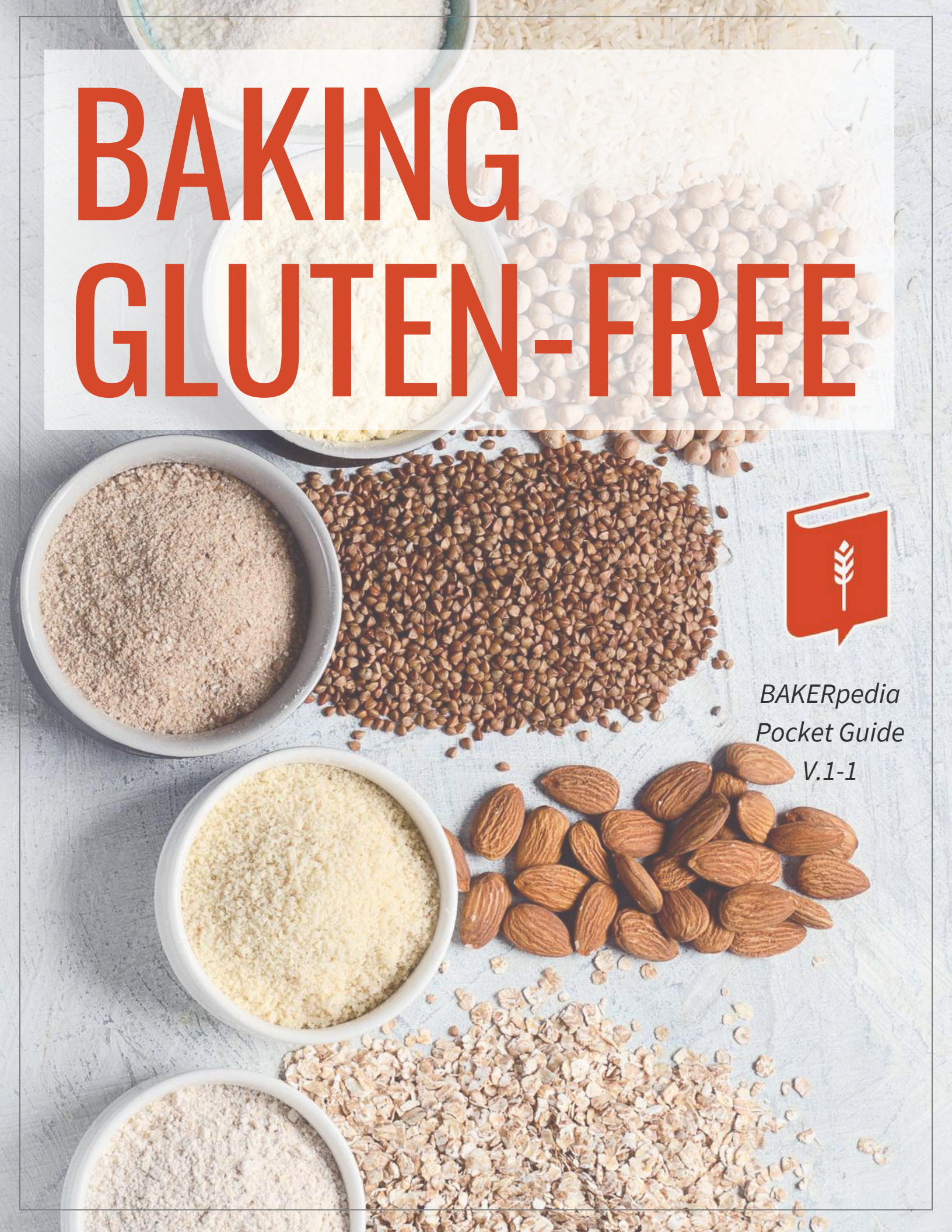
BAKING GLUTEN-FREE



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Pocket Guide
V.1-1

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INTRODUCTION

Gluten-free products have taken over the bakery industry in the last couple of years due to an increase in celiac disease, gluten intolerance, and overall health awareness. With an annual CAGR of 10.8% from 2022 to 2030 according to a report by Grand Review Research, the gluten-free trend doesn't look like it is going away. Though gluten-free is a strong trend, it is built on the coattails of celiac disease. Celiac disease is an autoimmune disorder caused by the ingestion of gluten. Gluten is a protein found in wheat, barley, and rye flour. It is responsible for a wide variety of wheat-based baked goods properties. Due to the importance of gluten in baked goods production, its substitution represents a significant challenge for conventional bakers.

The absolute substitution of wheat flour is necessary for individuals with celiac disease, this substitution can be made with a wide variety of alternative flours. In combination with starches and hydrocolloids, they produce baked goods with similar organoleptic properties to those obtained with the use of traditional wheat flour.

Gluten-free baked goods have gained popularity in recent years, not only among those with gluten-related conditions but also among individuals who choose to follow a gluten-free diet for personal reasons or due to the halo effect generated by their surrounding environment. A family member or friend may have celiac disease and thus require a gluten-free diet, this may incentivize other family members and friends to consume these due to the overall health benefits and tasty products just as the conventional wheat-based ones. These products provide a tasty and inclusive option for individuals seeking to maintain a gluten-free lifestyle without compromising on flavor or texture

Gluten-Free Market Opportunities

- Current market is valued at **12.3 billion USD billion** as of 2023.
- The gluten-free market is expected to grow at a compound annual rate (CAGR) of **10.1 %** from 2024 to 2032.
- The main driving factor of the market is the health concerns of consumers.
- Novel product releases are increasing the industry's interest, which has driven its growth.

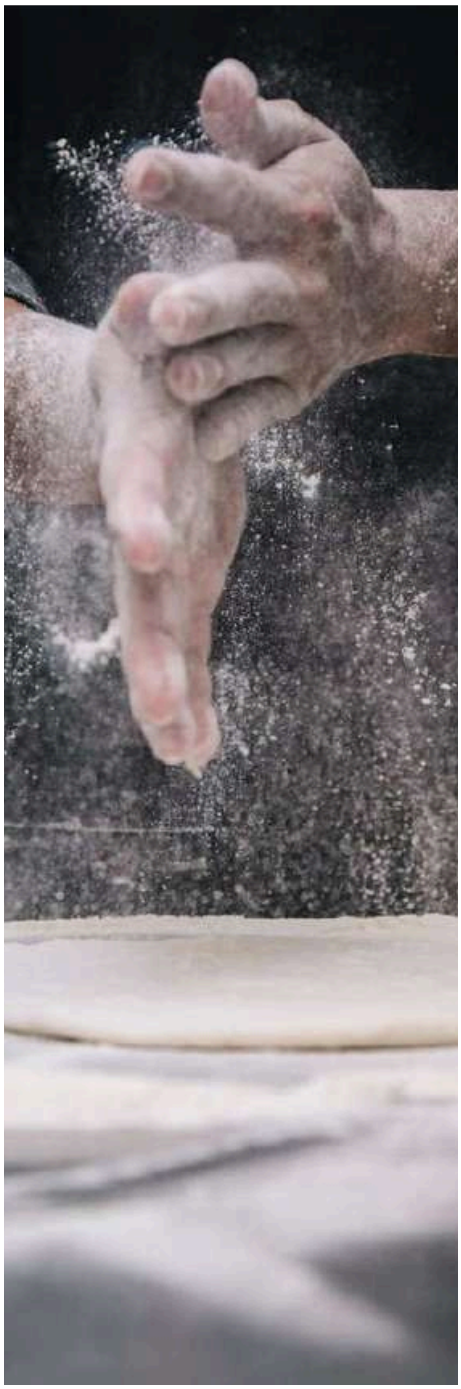
"gluten-free Food Market Size, Growth Outlook 2024 - 2032." Global Market Insights Inc.,https://www.gminsights.com/industry-analysis/gluten-free-food-market#:~:text=Gluten%20Free%20Food%20Market%20size%20was%20valued%20at%20USD%2012.3,celiac%20disease%20and%20gluten%20sensitivity. Accessed 02 June 2024.

INGREDIENTS

Wheat flour is the main building block of conventional baked goods. Its substitution requires careful consideration when producing gluten-free baked goods. However, many ingredients may intervene with this during the product development process. This leads to a product that has less desirable texture, flavor, aroma and mouthfeel.

The main ingredients found in the formulation of gluten-free baked goods are further explained here:

Wheat Flour Alternatives



- **Chia seed flour:** is made from finely ground chia seeds. It is highly nutritious and is commonly used to replace wheat flour and eggs in sweet and savory baked goods. Due to its natural mucilage, it can be used as a partial or total substitute for wheat flour with great results. It can be used as a partial or total substitute for wheat flour in baked goods with acceptable results. Chia flour provides a mild nutty flavor, and it may provide a grayish color to the crumb. It can also provide a higher water absorption than other alternatives due to the mucilage.

- **Rice flour:** is the fine product obtained from the milling of rice grains. It is commonly used for the production of gluten-free baked goods or as a dusting powder for commercial-scale baking. This flour provides a neutral flavor and a bright color to baked goods. Loaf volume may decrease with the use of rice flour, resulting in a firmer texture.

- **Tapioca flour:** is the starchy and fibrous powder obtained from the milling of cassava or tapioca roots, during a wet or dry milling process. It is commonly used as an ingredient to improve the gelling, pasting, and retrogradation properties of food products. Its main purpose in gluten-free products is to aid in adhesion and binding. It also aids in water retention for buns and bread.
- **Coconut flour:** is made from dried coconut meal. It has a high water absorption capacity and provides a slight coconut flavor to baked goods. It can be added to baked goods to improve the nutritional value of the product due to its high fiber and protein content.
- **Almond flour:** is dry milled almonds, commonly known as ground almonds sieved through to an appropriate particle size. It is commonly used in premium baked goods and gluten-free products. It has a high water absorption due to its high fiber content. Almond flour also improves the nutritional profile of the product and provides a mild nutty flavor.
- **Corn flour:** is dry milled corn utilizing just the corn endosperm. It is a staple ingredient in Latin American cuisine commonly used to make traditional products such as arepas, tortillas, tamales, and empanadas.

- **Quinoa flour:** is from dry milled quinoa seed, a pseudocereal from the Andes. It is high in antioxidative properties and is therefore commonly used in combination with other gluten-free flour to improve the nutritional profile of the final product.
- **Buckwheat flour:** is dry milled from the Buckwheat seed. Since it is a pseudocereal, it is not a grain and does not contain wheat components or gluten. It has good nutritional value and a unique nutty, earthy, and bitter flavor which adds complexity to baked products. It is commonly used in combination with other gluten-free flour to improve the flavor profile of the final product.
- **Hemp flour:** is made from ground hemp seed that is sieved through to a specific particle size. It can provide a unique nutty flavor, reduce crumb flexibility and consistency, and impart a strong unique aroma due to the presence of alpha-humulene, caryophyllene, and caryophyllene oxide. It may also impart a light brown color.

Water

Water aids in a variety of functions in both regular and gluten-free baked goods. One of the main functions of water in baked goods is the hydration of ingredients aiding in the binding of the gluten-free system and facilitating the formation of the dough or batter. Lastly, water functions in the activation of ingredients such as chia and flax seeds to activate their mucilage and gelling function.

The amount of water used in gluten-free bread formulations can vary depending on factors such as the type of baked goods, the type of flour, the desired texture of the products, and the environmental conditions during baking.

One more factor to consider is the type of water. The concentration of minerals like calcium and magnesium can result in hard or soft water. Therefore, water can be classified as soft or hard water depending on the mineral concentration. They also provide nutrients for yeast, resulting in faster fermentation times. Therefore, affects the final dough quality.

Classification of Water Hardness

Hard

(>100 ppm)
It strengthens the dough and quickens fermentation.

Medium

(50-100 ppm)
Best suited for baking.

Soft

(<50 ppm)
It produces sticky, soft and slack dough and decreases fermentation rate. May require yeast nutrients.

Hydrocolloids

Hydrocolloids are viscosity enhancers. They play an important role in the production of gluten-free baked goods by providing structure, texture, and moisture retention. These ingredients, such as xanthan gum, guar gum, carboxymethylcellulose (CMC), hydroxymethyl propyl cellulose (HPMC), act as binders and stabilizers in the absence of gluten providing an appropriate texture and viscosity to the batter or dough.

Common Hydrocolloids

- Acacia gum or gum arabic
- Agar
- Alginates
- Arabinoxylans
- Carrageenan
- Carboxymethylcellulose (CMC)
- Cellulose
- Methylcellulose
- Guar gum
- Pectin
- Xanthan
- Hydroxypropyl Methylcellulose (HPMC)

Hydrocolloids help improve the overall structure and elasticity of gluten-free dough and batter. They aid in the substitution of gluten by creating a film that traps gas and gives the baked goods a lighter and less crumbly texture, similar to the gluten network.

They also aid in moisture retention, preventing gluten-free baked goods from becoming excessively dry. They absorb and retain water, contributing to a moist and tender crumb.

Finally, hydrocolloids assist in preventing ingredient separation and maintaining the stability of the batter or dough during mixing and baking. They enhance the viscosity and provide stability, allowing the ingredients to bind together more effectively.

The appropriate amount and type of hydrocolloid vary depending on the formula and desired outcome, so it's important to follow formula guidelines to achieve optimal results in gluten-free baking.

Modified Starches

Modified starches are network supporters. They are starches that have gone through a chemical or physical process that modified or altered their properties, improving their overall functionality. They play a crucial role in providing texture, structure and stability in gluten-free baked goods.

Common Modified Starches

The most common modified starches available for gluten-free baking come from corn

potato, rice, or tapioca.

Here are a few considerations:

- Heat stable
- Acid stable
- Pre-gel
- Shear stable

One of the main benefits of modified starches is their ability to improve the texture and mouthfeel of gluten-free baked goods. They contribute to a smoother, less gritty texture, creating a more appealing eating experience. Modified starches also enhance the structural integrity of gluten-free baked goods They act as binders, helping to hold the ingredients together and prevent crumbling. This is particularly important in products such as breads, tortillas, pizza, cakes, and cookies, where a cohesive structure is required.

Moreover, modified starches aid in moisture retention, keeping gluten-free baked goods moist and fresh. They absorb more water, improving shelf-life by reducing staling.

Proteins

Proteins are the foundation of all baked goods, therefore replacing the gluten protein functionality in baked goods is the key to success for all gluten-free baked goods. Protein isolates are commonly used in gluten-free formulas due to their excellent functionality. Protein isolation involves several methods to separate protein from other components like fats, carbohydrates, and minerals. After which, filtration is commonly employed, utilizing various types such as microfiltration and ultrafiltration to selectively segregate proteins from other molecules.

Another method to produce isolates uses precipitation. In this method precipitation, in this method reagents like acid or salt are added to the solution, causing proteins to aggregate and separate. Chromatographic techniques like ion exchange, size exclusion, and affinity chromatography are also utilized after the product is isolated. Other processing such as drying may be performed to improve shelf stability.

Tip

Protein isolates from pea, whey or soy are commercially available in the US market.

In gluten-free products, protein isolates can be used to improve the volume, texture, and structure of baked goods by providing similar functions to gluten, such as the formation of a cohesive network, improving the chewiness and moistness of the product. It helps to strengthen doughs and batters, and aids in the improvement of the gas retention capacity of gluten-free doughs; thus improving loaf volume and texture. Last but not least, protein isolates can improve the protein content of the final baked product.

Sugar

Sugar is an essential ingredient in many baked goods especially in sweet goods and desserts. Not only does it provide sweetness, but it helps create a moist and tender texture and contributes to Maillard browning. In addition, it acts as a substrate for yeast during the fermentation process in bread and some sweet pastries. In some cake types, it contributes to leavening due to the creaming step with butter.

In cookies, sugar has a significant role in final product tenderness and moistness. Sugar provides the final product with a tender structure by decreasing starch gelatinization and water activity. Common sugars used are in the form of beet and cane sugar, confectioner's sugar, honey, inverted sugar, agave syrup, maple syrup, and fruit concentrates.

Fats and Oils

Fats plays an important role in baked goods production. The most commonly used kinds are vegetable oils, margarine, butter, or shortening. One of the main contributions of fat in baked goods is as a tenderizer by coating flour particles, restricting the formation of a gluten network. They also aid in moisturizing, flavor, and leavening in combination with sugar and color. Fats such as butter also contribute to the final product's mouthfeel and flavor. Lastly, it improves browning when it is sprayed onto baked goods due to its excellent heat transfer properties.

Common Fats and Oils

- Butter
- Clarified butter
- Cocoa butter
- Coconut oil
- Lard
- Margarine
- Palm oil
- Vegetable oils

Yeast

Yeast is a single-celled microorganism crucial for leavening in bread making. It provides the gasses required for leavening bread, contributing to the volume and final product texture. When yeast enters into contact with water and a substrate (e.g., sugars), fermentation occurs, producing acids, aromas, and carbon dioxide. When scaling up to continual processes or when producing frozen batters, single-acting baking powders or leavening acids are needed to cater to your products.

Yeast can also help in dough conditioning by releasing enzymes that break down sugars and starches, making them more accessible for fermentation and thus improving the texture and flavor of the bread. This is why yeasted gluten-free dough has better pan flow. Finally, yeast can help extend the shelf life of bread by producing acids, reducing pH, and aiding in shelf-life preservation.

Leavening Agents

Chemical leavening agents play a crucial role in the development of gluten-free baked goods because the absence of gluten poses challenges to achieving a light and airy texture. Gluten-free baked goods formulas often rely on chemical leavening agents such as leavening acids and baking soda to provide the desired rise and structure.

Some of the commonly used chemical agents are baking powder, a combination of baking soda, acid, and a stabilizer. When baking powder comes into contact with moisture and heat during baking, it releases carbon dioxide gas, causing the batter or dough to expand and rise.

Baking soda, on the other hand, requires the presence of an acid ingredient to create the necessary reaction and release carbon dioxide. The gas bubbles produced by these leavening agents get trapped in the dough or batter, resulting in a lighter texture. Proper measurement and balance of these chemical leavening agents are essential to achieve optimal results in gluten-free baking, ensuring well-risen and delicious baked goods.

For batch processes, double-acting baking powder is normally used in gluten-free formulas. When scaling up to continual processes or when producing frozen batters, single-acting baking powders or leavening acids are needed to cater to your products.

Other ingredients (emulsifiers, dough conditioners)

The substitution of gluten in gluten-free baked goods requires the use of other ingredients to accomplish this feat. This may require the use of other ingredients like emulsifiers and dough conditioners.

Emulsifiers

Emulsifiers have a water-loving side and an oil-loving side. This makes fat and water systems more stable, like gluten-free batters and doughs. It aids in a variety of ways for the improvement of the overall texture, structure, moisture retention, and quality of the baked good.

Dough Conditioners

Dough conditioners are used to improve certain characteristics of gluten-free doughs. Some of the most commonly used dough conditioners include starches, emulsifiers, and hydrocolloids used in gluten-free doughs. Lastly, let's not forget enzymes. It's an extremely important clean-label dough conditioner.

Enzymes

Enzymes like amylases, phospholipase, and proteases, are used to improve dough handling properties and increase the stability of gluten-free dough. They help break down complex carbohydrates and proteins, promoting better hydration and dough development. Enzymes can enhance the texture and volume of gluten-free bread while providing a clean-label solution.

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FORMULA DEVELOPMENT

Gluten substitution represents a challenging opportunity for baker's around the world, due to its vital role in dough and batter development and overall baked good structure. Other substances such as hydrocolloids, modified starches, emulsifiers and enzymes need to be added to the formula to be able to accomplish baked goods with the desired volume, texture, crumb structure, shelf life and overall sensory qualities.

The key lies in understanding the properties of different gluten-free flours and binders. Experimentation with various combinations, ratios, and techniques are crucial for achieving the desired results.

Selecting the appropriate gluten-free flour is fundamental to formula development. Usually a combination of several gluten-free flours like rice, sorghum, millet, and tapioca in specific proportions is required. Their combination with other ingredients can replicate the texture and taste of gluten-containing counterparts. Each flour brings unique attributes, such as structure, moisture retention, and tenderness. Baker's need to explore different flour blends and adjust ratios to find the perfect balance.

Hydrocolloids and structure builders play a crucial role in formula development for gluten-free baked goods. Xanthan gum and guar gum are commonly used to mimic gluten's binding properties. The challenge lies in using these ingredients properly, as excessive amounts can lead to an undesirable gummy or dense texture. Bakers must carefully experiment with different quantities to achieve the right balance of structure and texture.

Bakers need to consider moisture and flavor enhancement. Ingredients such as eggs, applesauce, yogurt, or fruit puree can contribute both moisture and flavor to gluten-free baked goods. These additions impact the overall structure and tenderness of the final product. Finding the right combination and amount of these ingredients is a crucial step in formula development.

GLUTEN-FREE BREAD

Ingredient	Percentage
Benexia® Xia Powder 435 W LM	32.0%
Tapioca or brown rice flour	8.0%
Hydroxy propyl methyl cellulose	1.0%
Sugar	5.6%
Egg	3.2%
Salt	0.8%
Benexia® 125WO LM Chia Protein	0.4%
Cultured rowanberry extract	0.4%
Oil	3.2%
Vinegar (5-10% acidity)	0.8%
Syrup	1.6%
Water	42.0%
Yeast (Fresh)	1.0%

Table 1. Gluten-free bread formulation.

GLUTEN-FREE CAKE

Ingredient	Gluten-free Chocolate Cake	Gluten-free Yellow Cake
Benexia® Xia Powder 435 W LM	14.9%	15.96%
Sweet white sorghum flour	1.7%	1.77%
Sea Salt	0.3%	0.35%
Baking Powder	0.7%	0.71%
Hydroxy propyl methyl cellulose	0.2%	0.27%
Sodium carboxymethylcellulose	0.2%	0.27%
Carboxy methylcellulose	0.1%	0.13%
Lecithin	0.3%	0.35%
Granulated sugar	29.0%	29.27%
Cocoa powder	5.8%	0.00%
Unsalted butter	11.6%	13.30%
Vanilla	0.8%	0.89%
Whole eggs	15.2%	16.32%
Whole milk	19.1%	20.40%

Table 2. Gluten-free cake formulation.

GLUTEN-FREE COOKIE

Ingredient	Gluten-free Chocolate Cake
Cornstarch	30.73%
Liquid whole eggs	20.90%
Coconut oil	8.91%
Honey	15.06%
Chocolate Chips	7.38%
Benexia® Xia Powder 435 W LM	7.99%
Benexia®chia seed LM	3.07%
Cocoa Powder	2.61%
Sweetener (Sucralose)	2.58%
Baking Powder	0.77%

Table 3. Gluten-free cookie formulation.

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Substituting Traditional Ingredients with Gluten-Free Alternatives

When formulating gluten-free baked goods some additional considerations should be taken into account to obtain products with the desired organoleptic properties of each baked good produced.

- **Hydration:** ingredients such as hydrocolloids must be fully hydrated to ensure proper functionality.
- **Aeration**: Incorporated air cells should be stabilized with surfactants like mono & diglycerides, polysorbate 60, alpha dextrins, and lecithin. This helps compensate for gluten's film-forming capability.
- **Mixing times:** shorter mixing times are experienced. Hydration and homogenization of the batter/dough happen during this time. Due to the lack of gluten, there is no need for dough development.
- **Proofing time:** proofing times should be limited, due to the delicate nature of the dough. Unless the system is heavily supported by hydrocolloids and emulsifiers, proofing temperatures shouldn't go above 32°C (90°F).
- **Baking time:** based on the water absorption, baking batter-based bread will take longer than dough-based bread. In general, baking gluten-free would require a longer baking time at a lower baking temperature.
- **Cooling:** it is important to let gluten-free bread completely cool down before slicing to avoid deformation and jagged cuts. Slicer blades need to be frequently changed to reduce damage to bread loaves.

The usage of ingredients such as enzymes and hydrocolloids improves the quality of gluten-free baked goods and is the main alternative to gluten. Producing gluten-free baked goods that look and taste like conventional wheat products.

GLUTEN-FREE PROCESSING

In general, the production of gluten-free baked goods is similar to that of conventional baked goods. Some modifications in formulation, mixing, proofing, baking, and cooling time and temperature may need to be adjusted to get that optimal-tasting baked good.

GLUTEN-FREE BREAD

1. Scaling of Ingredients
2. Mixing
    - Blend the dry ingredients. Add the water and liquid ingredients.
    - Mix on first speed to gently blend and incorporate the liquids. Then increase to the second speed. Mix for a good 3-5 mins or until the dough is smooth.
    - Lack of gluten proteins means there is no need to knead and develop the dough.
3. Panning / depositing: dough depositing equipment are usually used at high output bakeries.
4. Proofing: let the dough rise in a proof box (90°F / 70% RH) (32°C / 70% RH) until the dough is level with the top of the pan.
5. Baking: bake gluten-free loaf bread for 60 to 70 minutes at 190°C (375°F). Or until an internal temperature of 93.5°C (200°F) is reached for over 20% of the baking time.
6. Cooling: remove bread from the oven, transfer the bread to a wire rack, and cool for as long as necessary to reach 30°C (86°F).

GLUTEN-FREE CAKE

1. Scaling of Ingredients
2. Creaming: shortening or butter is creamed with sugar
3. Mixing: liquids are added gradually, followed by the dry ingredients. When everything is thoroughly mixed, increase to the next speed to aerate the batter.
fat. Vanilla and other essences are added
4. Baking: batters deposited in baking pans are baked at 180 °C (360°F) for 30 min
5. Cooling

GLUTEN-FREE COOKIE

Given the absence of a viscoelastic network normally provided by gluten, most gluten-free cookies are made to have a short and fluid rheology, with particular spread responses. These two conditions are best suited for extrusion and wire-cut forming.

A typical production process for gluten-free cookies is:

1. Scaling of Ingredients
2. Multi-stage mixing method
    - Creaming
    - Addition of liquids
    - Addition of dry ingredients
    - Addition of chocolate chips or inclusions at low speed until full incorporation
3. Forming or depositing
4. Baking: bake the product, in a gas-fired oven at 392°F / 200°C for 6 to 7 minutes. Baking times and temperatures are usually consistent with those used to bake wheat-containing counterparts.
5. Cooling: cool cookies for at least 1.5 times the baking time.
6. Packaging

TROUBLESHOOTING GLUTEN-FREE BAKED GOODS

How can I reduce the stickiness of batter-type, gluten-free doughs?

This is usually caused by excess water that is not absorbed by the gums and starches. Some of this water that is highly free or moving in between capillary spaces can be controlled by reducing total absorption, or just increasing the amount of gums in the formula. It is typical that a gluten-free dough is sticky. Sometimes, this is an issue at the dividers or depositors. If reducing water is not possible, try spraying vegetable oil onto the contact surfaces. There needs to be a balance between water-holding components and water; this creates enough viscosity in the gluten-free batter and still renders a cohesive network.

Does gluten-free flour have an impact on the shelf life of cake or bread?

Yes, indeed. Gluten-free flours mostly provide starch and lower amounts of proteins that do not contain gliadins and glutenins. The complex combination of starches from different sources that is commonly found in gluten-free flours creates a totally different staling behavior in baked products. The high levels of carbohydrates and starches in gluten-free baked goods increases staling rates. Staling is actually one of the major challenges in gluten-free baking. Therefore, extended shelf-life enzyme solutions are recommended for gluten-free cakes and bread.

What can I do to make my gluten-free mix last longer?

Given their extremely low water activity and physical state, gluten-free dry mixes do not require traditional amounts of preservatives. A very small amount of sorbic acid (and its salts) is often more than enough to secure a long shelf life. If the mix has a high amount of fat, and your water activity is lower than 0.3 or higher than 0.5, then you would have to use a chelating agent to prevent rancidity. Most importantly, an air tight packaging is key to improving shelf life. Lastly, a packaging material that is airtight and light impermeable would also help extend the shelf life of the mix.

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QUALITY ASSURANCE FOR GLUTEN-FREE PRODUCTS

Gluten-free baked goods are measured similarly to traditional baked goods, both types of baked goods share the same basic quality parameters. As mentioned before, one of the main challenges of today's bakers is to produce gluten-free baked goods with similar characteristics to traditional baked goods, thus the reference quality parameters are the same as those expected in perfectly executed traditional baker products.

Typical quality parameters

Baked goods quality is determined by several parameters, some of which may be exclusive of some products but overall shared among the wide expanse of baked goods commercially available.

Some of the most important bakery product assurance parameters are:

- pH: influences the rate of reaction for the chemical leavening agents. A higher pH tends to favor the browning Maillard reaction. The final pH affects mold growth on the product. The typical pH of a classic cake lies between 6.0-7.0.
- Specific Gravity: is a measure of the air added to the cake batter that aids manufacturers in the determination of the batter density. A cake-specific gravity can be measured through a simple method that consists of weighing the batter in a container and dividing that value by the weight of water in the same container.
- Moisture Content: is the water content of the product. It affects the shelf life and sensorial acceptability of finished products. Moisture content is commonly measured by a direct method of evaporation (e.g. convection oven, vacuum, microwave ovens) or by indirect methods (e.g. spectroscopy or thermogravimetry).
- Water Activity: it determines the microbial and chemical stability of the product and impacts the staling rate of the cake.
- Texture: a wide variety of sub-parameters define cake texture, among the most relevant are hardness, cohesiveness, springiness, and resilience. Texture can be measured with a trained sensory panel or by instrumental methods like texture profile analysis (TPA).
- Cake Volume: associated with the lightness and fluffiness of the cake. It can be measured through instrumental methods.
- Cell structure: considering number of cells, cell diameters, cell volume, cell elongations, among others. It can be measured through instrumental methods.
- Color: produced during the baking process due to the browning reactions, affects the acceptability of the product. It can be measured through instrumental methods or by trained sensory panels.
- Inclusions: (such as fruit or chocolate chips) can be quantified to provide information about the evenness of distribution within the slice.

Measuring Quality Parameters

Quality parameter measurements can be taken both by instrumental and sensory evaluation methods. Depending on the monetary and time constraints of the company, one choice may be preferred over the other one. Instrumental methods produce objective results when using the appropriate methods for their respective samples and parameters; while sensory evaluation methods can be used for a wide variety of parameters and samples but time and economic constraints may restrict their usefulness in smaller companies.

Objective results can be accomplished with traditional sensory methods when the appropriate considerations (e.g sample size, appropriate analysis, correct data analysis, panel training, etc) are taken into account and followed through.

The most common instrumental techniques used for the most commonly measured parameters are seen in the following table:

Parameter	Evaluation technique
pH	pH meters
Moisture content	Direct methods: evaporation (e.g., convection oven and microwave oven)Indirect methods: spectroscopy or thermogravimetry
Water activity	Resistive Electrolytic Hygrometers (REH) , Capacitance Hygrometers and/or Dew Point Hygrometers
Texture	Texture Analyzer
Loaf volume and cell structure	C – Cell analyzer or Sightline
Color	Colorimeter or Sightline

Table 4. Quality Parameters

SUMMARY

The Gluten-free trend is here to stay! Novel technologies and techniques are being developed to improve the organoleptic properties of gluten-free baked goods so that they resemble the traditional wheat flour versions. Including how it performs over shelf-life.

Health trends continue to grow this gluten-free segment, creating an ingredient market that is offering better-functioning gluten-free ingredients. We hope the tips and tricks in this pocket guide help you navigate your gluten-free baking journey!

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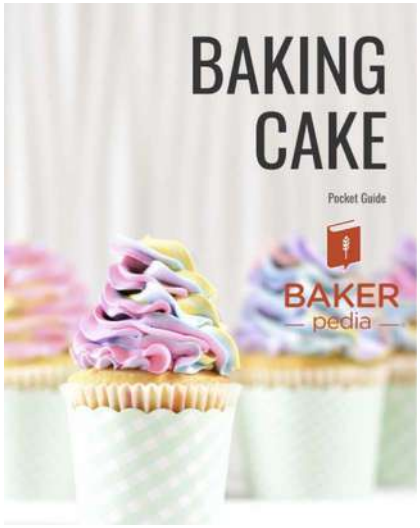

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