of the MYCOMIX project, 85 were selected for this study. Based on consumption data, 12 food additives were selected. Estimated intakes higher than the DDAs for sulfur dioxide (E220), fumaric acid (E297) and sodium nitrite (E250) were observed. "Sugar, confectionery and sugary desserts", "Milk and dairy products", "Cereals and derivatives" and "Composite dishes" were the food categories that most contributed to the exposure to the selected additives.

**Conclusions:** This study allowed to infer the profile of children exposure to food additives and to launch preliminary results to justify the need for more detailed and refined studies, as well as the development of a national monitoring program for evaluation of additives intake.

**Acknowledgments:** MYCOMIX Project (PTDC / DTP-FTO / 0417/2012), funded by FCT and MONITADITIVOS funded by INSA.

## Risk assessment of foods consumed by children – a case study

Ricardo Assunção<sup>1,2</sup>, Carla Martins<sup>1,2,3</sup>, Elsa Vasco<sup>1</sup>, Baltazar Nunes<sup>4,5</sup>, Paula Alvito<sup>1,2</sup>,

<sup>1</sup>Food and Nutrition Department, National Institute of Health Dr. Ricardo Jorge, Lisboa, Portugal; <sup>2</sup>Centre for Environmental and Marine Studies, University of Aveiro, Aveiro, Portugal; <sup>3</sup>NOVA National School of Public Health, Universidade NOVA de Lisboa, Portugal; <sup>4</sup>Epidemiology Department, National Institute of Health Dr. Ricardo Jorge, Lisboa, Portugal; <sup>5</sup>*Centro de Investigação em Saúde Pública, Escola Nacional de Saúde Pública, Universidade NOVA de Lisboa*

Email address: [ricardo.assuncao@insa.min-saude.pt](mailto:ricardo.assuncao@insa.min-saude.pt)

Children can be biologically more sensitive to certain toxicants on a body weight basis than adults. Current understanding of the rates of maturation of metabolism and evidence from case studies indicated that this population group typically lack the capacity to detoxify and eliminate substances as readily as adults. Consequently, a disproportionate burden of exposure from food contaminants, as mycotoxins, is borne by children. In many parts of the world, children are routinely exposed to many mycotoxins via food chain and aflatoxins, fumonisins and deoxynivalenol are the three most common.

Risk assessment constitutes an essential component in modern science-based food safety systems and plays a growing and important role in guiding food safety authorities. Most studies have focused on the risk assessment of single mycotoxins and there are scarce data concerning the risk associated with human exposure to multiple mycotoxins in foods, especially for those intended for children consumption. MYCOMIX, a recent Portuguese project (<https://www.youtube.com/watch?v=CsKaz3mt2J4>), assessed for the first time, the risk associated with the simultaneous exposure to 13 mycotoxins in cereal-based food products usually consumed by children until 3 years old from Lisbon region, Portugal. Results on mycotoxins occurrence showed that 94% of the analysed samples were contaminated with at least one mycotoxin, although at levels below the legislated limits. Co-contamination was observed in 75% of the analysed samples. Estimated aflatoxins exposure suggested a potential adverse health effect for percentiles of intake above or equal to P50, determined through margin of exposure concept.

Considering the potential benefit effects linked to the consumption of cereal-based products, as those associated with fibres, future studies considering the risk-benefit assessment are of utmost importance to establish recommendations based on scientific evidences to protect children's health.

## Effect of selected food components on effectiveness of dietary exposure mitigation to chemical contaminants

Isabel Castanheira<sup>1</sup>, Inês Coelho, Inês Delgado, Susana de Jesus,

Marta Ventura

<sup>1</sup>Food and Nutrition Department, National Institute of Health Dr. Ricardo Jorge, Lisboa, Portugal

Email address: [isabel.castanheira@insa.min-saude.pt](mailto:isabel.castanheira@insa.min-saude.pt)

The risks and benefits associated with food consumption is nowadays a matter of prominent research. Animal and plant foods are current sources of micronutrients necessary for a healthy diet. However, these foods can contain several chemicals, like heavy metals or organic compounds, from environmental contamination or formed during food processing such Maillard reaction products. This work reviews the most promising strategies for mitigating the impacts of chemical contaminants referred as mutagenic or carcinogenic by IARC. Such strategies involve the use of food components able to reduce the effects of precursors of acrylamide or AGEs. The implications of micronutrients and bioactive compounds in reducing the binding of heavy metals to protein in the body or during food processing are also discussed. Efforts to reduce the health risk from organic and inorganic contaminants are debated. Several examples illustrate the importance of metrological tools in the rigor of values associated with occurrence data. Investigations recently published referring the use of neural networks and other predictive models to the reduction of acrylamide are highlighted. Emphasis is given to how compounds with different structures, or functional groups, could react with chemical contaminants as with intermediates of the reaction or with toxicant itself, leading to dose-dependent reduction effects. This work concluded that the potential of mitigation strategies involving food components is promising for the interests of the industry, regulators and consumers. Measures intended at reducing the exposure to contaminants through food, either from the food sector, codes of practice, regulatory limits or a consequence of consumer education, are reported.

## Evaluation of the benefit/risk associated to the consumption of seaweeds based on the bioaccessibility of antioxidant compounds and contaminants

Francisco J<sup>1</sup>, Cardoso C<sup>2,3</sup>, Bandarra N<sup>2,3</sup>, Horta A<sup>1</sup>, Afonso C<sup>2,3</sup>, Gil M M<sup>1</sup>

<sup>1</sup>MARE – Marine and Environmental Sciences Centre, Polytechnic Institute of Leiria (IPLEIRIA), Peniche, Portugal; <sup>2</sup>Division of Aquaculture and Upgrading (DivAV), Portuguese Institute for the Sea and Atmosphere (IPMA, IP), Lisbon, Portugal; <sup>3</sup>CIIMAR, Interdisciplinary Centre of Marine and Environmental Research, University of Porto, Porto, Portugal.

Email address: [maria.m.gil@ipleiria.pt](mailto:maria.m.gil@ipleiria.pt)

Seaweeds (SW) consumption has increased worldwide due to the growing awareness of its several benefits. In fact, edible SW contains valuable biomolecules, namely essential amino acids, essential elements, vitamins, important lipids, carbohydrates and dietary fiber. Additionally, they are an excellent source of antioxidant compounds associated to secondary pathways, such as carotenoids, bromophenols, or phlorotannins. (known to defend the organism against reactive oxygen species that can cause serious DNA, lipid and protein damage). On the other hand, due to the increasing levels of pollution in the oceans, seaweeds also tend to bioaccumulate contaminants that can compromise their consumption. In this context, knowledge about the benefits / risks associated to the consumption of seaweeds is of great importance to consumers, producers and health authorities. Also, bioaccessibility of compounds are still poorly understood to undertake more realistic risk/benefit assessment. In fact, the majority of studies only evaluated the concentration of the target compounds, neglecting the bioaccessibility. The main objective of this work was to assess the benefit/risk associated to the consumption of *Fucus spiralis* based on the bioaccessibility of antioxidant compounds and contaminants (simulating the human digestive process). Bioaccessibility was estimated as the percentage of elements recovered after the digestion process. The results attained for the bioaccessibility measured indicate that the majority of the *F. spiralis* antioxidants can resist to the stress provoked by the digestion, and thus being available to be absorbed by the intestine cells. Similarly, contaminants presented high bioaccessibility percentages being a good indicator that *F. spiralis* might be a good source of antioxidants, but can also represent a hazard in case of habitats with higher contaminant levels. However, further research is required to better understand how the digestion affects antioxidants in their structure, function, role and even how they interact with the intestine in order to be absorbed by the consumer.

## **An overview of the risk-benefit assessment associated to contaminants and nutrients intake through seafood consumption: case studies**

Afonso C<sup>1</sup>, Bandarra NM<sup>1</sup>, Cardoso C<sup>1</sup>

<sup>1</sup>Division of Aquaculture and Upgrading, Portuguese Institute of the Sea and Atmosphere, IPMA, I.P., Lisboa, Portugal

Email address: [cafonso@ipma.pt](mailto:cafonso@ipma.pt)

Seafood is part of the cultural tradition of the Portuguese population, but also an essential component of the diet of many other countries worldwide. In recent decades, the link between food and health has been shown to be fundamental. Indeed, food, if of the right sort and in the adequate amount, can be the best medicine in promoting wellbeing and health. Accordingly, world health organizations have issued recommendations that aim at a better diet. These guidelines have comprised a strong commitment to the increase of the seafood component in the diet. In fact, seafood consumption (including fish, seaweeds, and microalgae) is advised in a healthy balanced diet because it offers nutritional and health benefits. Seafood belong to the group of high nutrient density foods, that is, they are able to provide a high nutritional value combined with a low caloric content, having a wide range of essential constituents - elements (such as selenium and iodine), proteins (with all essential amino acids), carbohydrates, lipids such as omega-3 polyunsaturated fatty acids, particularly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), and several bioactive compounds. Such bioactive substances have shown different biological activities, from antioxidant and anti-inflammatory to antidiabetic or immunomodulatory. However, seafood consumption is subject to a nutritional-toxicological conflict since they are the main route of exposure to some contaminants, like methylmercury and arsenic. Thus, it is essential to weigh risks versus benefits associated to seafood consumption and formulate advices that help stakeholders take decisions.

In the area of risk-benefit assessment, the bioaccessibility or bioavailability of the nutrients, bioactives, bioactivity properties or contaminants in different seafood products (raw or cooked) is a promising field of research that may shed light into the real risks and benefits associated to their consumption. Instead of performing a risk-benefit analysis on the basis of the total contents of compounds, it can bring insight and be more realistic to use data based on the levels of these substances in the bioaccessible fraction (available to be absorbed across the intestinal wall) or bioavailable amounts, thus having these as inputs in a mathematical model that takes into account the full data variability. Hence, our group research has pursued a doubly innovative approach by combining *in vitro* digestion modeling or *in vivo* bioavailability results and advanced statistical processing of the probabilities of exceeding the advised nutritional requirements and contaminant thresholds.

Based on the work that has been developed by our team in this area over the last years, we have found strong evidence pointing to the critical importance of coupling bioaccessibility (or bioavailability) studies with state-of-the-art applied mathematics in order to have a realistic assessment of the risk-benefit balance associated to seafood consumption. Moreover, processing (e.g. canning), culinary treatment, and modeling of dose-response functions are other key aspects that have been studied and proven decisive in the risk-benefit conflict outcome. Such approach can be performed on the basis of survey consumption data or assumed scenarios and may target the whole population or specific groups, such as children.



### **Session III:**

#### **Risk -benefit assessment – future perspectives**

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## **RiskBenefit4EU – Partnering to strengthen the risk-benefit assessment within EU using a holistic approach**

Assunção R<sup>1,2</sup>, Martins C<sup>1,2</sup>, Viegas S<sup>1</sup>, Fernandes P<sup>1</sup>, Carvalho-Oliveira I<sup>1</sup>, Torres D<sup>3</sup>, Lopes C<sup>3</sup>, Monteiro S<sup>4</sup>, Nabais P<sup>4</sup>, Membré JM<sup>5</sup>, Boué G<sup>5</sup>, Persson M<sup>6</sup>,  
Thompson S<sup>6</sup>, Jakobsen L<sup>6</sup>, Pires S<sup>6</sup>, Poulsen M<sup>6</sup>, Alvito P<sup>1,2</sup>

<sup>1</sup>National Institute of Health Dr. Ricardo Jorge (INSA), Lisboa, Portugal; <sup>2</sup>Centre for Environmental and Marine Studies (CESAM), University of Aveiro, Aveiro, Portugal; <sup>3</sup>University of Porto, Faculty of Food Sciences and Nutrition (U.PORTO), Porto, Portugal; <sup>4</sup>Economic and Food Safety Authority (ASAE), Lisboa, Portugal; <sup>5</sup>Institut National de la Recherche Agronomique (INRA), Paris, France; <sup>6</sup>National Food Institute, Technical University of Denmark (DTU), Lyngby, Denmark.

Email address: [paula.alvito@insa.min-saude.pt](mailto:paula.alvito@insa.min-saude.pt)

“RiskBenefit4EU – Partnering to strengthen the risk-benefit assessment within EU using a holistic approach” is a recent European pilot project funded by EFSA and coordinated by Portugal (PT). This project integrates a multidisciplinary team from health and food institutes, national food safety authorities, R&D institutions and academia from PT, Denmark (DK) and France (FR). The main objectives of RiskBenefit4EU concerns the development of a set of RBA tools that can estimate the overall health effects of foods, food ingredients and diets and that can be applied to data from different countries. RiskBenefit4EU aims to strengthen the EU capacity to assess and integrate food risks and benefits using an holistic approach integrating the areas of toxicological, nutritional and microbiological components through the development of a harmonized framework. This pilot project will validate the RBA framework created using data from different areas of the Portuguese reality: a Portuguese case study on breakfast cereals, including results obtained under the MYCOMIX project (<https://www.youtube.com/watch?v=CsKaz3mt2J4>), the National Food, Nutrition, and Physical Activity Survey (IAN-IF, <https://ian-af.up.pt/>) and data provided under the National Sampling Plan (PNCA, <http://www.asae.gov.pt/>).

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## Future perspectives and opportunities in risk-benefit assessment of foods

Boué Géraldine<sup>1</sup>

<sup>1</sup>SECALIM, INRA, Oniris, Université Bretagne Loire, Nantes, France

Email address: [geraldine.boue@oniris-nantes.fr](mailto:geraldine.boue@oniris-nantes.fr)

To date, the scientific knowledge about “food” and “health” is huge as the number of projects and publications on this topic is increasing exponentially in various domains of research: toxicology, microbiology, nutrition and epidemiology. Addressing food public health issues with individual approaches in each domain of research led to contradictory conclusions in the past. For instance toxicological risk assessment of fish consumption suggested the need to decrease fish consumption while at the same time studies in nutrition were highlighting potential health benefits suggesting a need to increase its consumption. These conflicting messages have highlighted the need to consider public health issues related to food as a whole by integrating in a global perspective all potential adverse and beneficial health effects. It has stimulated the development of a new area of research: the risk-benefit assessment (RBA).

RBA is now recognized as a well-established area of research and the previous 100 RBA case studies performed up to date have demonstrated its feasibility and added value. Moreover, RBA is currently high in the agenda of different European countries as highlighted by several international actions that are suggesting promising developments at short term in this area. In this context, RBA is now enough advanced and a wide range of food risk-benefit issues could benefit from this holistic approach. As a non-exhaustive list, the following opportunities were identified:

- Recommendation of human diet, food choices and cooking practices
- Setting of nutritional reference levels while considering all together potential deficiency, toxicity and protective effects
- Optimization of food manufacturing process and food formulation, particularly of interest with current trends of clean label and low processed food
- Change in animal feeds to improve food composition
- Use of rational plant treatments
- ...

To conclude, RBA in foods can now be considered as an essential tool to perform comprehensive and scientific-based evaluations in order to help make best decisions using all available information. It is also a complex and multidisciplinary exercise which is inspired from traditional risk assessment but requires a more-in-depth analysis to aggregate all results. Consequently, RBA needs to be tackled by multidisciplinary teams and to be fed from previous RBA developments. More broadly in food safety and nutrition, we need to break borders among areas of research and to work together to address crosscutting issues and we need to develop international collaborations to facilitate RBA realizations and to build a shared Risk-Benefit culture.





