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Exploring the potential of sweet sorghum (*Sorghum bicolor* (L.) Moench) grain meal as a supplement for diabetic patients in African diets

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Abstract

In the context of Africa's rich cultural and traditional practices in healthcare, this study explored the potential of sweet sorghum (*Sorghum bicolor* (L.) Moench) grain meal as a supplement for managing diabetes within African diets. Diabetes poses a significant health challenge in Africa, prompting the search for appropriate dietary interventions. Sweet sorghum, a versatile traditional African crop, possesses unique nutritional and phytochemical properties that may offer benefits for diabetes management. Through a thorough literature review of reputable sources, including PubMed, Science Direct, Google Scholar, and NCBI, this study examined sweet sorghum's glycemic index, impact on blood sugar levels, and influence of its high fibre content on blood sugar control and metabolism within the African diet context. Additionally, this study assessed the cultural acceptability and feasibility of incorporating sweet sorghum grain meal into conventional African recipes, considering its culinary adaptability and potential to enhance regional dietary customs. The findings of this study highlight the promising potential of sweet sorghum grain meal as a dietary supplement for managing diabetes within African diets, emphasizing its unique nutritional and phytochemical properties. Despite its promising attributes, challenges such as limited availability, processing, and preparation techniques were identified. By integrating existing evidence and considering the specifics of the African diet, this research elucidates the potential advantages of sweet sorghum grain meal as a dietary supplement in the fight against diabetes in Africa. This finding underscores the importance of evidence-based dietary recommendations and long-term diabetes management strategies tailored to African communities' cultural and nutritional contexts. This study recommends further research, community engagement, and legislative support to promote the adoption of sweet sorghum grain meal as a dietary supplement for managing diabetes in Africa, emphasizing the importance of evidence-based dietary recommendations tailored to African communities' cultural and nutritional contexts.

Key words: sweet sorghum, grain meal, dietary supplement, diabetes

Introduction

The increasing incidence of diabetes mellitus constitutes a serious health risk for Africa, necessitating the adoption of novel and alternative diabetes care strategies. Dietary changes are essential for regulating blood sugar levels and lowering the risk of complications from diabetes (Olawole *et al*., 2018). To meet the special requirements of African communities, it is crucial to investigate locally accessible and culturally suitable food solutions. Sweet sorghum (*Sorghum bicolor* (L.) Moench) grain meal, widely cultivated and consumed across numerous African nations, exhibits potential as a prospective dietary adjunct for individuals with diabetes. (Ziółkiewicz *et al*., 2023; Motsi *et al*., 2022). The grain confers numerous health benefits as shown in **Figure 1.**

Figure 1. Health benefits of sweet sorghum (adapted from Mohamed *et al*., 2022).

The lack of gluten also conforms to the dietary needs of people with celiac disease or gluten sensitivity (Kahlon *et al*., 2021). Understanding the potential advantages and including sweet sorghum grain meal in African diets can support sustainable solutions and effective diabetes management strategies. By taking into account its glycemic response, nutritional makeup, cultural acceptability, and culinary versatility, this investigation intends to explore the potential of sweet sorghum grain meal as a dietary supplement for diabetic patients within the context of African cuisines. This study seeks to provide useful insights for healthcare professionals, policymakers, and people with diabetes in Africa by emphasizing the need for individualized interventions and comprehensive methods.

Type II Diabetes

Type II diabetes is a chronic condition marked by elevated blood glucose levels (Harvard Health Publishing, 2022). Approximately 90% to 95% of all cases of diabetes are type II, making it the most prevalent type (GBD,2021). Type II diabetes develops when the cells in the body become less responsive to insulin's intended function of bringing blood glucose inside the cells consequently inducing glucose accumulation in the blood (Harvard Health Publishing, 2022). The adverse effects of insulin on the body's major organs make it more difficult for them to use blood glucose. Moreover, the ability of the pancreas to produce insulin becomes severely impaired (Rahman et al., 2021).

Epidemiology of type II diabetes mellitus

Approximately 422 million people worldwide have diabetes, the majority of whom live in low- and middle-income nations (WHO, 2023). Most of these people have type II diabetes since this is the most prevalent type and accounts for approximately 90% to 95% of the total diabetes cases (Centers for Disease Control, 2022). Diabetes is directly responsible for 1.5 million fatalities annually and over the past few decades, both the incidence and prevalence of chronic diabetes have progressively increased (WHO, 2023). China has the greatest risk of diabetes, with approximately 116 million diabetic patients, while India has the second greatest risk 77 million followed by the United States of America, at 31 million (Alam *et al*., 2021). In Africa, there are approximately 24 million adults who have diabetes and by 2045, this number is expected to increase by 129% to 55 million (WHO, 2023). Type II diabetes is projected affect 11% of the world's population (783 million people) by 2045 (Dysted *et al*., 2021). Obesity is a significant contributing factor to type II diabetes, primarily due to the adoption of poor diets and inactivity (Ruze *et al*., 2023).

Management of type II diabetes mellitus

Promoting a lifestyle that includes a good diet, regular exercise, quitting smoking, and maintaining a healthy body weight is the cornerstone of type II diabetes care (Ogurtsova *et al*., 2021). Weight loss should be a top priority for individuals with type II diabetes because most people are prone to obesity. Each person's caloric intake needs to be customized for their unique body mass index and level of frequent activity (Butt, 2022). Through insulin dependent glucose transfer into muscle, moderate exercise helps reduce fat, and aids in reducing blood glucose levels (Alam *et al*., 2021). Daily moderate-intensity exercise of half an hour reduces glycaemia, improves cholesterol levels, lowers blood pressure, and helps people lose weight (by reducing the resting heart rate, increasing systolic volume, and reducing cardiac work) (Butt, 2022). The final stage in managing diabetes is medication (Alam *et al*., 2021) including injections of insulin, metformin tablets, sulfonylureas, and sodium-glucose co-transporter-2 (SGLT-2) inhibitors (Mayo Clinic, 2021). Along with blood sugar-lowering medications, people with diabetes frequently require blood pressure medications and statins to lower their risk of complications, such as foot care to treat ulcers, kidney disease screening and treatment, and eye exams to screen for retinopathy (WHO, 2023). Hypoglycemia, which is more dangerous than hyperglycemia, can occasionally result from improper insulin administration. It is frequently recommended that people with type II diabetes using insulin supplements should carry sugar or chocolate to combat this occurrence (Alam *et al*., 2021).

Dietary control of type II diabetes

The management and prevention of type II diabetes heavily rely on dietary considerations. Dietary recommendations must be customized to match the individual demands of each patient (precision diet) to achieve the overall aims of the treatment (Butt, 2022). Fruits (apples, pears, apricots, grapefruit and berries), vegetables (carrots, broccoli, cabbage, lettuce and tomatoes), whole grains (wheat, oats, barley, maize, rye, millets and brown rice), lean meats, and nonfat or low-fat dairy products should all be included in the meal plan (Centre for Disease Control, 2022). Foods with fewer calories, saturated fat, trans-fats, sugar, and salt should be chosen (Mayo Clinic, 2021). Fewer than 30% of calories should come from fat, with fewer than 10% of those calories coming from saturated fats; at the same time, proteins should make up 10% to 20% of the calories ingested (Butt, 2022). Broccoli, spinach, and green beans are examples of non-starchy vegetables that should be consumed more frequently, while added sugars and refined grains should be avoided

(Mayo Clinic, 2021). Wherever possible, whole foods should be preferred to highly processed foods (Touvier et al., 2023). Monitoring blood sugar levels and eating at regular intervals without skipping meals are also essential (Centers for Disease Control, 2022). Alcohol consumption should be kept to a minimum and water should always be preferred over sugar-sweetened beverages (Mayo Clinic, 2021). Beef, chicken, and fish can be substituted with plant-based protein meals such as beans, lentils, nuts, and soy-based products (Reynolds and Mitri,2019). In this context, the inclusion of sweet sorghum grain meal as a dietary supplement holds promise for enhancing the dietary control of diabetes. With its low glycemic index and potential to provide essential nutrients, sweet sorghum grain meal offers a valuable addition to the precision dieting approach in managing diabetes effectively.

Properties of sorghum

Nutritional characteristics of sweet sorghum grain

The grains are approximately 2 to 4 mm in diameter, and can be orange, tan, red, white, bronze, black and purple depending on variety (Osman *et al*., 2022). Grains are rich in vitamins and micronutrients such as iron, copper, phosphorous, zinc, potassium and magnesium (Osman *et al*., 2021), however, their calcium content is relatively low in comparison to that of finger millet (Abah *et al*., 2020, Ojulong *et al*., 2021). The wide and varied mineral and amino acids content of the grain makes it a good source for fighting micronutrient malnutrition particularly in Africa where the crop is widely consumed (Abah, 2020; Lin *et al*., 2021). Sweet sorghum grains contain approximately 4 - 21.1% protein, of which prolamin and albumin are predominant, and the glutelin content is lower than that of wheat; approximately 55.6 - 76% starch and 1.3 – 3.5% total minerals such as ash and 6.7% fibre (Abah *et al*.., 2020; Khalid *et al* 2022c). Lower glutelin and high iron contents are important they make the crop suitable for consumption by those individuals suffering from celiac disease, and anemia and the high fibre content is suitable for people with diabetes (Ajani *et al*., 2021, Osman *et al*., 2021). The pericarp contains tannins, hydrocyanic acid, and bioactive compounds such as ferrullic acid and gallic acid, which are key ingredients in food and medical industries (Hu *et al*., 2022).

Phytochemical composition of sweet sorghum grain

Phytochemicals are plant-based compounds (secondary metabolites) that help plants fend off herbivory and microbial infections, although they are not essential nutrients for humans or animals. However, they play important roles in antioxidant and anti-inflammatory responses as well as cancer fighting properties (Lee *et al*., 2020; Lee *et al*., 2021; Wang &Wei *et al*., 2022). The phenolic compounds present in sweet sorghum grain include flavonoids such as naringenin, luteolinidin and apigeninidin as well as phenolic compounds such as caffeic acid, ferrullic acid, gallic acid, p-coumaric acid, and 3-deoxyanthocynindins (3-DXA) (Khoddami *et al*., 2021; Hu *et al*., 2022; Pontieri *et al*., 2022). Phenolic compounds protect against cellular damage by scavenging free radicals thus they prevent oxidative stress, and their antioxidant properties also help reduce gastric indigestion (Lin *et al*., 2020; Mohamed *et al*., 2022). Flavonoids, phenolics and phytosterols also display antimicrobial, antiatherogenic, anticancer and antidiabetic properties (Lee *et al*., 2020; Mohamed *et al*., 2022; Pontieri *et al*., 2022). Tocopherols (α- and γ-tocopherols), and carotenoids (beta carotene and lutein), are also antioxidants that are involved in the formation of vitamin E and vitamin A respectively (Wang & Wei, 2022), and they play a significant role in inhibiting the inflammatory response through gene silencing (Mohamed *et al*., 2022; Cruet-Burgos *et al*., 2023). Phytosterols, polycosanols and saponins which regulate cholesterol levels in blood, and thus help prevent cardiac diseases and dyslipidemia, are also phytochemicals found in sweet sorghum grain (Mohamed *et al*., 2022; Pontieri, 2022).

Sweet sorghum grain meal in the control of type II diabetes

Sweet sorghum grain meal has gained attention for its potential in managing type II diabetes. It offers several beneficial components that can help regulate blood sugar levels and manage diabetes. Because of its high fibre content and antioxidant content, digestion is easier and gradually reduces insulin surges in diabetic patients (Singh *et al*., 2022).

Dietary fibre

Sweet sorghum grain meal is rich in dietary fibre, including both soluble and insoluble fibre. Soluble dietary fibres (SDF) (pectin, mucilage, gums, fructans and β-glucan) are fermented in the colon (Soliman, 2019; Motsi *et al*., 2022) and play a crucial role in managing blood glucose levels by slowing the digestion and absorption of carbohydrates. Millets have a low glycaemic load, and their metabolism is prolonged; thus, they require less insulin for glucose absorption (Ren *et al*., 2022). Fermentable gastrointestinal soluble fibres and soluble dietary fibre supplements improve glycaemic control by increasing the viscosity of chyme, delaying gastric motility and lowering glucose absorption (glycaemic impact) in the small intestine (Tsitsou *et al*., 2023) hence nutrients reach the distal ileum (Karthikeyan *et al*., 2019). Reduced digestibility of soluble dietary fibres and short-chain fatty acids (SCFAs) produced from colonic fermentation may also contribute to glycemic control. SCFAs act on intestinal endocrine cells and/or neurons of the enteric nervous system to alter gastrointestinal motility and secretion (Giuntini *et al*., 2022). If an SDF delays the arrival of sugars in the intestinal lumen, it limits their accessibility to their respective enterocyte receptors (Alexander *et al*., 2019).

Inulin, a non-viscous and prebiotic SDF, delays gastric emptying, reducing glucose absorption and postprandial blood glucose elevation. Propionic acid, a fermentation product, may reduce hepatic gluconeogenesis and affect hepatic glucose metabolism (Wang *et al*., 2019). Studies have shown improvements in insulin sensitivity, delayed glucose entry, and decreased postprandial blood glucose rise due to the viscosity of soluble fibres in the gastrointestinal tract (Abutair *et al*., 2016). Postprandial hyperglycemia and hyperinsulinemia are significantly influenced by gastric emptying and intestinal glucose absorption (Dimitriadis *et al*., 2021). Derivative fibre from cereals may improve body weight and insulin sensitivity, and high-fibre intake has been linked to a reduced risk of type II diabetes (T2DM) (Weickett & Pfeiffer, 2018). A systematic review revealed that dietary fibre significantly reduced glycated hemoglobin A1c, fasting glucose, insulin, and homeostatic model assessment for insulin resistance (HOMA-IR) in patients with T2DM (Mao *et al*., 2021). Soluble fibre serves as a prebiotic, providing nourishment for beneficial gut bacteria. These bacteria can produce short-chain fatty acids, which have been shown to improve insulin sensitivity and glucose metabolism (Meena *et al*., 2022).

Polyphenols and antioxidants

Sweet sorghum grain meal contains various polyphenols and antioxidants, including phenolic acids, flavonoids, and tannins as shown in **Figure 2**. These compounds possess anti-inflammatory and antioxidant properties, which can help reduce oxidative stress and inflammation associated with diabetes (Khalid *et al*., 2022). Additionally, some studies suggest that polyphenols may enhance insulin sensitivity and improve glucose metabolism.

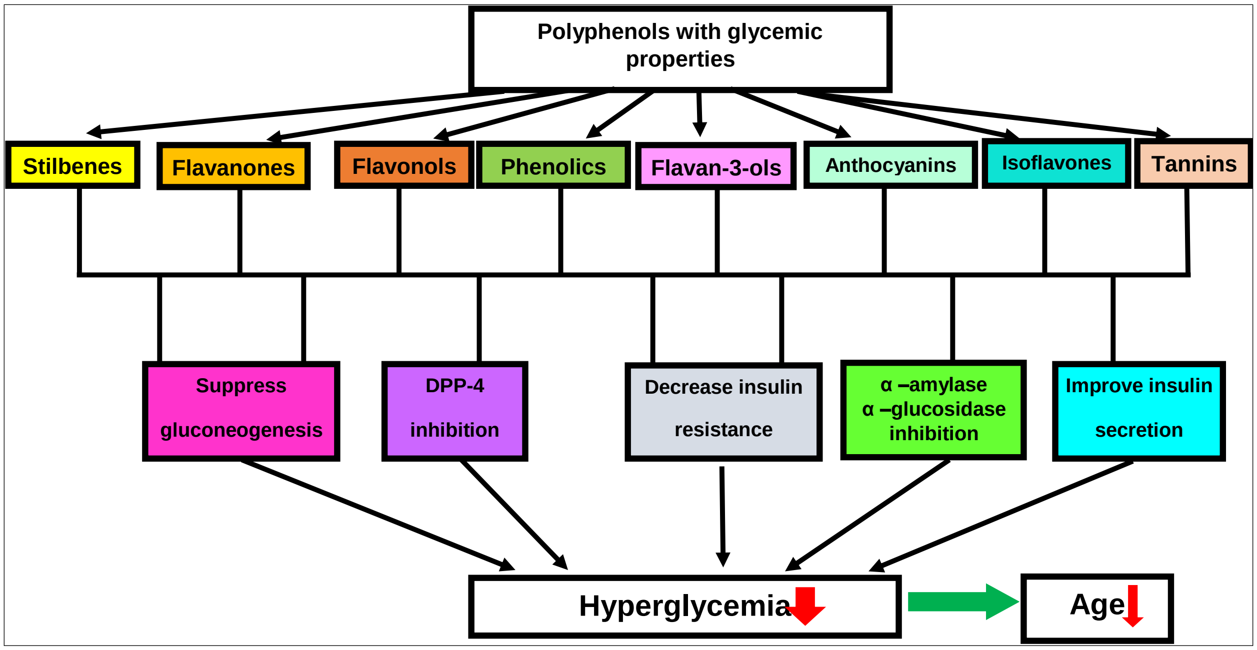

Figure 2. Phytochemical profile of sweet sorghum and its functions in the management of diabetes

Sweet sorghum contains bioactive phenolic compounds such as flavonoids, gallic, ferulic and caffeic acids and tannins that are linked to decreased risk of diabetes (Chen *et al*., 2021). Flavonoid-rich phenolic compounds inhibit α-glycosidase and α-amylase catalysis by binding to amino acid residues in their active sites. These inhibitors have potential applications in therapeutic approaches to manage the effects of type II diabetes (Ofosu *et al*., 2021; Meena *et al*., 2022). α-Glycosidase and α-amylase are responsible for dietary starch digestion, oligosaccharide degradation and glucose absorption in the small intestines, which results in an increase in postprandial glucose (Corkovic *et al*., 2022). By maintaining glucose levels, diabetic patients may experience fewer fluctuations in blood glucose levels, reducing the risk of shock and other complications. Raimundo *et al*. (2020) conducted a meta-analysis of interventional studies and concluded that the consumption of polyphenols may contribute to lower glucose levels in individuals with T2DM or at risk of diabetes and that these compounds may also act in combination with antidiabetic drugs. The antidiabetic properties of phenolics enhance the effect of insulin on skeletal muscle and liver cells by decreasing plasma free fatty acid levels, and hepatic gluconeogenesis, and increasing glucose uptake (Golovinskaia *et al*., 2023).

Studies have shown that millets are effective in glycemic management, lowering fasting, lowering the insulin index and resistance, and lowering glycosylated haemoglobin (Geetha *et al*., 2020;

Singh *et al*., 2020; Sobhona *et al*., 2020). In a study among diabetic patients who consumed control foods (wheat, maize and rice) and those who included sweet sorghum grain in their diet, decreases in glucose and insulin levels of 26% and 55% respectively were observed (Anitha *et al*., 2021; Nagaraju *et al*., 2020; Sobhona *et al*., 2020). High tannin containing sorghum is characterized by a low glycemic index, which is beneficial for people with diabetes due to its prolonged digestibility (Li *et al*., 2018; Khalid *et al*., 2022). Anthocyanins, on the other hand, are known for their antioxidant and anti-inflammatory properties, which may contribute to overall health and potentially have a positive impact on diabetes management (Frankowski *et al*., 2022).

Weight Management

Managing and maintaining of a healthy weight is paramount for individuals with type II diabetes. The low calorific high dietary fibre content of sweet sorghum increases satiety and is indispensable in improving insulin sensitivity and glycemic control in individuals with diabetes (Weickert and Pfeiffer, 2018; Meena *et al*., 2022).

Reduced Insulin Resistance

Type II diabetes is characterized by insulin resistance, an event in which body cells are less responsive to insulin. However, soluble fibre found in sweet sorghum grain has been shown to improve insulin sensitivity, allowing cells to respond effectively to insulin and facilitating the uptake and utilization of glucose and the utilization of glucose (Cutler *et al*., 2019; Moraes *et al*., 2018). A reduction of insulin resistance caused by dietary fibre helps improve overall glycemic control in individuals with type II diabetes (Dimitriadis *et al*, 2021). Insulin resistance manifests as postprandial hyperglycemia and can induce oxidative stress, the formation of advanced glycation end products (AGEs), and lipid peroxidative products, leading to endothelial dysfunction, dyslipidemia, and the expression of inflammatory genes (Giri *et al*., 2018). Postprandial hyperglycemia occurs after a meal high in carbohydrates due to the hydrolysis of starch by digestive enzymes (α-amylase and α-glucosidase) and glucose absorption in the small intestine. Postprandial hyperglycemia can be improved by suppressing α-amylase or α-glucosidase in the digestive tract (Khalid *et al*., 2022). The numerous pharmacologically active components of natural products, such as phenolics, reduce hyperglycemia by reducing insulin resistance and inhibiting α-glucosidase in the small intestine.

Mineral Content

Sweet sorghum grain meal is a good source of essential minerals such as magnesium and potassium. A 192-gram serving of sorghum grain contains 24.96 mg of calcium and 697 mg of potassium (Moraes *et al*., 2018). Magnesium plays a crucial role in glucose metabolism and insulin secretion, and magnesium deficiency has been linked to insulin resistance and impaired glucose control (Moraes *et al*., 2018). Magnesium is required for the activation of enzymes involved in glucose metabolism and the synthesis of insulin. Potassium, on the other hand, helps maintain normal blood pressure and supports heart health, which is particularly important for individuals with type II diabetes who are at a greater risk of cardiovascular complications (Baqar *et al*., 2020; Chatterjee *et al*., 2011; Badr Eslam *et al*., 2020).

Overall, the diverse array of beneficial components present in sweet sorghum grain meal makes it a valuable addition to the diet for individuals with type II diabetes. Its inclusion, alongside other dietary modifications and lifestyle changes, can contribute to better glycemic control, reduced risk of complications, and improved overall health outcomes for individuals managing type II diabetes.

Dietary implementation of sweet sorghum grain meal

Most foods consumed from sweet sorghum grain meal are boiled, baked or processed (Kam *et al*., 2016; Olawole *et al*., 2018). **Table 1** shows possible meal course plan designs that were developed for breakfast, lunch, supper and snacks that incorporate sweet sorghum grain meal/ flour.

Table 1. Applications of Sweet sorghum grain meal/flour in various recipes

Recipe	Preparation steps	Benefits/Uses
Unfermented porridge	Boil water, add sweet sorghum grain meal, simmer and serve	Quick and easy to prepare; versatile base for various toppings
Fermented porridge (sour porridge)	Soak sweet sorghum grain meal overnight in water, heat until thickened, simmer and serve	Enhanced flavor and nutrition due to fermentation; improved digestibility
Bread	Add salt and yeast to sweet sorghum grain flour, add warm water and mix	Offers a nutritious and filling bread

	thoroughly to a make dough, bake and serve	alternative; versatile for sweet or savory toppings
Dumplings (*Amaqebelengwane*/Ndebele)	Mix sweet sorghum grain flour/meal, bicarbonate of soda, salt and water/milk	Traditional African muffins; suitable for various accompaniments or eaten on their own
***Mpholokoqo/*Ndebele**	Mix sweet sorghum grain meal with salt, boil in water	Quick and easy side dish; complements tea or other beverages
Lunch/ Supper	Prepare thick porridge/sadza (Shona)/isitshwala (Ndebele) with sweet sorghum grain meal	Traditional main staple dish; complements various meat or vegetable relishes
Boiled grains as a snack *Muchakachi/ Shona Uhayezi/Ndebele*	Using mortar and pestle, pound the sweet sorghum grains until the outer layer is removed, winnow to remove chaff. Put the grains in hot water and steam until cooked, then add a pinch of salt as seasoning then serve.	
Non-alcoholic beverage *Maheu/*Shona *Amahewu/*Ndebele	Add grain meal to boiling water as if you are preparing porridge then allow to simmer for 5-10 minutes. Let the porridge cool then add cold water and stir to mix. Put the grist in a closed container and leave it for a day or two to ferment. Stir then serve as drink.	Maheu is a nourishing food and drink.
Bread	Put a cup of grain flour in a bowl. Add a pinch of salt, a teaspoon of sugar, a quarter of a teaspoon of yeast and mix the dry ingredients. Add a cup of warm water and mix to form thick dough. Put the dough in a pot, place the pot on hot charcoal and place the hot charcoal on the lid of the pot. Bake until golden brown and serve.	

Pancakes	Put a cup of grain flour in a bowl. Add a pinch of salt, a teaspoon of sugar and a teaspoon of baking powder. Add a cup of milk and mix to a smooth paste of pouring consistency. Then, use a frying pan to prepare the pancakes.

Sweet sorghum grain can also be used to make, using modern technology, instant cereals and a variety of baked confectionaries including buns, cookies, muffins and cup-cakes (Mohamed *et al*., 2022).

Integrating traditional healing practices into modern healthcare systems: strengths and challenges

Traditional healing practices have long been ingrained in African cultures, offering alternative approaches to healthcare. Integrating these practices into modern healthcare systems presents both strengths and challenges, particularly in the context of exploring the potential of sweet sorghum grain meal as a supplement for diabetic patients in African diets. These practices often incorporate holistic views of health, considering not only physical but also mental, emotional, and spiritual well-being (Zhang, 2015). In the management of diabetes, traditional systems may offer culturally sensitive approaches that resonate with patients' beliefs and lifestyles, enhancing treatment adherence and outcomes.

Moreover, traditional medicine practices often utilize locally available resources, such as sweet sorghum grain, which can be beneficial for promoting health and managing diseases like diabetes (Frankowski *et al*., 2022). In the case of sweet sorghum grain meal, which has shown potential in regulating blood sugar levels and improving insulin sensitivity, thus integrating it into traditional medicine practices can leverage indigenous knowledge systems to address health challenges effectively (Levy, 2024; Badasar *et al*., 2024). Furthermore, traditional medicine plays crucial roles in community healthcare delivery, especially in rural and underserved areas where access to modern healthcare facilities may be limited. Traditional medicine can complement the efforts of modern healthcare systems in reaching marginalized populations (Zhang, 2015).

However, integrating traditional medicine practices into modern healthcare systems also poses significant challenges. One major challenge is the lack of standardization and regulation, which may lead to variability in treatment quality, outcome and safety (Dew & Liyanagunawardena, 2023). Balancing the integration of traditional healing with modern medical standards poses regulatory challenges related to licensing, accountability, and ethical considerations (WHO, 2023). In the case of sweet sorghum grain meal supplementation for diabetes management, ensuring consistent and evidence-based practices is essential to safeguard patient health and optimize treatment outcomes. Additionally, there may be cultural and ideological differences between traditional and modern healthcare systems, leading to tensions or conflicts in their integration (Mutombo *et al*., 2023). Modern healthcare systems, often rooted in biomedical models, may overlook or dismiss traditional medicine practices, undermining their potential contributions to patient care. Bridging these gaps requires open communication, mutual respect, and collaboration between practitioners of both systems.

Moreover, traditional healing practices may face stigma within modern healthcare settings, hindering their acceptance and integration (Mutombo *et al*., 2023). Addressing these perceptions necessitates raising awareness about the value of traditional knowledge and practices, backed by scientific evidence where available, to foster greater acceptance and collaboration between traditional and modern healthcare practitioners.

Implications of incorporating sweet sorghum grain into the African diet for diabetic patients

The adoption and incorporation of sweet sorghum grain meal into African diets can have several implications. There is a fundamental need to boost sweet sorghum production in both the commercial and smallholder sectors to meet domestic needs and curb imports. This can lead to increased income for farmers and contribute to economic growth (Cifuentes *et al*., 2014). Sweet sorghum grain meal can be used as a healthier alternative to refined grains, such as white rice or wheat flour. Refined grains have undergone extensive processing, resulting in a loss of dietary fibre and nutrients. By replacing refined grains with sweet sorghum grain meal, individuals with type II diabetes can improve their overall diet quality, increase fibre intake, and better manage their blood sugar levels (Anitha *et al*., 2021).

Sweet sorghum is a nutritious whole grain that contains essential nutrients such as vitamins (B vitamins), minerals (iron, magnesium and potassium), and dietary fibre (Osman *et al*., 2021; Abah *et al*., 2021; Khalid *et al*., 2022c). By incorporating sweet sorghum into their diets, Africans can access a rich source of nutrients that contribute to overall health and well-being. The consumption of sweet sorghum grain can help increase mineral intake and improve overall health, including glucose control and insulin sensitivity (Pereira & Hawkes, 2022; Baqar *et al*., 2020; Morae *et al*., 2018). Sweet sorghum grain contains phytochemicals with glucose-lowering or hypoglycemic properties, improving insulin sensitivity and antidiabetic effects in animal models (Khodami *et al*., 2021; Mohamed *et al*., 2022). Incorporating sweet sorghum grain meal into diabetic diets may help regulate blood sugar levels and improve glucose control. A low glycemic index prevents rapid spikes in blood sugar and promotes better glycemic control (Anitha *et al*., 2021).

Sweet sorghum is a resilient crop that can grow well in arid and semi-arid regions, making it suitable for parts of Africa facing food insecurity and climate challenges. Integrating sweet sorghum cultivation can help diversify food sources and reduce dependency on a limited range of crops (Pereira & Hawkes, 2022). Many African countries heavily rely on a few staple foods such as maize, rice, and wheat. The introduction of sweet sorghum as a new staple food diversifies the diet and helps ensure that a wider range of nutrients are available. Sweet sorghum is a multi-use crop that can be utilized for food, fuel, fibre, and fodder. The incorporation of sweet sorghum into the African diet can help address socioeconomic challenges for smallholder farmers and improve food security and poverty alleviation in sub-Saharan Africa (Malobane *et al*., 2018).

Sweet sorghum requires less water and fertilizer inputs than certain other cereals, making it a more sustainable crop choice. Promoting the cultivation of sweet sorghum can foster sustainable agricultural practices, especially in regions with limited water resources. Sweet sorghum is a drought-tolerant crop that can grow on marginal land (Nasidi *et al*., 2019). Incorporating sweet sorghum into the African diet can help promote food security and sustainability by reducing the dependence on other crops that require more water and resources. In many African countries, sorghum has a long history as a traditional staple food (Maphosa & Dube, 2022; Khodami *et al*., 2021)). By adopting sweet sorghum grain meal, communities can preserve their cultural heritage and culinary traditions. The incorporation of sweet sorghum grain meal into the diet supports the utilization of a locally available and sustainable crop, making it accessible to a larger population.

Conclusion and future perspectives

The findings from this study reveal that incorporating sweet sorghum grain meal as a diabetic supplement in African diets can be beneficial. The soluble fibre in sweet sorghum plays a crucial role in slowing down glucose absorption, leading to reduced post-meal blood sugar spikes and improved insulin response. Furthermore, its gluten-free nature makes it a viable option for individuals with gluten sensitivities. The nutritional benefits of sweet sorghum, including essential vitamins, minerals, and dietary fibre, address concerns related to nutrient deficiencies commonly observed in diabetic diets. Additionally, promoting the cultivation and consumption of sweet sorghum can contribute to food security and sustainable agriculture in Africa due to its adaptability to semi-arid regions. Further research is crucial to establish the efficacy and safety of sweet sorghum grain meal as a diabetic supplement in African diets. Clinical trials with larger sample sizes are needed, along with clear guidelines for its inclusion in diabetes management. Awareness campaigns, value chain development, and educational initiatives targeting both individuals with diabetes and healthcare professionals will promote its acceptance and integration into local diets. Government policies supporting sweet sorghum cultivation and research funding are necessary, recognizing its role as a supplement alongside traditional diabetes treatments and lifestyle interventions.

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