DOI: 10.4274/tjem.2877

Glycaemic Responses to Corn Meals in Type 2 Diabetics and Non-Diabetic Controls

Tip 2 Diyabetikler ve Non-Diyabetik Kontrollerde Mısır Yemeklerine Glisemik Cevaplar

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Abstract

Purpose: Dietary modification in association with life style changes is important in the management of the diabetes. Cereals account for as much as 77% of total caloric consumption in most African diets. Corn which is the largest cultivated cereal crop in Nigeria is prepared as a meal in many forms. The objective of this study was to assess the glycaemic responses to different preparations of corn meals.
Material and Method: The design was a quasi-experimental with a total of 32 participants, 16 subjects with type diabetes and 16 age-and sex-matched non-diabetic control subjects. After an overnight fast, the participants were given corn meals to eat and had their blood sample collected every 30 minutes for over a 2 hour period for the assessment of blood sugar level and estimation of glycaemic responses. This was repeated weekly till the glycaemic index (GI) and plasma sugar level response to the different test corn meal preparation, such as boiled corn, roasted corn, pap and cornflakes had been assessed.
Results: All the different corn meal preparations had high GI, with corn flakes having the highest GI and pap the lowest. The GI for the corn meals in the non-diabetic were; pap 71.7±14.4%, roasted corn 76.5±14.9%, boiled corn 82.2±14.9% and cornflakes 88.1±14.4%.
Discussion: Methods of preparing a meal from corn affect glycaemic response. *Turk Jem 2015; 19: 79-82*
Key words: Glycaemic index, corn meal, type 2 diabetes, Nigeria

Özet

Amaç: Yaşam tarzı değişiklikleri ile birlikte diyet değişiklikleri diyabet tedavisinde büyük öneme sahiptir. Tahıl çoğu Afrika diyetinde toplam kalori tüketiminin %77 kadarını oluşturmaktadır. Mısır Nijerya'da en çok ekilen tahıl türüdür ve çeşitli biçimlerde yemek olarak hazırlanır. Bu çalışmanın amacı, farklı mısır yemek tarzlarına glisemi yanıtlarını değerlendirmektir.
Gereç ve Yöntem: On altı diyabetik hasta ve 16 yaş ve cins uyumlu non-diyabetik kişi olmak üzere toplam 32 hasta yarı-deneysel tasarımlı bu çalışmaya alındı. Bir gecelik açlığı takiben katılımcılara mısır yemekleri verildi ve kan şekerini ve glisemik cevabı tespit etmek için 2 saat boyunca her 30 dakikada bir kan örnekleri alındı. Haftada bir bu işlem haşlanmış mısır, kavrulmuş mısır, pap ve mısır gevreği gibi farklı mısır yemekleri için tekrarlandı.
Bulgular: Mısır gevreği en yüksek, pap en düşük glisemik indekse (GI) sahip olmak üzere tüm mısır yemek çeşitleri de yüksek glisemik indekse sahipti. Non-diyabetiklerde mısır yemeklerinin GI'leri şöyleydi; pap %71,7±14,4, kavrulmuş mısır %76,5±14,9, haşlanmış mısır %82,2±14,9 ve mısır gevreği %88,1±14,4.
Tartışma: Mısırdan hazırlanan farklı yemekler mısırın glisemik cevabını etkileyebilir. *Turk Jem 2015; 19: 79-82*
Anahtar kelimeler: Glisemik indeks, mısır unu, tip 2 diyabet, Nijerya

Introduction

Diabetes mellitus (DM) is a metabolic disorder of multiple aetiology, characterised by chronic hyperglycemia which is associated with disturbances of carbohydrate, fat and protein metabolism. This disorder results from a defect in insulin secretion, insulin action or both (1).

Diet in combination with lifestyle changes such as regular exercise helps patients with diabetes to lose weight and to also improve their overall metabolic control (2,3,4). The first documented dietary prescription in the treatment of presumed diabetes appeared in the Papyrus Ebers, written around 1500 BC (5). High carbohydrate diets produce a marked rise in post-prandial glucose, especially if refined or if it has a low fibre (6). Complex carbohydrate,

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Turkish Journal of Endocrinology and Metabolism, published by Galenos Publishing.

vegetables, fruits and soluble and viscous fibers like pectin found in legumes are more effective in achieving normal plasma glucose and lipid levels than the insoluble fiber such as cellulose found in cereals (6,7). Cereals account for as much as 77% of total caloric consumption in most African diets (8,9). Cereal grains include wheat, rice, corn, barely, millet, oat and rye; of these, corn is by far the largest cultivated cereal crop in Nigeria (10). Corn is prepared as a meal in many forms; it can be boiled, roasted or processed and then prepared as pap or as cornflakes. Corn meals serve as an important source of carbohydrate. Studies have shown that the metabolic response to various foods in patients with type 2 diabetes differs from that in non-diabetic persons (7).

Corn as a meal has a high glycemic index (GI) (11), but studies have shown that when meals are prepared in different forms from a major ingredient they produce different glycemic responses. We therefore decided to assess the glycemic responses to the different forms of preparations of corn meal (12,13). The main objective of this study was to assess the potential role of corn meals in the dietary management of DM, by determining the glycemic response of various corn meals preparation in patients with type 2 diabetes and compare this to the response in non-diabetic controls.

Materials and Methods

The study was carried out at the Endocrinology and Metabolism Unit of Medicine Department of Lagos University Teaching Hospital. The study design was quasi-experimental interventional study with a total of 32 subjects. Sixteen subjects with type 2 diabetes attending the endocrinology clinic of the hospital that consented and met the inclusion criteria were matched for age and sex with sixteen non-diabetic controls who were members of staff in the hospital, including medical students. The study had a cross-over period of one week during which each subjects served as their own internal control for the different preparation of corn meals that were assessed. The different corn meal preparations were boiled corn, roasted corn, cornflakes and pap.

At enrollment, all subjects were clinically examined and their anthropometric measurements were recorded. Male and female type 2 diabetics with good glycemic control on diet alone or diet with oral hypoglycemic agents and aged between 20 and 50 years were included in the study. Subjects, who were obese, with BMI ≥30 kg/m^2, type 1 diabetic, all insulin-treated type 2 diabetics, patients with history or evidence of chronic complication like gastro-paresis were all excluded. Healthy volunteers who were not currently on any drug known to affect carbohydrate metabolism, with no known family history of diabetes mellitus, BMI <30 kg/m^2 and aged between 20 and 50 years were also included in the study. The protocol was submitted to the institutional ethics committee for review and approval.

The test meals were prepared by the dietetics unit of the hospital. The meals and ingredients were bought at the same time, from the same source and prepared by the same dietitian. The components of the meals were calculated from food tables to provide equivalent 50 g of carbohydrate (13). Pap was prepared from corn flour. A single brand of cornflakes was bought from open market and about 50 g carbohydrate equivalent portion was calculated from the food table on the pack. Boiled and roasted corn meals were prepared from fresh corn as appropriate.

All the 32 participants, 16 type 2 diabetics and 16 non-diabetics subjects took different meal each test day of the week till all the different meals had been tested over a four week period. All the 16 non-diabetic subjects took an oral glucose tolerance test (OGTT) with 50 g of anhydrous glucose at the start of the study after they had been on unrestricted diet containing at least 150 g of carbohydrates per day for at least 72 hours prior to the test. They were also requested to abstain from smoking, strenuous physical activity and ingestion of alcohol 2 days before the test. All participants were requested to observe an overnight fast before taking the test meal, diabetic subjects were told to take their usual doses of oral hypoglycemic agents during the study period. Subjects on glibenclamide or rosiglitazone took the medication 30 minutes before study meals consumption while those on metformin took the drug at the end of meal consumption. The participants were made to sit and rest for at least 30 minutes before commencement of the test procedures. An indwelling cannula was kept patent with heparinized saline was introduced into a forearm vein of each participants. Baseline blood samples for fasting blood glucose were then taken from each subject. Test meals were served warm in disposable plates and consumed over a period of 10-15 minutes followed by drinking 250 ml of water. Blood samples were collected at half hourly intervals for two hours for the measurement of plasma glucose.

The software used for the analysis was SPSS (version 16), quantitative variables were expressed as mean + standard error of mean (mean + SEM). The differences between means were tested with Student's t test. The level of statistical significance was taken as p value ≤0.05.

Results

The results showed that the participants in the two groups were similar in their demographic and anthropometric profiles except for the mean waist circumference which was significantly higher in participants with diabetes compared with non-diabetics subjects. Two female diabetics and two female non-diabetics dropped out during the study period due to discomfort from repetitive venipuncture and the inconvenience of follow-up (Table 1).

The mean fasting plasma glucose (FPG) level for non-diabetic subjects assessed before serving them the test meals were within the normal limits (<110 mg/dl), the levels among the diabetic subjects were higher compared with non-diabetics. Cornflakes had the highest post-prandial glucose response among all the corn meals. The plasma glucose levels peaked at 60 minutes for all test meals in the non-diabetics and the 2 hour postload glucose (2HPPG) levels were comparable to the corresponding FPG levels, see Figure 1.

The calculated GI for the corn meals in the non-diabetic was as follows: pap: 71.7% (±14.4), roasted corn: 76.5% (±14.9), boiled corn: 82.2% (±14.9) and cornflakes: 88.1% (±14.4). The plasma glucose response indices showed that pap has best profile with the least maximum increase in plasma glucose and least incremental area under glucose curve (IAUC) among subjects with diabetes (Table 2).

Discussion

The study demonstrated that corn meal in its different forms has a high GI and that the GI for corn meal differs according to how the meal is prepared. This finding is important because it will guide health care workers involved in the management of patients with diabetes to make appropriate recommendation on the best way to prepare corn meals for dietary control and management of diabetes. GI is the extent to which a test food raises the blood glucose level compared to how much the level is raised by an equivalent amount of pure glucose (14,15). GI is determined by calculating the ratio of the IAUC for a reference meal (usually 50 g of pure glucose) to that of an equivalent amount of a test meal (16,17). A food is considered to have a high GI if its response is more than half the value of that of glucose (12). The classification of GI is as follows; low GI: <55%, medium GI: 55-69% and high GI: >70%.

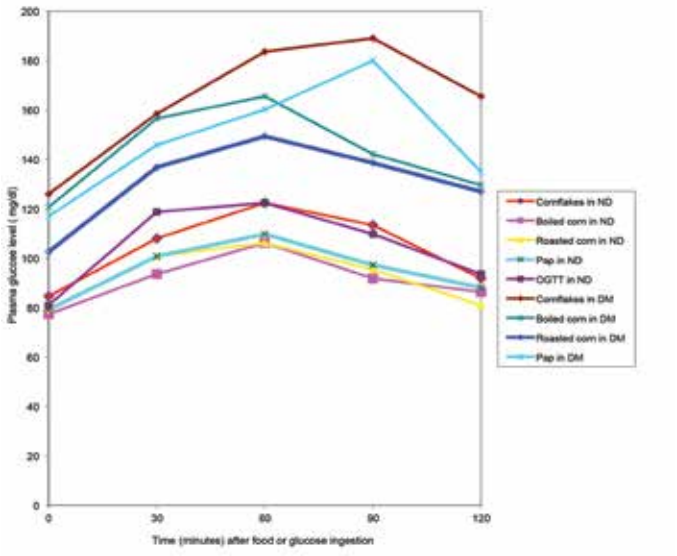

Figure 1. Baseline and the timed glycaemic profiles of subjects with diabetes and non-diabetics to different preparation of corn meal

Table 1. Baseline characteristics of diabetics and non-diabetics participants

Characteristics	Means (SEM)		
	Non diabetic	Type 2 diabetic	P value
Sex			
Male	6	5	
Female	10	11	0.7
Age (years)	44.9 (1.7)	44.6 (1.7)	0.9
BMI (kg/m^2)	26.1 (0.8)	25.3 (0.8)	0.5
Waist circumference (cm)	82.7 (2.4)	93.1 (2.4)	0.001
WHR	0.88 (0.02)	0.9 (0.02)	0.3
Duration of DM (months)	-	78.8 (19.6)	

BMI: Body mass index, WHR: Waist circumference to hip ratio, DM: Diabetes mellitus

Knowing the GI of a food is important because diet has been implicated in the aetiology of type 2 diabetes among people with high risks for the disease (18). Caloric intake in excess of requirements is known to contribute to developing obesity which is a known risk factor for the disease (18). The different GI of various corn meal preparations is lowest for pap, this is prepared from a processed corn flour and highest for cornflakes another processed corn product. Cornflakes have the highest peak plasma glucose and the highest maximum increase in plasma glucose which suggests that cornflakes are not ideal meal for diabetics. Among the non-diabetics, cornflakes also had worse glycemic profile. The better GI of pap compared to the other corn meal preparations may be explained by the fact that it has a low fat, calorie and fiber content. This may be due to the various steps in its processing such as steeping, milling and sieving which lead to substantial nutrient loss. Much of the protein in cereal grains is located in the testa and germ which are usually sieved off during processing. Studies have shown that processing grains modifies their glycemic index profiles (19,20). Milling of wheat serves to separate them into different components such as bran, germ and endosperm producing a finely ground flour (21,22). Bread made from finely ground whole-meal flour has a GI of 71±2%, this average was from 13 different studies, and it is not different from the GI of white bread (23). In contrast, bread containing a substantial proportion of whole or cracked wheat kernels has a GI some 20-30% lower than white bread (23). In a study by Fasanmade and his co-worker in Ibadan, South-Western Nigeria, they reported that the GI for maize flour

Table 2. Glycemic response indices of corn meals in persons among diabetic and non-diabetic participants

	Mean (SEM)		
PGRI	Non-diabetic	Type 2 diabetics	P value
Cornflakes			
PPG (mg/dl)	129.6 (5.4)	199.8 (5.4)	0.00001`
MIPG (mg/dl)	45 (5.4)	73.8 (5.4)	0.00172
IAUGC (mmol*min/l)	157.4 (26.2)	292.6 (26.3)	0.00089
Roasted Corn			
PPG (mg/dl)	115.2 (5.4)	160.2 (9)	0.00005
MIPG (mg/dl)	36 (3.6)	55.8 (9)	0.00127
IAUGC (mmol*min/l)	125.3 (19)	217.4 (27)	0.00199
Boiled Corn			
PPG (mg/dl)	111.6 (9)	1692 (9)	0.00007
MIPG (mg/dl)	37.8 (5.4)	48.6 (5.4)	0.18911
IAUGC (mmol*min/l)	114.3 (16.2)	181 (16.2)	0.00746
Pap			
PPG (mg/dl)	117 (5.4)	169.2 (7.2)	0.00001
MIPG (mg/dl)	37.8 (5.4)	48.6 (5.4)	0.02717
IAUGC (mmol*min/l)	121 (12.7)	186 (25)	0.02022

PGRI: Plasma glucose response indices, MIPG: Maximum increase in plasma glucose, PPG: Peaked plasma glucose, IAUGC: Incremental area under glucose curve

was 54.83±26.74% and 26.61±11.33% in diabetic and non-diabetic subjects, respectively (16). The GI was lower than the 71±14.4% recorded in non-diabetics in our study. This may be explained by the fact that the meal prepared from maize flour in their study was served with a soup of a vegetable leaf specie (Corchorus olithorus), tomato sauce and 25 g of boiled beef meat (16). In another study in Philippines on healthy volunteers, the GI for boiled corn meal prepared from a variety of maize known as the quality protein maize was 80.29±17.11%. The finding in the Philippines study is similar to the result of GI for boiled corn in our study which was 82.2±14.9% (24). Ekpebegh in his work on assessment of glycemic response to meals prepared from sorghum and maize among Nigerian males reported that glycemic response to these meals was attenuated because they were prepared mixed with bean products (25). These effects are probably due to the high fiber content in the bean covering like in all legumes (13,26).

The finding that the FPG and the 2HPPG levels in all the non-diabetic subjects were within normal range confirmed that they were all glucose tolerant. The mean fasting glucose levels in subjects with diabetes were also within normal range. This is explained by the fact that they were all well-controlled on their regular doses of oral hypoglycemic agents.

Different methods of preparing corn meal affect its glycemic response. This study showed that cornflakes may not be an ideal corn meal preparation for diabetics; it had the highest glycemic response among all the tested corn meal preparations. Its consumption should be in a measured quantity. Pap had the lowest GI and we therefore recommend it as the ideal corn meal preparation. In line with the reports from other studies, taking corn meal mixed with vegetables lowers their glycemic response and should be the preferred form of serving the meal.

Acknowledgments

This work was part of a dissertation submitted to the National Postgraduate Medical College of Nigeria in partial fulfillment of the requirements for the award its Fellowship in Internal Medicine with sub-specialization in Endocrinology and Metabolism.

Ethics Committee Approval: It was taken, **Informed Consent:** It was taken, **Concept:** Akinola Dada, Sunday Ogundele, Olufemi Fasanmade, Anthonia Ogbera, Augustine Ohwovoriole, **Design:** Akinola Dada, Olufemi Fasanmade, Anthonia Ogbera, Augustine Ohwovoriole, **Data Collection or Processing:** Akinola Dada, Sunday Ogundele, Olufemi Fasanmade, Augustine Ohwovoriole, **Analysis or Interpretation:** Akinola Dada, Sunday Ogundele, Olufemi Fasanmade, Anthonia Ogbera, Prof Ohwovoriole, **Literature Search:** Akinola Dada, Sunday Ogundele, **Writing:** Akinola Dada, Sunday Ogundele, Olufemi Fasanmade, Augustine Ohwovoriole, Anthonia Ogbera, **Peer-review:** External and Internal peer-reviewed, **Conflict of Interest:** No conflict of interest was declared by the authors, **Financial Disclosure:** The authors declared that this study has received no financial support.

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