Review Article

Incorporating low glycemic index ingredients in bakery products: A review

Abstract

Diabetes can be caused by various factors such as high sugar intake, hormonal imbalances, and genetics. Eating low-GI meals can lead to reduced blood lipid levels, decreased postprandial blood glucose levels, decreased insulin demand, increased colon fermentation, and enhanced satiety. The purpose of this review is to provide insight into the Glycemic Index (GI) and its effects on the human body. Low-GI foods are associated with a decrease in contemporary lifestyle conditions such as obesity, diabetes, some cancers, and heart attacks. This review discusses the significance of low GI foods, the factors that influence GI, and the fundamental processes and strategies for creating low-GI products. Additionally, the review provides a summary of research trends on the benefits of eating low-GI foods for health. Different formulations of snacks are also discussed, which incorporate several types of flours and fruit pulps that contribute to the reduction of GI of the food and increase in fiber.

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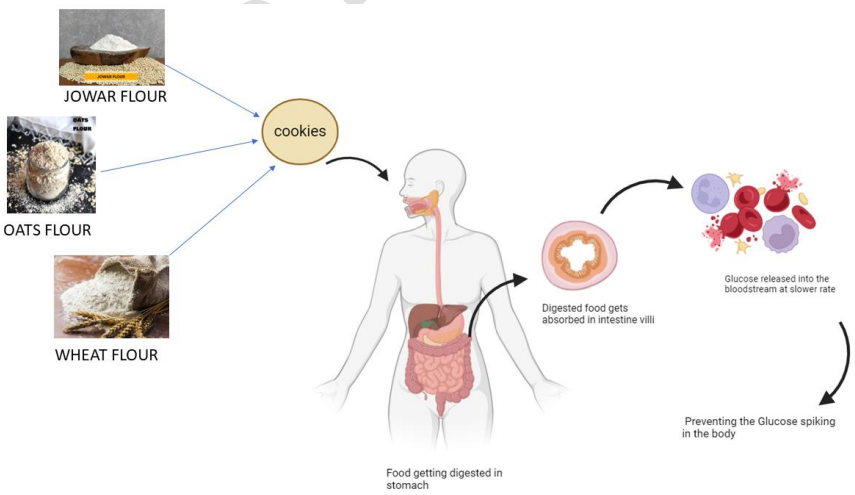

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Figure 1 Ingredients and metabolism of low glycemic index cookies.

1.Introduction:

The glycemic index is a useful tool for determining how much a food can change your blood sugar levels. The glycemic index of food is impacted by several factors, including cooking method, nutritional composition, and degree of ripeness.Whole grains and legumes are examples of complex carbohydrates that have a lower glycemic index (GI) because they release glucose into the bloodstream more gradually, which helps to maintain stable blood sugar levels.

Fruits, vegetables, and nuts are examples of foods high in fiber that can lower a meal's GI by lowering the influence of carbs on blood sugar levels through slower digestion and absorption. The idea of GIwas first proposed byJenkins et.al (1988) to measureglycemic response to carbohydrates in different food products byCairano et. al (2022). In general, GI is a measure of the quality of carbohydrates in meals and is a relative glycaemic response. On the other hand, depending on GI and the total amount of carbs consumed, GL indicates the number of carbohydrates that affect the glucose response Ferrer et. al (2012).Foods are classified into three categories on the GI classification system: high GI (>70), medium GI (55 to 70), and low GI (55). Cairano et. al (2022). Living in an obesogenic atmosphere increases hunger and increases the risk of diabetes in many metropolitan countries. Frequent use of processed foods, such as white bread, is one of the dietary factors that aggravate these metabolic problems. The international tables of GI and GL values show that breads have an average GI value between 24 and 100 Particularly wheat white bread has a significantly high GI [GI > 70]. The GI, or glycemic index, measures how much a portion of food is high in carbohydrates and influences blood glucose levels after a meal as compared to a reference product (usually white bread ormostly glucose) with an equivalent amount of readily available carbohydrates.

It is crucial to effectively control postprandial glycemia and insulinemia in order to minimize the chances of developing cardiovascular disease and type 2 diabetes..whereas the rise is not as noticeable after eating foods low in GIglycemic index (GI) was created to measure "the blood glucose-raising potential of the available carbohydrates in high-carbohydrate foods" in an effort to manage postprandial glycemia and insulinemia.It is commonly known that while a low GI diet can enhance health, high GI foods can raise the chances of obesity, diabetes, several types of cancer, and cardiovascular disorders. When it comes to satisfying sweet cravings without compromising on health, low GI foods emerge as a smart and delicious choice. Nowadays the people are getting aware of their health and have

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started choosing a new and healthy lifestyle. This awareness in them gives a positive boost to such different products. These products are crafted with ingredients that have a slower impact on blood sugar levels, offering a balanced alternative to traditional high GI treats.Some whole grains food products (oats, quinoa, or brown rice) are popular low-GI ready-to-eat foods that come in the form of crackers, chips, and bars, remade salads using low-GI ingredients, such as tofu or grilled chicken. Meals that are frozen that include lots of veggies, lean proteins, and nutritious grains pasta dishes, casseroles, and stir-fries. There are many different options for a healthy breakfast such as healthy grains, nuts, and seeds, granola bars, oatmeal sachets, and low-GI morning cereals. Nuts, seeds, and dried fruits in snack bars Low-GI and easily portable food options are provided by energy and protein bars. As people prioritize controlling blood sugar levels for improved health, there is a growing demand for low-GI ready-to-eat meals due to increased consumer awareness of the glycemic index (GI).

The health benefits of consuming the low GI food have been described by various studies. The study by Barbosa et.al (2017)found that the majority of respondents stated that they had used natural resources—especially plant species—as a treatment or supplement in their studies. People have been using medicinal herbs for ages all across the world. It also lowers blood sugar levels and is a more accessible source than other medications. Inthe work done by Salehie et. al (2019),It has been found that conventionally used therapeutic Plants work well. Many plants have been shown to have glucosidase-lowering, anti-hyperglycemic, and anti-diabetic effects.The phytochemicals found in plant extracts are a group of compounds that give plants their anti-diabetic properties. Alkaloids, glycosides, phenolic acids, stilbenes ,saponins,flavonoids polysaccharides and tannins are the main phytochemicals with anti-diabetic properties.The preparation of pasta using oatmeal is justified, according to Oliveira & Manfrinato (2018), for the improvement of the product's nutritional value, as evidenced by the significant increase in fiber content and has decrease in glycemic index, making the food healthier. This generally happens in conjunction with conditions that call for a particular diet that includes a small amount more fiber in order to reduce blood glucose. The study done by Li et.al (2016), demonstrated that overweight patients' glycolipid metabolism benefited from a low-fat, high-fiber diet; these benefits were amplified when oatsconsumption was included. This suggests that this food can be useful in managing excess weight and, primarily, in lowering glycemic levels.Santiago et. al(2017) highlighted the high amount of minerals and proteins in diet cookies made with flour derived from passion fruit peel, in addition to their low energy value and nutritional benefit from

dietary fiber like pectin. Robert et. al(2016) demonstrated that the blood sugar response and blood sugar index of bread can be considerably decreased by using fenugreek seeds in place of 10% refined wheat flour. As a result, fenugreek powder is regarded as a useful component that can effectively decrease blood sugar.

Glycemic index of different foods

The glycemicindex of different foods depends on its composition and factors like ripeness of fruits, storage time, cooking method and variety in case of grains. Based on the different level of GI the foods are classified as low GI where GI of food ranges from 55 or less, medium GI where food GI levels ranges from 56-69, and high GI foods which ranges more than 70.. Fruits, legumes, and dairy products were shown to have low GI values. High and low GI varieties of breads, cereals for breakfast, and rice (including whole grain) were offered. Some of the glycemic values of different basic foods has been represented in table 1.

Table 1 :-Different foods and their GI

S.no	Foods	GI index	Glycemic load
1	Almonds	15	1.9
2	Apple juice	41	4.5
3	Avocardo	10	0.9
4	Banana	48	10.1
5	Barley flour	30	16.8
6	Bread	47	19.2
7	Brown rice	50	36.5
8	Cashew nuts	25	3.1
9	Cherry	25	4
10	Chick pea	10	6.1
11	Green apple	36	5
12	Kiwi	50	7.3
13	Milk	49	28.9
14	Multi grain cookies	51	33.2

Source:- https://glycemic-index.net/glycemic-index-chart/

2.Different low GIbakery foods

Many bakery food products are staple food in manycountries, acting as breakfast , snacks, and decadent treats. They are easy sources of energy, carbohydrates, and pleasure for dieters. Obesity and diabetes are among the health problems caused by the excessive concentrations of processed carbs, sweets, harmful fats, and missing nutrients found in many traditional bakery items. Reduce sugar content and add whole grains to increase nutritional value and decrease the glycemic index in order to overcome these issues. Choose healthy fats and add fruits, vegetables, nuts, and seeds to baked goods to boost nutrient density.

2.1Low GIbiscuits

A biscuit is a tiny, baked, flour-based food item that can be either savory or sweet, depending on the recipe and local variations. Biscuits are usually crispy. A baked good with a low glycemic index is composed of components that gradually release glucose into the bloodstream, promoting stable blood sugar levels. Frequently used components in low-GI biscuits are whole-grain flour, almond flour, among other nut flours natural sweeteners (such as erythritol, date syrup, and stevia), components high in fiber (such as flaxseed and oats), and unsaturated fats (such as avocado and olive oil). The addition of fiber and good fats from whole grain and nut flours encourages slower digestion and a lower glycemic index. Sweetness is provided by natural sweeteners without quickly raising blood sugar levels. Ingredients high in fiber encourage fullness and slow down digestion, and unsaturated fats help keep blood sugar levels stable.A study conducted by Anju et. al (2010**)** on the development of low glycemic index biscuits and concluded that based on the results obtained, refined wheat flour and millet flour were used in the ratio of 45% and 55%, And other ingredients are eggs (5.5), powdered sugar (14%), hydrogenated fat (23%), baking powder, and curde (11.5). This product has the highest crude protein, crude fiber, ash, carbohydrate, physiological energy, starch, various minerals, low GI, and better in sensory quality, storage stability, and nutritional quality and delicious product has been formulated and had a great health benefit to human health.The case study done by Hussain, S.Z et. al (2020)developed biscuits using waterchestnutandbarleyflour. In order to develop biscuits withthedesiredsensoryproperties they combining WCF and BF in a 70:30 ratio was possible. The finished product was found to have a greater resistant starch concentration than WCF and

BF. Research has shown that adding BF in place of 30% WCF can result in biscuits with the right sensory qualities and a low glycemic index. According to the storage investigation, the created metallized polyethylene biscuits could be kept in a refrigerator for up to 35 days and in an ambient environment for up to 28 days. (overall acceptability rating more than 3 on a 5-point scale).Another case study done by the author Franca Marangoni et. al (2008)developed low glycemic index bread and biscuits and described that time and temperature combination with glucose content while baking the biscuits, control sample and modified sample has 75g carbohydrates, and a solution of 74g glucose were available in a person after eating the low glycemic index biscuits.After baking the nutritional value of low glycemic index biscuit waskcl 481, carbohydrate % 55, fat% 25, protein % 9 total fiber % 6 and the water % was 5.

2.2. Low GIcookies

Low glycemic cookies are the type of cookies that are formulated to have a low impact on blood sugar levels. To obtain such results the cookies are made with low GI ingredients like whole grain flour and multigrain flour including fibers which have a huge impact in the GI, by lowering the starch digestion time and slower glucose absorption.One of the studies on the cardaba banana flour was used to make the cookies B. Olawoye et. al (2020). The cardaba bananas were de-bunched, peeled under water, sliced, and dried in a traditional hot air oven at 50 C for eight hours. Olawoye and Gbadamosi's method (2020a) was used to isolate the starch from the banana.The recipe from Giubertiet. al (2015) was used to make the gluten-free cookies. To put it briefly, The ratio of modified cardaba banana starch to cardaba banana flour was 20:80 (w/w)B. Olawoye et. al (2020). The results of the experiments conducted by B. Olawoye et.al(2020) indicated L*, a*, and b* values of cookies were 49.83 0.84–61.39 0.80, -4.93 0.03–1.85 0.01, and 9.38 0.21–11.60 0.09. The Maillard reaction may have started or accelerated during the cookie-making process, as evidenced by the reduction in L and a value and increase in b values that followed an increase in baking time and temperature. Additionally, the hardness of the cookie samples—which is correlated with the force needed to shatter them—varied from 43.11 0.53 to 67.92 1.06 N. The study's findings showed that, as baking time increased, neither the baking temperature, the cookies' breaking strength increased.

Another case study by BNaseer et. al (2021) developed low glycemic gluten-free cookies from high amylose rice flourusing broken grains of white rice (Lalat variety).The

carboxymethyl cellulose concentration, baking time, and temperature were adjusted to range from 0.2 to 1%, 12 to 25 minutes, and 170 to 190 °C. Conversely, the anticipated glycemicload and glycemic index declined as the carboxymethyl cellulose concentration increased. Design experts determined that 0.8% carboxymethyl cellulose content, 185 °C baking temperature, and 22 minutes of baking time would be ideal for creating Rice flour is used to make these gluten-free and also low-glycemic index cookies. The generated cookies' dietary fiber content was found to be 4.66%. According to in vitro studies on starch digestibility, resistant starch rose from (2.85% in rice flour to 7.20% in cookies). Meanwhile, for rice flour, the expected glycemic load and index dropped from 50.12 to 30.07 and for cookies, from (44.60 to 17.51). The cookies overall acceptability was rated at 8.90 (on a 9-point hedonic scale).

2.3.Low GIbread

Bread is a common food that is usually made by baking dough made of flour, typically wheat. Low glycemic bread is a type of bread that has a low glycemic index, meaning that it has a minimal impact on sugar levels in the blood. This bread is made using ingredients that slow down the digestive process, as opposed to regular bread, which is usually made from refined white flour that is easily digested and absorbed by the body. This prevents sudden spikes in blood sugar levels, providing a more sustained energy supply by slowly releasing glucose into the bloodstream.Low-glycemic bread is often made using whole grains due to their ability to retain their natural nutrients and fiber. Water has been a fundamental part of many cultures' diets throughout history, both globally and religiously. It is one of the earliest foods produced by humans, having been valued since the beginning of agriculture.In this study, done by M. Prabhahar et.al (2022), Glycyrrhiza glabra extracts were infused into regular bread to transform it into useful herbal bread. Liquid chromatography-mass spectroscopy (LCMS) was used to examine the Glycyrrhizaglabra's functional components. The extract has a strong antioxidant potency, according to the antioxidant study. The extract's antidiabetic effectiveness was also examined in this investigation. Different amounts of Glycyrrhiza glabra, such as 2, 4, and 6, are used to fortify bread. A number of sensory and flavor factors were examined in the enriched bread analysis. Glycemic index and other biochemical tests, such as the in vitro digestibility test, indicate that enriched bread lowers the glycaemic index. Compared to 2 and 4%, it was concluded from the study that 6%

of infused bread had great potency as a functional food. According to the a forementioned study, enriched bread lowers the glycaemic index and is therefore ideal for diabetics and dieters adhering to a diet.Studies have demonstrated that ingredient reformulation, such as partially substituting resistant starch, dextrin, and lentil flour for wheat flour, can lower baked goods' glycemic index (GI). This is especially crucial for gluten-free goods, since their decreased protein, fiber, and mineral content frequently results in a higher GI. It has also been discovered that GI of cereal-based goods can be decreased by adding pulse components, such as pea and lentil flour. Furthermore, because coconut flour has a high dietary fiber content, its GI can be lowered with increasing amounts in baked products that use it.

2.4. Low GIcrackers

Low-GI crackers are a good choice for people who want to efficiently control their blood sugar levels. These crackers are categorized as low GI foods since their glycemic index (GI) is less than 55. Low GI crackers have been linked to improved sensations of fullness and control over postprandial glycemic reactions, which may be beneficial for both glycemic control and weight management, according to research.The work done by Diana N et. al(2018) made chocolate crackers, a smooth dough was made with the appropriate amounts of wheat flour, margarine,stevia sugar,cocoa powder, skim milk ,baking soda, yeast, and modified kepok banana flour. The dough was then flattened into sheets that were (1-2 mm) thick. After that, the sheets are cut into (2 by 2 cm) squares and baked for 20 minutes at 100°C. Additionally, chocolate crackers made with kepok banana flour felt hard and broke readily because of the flour's low gluten level. These crackers tasted bland as well since stevia was used in place of sucrose**.**In terms of flavor, texture, and aroma of the organoleptic properties, the chocolate crackers in the AC group that substituted 50% of the banana flour with kepok had the highest values. Additionally, their starch concentration was the most resistant. Diana N et. al (2018) observed that chocolate crackers that made using 75% kepok banana flour using the ACF method had the lowest digestibility of starch (22%) in vitro and the highest resistant starch content (9%). The chocolate crackers in the AC group, which had 50% less banana flour than kepok, exhibited the best organoleptic attributes in terms of taste, texture, and scent. Both the AC and ACF group crackers had a lower GL and a low GI of less than 55 when compared to non crackers. Kepok banana flour, which is made by autoclaving

and cooling, and then fermenting bananas, might be a helpful component in lowering the GI and producinglow-GL snacks for people with type 2 diabetes.

2.5 Other low GIfoods

Low GI pasta

Pasta is a cuisine that is typically made by mixing wheat flour,eggs and water to form a flat dough. The dough is then shaped into sheets or various shapes and cooked by boiling or baking. Although traditionally only durum flour was used to create pasta, the term now also includes other gluten-free flour substitutes such as rice flour and legumes like beans and alternates like lentils. While pasta is believed to have originated in Italy and is an essential component of Italian cuisine.The case study of PachipulusuM et. al (2020), developed low glycemic index noodles and concluded that these flours can be added to noodle formulations withlegume flour (X2-35%), and leafy green vegetable powder (X3-12.5%),millet flour (X1-52.5%) without compromising the sensory and textural qualities of the finished product, according to the results obtained. Of all the products created, this one contains the most fiber, protein, and low GI content. It is also the most sensory-friendly.To enhance pasta's sensory qualities, a blend of these flours is employed. It is possible to create goods that are both nutrient-dense and aesthetically pleasing by utilizing the capabilities of the combination of different ingredient designs and sensory analysis**.** Therefore, this pasta has great potential to bring good health benefits to public health.

Low GImuffins

Muffins are quick breads, resembling cakes, that can be sweet or savory and baked in individual servings. They are loved by many for their delicious taste and soft texture. However, the primary ingredient in all bakery goods, wheat flour, has a medium to high glycemic index (GI). When additional ingredients like sugar are added, the GI of the baked goods is further increased, making them unsuitable for people with diabetes.The recipe used to make the muffins was created by Hussain, S et. al (2019). The recipe involves combining sifted dry ingredients and beating eggs individually with a flat beater in a stand mixer. The beaten eggs are then combined with creamed shortening while being constantly stirred. Water and emulsion are added to the dry mixture and mixed well. The batter is then filled into

cupcake pans (65g) and frozen for four hours at a temperature of -20°C. The batter-filled cups are then baked for 30 minutes at 180°C in an oven. After cooling down to normal temperature, the baked muffins are placed in a bag and stored at -20°C for up to 72 hours.

3. Conclusion

In affluent societies, the increase in the number ofcases of obesity, type 2 diabetes mellitus, and cardiovascular disease (CVD) is linked to increased energy intake that is exacerbated by physical inactivity. Consuming too much fat is generally accepted to be a significant contributing factor to these conditions. As a result, a low-fat diet is advised by a number of public health groups (American Diabetes Association, 1997) dedicated to the management and avoidance of obesity and diabetes. One potential negative consequence of these recommendations might be a true decrease in fat intake combined with an increase in dietary CHO, which would increase the GL and potentially the diet's overall GI. Making low-GI meal choices is crucial for those who see a notable drop in their dietary fat intake. This study contributes to educating individuals and guiding them towards healthier lifestyle choices by exploring recent advancements in bakery products.

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