In early 2008, the AACC International (AACC) Board approved the following statement (1) on sprouted or malted grains:

Malted or sprouted grains containing all of the original bran, germ, and endosperm shall be considered whole grains as long as sprout growth does not exceed kernel length and nutrient values have not diminished. These grains should be labeled as malted or sprouted whole grain.

This definition was subsequently endorsed by the U.S. Department of Agriculture. Information on this and other industry definitions is provided by the Whole Grains Council on its website (12).

Impact of Sprouting on Nutrient Content of Grains

Sprouted grains are continuing to gain traction in the marketplace as an ingredient and represent a re-emerging trend in natural foods. Increasing the vitamin content of grains using germination techniques may offer a practical, natural process to increase the health benefits and consumer acceptance of whole grains (9).

Sprouting has been reported to increase key nutrients in grains, including antioxidants, tocopherols, thiamin (vitamin B1), riboflavin (vitamin B2), pantothenic acid (vitamin B5), biotin (vitamin B7), folate (vitamin B9), and fiber, by 1.5–3.8 times in germinated seeds (5,8,10,11). In addition, sprouting grains may reduce anti-nutrients such as phytic acid and trypsin inhibitors because sprouting increases native phytase activity in seeds. Phytic acid binds with important minerals such as calcium, magnesium, iron, and zinc, making them insoluble and unavailable as nutrients (4). Phytic acid also chelates niacin, making it unavailable for absorption in the body. Trypsin inhibitors reduce the bioavailability of several micronutrients in both humans and animals (3). As a result, proponents of sprouted grains insist that grains that have just begun sprouting, straddling the line between a seed and a new plant in a dormant stage, provide all the health benefits of whole grains while being more readily digestible.

Controlled Sprouting Process

The growing trend in use of sprouted whole grains has yet to lead to a standard sprouting process. Currently, controlled sprouting of grains includes three major steps: steeping, germination, and kilning. During steeping the grain is submerged in water for a set time with aeration. This washes and hydrates the grain prior to germination. During germination, humid air is circulated around the grain to control growth. The last stage is kilning, during which warm air is circulated around the grain to dry it, develop flavor and color, and stop the germination process. Temperatures during kilning need to be high

\[ \text{Stability} = \frac{\text{FARINOGRAPH INDEX}}{100} \]

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Fig. 1. Comparison of stability for bread dough made with nonsprouted (control) versus sprouted whole wheat flour, as measured by a farinograph. Values in bottom graph with different letters are significantly different.
enough to stabilize the grain and denature the enzymes but low enough to not damage the gluten in the grain.

The challenge encountered in sprouting wheat is controlling the degree of enzyme activity, which can negatively impact baking performance (7). The degree of sprouting can be quantified based on the level of \(\alpha\)-amylase activity. The enzyme \(\alpha\)-amylase is considered one of the most important enzymes for bread production and can be measured using AACC1 Approved Method 56-81.03 to determine the falling number (2). An increase in enzymes such as amylase can lead to excess starch degradation, which can result in a sticky dough and low loaf volume. Wheat with a falling number higher than 300 sec is considered unsuitable for breadmaking (6). Use of germinated wheat for baking, thus, has been restricted until now (5).

Development of 100% Sprouted White Spring Whole Wheat Flour

The growing demand for sprouted wheat led Ardent Mills and Cargill Malt to partner in developing a 100% sprouted white spring whole wheat flour for bread applications. The wheat was sourced by Ardent Mills, sprouted by Cargill Malt, and milled using a dedicated whole wheat mill at Ardent Mills. The patent-pending process deactivates the cellular machinery involved in \(\alpha\)-amylase production and targets a 12% moisture content, retention of gluten functionality, and product stability. Typically, drying wheat grain requires temperatures lower than 60°C to avoid damaging the gluten in the grain, and \(\alpha\)-amylase remains active at temperatures as high as 70°C. As a result, temperatures must be controlled carefully to produce a consistent sprouted wheat product.

The following methods were used in this study. Dough strength was measured using a farinograph according to AACC1 Approved Method 54-21.02 (2). Farinograph stability is an important measurement for bread bakers because it helps quantify the ability of a flour to tolerate stress during production. For the bread application, a sponge-and-dough method was used to compare breads formulated with 100% white whole wheat flour (control) versus 100% sprouted white whole wheat flour. A rapeseed volumeter was used to determine loaf volume.

For the bread formula, sponge ingredients (in baker's percent) were 70% flour, 54% water, 3.5% yeast, 0.5% yeast food, and 0–5% vital wheat gluten; dough ingredients (in baker's percent) were 30% flour, 20% water, 12% sugar, 2% salt, 4% shortening, and 2.5% yeast. The baking procedure was as follows: sponge was mixed for 3 min at high speed and fermented at 85°F and 85% RH for 3.5 hr. The dough was then remixed for 7 min at high speed, proofed to height for ~60 min, and baked at 425°F for 25 min.

To compare the results, a 2 × 3 completely randomized design was used. The experimental factors were two types of wheat flour (control [nonsprouted] versus sprouted), and three levels of added vital wheat gluten (3, 4, and 5%) were used to determine bread baking performance.

Comparison of Nonsprouted and Sprouted Wheat Flours in Bread Baking

Bread dough made with sprouted white whole wheat flour showed increased farinograph stability compared with dough made with the nonsprouted control flour (Fig. 1). Proof times also decreased by 10% for the bread dough made with sprouted white wheat flour (Fig. 2). These improvements can be attributed to the sprouting and kilning processes. The sprouting process increases the level of \(\alpha\)-amylases, which hydrolyze the starch. Sugar fermentation by the yeast produces gas and leavens the dough. Kilning exposes wheat grains to higher temperatures that could naturally mature the flour. Maturing the flour can improve the ability of a dough to retain gas and oxidize it to increase stability.

In bread production, loaf volume for bread made with sprouted wheat flour showed a 5–9% increase compared with the nonsprouted control flour (Fig. 3). Addition of different concentrations of vital wheat gluten did not affect the ability of the dough to develop an acceptable structure.

After completion of this experiment, a separate study was conducted to determine the effects of 0% vital wheat gluten addition because the original experiment produced good bread loaves at all three vital wheat gluten levels tested. At 0% vital wheat gluten, both the sprouted and nonsprouted wheat flours were able to form good quality bread loaves, as shown in Figure 4. Sensory evaluation indicated that bread made with sprouted wheat flour had less bitterness in the crust compared with the nonsprouted control bread.
Conclusions
Sprouted grains are well positioned to draw health-conscious consumers based on their nutritional benefits and a more “natural” processing of grains. The 100% sprouted whole wheat flour studied consistently had longer farinograph stability, increased mixing tolerance, shorter proof times, increased bread volume, and improved sensory results compared with the 100% nonsprouted whole wheat control flour. Additionally, the sprouted whole wheat flour performed well and created good quality bread without the addition of vital gluten. After sensory evaluation, it was concluded that the bread made with sprouted wheat flour had less bitterness in the crust compared with the nonsprouted control. Ideal applications for sprouted whole wheat flour include tortillas, bagels, pizza crusts, crackers, and more.

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