Monosaccharide Management in Diabetes: A Pathway to Better Health Outcomes: An Article Review

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ABSTRACT

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Diabetes is a common disorder that can afflict individuals of any age; about 537 million have diabetes across the world. This figure will increase to 634 million by 2035 and 783 million by 2045. Diabetes type 2 is the most common; it has also been proposed that a variety of pharmacologic approaches and non-pharmacological agents can enhance glycemic control in diabetic patients. Monosaccharides affect glycemic especially glucose causing diabetic mellitus due to raised glucose levels. Not only does glucose affect high glucose levels of sugar but other monosaccharides can contribute positively or negatively such as fructose, and trehalose. Moreover, many other monosaccharides contribute to type 2 diabetes, all have great interest and are discussed in this article, with the management of diabetic type 2 through monosaccharides. The conclusion states free sugars should be cut down on to regulate sugar levels, resistance starch doesn't affect glycemia, and nutritive sweetener management affects health. It doesn't relate to T2D, and trehalose affects glucose homeostasis by many pathways. The effects of each of these monosaccharides suggest the potential of non-pharmacological agents for the management of diabetes.

Keywords: Monosaccharide metabolism, Diabetes, Health Outcomes, Nutrition

This review hypothesis on sugars contributing to diabetes mainly monosaccharide or related digested monosaccharide. Managements of monosaccharides especially glucose, fructose, and trehalose will be examined in detail, other sugars such as galactose and artificial sweeteners not impacted here.

Navigating Diabetes:

Diabetes is a disorder in which the pancreas produces either insufficient or no insulin, resulting in excessively high blood sugar levels. When the body does not effectively respond to the effects of insulin, it develops type 1 diabetes and type 2 diabetes. Symptoms of type 1 diabetes can develop quickly over little weeks or months as indicated by **Zheng, (2018).** They could lead to the development of further symptoms signaling severe complications known as diabetes-related ketoacidosis (DKA). DKA is a potentially fatal condition that demands immediate medical intervention. Type 2 diabetes and prediabetes may not exhibit any symptoms or may go unnoticed due to their slow development. Routine blood work may reveal high blood sugar levels before recognizing the symptoms (**ADA, 2010)**. Darkened skin in specific body areas (acanthosis Nigerians) is another sign of prediabetes. The signs of gestational diabetes are also unnoticed and a test for gestational diabetes should only be performed between weeks 42 and 28 of pregnancy. All of these types are diagnosed by measuring blood glucose levels by three tests: fasting blood glucose test, random blood glucose test, glycated hemoglobin test HbA1c. Diabetes is caused by too much glucose flowing in the bloodstream, regardless of the type; however, the reasons for elevated blood glucose vary depending on the type of diabetes **(Karagiannis, 2010)**. Such reasons include insulin resistance, hormonal imbalance, and extended use of certain medicines such as H1V/AIDs, and corticosteroids raised to type 2 diabetes. T2D is mostly caused by insulin resistance, which occurs when cells in muscle, fat, and the liver do not respond to insulin as they should. During pregnancy, the placenta produces hormones that promote insulin resistance and gestational diabetes; if the pancreas is unable to produce enough insulin to overcome the insulin resistance,

type 2 diabetes is raised. Type 1 diabetes **(Umpierre, 2011)** is mainly caused by the immune system attacking insulin-producing cells in the pancreas, pancreatic damage and genetic mutation are also contributed **(Holman, 2008)**.

Optimizing Diabetes Care:

Monosaccharides are the simplest form of carbo-hydrates, and cannot be further broken into smaller units. Biosynthesis requires the conversion of monosaccharide to activated sugar nucleotides then donates the sugars to various acceptors using specific glycosyltransferases. To achieve this monosaccharide must be imported to cells. Mono-saccharides are known to affect blood glucose levels mainly glucose, and carbohydrates consumed influence glycemia **(Fang, 2021)**, when glucose in the bloodstream does not find a key (insulin hormone), to reach its final destination, or does not use it properly, glucose build-up causes high blood glucose, and hyperglycemia.

Glucose monosaccharide and diabetic management:

Glucose also called dextrose, is the most common monosaccharide and is utilized by cells as fuel and is found as free glucose in honey (31%), ripe fruits, and vertebrate bodily fluids. Moreover, glucose polymerizes into polysaccharides and integrates into disaccharides. Glucose is found naturally in nature, fruits, dairy food, or added to food and drink manufacture, all these are called free sugars (**Fang, 2021); Varki, 1999)**. In all debates around free sugars and health, table .1 shows sugary food. The three principal mono-saccharides released from the breakdown of carbohydrates are glucose, fructose, and galactose. Eighty percent of all mono-saccharides are made up of glucose, which is mostly absorbed in the small intestine's duodenum and upper jejunum, and it is only the monosaccharide that is absorbed by the intestine. The absorption ratio is maximum for galactose, moderate for glu-cose, and minimum for fructose.

The mechanisms by which different sugars are absorbed vary. Glucose is delivered into intestinal mucosal cells via carrier-mediated and energy-requiring mechanisms

(**Varki, 1999)**, glucose and sodium share the same transported system called sodium-dependent glucose transporter. Other sugars use different simple absorption mechanisms. Glucose malabsorption and many other factors are related to diabetic mellitus. Diabetic mellitus is the most common metabolic condition, accounting for major morbidity and mortality in humans. Many treatment medications have been identified for normalizing glycemic profiles in diabetics. However, various non-pharma logical or pharma-logical strategies could help manage the uptake of certain monosaccharides or related digestion monosaccharides. Eating too many sugary foods harms health **(Reynolds, 2020; Reynolds, 2020; Cozma, 2012)** due to being overweight. Being overweight can make it difficult to manage diabetes and increase the risk of getting serious problems such as heart attacks and stroke in the future. Adults' maximum recommended daily amount of sugar is 30 g (Table 1) (**Yoshitaka, 2023)**. This works out as just seven teaspoons a day, given that a tablespoon of ketchup contains around one teaspoon of sugar (**Evert, 2014)**. A chocolate biscuit has up to two spoons, and a small serving of baked beans has almost three spoons. you can see how quickly the tea spoons lots up. However, do not cut sugar out of your diet completely to avoid hypoglycemia, and try safe sugars that are found naturally in fruits and vegetables (**Schwingshackl, 2019; Fitch, 2012)**. It is better to eat this sugar in raw form rather than in juices or smoothness, this will help in controlling diabetes. Even pure juice contributes to free sugar intake, in case of having them, keep just one small amount around 150 ml a day. It is free sugars, all must be cut down on, not just obvious sugars like sweet food, but also sugars that lurk in many foods such as starch. Storage starch is found in refined cereals, potatoes, legumes, and bananas, although dietary starch consumption is rarely documented (**Reynolds, 2019)**.

Nutritive sweeteners mono-saccharide and diabetic management:

Fructose belongs to the ketose group of differently shaped sugar. It is a monosaccharide that

breaks down particular energy. Fructose absorbs it simply and does not require energy. It is transported by facilitated diffusion mediated by a carrier inside the epithelial cells. The majority of fructose is converted to glucose, which subsequently enters circulation. Fructose is a naturally occurring monosaccharide (table .2). Sucrose (Table sugar), a disaccharide made up of one glucose molecule and one fructose molecule, provides 4 calories per gram. (**Reynolds, 2020),** The existing clinical study evidence does not suggest that the total amount of dietary sucrose is associated with the incidence of type 2 diabetes. However, it is linked to weight gain and tooth caries. Given the link between excess body weight and type 2 diabetes occurrence, promoting sugar intake reduction and replacing sugar-sweetened beverages, including fruit juice, with water or low-calorie beverage intake as much as possible is considered a point of nutritive management (**Mann, 2023).** Recent studies demonstrated that fructose feeding in diabetic people compared with other sources of carbohydrates impacts glycemic control (**Reynolds, 2020)**. The studies discovered that the isocaloric exchange of fructose carbohydrates had no significant effect on fasting glucose or insulin, and reduced glycated blood proteins **(Schwingshackl, 2019).** Evidence states that consuming a high quantity of fructose-containing beverages may have particularly negative effects on the selective deposition of ectopic and visceral fat, lipid metabolism, blood pressure, and insulin sensitivity when compared to glucose-sweetened beverages (table 1). Those in trials lasting less than 12 weeks, the short duration is a potential limitation of the studies, so recommendations for dietary fructose tend to promote reducing fructose added to food, such as fructose-containing beverages, while promoting whole fruit, which can contain intrinsic fructose. Fructose foods that contain fiber may result in better glycemic management than isocaloric ingestion of sucrose or fructose-added foods, also fructose is not affected triglyceride as long as intake unless excessive less than 12% energy **(Schwingshackl, 2019)**.

Trehalose monosaccharide and diabetes

Diabetic mellitus acts as a powerful upstream event for numerous pathophysiology mechanisms such as oxidative stress, inflammation, apoptosis, and fibrosis, which in turn induce the onset and progression of various forms of diabetic complications. As a result, normalizing the glycemic profile and managing chronic hyperglycemia is of paramount importance (**Eleutherio, 2015; Mayer, 2017).** Trehalose is a disaccharide, produced by many species ranging from bacteria to plants, but not in humans (**Richards, 2002)**, This unreactive disaccharide has important metabolic roles, including energy storage. Trehalose was initially synthesized by an enzymatic technique in 1995. Trehalose is a naturally occurring non-reducing sugar that consists of two D-glucose molecules joined by an α-1.1-glycoside bond bridge. Compared to sucrose, trehalose is a slower sweetener and can be broken down into two glucose molecules by the trehalase enzyme, providing significant energy (**Figueroa, 2016; Richards, 2002).** Trehalose has stable properties due to the lower energy of glycoside oxygen bond, so used as stabilizing in many food, biotechnology, and pharmaceutical industries. Treh-alose acts as an Osmo protectant, namely against ethanol and osmotic pressure. It stabilizes the cellular membrane by increasing the plasma membrane's endurance to dehydration, shriveling, and temperature shock. Recent studies demonstrated that trehalose can influence glucose homeostasis via at least seven molecular pathways (Table 3) (**Mayer, 2016; Maki, 2009).** Trehalose consumption improves hyperglycemia by ameliorating pathophysiology mechanisms such as oxidative stress, inflammation (**Sato, 2012); Van Can,2012)**, and apoptosis, improving beta cell function, reducing postprandial insulin release, and normalizing lipid profile **(Arai, 2013; Yoshizanae, 2017).** Trehalose has a milder stimulus on postprandial insulin release than other sugars. It also reduces dependent postprandial adipocyte formation, which regulates after carbohydrate eating **(Feofilova, 2014).** Evidence suggests that other potential relationships between trehalose

consumption and insulin sensitivity include homogenies **(Arai, 2010),** insulin stability (**Arai, 2001),** and the prevention of mitochondrial dysfunction. Although the trehalase enzyme is broadly expressed in humans, it is localized in the brush border of mucosal gut cells. There is no evidence of trehalose molecule synthesis in humans **(Eleuthero, 2015)**, this point is very important as suggesting new windows studies for treating diabetes.

The health consequences of dietary starch intake are frequently studied using important sources (**Reynolds, 2020).** Starch enclosed within cell walls is not absorbed or digested in the small intestine, so do not promote postprandial glycemia and diabetes, those fermented in the colon by microbiota (**Reynolds,2020; Reynolds,2020)**. Most starches are resistant to digestion by pancreatic amylase in their raw form (**Evert, 2014)**. Dietary starch intake is rarely reported, so the health effects of dietary starch intake are frequently assessed through refined grains and potatoes, with potatoes being largely determined by cooking methods (**Reynolds, 2020; Schwingshackl, 2019**). Fried and salted potatoes are related to an increased risk of type 2 diabetes and hypertension. Boiled and roasted potatoes had no association with increased or decreased health risks (**Mann, 2023)**.

CONCLUDING AND SUGGESTIONS:

Management of monosaccharides depends on their different routes of absorption, which are complex for glucose and simple for fructose, or not impacted as starch, but in general, cutting down amounts of sugars can help in management especially glucose-containing food, fructose meals, and resistance starch will be optimistic control glucose level with the appreciated amount and method of eating. Consumption of trehalose-containing food as log times will also provide help in managing glucose levels and their complications, further studies suggested measuring trehalase enzyme in diabetic and prediabetic patients, and trials to synthesize trehalose in vivo will be the perfect and optimistic goal in controlling diabetes, as trehalose open new

window for management of diabetes.

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Table 1**. Drinks and foods as free sugars Varki, (1999)**

Free Sugar Food		Trehalose
Glucose food	**fruits**	
Honey	**Candy**	**Mushrooms**
Fruit	**Pank cake**	**Honey**
Dried fruit	**syrup**	**Shrimp**
Sweet corn	**ice cream**	**Yeast**
Juice	**cookies**	**soya Beans**
Molasses	**jams**	
	soda juice	
	pasta	
	sauces	

Table .2 **Free sugar that raises glucose levels quickly Yoshitaka, (2023)**

Name	Amount	Carbs amount
regular soda	1 can	45 g
juice (include 100% fruit)	1 cup	29 g
sweetened lemonade	1 cup	30 g
Capri Sun	1 pouch	17 g

World Health Organization (WHO) recommends no more than 30 gm (6 teaspoons) per person per day

Table .3. trehalose glucose hemostasis

Molecular pathway	Effect	ref
Sensitivity to insulin	increase insulin sensitivity by multiple pathways, such as IRS up-regulation	**Mayer, (2016)**
secretion of insulin	Decreased release of postprandial insulin	**Mayer, (2016)**
Metabolism of glucose	Regulate the amount and metabolism of glucose	**Maki, (2009)**
Oxidative stress	Changes in oxidative stress, resulting in enhanced insulin sensitivity	**Maki, (2009)**
Metabolism of lipid	Modulates postprandial insulin release to improve lipid metabolism.	**Mayer, (2016); Maki, (2009); Yoshizanae, (2017)**

إدارة السكريات الأحادية في مرض السكري: مسار لتحقيق نتائج صحية أفضل

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ملخص عربي:-

داء السكري حالة مرضية تؤثر في كل الاعمار –يوجد 537 مليون شخص حول العالم يعاني من مرض السكر ومتوقع زيادة الغدد الي 634 لعام 2035 و 783 لعام 2045 –مرض السكر نوعان و النوع الثاني اكثر تعقيدا و اهمية – علاجات صيدلية و غير كيميائية تستخدم لعلاج النوع الثاني من مرض السكر – وتفترح للتحكم في مستوي السكر في الدم، السكريات الاحادية تؤثر في رفع مستوي السكر في الدم وخاصة الجلوكوز مسبب مرض السكري –السكريات الاحادية الحرة غير الجلوكوز وخاصة الفركتوز وترهيلوز تؤثر بشكل كبير علي مستوي السكر في الدم –تهدف هذا المقال الي وضع استراتيجية للتغامل مع السكريات الاحادية المذكورة لعمل كنترول غلي مستوي السكر في الدم وتوقع عوامل كشف وعلاج جديدة

الكلمات المفتاحية : التمثيل الغذائي للسكريات الاحادية – مرض السكري - الصحة – التغذية