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Whole-Wheat Bread for Human Health

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His Staple Highness – The Intact Kernel



Preface

Whole wheat with high kernel envelope content and with relatively small endosperm was the main staple food and the main pillar of the Western civilization during the millennia when the Western civilization evolved. The plethora of anti-oxidant components that are mostly bound to carbohydrates and the related ingredients have protected and enabled the survival of wheat kernel and supported its spreading over the globe. With wheat cultivation, these compounds have sustained the human population. However, during the long run of wheat breeding, wheat was selected for a higher kernel weight and a higher endosperm (starch) content, followed by an extreme decrease in the dietary fiber and a marked reduction in hundreds of compounds, maintaining the anti-oxidant capacity and other compounds with alleviative flour quality of health claim. Along with the history of wheat cultivation and harvesting, wheat flour is consumed unrefined. Since the ancient eras, tiny amounts of wheat flour were refined to produce white flour with a higher quality of dough but with a lower nutritious quality. People have used to believe that white bread is most nutritious than the black whole bread. Such a notion is still believed.

The industrial revolution, at the second half of the nineteenth century, enabled mass refining of flour and drove more and more people to consume refined flour and throw away most of the nutritious ingredients embedded in the wheat bran for animal feeding.

The main target of the present book is to restore the consumption of the whole-wheat bread for the well-being of the people.

In the last two to three decades, the quality of dough and the baking quality of whole flour have tremendously improved by the introduction of a long list of baking improvers and baking technologies. Concomitantly, the nutritious predominance of the whole-wheat flour was gradually explored and published. Thus, the advantage of the whole bread has become a fundamental nutritional recommendation. Even so, whole bread consumption, in most of the countries, covers less than 20% of bread consumption.

As we clearly show (Chap. 15), the consumption of the whole bread lowers the incidence of many NCD (noncommunicable disease) very significantly. This impact is evaluated by 20 categories of morbidity and cause of mortality, including various vascular disorders and malignancy incidence, based on studies including more than 37 million subjects, within hundreds of studies around the globe.

Such an evidence-based effect, produced by consumption of one essential food has presumably never been previously shown. The facts presented here might help to convince health authorities to undertake active measures to recommend and enhance whole bread consumption.

We presume that beyond the reduction in the relative risk of morbidity and mortality, by a routine whole bread, it would also reduce the disability years of aging. Such a burden embraces a major load on the individual, his family, and the society which is estimated to have an average of 3 hard life years for each individual. The explanation for such an effect is described in details in this book.

The incidence for each of the 19 defined categories of morbidity and mortality has reduced by about 25% (relative risk of 0.75) in subjects consumed whole-wheat bread versus refined-flour bread.

The dietary fiber is considered as the major or the sole element supporting the health benefit of the whole bread. Indeed, adequate consumption of the whole bread accomplishes the prevailed inadequate dietary fiber intake. However, the dietary fiber is only part of the whole bread story since it contains a wide plethora of other ingredients and particularly the bound phenolic compounds found in high concentration in the whole bread.

The consumption of white bread has severely contradicted the food security fundamental issue that is accepted by all health authorities. This book presents data concerning the composition and the average concentrations of hundreds of the kernel compounds gathered from over 210 publications with further description of these ingredients.

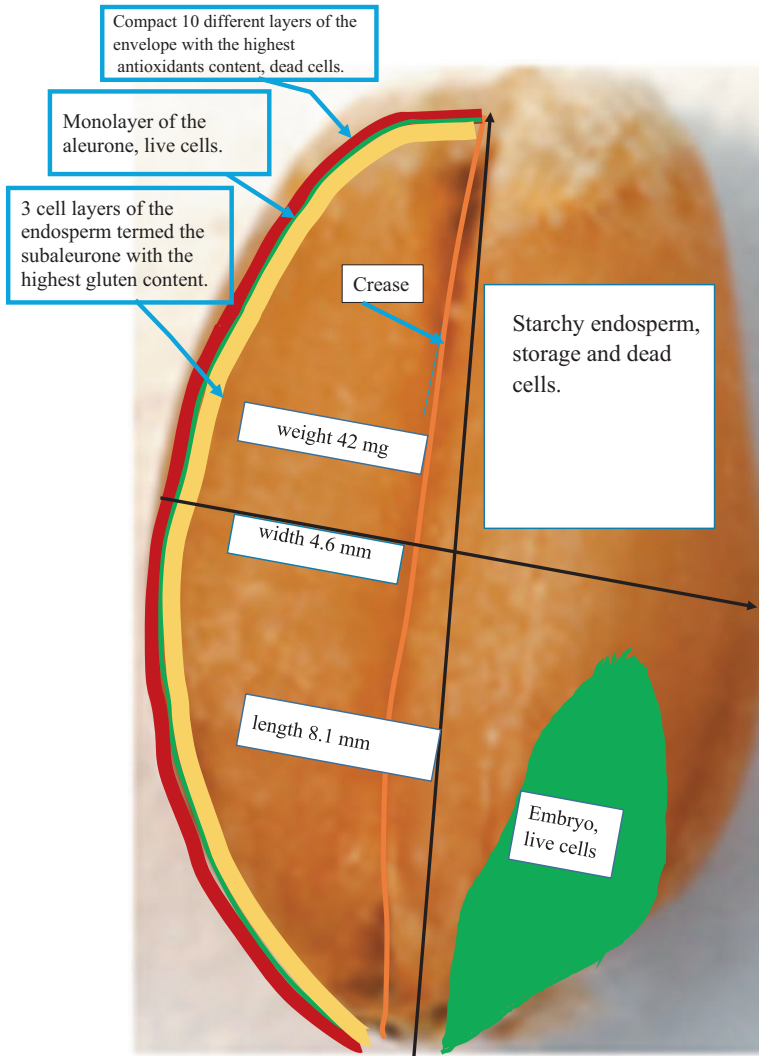
Except for the effect of the whole bread on the decrease in the incidence of the main morbidities, some other effects are described such as those of the yellow pigments on ophthalmologic burdens and various ingredients of the whole bread on the aging of cellular activities such as autophagy with its major role in the brain integrity.

Adherence to the gluten-free diet (GFD) is an important practice to prevent damage for the celiac wheat-sensitive people that comprise a small population segment (<1%). However, expanding of such practice for other people deprived them from the wide benefits of the wheat kernel and surges the dietary expenses. The description of the celiac and the wheat sensitivity issues are also detailed here as well as the possible damage of the unnecessary use of GFD.

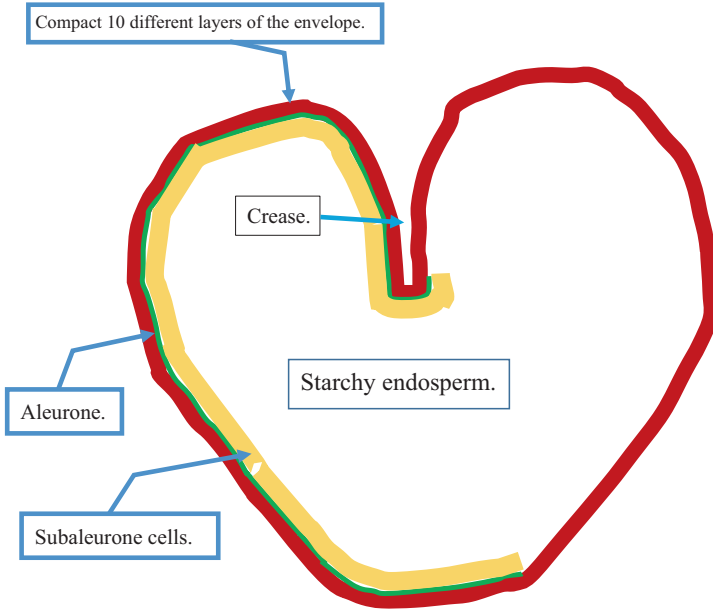
Industrial and the homemade whole wheat bread techniques with precise recipes are presented in the latter part of this book.

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A scheme of the longitudinal aspect of the wheat kernel. The embryo and the aleurone layer (green) are the only live kernel cells on dormancy. The envelop (red) that protects the kernel is a compact tissue composed of ten different layers that protect the kernel with the highest anti-oxidant content. The sub-aleurone layers (yellow) are part of the starchy endosperm and contain the highest gluten content that probably might have a role against the pests. These cells are “prismatic,” while the “central” cells are more variable in shape. The white starchy endosperm layers compose the main kernel content. During grinding and refining, the sub-aleurone layer remained attached to the white flour while the aleurone layer leftover with the bran.



A scheme of the transverse aspect of the wheat kernel. The crease area which is an important kernel area on its development, stays intact on the debranning phase during the initial grinding process.

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- Fig. 5.1 α -linoleic acid (C18:2), shown in two graphical presentations. α -linoleic acid is a doubly unsaturated fatty acid, also known as an omega-6 fatty acid, occurring widely in plant lipids. In this particular polyunsaturated fatty acid (PUFA), the first double bond is located between the 6th and 7th carbon atom from the methyl end of the fatty acid (n-6). Linoleic acid is an essential fatty acid in human nutrition because it cannot be synthesized by human tissues. It is used in the biosynthesis of prostaglandins (via arachidonic acid) and cell membranes (HMDB) 85
- Fig. 5.2 α -linolenic acid (C18:3), shown in two graphical presentations. α -linolenic acid (ALA) is a polyunsaturated fatty acid (PUFA) with 3 double bonds (unsaturated). It is a member of the group of essential fatty acids called ω -3 fatty acids. α -linolenic acid, in particular, is not synthesized by mammals and therefore is an essential dietary requirement. The ω -3 fatty acids get their name based on the location of one of their first double bond. In all ω -3 fatty acids, the first double bond is located between the third and fourth carbon atom counting from the methyl end of the fatty acid (n-3). Although humans and other mammals can synthesize saturated and some monounsaturated fatty acids from carbon groups in carbohydrates and proteins, they lack the enzymes necessary to insert a cis double bond at the n-6 or the n-3 position of a fatty acid. ω -3 fatty acids like α -linolenic acid are important structural components of cell membranes. When incorporated into phospholipids, they affect cell membrane properties such as fluidity, flexibility, permeability and the activity of membrane-bound enzymes. Linoleic acid is an essential fatty acid that must derive from food for proper health (HMDB) 86
- Fig. 6.1 The glucose which composes the building block of the starch, glycogen, and the cellulose and other polymers, shown in two graphical presentations. D-Glucose is a monosaccharide containing six carbon atoms with an aldehyde group and therefore referred to as an aldohexose. The glucose molecule can exist in an open-chained (acyclic) and ring (cyclic) form, the latter being the result of an intramolecular reaction between the aldehyde C atom and the C-5 hydroxyl group to form an intramolecular hemiacetal. In water solution, both forms are in equilibrium and at pH 7 the cyclic one is predominant. The glucose is a primary source of energy for the living organisms. It is naturally occurring and found in fruits and other parts of the plants in its free state. In the animals, the glucose arises from the breakdown of glycogen. The glucose synthesized in the liver and the kidneys from

- non-carbohydrate intermediates, such as pyruvate and glycerol, by a process known as gluconeogenesis. The starch composes entirely from the glucose (Bertoft 2017). Water solubility 1.2 g/mL; density 1.54 g/mL. 94
- Fig. 6.2 The amylose. The amylose defined as a linear molecule of (1→4) linked α -D-glucopyranosyl units but is well established that some molecules are slightly branched by the (1→6)- α -linkages. The oldest criteria for the linearity consisted of the susceptibility of the molecule to complete hydrolysis by the β -amylase. This enzyme splits the (1→4) bonds from the non-reducing end of a chain releasing the β -maltosyl units but cannot cleave the (1→6) bonds. When degraded by pure β -amylase, linear macromolecules completely converted into maltose, whereas branched chains give also one β -limit dextrin consisting of the remaining inner core polysaccharide structure with its outer chains recessed. The starches of the different botanical origins possess different granular sizes, morphology, polymorphism, and enzyme digestibility. These characteristics related to the chemical structures of the amylopectin and the amylose and their arrangement in the starch granule (HMDB). 95
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- Fig. 6.5 Galactose, mannose, and fructose (gray, red and white balls are carbon, oxygen, and hydrogen, respectively) (Wikipedia), shown in two graphical presentations. **(a)** β -D-galactose is an aldohexose that occurs naturally in the D-form in lactose, cerebrosides, gangliosides, and mucoproteins. The D-galactose is an energy-providing nutrient and a necessary basic substrate for the biosynthesis of many macromolecules in the body. The metabolic pathways for the D-galactose are important not only for the provision of these pathways but also for the prevention of the D-galactose and the D-galactose metabolite accumulation. **(b)** D-Mannose: A high-mannose-type oligosaccharides have shown to play important roles in the protein quality control. **(c)** D-fructose, or levulose, is an isomer of glucose. Fructose is the sweetest naturally occurring sugar, estimated to be twice as sweet as sucrose with a “fruity” aroma. Although the fructose is a hexose, it generally exists as a 5-member hemiketal ring (a furanose that is responsible for the long metabolic pathway and high reactivity) compared to glucose. It used as a preservative and an intravenous infusion in parenteral feeding 98
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- Fig. 7.3 Metabolites of the hemicellulose (HMDB).
(a) 4-O-Methyl-a-D-glucosyl-(1→2)-b-D-xylosyl-(1→4)-D-xylose. **(b)** 2-O-b-D-Xylopyranosyl-L-arabinose is found in cereals and cereal products. **(c)** 4-O-Methyl-a-D-glucosyl-(1→2)-b-D-xylosyl-(1→4)-D-xylose is found in cereals and cereal products. 4-O-Methyl-a-D-glucosyl-(1→2)-b-D-xylosyl-(1→4)-D-xylose is from oat hull hemicelluloses. **(d)** Aldobiouronic acid D3 is found in cereals and cereal products. Aldobiouronic acid D3 is isolated from }partial acid hydrolysates of gum chagual (*Puya* species) and the hemicelluloses from corn hulls and wheat bran 114
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Like the cysteine, the glutathione contains the crucial thiol (-SH) group that makes it an effective anti-oxidant. The most important of these are the redox reactions, in which the thiol grouping on the cysteine portion of cell membranes protects against peroxidation; and conjugation reactions, in which GSH binds with toxic chemicals to detoxify them. Apart from the role in storage and transport of reduced sulfur glutathione takes part in the detoxification of reactive oxygen species, directly or indirectly acting in the reactive oxygen species detoxification, glutathione participates in methylglyoxal detoxification. It acts as a cofactor in different biochemical reactions, it interacts with hormones, signaling molecules, and its redox state triggers signal transduction. Glutathione modulates cell proliferation, apoptosis, fibrogenesis, growth, development, the cell cycle, gene expression, protein activity, and immune function (Hasanuzzaman et al. 2017). It is a coenzyme in various enzymatic reactions. The GSH is a cofactor for the enzyme GSH peroxidase (HMDB) 146

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- and comes in 2 main primary forms: α - and β -carotene, and also γ -, δ - and ϵ -carotenes. Carotene can be stored in the liver and converted into retinol as needed. The β -carotene is an anti-oxidant and such can be useful for curbing the excess of damaging free radicals in the body. However, the usefulness of β -carotene as a dietary supplement (taken as a pill) is still subject to debate. The β -carotene is fat-soluble, so a small amount of fat needed to absorb it into the body. 153
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methionine, also producing N, N-dimethylglycine. The donation of the methyl groups is important for proper liver function, cellular replication, and detoxification reactions. Betaine also plays a role in the manufacture of carnitine and serves to protect the kidneys from damage. Betaine derived from the diet or by the oxidation of choline. Betaine insufficiency is associated with metabolic syndrome, lipid disorders, and diabetes, and may have a role in vascular and other diseases. Betaine is important in development, from the pre-implantation embryo to infancy. Betaine is also widely regarded as an anti-oxidant. Betaine has shown to have an inhibitory effect on NO release in the activated microglial cells and may be an effective therapeutic component to control neurological disorders. As a drug, betaine hydrochloride was used as a source of hydrochloric acid in the treatment of hypochlorhydria. Betaine has also used in the treatment of liver disorders, for hyperkalemia, for homocystinuria, and gastrointestinal disturbances (HMBD). In the USA, the average dietary betaine intake is about 100–300 mg/day and rarely exceeds 400–500 mg. Human blood plasma typically contains 25–66 μM (Hefni et al. 2018; Bjørndal et al. 2018). 164

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- (HMDB). (c) *cis*-Ferulic acid [arabinosyl-(1->3)-[glucosyl-(1->6)]-glucosyl] ester. (d) **Diferulic acids** (also known as dehydrodiferulic acids) are formed by dimerization of the ferulic acid and found in the cell wall of the plant (Wikipedia) 185
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