

Exploring the use of gluten-free flours in innovative bakery product development: A comprehensive review

Dharani Raja Sree B ^{1,*} and Sindhu S ²

¹ Department of Foods and Nutrition, India.

² Department of Food Processing Technology PSG College of Arts and Science, Coimbatore, India.

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Abstract

Rising incidence related to gluten illness, have gained significant attention and more demand for gluten free diet. This upsurge can be traced not only from the population that suffered from gluten-related disorders but also people who prioritize healthy lifestyles and practicing gluten free diets. The availability of gluten-free bakery products has increased dramatically in the last five years. Typically, conventional wheat products like pastas, breads, crackers and baked goods contain gluten. Nevertheless, numerous gluten-free alternatives exist, utilizing different flours and grains. However, developing an innovative gluten free product with highly acceptable sensory properties is the most challenging task. In addition to its nutritional advantages over regular wheat flour, gluten-free flours have higher levels of protein, fiber, vitamins and minerals. This can lead to bakery products having reduced levels of harmful fats, refined carbohydrates and sugars, making them a better choice for people trying to adopt a diet with a healthy lifestyle. Those who have celiac disease or gluten sensitivity can find a safe substitute that doesn't cause side effects of gluten. Diverse dietary preferences are catered by the bakery industry's increasing awareness of accessibility to gluten-free choices. The size of the market for gluten-free baking offers potential for innovation, technological improvement and adaptation to shifting consumer preferences. Hence, incorporating a range of gluten-free flours into a diet can enhance dietary diversity, which is beneficial for nutrition and overall health. This article reviews the use of gluten free flours in baking.

Keywords: Gluten-free; Bakery products; Gluten-free flour; Celiac-disease; Gluten sensitivity

1. Introduction

The storage protein fraction present in cereal grains is commonly referred to as gluten which is found in cereals such as wheat (70 to 80 per cent), barley (5 to 8 per cent) and rye (16 per cent). Gluten is made up of two protein fractions, prolamins or gliadin and glutenins. Prolamins aid in the dough viscosity and extensibility (Stantiall) [1] whereas glutenin provides strength and elasticity. One of the primary factors influencing dough characteristics and baking performance is the distribution of glutenins (Herbert) [2]. Gluten imparts significant qualities to baked products. It retains gas inside and makes dough elastic and stretchy, giving baked goods a light, airy texture (F.Watson) [3]. However, in the human body, high proline and glutamine content from baked goods, crosses the epithelial barrier and activate the immune system, which can lead to an allergic reaction or an autoimmune response like celiac diseases (R., Macdalyna)[4]. The immune system targets the lining of the small intestine after identifying gliadin as a foreign intruder, resulting in inflammation and damage. These reactions may cause gluten-related illnesses like wheat allergy, non-Celiac gluten sensitivity and celiac disease. The only way to prevent the ill effects of gluten food sources is to encourage a gluten free diet for the rest of individual life. If the amount of gluten per kilogram is less than twenty milligrams per kilogram, the food is considered gluten-free. Several studies state that rigorously adhering to a gluten-free diet claims to be the only treatment available for persons suffering from these symptoms (*Akriti*)[5]. Consequently, *the* quantity of

* Corresponding author: Dharani Raja Sree

gluten-free goods that customers may purchase is expanding quickly. (Stantiall)[1] The increased diagnosis of gluten-related diseases and the general health benefits of a gluten-free diet among consumers are the two main causes of the surge in demand for gluten-free products. As a result, it is reasonable to assume that the consumption of gluten-free products will continue to rise in the future. The lack of substitute ingredients that can mimic the functional properties of gluten free products is one of the most difficult problems in the creation of Gluten free products. Several studies have been done on the utilization of gluten free flours like buckwheat, rice, lentils, and maize in making gluten-free baked products. This review examines the potential of different kinds of rich flours free of gluten that are used to make baked products.

2. Gluten free flours used in baking

2.1. Amaranth flour

The amaranth plant yields amaranth, a wholesome grain free of gluten that is high in protein (14.7 g), fiber (13.2 g) and minerals like iron (6.9 mg), calcium (157 mg), manganese (2.20 mg) (DIVYA)[34] and it can be added to baked products such as bread, cookies, muffins, brownie and cakes. (Akriti)[5]. Amaranth changed the dough's texture by decreasing its elasticity and increasing its softness. By raising all of the polyphenol fractions, especially the bio accessible fraction as well as the protein and ash content, the amaranth substitution enhanced the quality of gluten free flatbread. Its phytochemicals like flavonoids, phenolic acids and saponins have excellent antioxidant properties. Studies show that the sensory attributes of the cookies made with up to 60% amaranth was favorable (Chauhan) [33]

2.2. Brown rice flour

This flour is referred to as whole grain flour since it includes the bran, germ, and endosperm. 366 kcal, 7.5 g of protein, 76.2 g of fat, 2.8 g of carbohydrates, and 8 mg of salt (Akriti)[5] are included in the brown rice. Brown rice flour was used to make bakery goods such as muffins, cakes, cookies, cupcakes, bread, and pancakes. A mixture of 30.71% tapioca starch, 9.29% potato starch, and 60% high protein brown rice flour worked best for the cupcakes. (Sukhmandeep)[31]

2.3. Buckwheat flour

Plant's tiny seeds are mashed to flour, which complements yeast breads and quick breads excellently with its rich, earthy flavor. Compared to other cereals like rice and wheat, buckwheat flour has more nutrients (per 100 g) such as protein (12.0 g), non-fibrous carbohydrate (69.6 g), dietary fiber (4.3 g) (Farzana)[29] This flour is a good source of necessary amino acids, fiber and B vitamins. It also has minerals like copper, manganese and magnesium. Shortbread, pan cake, brownies, cakes, cupcakes, cookies, waffles, and biscuits are produced using buckwheat flour. The gluten-free flour mixes made with maize starch, amaranth flour and chickpea flour were combined with the buckwheat flour (62g) which has a high mineral content and was highly acceptable. (Peñalver)[30]

2.4. Corn flour

Corn flour is prepared by finely grinding whole corn kernels, commonly referred to as maize flour. It is frequently utilized in Latin American and Caribbean cuisine to prepare foods including arepas, tamales, and tortillas (Grassi)[9]. In addition to vitamins like niacin (1.9 mg) and minerals like potassium (315 mg) and iron (2.38 mg), it is a good source of fiber (7.3 g) (USDA)[35]. Bread that is acceptable to consumers can now be made with 20% corn flour (Akriti)[5]. When used in baked foods, it is lighter and has a finer texture. Muffins and cornbread are all made with cornmeal. A mixture of corn flour and quinoa was used to produce bread and biscuits (Shehry)[36]

2.5. Oat flour

Oat flour is produced by finely powdering entire oats (Akriti)[5]. A common gluten-free substitute for wheat flour. Oat flour is rich in fiber (10 g), vitamin B1 (0.4 mg) and minerals including calcium (50 mg) and magnesium (130 mg). A range of recipes, such as those for bread, brownie, pancakes, muffins and other baked products benefit from the mild slightly sweet flavour of oats flour. High in biological value, oat flour is a powerful source of protein (15%). The flour is a fascinating addition to white bread, both wheat and wheat-rye and because of its advantageous amino acid composition and high concentrations, it can be used in proportions up to 20% of the mass of wheat flour (Halina)[7].

2.6. Quinoa flour

Quinoa is a grain that is rich in nutrients and has a lot of protein, fiber and vitamins as well as minerals like potassium, magnesium, and iron (Akriti)[5]. Quinoa flour can be used in savoury and sweet recipes owing to its mild nutty flavor and pale tint. It works great for breads and muffins, as well as cake and cookies. The addition of Quinoa flour to the

cookie samples resulted in a small rise in product thickness. However, a significant decrease was not observed when 10% Quinoa flour was added. Cookies, cakes, muffins, pies and tarts were prepared with quinoa flour. The products that incorporated 10% of roasted quinoa flour (10%) with rice (45%) and oat flour (45%) were deemed to be extremely satisfactory, in all sensory properties (Sukhmandeep)[31]

2.7. Pearl millet flour

Pearl millet's chemical analysis revealed that it had 12 per cent moisture, 12 g protein, 5 g fat, 2 g mineral, 1 g fiber, 67 g carbohydrate, 42 mg calcium, 242 mg phosphorus and 8 mg iron, along with 360 calories of energy. Its nutritional composition was greater than those of wheat and rice. Since numerous studies have shown reduced glycemic response and enhanced heart health, bajra aids in the proper treatment of diabetes (Rustagi) [14]. Pearl millet's incorporation into cookies boosts both the food's nutritional content. For those who are health-conscious, substituting millet flour for whole-wheat flour could be just one more item on the growing list of nutritious foods (Kulkarni) [15].

2.8. Sorghum flour

The whole grain kernels of the sorghum plant are ground to make milo or jowar flour. It comes in a red and white variety with a little bit of sweet flavour. It has a lot of protein, dietary fiber, iron, B vitamins, potassium, and phosphorus which can aid with digestion and assist to keep blood sugar stable. The process of phosphorylating sorghum flours enhances the textural characteristics of cakes without gluten. Better nutritional value can be found in gluten-free cakes made with sorghum. The bakery products like breads, muffins, cookies and pancakes work well using this flour (Akriti)[5]. Products such as breakfast waffles (17%) and sweet potato muffins (25%) made with sorgam flour were highly acceptable (aidan) [27].

2.9. Chickpea Flour

Ground chickpeas, sometimes referred to as Garbanzo beans, are used to make chickpea flour also known as gram flour or besan (Akriti)[5]. Usually, it is used to prepare foods like pakoras in Indian, Middle Eastern and Mediterranean cuisine. In addition to being high in protein (58 g), fat (22 g) and carbohydrate (6 g) in 100g flour (Akriti)[5] it is also rich in potassium (584 mg), magnesium (115 mg) and phosphorus (391 mg) (Dandachy) [28] Adding gluten-free chickpea flour to wheat flour improved the bread's protein, fiber and mineral content. Breads enriched with chickpea flour exhibited better organoleptic properties (Simona) [16]

2.10. Faba bean/ faba bean husk

Dry beans are ground into flour and used to make biscuits and cookies. Increasing the protein level of cookies may also be achieved by substituting a substantial portion of wheat flour with flour made from pulses. Certain demographics, including the elderly, who commonly struggle with low protein intake, would find this healthy when consuming baked products. (Schmelter)[17]. The results of the several studies clearly demonstrate that it is possible to formulate cookies using alternative, gluten-free crops with a higher protein content than wheat flour equivalents and also the faba bean husk is high in fiber which can be used to fortify the bread. These products would be low in cost and without compromising the quality characteristics of gluten free formulation (Suwimol)[18].

2.11. Sabudana Flour

Sabudana is a processed vegetarian meal. In India, it is also referred to as "sago," and is manufactured from tapioca root starch (tuber). Small pearl-shaped Sabudana products are sold commercially. Sabudana is high-carb, low-fat that is consumed in all of India's states. It digests quickly and provides quick energy and is utilized as a healthy meal for sick people. Sabudana provides 351 calories, 87 per cent of carbohydrates, 0.2 per cent of fat and protein (Ohtsuka) [22] Sago flour was used to make bakery products such as bread, crackers, cookies and biscuits. It was combined with other gluten-free flours like rice flour, maize flour and **Rajgira** flour (Yenkar) [24] and it was found that Rajgira and Sabudana fasting biscuits in the ratio of 3:2 was highly acceptable.

2.12. Arrowroot

An indigenous tropical tuber to Indonesia is called arrowroot (*Maranta arundinacea*). Most often, it is ground into arrowroot flour powder. The rhizome, or subterranean stem with numerous roots that stores the starch and energy of the plant, is where the powder is extracted. Powdered arrowroot is a highly processed form of starch. It is also a great source of protein and is gluten-free, making it ideal for those with celiac disease. Along with having good levels of iron, manganese, phosphorus, magnesium and zinc, arrowroot flour is a great source of potassium (Casiana) [25]. Use of it as flour for more baked items is common for making cookies, cakes, cupcakes and pan desal (Sudaryati) [26]. The studies showed that arrowroot incorporated pan desal was highly acceptable than the traditional form.

2.13. Almond flour

Almonds, with or without their skins, are ground into a fine powder that is referred to as almond meal. Almonds with their skins on will provide flour with a deeper tint, making it appropriate for use with rustic breads or other baked items like gingerbread or chocolate desserts that are also dark in color. The hue of blanched almonds is pale ivory when it comes to almond flour without the peel. Light-colored cakes and muffins can benefit from its usage. It tastes a little sweeter and contains more minerals and less carbohydrates. Almond flour has additional health benefits over wheat flour, including a reduction in insulin resistance and "bad" LDL cholesterol. Foods that have almond flour added to them in amounts of 20, 40 and 60 per cent have higher nutritional value (Daniela S) [21]

2.14. Coconut flour

The fruit of the *Cocos nucifera* palm tree is used to make coconut flour, which is gluten-free. In recipes, it can be used to partially substitute wheat flour, or it can be blended with other gluten-free flours to create a gluten-free flour substitute. This flour is high in fiber, has a light ivory colour and a subtle coconut taste. Stable blood sugar levels, good digestion and heart health are all enhanced. The amount of flour required to produce the desired result was less due to the water-binding qualities of coconut flour (Hopkin) [20].

2.15. Bambara groundnut flour

Bambara groundnut, is a leguminous crop that is regarded as a complete diet due to its high protein, carbohydrates, minerals, low fat content, and an excellent balance of key amino acids, which are typically limited in most legumes. Value-added snacks, biscuits, low-fat spreads, spaghetti, yoghurt, breakfast cereal, chocolate bars and milk are a few of the items prepared from Bambara groundnut flour (Beatrice) [19].

3. Conclusion

The need for healthier options has led to a rise in the demand for gluten-free alternatives, and the development of gluten-free bakery products has continued to prioritize quality, variety, and customer satisfaction. Thus, gluten-free bakery products have a bright future in the bakery industry. Personalized nutrition, sustainable sourcing, enhanced taste and improved texture can all be accomplished with the use of alternate grain flour and creative baking techniques. However, enhancing the nutritional value of gluten-free baked products with cereals, legumes, millets and root and fibers can significantly impact customer acceptability in the new market and an individual's health. The strategies to efficiently boost the nutrient content of bakery products without sacrificing their low glycemic index and distinctive sensory features to a wide range of innovative gluten-free product formulations with new alternative nutrient dense ingredients need to be explored in future research.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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