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Building capacity in risk-benefit assessment of foods: lessons learned from the RB4EU Project

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Abstract

Background

Human diet may present both risks and benefits to consumers' health. Risk-benefit assessment of foods (RBA) intends to estimate the overall health impact associated with exposure (or lack of exposure) to a particular food or food component.

Scope and Approach

"RiskBenefit4EU – Partnering to strengthen the risk-benefit assessment within EU using a holistic approach" (RB4EU) is a project funded by the European Food Safety Authority (EFSA) that integrates a multidisciplinary team from Portugal, Denmark and France. This project aims to strengthen the EU capacity to assess and integrate food risks and benefits regarding toxicology, microbiology and nutrition. One of the specific objectives of RB4EU was to build capacity in RBA among the recipient partners from Portugal. In order to achieve this objective, a capacity building strategy including theoretical and hands-on training and the development of a case-study were established. This paper aims to present the strategy used in the RB4EU project to build capacity within RBA, including the main training approaches and the lessons learned.

Key findings and conclusions

The capacity-building program included three main activities: theoretical training, focusing on RBA concepts; hands-on training, applying the acquired concepts to a concrete case-study, using the methods and tools displayed; and scientific missions, intending to provide advanced training in specific domains of RBA. The developed strategy can be used in the future to build capacity within RBA.

Key-words: Risk-benefit assessment, capacity building, training, food, microbiology, toxicology, nutrition

1. Introduction

The human diet may present both potential risks and benefits to consumers' health. The balance between risks and benefits is of interest to authorities from food-related areas to develop food policy and consumer advice, to businesses developing new food products, and to consumers considering dietary changes (Hoekstra et al., 2013). Risk-benefit assessment (RBA) of foods, a relatively new discipline, intends to estimate the human health benefits and risks following exposure (or lack of exposure) to a particular food or food component and to integrate them in comparable measures (Boué, Guillou, Antignac, Bizec, & Membré, 2015). The beneficial and adverse health effects may occur concurrently from the intake of a single food item or a single food component, within the same population. This means that any policy action directed at the adverse effects also affects the degree of beneficial effects and vice versa.

RBA has evolved substantially in the last decade during the progress of several national and international projects (e.g. BRAFO (Hoekstra et al., 2012), Qalibra (Hart et al., 2013), Beneris (Tuomisto, 2013), and BEPRARIBEAN (Verhagen et al., 2012)). International organizations such as the Food and Agriculture Organization (FAO) and the World Health Organization (WHO) started to use RBA to address specific risk-benefit questions (FAO/WHO, 2008, 2010). In parallel, the European Food Safety Authority (EFSA) has motivated the implementation of RBA by developing a first guidance on RBA (EFSA, 2010; European Food Safety Authority, 2007).

Currently, several research groups and national authorities within Europe allocate resources to expand the application of RBA of foods. These include national efforts in Denmark (Nauta et al., 2018; Persson, Fagt, & Nauta, 2018; Pires et al., 2018; Thomsen et al., 2019, 2018), France (Boué, 2017, 2018, Boué et al., 2016, 2017, 2015; Boué & Membré, 2018) and Sweden (H Eneroth et al., 2016; Hanna Eneroth, Gunnlaugsdóttir, et al., 2017; Hanna Eneroth, Wallin, Leander, Nilsson Sommar, & Åkesson, 2017), among others. Ongoing activities lead to promising developments in terms of data collection and analysis, of method development, and increased awareness of the utility of RBA to inform policy and consumer advice. In parallel to ongoing research and advisory work, a recent collaboration platform has been developed to increase cooperation and knowledge-sharing within RBA – the Risk-Benefit Assessment International Network (Pires et al., 2018).

1.1. RiskBenefit4EU – the current project

In Portugal, previous reports on RBA only assessed issues related to fish and seafood consumption, mainly dedicated to the nutritional and chemical components (Afonso, Cardoso, et al., 2013; Afonso, Costa, Cardoso, Bandarra, et al., 2015; Afonso, Costa, Cardoso, Oliveira, et al., 2015; Afonso, Lourenço, et al., 2013; Cardoso, Bandarra, Lourenço, Afonso, & Nunes, 2010; Costa et al., 2013; Jacobs et al., 2017, 2015; Matos et al., 2015). Considering the limited experience, technical and scientific support, an updated knowledge to develop and implement quantitative RBA in Portugal is needed. Opportunities allowing to share the achieved know-how concerning RBA between different institutions constitute important steps to evolve and become proficient within this research domain. RiskBenefit4EU – Partnering to strengthen the risk-benefit assessment within EU using a holistic approach (RB4EU) is a project funded under EFSA's Partnering Grants (EFSA, 2017), intending to strengthen the capacity to assess and integrate food risks and benefits in the areas of microbiology, nutrition and toxicology through the development of a harmonized framework that will be available to EU member states organizations.

Specific objectives of RB4EU are: 1) to build capacity among recipient partners on RBA of foods; 2) to develop RBA tools that can estimate the overall health effects of foods, food ingredients and diets; 3) to develop a harmonized framework for RBA that can be applied to data from different countries; 4) to validate the generated framework through the application on a case study; and 5) to disseminate and promote the harmonized framework to potential EU users.

Project activities of RB4EU include three key components: training (transferring and exchanging knowledge between project partners), research (framework development and its application to a case study) and dissemination and promotion activities (through web-site dissemination, publications and international conference organisation). As summarized in Figure 1, these activities, organized in five different tasks, were mainly developed in order to build capacity among partners to perform and develop RBA..

(**Figure 1.** Task organization of RiskBenefit4EU project. The present paper focused outputs from Task 2.)

The present paper describes a strategy to build capacity within a multidisciplinary team to perform a RBA of foods. A summary of the main capacity-building activities performed under the RB4EU project (Task 2 referred in Figure 1), including the training activity approaches and the lessons learned from the RB4EU project within this domain, was included.

2. Capacity-building strategy

According to the Advisory Forum Discussion Group on Capacity Building, capacity building can be considered as a process of development that leads to higher levels of skills and abilities to respond to current and future needs. It uses a country's human, scientific, organizational and institutional resources and capabilities to increase the level of expertise and capacity of those earning these opportunities (EFSA Advisory Forum Discussion Group on Capacity Building, 2018).

Within RBA, capacity building is intended to provide the scientific foundation on RBA of foods, the skills needed to identify and quantify beneficial and adverse health effects of foods, food constituents or nutrients, and to measure the risk-benefit balance of these. The capacity-building efforts should enable the trainees to produce reliable risk-benefit information/data to be used as scientific evidence on health impact of food consumption, assisting the definition of food safety policies, regarding food consumption, nutrients and/or food contaminants. Therefore, key activities of the capacity building should be directed towards the transfer of knowledge on RBA methodologies, between partner entities, in order to increase their level of expertise and capacity. Training through short courses and specific short-term training programs, in a learning-by-doing process, and scientific mentoring by experienced colleagues are important components of this process, that should be reflected in a capacity-building strategy.

(**Figure 2.** Capacity-building triangle on risk-benefit assessment of foods (RBA) – Scientific expertise using data from different domains, using different methods to promote the development of new knowledge on RBA.)

As summarized in Figure 2, performing a RBA may require a large range of expertise including: food safety, exposure assessment, risk assessment in toxicology, microbiology and nutrition, epidemiology, dietary assessment, health impact assessment and data analysis (EFSA, 2010; Tijhuis, Pohjola, et al., 2012). In addition, RBA requires also quantitative skills such as modelling, statistics and uncertainty analysis. All these constitute important fields that should be covered in the capacity-building strategy in order to establish the basis to perform a RBA.

Therefore, as a first step, the capacity-building activities need to focus on the process of assembling a multi-disciplinary team and on the promotion of collaboration, networking and scientific partnerships. The question: "What are the competences that a team needs to bring together in order to initiate a national RBA research?" should be addressed by countries or institutions with the intention to implement a RBA methodology. The EFSA Scientific Committee recommends a "close collaboration between risk and benefit assessors in order to ensure that generated data by one or the other can be used in a broader risk-benefit assessment context" (EFSA, 2010). The RBA team should include members covering the different areas of expertise, as presented in Figure 2. Team members should be familiar with specific methods and trained to apply them to specific case-studies. They should also have knowledge about and access to national or regional data sources concerning: i) food consumption, ii) chemical and microbiological contamination of foods, iii) profile on nutrients and other bioactive compounds of food components, foods and diets. A multidisciplinary team could also benefit from international collaborations to address common issues in RBA, as it will facilitate RBA applications by building on previous work and contributes to a shared risk-benefit culture and approach (Boué, 2018).

3. Results of the capacity building experience under the RB4EU project

3.1. Creation of a multidisciplinary team

Expertise in RBA and each individual field of research were joined within the RB4EU project by creating a multidisciplinary and complementary team. The project integrated participants from different National institutions. The list of participants and associated institutions is presented in Table S1.

INSA (the National Institute of Health Dr. Ricardo Jorge) brought expertise in risk assessment in toxicology and microbiology, occurrence data collection and food safety, UPorto (the University of Porto, Faculty of Nutrition and Food Sciences) in nutrition, epidemiology, dietary assessment, food science and technology and ASAE (the Economic and Food Safety Authority) in data collection of chemicals and pathogens in foods. RB4EU aimed to train the three teams in RBA but also to open new doors for future collaborations. For building capacity, two institutions with experience in RBA, INRA (Institut National de la Recherche Agronomique) from France and DTU (National Food Institute, Technical University of Denmark) from Denmark, have worked in close collaboration to create the first training on basic concepts required to perform a RBA.

3.2. Harmonization of concepts between the partners

There is no official consensus on the definitions used in RBA. Nevertheless, a key point is to share a common language between team partners and among the multidisciplinary teams and to harmonize concepts and terminologies. In the context of the RB4EU project, partners brainstormed and agreed on the meaning and definition of the following terms: hazard, health effect, adverse health effect, beneficial health effect, risk, benefit, health and health impact, as presented in Table 1.

(**Table 1.** Key terms and definitions agreed among team members of the RB4EU project.)

3.3. Stepwise approach followed under RB4EU project

Under RB4EU project a RBA stepwise approach (Figure 3) was followed. This approach was based on the main steps already clearly identified by Boué et al. (Boué, 2017; Boué et al., 2017). This approach considers four main steps, addressing the following key points: i) definition of a general frame and scope, including the problem definition and the scenario identification; ii) selection of the health effects, through identification and prioritization; iii) risk and benefit quantification, including the individual assessment of risks and benefits and the health impact quantification; and, iv) comparison of scenarios and interpretation of results and their communication. Training activities were organized to follow this stepwise approach, in order to provide all skills and tools required to carry out a RBA.

(**Figure 3.** Flowchart of RBA stepwise approach followed under RB4EU activities (adapted from Boué, 2017 (Boué, 2017)).)

This stepwise approach consists of six steps. First, the problem definition (step 1/6) should state the scope of assessment and the research question to be answered, including the population of interest (general or a sub-group population), the level of aggregation (food component, food or diet) and the type of assessment (qualitative or quantitative) (A. Boobis et al., 2013; Nauta et al., 2018). The second step is the scenario definition (step 2/6), which is a narrative description of hypothetical or real situations. The scenarios are always defined with a reference scenario (or baseline scenario) as a point of comparison, usually considering the current situation or a hypothetical situation of zero exposure, and alternative scenario(s) that will be compared with the reference scenario. These alternative scenarios will be assessed in a perspective of a perceived improvement in health (A. Boobis et al., 2013). In order to be considered a true RBA, both risks and benefits must be associated with the change from the reference scenario or the alternative scenario(s) (Hoekstra et al., 2012).

The following step in an RBA of foods is the selection of the health effects of interest (step 3/6). An adequate way to start this selection is to perform a literature review where particular attention should be given to the degree of evidence and quality of data. As stated by EFSA, “the confidence in the relationship between the exposure to an agent and consequences for human health will depend on the type of data” (EFSA, 2010). There are many sources of data but the most adequate rely on systematic reviews and meta-analysis of robust analytical studies, expert group evaluations (e.g. International Programme on Chemical Safety - WHO (IPCS-WHO), EFSA Panel on Contaminants in the Food Chain (CONTAM Panel), European Chemicals Agency (ECHA)) and public health surveillance data. After literature search, the quality of data and the level of evidence should be considered. However, due to differences in studies and data, the assessment of the evidence can be specific to the field of work: nutrition, toxicology or microbiology (e.g. WHO criteria, GRADE and AMSTAR 2 (Guyatt et al., 2008; Shea et al., 2017; WHO, 2003) or Bradford Hill criteria, Klimisch criteria, IPCS framework and EFSA guidance for weight on evidence (A. R. Boobis et al., 2006; EFSA, 2018; Klimisch, Andreae, & Tillmann, 1997; Lucas & McMichael, 2005). The evidence on the size of the effect in terms of toxicology, microbiology, nutrition and epidemiology constitute an important aspect that should be also considered. Overall, it is important to gather a group of experts to interpret the significance and level of evidence of the selected studies with respect to either risks or benefits to human health and the question raised.

In the step of individual assessment of risks and benefits (step 4/6), the chosen approach (qualitative, semi-quantitative or quantitative) is related to the type of questions raised and available data, usually performed in the previous steps of RBA, as schematically presented in Figure 3. If the available data are scarce or if the biological mechanisms are not comprehensively characterized, a qualitative or semi-quantitative approach should be performed. On the contrary, if enough and robust data exist, a quantitative assessment is desirable, through application of mathematical modeling to quantify the risks and benefits. For the quantitative assessment, two major approaches could be applied: i) the bottom-up approach, which is similar to the risk assessment approach, estimating the incidence of disease due to an exposure via dose-response models, usually applied for microbiological and chemical hazards, or ii) the top-down approach, that starts from the epidemiological and incidence data and estimates the number of attributable cases of a certain disease due to an exposure, usually applied for nutrients and nutritional factors and also for chemical hazards (Nauta et al., 2018). In RBA of foods, it is often necessary to combine these two approaches when performing the assessment, which inevitably brings additional sources of uncertainty and risk of bias that should also be taken into account (Tijhuis, de Jong, et al., 2012).

After assessing all the risks and benefits selected for the RBA scenario, the next step is the quantification of the health impacts in a common metric (step 5/6), which will enable the comparison. Health impact quantification can be defined as the expression in numerical terms of the change in health status in a specific population that can be attributed to a specific policy measure (Veerman, Barendregt, & Mackenbach, 2005). Most existing RBAs have taken three different approaches for the comparison of risks and benefits: the comparison of levels of exposure with safety reference levels (e.g. toxicological reference values), the comparison using a same scale (e.g. the impact on the intellectual quotient) and a comparison based on composite metric (e.g. Disability Adjusted Life Years).

In the final step, the results of the RBA are summarized in order to compare the scenarios (step 6/6). Different ways to compare scenarios can be used (e.g. tables, bar chart or graphs) but this process should, as much as possible, facilitate the decision-making by the policy makers, that is per definition, a complex process. Consequently, the scenario comparison should be transparent, robust and should use comprehensive methodologies that will feed into the decision-making process. Results should be displayed in an informative format, easy to understand and allowing anyone to make informed choices. Figure 3 presents, as an example, a transparent way to present results. The suggested table includes the different health effects from the different disciplines (risk and/or benefits) and the results from the health impact quantification (e.g. DALYs) for each scenario. Through this approach, and using for example a color code, it is easily possible to compare the different scenarios, and establish the main messages and conclusions of the assessment.

As a consequence of assumptions and approximations included in the RBA model, needed to accommodate the lack of knowledge or data, uncertainty should be identified and characterized. This level of uncertainty directly influences the level of confidence that decision makers can have regarding predicted risks and benefits (Tijhuis, de Jong, et al., 2012), namely how confident the policy makers could be about the estimated health impact of the different options assessed.

3.4. Training on the key steps of RBA methodology

A one-week theoretical training on the RBA stepwise approach was conducted to establish a baseline of knowledge and a common approach for RBA (programme presented in Table S2). Practical exercises were performed for a better comprehension of the proposed contents. Included in the hands-on training, and referred elsewhere in this paper, the RBA concepts, methodologies and tools were to be applied to a case-study. In addition, taking the opportunity to gather trainers and team members, an international Workshop on risk-benefit assessment of foods was organized (21st and 23rd May 2018, Lisbon, Portugal, (https://riskbenefit4eu.wordpress.com/publications/), contributing to raising awareness on the importance and utility of RBA and discussion of its future perspectives (programme of workshop presented in Table S2).

Table 2 summarizes the main topics addressed during the theoretical training, as well as, their learning objectives and the performed activities for each topic. Topics were divided comprehensively in two sections: 1) background information and 2) RBA stepwise approach. Background information on subjects that were considered as pre-requisites to the RBA, i.e. knowledge on risk assessment, variability, uncertainty and deterministic and probabilistic approaches were addressed.

(**Table 2.** Risk-benefit assessment (RBA) topics considered in theoretical training under RB4EU project.)

3.5. Future activities under RiskBenefit4EU project

During the process of capacity building, a movement from conceptual knowledge toward action is an essential step to effectively increase performance. It is only from experience with case-studies that expertise can emerge. In addition to integration and harmonization of scientific knowledge on nutrition, toxicology and microbiology, the development of training activities for application of knowledge to practical case studies is important for the RBA capacity building. A case study, based on previous questions raised during the MYCOMIX project (Assunção et al., 2018) was proposed to give space to apply and adjust knowledge and skills to this specific challenge. A second training period and short-term missions were also planned under RB4EU. During the second training, the team members were divided into three different working groups according to their expertise (microbiology, toxicology or nutrition), and worked on health effects identification and prioritization and data collection for the individual assessments of risks and benefits as well as health impact quantification. In addition, short-term scientific missions to partner institutions were organized, focusing on discipline-specific and advanced tutorials, in a one-to-one learning process.

4. Lessons learned from the RB4EU project

RBA is now a well-established area of research and significant progress have been made to set general principles for conducting RBA of foods (Boué & Membré, 2018; Vidry et al., 2013). To date, one of the remaining challenges is to build and capacitate new teams to conduct RBA studies due to multidisciplinary and specific expertise required (Hanna Eneroth, Gunnlaugsdóttir, et al., 2017; Pires et al., 2018). The RB4EU project applied a collaborative method to train a new team to perform RBAs of foods and face the challenge of cooperation between experts from different disciplines. It was to date the first training created and organized in RBA. Main lessons learned from this capacity-building experience are described in Table 3 with associated recommendations for new collaborative projects in RBA.

(**Table 3.** Lessons learned from the capacity-building experience and recommendations.)

5. Conclusions

The suggested strategy can now be re-used to capacitate other new teams in RBA and can be considered as a basis to build upon. The development of the training activities was a great opportunity to work on a common RBA approach between INRA and DTU (as capacity-builders), to transmit this shared method to new teams and thus contribute to the harmonization of the RBA method at the international scale. Under the RB4EU project, and as referred before, a case study on infant cereal-based foods consumed in Portugal will be assessed. This will be done by the new trained RBA teams (INSA, ASAE and UPorto) in close collaboration with experienced RBA researchers (DTU and INRA).

On a wider scale, the perspective of evolution of RBA research is promising due to an increasing interest on all health aspect of foods. There is now a clear interest to consider other tools such as food dietary recommendations, food (re)formulation and process optimizations. Consequently and more broadly in food safety and nutrition, we need to break borders among areas of research and build on previous experience in RBA to address crosscutting issues (Boué, 2018). This will be possible by developing international collaborations including specific experts required to address the risk-benefit issue and RBA experts to facilitate the case-study accomplishment and to build a shared and harmonized RBA approach and culture.

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[1] The authors declare that this manuscript reflects only the authors’ view and EFSA is not responsible for any use that may be made of the information it contains.

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Table 1. Key terms and definitions agreed among team members of the RB4EU project.

Terms to be defined	Definition agreed by team members	Source
Hazard	A biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect upon exposure.	Adapted from EFSA (European Food Safety Authority, n.d.), Codex Alimentarius Commission (Joint FAO/WHO Codex Alimentarius Commission & FAO/WHO, 2015), IPCS (IPCS, 2004), OECD (OECD, 2003)
Health effect	A change in morphology in the human body, or physiology, growth, development, reproduction or life span of humans that results in a change of human health status.	Adapted from FAO/WHO (FAO/WHO, 2006), modified from IPCS (IPCS, 2004)
Adverse health effect	Implies that the health effect reduces quality of life or causes a loss of life.	Adapted from EFSA (European Food Safety Authority, n.d.)
Beneficial health effect	Implies that the health effect increases quality of life, prevents a reduction in quality of life, or prevents loss of life (often equivalent to the prevention of an adverse health effect).	
Risk	A function of the probability of an adverse health effect and the severity of that effect, consequential to exposure to a hazard in food or consumption of a food or diet.	Adapted from EFSA (European Food Safety Authority, n.d.), IPCS (IPCS, 2004), OECD (OECD, 2003)
Benefit	A function of the probability of a beneficial health effect and the consequences of that effect and/or the probability of a reduction of an adverse health effect, consequential to exposure to a compound in food or consumption of a food or diet.	Adapted from the definition of risk by Codex Alimentarius Commission (Joint FAO/WHO Codex Alimentarius

		Commission & FAO/WHO, 2015)
Health	A state of complete physical, mental, (emotional?) and social well-being and not merely the absence of disease or infirmity.	Adapted from Preamble to the Constitution of WHO (WHO, 1948)
Health impact	The magnitude of the overall difference in health status due to a change in exposure to a food compound or consumption of a food or diet, which may be expressed in a composite health metric, but can also be a combination of metrics.	

Table 2. Risk-benefit assessment (RBA) topics considered in theoretical training under RB4EU project.

Addressed topics	Learning objectives	Performed activities under RB4EU
➢ **Section 1: Background information**		
Risk assessment in - Toxicology - Microbiology - Nutrition	- To understand the purpose to perform risk assessment in toxicology, microbiology and in nutrition - To recognize the key concepts in risk assessment: toxicology, microbiology and in nutrition - To identify the main differences between the purpose of risk assessment and the risk-benefit assessment	- Discussion on the main aspects of risk assessment paradigm - Presentation of the critical aspects for toxicological risk assessment (e.g. toxicity testing, safe dose for humans, threshold versus non-threshold effects) - Presentation of the critical aspects for risk assessment in microbiology (e.g. dynamics of a pathogen, predictive microbiology, dose-response) - Presentation of the critical aspects for risk assessment in nutrition (e.g. dual risk paradigm, dietary reference values)
Variability, uncertainty	- To be familiar with the concepts of variability and uncertainty and how to tackle them in risk assessment and RBA	- Interactive session concerning some examples showing the variability of data (e.g. food consumption in a specific country) - Discussion of examples in order to identify the associated uncertainty (data quality, models choice) - Discussion of examples on how to tackle variability and uncertainty (e.g. probabilistic approach, separation of variability and uncertainty)
Deterministic and probabilistic approaches	- To recognize the differences between deterministic and probabilistic approaches - To identify different tools that can assist in RBA	- Presentation of the main differences between deterministic and probabilistic approaches - Presentation of different examples of both approaches - Demonstration on how different tools (e.g. software to perform probabilistic approaches, predictive microbiology, dose-response modelling)
➢ **Section 2: RBA stepwise approach**		

Harmonization of terminology	- To discuss central terminologies used in RBA	- Brainstorming exercise about the key concepts in (RBA): hazard, health effect, adverse health effect, beneficial health effect, risk, benefit, health and health impact
Problem definition	- To be able to define a risk-benefit question - To identify different levels of aggregation under RBA - To recognize differences between qualitative and quantitative risk-benefit questions	- Presentation of examples of different questions and levels of aggregation - Exercises to distinguish qualitative and quantitative risk-benefit questions on each level of aggregation
Scenarios definition	- To be able to define fit-for-purpose scenarios - To recognize the link between the scenarios definition and data needed	- Brainstorming exercise on what is a scenario - Exercises to practice the definition of scenarios, considering the risk-benefit question (e.g. fortification of food, substitution)
Health effects identification and selection	- To identify important sources of evidence for health effects identification - To recognize different methodologies to weigh evidence - To understand how to select health effects	- Presentation of different possibilities to search for health effects (literature search) - Discussion of the importance of having an overview of the potential health effects (map of health effects) - Presentation of different examples of weighing the evidence in toxicology, microbiology and nutrition
Individual assessment of risk(s) and benefit(s)	- To identify data needed - To understand the bottom-up and top-down approaches	- Presentation of examples of data needed for the individual assessment - Presentation of the differences between bottom-up and top-down approaches - Exercises for calculation of incidence

Health impact quantification	- To discuss concepts of “health” and “health quantification” - To understand what is health quantification - To recognize main differences between the options to quantify the health impact	- Brainstorming exercise what is health, if it is possible to quantify it and how - Presentation of the approaches to quantify health used in RBA, and the advantages and disadvantages of each one - Exercise on health quantification (Disability Adjusted Life Years quantification)
Scenarios comparison	- To identify different possibilities for scenarios comparison - To discuss different possibilities for communication of results uncertainty	- Presentation of different possibilities to compare scenarios - Presentation of different possibilities to communicate the results uncertainty

Table 3. Lessons learned from the capacity-building experience and recommendations.

Main lessons learned *from the capacity-building experience*	**Recommendations** *for future RBA training initiative*
A one-week face-to-face training was valuable to enable active participation and facilitate discussions	Dedicate one face-to-face week with all participants
Training organized by researchers experienced in RBA to: - avoid starting from scratch - build on previous work - share and improve a harmonized Risk-Benefit approach at the international scale	Build a team including experienced researchers in RBA and a multidisciplinary team of experts eager to perform the RBA case study was considered as a valuable partnership
Sessions on basics concepts is necessary to create a common scientific culture and understanding of all individual fields of research and methods used in RBA	Allow time for training on basic concepts used in RBA
Organisation of brainstorming sessions on RBA language was worthwhile because it made participants create a common understanding and language which is necessary to when work on a RBA case study	Define a shared language through brainstorming sessions to create a consensus on terminologies on: hazard, health effect, adverse health effect, beneficial health effect, risk, benefit, health impact and health
Introduce and illustrate the RBA stepwise approach with examples of previous RBA performed was an efficient way to become familiar with this complex exercise	Use previous RBA case studies to illustrate and make less abstract the RBA stepwise approach
A particular attention was dedicated to the consideration of uncertainty and variability in RBA because it is a crucial point that need to be considered at every stage of the RBA	Introduce concepts of variability and uncertainty early in the week and pay attention during following sessions to these concepts

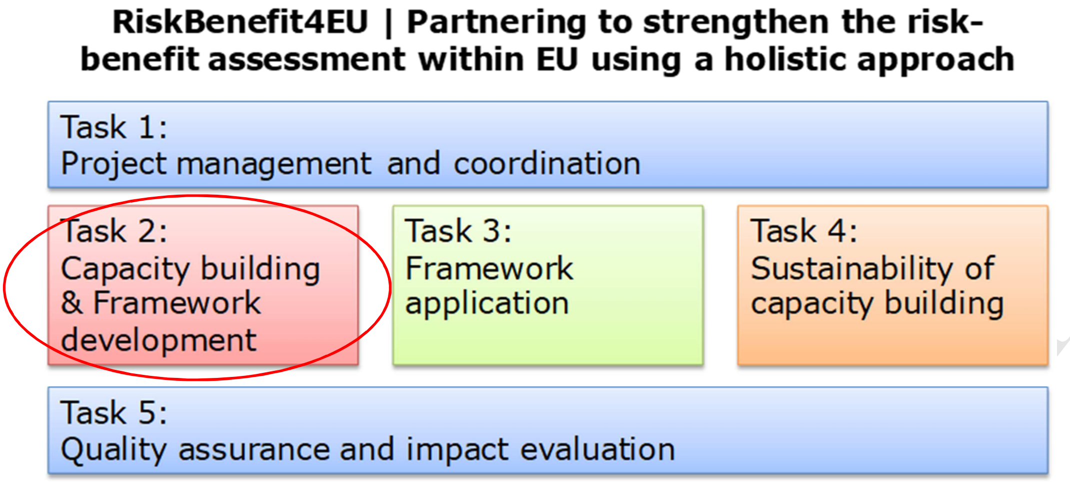

Figure 1. Task organization of RiskBenefit4EU project. The present paper focused outputs from Task 2.

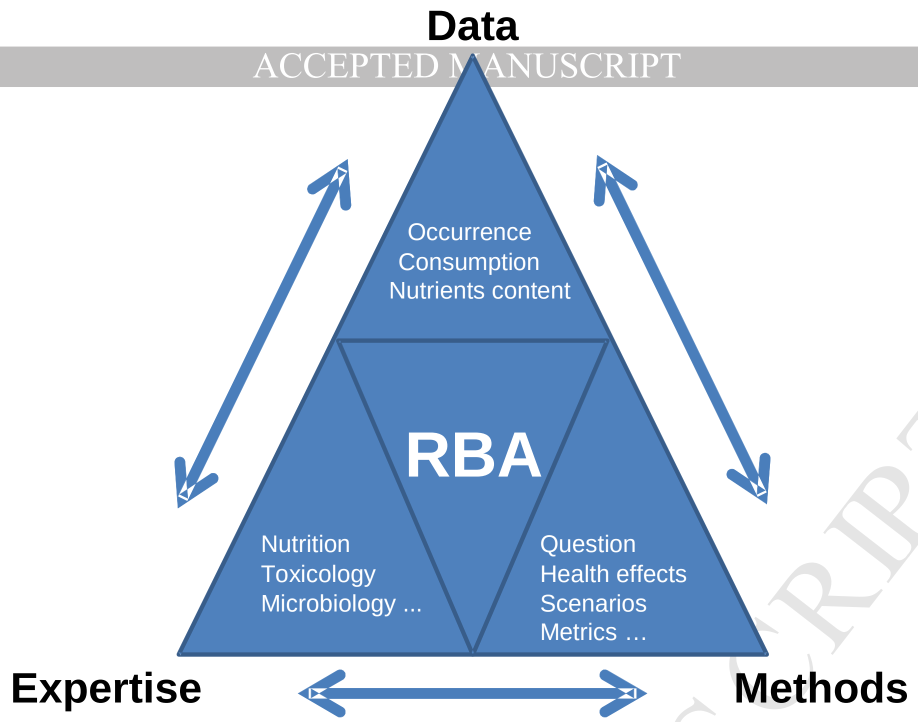

Figure 2. Capacity-building triangle on risk-benefit assessment of foods (RBA) – Scientific expertise using data from different domains, using different methods to promote the development of new knowledge on RBA.

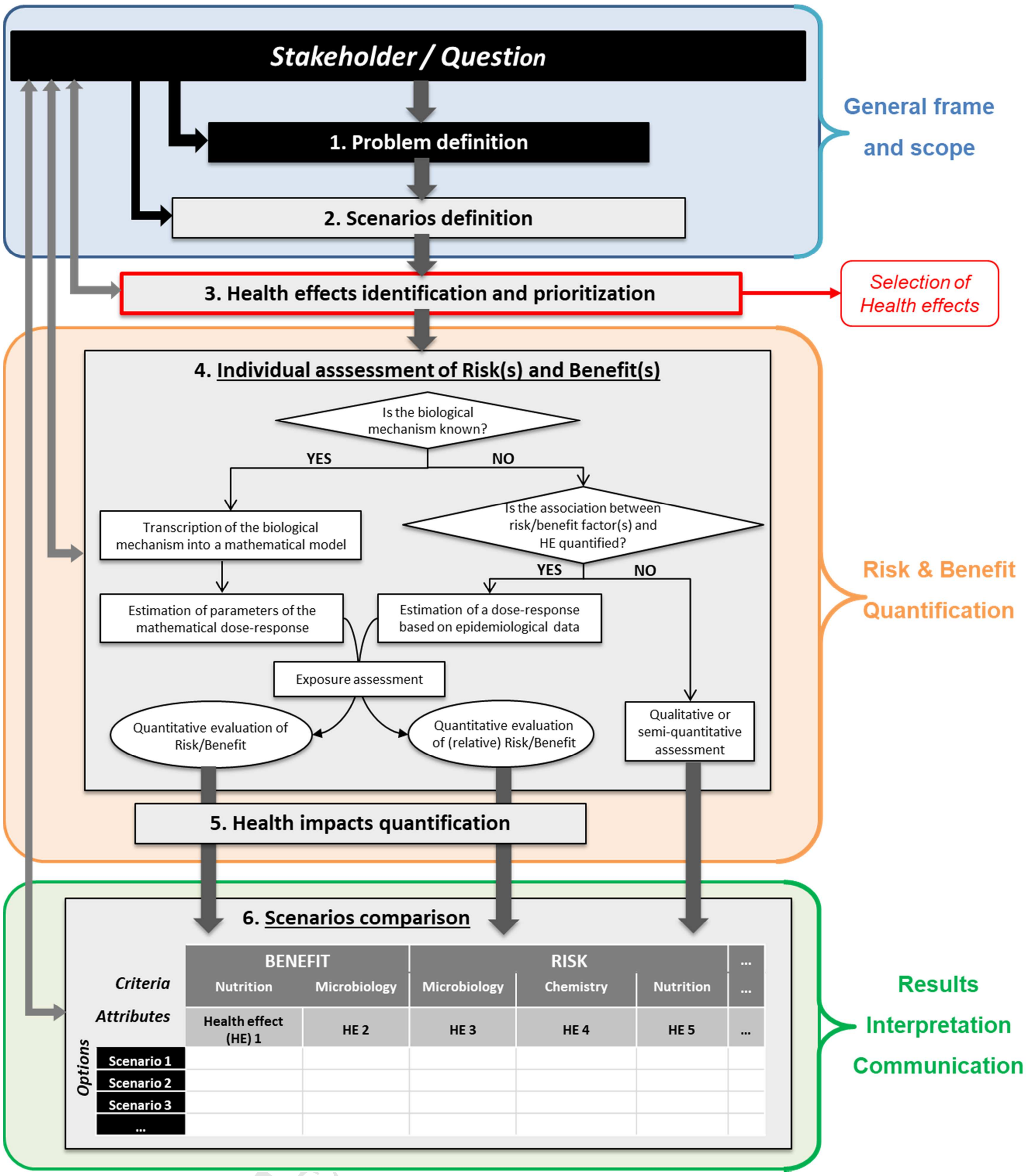

Figure 3. Flowchart of RBA stepwise approach followed under RB4EU activities (adapted from Boué, 2017).

Highlights

- Risk-benefit assessment (RBA) aims to estimate health benefits and risks of foods
- Capacity building actions contribute to acquire scientific foundation on RBA
- RiskBenefit4EU project aims to strengthen the EU capacity to perform RBA
- A capacity building strategy was developed and implemented under RiskBenefit4EU
- Lessons learned through this capacity building process were reviewed and discussed