Effect of Kenyan Finger Millet and White Maize Flours on Postprandial Glycemic Response in Healthy Individuals

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Abstract
Cases of diabetes have been on the rise in Kenya. Kenya's prevalence of type 2 diabetes has now surpassed WHO estimate of between 1 – 6% with incidence being as high as 14 % in the urban areas. There is therefore a need to provide appropriate dietary therapies suitable to the local setting to address this increasing incidence.
The study aimed at documenting the effects of finger millet flour compared to white maize flour on the postprandial glycemic response in healthy individuals. This was meant to help diabetic patients, health practitioners, diet therapists and the public at large to make an informed choice in using finger millet flour to control of hyperglycemia. Many health practitioners in Kenya advocate, while many diabetes patients prefer use of millet flour as opposed to white maize flour mainly due to the argument that finger millet flour may have lower postprandial glycemic response. However, documentation of the glycemic response of finger millet flours as opposed to white maize flour was lacking.The study was a controlled experiment involving randomly selected apparently healthy student in the University of Nairobi, CAVS.24 participants underwent three blood sugar finger prick tests; fasting levels and two others at 45th minute and 2 hours after ingestion of test flour which was administered as porridge.The participant's mean age, BMI and fasting blood sugars were 22.5, 22.4 years, 22.07, 21.26 kg/m2 and 3.21,3.31mmol/l for finger millet and maize respectively.The glycemic response of maize and finger millet at 45 minutes had a $p<0.001$ and 0.200 at 2 hours. The same response was evident between males and females.
Keywords: Glycemic response,Blood glucose ,Blood glucose level, Blood glucose meter,Body mass index (BMI)

CHAPTER 1:

1.0. Introduction

1.1. Background

Clinical trials in both type 1 and type 2 diabetes indicate that improving glycemic control greatly reduces the development and progression rate of micro vascular and neuropathic complications, (Mann,2001).

Diabetes therapy's main goal is to prevent acute complications of hyperglycemia and reduce the risk of long term complications like cardiovascular diseases.

Postprandial glycemic response is of concern in the management of diabetes mellitus due to acute complications of hyperglycemia in type 2 diabetes.

Some factors that influence glycemic response include Amount of carbohydrates, nature of monosaccharide component, nature of starch, and other food components like fat, protein, antinutrients dietary fiber and organic acids.

This study aimed at assessing the postprandial glycemic response of millet flour, a commonly recommended cereal by health practitioners in Kenya, for people with diabetes.

1.2. Problem statement:

Cases of diabetes have been on the rise in Kenya. According to research by Kenyan diabetes experts, Kenya's prevalence of type 2 diabetes has now surpassed WHO estimate of between 1-6 % with incidence being as high as 14% in urban areas and the factors associated with this trend in urban areas are thought to be high consumption of refined carbohydrates. (Otieno, 2008).

Therefore, there was the need to provide appropriate dietary therapies suitable to the local setting to address the increasing postprandial hyperglycemia which is of main concern with the diabetes.

1.3. Study justification:

Many health practitioners in Kenya advocate, while many diabetes patients prefer use of millet flour as opposed to white maize flour mainly due to the argument that finger millet flour may have lower postprandial glycemic response. However, documentation of the glycemic response of finger millet flours as opposed to white maize flour was lacking.

1.4. Study objective:

To determine the effect of finger millet flour compared to white maize flour on postprandial glycemic response among healthy individuals in order to contribute to the reduction and control of acute complications of

hyperglycemia among diabetes patients.

1.4.1. Specific objectives:

- To determine the subjects' BMI.
- To determine fasting blood sugar
- To determine the levels of blood sugar at 45th minute and 2 hours after consumption of porridge prepared from test flour .

1.5. Study hypothesis

There is significant difference in the postprandial glycemic effects of finger millet and white maize flours in healthy individuals.

1.6. Benefits:

The study documented the postprandial glycemic effects of finger millet and white maize flour for the benefit of diabetic patients, health practitioners, diet therapists and the public at large for use in control of hyperglycemia

1.7. Assumption:

The main assumption for this study was that the participants would comply with the study procedures and cooperate throughout the study.

CHAPTER TWO:

2.0 Literature review:

2.1 Diabetes mellitus

Diabetes refers to a metabolic disorder characterized by impaired carbohydrate, fat, and protein metabolism due to inadequate insulin secretion, impaired insulin action or both. People at high risk includes, being related to a diabetic person, being a mother of a large baby, being overweight and being in stress situations.

The main types of diabetes are Type 1 and type 2. Other common types are gestational and diabetes secondary to pancreatic damage.(Rosett et.al, 2001).

2.1.1Type 1 diabetes

This is a T-cell mediated autoimmune disease affecting the beta cells of the Islets of Langerhans.It is characterized by absolute insulin deficiency.

The pathogenesis of type 1 diabetes involves genetic factors, immunologic factors and environmental factors.

A link between type 1 diabetes and histocompatibility system has been confirmed by population studies showing that genetic susceptibility to disease is related to genes located on chromosome 6, (HLA-DR and HLA-DA).(Riccardi et.al, 2005).

Environmental factors that contribute to the pathogenesis of Type1 diabetes include chemicals, viruses like mumps and dietary factors. These exert a direct toxic effect on the beta cells, trigger autoimmune reaction against the beta cells and damage cells to increase susceptibility to autoimmune destruction. (Riccardi et.al, 2005).

The main management of this type 1 diabetes is insulin therapy and exercise; to control hyperglycemia and body weight respectively, (Frier et.al, 2001).

2.1.2 Type 2 diabetes*:*

The development of type 2 diabetes is associated with insulin resistance; inadequate pancreatic and beta cells compensatory insulin production and increasing obesity.

It contributes to 90-95% of all diabetes cases.

Insulin resistance is a state in which a given concentration of insulin produces a less normal biological response i.e, the insulin do not efficiently lower blood glucose by suppressing glucose production from the liver or promoting uptake of glucose by peripheral tissues.

2.1.3 Comparison of type 1 and type 2 diabetes*;*

Type 1 and Type 2 diabetes vary in various aspects which are shown in the table.

Table 1: Comparison of type 1 and type 2 diabetes:

Characteristic	Type 1 diabetes	Type 2 diabetes
Age at onset	<40 years	>50 years(though can be earlier)
Duration of symptoms	Weeks	Months to years.
Body weight	Normal	Obese
Ketonuria	Yes	No
Rapid death without insulin therapy	Yes	No
Auto antibodies	Yes	No
Family history of diabetes	Uncommon	Yes
Other auto immune diseases	Yes	Uncommon
Diabetic complications at diagnosis	No	25%

Source: (Frier, 2005).

2.1.4 Major manifestations of diabetes *:*

According to (Frier, 2005) Hyperglycemia is a very common biochemical abnormality. Diabetic ketoacidosis is another manifestation. Both of these can lead to complications that include:

1. Microvascular complications;
   - ❖ Retinopathy, cataract – impaired vision
   - ❖ Nephropathy – renal failure
   - ❖ Peripheral neuropathy –sensory loss and motor weakness
   - ❖ Autonomic nephropathy –postural hypotension, GI problems
   - ❖ Foot disease – ulceration and atrophy

2. Macrovascular complications:
   - ❖ Coronary circulation –myocardial ischemia
   - ❖ Cerebral circulation ;stroke
   - ❖ Peripheral circulation: Ischemia.

2.1.5Management of diabetes:

The overall goal of diabetes therapy is to normalize energy metabolism to prevent acute complications such as hyperglycemia and ketoacidosis.

Diabetes can be managed through diet, physical exercise, oral hypoglycemic agents and insulin therapy.

- ➢ Diet:

In many patients with type 2 diabetes, diet may be the only therapy required. Diet allows more accurate glucose control, (Geissler,2005).All nutritional programmes should be adapted to the specific needs of the individual. The diet should contain <10% saturated fat, <300mg/day cholesterol, 10-20% protein and the remaining being carbohydrates and saturated fats.

- ➢ Physical exercise:

Aerobic physical exercise of moderate intensity but performed on regular basis(not less than four times a week) has been shown to improve blood sugar control, reduce insulin resistance and prevent incidence of type 2 diabetes.

Exercise increases peripheral glucose uptake in Type 2 diabetes.

In Type 1 diabetes patient, glycemic changes during exercise depend largely on blood insulin levels; insulin administration. (Riccardi, 2005).

- ➢ Oral hypoglycemic agents:

These drugs are used to achieve optimal blood sugar control by patients with type 2 diabetes. They are used when nutritional management and physical exercise have failed to achieve optimal blood glucose control. They have the ability to reduce weight in overweight diabetic patients. They can also slow down carbohydrates metabolism and increase insulin secretion hence are quite useful in reducing postprandial blood glucose. (Riccardi, 2005)

- ➢ Insulin therapy:

This is an essential life saving drug for type 1 diabetes patients and can also be used in the treatment of type 2 diabetes when non pharmacological therapy plus oral glycemic drugs are no longer able to achieve the desired blood sugar.

Insulin control blood sugar by suppressing glucose production from the liver and by promoting uptake of glucose by peripheral tissues especially the skeletal muscle. (Riccardi, 2005).

2.2. Glycemic response for carbohydrate foods:

It has for long been regarded as important for control of diabetes to avoid excessive rise in blood glucose and concomitant high postprandial insulin levels with rapid decline of blood glucose below fasting level. A stable blood glucose help diminish the risk of developing both maturity onset diabetes and cardiovascular diseases.

The blood glucose concentration is determined by the rate of intestinal carbohydrate absorption, the net liver uptake and output and peripheral glucose uptake, which in turn depends upon the insulin level and sensitivity to the tissues to insulin. With a constant dietary carbohydrate load, there is a range of blood glucose responses between individuals. (Asp and Bender 2005).

Glycemic response of a food refers to the measure of the food's ability to elevate blood sugar.Glycemic response depends on the rate and the extent of digestion, absorption and clearance of a food from the plasma.

Glycemic index refers to the rise in blood plasma glucose after a 50 g carbohydrate load from a food or from a reference carbohydrate source. The plasma glucose rise 15 -45 minutes after consumption of a carbohydrate containing food and goes back to fasting levels at 2-3 hours later. (Mann, 2001).

Carbohydrates with high glycemic index generally provoke a higher secretion of insulin than those of low glycemic index.

Carbohydrates can be divided into three groups, polysaccharides, oligosaccharides and sugars. Nutritionally, carbohydrates can be classified as available and unavailable. (Asp and Bender, 2005). Later FAO/WHO (1998) expert consultation on carbohydrates in human nutrition recommended the term glycemic carbohydrates for available carbohydrates include Starch, fructose, sucrose, lactose, and dextrin. The available carbohydrates are responsible for glycemic response postprandial.

Some factors that influence glycemic response include Amount of carbohydrates, nature of monosaccharide component, nature of starch, and other food components like fat, protein, antinutrients dietary fiber and organic acids.

In order to improve the supply of calories to the body through adequate intake of carbohydrates, without compromising glycemic control, those of low glycemic index are recommended. The postprandial glycemic response for example to a morning meal may influence the metabolic response of the subsequent meals. Therefore, to obtain correct postprandial glycemic response of a food, it is advisable to use the fasting plasma glucose levels.

2.2.1. Cereals:

Cereal grains are dietary staples that provide a very substantial proportion of dietary energy, protein and micronutrients for much of the world's population. The major cereal crops are rice, maize, wheat, barley, sorghum, millets, oats and rye that are subjected to a very diverse range of traditional and technologically advanced processes before consumption.

2.2.1.1Finger millet (Eleusinian coracanal)

Finger millet, *Eleusine coracana*, is also known as African millet, *koracan,* ragi (India), wimbi (Swahili), bulo (Uganda) and telebun (the Sudan). It is an important staple food in parts of eastern and central Africa and India. It is the principal cereal grain in northern and parts of western Uganda and northeastern Zambia. The grains are malted for making beer. Finger millet can be stored for long periods without insect damage (Purseglove, 1972) and thus it can be important during famine. Numerous cultivars have been identified. In India and Africa, two groups are recognized: African highland types with grains enclosed within the florets; and Afro-Asiatic types with mature grains exposed outside the florets. It is believed that Uganda or a neighbouring region is the centre of origin of *E. coracana*, and it was introduced to India at a very early date, probably over 3 000 years ago. Though finger millet is reported to have reached Europe at about the commencement of the Christian era, its utilization is restricted mostly to eastern Africa and India.

The height of cultivars varies from 40 cm to I m and the spike length ranges from 3 to 13 cm. The colour of grains may vary from white through orange-red deep brown and purple, to almost black. The grains are smaller than those of pearl millet, and the mean seed weight is about 2.6 g.

It is an important staple food in parts of Eastern and Central Africa. Almost 30million tones are utilized in the world every year. It accounts for a third of total cereal consumption in Kenya. However, there is a fluctuation in its production due to change on eating habits and its low productivity (GoK 2002).Most people are consuming maize in place of millet.

2.2.1.2Maize (Zea mays)

It is a grain cereal which is highly productive and is the most consumed cereal in Kenya since it is easily available.

Maize is prepared and consumed in a multiple of ways. It is usually ground and pounded. The maize meal is cooked with water to provide a thick mush (Ugali).

Table 2: Nutrient composition of finger millet and maize per 100g edible portion; 12%moisture.

Nutrient	Finger millet	Maize
Protein (g)	7.7	9.2
Fat (g)	1.5	4.6
Ash(g)	2.6	1.2
Crude fiber (g)	3.6	2.8
Carbohydrate(g)	72.6	73
Energy(Kcal)	336	358

2.3. Gaps in knowledge:

There was no documentation in literature of the contribution of finger millet in controlling hyperglycemia. There are only but assumptions that finger millet flour could be of lower glycemic index and therefore useful in the management of diabetes

3. Conclusion

From the results, the glycemic response of finger millet and maize was evident at 45 minutes ($p<0.001$), but the difference between their responses was not significant ($p=0.157$,it is above 0.005 at 95% confidence interval). Therefore the null hypothesis of the study was proven; that there is no significant difference on the glycemic response between maize and finger millet flours.

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