Editorial

The Chemistry behind Health Effects of Whole Grains

Cereal foods constitute a backbone of human diet all over the world and are typically the most important sources of energy and dietary fiber intake. Cereals typically contribute about 50% of dietary fiber intake in western countries. A high whole grain (WG) intake has been consistently associated with reduced risk of developing type 2 diabetes, cardiovascular diseases, and colorectal cancer, mainly based on evidence from observational studies [1, 2]. A major challenge in this area of research is that the active components and the underlying mechanism have not been fully explored. Dietary fiber has been reported to be responsible for the health effects of WG consumption. Evidence from in vitro and rodent studies is emerging that, in addition to dietary fiber, the unique phytochemicals in WGs may in part contribute to these health-promoting effects. WGs are rich sources of various bioactive phytochemicals, which are structurally diverse secondary metabolites synthesized by plants. Different WGs may have different phytochemicals. The chemical profiles of the major WGs are still largely unknown. A major group of phenolic compounds in WG wheat and rye is the 5-n-alkylresorcinols (ARs). Among commonly consumed foods, ARs are present in high amounts only in the outer layer of wheat and rye. Avenanthramides (AVAs) and avenacosides A and B are phytochemicals unique to WG oats. To improve the understanding of WG foods for human health, there is a need to further study the roles of specific phytochemicals in WGs for chronic disease prevention.

The aim of this special issue is to provide a comprehensive summary and update the current knowledge on bioactive phytochemicals in WGs and their roles in human health. Such knowledge could pave the way for development of tailored raw material, food processing techniques and dietary advice for optimal health. This special issue includes five reviews and seven research articles.

As highlighted by Bach-Knudsen et al., phytochemicals especially phenolic acids and lignans, which are conjugated with fiber in grains, are enriched in the outer layers of the grains, referred to as the dietary fiber complex. This makes it difficult to elucidate the separate effects of dietary fiber and these phytochemicals. Most likely there are synergies between fiber and phytochemicals. Zhu et al. summarized the phytochemicals identified in WG wheat including ARs, benzoxazinoids, phytosteroids, sphingolipids, lignans, flavonoids, phenolic acids, fatty acids, glycolipids, tocols, carotenoids, and other minor components, as well as their bioactivites. Sang et al. updated the current knowledge on the chemistry, stability, bioavailability, and health effects of two unique phytochemicals in oats, AVAs and avenacosides A and B, and conclude that studies on the beneficial effects of AVAs and avenacosides A and B are still in their infancy, and additional health benefits of these unique oat components may yet be identified. Tang et al. reviewed the major phytochemicals in quinoa and amaranth, the two pseudocereal grains, and their antioxidant and anti-inflammatory activities.

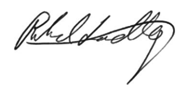
One of the research hypes of today is on the role of gut microbiota in human health, and we know that dietary fiber plays an important role in modifying gut microbiota into a healthier direction [3]. But less is known about the interactions of gut microbiota with phytochemicals in WGs. Koistinen et al. outlined recent insights gained on the microbial and endogenous metabolic conversions of phytochemicals found in rye. Gimenez-Bastida et al. reported the antioxidant, anti-glycation, and anti-inflammatory effects of buckwheat flavonoids and their microbial-derived phenolic metabolites. And Wang et al. presented for the first time gut microbiota derived metabolites from avenacosides in oats. Research is needed to elucidate to what extent gut microbiota mediated-effects on health can be explained by the bioactive compounds in WGs.

Many epidemiological studies have failed to generate consistent results on the beneficial health effects of WG intake due to a lack of tools to accurately assess dietary intake. Wang et al. and Wierzbicka et al. have discovered promising specific dietary biomarkers of WG oats, wheat, and rye, respectively. Such biomarkers will facilitate epidemiological studies on the role of specific grains for human health and advance our knowledge beyond mere association among WG intake and health and disease etiology.

Rapid developments in metabolomics now allow high-throughput screening of bioactive compounds in cereal grains and has sped up the discovery of new dietary biomarkers. Shewry et al. illustrated elegantly how ^{1}H-NMR spectroscopy can be used as a rapid high-throughput method to determine diversity within and between species, and to quantify individual components that may affect the quality of wheat-based foods for human consumption. Shi et al. reported differences in the extended postprandial plasma metabolome of healthy subjects after intake of WG rye porridges versus refined wheat bread using targeted metabolomics.

The two final manuscripts in this collection shed light on the underlying mechanisms of the observed health effects of WG intake. By investigating gene expressions in the liver and small intestine of oat-treated mice, Andersson et al. reported that retention of bile acids in the intestinal lumen rather than decreased uptake capacity is an important mechanism of action behind the cholesterol-lowering effect of oats. Agah et al. provided new insights on the synergistic effects of sorghum flavones and legume flavonols against LPS-induced inflammation, indicating that phytochemicals in WGs may generate their health effects via interactions with compounds in other foods.

As shown by the findings in this special issue, the chemistry remains one of the core players behind the health effects of grains and should be studied in more detail.



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