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REVIEW ARTICLE **Open Access**

Glucose Content and Glycemic Index of Indonesian Local Foods as Alternative Carbohydrate Sources for Diabetic Patients: Article Review

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ABSTRACT

Background: Indonesian society is highly dependent on white rice as its primary carbohydrate source. However, white rice is known to have a high glycemic index (GI), which can trigger inflammation and contribute to the development of various diseases, including type 2 diabetes mellitus (T2DM). Dietary modifications, such as adopting a low-GI food diet, have been shown to effectively regulate glucose metabolism and improve insulin resistance. The purpose of this study was to review several Indonesian local foods that have the potential as alternative carbohydrate sources for T2DM patients based on carbohydrate value and GI value.
Content: Local Indonesian plants have varying GI values and carbohydrate content (7.34-90). The highest to lowest GI values in order are cassava, porang, black potatoes, white rice, sweet potatoes, red rice, corn, sorghum and black rice.
Conclusion: These foods contain high to low carbohydrate levels and exhibit lower GI values compared to white rice. Types of local Indonesian plants that have a low GI value and can be used as an alternative to rice for T2DM patients are black rice, sorghum, and corn.

Keywords: Diabetes, glycemic index, local food, porang, rice

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Introduction

Diabetes in Indonesia is no longer limited to the elderly and working-age adults but is now increasingly prevalent among school-aged children.[1,2] In 2019, approximately 9.5%, or 488 million adults (20-79 years old) worldwide, had diabetes. This number is expected to continue to increase to 10.2% in 2030 and 10.9% in 2045.[3] This rise in childhood diabetes cases is largely attributed to lifestyles and excessive consumption of fast food, typically high in carbohydrates, salt, and sugar while lacking adequate fiber.[1,2,4] Excessive consumption of high-carbohydrate foods leads to elevated glycemic index (GI) and glycemic load (GL), which ultimately increases blood glucose levels. This triggers oxidative stress while simultaneously raising plasma glucose levels, insulin resistance risk, and hypertension. Without prompt intervention, these metabolic disturbances may progress to various diseases including type 2 diabetes mellitus (T2DM), increased cardiovascular disease risk, female infertility, and colon cancer.[5-7] Furthermore, the prevailing dietary perception in Indonesia that considers rice as the sole staple food significantly contributes to diabetes prevalence. Many Indonesians regard a meal as incomplete without rice consumption. This cultural norm requires urgent attention, as diabetes has become one of the leading causes of mortality in Indonesia. One crucial strategy for diabetes prevention and blood glucose management involves consuming foods with lower carbohydrate content and GI values.

Glycemic index is an indicator used to measure the speed at which food increases blood glucose levels. According to Septiani, carbohydrate-containing foods can be classified into low (≤ 55), medium (56-69) and high (≥ 70). High-GI foods are typically digested rapidly in the intestines, accelerating postprandial hyperglycemia and increasing the risk of T2DM.[8] Conversely, foods with lower GI values digest more slowly, thereby delaying postprandial hyperglycemia. This mechanism is particularly beneficial for T2DM patients' blood glucose control, as it reduces oxidative stress, which leads to decreased HbA1c, plasma glucose, and cholesterol levels.[9,10] In addition, a diet of foods with low GI lowers the risk of COVID19 as revealed by previous studies in which insulin resistance, due to foods with high GI, is related to the severity of covid19. A person with complications of high blood pressure, hyperglycemia and diabetes has a high risk of death from COVID19.[11,12]

Alternative low-GI carbohydrate sources can be derived from local foods. Current trends indicate a growing consumer preference for staple foods that not only provide satiety but also help regulate blood glucose levels due to their high fiber content. These local food alternatives include maize rice, sweet potatoes, cassava, porang, red rice, and black rice. There have been many in vivo and in vitro studies that have explored the potential of these local foods

as antidiabetic agents. However, comprehensive reviews focusing on their carbohydrate content and GI remain limited. This paper examines the glucose levels and GI values of various Indonesian local foods that serve as alternative carbohydrate sources to rice.

Corn Rice

In several regions of Indonesia, corn serves as a traditional carbohydrate source. As a starchy food, corn contains two essential glucose polymers, namely amylose (10-30% composition) and amylopectin (74-76% composition). Amylopectin's branched-chain structure allows easier enzymatic breakdown by human digestive amylase compared to amylose. Furthermore, corn is rich in dietary fiber, which promotes digestive health, reduces disease risks, and enhances gut probiotic microbiota. These benefits contribute to improved immune function and cancer prevention. In addition to its high fiber content, corn rice is also rich in amino acids, including aspartic acid, glutamic acid, serine, histidine, alanine, tryptophan, and glycine.[13] Other ingredients of this rice are Mg, Fe, Ca, K, P, Cu, Mn and Zn which are beneficial for body health.[14] Corn rice is also known as *berasa batara* (Bulukumba, South Sulawesi), *balabinde* (Gorontalo), *nasi empok* (East Java).

Corn processing is not only limited to boiling and grilling but also be ground into corn rice. The rice can be directly cooked using a rice cooker or cooked like rice. There are two types of corn rice consumed by the public, namely white corn rice and yellow corn rice. Although both are popular, white corn rice has a higher carbohydrate content, moisture content and protein content than yellow corn rice.[15] The difference in color is because yellow corn contains xanthophyll pigment while white corn does not contain xanthophyll.

Corn rice consumption is clinically recognized for its blood glucose-regulating potential in diabetic patients because it has low GI value (Table 1). This therapeutic effect is supported by Luff Schoorl test results (unpublished), which quantified carbohydrate content at 16.90% in white corn rice and 17.35% in yellow corn rice, significantly lower than values measured in white rice, sorghum, and sweet potatoes. This result is different from the findings of Lalujan which stated that corn rice contains 75.64% carbohydrate based on the carbohydrate-by-difference method.[13] This method is different from Luff Schoorll because carbohydrate content is calculated roughly using the formula percentage carbohydrate = 100% - A (protein+fat+water content+ ash content). The Luff Schoorl method itself is the best method for analyzing the amount of carbohydrates in a sample with an error rate of 10% and in accordance with the rules of the Indonesian National Standard (Standar Nasional Indonesia, SNI). Research at the *in vivo* level successfully proved that glycemic levels in people who consume corn rice are lower than people who consume white rice.[16]

Table 1. Glycemic index and carbohydrate content from carbohydrate sources.

Carbohydrate sources	Glycemic Index	Category	Carbohydrate content (%)	References
Black rice	30-32	Low		30
Barley	34-70	Low-medium	60-70	31
Sorghum	43	Low	7,34	32
Corn	46-80	Low-high	77,46	33
Red rice	47-76	Low-high	23.03	32-35
Sweet potato	47-78	Low-high	70-89.7	36,37
Potato	55-111	Low-high	40-82	38
Rice white	55-85	Low-high	70-82	39
Black potato	60-62	Medium	18.92	39,40
Porang	67-85	Medium-high	74-76	41,42
Cassava	70-85	High	85-90	43

Sweet Potatoes

Sweet potato (*Ipomoe batatas*) or vine yam is one of the functional foods widely consumed by Indonesians. Besides being easy to grow, sweet potatoes can be harvested throughout the year, are easy to maintain and rich in nutrients. Based on color, sweet potatoes can be divided into white, orange, purple, and yellow sweet potatoes. Purple sweet potatoes are high in anthocyanins, saponins and carotenoids. Orange sweet potatoes are high in beta-carotene and anthocyanins and are a good source of minerals. White sweet potatoes are high in fiber. Other nutritional contents of sweet potatoes are carbohydrates, fat, protein, vitamins, minerals (Mg, Zn, Ca, P), vitamins (B1, B6, C, E) and fiber.[17-19] Based on the results of the proximate analysis, the four types of sweet potatoes mentioned before have different carbohydrate levels. The highest carbohydrate content was shown by purple sweet potatoes (27.1%), then yellow sweet potatoes (25.7%), orange sweet potatoes (18.5%) and white sweet potatoes (15.1%).[18]

The processing process also affects the carbohydrate content of sweet potatoes (table 2). Roasted red sweet potatoes produce a fairly high carbohydrate value compared to boiled, fried, or steamed.[20] This finding are supported by Bahado-Singh that baking sweet potatoes with their skin intact results in an elevated GI compared to peeled preparations.[21] The loss of moisture during roasting will reduce the formation of resistant starch during cooling resulting in increased GI. Other factors that influence the GI of foods are the type of food, cooking

method, degree of maturity, ratio of amylose to amylopectin, dietary fiber and storage period.[22,23]

Sweet potatoes can be a good alternative food for diabetes therapy because they're rich in nutrients and bioactive compounds that help control blood sugar. Previous study has found that the GI value of sweet potatoes is lower than that of white bread, potatoes and rice, but higher than that of cassava.[24] Based on Table 2, sweet potatoes have a low-high GI value. Furthermore, consuming boiled sweet potatoes for 14 days has been shown to reduce blood glucose levels.[25] Animal studies confirm that pure sweet potato flour (administered at 65 mg/20 g body weight/day for 30 days) also effectively lowers blood glucose.[26] At the cellular level, sweet potatoes exert their glucose-lowering effects through multiple mechanisms: upregulating GLP-1 gene expression, downregulating DPP-4 gene activity, enhancing insulin metabolism, repairing pancreatic damage, inhibiting α-glucosidase and α-amylase enzymes, reducing HOMA-IR (insulin resistance), regenerating pancreatic islet cells.[27,28]

Cassava

Cassava (*Manihot esculenta*) remains a staple food crop in several countries, including Indonesia. This is primarily due to its ease of cultivation, drought tolerance, ability to grow in poor soil conditions, and year-round productivity. Most importantly, cassava has a high carbohydrate content. Previous study has shown that 100 grams of cassava contains 35% carbohydrates and 1.2% protein.[29] Likewise, boiled cassava reportedly contains 191 calories, 40 grams of carbohydrates, 1.5 grams of protein, 3 grams of fat and 3 grams of fiber.[29] When compared to other carbohydrate sources, cassava ranks first for the highest carbohydrate content (Table 1), as well as the value of GI. As commonly recognized, cassava starch contains high amylopectin content and numerous enzymatic binding sites. This structural characteristic facilitates rapid hydrolysis during digestion, resulting in high digestibility and consequently a high GI (Table 1).

Cassava contains resistant starch that functions similarly to dietary fiber in the body. This resistant starch slows glucose absorption into the bloodstream, helping to regulate blood glucose levels in T2DM patients. Furthermore, as a soluble fiber, resistant starch contributes to colon health by fermenting into short-chain fatty acids in the large intestine. Beyond its starch content, cassava flour is also rich in polyphenols that exhibit antidiabetic properties through inhibition of α-amylase and α-glucosidase enzymes.[44] Another mechanism of cassava flour as an antidiabetes is to decrease the expression of intestinal glucose transporters thereby reducing glucose absorption.[45]

Table 2. Food processing and glycemic index value.

Carbohydrate sources	GI value	References
Boiled potato	82	47
Baked potato	72.3	48
Fried potato	63.6	48
Chips potato	56	49
Fresh black potato	61	40
Boiled black potato	60	40
Fried black potato	62	40
Boiled corn	56.19	50
Baked corn	64.57	50
Flavor corn	82	50
Bread corn	68.89	50
Popcorn	66.89	50
Tiwul	59	51
Fresh cassava	47.75	43
Fermented cassava	46.47	43
Boiled cassava	77	43
Sun dried cassava flavor	47.49	43
Steam White rice	21.6	52
Steam white rice after store 12 hours	24.7	52

GI: Glycemic index

Processing techniques significantly affect the GI of all food's ingredients. Boiled cassava contains 14.59% carbohydrates, notably higher than fried cassava (5.77%).[46] This discrepancy arises from prolonged heating duration and elevated temperatures during cooking. High-temperature processing induces starch gelatinization and structural breakdown. Gelatinized starch becomes more susceptible to enzymatic digestion, accelerating glucose release and elevating GI. Despite its carbohydrate content, cassava (GI >70) is not recommended as a dietary alternative for diabetes mellitus (DM) patients due to its high glycemic response.[32]

Porang

Indonesia is one of the world's producers of porang (*Amorphophallus muelleri*). Porang itself is a type of tuber, the skin of the tuber is bright yellow and there are fine fibers on the

surface. When it is two months old, secondary bulbils/tuber will be found on the leaves and base which resemble frogs. This distinguishes porang from other plants. Porang cannot be eaten raw due to its high oxalate content. Therefore, it must be processed before consumption. Porang is easily found growing wild in nature, known for its high productivity, economic value, and low maintenance requirements for cultivation. Porang is now recognized as a rice alternative due to its low glucose content and high fiber composition. The primary fiber in porang is glucomannan, a polar fiber with a significantly higher molecular weight compared to starch from other carbohydrate sources. Glucomannan's high molecular weight enables it to form fine, crystalline fibers, which are believed to benefit digestive health. However, porang also contains substantial calcium oxalate crystals, which can cause skin irritation and contribute to kidney stone formation. To ensure safe consumption, these oxalate crystals must be removed through thorough washing and soaking with lime water (calcium hydroxide solution) and lime juice prior to preparation.

The high content of glucomannan causes porang to be widely used as a healthy food. In the field of health, porang can control blood sugar levels and is categorized as a food with a medium-high GI value (Table 2). This is proven by giving 200 mg/head of porang flour to experimental animals that can reduce blood glucose levels by 176 mg/dl.[53] Porang has also been reported to increase insulin sensitivity and its effects are comparable to glibenclamide in lowering blood glucose levels. [4,30,55] and increasing *short chain fatty acids* (SCFA) so that it can reduce the risk of coronary heart disease.[56] Given its remarkable potential, it's no surprise that porang-based health foods are now emerging. The use of glucomannan-inulin blends in healthy snacks for obese individuals has been shown to aid weight loss while suppressing increases in cholesterol and triglyceride levels.[57] Similarly, glucomannan-enriched jelly provides longer-lasting satiety compared to regular jelly.[58] Today, porang is incorporated into various food products, including energy bars, whole wheat bread, noodles, nuggets, sausages, and meatballs. Beyond the culinary sphere, its pharmaceutical applications are equally significant, serving as a raw material for capsule shells, emulsion stabilizers, and even as a complementary therapy for diabetes patients.[59]

Black Potato

Black potato (*Plectranthus rotundifolius*), also known as "*umbi kemili*" in Indonesia, remains relatively unknown to the public. This perennial herb from the Lamiaceae family thrives in high-temperature and high-rainfall conditions. Traditionally, it's prepared simply, steamed, boiled, or fried. In recent years, however, processing methods have advanced with the production of black potato flour, which is now being transformed into healthy, body-

friendly snacks. Recent studies confirm that black potato biscuits meet SNI for nutritional quality, making them a viable complementary weaning food for toddlers.[60] Currently, black potatoes are being considered as an alternative food to rice and flour because it has high levels of carbohydrates, nutritional values and minerals and is gluten-free.

The carbohydrate content of black potatoes is 33.7% and higher than ordinary potatoes, as well as the mineral content.[61,62] Specifically, it can be said that in 100 grams of black potatoes there are 70.09 grams of carbohydrates. Previous study stated that black potato flour contains moisture content (8.40%), ash content (2.09%), protein (3.42%), fat (0.79%), crude fiber (4.30%), carbohydrate (85.30%), total starch content (78.85%), amylose (30.22%) and amylopectin (48.63%).[63] In addition, black potatoes also contain various active compounds such as phytosterols, ascorbic acid, thiamine, riboflavin, niacin, calcium, triterpenoic acid, ursolic acid, flavonoids and sigmasterol.[62] The presence of these compounds makes black potatoes a potential food, anticancer, antioxidant and also antihyperlipidemic. Recent research has isolated heptulose, seven-carbon (7-C) sugars, rosmarinic acid and benzyl benzoate from black potatoes. The heptulose compound has ant obesity effects in experimental animal models while rosmarinic acid has effects as an antioxidant and collagen biosynthesis.[64,65] Using *in vivo*, black potatoes reduce glucose levels and increase HDL levels in diabetic animals.[66] This statement is supported by Sethuraman et al. who found that bread made from black potato starch is classified as a low GI food based on in vivo tests.[61] However, in this review, black potatoes are included in the foods with a medium GI value because the GI value obtained is 60-62.

Sorghum

Sorghum (*Sorghum bicolor*), a vital cereal crop from the Graminae family, plays a crucial role in global food security. Beyond serving as a staple food, sorghum is also utilized as a bioenergy source, industrial raw material, and livestock feed. Despite its versatility, sorghum remains underutilized in Indonesia as a rice alternative, even though it boasts diverse nutrients and high carbohydrate content. In fact, sorghum contains diverse nutrients and high levels of carbohydrates. Carbohydrates in sorghum are 70-84.06%, protein of 4.7-18%, fat of 0.35-19%, 0.35%, dietary fiber of 1.25%-4.00%, and various minerals.[67,68]

Sorghum has a high carbohydrate content but a low GI (Table 1). Based on the results of Luff-Schoorl's analysis, it was found that the carbohydrate content of sorghum was 42.10% and higher than white rice (29.07%) (personal data not published). However, these findings differ from Diyah et al. which actually states that sorghum has the lowest carbohydrate content (7.34 g/100 gr) compared to some other alternative carbohydrate sources.[32] The observed

variations in the results may be attributed to differences in the sorghum varieties tested. This assertion is supported by Anugrahwati et al., which states that each sorghum variety/genotype exhibits distinct sugar content during growth.[69] Additionally, nutritional differences among various sorghum types depend on genetic variations among sorghum cultivars, environmental conditions, and soil types.[68]

In *in vivo* testing, the GI value of sorghum was relatively low compared to white rice.[32] The low GI value of sorghum is due to the high and diverse total phenolic content of sorghum. Phenolic compounds found in sorghum are luteolin, apigenin, eriodictyol, naringenin and phenolic acids.[70] These phenolic compounds have long been known to be antidiabetic through the mechanism of inhibition of digestive enzymes in the small intestine. An in vitro study found that sorghum extract was able to inhibit the activity of the enzymes α-glucosidase and α-amylase.[71] The inhibition of these digestive enzymes directly contributes to reduced blood glucose levels, demonstrating sorghum's ability to maintain postprandial glucose homeostasis. Furthermore, animal studies have shown that sorghum supplementation decreases oxidative cellular damage (thereby lowering diabetes risk),[72] while also reducing body mass index and body weight.[73] These findings collectively establish sorghum's dual potential as both an anti-diabetic and anti-obesity functional food.

Black Rice

Black rice (*Zizania aquatica*) is widely cultivated by Indonesian farmers. This unique grain carries several evocative names: forbidden rice, purple rice, lucky rice, emperor's rice, and king's rice, titles rooted in its regal history across Asia, including Indonesia. During ancient dynastic eras, black rice was exclusively reserved for royalty and elites, as it was believed to enhance longevity and vitality. Common people were strictly prohibited from consuming it without royal authorization, reinforcing its status as a "forbidden" superfood of the privileged class.[74] Black rice is now gaining significant attention, not just for its distinctive appearance and culinary appeal, but for its rich profile of bioactive compounds, particularly anthocyanins concentrated in the aleurone layer. These pigments serve as potent combatants against oxidative stress and inflammation, and major contributor in fighting chronic diseases such as cardiovascular disorders, diabetes, and cancer.[75]

The addition of black rice to the daily diet can reduce the risk of various chronic diseases. This is because black rice contains anthocyanins in the form of cyanidin-3-glucoside (C3G) in large amounts. C3G compounds are reported to be hypoglycemic and anti-osteoporosis,[76] inhibit extracellular matrix aggregation, lower inflammatory cytokines and oxidative stress, lower insulin resistance, so that it can be used to prevent diabetic nephropathy

and blood sugar control of DMT2 patients.[77,78] Recent studies have shown that red rice anthocyanins work as antidiabetics through the regulation mechanism of the PI3K/AKT signaling pathway and the intestines of microbiota of the DMT2 model animal.[79]

The nutrition of black rice is quite diverse. Specifically, it can be mentioned that black rice contains carbohydrates (75.80-78.68%), protein (7.44-10.08%), fat (0.22-0.42%), crude fiber 0.06-0.10%, and minerals (0.24-1.77%).[80] However, the crude fiber possessed by black rice is relatively low (<36%) compared to the Food and Drug Monitoring Agency (Badan Pengawas Obat dan Makanan, BPOM) standard (>36%). The low fiber produced may be related to the loss of the fiber layer in the rice aleurone part of the milling process.[80] Recent studies have found that the fiber and protein from black rice are higher than red rice, brown rice, and white rice.[81] Foods with a high protein content have moderate digestibility which helps the slow release of blood glucose. In terms of processing, steamed black rice turns out to have a lower carbohydrate content than red rice, brown rice, and white rice, which is 30-32 and belongs to the low GI category.[82,83] This indicates that black rice can be used as an alternative source of carbohydrates instead of rice.

Red Rice

Despite its nutritional benefits, red rice struggles to gain popularity in Indonesia. Consumers often reject their chewier texture, tendency to turn rancid quickly, and inconvenient cooking properties, requiring more water and time than white rice. Additionally, its milder flavor and firmer bite further reduce appeal among those accustomed to white rice's soft texture.[84] Other contributing factors include its less visually appealing appearance, higher cost, limited market availability, and lack of public awareness regarding its nutritional value. These challenges stem from the minimal processing of red rice, it only undergoes partial milling, allowing the bran layer to remain intact. Ironically, this very bran layer makes red rice nutritionally superior. Bran layer is rich in dietary fiber and essential fatty acids. However, in recent years, the demand for pigmented rice, such as red rice, has begun to attract the attention of the public due to the high awareness of the importance of healthy food. Red rice is a food with a low to high GI value because the GI value obtained is 47-76 (Table 1).

Red rice is claimed to be suitable for people with diabetes and obesity. Red rice contains carbohydrates (73.16-79.58), protein (7.72-9.10%), fat (1-2.07%), crude fiber (0.24-1.77%), total ash (0.43-1.01).[80] Not only that, red rice also contains anthocyanins, carotenoids, tocotrienols and tocopherols which are known to be able to ward off free radicals.[85,86] Previous study has also revealed that red rice contains B vitamins, functional lipids, essential amino acids, phytosterols, phenolic acids, flavonoids, anthocyanins, proanthocyanidins, GABA, and

phytic acid.[84] Phenolic compounds from red rice that have been identified are p-coumaric acid, ferulic acid, methyl ferulic acid, syringic acid, quercetin, catechin and gallic acid.[87,88] These phenolic compounds are associated with various health benefits for humans including anti-obesity and anti-diabetes. As an anti-obesity, red rice works by inhibiting glucose transport into 3T3-L1 fat cells through inhibition of α-glucosidase and α-amylase enzymes, modulation of liver and skeletal muscle GLUT4, secretion of skeletal muscle insulin-degrading enzymes thereby reducing insulin resistance of obese patients.[89] As an antidiabetic, red rice reduces hyperglycemia, glucose resistance and glycogen accumulation through decreasing the expression of intestinal glucose transporters.[45] In addition, red rice is high in flavonoids that effectively exert hypoglycemic effects through the inhibition of amylolytic enzymes, namely α-glucosidase and α-amylase.[88]

Given the immense potential of red rice, it is not surprising that diversification of red rice products. One innovative approach involves substituting wheat flour with red rice flour, aiming to reduce reliance on traditional wheat flour which is high in carbohydrates and gluten. Several red rice product variations have already emerged in the market, including red rice tea bags, traditional cakes and pastries, *angkak* (red yeast rice) health beverages, and flaked snack products. Moreover, these processed red rice products serve as excellent snack options for diabetes patients due to their low GI, making them both nutritious and diabetes friendly.

White Rice

White rice is a staple food derived from rice (*Oryza sativa L.*) and is the main source of carbohydrates for the Indonesian people and several countries in the world. In addition to glucose, rice also contains protein, iron, zinc, vitamin B6 and magnesium. From various literature, it is known that rice contains a high level of glucose compared to several other sources of carbohydrates (Table 1). This is due to the high amylopectin content in rice, which is around 70% of the total average total starch content.[90] According to Ahmad, foods with high amylopectin content have high digestibility which leads to high GI as well.[91] The glucose level of rice is 25.40 g/100g while the GI value is 82 and higher than red rice, corn, sorghum, cassava, breadfruit and boiled bananas.[32] The high GI value of white rice is associated with an increased risk of diabetes, as well as other diseases. As explained in previous studies, an increase in the daily serving of white rice was associated with an 11% increase in DMT2 risk,[92] cardiovascular disease and cancer.[93,94]

Several methods have proven effective for lowering the glucose content of white rice. Adding pandan leaves and coconut oil during cooking can significantly reduce the rice's glucose levels.[95] Similarly, consuming rice that has been pre-cooled, either at room temperature

or via refrigeration, also helps decrease its glycemic impact.[95,96] This cooling process promotes the formation of resistant starch, which not only lowers digestible carbohydrates but also enhances satiety, helping to control hunger for longer periods Another study revealed that incorporating virgin coconut oil (VCO) into the rice during preparation, which alters its starch structure and reduces both glucose absorption and calorie content by 10-15%.[97] Storage duration also plays a role because keeping rice in a rice cooker for extended periods gradually lowers its glucose levels.[98] Most importantly, balancing rice consumption with other nutrients like proteins, vegetables, and healthy fats further helps manage post-meal blood sugar spikes. Figure 1 summarizes the discussion regarding GI of Indonesian local foods.

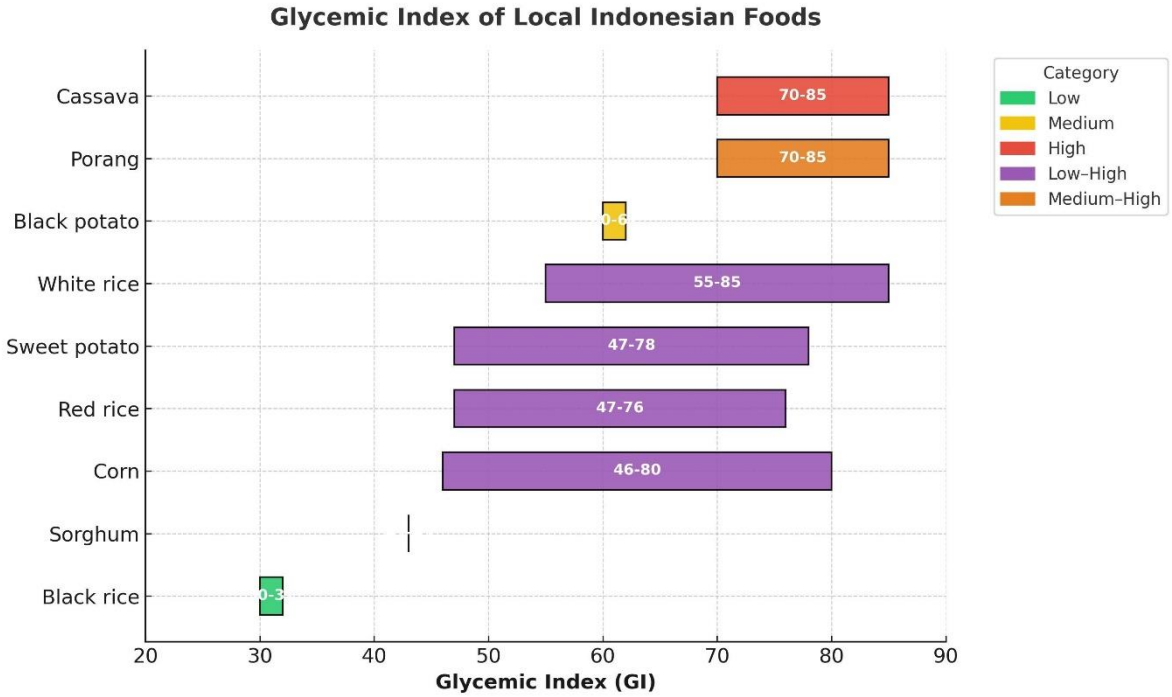

Figure 1. Glycemic index values of several local Indonesian foods as alternative carbohydrate sources.

Conclusion

Local foods such as corn rice, sweet potatoes, cassava, black potatoes, sorghum, porang, red rice and black rice can be used as alternative carbohydrate sources for DMT2 patients. Types of local Indonesian plants that have a low GI value and can be used as an alternative to rice for T2DM patients are black rice, sorghum, and corn.

Conflicts of Interest

Nothing to declare.

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Nothing to declare.

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