



Whole Wheat Flour Analysis

Whole Wheat Flour (WWF) and its subsequent products market has resurfaced in the last couple of decades due to the interest of consumers in healthier and more fulfilling whole grain products. WWF baked goods, specifically breads are now commonly regarded as beneficial for the overall health of the consumer due to their high fiber content, and the wide variety of minerals, phytochemicals and other beneficial micronutrients in a larger proportion than its refined counterparts. The WWF market is showing a significant increase with a Compound Annual Growth Rate (CAGR) of 6.7% per year for the period 2022 - 2032. Current market value of WWF as of 2022 was of \$ 72.7 billion dollars and it's expected to reach \$130.3 billion dollars by 2032 according to Future Market Insights.

However, many challenges present themselves when working with this ancient flour type and universally accepted specifications are scarce. Thus the importance of developing novel adapted technologies for the control and standardization of this product and its subsequent baked goods to maintain consumers satisfaction.

What is Whole Wheat Flour?

Whole wheat flour (WWF) is the powder obtained from the milling of wheat other than durum, and it contains the natural kernel proportions of bran, endosperm and germ found in the actual grain. WWF has a shorter shelf life than its white flour counterpart, due to the oil present in the bran and germ.

Characteristics of Whole Wheat Flour

Whole wheat flour (WWF) is characterized by its high quality nutritional profile. It is low in saturated fats and cholesterol making it an ideal ally to battle and reduce the risk of heart disease as well as certain cancers such as breast cancer. It is also known for its high fiber content in comparison with traditional wheat flour, thus influencing the feeling of satiety in consumers which may aid in weight management.

WWF just as conventional wheat flour has several functions in bread and bakery systems; its main purpose is to act as a structure builder by providing gluten and starch for the development of the main structure of the bakery product. It absorbs liquids (e.g water) and thus binds ingredients together.



Finally, WWF significantly contributes to the final product flavor and color by providing substrate for Maillard browning reaction, during this reaction flavor and aroma compounds are also produced providing the characteristic nutty and bitter taste of WWF breads.

When considering the processing characteristics of Whole Wheat Flour, it may require higher quantities of water for dough development due to the high amount of fibers. Aside from water absorption, another characteristic of WWF bread or bakery products in general is its darker color due to the presence of the bran, and a lower specific volume and denser texture. WWF bread tends to have a bitter taste or flavor that may not be widely accepted by consumers.

Nutritional benefits of Whole Wheat Flour



Whole wheat flour has a wide variety of nutritional and health benefits thus making it one of the preferred products by health-conscious consumers. It is full of essential nutrients due to the fact that it retains the bran, germ, and endosperm of the wheat kernel, ensuring a rich supply of dietary fiber, vitamins, and minerals. Its high fiber content aids in digestive health, preventing constipation and supporting bowel health.

Additionally, WWF has a lower glycemic index compared to refined wheat flour, aiding in the maintenance of stable blood sugar levels and providing a sustainable source of energy, and reducing the risk of type 2 diabetes.

Furthermore, its high B vitamins content, including folate and niacin, aid the metabolism and overall well-being. WWF is also a source of essential minerals like iron, magnesium, and phosphorus, which partake in various bodily functions, from oxygen transport to bone health. Moreover, WWF contains antioxidants, such as phenolic compounds, which protect cells from oxidative damage and contribute to long-term health.

Challenges when baking with Whole Wheat Flour

A wide variety of challenges present themselves when working with whole wheat flour, in all stages of breadmaking considerations would need to be taken into consideration to guarantee a commercially viable product that meets consumers expectations.



For the miller

From the starting point, the miller may confront challenges associated with a higher risk of rancidity associated with the lipid content of the flour, this mainly comes from the outer layers of the grain (e.g bran and germ) and due to the presence of lipase enzymes the risk of rancidity increases. To counteract the issues presented by high lipase levels, millers can use several treatment techniques to the bran; from steaming treatments to dry heat treatment of the external layers. These treatments may aid in the reduction of lipase level on the outer layers of the grain and thus improving storage stability.



For the baker

WWF has a huge impact on the organoleptic properties of the final product from the final loaf volume to the actual handling and formulation of the bakery system. WWF is characterized by its higher water absorption that required reformulation of traditional recipes, higher development times and machinability of the dough to obtain satisfactory product.

The absence of a standard specification such as those found for conventional wheat flour caused a huge variability and inconsistency in products classified as whole wheat flour. This challenge has been confronted by several institutions both commercial and academic to standardize the parameters of this product.



Tools to Master Your Whole Wheat Baking Process



Application Tips of Whole Wheat Flour

Working with whole wheat flour as mentioned above is a challenging task for bakers worldwide, thus a variety of considerations should be taken into account to obtain successful results. The main factor determining flour quality is the milling process, in some instances even more than wheat type.

Hydration



Whole wheat flour absorbs more liquid than regular bread flour. Adjustments of liquid content in formulation may be required, depending on their water absorption capacity. This may vary widely, affecting the importance of the determination. This inability to properly predict has great quality impact on the final quality of the product.

Kneading Time



When making bread an increment of kneading time may be required, as well as potential kneading or mixing speed to aid in dough development.

Baking Temperature



Whole wheat flour can brown more quickly due to its higher bran content. Reduction of baking temperature or covering of the dough may be recommended to avoid excessive browning of the final product.

KPM specializes in technical solutions for bakers and millers, providing analyzers to simulate the baking process and gather crucial data on dough behavior. Analyzing whole wheat flours traditionally posed challenges due to only having methods designed for white flour. KPM Analytics addresses this with equipment tailored for whole wheat analysis. [Learn more.](#)

Flavor Enhancements



Whole wheat flour has a nuttier flavor compared to all-purpose flour. Usage of complementary ingredients like honey, molasses, or spices can aid in enhancing the flavor in the final product formulation.

Storage



Whole Wheat Flour bread and bakery products tend to have a shorter lifespan due to the presence of lipids that may go rancid. Storage in dark and dry places and containers is recommended to improve or increase shelf life.

Rule of Thumb



Some points to considered when working with WWF at small scale:

- *Addition of around 4 - 5 g of liquid per 100 grams of flour due to bran's high water absorption.*
- *Blend $\frac{1}{4}$ or $\frac{1}{2}$ parts of whole wheat flour with one part of bread flour for similar tasting baked goods.*
- *Increase resting time for liquid absorption.*



Quality Testing of Whole Wheat Flour

Whole Wheat Flour quality assessment standards and specifications are currently in development by several industrial and academic institutions. Currently, they are based on the measurement of the granulometry, humidity and protein content of the flour; however recent advancements have proposed the inclusion of rheological measurements for a better understanding of the behavior of the dough when processed, a feat that was not previously possible due to the inherent difference between white flour and whole wheat flour .

The challenge that existed beforehand was that the methods were solely designed for the evaluation of white flour, the inherent differences between both types of flours didn't allow for a reliable analysis of WWF; years of research and technological improvements have allowed the development of new methods of analysis for WWF.

Among the most relevant rheological measurements to consider are: water absorption, dough development time and speed, elasticity, volume, stability, among others.



**Tools to
Master
Your
Whole
Wheat
Baking
Process**



Considering the above mentioned parameters, the following table summarizes the current available technologies for a more comprehensive analysis of whole wheat flour quality

Parameter	Instrument	Consideration
Water absorption Kneading behavior Starch gelatinization Starch gel stability Starch retrogradation	Mixolab 2	Increment of mixing speed from 80 rpm (traditional wheat flour) to 200 rpm to accomplish the dough formation in under 8 min.
Tenacity Extensibility Elasticity Baking strength	Alveograph®	<ul style="list-style-type: none"> • Water absorption of 60% • Mixing speed of 80 rpm to ensure gluten development • Air flow of 40 l/h to ensure smooth deformation of the gas bubble
CO ₂ production CO ₂ retention Volume	Rheo F4	<ul style="list-style-type: none"> • Development of the dough takes place in imposed conditions • Temperature and weight are established per protocol



Troubleshooting Whole Wheat Flour Baking



I want to add 25% WWF to one of my recipes and I need to anticipate the impact on the shelf life. What should I do?

Shelf life of products made with WWF is reduced in comparison with its white flour counterparts due to their higher water activity. WWF may have a significant impact in the staling rate of the final products, and thus the determination of the stability over time of the product is primordial for bakers. To better understand how the product will behave during its shelf life, the Mixolab curve can be used; at the end of the test, the temperature decreases thus simulating what is happening at the end of the process (take the product out of the oven and let it rest). In this last part of the test, starch retrogradation can be determined, which is a great indicator of shelf life.



I'm adding oat fiber to my whole wheat sandwich bread up to 10%. How does the additional fiber affect how I should hydrate the dough?

Addition of fibers from any source changes the organoleptic and rheological properties of the final product by increasing the crumb firmness, producing a darker crumb color and characteristic aroma, thus its addition must be carefully considered. An addition of oat fiber may need reformulation of the proportion of liquid present in the dough, due to the increased water absorption capacity of the dough by the addition of fiber. Testing increments of 10 g per 20 g of water (prehydration) is recommended when adding oat fiber to bread formulation or evaluating water absorption with an adapted method, such as the Mixolab 2. Aside from these alternatives, addition of vital wheat gluten is recommended to improve final bread volume due to the loss of gluten structure due to gluten dilution.

References

1. "Whole-Wheat Flour Market". Futuremarketinsights.Com, 2023, <https://www.futuremarketinsights.com/reports/whole-wheat-flour-market> . Accessed 4 September 2023.KPM Analytics.
2. "How to Analyze & Predict the Behaviors of Whole Wheat Flour/ High-Fiber Flours" October 3, 2022. <https://www.youtube.com/watch?v=N8JBUOVJwGY> BAKERpedia.
3. " Whole Wheat Flour Quality and Control | BAKERview| BAKERpedia". May 23, 2023. <https://www.youtube.com/watch?v=U-YNdQjUa5k> Figoni, P.
4. How Baking Works: Exploring The Fundamentals Of Baking Science. 2nd ed., John Wiley & Sons, Inc., 2008.
5. Gómez, Manuel, Luiz C. Gutkoski, and Ángela Bravo-Núñez. "Understanding whole-wheat flour and its effect in breads: A review." *Comprehensive Reviews in Food Science and Food Safety* 19.6 (2020): 3241-3265.
6. Ngozi, Agiriga Anna. "Effect of whole wheat flour on the quality of wheat-baked bread." *Global Journal of Food Science and Technology* 2.3 (2014): 127-133.
7. "Whole Wheat Flour | Baking Ingredients | Bakerpedia". Bakerpedia, 2015, [https://bakerpedia.com/ingredients/whole-wheat-flour/#:~:text=Whole%20wheat%20flour%20\(WWF\)%20is,in%20the%20bran%20and%20germ](https://bakerpedia.com/ingredients/whole-wheat-flour/#:~:text=Whole%20wheat%20flour%20(WWF)%20is,in%20the%20bran%20and%20germ). Accessed 5 Sept 2023.
8. BAKERpedia. " Tuesday 10 at 10: Adding oat fiber to breadBAKERpedia". December 29, 2020. <https://www.youtube.com/watch?v=z0bb32R0nTE>
9. Kurek, Marcin, et al. "The effect of oat fibre powder particle size on the physical properties of wheat bread rolls." *Food Technology and Biotechnology* 54.1 (2016): 45-51.
10. Lin Carson, PhD. "Baking With Spelt Flour For Flavor And Nutrition | Blog | Bakerpedia". Bakerpedia, 2020, <https://bakerpedia.com/baking-with-spelt-flour/>. Accessed 5 Sept 2023.

