GLYCAEMIC INDEX OF THREE COCOYAM VARIETIES CONSUMEDIN IMO STATE, NIGERIA

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ABSTRACT

Background: Diabetes mellitus (DM) especially T2DM caused by defects in insulin secretion and / or action affects carbohydrate, fat and protein metabolism. This effect results to chronic hyperglycemia with high prevalence of morbidity, mortality and loss of quality of life. Carbohydrate foods have the highest influence on blood glucose and the goal of diabetes management is to achieve adequate glycemic control.

Objective: The main objective is to determine the glycemic index, glycemic load and glycemic response of three cocoyam varieties; red cocoyam *(x. sagittifolium*) the white cocoyam *(X. Atrovirens)* and *Ede Anambra"* (*colocasiaesculentavarantiquorum*) on healthy subjects.

Methods: Thirty non diabetic young adult volunteers were recruited for the study. The study was carried out in the food laboratory, Department of Nutrition and Dietetics, Imo State University Owerri for a period of three days. The subjects were randomly grouped into three. A cross-sectional study design was adopted. Cocoyam and medical materials were procured from Owerri main market. Selection of the subjects was based on the exclusion criteria and consent. The subjects were grouped into three to accommodate 10 participants for each group of cocoyam variety. The subjects were blinded on the variety of cocoyam they consumed. Anthropometric measurement was carried out on the first day. Fasting blood sugar was carried out before and after feeding the reference food after an overnight fast of 10 hours at 0, 30, 60, 90, 120 minutes on the second day. Feeding of the test food was carried out on the third day. Blood glucose level was measured by qualified medical laboratory scientists before and after feeding at 0, 30, 60, 90, 120 min. Glycemic index (G.I) was determined using a standard method with glucose as the reference food. 50g available carbohydrate portions of the cocoyam were given to volunteers. Data were analyzed using statistical package for social sciences (SPSS) version 20.0.

Results: Mean age of the subjects was 23.6 $\pm$1.52 years and mean BMI was 22.42$\pm$2.69kg/m^2. G.I of Red cocoyam was (57), white cocoyam (55), *Ede Anambra* (67) and glucose (100). The glycemic response of glucose was highest, followed by the red cocoyam, white cocoyam, and *ede Anambra.* The glycemic load of cocoyam varieties reported red cocoyam (8.6), white cocoyam (8.2), and *ede Anambra* (10) while glucose (15).

Conclusion: The GI of the cocoyam varieties studied shows medium GI, low GL and moderate GR. Cocoyam cold be used
in prevention and management of diabetes and should be recommended to over-weight, obese and diabetic individuals.

Key words: cocoyam, glycemic index, diabetes, glycemic load

INTRODUCTION

Glycaemic Index (G.I) is a numerical scale used to indicate how fast and how high a particular food can raise blood glucose level (1). GI is defined as the "area under glucose response curve after the consumption of 50g carbohydrate from a test food divided by area under curve after consumption of 50g carbohydrate from a control food (glucose or white bread)" (2). When carbohydrate food is eaten, the sugar (glucose) from the food breaks down during digestion, blood glucose rises and energy is released. The rate at which blood glucose rises after food consumption is called the glycemic response (3). Carbohydrate that breakdown quickly during digestion have a high G.I because their B-glucose response is fast and high. Carbohydrate that breaks down slowly has a low G.I (4). For healthy eating particularly in persons with diabetes, obesity and insulin resistance, foods with low G.I are recommended as they may help keep the euglycemia and normal spectrum of lipoproteins (1, 4, 5, 6). These effects result in decreased cardiovascular danger and probably reduced risk for colon and breast cancer (7).

The red cocoyam *(x. sagittifolium*) belongs to the *Xanthosoma* species which is generally referred to as Tannia, the white cocoyam *(X. Atrovirens)* belong to the family *Araceae* while *Ede Anambra"* (*colocasiaesculentavarantiquorum*) belongs to the colocasia species and is commonly known as Taro. They are grown primarily for their edible starch, storage corms and cormels called tubers and secondarily as a leafy vegetable (8). Cocoyam is an edible, highly nutritious and an underutilized crop. It is a staple food for millions of people living in the tropics and subtropics (9, 10). In Nigeria, cocoyam is one of the underexploited tropical root plants that is very nutritious but its utilization is still at the subsistence level and a highly neglected crop (11). The *Igbos* of Eastern Nigeria calls it *ede* while the *Yorub as* call it *kobo* and the *Hausas* of Northern Nigeria call it *gwasa* or*makani*. Cocoyam is mainly used for thickening soups while it is used by low income earners as fofo or porridge. Cocoyam may be boiled in curries or fried to make crispy chips. Raw cocoyam contains toxic compound, calcium oxalate or prussic acid which causes irritation especially in *colocasia* and *xanthosoma*. It can be destroyed by thoroughly peeling, soaking, cooking or steeping in cold water overnight before eating (12).

The prevalence of type II diabetes accounts for 90-97% of all cases of diabetes mellitus with increased attendant economic stress on the health care system (3). The risk factors attributable to type 11 diabetes includes dietary habits, obesity, genetics, smoking, sedentary lifestyle, inactivity (13), though there is little association between the risk of type II diabetes and intake of total carbohydrate (14). Blood glucose response to various diets is determined by the amount of carbohydrate they contain which led to the traditional diabetes diet plans. But, glycemic index which classifies blood glucose raising potential of carbohydrate food relating to glucose and white bread (15) has shown that foods with similar carbohydrate contents did not usually have the same impact on blood glucose level (16,17). Variety affects the glycemic index of foods (18). Though with the same variety, glycemic indices may vary probably due to differences in accessions within the same variety (19). This study evaluates the glycemic indices, response and load of three cocoyam varieties in non-diabetic young adults.

MATERIALS AND METHODS

Study Area

The study was conducted in Imo State University (IMSU), Owerri, Nigeria. The institution was established in the year 1981 through law No 4 passed by the Imo State House of Assembly Owerri. It is situated along Okigwe Road, Owerri Urban. Imo state University is an autonomous public institution with the general function of providing liberal education and encouraging the advancement of learning. Imo State University lies between latitude of 5^{0}30'13'N and longitude of 7^{0}2’37'E. There are 11 faculties with 72 department and other academic units in Imo State University (20).

Survey Design

A cross-sectional study design was adopted for the study.

Informed Consent

The study was approved by the research committee of the department. Written consent was signed by the students before commencing the study.

Population of study

Non-diabetic undergraduate students from the department of nutrition and dietetics, faculty of health sciences aged 20-30 years old constituted the population of study.

Sample selection

Advertisement on the research was done in the department of Nutrition and Dietetics, Faculty of Health Sciences. Volunteers were asked questions on general eligibility. The eligible subjects were given consent form to study and sign. Volunteers who returned the form were potentially eligible. Thirty-two non-diabetic undergraduate students were enrolled into the study after interview on the exclusion criteria. The goal and objectives of the study including skipping breakfast in order to carry out fasting blood sugar was explained. The subjects were randomly grouped into three for each test food: red cocoyam *(X. sagittifolium*), the white cocoyam *(X. atrovirens)* and *Ede Anambra*(*colocasiaesculenta*). Two volunteers dropped out based on medical condition.

Exclusion criteria

Exclusion criteria for the study included diabetic young adults, smokers, alcoholics, strenuous exercise and consumption of meal after dinner.

Recruiting of research assistance

Three medical laboratory scientists were recruited for the study. Five final year undergraduate students of the Department of Nutrition and Dietetics, Faculty of Health Sciences were also recruited. The objectives and techniques of the study were explained to them.

Procurement of test food, reference food and medical materials

Cocoyam, glucose, water and medical materials for the research such as glucometer, test strips, lancets, cotton wood, hand gloves and methylated spirit were purchased from Owerri main market, Imo State.

Plate 1: Ede Anambra (colocasiaesculenta)

Plate 2: White Cocoyam (X. Atrovirens)

Plate 3: Red Cocoyam (X. Saggittifolium)

Preparation of the test meals

The fresh cocoyam tubers was cleaned, peeled and washed in clean water and boiled in a low heat without salt until it was tender. But *Ede Anambra*(*colocasiaesulenta*) was boiled and steeped in water over night to remove irritation in the cocoyam. The cocoyam was served to the subjects without any oil or stew. This is because, some factors like fiber, fat, protein, mixed meals and processing techniques affects GI of foods (3).

Cocoyam Tubers

↓

Cleaning

↓

Peeling

↓

Washing

↓

Boiling

↓

Cooked cocoyam

Fig 1: Flow Diagram of Cocoyam preparation

Data collection

Anthropometric measurements

Weight Measurement

Weight was measured with a bathroom scale of 120kg capacity. The measurement was done in light clothing and bare foot. The scale was zeroed before measuring. The subjects were asked to stand erect on the scale with both arms at the sides head back and heels put together without touching anything as described by (21). Weight was taken and recorded to the nearest O.1kg.

Height Measurement

According to WHO (21), a calibrated wooden standiometer (improvised) was used for height measurement. The height measurement was taken with the subjects standing erect on bare feet (removing their shoes), arms relaxed by the sides, with head raised and face straight, buttocks and heels touching the flat surface of the improvised standiometer. The reading was taken to the nearest 0.1cm.

Calculation of the test meal

152g of cocoyam that will give 50g carbohydrate was calculated using FAO (22).

Feeding procedure

Nutrition and Dietetics food laboratory, Imo State University Owerri was used as the feeding centre. Using the procedure described by Bronus*et al*. (23), which agrees with the procedure approved by FAO/WHO (24) for glycemic index studies following overnight fast of 10 hours. On the first day, anthropometric measurements of the subjects were taken. On the second day, the subjects were asked to rest for 30 minutes on arrival before commencing the study. Blood samples were collected for fasting blood glucose test (0min) to ascertain that none of them is diabetic. They were given the reference food containing 50g glucose (equivalent of 50g carbohydrates) dissolved in 250ml of water. Blood samples were taken from the volunteers using lancets after eating at 30, 60, 90, and 120 minutes intervals. On the third day, blood samples were collected at 0min after an overnight fast. Each of the test meals was served using calculated quantities equivalent to 50g available carbohydrate to each subject. The subjects were blinded to the variety of cocoyam they consumed. The food was consumed within 12minutes. Finger-prick capillary blood samples were taken from the volunteers using lancets before and after meal consumption at 0, 30, 60, 90, and 120 minutes intervals. The food was served systematically on interval of 3mins among the subjects; also blood sample was collected at 3mins interval summing 30mins for the ten subjects in each group. Subjects were advised to remain seated in order to avoid physical activity. Incentives (gala, one egg, bottle of malt and water) were given to subjects after the experiment for the three days.

Blood glucose determination

Qualified medical laboratory scientists performed all the blood glucose measurements. Finger- prick capillary blood samples were collected from each subject taken at 0 (fasting), 30, 60, 90and120 minutes after each of the test meal using sterile and disposable lancing device. Blood glucose was measured using One Touch Lifescan Glucometer (Lifescan, Inc.). Fingertips were not squeezed to extract blood in order to minimize plasma dilution. The first blood expressed was discarded, while the subsequent drop of blood was used for testing.

Data processing

Anthropometric measurement

Data collected on weight and height measurement were processed and classified according to WHO (21) criteria.

Glycemic Index.

The G.I for each test meal for all the subjects were calculated as:

$$\boldsymbol{G.I} = \frac{\textbf{IAUC of test food}}{\textbf{Mean IAUC of standard food}} \text{X} \frac{\textbf{100}}{\textbf{1}}$$

Where:

IAUC=Incremental Area Under the blood response curve for the tested meal.

IAUCS=Incremental Area Under the blood response curve for the Standard reference meal.

The GI for every test meal was calculated as the meal from the respective average GIs of the 3 groups. Data collected on Glycemic Index was coded and means and standard deviation were calculated, as well as percentages and were tabulated.

Glycemic Index classification according to Kati *et al*. (25):

70% to 100% = High

56% to 69% = Medium

≤ 55 = Low

Glycemic load (GL).

According to Monroe and Shaw (26), GL is calculated as:

$$G.L_{food} = \frac{(G.I\ food\ X\ amount(g) of\ available\ carbohydrate\ food\ per\ serving}{100}$$

Where

GL = Glycemic load

GI = Glycemic index

CHO = Carbohydrate value of tested meal from the proximate analysis

Glycemic Load was graded according to Brand-Miller *et al*. (1) as:

≥20% or above = High

11% to 19% = Medium

≤10% = Low

Glycemic Response (GR)

GR of the test foods were calculated based on the time with which the test foods had effect on blood glucose after consumption. Data collected on the time, blood glucose level rises was coded and means were calculated. Literature does not have criteria for classifying GR yet.

Statistical analysis

Statistical package for social sciences (SPSS) version 20.0 was used. Descriptive statistics was used in analyzing the glycemic index. The increase in glucose response area was analyzed statistically using one-way ANOVA, using Duncan model.

Results

The table 1 shows the mean anthropometric indices of the subjects. The mean weight and height of the subjects were 65±8.30kg and 1.7±7.20m. Body mass index (BMI) was 22.49±2.69kg/m^2. Figure 2 shows the glycemic index of the test foods (white cocoyam, red cocoyam and "*ede Anambra*"). The result shows that glucose had the highest glycemic index (100%), "*ede Anambra"* (66.95%), red cocoyam (57.47%) and white cocoyam (54.62%). Figure 3 shows the glycemic load of the test foods "*ede Anambra"*, red cocoyam and white cocoyam having glycemic loads of 10, 8.6 and 8.2 respectively. From the result, the test meals of white cocoyam and "*ede anambra''* had lower GI and GL than red cocoyam.

Table 2 shows the mean glucose of test food and glucose at each interval. For glucose there was no significant difference (p>0.05) between G.I determined in the morning (0mins) and at 120mins, there was no significant difference (p>0.05) between G.I determined at 30, 60 and 90mins but there were significant differences (p<0.05) between 0mins and (30, 60,90mins), 120mins and (30, 60,90mins). There was no significant difference (p>0.05) between time of consumption in white cocoyam. In red cocoyam, there was no significant difference (p>0.05) between 0mins and 120mins but there was significant difference (p<0.05) between (0mins and 30mins), (0mins and 60mins), (30mins and 90mins), (30mins and 120mins), and there was slight significant difference between (30mins and 60mins), (0mins and 90mins), (120mins and 90mins). *Ede Anambra* shows a significant difference (p<0.05) between (0mins and 30mins), (0mins and 60mins), (0mins and 90mins), and there was slight significant difference between (0mins and 120mins), (30mins and 90mins), (60mins and 90mins).

Figure 4-7 shows the glycemic response of both the test food and reference food. At 30minutes, glucose D had the highest glycemic response of 120mg/dl blood sugar after test food consumption, followed by red cocoyam (115mg/dl), white cocoyam (105mg/dl) and *ede Anambra*(103mg/dl).

Table 1: Anthropometric Indices of the undergraduate students

Parameters	N	$\bar{x}$	SD
Age (yr) 20-30	30	23.6	1.52
Weight (kg)	30	65.0	8.30
Height (cm)	30	1.7	7.20
BMI (kg/m^2)	30	22.49	2.69

Table 2: Mean glucose readings for the test food and reference food at each time point.

Time (mins)	Glucose (50g)	White Cocoyam	Red cocoyam	*Ede Anambra*
0	85.4 ± 11.1^a	87.8± 12.3^a	92.6± 12.0^a	80.6± 10.2^a
30	120.5 ± 20.4^b	107.3 ± 12.2^b	115.4 ± 14.5^c	109.8 ± 12.2^c
60	113.8 ± 18.5^b	103.7 ± 12.9^b	106.8 ± 11.9^{bc}	101.9 ± 14.7^c
90	107.2 ± 10.3^b	92.3 ± 11.0^a	101.5 ± 12.2^{ab}	99.0 ± 16.0^{bc}
120	87.4 ± 10.5^a	87.0 ± 7.3^a	95.0 ± 11.0^a	89.2 ± 11.1^{ab}

Value with same alpha subset means No significance while value with different alpha subset means significant.

Figure 2: A bar chart of the glycemic index of the standard (glucose) and test foods (White Cocoyam, Red Cocoyam and Ede *Anambra*)

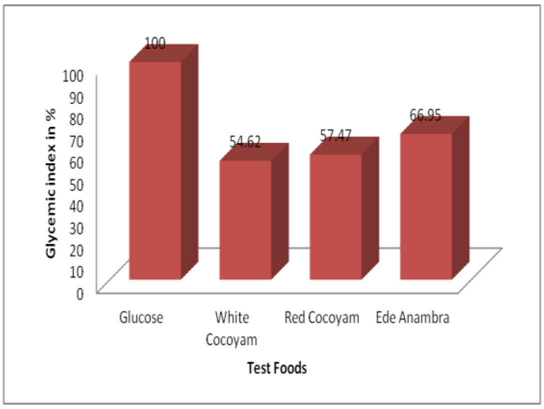


Figure 4: Graphical representation showing the glucose response area of test food white cocoyam and reference food (glucose D).

Figure 3: A bar chart of the Glycemic Load of the standard (glucose) and test foods (White Cocoyam, Red Cocoyam, and Ede *Anambra*)

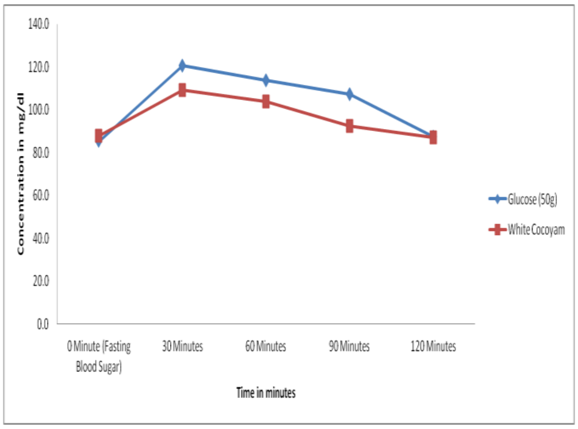


Figure 5: Graphical representation showing the glucose response area of test food red cocoyam and reference food (glucose D)

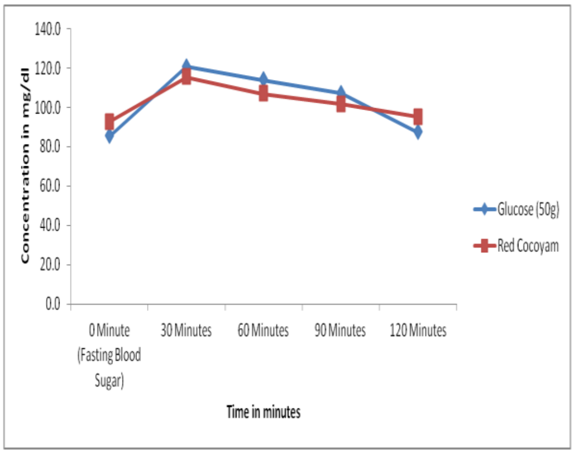


Figure 6: Graphical representation showing the glucose response area of test food *Ede Anambra* and reference food (glucose D).

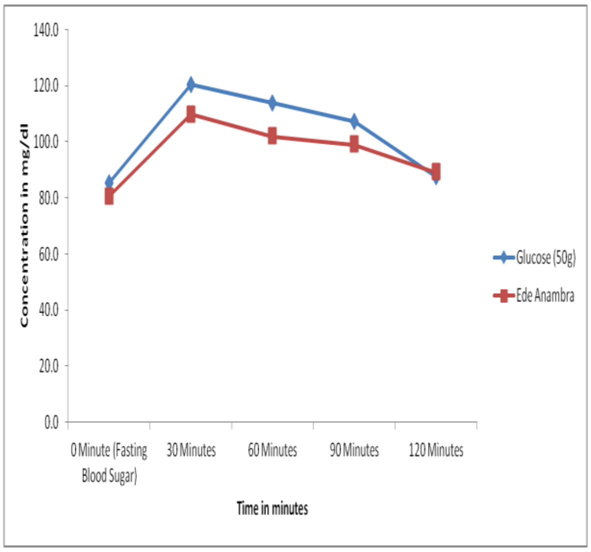
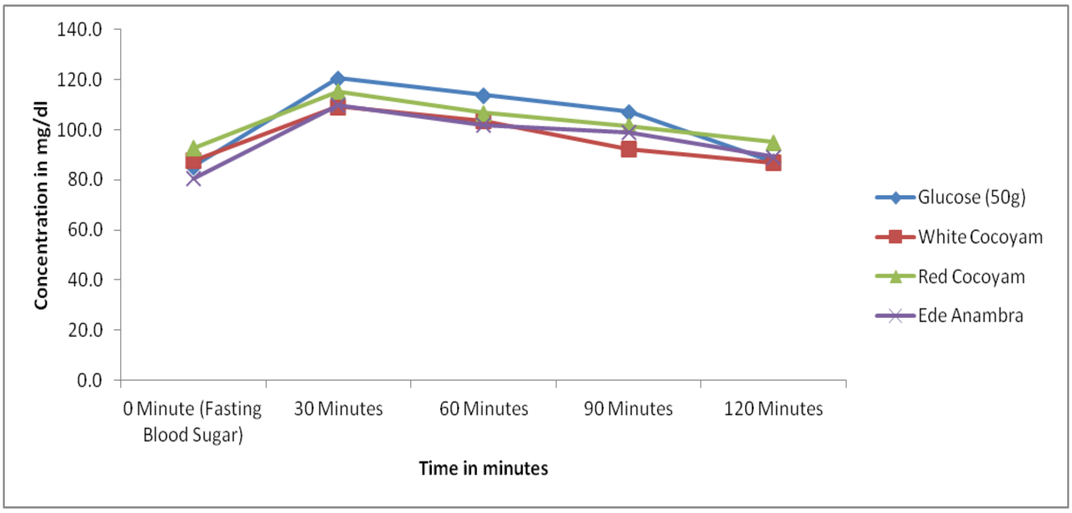


Figure 7: Graphical representation showing the glucose response area of test food White Cocoyam, Red Cocoyam and *Ede Anambra* and reference food (glucose D).



DISCUSSIONS

The mean age (23.6±1.52) of the subjects shows that they are young adults. This was higher than the study by Queiroz *et al.* (27), who observed a mean age of 12.6 ±3.6 years and lower than AlGeffari *et al.* (28) where a mean age of 31.2± 4.8 years was used to investigate the GL, GL and GR of 17 varieties of dates grown in Saudi Arabia. The mean BMI (22.42kg/m^2) shows that the subjects are healthy unlike (27) where some of the subjects are overweight and underweight though the research study was on school aged children and adolescence while (28) reported a BMI of 27.5 which indicates over weight. The disparity in the result could be as a result of the objectives and target groups needed for the study.

Variety affects the glycemic index of foods (18). Though with the same variety, glycemic indices may vary probably due to differences in accessions within the same variety (19). *Ede Anambra* had the highest glycemic index than white and red cocoyam. This is consistent with Deepa*et al*., (18) where variety affected the glycemic index of rice varieties. However, the GI of cocoyam varieties studied shows that it has a medium GI. This shows that when other food materials are added (like vegetable, oil, protein rich food materials etc.) in preparing cocoyam dish it will reduce the GI to low GI (3). That is why cocoyam is recommended to diabetic patients.

The glycemic load is essential in determining the glycemic effects of food (29) and is used to adjust serving sizes. Cocoyam is a root vegetable and has a low GL. Queiroz*et al.* (27) hypothesized that consumption of a medium GL food may help to improve glycemia. Low GL has been associated with lower risk of developing type 2 diabetes and coronary heart disease (30, 31) and may help individuals with insulin resistance (28). Glycemic load measures the degree of insulin demand and glycemic responses followed by a particular amount of food. It reflects both quality and quantity of dietary carbohydrate (32). WHO/FAO recommends consumption of low GI and GL food to prevent lifestyle related diseases (24).

For GR, *edeAnambra*had lower GR than white and red cocoyam. GR refers to changes in blood glucose after the consumption of a carbohydrate food which could be affected by variety, carbohydrate type, and fibre etc. The lower the GL, the smaller the expected increase in blood glucose (GR) (33). *Ede Anambra*from the study had a lower GL of 10 which explains the reason why it had a lower GR. However, it was higher than white and red cocoyam which had 8.2 and 8.6 respectively. This could be explained by the amount of available carbohydrate (carbohydrate that is actually digested and absorbed into the blood and metabolizes) and/or fiber content of the cocoyamvarieties which affects the rate of gastric emptying and small intestinal absorption or other factors (3).

Conclusion

The glycemic index of the three varieties of cocoyam studied shows medium GI, low GL and moderate GR. Cocoyam could be used in prevention and management of diabetes. Cocoyam should be prepared with food ingredients from different food groups. Farmers should also go into the production of cocoyam to make it more available. However, more studies should be carried out using a large sample size, glycated hemoglobin, and analyze the proximate composition of the test foods.

REFERENCES

1. Brand-Miller, J.C., Holt, S.H., Pawlak, D.B. and McMillan, J. (2002). Glycemic Index and Obesity. Am J ClinNutr; 76:2815-2855.
2. Omoregie, E.S. and Osagie, A.U. (2008). Glycemic indices and glycemic load of some Nigerian foods. PakJNutr; 7: 710-717.
3. Eleazu, C.O. (2016). The concept of glycemic index and glycemic load food as a panacea for type 2 diabetes; prospects, challenges and solutions. AfriHeaSci; 16(2):468-479.
4. Kabir, M., Oppert, J.M., Vidal, H., Bruzzo, F., Fignet, C., Wursch, P., Slama, G. and Rizkalla, S.W. (2002). Four-week of low glycemic Index breakfast with a modest amount of soluble fibers in Type 2 diabetic men. Met ClinExpe; 51: 819- 826s
5. Sievpiper, J.L., Jenkins, A.L., Whitham, D.L., Vuksan, V. (2002). Insulin Resistance: Concepts Controversies and role of Nutrition. Can J Diet Prac; 63:20-32
6. Jenkins D.J., Kendall C.W., Augustin L.S., Vuksan V. (2002). High-Complex Carbohydrate or Low Carbohydrate Foods. Am J Medi; 113 (98):305-375
7. Augustine, L.S., Gallus, S., Bosetti, C., Levi, F., Negri, E., Franceschi, S., DakMaso, L., Jenkins, D.J., Kendal, C.W., La Vecchia C. (2003). Glycemic Index and Glycemic Load in Endomental Cancer. Int J Can; 105: 404-407
8. Aregheore, E. and Perera, D. (2003) Dry Matter, Nutrient Composition and Palatability/Acidity of Eight Exotic Cultivars of Cocoyamstrisamoe. PFHN; 58:1-8.
9. Nwanekezi, E.C., Onwuamanam, C.I., Ihediohanma, N.C., Iwuono, J.O. (2010). Functional, Particle Size and Sorption/Sothern of Cocoyam Cormenl Flours. J Nutr; 9:973-979.
10. Ojinnaka, M.C., Akobundu, E.N.T. and Iwe, M.O. (2009). Cocoyam Starch Modification

Effects on Functional, Sensory and Cookies Qualities. Pak J Nutr; 8(5):558-567

11. Chukwu, G.O., Nwosu, K.I., Mbanaso, E.N.A., Onwubuiko, O., Okoye, B.C., Madu, T.U., Ogbonye, H., Nwoko, S.U. (2009). Development of Multiplication Technology for Cocoyam.
12. FAO (1990). Roots, tubers, plantain and bananas in human nutrition: FAO Corporate Document Repository, Rome.
13. Al-Jiffri, O. and Abd El-Kader, S. (2015). Psychological wellbeing and biochemical modulation in response to weight loss in obese type 2 diabetes patients. AHS; 15:503-511.
14. Omoregie E.S., Osagie A.U. (2008). Glycemic indices and glycemic load of some Nigerian Foods. Pak J Nutr; 7:710-716
15. Wolver, T.M.S., Katzman-Relle, L., Jenkins, A.L., Vuksan, V., Josse, R.G., Jenkins, D.J.A. (1999). Glycaemic index of 102 complex carbohydrate foods in patients with diabetes, Nutr Res; 4:651- 669.
16. Hoebler C., Devaux M.F., Karinthi A., Belleville C., Barry J.L. (2000). Particle size of solid food after human mastication and vitro simulation of oral breakdown. Int J Food SciNutr; 51:353-366.
17. Kati, H., Riitta, T., Isabel, B. and Jenna, P. (2010). Impact of dietary polyphenols on carbohydrate metabolism. Int J MolSci; 11 (4):1365-1402.
18. Deepa G., Singh V., Naidu K.A. (2010). Comparative study on starch digestibility, glycemic index and resistant starch of pigmented (‘Njavara’ and ‘Jyothi’) rice varieties. J Food Sci Technol; 47:644-649.
19. Dan, R.D., Rene, L.C.I., Suruji, T., Thomas, M.S.W. (2004). Glycemic index of selected staples commonly eaten in the Caribbean and the effects of boiling vs crushing. Am J Nutr; 91:971-977.
20. Imo State University Owerri website www.imsu.edu.ng
21. World Health Organization (2007). MultiCenter Growth Reference study Group. WHO child Growth standard: method and development; length/height for age, weight for age, weight for length and body mass index. WHO Geneva Switzerland.
22. Stadlmayr, B., Charrondiere, UR.,Enujiugha, V.N., Bayili, R.G. and Fagbohoun, E,G. (2012). West African Food Composition Table. FAO. Rome.
23. Brouns F, Bjorock I, Frayn KN, Gibbs L. (2005). Glycemic index methodology. *Nutr. Res Rev*; 18(1):145-71.
24. FAO/WHO (1997). Carbohydrate in Human Nutrition. Report of a joint FAO/WHO experts consultation, Rome, 14-18 April 1997. FAO food and nutrition paper, 1998.xvi:140.
25. Kati, H., Riitta, T., Isabel, B., Jenna, P. (2010). Impact of dietary polyphenols on carbohydrate metabolism. Int J Mole Sci; 2010:1365-1402.
26. Monroe, J.A. and Shaw, M. (2008). Glycemic Impact, Glycemic Glucose Equivalents, Glycemic Index and Glycemic Load: Definitions, Distinctions and Implications. Am J ClinNutr; *87(1):2375-2435.*
27. Queiroz, K.C., Silva, I.N., Alfenas, G. (2012). Influence of glycemic index and glycemic load of diet in glycemic control of diabetic children and teenagers. NutrHosp; 27(2):1-10.
28. AlGeffari, H.A., Almogbel, E.S., Alhomaidan, H.T., El-Mergawi, R., Marrimah, I.A. (2016). Glycemic indices, glycemic load and glycemic response for seventeen varieties of dates grown in Saudi Arabia. Ann Saudi Med; 36 (6):397-403.
29. Salmeron, L., Ascherio, A., Rimm, E.B., Colditz, G. (1997). Dietary fiber, glycemic load, and risk of NIIDM in men. Diabetes Care; 20(4):545-550.
30. Livesey, G. Taylor, R., Livesey, H., Liu, S. (2013). Is there a dose-response relation of dietary glycemic load to risk of type 2 Diabetes / meta-analysis of prospective cohort studies? Am J ClinNutr; 97:584-96.
31. Mirrahimi, A., de Souza, R.J., Chiavaroli, L. (2012). Association of glycemic index and load with coronary heart disease events: a systematic review and meta- analysis of prospective cohorts. JAHA; 1:e000752
32. Augustine, L.S.A., Kendall, C.W.C, Jenkins, D.J.D., Willet, W.C. (2015). Glycemic index, glycemic load and glycemic
33. response: An International Scientific Consensus Summit from International Carbohydrate Quality Consortium (ICQC).NutrMetabCardiovasc Dis*; 25(9):795-815*
34. Foster-Powell, F., Holt, S.A.H., and Brand-Miller, J.C. (2002). International table of glycemic index and glycemic load values. Am J ClinNutr. 76:5-56