Editorial: **Quantitative tools for sustainable food and energy in the food chain**

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Food production is vital to the competitiveness of the European food industry - one of the largest manufacturing sectors with a turnover of c. €1 trillion in the EU and the highest level of employment (4.2 million people in 2017) (FoodDrinkEurope, 2017). The sector also has a direct impact on human and environmental health and vitality of the human population. Food safety and quality worldwide faces increased pressures and challenges arising from the globalisation of food trade, intensive production systems and changing consumer preferences (FAO, 2017). The EU has highlighted the need to double food production by 2050 to cater for population growth. This potential expansion is not without its resource and environmental concerns or costs (Freibauer etal., 2011; Tomlinson, 2013). The ongoing challenge for the entire food sector isto produce high quality safe food in a sustainable manner. Food production, consumption and waste (products and water) are major contributors to environmental degradation and GHG emissions: the impact of production and consumption accounts for 20% to 30% of the impact of private energy demand (Tukker etal., 2006). Improvements to the food chain to reduce water and energy consumption and to prolong shelf life are essential for food safety and sustainability (FAO, 2017).

Awareness of consumer and product safety has probably never been so high. Significant food crises in Europe during the past number of years have given rise to concerns about food products put on the market. Health scares, including the outbreak of Shiga toxin producing E. coli (STEC) O104:H4, BSE crisis, growth hormones in meat, dioxin, sudan red and avian flue scares, have made consumers more wary about the origin, traceability and safety of the food they eat (Pederson & Hernández, 2014). On the other hand it is estimated that the food chain is responsible for the release of 195 MtCO2e and for the generation of 15 Mt. of food waste, of which the vast majority have the potential to be reused as a resource into the food chain, causing significant environmental impacts. Life Cycle Assessment (LCA) and related tools (such as carbon or water footprints) have proved to be essential and valuable decision-making support elements in the evaluation of the environmental performance of food value chains. For example, Jensen and Arlbjørn (2014) and Liu, Wang, and Su (2016) calculated the carbon footprint of food

products, while Rivas Ibáñez, Molina Ruíz, Román Sánchez, and Casas López (2017) and Roibás, Martínez, Goris, Barreiro, and Hospido (2016) used the water footprint as part of a performance evaluation. Making improvements to the food chain to reduce energy use, materials consumption and waste generation, as well as to prolong shelf life is essential for food security and sustainability but represents a significant challenge for the industry.

In order to achieve a balance between feeding a growing population and optimizing safety, quality and sustainability, there is a need to be more proactive in our approaches for quality surveillance in foods while making improvements to the food chain. Food safety and sustainability has become a priority research area worldwide as the global food supply evolves (Kendall etal., 2018).

Predictive modelling, LCA and quantitative (microbial, chemical) risk assessments all play crucial roles in ensuring food quality and safety around the globe. Predictive tools and risk assessments are used by the food industry, policy makers and managers to formulate and implement risk management policies and controls with the view to protecting human health. The added value of quantitative tools for advancing research in the area of predictive modelling, risk assessment and LCA is well recognized worldwide and in this context this special issue deals with quantitative tools for sustainable food and energy in the food chain, with a specific focus on the extended works presented at the conference Quantitative Tools for Sustainable Food and Energy in the food chain (Q-Safe under the ERASMUS+ programme KA2) (10–12April 2017, Syros, Greece). Submissions address one of the following core themes: 1)Modelling in bioscience and food with a focus on predictive microbiology and computational mathematics; 2)Quantitative Microbial Risk Assessment (QMRA) with a focus on QMRA in food processing and storage and analysis of uncertainty and variability; 3) Process modelling and LCA with a focus on energy use, environmental performance and sustainability. The special issue is a culmination of works in the area from many researchers across the globe.

The editors would like to thank all the authors for their significant contributions and for sharing their valuable work. The editors would also like to extend a sincere thanks to the many reviewers who gave their time and expertise to critically review all submissions and provide constructive comments. Much appreciation also goes to Prof. Anderson de Souza Sant'Ana, Editor-in-chief of Food Research International, for his support of the special issue and also the extended Elsevier team for their assistance in making this special issue a reality. We hope you, the reader, will enjoy the suite of works presented and develop new knowledge on quantitative tools for sustainable food and energy in the food chain.

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