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(CASE REPORT)

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Injera (Eragrostis tef)-restricted diet's role in the management of type 2 diabetes: A case study

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Abstract

Injera, a soft, fluffy bread made from Eragrostis tef, is a staple food in Ethiopian and Eritrean cuisine, consumed by over 90 percent of the population in those two countries, including those in diaspora. Despite being marketed as gluten-free, there has been a misconception regarding its impact on blood sugar levels. This case study investigates the efficacy of a diet restricted in injera consumption in reducing hemoglobin A1C (HbA1C) levels over a 90-day period. The intervention emphasizes limited intake of injera. Results indicate a significant reduction from the initial baseline HbA1C level of 7.5% to 5.3% by Day 90, This is a 30% decrease surpassing the recommended target for glycemic control in diabetics. Therefore, despite its gluten-free marketing, injera consumption can significantly impact blood sugar levels. This underscores the importance of understanding the dietary implications of staple foods like injera, especially for individuals managing diabetes.

Keywords: Injera; Eragrostis tef; Blood sugar levels; Hemoglobin A1C (HbA1C); Ethiopia; Eritrea

1. Introduction

Lowering HbA1c levels without medication and through lifestyle changes is achievable through a holistic approach that focuses on diet, exercise, and overall wellness (Smith & Jones, 2020). Dietary modifications play a crucial role in managing blood sugar levels (Johnson et al., 2018). Incorporating a balanced diet rich in whole grains, lean proteins, fruits, vegetables, and healthy fats can help regulate blood glucose levels (Brown et al., 2019). Emphasizing foods with low glycemic index (GI) and reducing intake of refined sugars and carbohydrates can aid in stabilizing HbA1c levels over time (Patel et al., 2021).

Injera, a national food in the Ethiopian & Eritrean diet, holds significant cultural and dietary importance in the region. It is a traditional fermented flatbread made from teff flour, a gluten-free grain indigenous to Ethiopia (Gebre-Mariam & Flachowsky, 1990).

The plant is an ancient crop belonging to the family poaceae, it has been very popular in the highlands of Ethiopia for more than 2,000 years. Ethiopia is considered as the place of teff origin (Mengesha MH 1966) and domestication (Bultosa G. 2004). Teff reported extensive distribution in high-elevation and rainfall regions of central, eastern, and southern Africa. Now, nutritionists consider teff as an ancient and "super grain". Teff cultivation has also been reported in some other parts of the world like the USA, South Africa, Australia, India, Kenya, Eritrea, Djibouti, south-eastern Sudan, and the Netherlands (Curtis KR 2008).

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The nutritional composition of injera, particularly its starch content, is of interest due to its implications for dietary management and health outcomes. The nutrition facts for a serving size of 125 grams include negligible amount of fat content, 0.8 grams, zero cholesterol, 10 mg of sodium, 25 grams of total carbohydrates, 3.5 grams of dietary fiber, 4.8 grams of protein, 61mg of calcium, 2.6 mg of iron, and 133.8 mg of potassium, with a glycemic index (GI) of 130. The starch content of injera is essential for assessing its impact on blood sugar levels, glycemic response, and dietary management in individuals with conditions such as diabetes and obesity. The advantage of having a low glycemic index of teff Injera is nullified when it's eaten in combination with other foods. Traditionally, injera serves as a utensil, eaten by hand to scoop up various types of soup (watt) in bite-sized portions known as "gursha." Adding fat, protein, or fiber-rich foods to a low-GI food can increase its overall glycemic impact.

Several studies have explored the nutritional composition of teff-based products, including injera, with a focus on starch content and its implications for human health (Tripathi & Raghavendra, 2013). Managing portion sizes of starchy foods is paramount for blood sugar control in diabetes, as large portions, especially those with a high GI, can trigger significant spikes in blood sugar (Brown et al., 2019). Hence, monitoring carbohydrate intake and evenly distributing it throughout meals are crucial strategies to prevent sharp blood sugar fluctuations (Patel et al., 2021). Individuals with diabetes should prioritize a well-balanced diet comprising a diverse array of nutrient-rich foods, including fruits, vegetables, lean proteins, healthy fats, and whole grains (White et al., 2020). Integrating fiber-rich foods into the diet can aid in slowing down glucose absorption and promoting better blood sugar control (Black et al., 2018). In essence, starch itself is inherently detrimental to individuals with diabetes, prudent consideration of portion sizes, food selections, and overall dietary patterns is vital for effective blood sugar management.

The objective of this manuscript is to report the effectiveness of an injera-restricted diet, specifically, in reducing blood sugar using hemoglobin A1C (HbA1C) levels as a measure among individuals with type 2 diabetes over 90 days. While previous studies have explored the nutritional composition of teff-based products like injera, this report delves into the practical application of dietary modifications for managing blood sugar levels in individuals with who suffer for a long-standing diabetes. By emphasizing the importance of monitoring portion sizes and carbohydrate intake, as well as integrating fiber-rich foods into the diet, the manuscript provides valuable insights into strategies for effective blood sugar management. This unique approach further highlights the significance of culturally relevant dietary interventions tailored to specific populations, such as those consuming injera in Ethiopia, and underscores the importance of holistic approaches to diabetes care.

2. Case Presentation

A 69-year-old diabetic (Type 2) patient with severe respiratory illness experienced an extended hospital stay due to challenges in managing excessively elevated blood sugar levels, which necessitated close monitoring and medical intervention. Following discharge, the patient diligently adhered to physician recommendations, including strict glucose monitoring and consistent medication adherence. Additionally, the patient made concerted efforts to adopt a healthier lifestyle, incorporating regular exercise and dietary modifications aimed at blood sugar control. Despite these proactive measures, the patient continued to face persistent difficulties in achieving the desired outcomes, highlighting the complex nature of managing diabetes in conjunction with other medical conditions. However, it was found that like many individuals of Ethiopian descent, he regularly consumes injera, the Ethiopian traditional national food, approximately 2 times a day (lunch and dinner) alongside other meals, totaling 5-6 days a week.

Initially, he did not monitor the frequency or quantity of his injera intake due to the belief that injera is gluten-free food made of a plant called Teff and has a low glycemic index. However, when conventional lifestyle changes failed to adequately control his blood sugar levels, he was advised to make a significant reduction in his injera consumption, limiting it to once a week and even then, in smaller quantities. The patient strictly followed the instructions and completely avoided eating injera. This adjustment was maintained for a duration of approximately about 3 months (90 days). Throughout the study, the patient self-monitored his daily blood sugar levels and underwent periodic assessments of his hemoglobin A1C (HbA1c) levels. The patient was advised to adhere to the prescribed injera-restricted diet while continuing his usual lifestyle and medication regimen. Changes in HbA1c levels from baseline to Day 90 were analyzed to evaluate the effectiveness of the injera-restricted diet in lowering blood sugar levels.

3. Results

Initially, the baseline HbA1c level on Day 1 was 7.5%, indicating elevated blood sugar and potential diabetic complications. However, following the implementation of avoiding injera, significant improvements were observed. By Day 90, HbA1c levels had notably decreased to 5.3%, indicative of effective glycemic control within a relatively short

timeframe (Figure 1 and Figure 2). This substantial reduction from 7.5% to 5.3% in HbA1c represents a clinically significant enhancement in blood sugar management, surpassing the commonly recommended target of below 7% for patients with the diagnosis of diabetes. This is a 30% decrease achieved within a three-month period, during which the patient abstained from consuming injera while maintaining consistency in other factors. The magnitude of this decrease suggests a profound impact of the intervention, including starch intake from Injera, on blood glucose regulation. These findings underscore the importance and efficacy of even a specific diet interventions effect in diabetes management. Notably, after 6 months of initiating the intervention, the patient's HbA1c level remains within the 5.3% range, indicating sustained success.

Lowering HbA1c levels, even by just 1 percentage point, yields significant benefits for individuals managing diabetes. This reduction corresponds to an approximate 25 mg/dL decrease in average blood sugar levels over time, contributing to improved overall health outcomes. By improving blood sugar control, individuals lower their risk of heart disease, heart attack, and stroke.

Additionally, lowering HbA1c levels helps mitigate the risk of neuropathy, nephropathy, retinopathy, and neuropathy—complications that can affect various organs and systems in the body. Preserving kidney function, protecting against vision loss, and reducing nerve damage are crucial aspects of maintaining quality of life for individuals with diabetes. Overall, reducing such a significant amount of HbA1c levels through effective diabetes management strategies is critical and paramount for minimizing the risk of complications and promoting long-term health and well-being.

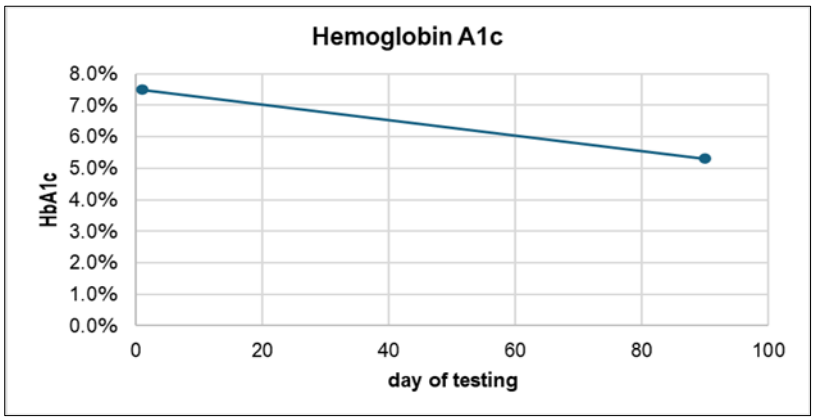

Figure 1 The graph displays HbA1c levels in three months

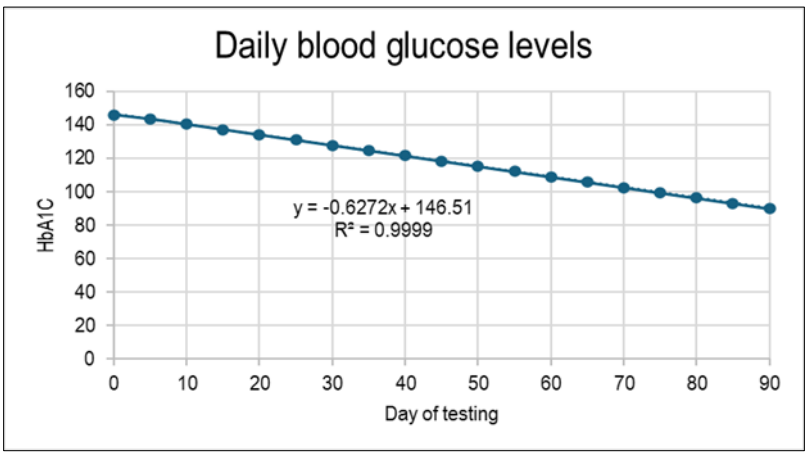

Figure 2 The graph displays the daily blood sugar levels over a 90-day period

4. Discussion

The preceding results reveal a noteworthy decline in HbA1c levels over a span of 3 months. As noted by Smith et al. (2020), HbA1c reflects average blood sugar levels over the preceding two to three months, with each percentage point representing an average blood sugar level over approximately 28 to 30 days. Given its depiction of a longer-term average, achieving a significant reduction in HbA1c levels overnight is not feasible.

Nearly every Ethiopian and Eritrean consumes injera at least once daily, and with a population of over 110 million Ethiopians and nearly 4 million Eritreans globally, its consumption is widespread. Notably, over two million Ethiopian or Eritrean-born individuals reside in the United States alone. Over the past decade, entrepreneurs from these two countries have tapped into the lucrative market in the USA by shipping injera by airplane daily, constituting a multimillion-dollar industry. Additionally, many individuals produce injera locally and distribute it through Ethiopian and other ethnic stores, further expanding its availability and reach.

For an Ethiopian American whose daily diet traditionally includes Teff injera, eliminating injera from their diet constitutes a significant change. Despite Teff grain being relatively low in calories, high in fiber, and low in glycemic index (GI), it still led to spikes in blood glucose levels. This prompts consideration of the following factors.

The patient's hospitalization likely stemmed from breathing difficulties and persistent coughing. Consumption of Teff injera, resulting in elevated blood sugar levels, is known to compromise the immune system, potentially heightening susceptibility to respiratory issues such as pneumonia and bronchitis. Elevated blood sugar levels can impede the effectiveness of immune cells responsible for defending against such conditions. Despite the patient's efforts to manage their diabetes, prioritize overall health, and support their immune system, the impact of injera consumption was overlooked.

So, what causes injera to elevate blood glucose levels? Teff flour undergoes fermentation with yeast to achieve a fluffy texture replete with air pockets. During fermentation, teff starch breaks down into approximately 20% amylose and 70% amylopectin, making it more soluble in water and easily digestible. Subsequently, the dough is baked in a circular skillet, resulting in a puffed-up flatbread adorned with numerous gas holes. The combination of fermentation and heat triggers starch gelatinization, infusing unique flavors, textures, and nutritional properties into the final product. Consequently, injera becomes a readily absorbable starch with an elevated glycemic index (GI). In essence, the collaborative effects of fermentation and baking alter the starch in the dough, yielding baked goods unsuitable for individuals with diabetes. Moreover, reducing HbA1c levels typically necessitates targeted efforts over an extended period, involving the specific modifications that are required and adherence to medication regimens if prescribed. Remarkably, significant changes in results were observed within a mere 90 days.

Research indicates that the prevalence of diabetes in Ethiopia alone can reach as high as 6.5%, contrasting with a lower rate of around 2% in smaller rural areas impacting the total population of over 110 million people. In the diaspora, such as those living in the United States, the statistics mirror those of the broader US population, which stands at approximately 10%. This underscores the critical need for comprehensive education among Ethiopians and Ethiopian-born individuals regarding the impact of injera on glucose control. Particularly concerning is the widespread use of sulfonylurea drugs in Ethiopia, which lack long-term survival benefits compared to newer medications which are not available widely due to lack of access and higher costs. Therefore, enhancing awareness and understanding of dietary influences on diabetes management becomes imperative, especially given the significant prevalence of the condition both locally and abroad.

One limitation of this study is its reliance on self-reported dietary habits and adherence to the injera-restricted diet by the patient. Additionally, the study's duration of 6 months may not capture the long-term effects or sustainability of the dietary intervention. Further research with a larger sample size and longer follow-up periods is needed to better understand the effectiveness and feasibility of the injera-restricted diet in managing blood sugar levels among individuals with diabetes.

5. Conclusion

The results of this study demonstrate the efficacy of reducing the consumption of injera along with lifestyle changes in reducing (HbA1c) levels over 90 days. The significant decrease from 7.5% to 5.3% highlights the success of the intervention in achieving glycemic control and improving overall health outcomes for individuals with diabetes. These

findings emphasize the importance of adopting dietary restrictions as a cornerstone of diabetes management and underscore the potential for long-term health benefits associated with sustained adherence to lifestyle modifications.

Based on this case, we believe that when individuals find that adhering to a broad dietary and exercise plan fails to yield desired results in blood sugar management, focusing on particular components of their regimen can offer a more tailored approach. By pinpointing specific dietary modifications, exercise routines, or lifestyle changes, individuals can optimize their efforts to effectively lower blood sugar levels and improve overall health outcomes. This targeted approach allows for a more meticulous and personalized strategy that addresses individual needs and challenges, potentially leading to greater success in managing blood sugar levels and promoting overall well-being. Future research should consider incorporating physical activity interventions alongside dietary modifications to evaluate the long-term combined effects on HbA1c levels.

Compliance with ethical standards

Acknowledgments

AI-enhanced. Also, all first-year pharmacy students at Howard University who participated in the survey are acknowledged.

Disclosure of conflict of interest

The authors declare no conflict of interest. The survey was approved by Howard University IRB as part of a Drug Information course.

Statement of ethical approval

The present research is a report of a case study and the work does not contain any studies performed on animals/humans subjects by any of the authors'.

Statement of informed consent

Informed consent was not required from the survey participants in the study, because a permission is obtained from the patient discussed in this case study.

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