Grains and Pulses in Baking

While wheat tends to dominate our thought processes associated with the manufacture of baked goods, there are many other grains and pulses that may be used as well. In fact, if we delve into the history of baking we find that many grains other than wheat have been used over time, including rye, barley, and oats. As far back as pharaonic times in Egypt, barley breads were produced alongside wheat breads (1). The distinction between production and consumption of the two types of bread depended on a person’s position in the Egyptian social hierarchy of the times, with wheat bread consumed by the social elite and barley bread commonly consumed by the masses.

The link between social status and the type of bread consumed was also seen in medieval Europe, where trenchers (1) were used as “organic” plates by the higher strata of society. Wheat in admixture with barley or rye was baked in large loaves that were then thickly sliced to yield trenchers, which were designed to soak up gravy and juices from meat. It was considered impolite to eat one’s trencher, as used trenchers generally were given to the servants, the poor, or the dogs.

Barley, rye, and oats tend to grow more readily than wheat in northern European climates. This has resulted in a pattern of agricultural production and consumption based on a series of rye breads that we still see today. Rye breads have a distinctive texture and flavor compared with wheat breads, and over time there have been attempts to modify the qualities of rye breads to more closely resemble those of wheat breads. Mixtures of rye and wheat have commonly been used to manipulate the eating qualities of the end product and, in doing so, increase the appeal of rye breads to a wider range of consumers. Manipulation of rye grain quality was attempted in the early 1900s with the development of triticale, a cross of wheat and rye (perhaps the first “genetically manipulated” grain). Today, triticale is grown in many parts of the world, although most of it is utilized in the animal feed chain rather than in the human food chain.

Pulses too have been utilized as the basis of traditional processed food products. One example is the pulse commonly referred to as black gram (Vigna mungo), which is used to make papadum, a flatbread, and dal, a preparation of pulses stripped of their outer hulls and eaten with rice and vegetables.

Today, there is an increased interest in using a wider range of grains and pulses to deliver more products with perceived health benefits. They are often used in admixture with wheat flour because most other grain and pulse materials lack the ability to form a gluten network and thereby deliver the aerated structures consumers favor. Of course, there also is increased interest in alternative grains and pulses that do not form gluten for use in an expanding array of gluten-free products.

Barley and Oats

More commonly associated with animal feed, brewing, and malting, barley does not appear in many modern baked product formulations. In the past, barley flour generally was used to extend the use of wheat through partial replacement. Barley flours do not form a significant gluten network, although the presence of gluten storage proteins makes them unsuitable for use in products consumed by people with celiac disease. Indeed, even the use of barley for brewing beer can render the product unsuitable for consumption by those with celiac disease.

Malted barley products, both enzyme active and inactive, have been used for many years by bakers as dough and bread improvers and to confer distinctive flavors. The use of malted barley flour as a bread improver has fallen out of favor in recent times, and its role has been superseded by a cocktail of specialized enzymes. The addition of enzymes as processing aids in many parts of the world renders them nondeclarable on product labels, but I wonder how long this position can be maintained and whether malt flours may make a comeback as a bakery ingredient because of their relative “naturalness.” The relatively high levels of β-glucans and pentosans in barley suggest a potential role for their future inclusion in baked products.

Although oats are commonly thought of as a grain that is fed to animals, oats have found their way into the human food chain in a number of innovative forms. Perhaps the most familiar and successful oat product has been the development of a range of breakfast “porridges.” For those living in cold northern climes, the “hearty start to the day” provided by porridge has become an iconic image in advertising campaigns.

More recently, identification of the nutritional and therapeutic benefits offered by oats has helped expand its use in mainstream baking, often in spite of its characteristic flavor (once described to me by a colleague as “like eating the cardboard box”—some people have strange diets). In an unexpected way, the distinctive flavor of oats has played a part in a bread product success story. Ready-prepared sandwiches in many parts of the world must be stored under refrigerated conditions for food safety reasons. However, if a sandwich is consumed when it is cold, the bread lacks flavor (especially for bread formulations containing lower salt levels). The addition of a proportion of oat flour has been shown to restore some of the flavor profile, so much so that in the United Kingdom the second most popular sandwich has become a prawn and mayonnaise filling on bread made with wheat and added oat flour.

While at the recent AACCI Annual Meeting I attended a session related to acrylamide. I had not previously appreciated that acrylamide levels in oat products can be significantly higher than in wheat products. It struck me that this is a good example of the dilemma facing us when we manufacture baked products:

http://dx.doi.org/10.1094/CFW-59-1-0038
namely, that the potential health benefits provided by an added ingredient, such as higher β-glucan levels in oats, may be counterbalanced by potential negative health effects produced by the same ingredient, such as higher acrylamide levels in oats.

**Pulses**

Pulses, or grain legumes as they are sometimes called, include beans, peas, chickpeas, lentils, and lupines. They are typically a good source of protein, with levels ranging from 20 to 25%, roughly twice that of wheat. They are also rich in oligosaccharides and dietary fiber, including soluble fiber. Although they are an excellent source of nutrition, pulses are not often used in bakery products. This is due, in part, to their strong colors and flavors, which carry through to the baked product. Consumers frequently negatively comment on the “beany” flavor of baked products containing pulses.

There are some exceptions, however. For example, in Japan, China, and Korea azuki beans are used to make a very popular sweetened filling for steamed buns and in sweet pastries such as mooncake. Given the level of sugar used in the filling and the total number of calories that each small unit contains (around 1,000 cal in the case of a mooncake), I am not quite sure where such products lie on the healthy nutrition scale, but as a dessert or treat they are extremely popular. The Korean *chalboribbang* (or sticky barley bread) is an interesting product with a slightly healthier profile; it is based on a pancake made from glutinous barley flour and filled with sweetened red bean paste.

One pulse that has a long history of use in baking is the soybean. Rich in the enzyme lipoxgenase, its addition to bread dough improves gas retention, and its natural bleaching effect improves the color of bread products. Soybeans also may be used in cake making. The use of enzyme-active soy flour is limited, in large part, due to its distinctive odor and flavor in baked products; nonetheless, soy flour remains a popular base for delivering other functional ingredients in bread formulations. In some parts of the world, the use of soy flour has become limited due to concerns over genetically modified material entering the human food chain, as well as concerns over the allergenicity of the material.

Lupine seeds have been used as a human food source around the world for thousands of years and are increasingly seen as a potential replacement for soybeans. More than 80% of the current global supply of lupine seeds is grown in Western Australia. Lupine seeds have higher protein and lower fat levels than soybeans and also exhibit high enzyme activity. Today, interest in using lupine flour in baked goods is growing.

I was at a U.K. baking conference recently, listening to a presentation on trends in the baking industry, and was interested to hear the results of a survey (unpublished) that reported 42% of consumers claimed they would try bread that incorporates "vegetables" for the potential health benefits. I guess this might include bread with significant levels of pulses—maybe markets are opening up for more “exotic” bread types? The same survey suggested that 39% of consumers would eat more bread if they perceived there to be health benefits. Cynic that I am, I am always suspicious when it comes to consumer claims regarding healthy eating. If consumers are really that keen to eat healthier foods, would they not just eat more whole grain products?

**Challenges Associated with Using Grains and Pulses**

Humans have exploited the nutritional benefits of grains and pulses for thousands of years, so you could say that the potential for their use is well established. Many different regional foods have been developed using indigenous raw materials, yet new ways of using grains and pulses are always being sought. In part, this is related to the quest for something special in a nutrition context and, in part, to the constant market-driven desire for something to differentiate one's products from the competition. With the globalization of crops and foods, raw materials previously considered “exotic” have become commonplace and with increased exposure have come challenges for future production. The growth of global communications now quickly creates markets for products that previously never existed or were created very slowly, and this can place great strains on local economies.

The development of wheat-based breads as a global food source has undoubtedly been a success, but with it come challenges for those parts of the world where it is difficult to grow wheat. To satisfy demand in these parts of the world, importation is necessary, yet all too often the importation of wheat is costly and can have a disturbing impact on fragile local economies. In some cases, projects have been developed to stretch wheat supplies by supplementing bread products with local grains and pulses, and to some extent, this has been successful. Composite flours, as they are often referred to, offer significant opportunities not only to limit wheat imports but also to contribute to a more nutritionally balanced diet in a convenient form. It is the convenience and versatility of wheat bread as an adjunct to or the basis of meals that are perhaps the keys to its global success. As successful as the globalization of wheat bread has been, it perhaps has closed our eyes to other food opportunities offered by grains and pulses. Today, we may be more aware of the potential of other grains and pulses because of a greater interest in issues such as celiac disease, but we still have a long way to go to understand and exploit the opportunities offered by the many different grains and pulses that are available globally.

**Reference**