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New hypotheses for the health-protective mechanisms of whole-grain cereals: what is beyond fibre?

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Epidemiological studies have clearly shown that whole-grain cereals can protect against obesity, diabetes, CVD and cancers. The specific effects of food structure (increased satiety, reduced transit time and glycaemic response), fibre (improved faecal bulking and satiety, viscosity and SCFA production, and/or reduced glycaemic response) and Mg (better glycaemic homeostasis through increased insulin secretion), together with the antioxidant and anti-carcinogenic properties of numerous bioactive compounds, especially those in the bran and germ (minerals, trace elements, vitamins, carotenoids, polyphenols and alkylresorcinols), are today well-recognised mechanisms in this protection. Recent findings, the exhaustive listing of bioactive compounds found in whole-grain wheat, their content in whole-grain, bran and germ fractions and their estimated bioavailability, have led to new hypotheses. The involvement of polyphenols in cell signalling and gene regulation, and of sulfur compounds, lignin and phytic acid should be considered in antioxidant protection. Whole-grain wheat is also a rich source of methyl donors and lipotropes (methionine, betaine, choline, inositol and folates) that may be involved in cardiovascular and/or hepatic protection, lipid metabolism and DNA methylation. Potential protective effects of bound phenolic acids within the colon, of the B-complex vitamins on the nervous system and mental health, of oligosaccharides as prebiotics, of compounds associated with skeleton health, and of other compounds such as α-linolenic acid, policosanol, melatonin, phytosterols and *para*-aminobenzoic acid also deserve to be studied in more depth. Finally, benefits of nutrigenomics to study complex physiological effects of the 'whole-grain package', and the most promising ways for improving the nutritional quality of cereal products are discussed.

Whole-grain wheat: Bioactive compounds: Physiological mechanisms: Health

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Introduction

There is growing evidence that whole-grain cereal products protect against the development of chronic diseases. The most important of these in terms of public health are obesity[1,2], the metabolic syndrome[3,4], type 2 diabetes[5,6], CVD[7] and cancers[8–12]. Whole-grain cereal consumption has also been shown to be protective against mortality, as was shown with inflammation-related death (i.e. non-cardiovascular and non-cancer inflammatory diseases such as, for example, respiratory system diseases)[13] and with cancer and CVD[4,14,15]. These conclusions are supported by the effects of consuming refined cereal products (bread, pasta and rice), as these have been associated with an increased risk of digestive tract, pharynx, larynx and thyroid cancers in northern Italians[16]. However, an association between a lower risk of developing a chronic disease and a high whole-grain cereal consumption does not mean a direct causal relationship and provides no information about the physiological mechanisms involved.

These metabolic diseases are related to our daily lifestyle, notably an unbalanced energy-rich diet lacking fibre and protective bioactive compounds such as micronutrients and phytochemicals. Today, it is agreed to advance that this is the synergistic action of the compounds, mainly contained in the bran and germ fractions of cereals, which is protective[17,18]. Some specific mechanisms are today well recognised. For example, food structure influences satiety and the slow release of sugars recommended for type 2 diabetes. Dietary fibre improves gut health, and the antioxidant and anti-inflammatory properties of most phytochemicals can help

Abbreviations: AACC, American Association of Cereal Chemists; DW, dry weight; FRAP, ferric-reducing ability of plasma; GI, glycaemic index; GSH, reduced glutathione; GSSG, oxidised glutathione; RS, resistant starch; USDA, US Department of Agriculture.

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