https://doi.org/10.33472/AFJBS.6.4.2024.859-873

African Journal of Biological Sciences

GLUTEN FREE DIET: OBTAINABILITY AND SUSTENANCE

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Abstract

The increasing popularity of gluten-free diets has impacted food producers, medical experts, and consumers. Food production has refined and modified its manufacture processes to cope up with consumer demands, and medical professionals are curious about the diet's nutritional value and potential for treating gluten-related illnesses. Although the quality of these substitutes is usually lower than that of gluten products, the introduction of other starches, flours, hydrocolloids, and fibre bases has helped to mimicking the texture and sensory experiences of gluten in gluten-free items. A gluten-free diet has been connected to nutritional imbalance even though it can help with some gluten-related disorders. The gluten-free diet has sensory limitations and nutritional inadequacies that consumers should be aware of, as there is not enough evidence to recommend its use outside of therapy of gluten-related diseases. Efforts are being made to enhance the overall quality of gluten-free food products, but caution should be exercised when making dietary choices. The objective of this investigation is to analyse the function of gluten-free diets, acceptability, availability, nutritional and non-nutritional information, and inclusion of gluten-free cereal products in the market.

Key words: gluten-free diet, celiac disease, availability, nutritional adequacy, non-nutritional adequacy, product development.

Methodology

Various literature research approaches were utilised to investigate the role of gluten-free goods in Indian diets. Multiple research platforms such as PubMed and Google search engines were utilised with full effort to construct an outline of understanding the acceptance, availability, pricing, nutritional and non-nutritional facts of gluten-free items. Multiple search terms or keywords like “gluten-free diet”, “nutritional and non-nutritional” facts were used. Necessary cross references are

also provided in detail to refer to prior research on the acceptance, accessibility, and pricing of gluten-free product in the Indian market.

1. Introduction.

As per WHO, a good healthy diet prevents both under-nutrition and over-nutrition. “A nutritious meal can also help guard against non-communicable diseases (NCDs) which are a serious public health problem and can be costly for healthcare systems in industrialised nations” (Healthy diet, 2018).

A healthy diet should be diverse and well-balanced, in accordance with dietary guidelines worldwide. It should prioritize the consumption of food items “such as fruits, vegetables, whole grains, low-fat or non-fat dairy products, fish, legumes, and nuts”, while limiting intake of refined grains (Healthy diet, 2018). Additionally, it should provide minimum intake of fats, carbohydrates, salt, and saturated fats, and sufficient levels of nutritional fiber and saturated fatty acids.

Certain “medical conditions”, “food intolerances” and “allergies” need people to follow specific diets to maintain good health. They all involve restricting or eliminating certain food groups or ingredientsthat could potentially cause allergies, intolerances, or harm to certain individuals (Melini, 2019).

Adhering to a gluten-free diet (GFD) necessitates the avoidance of all gluten-containing foods, including those made after “wheat, rye, barley, oats, spelt, kamut, and their hybridized strains”. Instead, individuals following this diet consume foods that naturally lack gluten. Moreover, specially formulated gluten-free substitutes for wheat-based products are available, meeting the European standard of having a gluten content lower than 20 parts per million (Melini, 2019). Transitioning to a gluten-free lifestyle involves a significant adjustment in dietary habits, as individuals must scrutinize food labels and ingredients to ensure compliance with the diet. Consulting with dietitians or medical professionals can also be a great way to get support and help when navigating the challenges of following a gluten-free lifestyle.

A gluten-free diet (GFD) is necessary for addressing three distinct medical conditions: wheat allergy, non-celiac gluten sensitivity, and celiac disease (CD). Among these, wheat allergy presents as an immune response triggered by wheat proteins, often observed in paediatric populations. Conversely, non-celiac gluten sensitivity manifests as adverse symptoms upon the consumption of gluten-containing cereals, with notable improvements observed upon adhering to a gluten-free diet (Leonard, 2017). In contrast, celiac disease represents a more severe autoimmune condition distinguished by an abnormal immune response to gluten ingestion; lead to in damage to the small intestine lining. Thus, for individuals affected by these conditions, the adoption of a gluten-free diet is imperative to manage indications and maintain overall health.

CD is a chronic ailment characterized by immune-mediated harm to the small intestine, affecting around 1% of the Western populace, and diagnosed through specific antibodies against certain proteins. CD can result in severe long-term health complications like lymphoma, osteoporosis, and anemia (Freeman, 2009).

Despite a significant increase in availability over the last five years, the cost of gluten-free products has not decreased relative to those that include gluten (Panagiotou, 2017 & Burden, 2015). Gluten is often not individually listed on product labels and may lurk as a hidden ingredient under terms like "flavourings" or "hydrolyzed vegetable proteins." Finding foods that are safe for people with celiac disease becomes more difficult when gluten is used as a flavor enhancer, thickener, emulsifier, filler, and fortifier.Furthermore, celiac disease patients may encounter limitations in social and recreational pursuits (Silvester, 2016).

This article aims to assess the dietary value of gluten-free stuff accessible in today's era. It seeks to analyze their potential impact on the nutritional well-being of individuals with celiac disease who adhere to a gluten-free diet. Additionally, recent food surveys are reviewed to estimate the dietary makeup of popular gluten-free alternatives to wheat. These surveys aim to identify commonly deficient nutrients in these substitutes, shedding light on areas where nutritional supplementation may be necessary and how they affect those who have celiac disease.Overall, the article aims to provide insights into the dietary adequacy of gluten-free options and their implications for individuals with celiac disease.

2. GLUTEN-FREE DIET: DEFINATION

GFD refers to the total elimination of gluten from both whole meals and processed foods. The protein that is being eliminated is called gluten, and it can be found in wheat, barley, rye, and related cereals. The Codex Standard for gluten-free foods was established in 1976 by the WHO and the Food and Agriculture Organization, with subsequent revisions in 1983 and 2000. These standard mandates that gluten-free goods contain less than 20 parts per million (ppm) of gluten and must not include prolamines from wheat, spelt, kamut, durum wheat, rye, barley, oats, or their hybrid mixtures.

Recent studies have underscored the significance of strict adherence to GF guidelines, revealing that consuming as little as 50 mg of gluten daily for 3 months can result in significant gut damage. To maintain safety, the brink for gluten content in gluten-free products is set at less than 20 ppm, ensuring that daily gluten intake remains below the critical 50 mg threshold (Rajpoot & Makharia, 2013). By meticulously adhering to these standards, individuals following a GFD can minimize the chance of adverse effects associated with gluten consumption while enjoying a varied and nutritious diet.

2.1 Nutritional content of GFD

Research has indicated that those who strictly adhere to a GFD may have nutritional inequalities. Hallert et al. discovered vitamin insufficiency in CD affected individual those who are on a GFD, whereas Ciacci *et al.* (Ciacci et al., 2002) discovered significantly reduced weight, BMI, fat, and lean body mass in CD patients on a rigorous gluten-free diet assessed to beneficial control group participants. Reports further notified that the diet followed by CD patients was not balanced and that a large proportion of calories consumed came from fat and a lesser quantity from carbohydrates. According to the authors, the choice of gluten-free foods and individual dietary patterns of the subjects played a role in the nutrient deficiencies caused by GFD. The amount of fibre intake also gets reduced in CD patients on a strict gluten-free diet (Lohiniemi *et al.*, 2000; Grehn *et al.*, 2001).Gluten-free cereals are starchy and non-fibrous since they are prepared with non-fortified and unenriched gluten-free flour, which makes them a good source of carbohydrates and fats (Moreno *et al.*, 2014).Gluten-free food preparation involves some considerations, such as flavor and the fact that it lacks the stretching properties of gluten, making it difficult to form into a wide range of food products(Matos and Rosell, 2015).

Gluten-free food typically includes minimal amounts of protein and fiber(Fry *et al.*, 2018). Gluten free products have varying amounts of glycemic index depending upon the quality of ingredients

used and food processing process use to manufacturing them(Berti *et al.*, 2004). Much lower contents of folate, iron, niacin, thiamine and riboflavin are found in gluten-free products as they do not undergo a similar fortification or enriching process like other products (Thompson *et al.*, 1999).Many strengths have been produced to enhance the production of gluten free goods without limiting their physical quality (Alencar *et al.*, 2017).

An ideal GF product is the one which contains the same amount of nutrients as its gluten counterpart. This is another field of study which has been explored by researchers to strengthen the dietary profile of GF stuff (Jnawali*et al.*, 2016).

Table 1. Natural Gluten Free food items and their nutritive value.

S.No.	Name of the food.	Carbohydrates (in gm)	Protein (in gm)	Fat (in gm)	Iron (in mg)	Calcium (in mg)	Zinc (in mg)	Dietary Fibre (in gm)
1.	**Amaranth** (100gm)	59.98	14.59	5.47	9.33	181	2.66	7.02
2.	**Maize:Corn** (100gm)	64.77	8.80	3.77	2.49	8.91	2.27	12.24
3.	**Rice** (100gm)	78.24	7.94	0.52	0.65	7.49	1.21	2.81
4.	**Samai:Finger Millet** (100gm)	65.55	10.13	3.89	1.26	16.06	1.82	7.72
5.	**Quinoa** (100gm)	53.65	13.11	5.50	7.51	198	3.31	14.66
6.	**Bajra** (100gm)	61.78	10.96	5.43	6.42	27.35	2.76	11.49
7.	**Jowar** (100gm)	67.68	9.97	1.73	3.95	27.60	1.96	10.22
8.	**Ragi** (100gm)	66.82	7.16	1.92	4.62	364	2.53	11.18
9.	**Varagu:Kido Millet** (100gm)	66.19	8.92	2.55	2.34	15.27	1.65	6.39
10.	**Soy** (100gm)	12.79	35.58	19.82	8.29	239	4.01	21.55
11.	**Sorghum** (96gm)	69	10	3	18% of Daily Value (DV)	NIL	14% of Daily Value (DV)	6
12.	**Rice Flakes** (100gm)	76.75	7.44	1.14	4.46	9.19	1.49	3.46
13.	**Puffed Rice** (100gm)	77.68	7.47	1.62	4.55	15.09	1.45	2.56
14.	**Sago** (100gm)	83	0	0	1	10	0	NIL
15.	**Buckwheat** (100gm)	65.1	10.3	2.4	15.5	64	2.4	10

Source: Indian food composition tables National Institute of Nutrition HyderabadLongvahT et al, (2017), Nutritive value of Indian foods ,Indian Council of Medical Research,.Gopalan, C.,et al (1971).

3. COMPONENTS USED IN GLUTEN-FREE FLOURS AND PRODUCTS

When different variety of flours, starches, enzymes, proteins, and hydrocolloids are added to GF products, the viscoelastic or binding property of gluten is restored, improving the end product's structural characteristics(Marco and Rosell, 2008).

1. **STARCHES**: Gluten-free recipes make use of starch derived from naturally gluten free cereals like rice, cassava, tapioca, corn, potato and beans etc (Krupa *et al.*, 2010; Milde *et al.*, 2012). Rice flour and corn stiffener are being used in combination with GF starch, recently derived from a variety of wheat, in the production of GF products (Sarawong *et al.*, 2014). High viscosity is needed for batter to forming gluten free food items (Kang *et al.*, 2015). Naturally occurring starches can be modified to increase their variability and to display a distinct quality. “Their use in the preparation of gluten-free products has also been tested (Ziobro *et al.*, 2012)”.

2. **PSEUDOCEREALS AND LEGUMES**: Gluten-free food items are prepared with starch as well as with the flours of GF cereals and pseudocereals. It is said that oats should be avoided by people with gluten-related disorders; however, Past research has shown that eating oat flour does not negatively affect those with celiac disease (Hager *et al.*, 2012).The oats flour gets through in the formulation of gluten-free products must be certified as GF because during the harvesting season, oats often get mixed with other gluten-containing cereals making it a lot harder to separate one from the other. Flours of legumes such as “beans”, “chickpea”, “carob germ”, “carob”, “marama beans”, “soya” and “chestnut flours” have also been used to prepare gluten-free diet other than cereals and pseudocereal flour. (Minarro *et al.*, 2012; Moreira *et al.*, 2013; Nyembwe *et al.*, 2018; Paciulli *et al.*, 2016; Rostamian *et al.*, 2014; Tsatsaragkou *et al.*, 2014).

3. **DIETARY FIBRE**: To improve the dietary profile of GF food items, dietary fibre is used which also helps improve the textural conditions of the yields because of its ability to increase visco-elastic and gelling properties. There are some dietary fibres usually used in GF products are “β-glucan”, “inulin”, “oligofructose”, “linseed mucilage”, “apple pomace”, “carob fibre”, “bamboo fibre”, “polydextrose”, and “resistant starch” (Korus *et al.*, 2015; Martinez *et al.*, 2014; Pastuszka*et al.*, 2012; Rocha Parra *et al.*, 2015; Rozylo *et al.*, 2017; Sciarini *et al.*, 2017).

4. **HYDROCOLLOIDS:** Hydrocolloids are a group of polymers characterised by their thickening properties when mixed with water. Two types of mostly used hydrocolloids are “xanthan gum and hydroxypropyl methyl cellulose (HPMC)” (Dizlek*et al.*, 2016; Hager *et al.*, 2013; Mezaize*et al.*, 2009; Morreale *et al.*, 2018).Studies have been conducted on other gums as well such as “pectin, guar gum, locust bean gum, agarose, tragacanth gum, cress seed gum, and carboxymethyl cellulose” (Moreira *et al.*, 2013; Liu *et al.*, 2018; Nicolae at al., 2016; Naji-Tabasi*et al.*, 2014).

5. **PROTEINS:** The most effective non-gluten protein replacements of gluten protein in labels of textural and sensory properties are albumin and pea and lupine protein (even better than soy protein) respectively (Ziobro *et al.*, 2016). Examples of other non-gluten proteins are “legume, egg, dairy, and non-gluten cereal proteins” (1994; Crockett *et al.*, 2011; Espinosa-Ramírez *et al.*, 2018;

Rodriguez Furlán*et al*., 2015; Phongthai*et al*., 2016). On comparison of the dietary profile of gluten protein and its gluten-free protein alternatives, the latter provide an improved source of fundamental amino acids "such as lysine" which are usually found in lower quantities in gluten protein. Hence, gluten-free protein alternatives have a richer nutritional profile than gluten (El Khoury *et al*., 2018).

6. **ENZYMES**: enzymes are also used to produce GF products because of their networking ability which binds the polymers nearby in the yields ingredients. There are some enzymes such as "transglutaminase, glucose oxidase, tyrosinase, and laccase" used in their production (Mohammadi *et al*., 2015).Additional starch-hydrolyzing enzymes, such as alfa-amylase and amyl glycosidase, have also been employed to provide gluten-free yields(Cappa *et al*., 2013).

TABLE .2 INGREDIENTS USED TO MAKE GLUTEN FREE PRODUCTS

INGREDIENTS	TYPE
Starch	Cassava, tapioca, corn, potato, beans, rice
Pseudocereals	Amarnath, buckwheat, chia and quinoa
Naturally gluten free cereals	Sorghum, millet, corn, teff and rice
Dietary fibers	Beta-glucan, mucilage, insulin, oligofructose, bamboo fiber linseed, carob fiber, polydextrose, and resistant starch
hydrocolloids	agarose, hydroxypropyl methyl cellulose (HPMC), carboxymethyl cellulose, pectin, guar gum, locust bean gum, Xanthan gum, tragacanth gum, cress seed gum,
Protein	Legume, lupine, protein dairy, egg and non-gluten cereal protein, albumin, white pea,
enzymes	Transglutaminase, glucose oxidase, tyrosinase and laccase and starch hydrolyzing enzymes

4. IMPORTANCE OF DEVELOPING GLUTEN-FREE PRODUCTS

Celiac disease patients still have only one remedy is to adopt gluten free diet. Abstaining from foods containing gluten promotes intestinal healing, restores nutritional imbalances and an eventual subsiding of other symptoms (Dhankar, 2013).Not treating CD could eventually lead to serious health issues in the long run in CD patients, but adopting a GFD could help reduce the risk of developing these health issues (Health Canada, 2008).Adhering to a GFD presents a unique set of obstacles, which further complicates compliance. Avoiding commonly consumed gluten-containing foods is part of it, as it can also lead to social pressure and a feeling of social exclusion(Bauman and Friedlander, 2008).One of the biggest obstacles to following a gluten-free diet is the fact that most breads, cookies, pasta, and breakfast cereals are manufactured with wheat flour, so for many people, avoiding them may not be the best course of action. Hence gluten-free products as now in great demand(Jnawali*et al*., 2016).

5. GLUTEN- FREE DIET V/S NORMAL DIET

Nowadays, there is a wide variety of GF foods accessible in the bazaar with improved taste and texture and are popular amongst all including CD patients and the general public. The benefits of a GFD (including resolving symptoms of CD patients and improving their quality of life) outweigh minimal adverse effects of following the diet, which makes it safe to follow. A few people are also enticed to follow the diet because it allows them to eat healthy and balanced meals as it includes gluten-free wholegrains and also helps them to manage their weight because of fewer food

options (Rostami *et al.*, 2017).Currently there are no studies recommending that gluten-free diet is beneficial for the general population besides CD patients. Further speculations into the diet have also revealed that it has a poor nutritional profile and that it may also increase exposure to metabolic syndrome (Tortora *et al.*, 2015).These studies also point to an unhealthy dietary composition of gluten-free products as they may contain a rather high proportion of fats, salt and carbohydrates (Mariani *et al.*, 1998).Dietary fiber, proteins, minerals, and vitamins were found to be nutritionally deficient in a considerable percentage of CD patients (20–38%), making the GFD an inadequate source of nutrition (Saturni*et al.*, 2010).A lack of inclusion of nutrients may be a factor influencing occurrence of these nutritional deficiencies on the diet. For example, vitamin D deficiency in CD patients may be due to the contribution of secondary factor like lactose intolerance (Ojetti*et al.*, 2005).

A charity for CD patients based in the UK is of the viewpoint which is contrary to popular belief that "gluten-free substitute foods are not necessarily higher in sugar or lower in fibre". Gluten-free products have improved in quality over the years (Rostami *et al.*, 2017).

Any major lifestyle modifications including following a diet can cause some unwelcome effects as well besides the benefits. This is some essential information which must be investigated further and communicated to whoever follows this diet (Rostami *et al.*, 2015). On the other hand, treating the symptoms of IBS patients with medication has more toxic side effects than the former and costs a lot more money as well (Soubieres *et al.*, 2015).A helpful dietary consultation is a dietary consultation of any kind which can also guide the patient to include healthier options of preference by the patient and should not just press on the promotion of a diet devoid of gluten (Rostami *et al.*, 2017).

It is important to note that the side effects of a gluten-free diet such as higher calories and exposure to metabolic syndrome are not exclusive to the diet and hence, can also be caused by eating other food products containing gluten. There are bigger factors than gluten that influence the ability of an individual to gain weight and ultimately become obese such as genetics and lifestyle. CD patients and general population both showed a rise in obese population(Tucker *et al.*, 2012; Lobstein *et al.*, 2015).

6. Gluten-Free Products Adulterated with Gluten

It is possible that GF products might contain traces of gluten including commercialized GF products, as some studies have shown. There was a study conducted by Farage and colleagues to trial the occurrence of gluten in products which were sold by bakeries in Brazil; and they found a significant proportion of gluten (20 ppm) in 28 study samples out of a total of 130 gluten-free product samples (Farage *et al.*, 2017).Another similar study conducted in a different country showed only 9% gluten contamination (20ppm) of naturally gluten-free study samples (Verma *et al.*, 2017). There are some gluten-free products which are more susceptible to gluten contamination such as those containing oats. Oats are regarded as gluten-free because they contain a similar type of protein to gluten, but in far less amounts than in gluten-containing grains (Smulders *et al.*, 2018).

Unless we separate farmlands and processing equipment for gluten-free grains and gluten-comprising grains, the contamination of products which are gluten-free with gluten cannot be completely avoided (Khairuddin & Lasekan, 2021).

7. Availability, Nutritional - non nutritional facts and cost of gluten-free food items in market

Lack of awareness around the goods, their high cost, large amount of undiagnosed cases and ineffective value chain are some of the major issues which are preventing the gluten free market from flourishing.In India and the USA, the high cost of gluten-free goods is a major concern because they are more expensive than ordinary food products. Atleast in USA this difference in cost has reduced with the betterconvenience of gluten-free products (Masih, 2018). "Gluten-free flours baked foods and prepared foods are now 162 more costly than regular products" (House, 2016).Gluten-containing items have a lower nutritional value than gluten-free products, which some CD patients used to prefer(Anonymous, 2014). There is a chance for global brands right now to enter the Indian market of GF products as they are being locally prepared and have a poor nutrition profile. A global brand could flourish in India due to a rise in CD patients, improved awareness on international brands and better income. Both in America and India, consumers prefer less expensive gluten-free goods with a lower nutritional profile over those that cost more and have a better nutritional value(Makharia,2014).

It was established from a study that 73% of gluten-free food consumers are non-CD patients who prefer being on a gluten-free diet for reducing their weight, controlling diabetes and high blood pressure while the rest were diagnosed with a gluten-related disorder or were simply sensitive to gluten (Anonymous, 2016).

These kinds of studies are crucial for producersof gluten-free products as they can help design future gluten-free products matching the expectations of the consumers. And studying consumer behaviour in two different countries such as India and the USA could help in investigating the differences in food choices and preferences concerning gluten-free products (Masih, 2018).

Limited data exists regarding the accessibility, affordability, and wholesome value of GF food. The fortification of micronutrient in gluten free flours is not mandatory according to the U.K low. This study, the quantity and costs of GF products were investigated, and the nutritional data on the back of the package regarding components, and the occurrence of fortification nutrients were compared to those of conventional gluten-containing similar goods. Information about the products was gathered from four supermarket websites. Compared to GF, standard items were substantially less expensive and more plentiful. Products made from gluten-free bread had significantly more fat and fibre. All GF goods contained less protein than conventional products. Gluten-free loaves were provided with four vital nutrients: iron, calcium, nicotine acid or nicotine, and thiamine, whereas 28 % of gluten-free breads were fortified just with calcium as well as iron. Patients whosuffer from celiac disease or gluten allergies may be at a higher risk of vitamin deficiencies due to a deficiency of enrichment. According tofindings, it is suggested that fortification requirements be broadened to include all gluten-free goods while controlling their nutritional value. In adding to enhanced monitoring of the dietetic content of GF meals, fortification regulations should be amended to embrace all GF goods (Allen & Orfila, 2018).

Despite an increase in demand as well as use of GF foods items, there has not been a thorough examination of how they compare nutritionally to their gluten-containing counterparts. Some studies presented current data on the cost and nutritional value of GF food items in order to view the use of GF food products for both categories that require it and those who do not. A study performed (Missbach*et al.*, 2015)on the dietary composition and cost of the gluten-free foodstuffs and gluten rich products were collected methodologically from different supermarket in Austria. The gluten free foodhas greater than 2 times lower protein value by 57% of all categories of food. They found decreased salt concentration in 65% of the GF items. 19% of GF items can be categorised as high-fibre sources. In comparison to comparable gluten-containing items, the

average cost of GF foods was much higher. According to this research, there are no clear health advantages to eating GF foods; rather, while following a GF diet, some important nutrients must be taken into account. Gluten-free goods are more costly than that of gluten containing items for those who are not celiac patient, but they do not offer any further nutritional advantages in terms of health benefits.

Fry et al. discovered that gluten-free items cost 159 percent more than gluten-containing items (Fry et al., 2018). This data supported Hopkins and Soon's (2018) conclusion that gluten-free items were more expensive. In countries like Mexico, where subsidies for gluten-free food are non-existent, the expenditure is extremely high. Furthermore, the intricacy of the manufacturing process contributes to the higher market prices of gluten-free products. Lee et al. discovered another aspect, observing that certain customers with gluten sensitivity or celiac disease rigorously adhere to gluten-free diets (Lee et al., 2019).

Table. 3 Gluten Free Products Available in India

No.	Company Name	Product Names	Sources
1.	Wellversed	Gutwell - Gluten Free Flour	https://wellversed.in/collections/gluten-free
		NutraHi-Rice & Quinoa Spaghetti	
		Good to eat2-Jowar Idli mix	
		Artinci-Gluten free Mixed Nut Keto Cookies	
		Wheat free multi grain flour	
		Kivu-Rajgiri Coconut cookies	
		Kivu-Choco Oats Cookies	
		Roasty Tasty-Bajra Mixture	
		Taru Naturals-Sattu Flour	
2.	Wheatfree	TuttiFrutti Cookies - Gluten free	https://www.wheafree.com/wheafree-gluten-free-products/
		Rice Maize Peene Pasta	
		Rice Noodles	
		Maida Replacer - Gluten free	
		BajraRagi Mini Crackers	
		Gluten Free Porridge	
3.	Be Well	Ragi Flour	https://bewellindia.com/products/
		Soy Flour	
		Multigrain Dhokla Mix	
		Gluten Free Dalia	
		Wheat and Gluten Free Chocolates	
		Rice and Maize Puffs	
		Matar Snacks	
		BesanKhatai	
4.	Schar	Gluten Free Cereals Range	https://www.schaer.com/en-int/products
		Gluten free spaghetti and pasta range	
		Gluten free breads and biscuits range	
5.	NutriOrg	Gluten Free Rolled Oats	https://nutriorg.com/
		Gluten Free Instant Oats	
		Gluten Free Raw Steelcut Oats	
		Gluten Free Oats Cookies Butterscotch and Cranberry Flavors	

This table provides a comprehensive overview of the gluten-free products available in India along with their respective sources for reference.

Conclusion

A gluten-free diet is essential for individuals diagnosed with celiac disease and other conditions related to gluten intolerance. However, some people without diagnosed conditions also adopt this diet in hopes of health benefits, despite insufficient scientific backing. Substituting gluten in various foods poses a significant challenge, and while different methods and ingredients have been attempted, gluten-free product quality often falls short. Concerns arise regarding the adequacy of essential nutrients like minerals, vitamins, and fiber in gluten-free alternatives. Nonetheless, certain lesser-known grains and pseudo-cereals like amaranth, buckwheat, quinoa, sorghum, and teff show promise due to their higher protein, iron, calcium, and fiber content compared to wheat. Oats could also enhance the nutrient profile of gluten-free diets. While commercially available gluten-free items tend to be pricier, incorporating alternative grains like oats and quinoa could offer a more affordable option, fostering adherence to the diet among those with celiac disease. Further investigation is necessary to explore the potential of these minor cereals and pseudo-cereals in enhancing the nutritional value of GFD and reducing product costs. Therefore, it is crucial to develop safe and nutritionally balanced gluten-free food items for celiac and non-celiac gluten-sensitivity patients, taking into consideration factors such as texture, colour, choice of different flours, elimination of possible gluten-containing raw materials, and nutritional quality for labelling.

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