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Review on low glycaemic index functional food products

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Abstract
A low-GI diet is a menu plan based on how meals affect blood sugar levels. Low glycemic index diets cause hypoglycemia and insulin responses in healthy persons and enhance glycemic control in those with type 1 and well-controlled type 2 diabetes. For those with prediabetes or diabetes, low-GI diets may help with body weight loss and glycemic control. A diet with a high glycemic index may raise postprandial levels of insulin and blood sugar, increasing the chance of developing cardiovascular disease (CVD) The amount of processing an item has gone through, together with its nutritional composition, cooking method, ripeness, and cooking duration, all have an impact on its glycemic index. Foods high in refined carbohydrates and sugar are absorbed more rapidly and typically have a high GI, whereas those high in protein, fat, or fibre frequently have a low GI. As a result of not containing any carbs, foods including meat, fish, poultry, nuts, seeds, herbs, spices, and oils don't have a GI. The three GI ratings are as follows: Low, Medium, and High. As part of a well-balanced low glycemic diet, foods without a GI rating or with a very low GI can also be consumed. It can be much simpler to stick to a low glycemic diet if you know where your favourite foods rank on the glycemic index.

Keywords: Glycemic index, blood sugar, hypoglycemia, type 2 diabetes, cardiovascular disease

1. Introduction
The concept of the glycaemic index (GI) is based on the changes in blood glucose reactions after ingestion of the same amount of carbohydrates from varied diets, as well as the possible repercussions of these variations on health, performance, and overall well-being (Arvidsson *et al*., 2004) [8]. A primary nutritional classification of carbohydrates distinguishes between those that pass to the large intestine and provide substrate for the colonic microflora, i.e., dietary fibre, and those that digest and absorb in the small intestine and supply body cells with carbs (available carbohydrates, also known as "glycemic carbohydrates") (Anonymous, 1998) [1]. The glycemic reaction to a food is influenced by the rate of stomach emptying as well as the rate of glucose digestion and absorption from the small intestine, which in turn influences the insulin response (Jenkins *et al*., 1987) [39-41]. The time, composition, and GI of a previous meal may have an effect on how the body reacts glycemically to the current meal or diet. Extended glucose response following breakfast, or the "second meal effect," has been demonstrated to improve glucose tolerance at lunch. (Jenkins *et al*.,1982, Wolever *et al*.,1988, Bjorck and Elmstahl, 2003 and Liljeberg *et al*.,1999) [38-43, 14, 81, 49]. Numerous research has looked at the possible health advantages of low-GI meals ever since the GI concept was originally developed. The GI of meals may have significant effects on the management of the main reasons for mortality and morbidity in Western nations, such as type 2 diabetes, coronary heart disease, and obesity (Henry *et al*., 2005) [34]. The glycemic index (GI) of foods that are high in fibre is often low, however this is not always the case. Low-Glycemic Index, high-fiber diets have been linked to a number of positive outcomes, such as decreased postprandial insulin and glucose responses, better lipid profiles, and perhaps even decreased insulin resistance (Riccardi *et al*., 2008) [60]. The absorption rate, which in turn depends on how quickly food is broken down in the gastrointestinal tract and how quickly the stomach empties, determines the size and duration of the glucose surge that occurs after a meal. Ingested nutrients, such as amino acids and glucose, directly activate b-cells, regulating the amount of circulating insulin, while their effects on incretins, such as gut inhibitory peptide, produced by gut cells, indirectly affect the amount of circulating insulin. Endocrine and cerebral stimulation also have a role. As a result, the body responds to the quantity and pace of absorption of carbohydrates. The kind and level of food processing, together with the food's composition, all have an effect on

how quickly glucose is absorbed from starchy meals and, as a result, the GI value (Augustin *et al*., 2002) [10]. A carbohydrate's GI has a significant impact on the following insulin and glucose reactions. Dextrose and maltose are examples of high-GI carbohydrates that cause significant rises in blood sugar and insulin levels. Sucrose and lactose, which are moderate-GI carbohydrates, often only cause slight rises in insulin and glucose levels. Finally, fructose and maltodextrin, which are low GI carbohydrates, have negligible to no impact on insulin and glucose responses (Greenwood *et al*., 2008) [32] In addition to recommended cut lines for defining high (GI 70), medium (GI 56-69), and low (Glycemic index 55) GI levels, the International Standards Organization (ISO) published a more complete methodology for GI assessment in 2010. (Anonymous, 2010) [2]. The word given to the sugar molecules in your blood chemically is glucose. Your body digests or converts all the sugars, starches, and carbs you consume into glucose. Blood glucose is the measure of the quantity of glucose present in your body at any particular time. It's crucial for your health that you maintain your blood sugar levels within a certain range. If you have diabetes, you are well aware of how important eating well is for managing your blood glucose levels. You may manage your blood sugar levels with the aid of a balanced diet, prescription drugs, and consistent exercise. Follow the glycemic index, and you might be able to do it. The glycemic index of high-fiber meals is lower than that of highly processed foods, which are more processed. (Kerr, 2013) [44]. The surface of the shaded region under the curve represents how blood glucose levels fluctuate over time. The phrase "area under the curve (AUC)" is used to compute this. Thus,

$$\text{Glycemic index (\%)} = \frac{\text{AUC of the test food}}{\text{AUC of the refrence food}} \text{ x } 100$$

(Bell and Sears, 2003) [12]

2. Glycemic Index and its type

A diet's glycemic index can have a variety of effects on one's health. The results of certain recent research point to (1) Maintaining weight loss may be facilitated with a low-glycemic index diet. (2) Breast, prostate, colorectal, and pancreatic cancer risk are all increased by foods with high glycemic indexes. (3) The risk of both type 2 diabetes and cardiovascular disease is increased by a diet with a high glycemic index. (Anonymous, 2012) [3-6]. The glycemic index is easy to use: choose meals with a low Glycemic index rather than a high GI, and minimize those in between. Low glycemic index foods include the majority of vegetables and fruits, legumes, minimally processed meals, pasta, low-fat dairy products, and nuts (GI of 55 or below). The moderate glycemic index (GI) range includes white and sweet potato, corn, white rice, couscous, and breakfast cereals including Cream of Wheat and Mini Wheats (56 to 69). White bread, rice cakes, the majority of crackers, bagels, cakes, doughnuts, croissants, and packaged breakfast cereals all have a high glycemic index (GI) of 70 or more. (Anonymous, 2021) [5-7]. The lack of meals with Gls below 40 is one of the challenges faced by persons who want to maintain modest post-prandial elevations in glucose and insulin concentrations. It's crucial to take the whole amount of eaten carbohydrates into account when evaluating the overall glycemic effects of meals (Bell and Sears, 2003) [12].

2.1.1 Low Glycemic Index

Low glycemic index foods include the majority of fruits and vegetables, legumes, minimally processed meals, pasta, low-fat dairy products, and nuts (GI of 55 or below) (Anonymous, 2021) [5-7]. Foods with a low glycemic index (low GI) take longer to digest and absorb, which helps to regulate blood sugar levels. As a result, anyone interested in a low glycemic diet should choose them (Anonymous, 2021) [5-7]. Because full food categories are not eliminated, a low-glycemic diet may be readily maintained and be effective for long-term weight loss. Additionally, it could lower the chance of developing major illnesses including diabetes and cardiovascular disease (Anonymous, 2012) [3-6]. Numerous low glycemic index foods may be beneficial for your health, according to studies. A few advantages of low-glycemic meals include (1) Low glycemic diets lessen the incidence of type 2 diabetes because they generate less insulin production. (2) Individuals who have type 2 diabetes may benefit from low glycemic diets since they can lower blood sugar levels. (3) Whole grains, fruit, and veggies are low glycemic foods that are high in fiber, which lowers the density of harmful cholesterol (lipoproteins). (4) Low glycemic meals may aid in controlling weight gain and may assist weight reduction, according to certain research. Glycemic index-low foods have a lot of fibre. They could make you feel full if you're dieting, which will help you lose weight without feeling as hungry (Anonymous, 2021) [5-7]. The potential of ad libitum, low-fat diets to aid in weight loss may be increased by low-GI, high-carbohydrate meals that maintain insulin sensitivity (Ludwig, 2000) [51]. By encouraging satiety and increasing fat oxidation at the expense of carbohydrate oxidation, low-GI meals may aid in weight control in two different ways. These two characteristics of low-GI meals are a result of their slower rates of digestion and absorption and the resulting impacts on postprandial glycemia and hyperinsulinemia (Brand *et al*., 2002) [18]. Low-GI foods often cause more satiety than their high-GI equivalents when appearance and nutritional content are equal, which is followed by decreased calorie intake at future meals (Ludwig, 2000) [51]. A low-GI diet was discovered to provide an insignificant but considerable reduction in glucose profile in insulin-dependent diabetic mellitus (IDDM) patients, with plasma glucose falling into the ideal metabolic control range (Lafrance *et al*., 1998) [47]. In order to effectively regulate post-prandial insulin and glucose excursions, low-GI meals are chosen. Low-GI meals, in contrast to those with a high GI, only slightly elevate blood sugar levels after consumption, which in turn triggers little insulin production that is used for regulation. A subsequent drop in glycaemia levels below baseline frequently occurs following the significant spikes in glycaemia that are seen after eating high-GI meals. Contrarily, after consuming low-GI meals, the blood glucose levels gradually return to normal without exhibiting any symptoms of hypoglycemia (Rizkalla *et al*., 2002) [61]. The prolonged glycaemia levels following consumption of low-GI meals may be the cause of the favourable benefits on satiety, mood, cognitive function, and alertness that have been seen in both diabetes patients and healthy controls (Holt *et al*., 1992) [36]. In hyperlipidemic non-diabetic patients, plasma lipids were observed to be reduced by a low-GI diet (Jenkins *et al*., 1985 and Jenkins *et al*., 1987) [40, 39-41]. It's possible that a low-GI diet raises HDL cholesterol levels. Overall, by utilising the potential of local food customs, a diet with a lower GI can be attained (Buyken *et al*.,

2001) [22].

Table 1: List of Some Low Glycemic index foods

Food	Glycemic Index
Chana dal	8
Peanuts	14
Plain yogurt	14
Soy beans	18
Rice bran	19
Peas	22
Cherries	22
Barley	25
Grape fruit	25
Kidney beans	27
Black beans	30
Lentils	30
Soy milk	31
Skim milk	32
Chickpeas	33
Vermicelli	35
Whole wheat spaghetti	37
Apple	38
Pear	38
Tomato soup	38
Ravioli	39
Peach	42
Pudding	43
Pinto beans	45
Orange juice	46
Baked beans	48
Strawberry jam	51
Sweet potato	54
Pound cake	54
Brown rice	55
Popcorn	55
Fruit cocktail	55

***Source*:** (Greenwood *et al*., 2008) [32]

2.1.2 Moderate Glycemic index

Breakfast cereals including Cream of Wheat and Mini Wheats, maize, white rice, couscous, and white and sweet potatoes all fall within the moderate glycemic index (GI) range (56 to 69) (Anonymous, 2021) [5-7]. By preserving endogenous carbohydrate, a moderate-GI breakfast cereal increased hepatic glucose synthesis in the final 30 minutes of exercise until exhaustion. Low and/or moderate GI meals enhance performance as compared to a high GI meal or water (Kirwan *et al*., 2001) [45].

Table 2: List of Some moderate glycemic index foods

Food	Glycemic Index
Pita bread	57
Power bar	58
Honey	58
Blueberry muffins	59
Shredded wheat	62
Black bean soup	64
Macaroni and cheese	64
Raisins	64
Cantaloupe	65
Mars bar	65
Rye bread	65
Pineapple	66
Grapenuts	67
Angel food cake	67
Stoned wheat thins	67
Taco shells	68
Whole wheat bread	69

***Source*:** (Greenwood *et al*., 2008) [32]

2.1.3 High Glycemic index

Foods with a high glycemic index (GI) of 70 or more include the following: White bread, packaged breakfast cereals, most crackers, bagels, cakes, doughnuts, and rice cakes

(Anonymous, 2021) [5-7]. Foods with a high GI are those that are biologically converted into glucose or are quickly digested and absorbed (Jenkins *et al*., 1982, Bjorck *et al*., 1994, Granfeldt *et al*., 1995, Welch *et al*., 1987 and Foster and Miller, 1995) [38-43, 15, 31, 77, 28]. The bulk of commonly eaten starchy foods in North America, such as potatoes and goods made from refined grains, have a high GI which may be up to 50% greater than that of table sugar. Contrarily, fruits, vegetables, and legumes usually have a low GI (Foster and Miller, 1995) [28]. High-glycemic index (GI) carbohydrates have the power to increase the ratio of circulating tryptophan to LNAAs (tyrosine, phenylalanine, leucine, isoleucine, valine, and methionine; LNAAs) by the direct action of insulin, which promotes the selective uptake of LNAAs by muscle (Berry *et al*., 1991) [13]. If the plasma Trp: LNAA increases after a high-GI meal, it would be expected that this will promote sleep by increasing brain Trp and serotonin. (Wurtman *et al*., 2003) Foods having a high glycemic index have been said to be unhealthy, and healthy people should be advised to stay away from them (Pi-Sunyer, 2002) [58]. Diets with high glycemic index values have been linked to an increase in the risk of all forms of prostate cancer (Augustin *et al*., 2004) [11]. Based on how much carbs raise blood sugar levels after eating, the glycemic index values them from 0 to 100. (Jenkins *et al*., 1981) [42]. Low glycemic index foods have a beneficial impact on exercise performance while high glycemic index foods have no impact (DeMarco *et al*.,1999, Earnest *et al*., 2004 and Febbraio *et al*., 2000) [25, 26, 27]. There is conflicting evidence regarding the effects of consuming foods with various GIs on exercise performance, but several studies suggest that consuming LGI foods may be preferable to consuming HGI foods before engaging in prolonged exercise because they increase the availability of carbohydrates while exercising**.** (Siu and Wong, 2004 and Wee *et al*., 1999) [70, 76]. Consuming LGI and HGI carbohydrates had no substantial impact on b-endorphin levels during exercise or the rate at which carbohydrates and fats are burned (Jamurtas *et al*., 2011) [37]. High glycemic index (HGI) food consumption increases insulin secretion, which causes hypoglycemia to follow and reduces the availability of substrates that may be utilised as an energy source during exercise (Stevenson, Williams and Nute, 2005) [72]. The high- and medium-GI meals both comprised the identical foods and nutrients, with the exception of the kind of oatmeal used (instant oatmeal for the high-GI meal and "steel cut" oats for the medium-GI meal, both cooked for 15 minutes). (Ludwig *et al*., 1999) [52]. After the high-GI meal, blood insulin levels were high because glucose was absorbed fast. Contrarily, the meal's low protein content and the inhibition brought on by elevated plasma glucose and insulin concentrations resulted in lower plasma glucagon levels. (Rorsman, Ashcrof and Berggren, 1991) [63]. Consuming high-GI foods results in metabolic and hormonal changes that decrease the quantity of metabolic fuels available and lead to obesity in people. (Ludwig *et al*., 1999) [52]. Regarding how high-GI foods raise food intake, there are two competing ideas. The first is that it results from an increase in glucose, and the second, which has lately gained greater traction, is that it results from a high insulin response (Pi-Sunyer, 2002) [58].

Table 3: list of Some High Glycemic Index food

Foods	Glycemic index
White bread	70
Bagel	72
Watermelon	72
Graham crackers	74
French fries	75
Vanilla wafers	77
Gatorade	78
Fava beans	79
Jelly beans	80
Tapioca pudding	81
Rice cakes	82
Pretzels	83
Corn chex	83
Corn flakes	84
Baked white potato	85
Mashed potatoes	86
Dark rye	86
Instant rice	87
Crispix	87
Boiled Sebago	87
Rice chex	89
Gluten free bread	90
Baked red potato	93
French baguette	95
Peeled Desiree	101
Dates	103
Tofu frozen dessert	115

***Source*:** (Greenwood *et al*., 2008) [32]

3. Glycemic index effect on health

The GI has changed from a possible tool for planning diabetic meals in recent years thanks to its popularisers. Patients are now a crucial component in the fight against diabetes,

dyslipidemia, cardiovascular disease, and even some types of cancer in the general population. Regarding how high-GI foods raise food intake, there are two competing ideas. The first is that it results from an increase in glucose, and the second, which has lately gained greater traction, is that it results from a high insulin response (Pi-Sunyer, 2002) [58]. Many occurrences have been linked to this elevated insulin response, including: obesity brought on by more food consumption (Robert, 2000) [62], Insulin resistance caused by hyperinsulinemia (Frost *et al*., 1998) [29], type 2 diabetes resulting from beta-cell depletion (Salmeron *et al*., 1997 and Salmeron *et al*., 1997) [64, 65], Dyslipidemia causing coronary heart disease (CHD), and unidentified causes causing certain cancers (Liu *et al*., 2001) [50].

3.1 Obesity

Obesity raises the risk of acquiring various chronic conditions, including NIDDM, CHD, and different types of cancer. Overweight (BMI > 25 kg=m2) and obesity (BMI > 30 kg=m^2) are prevalent among middle-aged men and women in America, with 63 and 55%, respectively, being estimated prevalence rates. (Must *et al*., 1999) [54] and there has been an 8% increase in the incidence of obesity over the past 20 years (Kuczmarski *et al*., 1994) [46]. Decreased physical activity, an abundance of readily available, inexpensive, and tasty meals that are high in calories, social and economic factors, and these factors all likely have a role in the increased incidence of overweight and obesity Several low-fat, high-carbohydrate diets may be harmful for weight control since they have noticeably higher postprandial hyperglycemia and hyperinsulinemia. In Western diets, the majority of high-carbohydrate meals have a high glycemic response (high glycemic-index (GI) foods), which increase postprandial carbohydrate oxidation at the expense of fat oxidation and change fuel partitioning in a way that may be helpful for the build-up of body fat. Nonetheless, low-GI diets, which prioritise low-fat meals with a low glycemic response, may aid in weight management because they increase satiety, reduce postprandial insulin release, and preserve insulin sensitivity. (Brand *et al*., 2002) [18]. The most concentrated form of energy, fat, is efficiently stored as body fat. Moreover, isoenergetic portions of high-protein or high-carbohydrate meals are much more satiating than high-fat meals, which are often less satiating (Blundell *et al*., 1995 and Holt *et al*., 1995) [16, 35]. According to intervention research, high-carbohydrate diets can help people lose more weight than high-fat diets do. Clinical trials have demonstrated that cutting back on fat can help overweight people lose weight clinically significantly, albeit the outcomes are often small (Astrup *et al*., 2000) [9]. Several epidemiologic studies have demonstrated a correlation between relatively high dietary fat consumption and rising obesity rates (Seidell, 1998) [67]. Numerous human intervention trials comparing the benefits of low-GI diets on weight loss versus equivalent diets based on high-GI foods give data to support this theory. Low-GI meals may aid in weight control in two ways by increasing satiety and fat oxidation at the expense of carbohydrate oxidation. These two properties of low-GI meals are due to slower digestion and absorption rates, as well as the effects on postprandial glycemia and hyperinsulinemia. (Brand *et al*., 2002) [18]. Since high GI meals tend to preferentially drive nutrients towards storage in fat rather than oxidation in muscle, they may contribute to weight gain (Ludwig, 2000) [51]. During intravenous glucose tolerance testing, increased initial insulin secretion predicts weight growth in children of glucose-tolerant parents with diabetes mellitus (Sigal *et al*., 1998) [69]. Hormonal reactions to a high GI meal seem to reduce the amounts of metabolic fuels in the blood, increase appetite, and favour fat storage-events that can encourage excessive weight gain. The majority of traditional weight control methods are based on the idea that "a calorie is a calorie." This idea holds that an imbalance between energy intake and expenditure is what causes obesity. Eating less and exercising more is the suggested treatment. Yet, low-fat, calorie-restricted diets perform poorly over the long run in an outpatient context. These diets might be thought of as symptomatic treatments that don't deal with the physiologic causes of overeating. All calories are not created equal in terms of hormones (Ludwig, 2000) [51].

3.2 Cardiovascular Disease

Postprandial hyperglycemia is becoming more well recognised as a distinct cardiovascular disease risk factor. Glycemic "spikes" may negatively impact vascular structure and function through a range of mechanisms, including (acute and/or chronic) oxidative stress, inflammatory, low-density lipoprotein oxidation, protein glycation, and procoagulant activity. (Brand, Dickinson, Barclay and Celermajer, 2007) [19]. There is concern that some carbs, particularly those that accentuate oscillations in postprandial glycemia, insulinemia, and lipidemia, may exacerbate diabetes and cardiovascular disease (CVD) risk factors. (Gross *et al*., 2004 and Schulze *et al*., 2004) [33, 66]. A lower GI meal has less glycemic carbohydrates and sugars, which means they are absorbed and digested more slowly (e.g., fructose). Regardless of early dispute, the GI of single foods reliably predicts the relative order of postprandial hyperglycemia and insulinemic responses to mixed meals (McMillan *et al*., 2006 and Wolever *et al*., 2006) [53, 82]. A small number of foods (such dairy and chocolate items) have insulinemia levels that are greater than would be predicted given the degree of glycemia, suggesting a mechanism involving quicker glucose absorption. Although the therapeutic use of the GI has been the subject of heated discussion, there is now general agreement that using the GI can help manage diabetes in ways that total carbohydrate alone cannot (Sheard *et al*., 2004) [68]. Several lines of research support the notion that an excessive rise in blood sugar levels after eating increases the risk of chronic heart disease. It is becoming more frequently recognized that a high blood sugar level 120 minutes after the challenge is a substantial independent indicator of cardiovascular disease (CVD) in those who do not have diabetes. In prospective cohort studies, high post-challenge blood sugar levels are associated to all-cause and CVD mortality. The risk of CVD was increased in persons with the highest post-challenge blood sugar levels compared to those with the lowest. (Brand, Dickinson, Barclay and Celermajer, 2007) [19]. The vascular endothelium is a main victim of hyperglycemia due to its proximity to circulating prooxidant moieties and the fact that endothelial cells cannot regulate glucose transport across the cell membrane. (Brownlee, 2001) [20]. As a result, the glucose level in the endothelial cell equals the level in the blood. An oral glucose tolerance test or a normal blood sugar-level meal causes an immediate decrease in plasma antioxidant capacity and a rise in nitro tyrosine production, both of which are indications of oxidative stress (Ceriello *et al*., 2004) [23].

3.3 Diabetes

Normalizing the blood glucose profile, comprising the fasting and postprandial blood glucose concentrations, is one of the main goals of diabetes treatment. It wasn't that long ago that sweets were prohibited because we thought that starchy meals had considerably lower glycemic reactions than did sugars. The situation is more complicated in actuality. A lot of starchy meals cause reactions that are as strong as a load of glucose. Foods are ranked according to their acute glycemic impact using the notion of glycemic index (GI) (Jenkins *et al*., 1982) [38-43]. Diabetes is diagnosed when random plasma glucose levels surpass 11.1 mmol/l (200 mg/dl) or fasting blood sugar levels exceed 7 mmol/l (126 mg/dl). (Smushkin and Vella, 2010) [71]. Atherosclerotic disease, which is greatly impacted by diabetes, is the leading cause of morbidity, mortality, and expenditures among diabetics**.** (Vijan, 2010) [75]. The basic premise is that diabetic diets should include low-GI meals, or those that produce little change in blood sugar levels. Yet, the majority of scientists no longer see the GI approach as a useful strategy in the therapy of diabetes. Despite the dearth of considerable study on diabetics, monounsaturated fatty acids are becoming increasingly popular. (Garg *et al*., 1988) [30]. Incorporating low-GI carbohydrates in regular meal planning can help diabetics regulate their blood sugar levels and lose weight. The individuals' documented replies to questions about their conceptual and practical understanding of the GI demonstrate that they embrace this strategy as a long-term behavioural lifestyle change rather than a "diet." The encouraging findings of this study encourage diabetes educators to think about recommending low-GI diets to their diabetic patients since they attest to what was effective for these people (Burani and Longo, 2006) [21]. The prevalence of diabetes is rising as the population ages, the ethnic makeup of the population is changing, and obesity rates are rising. By 2030, the prevalence of diabetes is predicted to roughly double based on current trends (Wild *et al*., 2004) [78]. In 1998, a report on the identification and categorization of diabetes mellitus was delivered by an expert committee of the ADA. It offered several suggestions: Diabetes mellitus cases are classified based on their aetiology. The designations "insulin-dependent diabetes mellitus" and "non-insulin-dependent diabetes mellitus" are deleted. These ambiguous terminologies have frequently led to the categorization of patients according to their course of therapy rather than their cause and Diabetes types 1 and 2 are still referred to using Arabic numerals rather than roman ones (Lambert and Bingley, 2002) [48].

3.3.1 Type 1 diabetes

Type 1 diabetes (T1D) is caused by the pancreas's inadequate insulin production. In addition to secreting digestive enzymes, the pancreas is a glandular organ that also produces vital hormones. Islet cells, a kind of cell cluster found inside the pancreas, generate these hormones. Only beta islet cells, out of the five different types of islet cells—beta, delta, gamma (PP), and epsilon—produce the hormone insulin, which controls blood sugar levels. With an autoimmune disorder, the body's immune system may inadvertently target and harm or eliminate beta islet cells, which lowers the amount of insulin required to maintain healthy blood sugar levels (Anonymous, 2013) [4]. Insulin insufficiency caused by immune-mediated death of pancreatic beta-cells is a hallmark of type 1 diabetes. Hyperglycemia and the potential for ketoacidosis are the common biochemical endpoints of this process, but the clinical presentation varies greatly depending on the rate and severity of ß - cell failure. As a result, the distinction among both types of diabetes is becoming less clear, and type 1 diabetes is increasingly recognised to manifest in adulthood. These ideas are mirrored in the American Diabetes Association's most current report on the diagnosis and categorization of diabetes (Lambert and Bingley, 2002) [48]. People with type 1 diabetes who are undergoing intensive insulin therapy are trained to get comfortable with their short-term glycemic response to a carb meal through sufficient self-monitoring of blood glucose and to change their doses of short- or rapid-acting insulins accordingly. (Toeller, 1993) [74]. According to the present epidemiologic study, a lower GI in the diet was associated with significantly lower Hb A1c readings in European patients with type 1 diabetes**.** This is significant because individuals with type 1 diabetes will see a significant decrease in their chances of microvascular and neuropathic consequences if glycemia is further reduced (Nathan *et al*., 1993, Reichard *et al*., 1996 and Tesfaye *et al*., 1996) [55, 59, 73]. In people with type 1 diabetes, fast-acting insulins and insulin analogues can successfully reverse short-term rises in postprandial blood glucose levels; however, utilising these insulins does not achieve a perfect match between insulin concentration and glycemic response. We believe that a low-GI diet will improve long-term glycemic control even in the presence of modern insulin therapy because including low-GI foods into the diet reduces incremental glycemic responses (Buyken *et al*., 2001) [22].

3.3.2 Type 2 diabetes

This is a complex metabolic disease characterised by varying degrees of insulin resistance and b-cell dysfunction. Insulin resistance is linked to a variety of metabolic illnesses, including type 2 diabetes, polycystic ovarian syndrome, overweight, and hypertension. (Anonymous, 2013) [4]. Chronic hyperglycemia is a prevalent metabolic condition associated with type 2 diabetes. Due to a higher risk of cardiovascular disease, stroke, peripheral neuropathy, kidney failure, blindness, and amputation, it is linked to a decreased life expectancy. A diverse illness known as type 2 diabetes is characterised by decreased insulin production and action, which results in hyperglycemia (Smushkin and Vella, 2010) [71]. Type 2 diabetes mellitus (T2DM), which can be caused by either decreased insulin secretion, insulin resistance, or both, is characterised by dysregulation of carbohydrate, lipid, and protein metabolism (DeFronzo *et al*., 2015) [24]. Over time, hyperglycemia causes pancreatic cells to lose their ability to function, which can lead to glucose intolerance and ultimately an irreversible state of diabetes. The exact aetiology of this condition is unclear, and it has not been determined whether the loss of pancreatic function is predominantly caused by excessive insulin production (i.e., cell fatigue) or toxicity caused by hyperglycemia to cells (Willett, Manson and Liu, 2002) [79]. This has been ascribed to a number of variables, including an increase in sedentary behaviour, obesity, inactivity, eating an energy-dense diet, living longer, smoking, and more (Osama and Shehab, 2015) [57]. However there has been debate concerning the function of dietary carbohydrates. There is little correlation between overall dietary carbohydrate consumption and the incidence

of type 2 diabetes (Omoregie and Osagie, 2008) [56] A low glycemic index diet benefits patients with Type 2 diabetes who are well-controlled, with mean fasting blood sugar levels of 6.5 mmol 1-1 and normal blood lipid values. (Brand *et al*., 2008). It has also been shown that people with type 2 diabetes who are poorly treated and have high blood lipids. Despite decreasing urine C-peptide excretion, a marker of insulin secretion, lowering the glycemic index of the meal resulted in a modest improvement in blood glucose management and a drop in serum cholesterol despite no changes in macronutrient or fibre intake**.** (Wolever *et al*., 1992) [80].

4. Conclusion

Despite this, Glycemic index assessments of the rate of carbohydrate absorption after a meal have a significant influence on postprandial hormonal and metabolic responses. High glycemic index foods immediately raise insulin and blood sugar levels. This may promote binge eating, dyslipidemia, endothelial dysfunction, and beta cell dysfunction. Hence, eating meals with a high glycemic index often may raise your chance of developing heart disease, diabetes, and obesity. Last but not least, it was suggested that the physiological mechanisms under consideration here that " "One of the causes of hyperinsulinism [and hypoglycemia] is the excessive consumption of foods that contain glucose, and because overeating causes overactivity, it is possible that the hunger that comes with hyperinsulinism may be a factor in overeating and, ultimately, the obesity that so frequently precedes diabetes.

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