

Increasing Whole Grain Consumption in China: Processing and Sensory Challenges

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ABSTRACT

Whole grains and their products have existed or been introduced worldwide, but there are still some challenges facing researchers and food manufacturers. This article focuses on the current development status of whole grains and the processing and sensory challenges to increasing whole grain food consumption in China. Whole grain foods have been consumed in China for centuries; however, refined grain products became more popular with advances in grinding technology. In recent years, a decline in people's health has reminded consumers that whole grain foods are excellent alternatives in a healthy diet. The market share of whole grain foods started to increase at a very fast pace in China at the beginning of the 21st century. Processing technology is a key factor influencing the expansion of whole grain products. Due to the darker color and larger particle size of bran and active enzymes in the germ, whole grain foods usually present an undesirable appearance, mouthfeel, and shelf life. Grinding of the entire kernel, sprouting, fermentation, and extrusion techniques have shown great benefits in improving the texture and sensory characteristics of whole grain foods. Because of nutrient loss during processing, a balance between desirable flavor and nutritional value should be considered for future innovations in whole grain processing technology.

Whole grains contain intact, ground, or flaked caryopses in which all components, such as bran, germ, and endosperm, are present in the same relative proportions as in the intact grain (8). Generally, whole grains include wheat, barley, rye, maize, oats, buckwheat, millet, sorghum, amaranth, quinoa, teff, triticale, brown and colored rice, and wild rice. In 1993, the U.S. Food and Drug Administration (FDA) first defined whole grain foods as those in which the weight of whole grain comprises more than 51% of the total food weight. Since then, the definition of whole grain foods has been updated by several relevant organizations, such as the Whole Grains Council and the U.S. Department of Agriculture (USDA). Many epidemiological and clinical studies show that the long-term intake of whole grains provides many benefits to patients suffering from chronic diseases such as obesity, diabetes, and certain cancers (3). In light of the health-related benefits that whole grains can provide, the development and popularization of whole grain foods can play an important role in altering dietary patterns and improving the health conditions of people.

Current Development Status of Whole Grains in China

Whole grain foods have been consumed in China for centuries. For example, *youmian* noodles, which are made with hullless oats,

are a traditional staple food in western Inner Mongolia and Shanxi Province of China. They are produced by roasting oat grain, milling it into flour, mixing it with boiling water to form a dough, sheeting the dough into noodle sheets, and forming the noodles into different shapes (Fig. 1). In addition, corn, millet, sorghum, and colored rice have a long history of consumption in China, either as cooked grain or as porridge (Fig. 2). Brown rice is one of the most popular whole grain foods in China, as well as other Asian countries. Brown rice is a good source of vitamins, minerals, and dietary fiber due to the presence of the bran. It is commonly consumed after cooking in water using a rice cooker or milled into rice flour and incorporated into breads and noodles. Along with advances in grinding techniques, refined grain products became more popular in China because of their white color, soft texture, and smooth mouthfeel. However, many nutrients are lost due to finer processing, and a higher incidence of cerebrovascular diseases and obesity has reminded many consumers that whole grain foods

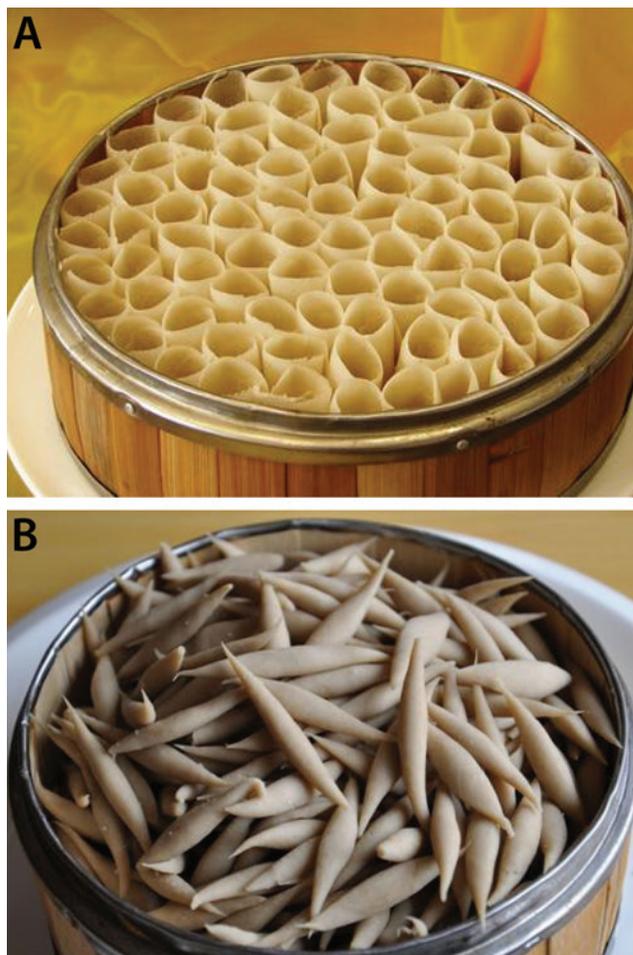


Fig. 1. *Youmian* noodles in China. A, *Youmian* rolls; B, “small fish” *youmian*.

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are an excellent alternative for a health-promoting diet. At the beginning of the 21st century, the market share for whole grain foods began to increase rapidly in China, especially for bakery and breakfast cereal products. The distribution of new food and beverage products with a “whole grain” claim in mainland China from 2000 to 2016 is illustrated in Figure 3 (2). The number of new products with a “whole grain” claim in mainland China from 2000 to 2016 are shown in Figure 4 (2).

Whole grain foods have received wide attention from many sectors of Chinese society, including the government, research institutions, and media. In 2015, the Technical Committee for Standardization of Chinese Cereals and Oils announced its definition of whole grain as being produced from the intact grain by flour milling technology, and all components, including bran, germ, and endosperm, being present in the same relative proportions as in the original grain. This definition is very similar to that of the Cereals & Grains Association (formerly AACC International) and the Whole Grains Council. The *Dietary Guidelines for Chinese Residents* (2016 version) first included whole grain foods and recommended a daily intake of whole grains and beans at 50–150 g. The 10-Year Development Plan for the Grain Processing Industry (2011–2020) issued by the Ministry of Industry and Information Technology and the Ministry of Agriculture drafted plans to facilitate the development of whole grain foods and increase the intake of whole grain foods in China. Scientific research focusing on whole grains grew more than fivefold from 2010 to 2019. Standards for whole grains and whole grain foods are also being developed. The first industrial standard for “whole grain flour” was issued in July 2015. Several industrial associations have also

released standards for “whole grain brew products,” “whole grain bakery products,” and “whole grain extrusion products” (6). In addition, the popularity of the phrase “whole grains” is rapidly increasing in major Internet search engines in China.

Processing and Sensory Challenges

Although there has been great progress in recent years, there are still some challenges hindering expansion of whole grain foods more widely in the Chinese market. Processing technology is a critical factor influencing the development and expansion of whole grain foods. Bran, including the seed coat and pericarp, contains cellulose, hemicellulose, and lignin, which are difficult to grind and commonly possess a darker color and larger particle size than the endosperm. Due to steric hindrance and an undesirable mouthfeel, bran components also cause a disaggregated dough structure and exert an adverse influence on the appearance, texture, and eating-related attributes of whole grain foods. To overcome the drawbacks of whole grain foods and meet the tastes of Chinese consumers, some manufacturers have tried including less bran or adding more sugar or emulsifiers. In addition, unsaturated fatty acids and a variety of enzymes contained in the germ pose difficulties in attaining a shelf life that is similar to refined products. Therefore, the development of whole grain foods with a good appearance and desirable taste using modern processing technologies is a vital challenge that must be overcome by researchers and food manufacturers.

Grinding technology is of vital importance in the production of whole grain foods and is considered an effective way to reduce the negative effects of bran and germ on end-use products. Meth-

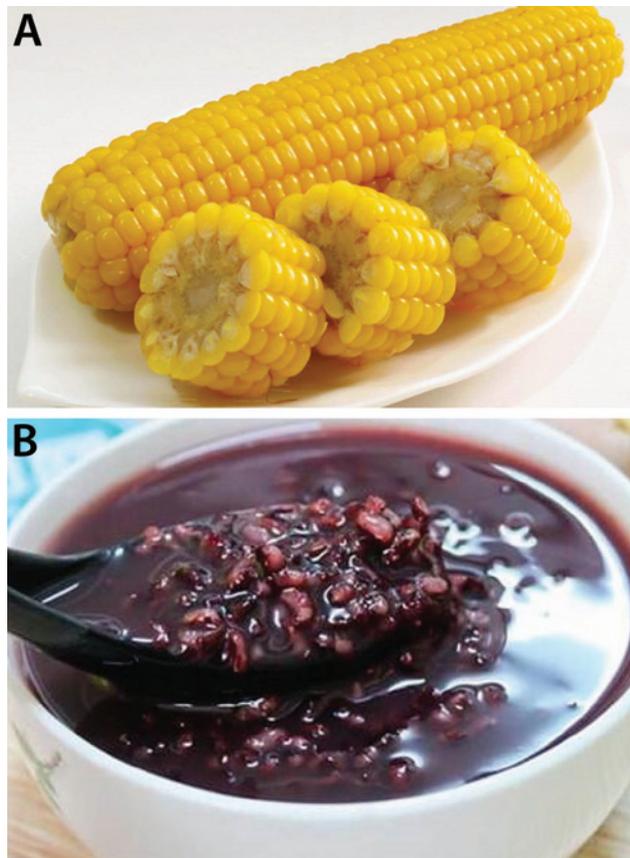


Fig. 2. Examples of traditional whole grain foods in China. **A**, Cooked corn on the cob; **B**, black rice porridge.

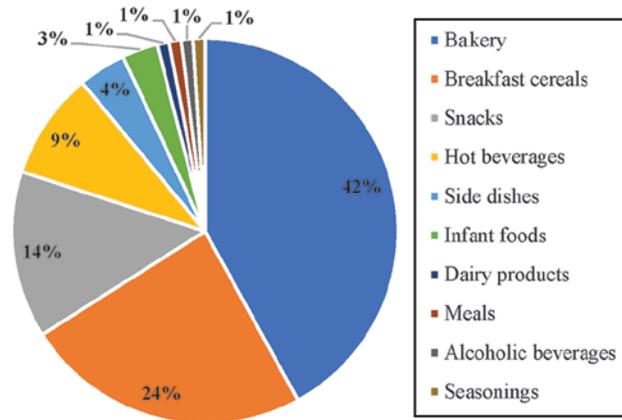


Fig. 3. Distribution of new food and beverage products with a “whole grain” claim in mainland China from 2000 to 2016. (Source: Mintel)

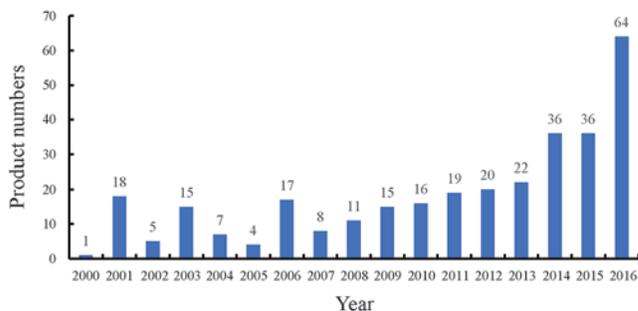


Fig. 4. Number of new products with a “whole grain” claim in mainland China from 2000 to 2016. (Source: Mintel)

ods of grinding the entire kernel have been applied in producing whole wheat flour. Sprouting, fermentation, and enzyme-assisted techniques have proven effective in modifying the technological properties of whole grains and enhancing the textural and sensory attributes of whole grain foods. The gluten quality and dough-mixing performance of whole wheat flour was enhanced after 5–15 hr of controlled germination. Controlled germination also improved nutritional value by increasing the γ -aminobutyric acid content (1). Germination and fermentation of brown rice significantly decreased phytic acid content (56–96% removal) and enhanced zinc bioavailability (4). As for shelf life, extrusion technology was successfully used to prolong the shelf life of whole grain foods by decreasing lipase and amylase activities (10). Additionally, some novel techniques, such as steam explosion, superheated steam, ultra-high pressure, and micro-fluidization, have been noted as having great potential for reducing process inputs and shortening the cooking time of whole grain foods (5,7,9). However, these techniques can induce a loss of nutrients such as phenols, vitamins, and minerals to various degrees, resulting from the mechanical forces, pressure, and heat that are applied during processing. Therefore, a balance between desirable taste and preservation of nutrients should be considered for future innovations in whole grain processing technology.

Future

Although some attempts have been made to increase the acceptance of whole grain foods in China, the lack of desirable textural characteristics remains a major hurdle in expanding whole grain foods in the mainstream marketplace. Several processing challenges need to be overcome to improve the sensory qualities of whole grain foods. Additionally, highly efficient preservation methods are required, especially for fresh products, such as fresh whole wheat noodles, due to the issues of discoloration, fat oxidation, and spoilage caused by microorganisms. Finally, an increase in consumer health-consciousness is crucial to the expansion of whole grain foods. The degree to which people value potential health benefits when purchasing a product influences their interest in choosing whole grain foods. Therefore, consumer education on the nutritional and health benefits of whole grains will play an important role in deepening consumer recognition of whole grain foods and increasing their consumption.

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