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Glycemic responses of local beans (Vigna unguiculata [Linn Walp] varieties) in persons with Type 2 diabetes mellitus and healthy controls - An experimental study

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ABSTRACT

Background: Medical nutrition therapy is an important aspect of managing diabetes mellitus (DM). Foods with low glycemic index are encouraged in individuals with DM. Despite the good glycemic indices associated with beans, glycemic responses of bean meals in persons with DM is unknown. The aim of this study is to determine whether there are differences in the glycemic responses of local beans (Vigna unguiculata [Linn Walp] varieties) in persons with Type 2 DM (T2DM) and healthy controls. Methods: This was an experimental study done at Lagos University Teaching Hospital over 12 weeks. Twelve consenting T2DM persons and 12 healthy controls participated in this study. Peak plasma glucose (PPG), the maximum increase in plasma glucose (MIPG), 2-h postprandial glucose (2HPPG), and incremental area under glucose curve (IAUGC) of three different varieties (V. unguiculata [Linn Walp] varieties) “oloyin,” “drum” and “sokoto white” were measured. Results: Among healthy participants “oloyin” bean meal had the lowest values of PPG, MIPG, and IAUGC, while “drum” bean meal had the highest values of MIPG and IAUGC (P = 0.039). Among persons with DM, “oloyin” bean meal had the highest 2HPPG, PPG but lowest MIPG values when compared with other bean meals while “drum” bean meal had the highest MIPG and IAUGC with the lowest 2HPPG of the three-bean meals. Conclusion: There were differences in the glycaemic responses of V. unguiculata (Linn Walp) varieties studied in persons with T2DM and controls. Glycaemic responses, in addition to glycemic indices of meals, should be considered in the management of persons with DM.

Key words: Beans (Vigna unguiculata [Linn Walp] varieties), diabetes mellitus, glycemic index, glycaemic response

INTRODUCTION

The role of diet or medical nutrition therapy cannot be overemphasized in nonpharmacologic approach to managing diabetes mellitus (DM). With the increasing global prevalence of DM, which is expected to be over 64.2 million in 2040,¹² prevention and or decreasing the new incidence of diabetes is essential. One of the ways of preventing a new incidence of DM is lifestyle modification, which includes a healthy low caloric, low-fat

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Beans as a meal have been shown to be one with low glycemic index, which fits the recommendation of the diabetes prevention study. The low glycemic index of beans is not the only important parameter or component of glycemic response but others such as the maximum increase in plasma glucose (MIPG), peak increase in plasma glucose, and 2 h postprandial glucose (2HPPG) responses are equally important. Even though attention is focused on glycemic index of a meal, which is one of the glycemic responses obtained, other aspects of glycemic responses should be given attention to prevent the development of disease processes and/or prevent complications.

Beans (Vigna unguiculata L. Walp), is one of the most important crops native to Africa, which can be grown in all types of soil, but best suited to sandy and sandy loam soils. The warm and moist climate of the tropics support the cultivation of the crop. In Nigeria, beans are majorly produced in the North in the savannah belt due to light rainfall. Beans production in the world in 2002 was estimated to be 2.27 million tons, of which Nigeria produces about 850,000 tons. Nigeria is one of the major consumers of beans in the world.

Despite beans being a low glycemic index meal, what appears to be unknown is the glycemic responses (plasma glucose excursion) following beans meal consumption and how it affects persons with DM and or prediabetes individuals.

This study aims to evaluate the glycemic responses of local beans (V. unguiculata [Linn Walp] varieties) in persons with Type 2 DM (T2DM) and healthy controls.

**METHODS**

This experimental study was conducted at Lagos University Teaching Hospital (LUTH), one of the tertiary hospitals in Lagos State, Southwest Nigeria. The study was conducted over a period of 12 weeks. It was approved by the Health Research and Ethics Committee of LUTH, and the guidelines of the declaration of Helsinki ethical principles of human research were followed.

The selection of the study participants was made by a multi-stage random sampling method. Sixty-two T2DM patients were selected by balloting from the DM register of the Endocrinology, Diabetes, and Metabolism (EDM) unit, as shown in Figure 1. Fifteen patients who were either older than 65 years or on insulin therapy in addition to other medications from the DM register were excluded, while seven patients were unavailable for interviews. Of the 40 T2DM interviewed, fourteen patients declined consent while five patients did not like bean meals and one patient was breastfeeding.

The twenty consenting T2DM subjects who met the inclusion criteria had their clinical, anthropometric, and biochemical measurements recorded into the study data forms. Fourteen T2DM participants were randomly assigned to the three varieties of bean meals on a weekly basis, while six patients were excluded on the first procedure day due to late arrival or nonadherence to pretest instructions. Twelve T2DM participants completed the study.

The non-DM (healthy) participants who met the inclusion criteria were recruited by purposive nonprobability sampling method, as stated below. Fifty-five apparently healthy individuals were invited with only thirty-six interviewed, as shown in Figure 2. Fifteen persons were excluded due to a family history of DM, no consent, or younger age (<30 years). Of the twenty-one persons who consented and had clinical, anthropometric, and biochemical measurements done, 15 individuals were randomly assigned to the three-bean meals and 50 g of glucose challenge test on a weekly basis. Twelve apparently healthy persons completed the study as three individuals withdrew from the study.

Inclusion criteria for persons with T2DM included consenting adults diagnosed with T2DM and age between 30 and 65 years, controlled on diet and exercise, with or without oral glucose lowering agents; while inclusion criteria for apparently healthy participants include age 30–65 years, apparently healthy individual without DM, no history of smoking or recent history of alcohol consumption. Exclusion criteria for persons with T2DM included individuals with age below 30 years and age above 65 years, T1DM patients, T2DM who were pregnant or lactating, T2DM subjects with gastrointestinal disturbances such as intolerance to milk and beans meals, malabsorption or diarrheal illnesses and finally individuals who declined consent. Exclusion criteria for the apparently healthy persons included nonconsenting persons, age <30 and >65 years, first degree relatives with DM, subjects with gastrointestinal disturbances such as intolerance to milk or reacts to beans meals, malabsorption, or diarrheal illnesses.

**The procedure**

T2DM participants were randomly administered the bean meals once weekly (every Wednesday morning by 7.00 am) for 3 weeks, while the apparently healthy participants had 50 g glucose challenge tests and bean meals given randomly on a weekly basis.

Each bean meal consumed was labeled as follows:

- Oloyin = V. unguiculata (Linn) Walp variety “oloyin” beans,
- Drum = V. unguiculata (Linn) Walp variety “drum” beans,
- Sokoto white = V. unguiculata (Linn) Walp variety “sokoto white” beans.

Pretest instructions given to all consenting participants included overnight fast of at least 8 h, avoidance of
legume (such as beans, cowpea, soya beans) in the meal preceding the fast, abstain from strenuous physical exercise and alcohol consumption at least 2 days to study. They were expected to consume at least 150 g of carbohydrate daily at least 3 days before the test. “Oloyin,” “drum” and “sokoto white” beans were rinsed and cooked separately by boiling only for about 2 h until the bean seeds become soft and edible for consumption. Ingredients such as salt, pepper, palm oil, etc., were deliberately avoided.

On the procedure day, following adequate rest on arrival, under aseptic technique, each participant had an intravenous cannula inserted into a superficial vein of the cubital fossa and heparinized. Two milliliters of blood was drawn into the fluoride oxalate bottle at 0 min. Participants (both persons with DM and healthy controls) consumed 50 g of carbohydrate in each of the test meals as randomly allotted [Figures 1 and 2]. The meals were eaten within 15 min at a comfortable pace for each participant, along with 250 ml of plain water. Subsequent samples were taken at 30, 60, 90, and 120 min into fluoride oxalate bottles, and these were analyzed for plasma glucose concentration using spectrophotometer with the aid of glucose oxidase preparation supplied by RANDOX Laboratory Ltd., United Kingdom using the principle of Trinder reaction.

**Statistical analysis**

Data were collated by means of study data forms and entered into a spreadsheet on Microsoft Excel for cleaning and storage. The analysis was performed using the statistical package for IBM social science (SPSS) version 20.0 (IBM SPSS Inc., Chicago, Illinois, USA). Data distribution was done using the Kolmogorov–Smirnov and Shapiro–Wilk normality tests to determine appropriate statistical tests. Descriptive data were listed as means, medians, confidence intervals, proportions, tables, and figures. Comparisons of the clinical, biochemical and anthropometric variables between T2DM and apparently healthy participants were made using nonparametric (Mann–Whitney U) inferential statistical test. Plasma glucose of the three varieties of

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*Figure 1: Flow chart of diabetes participants*
bean meals consumed by the study participants was not normally distributed; hence, Friedman’s statistical test was used to compare the variables of the three varieties of bean meals of each group (T2DM and apparently healthy participants). Thereafter, Wilcoxon signed-rank post hoc test with Bonferroni correction⁹ were carried out to identify the bean meal(s) with a statistical significant difference.

Definition of terms
- “Drum” bean: means *V. unguiculata* (Linn) Walp variety “drum”
- Glycemic Response: Glycemic response will be assessed by 2 h postprandial (2HPP), MIPG and peak plasma glucose (PPG)
- Incremental area under glucose curve (IAUGC) is the cumulative changes in the postprandial plasma glucose for the test meal or glucose load, which is calculated by the trapezoidal rule with fasting concentration as the baseline and truncated at zero
- MIPG: refers to the difference between the peak glucose level and the fasting plasma glucose level
- “Oloyin” bean: means *V. unguiculata* (Linn) Walp variety “oloyin”
- “Sokoto white” bean: means *V. unguiculata* (Linn) Walp variety “sokoto white”
- 2HPPG: refers to plasma glucose measurement 2 h after meal consumption.

RESULTS
A total of 117 (62 T2DM and 55 healthy controls) subjects were invited to participate in this study. The T2DM subjects were selected by a simple random sampling method, of which 42 were excluded as they did not meet the inclusion criteria. Of the 20 T2DM patients who gave consent, six were unable to participate, as shown in Figure 1. Twelve patients completed the study.

Fifty-five healthy controls were invited, as detailed in Figure 2. Thirty-six individuals presented for interview and screening. Twenty-one subjects were excluded, while 15 participants were assigned to the study meal.
Recruitment details are in Figures 1 and 2 for the study participants.

Twenty-three participants comprising eleven persons with T2DM and twelve apparently healthy individuals completed the study. Their ages ranged from 40 to 60 years with median ages of the DM and apparently healthy groups being 53.0 years and 50.5 years (Z = −0.617, P = 0.537), respectively [Table 1]. The average anthropometric values of the DM and the apparently healthy groups were not statistically significant different from each other [Table 2].

The glycaemic response to "oloyin," "drum" and "sokoto white," bean meals in healthy participants are shown in Table 3. "Oloyin" bean meal had the lowest values of PPG, MIPG and IAUGC while "drum" bean meal had the highest values of MIPG and IAUGC. There were statistically significant differences in the IAUGC of the three varieties of the three-bean meals ($\chi^2[2] = 6.500$, $P = 0.039$). The glycaemic response indices of the studied bean meals in persons with DM are shown in Table 4. "Oloyin" bean meal had the highest 2HPPG, PPG but lowest MIPG values when compared with other bean meals while "drum" bean meal had the highest MIPG and IAUGC with the lowest 2HPPG of the three bean meals.

**Post hoc** analyses with Wilcoxon signed-rank tests were conducted for the statistically significant glycaemic response (IAUGC) with Bonferroni corrections applied resulting in a significance level set at $P < 0.017$. Following **post hoc** analysis with Bonferroni corrections, there was a statistically significant difference between IAUGC of "oloyin" bean meal and "drum" bean meal of the apparently healthy participants [Table 5]. Among persons with DM, there was no statistically significant difference between IAUGC of "oloyin" bean meal and "sokoto white" bean meal or between "drum" bean meal and "sokoto white" bean meal. However, there was a statistically significant difference between IAUGC of "oloyin" bean meal and "drum" bean meal.

**DISCUSSION**

Glycaemic response to the bean meals were assessed by PPG, MIPG, 2HPPG, and Incremental area under plasma glucose curve (IAUGC).

### Table 1: Clinical and biochemical characteristics of the study participants

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Nondiabetic participants (n=12)</th>
<th>Persons with diabetes (n=11)</th>
<th>Mann-Whitney U-test</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>50.5 (45.5-55.5)</td>
<td>53.0 (48-56)</td>
<td>−0.617</td>
<td>0.537</td>
</tr>
<tr>
<td>Sex, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>8 (66.7)</td>
<td>7 (63.6)</td>
<td>0.023</td>
<td>0.879</td>
</tr>
<tr>
<td>Male</td>
<td>4 (33.3)</td>
<td>4 (36.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HbA1c (%)</td>
<td>4.85 (4.55-5.60)</td>
<td>6.7 (5.7-7.6)</td>
<td>−3.204</td>
<td>0.001</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>120 (115-130)</td>
<td>130 (120-140)</td>
<td>−1.112</td>
<td>0.128</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>80 (70-84)</td>
<td>80 (70-90)</td>
<td>−0.612</td>
<td>0.541</td>
</tr>
<tr>
<td>FPG (mg/dL)</td>
<td>91.5 (82.5-98)</td>
<td>121 (108-157)</td>
<td>−3.418</td>
<td>0.001</td>
</tr>
<tr>
<td>Duration of DM (months)</td>
<td>-</td>
<td>96.0 (48-168)</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Values are expressed as median (95% CI). P<0.05 is statistically significant. CI=Confidence interval, BMI=Body mass index, WC=Waist circumference, WHR=Waist circumference-to-hip circumference ratio

### Table 2: Anthropometric indices of the study participants

<table>
<thead>
<tr>
<th>Variables</th>
<th>Study participants</th>
<th>Mann-Whitney U-test</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (m)</td>
<td>1.65 (1.59-1.66)</td>
<td>1.65 (1.60-1.73)</td>
<td>47.500</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>78 (72-82)</td>
<td>70.0 (69-91)</td>
<td>60.500</td>
</tr>
<tr>
<td>BMI (kg/m$^2$)</td>
<td>29.1 (26.2-31.6)</td>
<td>27.6 (23-30.4)</td>
<td>−0.555</td>
</tr>
<tr>
<td>WC (cm)</td>
<td>98 (85.5-100.5)</td>
<td>101 (88-109)</td>
<td>−1.112</td>
</tr>
<tr>
<td>WHR</td>
<td>0.90 (0.84-0.93)</td>
<td>0.94 (0.87-0.98)</td>
<td>−1.762</td>
</tr>
</tbody>
</table>

Values are expressed as median (95% CI). CI=Confidence interval, BMI=Body mass index, WC=Waist circumference, WHR=Waist circumference-to-hip circumference ratio

### Table 3: Glycemic responses in apparently healthy participants

<table>
<thead>
<tr>
<th>Response index</th>
<th>Median (95% CI)</th>
<th>Friedman test</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPG (mg/dL)</td>
<td>88 (81.5-98.0)</td>
<td>2.667</td>
<td>0.264</td>
</tr>
<tr>
<td>2HPP (mg/dL)</td>
<td>91.5 (85-98.5)</td>
<td>0.128</td>
<td>0.938</td>
</tr>
<tr>
<td>PPG (mg/dL)</td>
<td>102.5 (96.5-106.5)</td>
<td>1.830</td>
<td>0.401</td>
</tr>
<tr>
<td>MIPG (mg/dL)</td>
<td>15.5 (10-20.5)</td>
<td>3.500</td>
<td>0.174</td>
</tr>
<tr>
<td>IAUGC (×10), mg/min/dL</td>
<td>31.03 (15.84-63.00)</td>
<td>6.500</td>
<td>0.039</td>
</tr>
</tbody>
</table>

Values are expressed as median (95% CI). *P<0.05 is statistically significant. CI=Confidence interval, PPG=Fasting plasma glucose, PPG=Peak plasma glucose, MIPG=Maximum increase in plasma glucose, 2HPP=2 h postprandial, IAUGC=Incremental area under glucose curve, GI=Glycemic index
Peak plasma glucose response to bean meals

PPG is a reflection of the impact of carbohydrate load on glucose excursion. It is affected by the meal composition, activity, insulin sensitivity, and gastric emptying rate. In this study, among nondiabetic participants, the median plasma glucose response peaked at 60 min after consumption of “oloyin,” “drum” and “sokoto white” bean meals as observed in similar studies.[7,8] Ascending median levels of PPG to “oloyin,” “drum” and “sokoto white” bean meals (sokoto white > drum > oloyin) were observed among the nondiabetic participants. The PPG of the bean meals were all lower than the mean PPG levels after 50 g of anhydrous glucose challenge test.

Among the DM participants, the PPG levels were higher, delayed, and sustained compared to the nondiabetic participants. The pattern of median PPG levels among the DM participants in ascending order were observed to be the three-bean meals; “drum,” “sokoto white” and “oloyin” (oloyin > sokoto white > drum). The observed higher PPG levels of “oloyin” bean meal compared to other bean meals among persons with diabetes could be attributed to a higher fasting plasma glucose before “oloyin” bean meal in comparison to the FPG before “drum” and “sokoto white” bean meals. Contrary to expectations, this study did not find a significant difference between the PPG levels of the bean meals in both nondiabetic and diabetic participants.

In the context of current knowledge, PPG values obtained among nondiabetic participants were consistent with findings obtained by Ohwovoriole and Johnson[9] following consumption of beans, “doda,” yam and rice. The PPG of the bean meals were lower than the fruit meals served to normal glucose tolerant individuals by Edo et al.[12] except for banana meal. This could be attributed to the rate of release of carbohydrates within the fruits. Dada et al.[11] reported higher PPG levels after corn meals in nondiabetic participants. The difference in the PPG of the bean meals compared to the corn meals may be attributed to the higher content of fibers in bean meals[11] and the method of cooking or processing of the corn meals.

It is encouraging to note that there were similarities in the PPG levels of the bean meals of the diabetic participants when compared with the PPG levels after boiled corn and pap meal consumption by diabetic participants[11] and after consumption of pineapple meal in Edo et al.’s study.[12] However, Ohwovoriole and Johnson[9] reported higher PPG in the diabetic group. Most likely consequent on the withdrawal of oral agents for 2 days and omission of insulin injection on the study day.

Maximum increase in plasma glucose response to bean meals

MIPG in non-DM participants did not show any significant difference among the bean meals but was observed in ascending order as “oloyin” followed by “sokoto white” and “drum” bean meal (drum > sokoto white > oloyin).

In persons with DM, the median MIPG levels were observed to be ascending from “oloyin” to “sokoto white” and “drum” bean meals (drum > sokoto white > oloyin). The possible explanation for the difference in the MIPG of the bean meals could be due to the types of carbohydrate and fibers present in the beans. Glycosylated hemoglobin which is the gold standard for glycemic control, correlates with MIPG of meal. The finding of “oloyin” bean meal with the lowest MIPG in comparison with other bean meals will help in

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**Table 4: Glycemic response in diabetic participants**

<table>
<thead>
<tr>
<th>Response index</th>
<th>Median (95% CI)</th>
<th>Friedman test</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>“Oloyin”</td>
<td>“Drum”</td>
<td>“sokoto white”</td>
</tr>
<tr>
<td>FPG (mg/dL)</td>
<td>141 (121-171)</td>
<td>115 (111-152)</td>
<td>128 (117-171)</td>
</tr>
<tr>
<td>2HPP (mg/dL)</td>
<td>156 (136-165)</td>
<td>148 (129-171)</td>
<td>136 (116-183)</td>
</tr>
<tr>
<td>PPG (mg/dL)</td>
<td>175 (141-185)</td>
<td>167 (143-180)</td>
<td>169 (126-193)</td>
</tr>
<tr>
<td>MIPG (mg/dL)</td>
<td>23 (16-41)</td>
<td>41 (28-57)</td>
<td>29 (15-52)</td>
</tr>
<tr>
<td>IAUGC (mg/min/dL)</td>
<td>29.23 (10.92-55.95)</td>
<td>50.78 (26.71-77.44)</td>
<td>22.98 (10.91-103.26)</td>
</tr>
</tbody>
</table>

There was statistically significant difference in the IAUGC of the three varieties of the three-bean meals (χ²(2)=8.727, P=0.013) using Friedman’s test. Values are expressed as median (95% CI); χ²<0.05 is statistically significant. CI=Confidence interval, PPG=Peak plasma glucose, MIPG=Maximum increase in plasma glucose, 2HPP=p-2 h post prandial, IAUGC=Incremental area under glucose curve, GI=Glycemic index

**Table 5: Post hoc analyses with Bonferroni corrections of significantly different responses**

<table>
<thead>
<tr>
<th>Study participants</th>
<th>Statistically significant response index</th>
<th>Comparison of bean meals</th>
<th>Wilcoxon signed rank post hoc analysis (Z)</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-DM</td>
<td>IAUGC</td>
<td>“Oloyin”&gt;“drum”</td>
<td>-2.667</td>
<td>0.008†</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“Oloyin”&gt;“sokoto white”</td>
<td>-3.334</td>
<td>0.028</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“Drum”&gt;“sokoto white”</td>
<td>-1.412</td>
<td>0.158</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“Oloyin”&gt;“drum”</td>
<td>-2.401</td>
<td>0.016†</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“Oloyin”&gt;“sokoto white”</td>
<td>-0.711</td>
<td>0.677</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“Drum”&gt;“sokoto white”</td>
<td>-1.205</td>
<td>0.223</td>
</tr>
</tbody>
</table>

†Bonferroni correction applied resulting in a significance level of P value set at < 0.027. IAUGC=Incremental area under glucose curve, GI=Glycemic index, DM=Diabetes mellitus, Non-DM=Nondiabetes mellitus
the dietary management of persons with DM who require intensive control to achieve better glycemic control.

The finding of the median MIPG among control subjects is similar to the mean MIPG after fruits meal in Edo et al.’s study. These could be attributed to similarities in the quantity of fiber contents in the studied fruits, which ranges from 1.8–3.9 g as to 2.22–3.20 g in 100 g of the dry weight of the studied beans. The MIPG of the bean meals in this study were lower than the mean MIPG after boiled yam meal, pounded yam, and cooked yam flour (referred to as “amala” in the local Yoruba dialect) meal in apparently healthy individuals in a study by Jimoh et al. Possible explanations for these differences might be the type of carbohydrate present within in the yam flour and pounded yam and the processing methods of the yam preparation.

Corn (maize) is known to be a rich source of high crude fibers as seen in the study by Fasanmade and Anyakudo. The mean MIPG of corn meals reported by Dada et al. in nondiabetic participants were higher than what was obtained after bean meals. The differences in MIPG of the corn meals were attributed to the method of cooking and processing (such as removal of the pericarp of the corn which contains about 87% of the fiber in the corn) of the corn which eventually leads to alteration and or loss of the fiber in the corn meals.

The results of MIPG to bean meals among DM participants have not been previously described. However, the MIPG of “oloyin” and “sokoto white” bean meals were lower than the mean MIPG after pawpaw meal, orange meal, and pineapple meal. MIPG of “drum” bean meal is compared to the MIPG of banana. These differences could be explained by the amount and probably the type of fibers in the bean meals affecting the absorption of the carbohydrate in the meal. In Dada et al.’s study of persons with DM, mean MIPG of corn meals were higher than the MIPG of the studied boiled beans. The processing of the meals and the cooking methods are some of the reasons accounting for the differences between the bean meals and corn meals. One of the issues that emerge from this finding is that though no significant difference in the MIPG of the bean meals, however glucose excursion by “drum” bean meal may be significant when consumed in large quantity in comparison to other meals.

Two-hour postprandial glucose response to bean meals

The results of this study did not show any significant difference in the 2HPPG of the three-bean meals among non-DM participants although in ascending order, “drum” bean meal was lower than “oloyin” bean meal while “sokoto white” had the highest value (sokoto white > oloyin > drum). On the question of 2HPPG among DM participants, this study found no significant difference in the three-bean meals (oloyin > drum > sokoto white). The 2HPPG of the persons with diabetes was higher than that of participants without DM. These findings help us to understand that despite bean meals being a low glycaemic index diet, caution must be taken when prescribing dietary plan for persons with DM.

Incremental area under the glucose response curve to bean meals

The most interesting finding among nondiabetic participants was that “drum” bean meal had the highest median IAUGC while “oloyin” bean meal had the lowest median IAUGC. “Sokoto white” bean meal occupied the middle position (drum > sokoto white > oloyin). These values are lower than IAUGC for 50 g glucose. There were significant differences in the IAUGC of “oloyin” bean meal compared to “drum” bean meal, as shown in Table 3. The possible reason for the difference in IAUGC might be due to the type of carbohydrate, fats and anti-nutritional factor composition of the beans. There were no wide differences in the fiber content of the two beans. There was no statistically significant difference in the IAUGC of “oloyin” compared to “sokoto white” bean.

In the DM participants, the highest IAUGC was after “drum” bean meal and the lowest was after “sokoto white” bean meal. “Oloyin” bean meal IAUGC is in the middle position (drum > oloyin > sokoto white). There was an insignificant difference between the IAUGC of “oloyin” bean meal and “drum” bean meal as seen in Table 4. One of the issues that emerged from this finding is that there is consistency in IAUGC of the bean meals between the diabetic and nondiabetic participants. It implies that there are differences in the nutritional composition of the studied beans and identifying the types of fibers and carbohydrates present in these beans will be of benefit to the research world. These results provide further support disapproving the hypothesis that there are no differences in the glycemic response of the bean meals. The higher IAUGC in the diabetic participants compared to nondiabetic participants is probably due to differences in the beta cells function of the study participants.

Although the IAUGC values for the bean meals and glucose challenge test differs from some previous research works, they are consistent with those of Rasmussen et al. The difference in the IAUGC values in this study compared to other studies is not clear, but it may have something to do with the method of calculating the area under curve. The most common method of calculating IAUGC is the trapezoidal rule. Others are the Simpson’s integration, polynomial interpolation of third- and fourth-degree and cubic interpolatory splines. Values obtained from the use of trapezoidal rule varies depending on the mathematical methods employed; that is, whether the net incremental area under the curve, positive incremental area under curve or is total AUC with or without baseline was done.
CONCLUSION

V. unguiculata (Linn) Walp variety “sokoto white,” V. unguiculata (Linn) Walp variety “oloyin,” V. unguiculata (Linn) Walp variety “drum” are varieties of beans with low glycemic index[3] and varied glycaemic responses. This study revealed that there are significant differences in the various parameters of glyemic responses measured between persons with T2DM and healthy individuals, which is a reflection of the state of the beta cells. MIPG was significantly high following “drum” bean meal as compared with other bean meals studied in both persons with T2DM and healthy controls. This significant differences in both cohort were probably due to the fiber contents which were higher in “sokoto white” and “oloyin” beans and the probably the type of carbohydrate each bean contain. MIPG has a direct impact on the outcome of 2HPPG and Incremental area under the plasma glucose curve (IAUGC), which is used to determine glycemic index. PPG was higher and sustained in people with T2DM compared to the healthy controls, and this study revealed that PPG is affected by the fasting plasma glucose.

Consumption of large quantities of low glycemic index meal such as V. unguiculata (Linn) Walp varieties “oloyin,” “sokoto white” and “drum” beans without restriction could be counter-productive in managing individuals with cardiovascular diseases such as DM.

Limitation of the study

This study has given us insight into the glycemic responses of V. unguiculata (Linn) Walp, but knowing the composition of the carbohydrate content of each bean would have provided better information on how it impacts each parameter of the glycemic response.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES