Novel insights into the health effects of fruits and vegetables

8

Impact paragraph

8.1 THE SOCIETAL IMPACT OF PREVENTING NON-COMMUNICABLE DISEASES

Non-communicable diseases (NCDs) are the leading cause of death worldwide, accounting for 71% of total deaths each year [1]. The four major NCDs with the highest number of deaths are cardiovascular diseases (CVD) (17.9 million deaths annually), cancers (9.0 million), respiratory diseases (3.9 million), and type II diabetes (T2DM) (1.6 million) [1]. NCDs threaten progress towards the 2030 Agenda for Sustainable Development, which includes a target of reducing the probability of death from any of the four main NCDs between ages 30 and 70 years by one-third. NCDs place a significant and growing burden on the health care system and the overall global economy [2]. Therefore, primary prevention of NCDs is essential to reduce morbidity, mortality, and disability related to those prevalent illnesses. Therapeutic targeting of chronic inflammatory processes, which were shown to be a significant risk factor for NCDs, has been attracting much interest as a promising preventive strategy [3–13].

Many advances have been made in the prevention of chronic low-grade inflammation (CLGI), including the implementation of dietary interventions. Adopting a healthy diet may support preventing the onset and progress of such conditions [3,6,14–20]. As previously highlighted in this thesis, whilst observational data indicate that diets rich in fruits and vegetables have a particularly positive effect on the inflammatory status and prevent the development of various NCDs [21–31], causal relationships have so far not yet been established [32–34]. This is partially attributed to the use of classical methodologies in nutrition research [17,20,21,32–41]. Nutrition can be expected to exert subtle effects on many pathways involved in the development of chronic diseases, whilst pharmacology is still dominated by the "one disease - one target - one drug" paradigm [15–20,42]. Methodologies in nutrition research however often follow this pharmacological paradigm. Thus, there is an urgent need for more novel approaches to investigate the health-promoting effects of nutrition, in particular for fresh produce.

In the PRO SANI study described in this thesis, we provide evidence that the effects of fresh produce on inflammation can be measured within hours with the highest degree of evidence (a double-blind RCT). We found that the use of integrative outcomes measures, non-invasive biomarkers, and heart rate monitoring can be seen as an efficient new approach to studying the subtle and pleiotropic effects of nutrition on inflammation. Challenging our resilience, e.g. the standardized caloric load used in our RCT, sheds new light on the health effects of fruits and vegetables and even allow for establishing cause-and-effect relationships. These results emphasize the need to study fruits and vegetables as a whole, rather than individual components often found in supplements. This can

promote consumer acceptance of fruit and vegetables and may break the notion that unhealthy diets supplemented with food supplements are healthy.

In addition, these effects were demonstrated in healthy participants, which is essential for substantiating potential health claims on food products. To support understanding of health benefits of foods and potentially functional food innovation, scientific risk assessment has to make use of these new developments. For this, it is fundamental to continuously review guidelines and implement new measurement methods in assessment procedures. Once challenge testing is validated and implemented, and scientific evidence is subsequently provided, future claims on fruit and vegetables are within reach. Subsequently, consumers can be exposed to these claims in the supermarket. This may lead individuals to make healthier choices, which is in line with most global discussions that address the risk factors of self–management and focus on the role of individual responsibility to manage the risk factors of NCDs. At the same time, policymakers can use this empirical substantiation of the health benefits of these products in defending legislative changes, such as VAT exemption on fruit and vegetables. Taken together, the new knowledge generated in this thesis can support information provision to consumers of health benefits and the development of evidence-based health policies. Both can contribute to increasing the consumption of fruits and vegetables, in turn reducing the global rise in NCDs and its health-related and economic consequences.

8.2 SCIENTIFIC AND COMMERCIAL IMPACT – NEXT STEPS TOWARDS INNOVATION

The research field for the prevention and treatment of NCDs shows a paradigm shift from studying each disease separately, towards a more holistic approach to understanding NCDs are multifactorial and caused by complex gene-environment interactions [43]. This proposed holistic strategy encompasses comprehensive patient-centered integrated care and multi-scale, multi-modal and multi-level systems approaches to tackle NCDs as a common group of diseases. In other words, intertwined gene-environment, socioeconomic interactions, and comorbidities leading to individual-specific complex phenotypes will be taken into account [43].

In the PRO SANI trial, the clear associations between heart rate parameters and circulatory inflammation biomarkers demonstrate the involvement of multiple organs and systems in the inflammatory response. The mild pro-inflammatory effect observed in the circulatory system and the beneficial effect on urinary platelet response caused by sulforaphane further demonstrate the complex interaction between integrated networks and mechanisms. For future nutritional research, these innovative measurements could

be widely used in the general population moving testing outside of the clinical setting. The scientific insights of the current work, together with future studies using integrative research approaches, may ultimately provide the much-needed evidence to develop research portfolios that will support the development of new healthy food products and associated health claims.

Already whilst undertaking this research project, different researchers and companies have shown interest in the methodology and findings of the PRO SANI study. In addition, this research project helped to strengthen collaborations between different partners, including academic, private, and public institutions. This is not only beneficial for future research projects but also allows for supporting the swift translation of research findings into real-world innovations. The research in this thesis is partly funded by industrial partners (food companies) that could use the presented findings as leads for future product development and health claim portfolios. Furthermore, the experiments performed in this thesis are relatively fast, accessible, and inexpensive compared to other, more pharmacological approaches. Since food business operators – often SMEs – usually don't have the resources for research and development that pharmaceutical companies do, this accessibility can be a decisive factor in stimulating research into their products.

The approach taken in the PRO SANI study and the results from our work have been and will be actively shared within the academic community and outside of that, with students, organizations active in the fruit and vegetable sector, as well as the general public. So far, this has resulted in the development of new PBL cases and lectures in University and University of Applied Sciences educational programs, coverage on social media and articles, columns and interviews in trade journals and other pressed media. The findings were shared within the scientific community via (inter)national conferences and by publishing all work open access. These activities will further promote the dissemination of information on the health effects of fruits and vegetables to scientists, health care professionals, food business operators and the general population.

8.3 REFERENCES

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