Whole grains from farm to fork

An overview for WGS Breeding & Technology World Café Participants

Breeding grains for improved nutrition

Wholegrain cereals are a rich source of health-promoting nutrients and micronutrients, including insoluble and soluble fibre, minerals (notably iron and zinc), phytochemicals and B vitamins. Biotechnology combined with conventional breeding can be used to increase the amounts and optimise the compositions of these components. Strategies may include increasing the aleurone layer (where these components are concentrated), increasing mineral accumulation by manipulating transporters involved in mobilisation in vegetative tissues and transport into the grain, and increasing the biosynthesis of phytochemicals, vitamins and fibre. Starch is the major component in cereal grain and is often associated with high glycaemic load. However, the composition of starch can be manipulated to reduce the digestibility in the small intestine (reducing the glycaemic load) so that it becomes a form of fermentable fibre, associated with beneficial effects on bowel biota and bowel health.

However, the major challenge is to combine these improvements with good processing quality and high consumer acceptability. Many consumers avoid wholegrain products due to the colour, texture and astringency and these effects need to be ameliorated. Similarly, effects on the compositions of major components such as starch and fibre will have impacts on processing properties resulting in limited take up by industry. Biotechnology and breeding should be used to mitigate these negative effects while improving the contents and compositions of beneficial components. This will be facilitated by closer collaboration and communication between the food industry, breeders and crop scientists.

Although the proof of principle for these improvements may be through transgenesis, the insights can be exploited by using non-GM approaches such as targeted mutagenesis or gene editing.

Contributors: Peter Shewry, Phil Larkin

Supply issues related to whole grain

Based on FAO data, global cereal production is appearing to head toward a new record level in 2017. Global wheat production forecast for 2017 is now 748.8 million tonnes, global rice production in 2017 is now forecast at an all-time high of 503 million tonnes. With the world's population heading towards 9 billion by 2050, the amount to be produced against future demand will surely be considerably higher. Competing demands for wholegrains vs grains for animal feed will be a major constraint, as the main population growth is predicted to be in households that will wish to grow its animal source protein in its diet. The feed to food conversion rate for cattle, sheep and pigs means that the land used to grow feed would ideally be better used for grains for direct human consumption. Climate change will also make the needed production increases difficult, with adverse weather events destroying crops and affecting prices. Longer-term climate change and intensive agriculture may see land currently used for cereals becoming less feasible for use. Water supplies for irrigation may become less reliable. In the developing world, cereal supply is also rife with food safety issues, such as aflatoxin contamination, which leads to large amounts of food loss and waste, affecting local supply. The rise of sustainable agriculture techniques, and their adoption, will be key towards ensuring a grain supply that can meet future demand. However, what the appropriate level of future need vs demand should be remains to be seen. It may be that to improve wholegrain supply, it will be important to work on reducing the level of dietary animal source protein globally.

Contributor: Karen Cooper

Existing whole grain ingredients: current uses and future possibilities

Based on the current popularity of cooking shows, Pinterest, baking and cooking blogs, etc., many formerly exotic whole grain ingredients have become familiar to a greater number of consumers. There are more whole grain ingredients than ever that are readily available to consumers via traditional supermarkets and particularly through on-line shopping options. Whether brown teff seeds, organic cracked rye, or sprouted whole quinoa flour, consumers can order as little as 1 lb for delivery in 1-2 days. Yet, although it appears that more consumers are experimenting with and consuming a greater variety of whole grains, there are still market segments and product categories that are underserved with whole grain options. For example, supermarkets now offer a wide variety of whole and multigrain sandwich bread and bun options, but there are markedly fewer whole grain bread and bun offerings in foodservice and bakery shops. And while whole grain dry boxed pasta product options are increasing, there are far fewer whole grain pasta options in frozen prepared meals and canned entrees found in the same supermarket. Factors that have slowed the development of whole grain prepared foods in certain food categories and market segments include higher ingredient cost, lower production throughput, and risk of product failure. What can millers do to help? Can millers develop practical, economical technologies that create more desirable and/or cost effective whole grain ingredients? Opportunities include methods to reduce energy usage, increase production efficiency and reduce other production costs. Are there new methods of grain cleaning, treatment, or milling that can significantly reduce microbial load? Are there ways to increase the yield of the desired particle configuration and size but reduce or eliminate by-products, as in the production of flakes or cut pieces with minimal fines? Can sprouting be incorporated as a step in a traditional flour mill footprint? Is it possible to develop new milling methods to extend the stability or even enhance the flavour of whole grain ingredients? There are also opportunities for millers to make higher extraction refined flours, which can be used as an alternative to or in combination with traditional refined flours in the development of partial whole grain foods. It is recommended that food developers and manufacturers to work together with millers to help drive new methods and products that have the greatest likelihood of increasing availability and consumption of whole grain foods.

Contributor: Elizabeth Arndt

Potential risks associated with whole grain ingredients

Whole grain foods are rich in health-promoting nutrients and bioactive compounds. However, whole grain meals and flours may contain higher concentrations of undesirable materials such as heavy metals, pathogens, mycotoxins, pesticides and other environmental contaminants. Whole grains may also contain phytates, tannins and enzyme inhibitors that may interfere with digestion and absorption of nutrients. While it is known that extremely high levels of some of these have caused problems when diets were marginal or various contaminated products resulted from high soil levels or other causes, data on the impact on other populations are limited. The presence of these components or “anti-nutrients” from increasing whole grain intake as part of recommended diets may not pose significant risk to consumers in most situations, but further research is needed.

Contributor: Devin Rose

Technical challenges to using whole grain in food products

Despite demonstrated health benefits, whole grain food consumption is rather low due to less preferred food structure, texture and flavour as compared to products made of refined flours. It is obvious that in order to deliver health benefits, whole grain foods should be as appealing as the refined foods. The use of WG flours has a tremendous impact on the rheological properties of the dough/batter of cereal food matrices, which eventually affects final product properties. Typical structural challenges in whole grain foods include reduced loaf volume, hard, crumbly texture (bread), increased spread ratio, hard and thin structure (biscuits), reduced expansion and crispiness, hard/crunchy texture (extrudates), chewy, sticky and hard texture (pasta). The majority of the aforementioned challenges arise either from the bran or germ component of the whole grain flours.

Various strategies can be applied to improve the structure, texture and sensory properties of the WG ingredients and WG foods. These routes are; germination of the grain, particle size reduction, fermentation or enzymatic modification of the WG flour or fractions, which can be later on utilized in reconstituting the WG flour, and in situ modification during food processing. All these different approaches are dictated by the WG and WG food claims.

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