Original Article

Glycaemic Index of Commonly Eaten Dough Staple Foods among Diabetics and Non-Diabetics in Makurdi

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ABSTRACT

Starchy dough food is the most commonly consumed food in Nigeria. However, the recent disease epidemiological changes from communicable to non-communicable diseases, has implicated changes in occupational choice from farming to sedentary works and consumption of predominantly dough starchy food as a notable culpable cause. Hence, this study examined the glycaemic impact of the commonly eaten staple starchy foods in Nigerian subjects. Therefore the study aims to determine glycaemic Index of commonly eaten dough foods on healthy subjects and diabetics. This was a cross-sectional study carried out on 16 healthy staff and diabetic patients from Benue State University Teaching Hospital. Each participant ingested food products (pounded yam, amala, fufu and garri) (equivalent of 50g glucose) and 50 g of reference meal. Samples were taken for blood glucose at intervals of0, 30, 60, 90,120 mins. The area under curve was determined using trapezoid method for different time intervals. The sum of area under curve for each test food was divided by the sum of area under curve for standard glucose and multiplied by 100 to determine the glycaemic index of the food products respectively. In this study the glycaemic index for diabetic group after intake of pounded yam, amala, garri and fufu were 80.95%, 69.32%, 84.08% and 97.04% respectively and for apparently healthy group it was 80.81%, 71.63%, 80.59% and 94.81% respectively. Glycaemic index for pounded yam, amala, fufu and garri is high in diabetics and healthy subjects. However, Cassava meals had higher glycaemic index compared to amala which is a yam product. Therefore, consumption of these starchy dough foods should be less frequent and in smaller portions in individual at risk of diabetes mellitus and diabetics.

Keywords: Dough foods, Glycaemic Index, Garri, Fufu, Pounded yam, Amala

INTRODUCTION

The intake of dough based meal is a common part of majority of Nigerian diet, these are consumed both in urban and rural areas as the most common traditional food. In many part of the country dough based meals such as cooked cassava flakes (garri), poundedyam, cassava (Fufu) are consumed on a daily basis along with small portion of soup to enable it to be swallowed. According to a recent study fufu is the second most commonly eaten meal among Nigerian adult dwellers.[1] These have been eaten for so many years that despite the change in lifestyle dynamics people still consume these foods routinely. According to Akarolo-Anthony *et al* traditional foods are still consumed frequently and it is very popular among urban dwellers. [1]It is traditionally known to gain popularity because they are energy giving foods which give high satiety and energy and enabled increased output among manual labourers. Since Farming was the predominant occupation in the past, these foods were commonly consumed as an energy giving food. However, with the fast changing occupation dynamics from farming to sedentary jobs which requires less physical activities, is there still need for daily consumption of these foods as dominant foods in our environs? There has been an increasing prevalence of metabolic disorder in developing countries and has been attributed to a change in lifestyle which has largely been associated with changes in work and dietary dynamics with focus on foreign fast foods with little attention to the contribution of our indigenous foods to the prevalence of these diseases. Could it be that change from manual labour to sedentary job without corresponding change in dietary habit contributed to increase in prevalence of diabetes mellitus and other related diseases? It is against this background that this research intends to find out the glycaemic index of some dough food commonly consumed in our locality in order to unravel how such diet may have contributed to increasing prevalence of metabolic diseases and poor glycaemic control in our locality. Therefore this study determined the glycaemic responses to some dough starchy foods both in apparently healthy and diabetic subjects in order to enable individuals in our environment to make informed choices in meeting their daily nutritional needs.

The glycaemic index ranks carbohydrate-containing foods on how quickly they elevate blood glucose levels. It is measured by comparing the increase in blood glucose level after eating 50 grams of carbohydrate from a single food with the increase in blood sugar after eating the same quantity of carbohydrate from a reference food, which is either pure glucose or white bread. The average change in blood sugar levels over the next two hours, compared to the change in blood sugar levels after consuming the reference food, is the glycaemic index value of that particular food.[2] Therefore, consumption of low glycaemic index food has been implicated to be helpful in prevention of obesity, diabetes mellitus, cancer and cardiovascular diseases.[3,4] The American Diabetes Association (ADA) reviewed the evidence on glycaemic index as a nutrition therapy intervention for diabetes and concluded that the total amount of carbohydrate is more important than the source (starch or sugar) or type (low or high GI), while acknowledging that low GI foods may reduce postprandial blood glucose levels.[5]Thus, glycaemic index can aid food planning for the diabetics as well as in prevention of metabolic syndrome.[6] Therefore, evaluation of the glycaemic indices of these dough foods commonly eaten in our locality will aid planning of menu for people with sedentary lifestyle and metabolic syndrome.

MATERIALS AND METHODS

This was a cross-sectional study carried out on 16

healthy staff and diabetic type 2 patients from Benue State University Teaching Hospital. Each subject ingested cassava (cassava fufu and garri), yam(pounded yam and amala) processed products and reference meal. The reference meal was pure glucose dissolved in 300mls of water. A meal type was served to all participants in a session as follows day 1(reference meal), day 2(garri), day 3(fufu), day4(pounded yam), day 5(amala), each test meal was eaten once. Food was portioned with each serving containing 50 g of digestible carbohydrate with 5mls of vegetable soup as served in this locality. The food composition tables for local food was used in calculation of meal portions. The weighed food of 225g of pounded yam, 243.5g of yam amala,143.9g of cassava fufu, 218g of Eba containing equivalent of 50g glucose were used respectively for the study.[6] The meals were prepared in the morning of the test. The subjects were fed at 8 am after an overnight fast.

Fasting blood samples was drawn for fasting blood glucose. This was used to determine glycaemic index of each meal in both healthy and diabetic subjects. The different meals from cassava and yam were obtained from the processing methods described below and was ingested by the participants after determining their serving size portions containing 50g digestible carbohydrates using standard methods of food analysis and a table of food composition for use in Africa.[8]

FOOD PREPARATION AND PROCESSING

Preparation of Garri (Cassava flakes)

Cassava tubers of same specie was obtained from a particular farm yard. Cassava was peeled, washed and grated; the grated mash was put in jute sacks and pressed using screw press and it was left for a day to dry and ferment, then the dehydrated mash was then sieved and fried to produce garri. The entire length of processing was 2 days. The garri dough was produced by adding it to boiled water till it forms a dough.

Preparation of Cassava paste (Cassava Fufu)

Peeled cassava was washed and cut into thick chunks and soaked in water for 3 days, during this period, the cassava fermented and softened, the cassava was sieved in clean water and the starchy particles that passed through the sieve were allowed to settle for about 3 to 4 hours. The water was then decanted while the sediment was packed into a cloth bag, tied, squeezed and subjected to a heavy pressure to expel excess water. Cassava meal was rolled into balls and cooked in boiling water for about 30 to 40 minutes. The cassava was then pounded with a mortar and pestle to produce a dough.

Preparation of Yam Fufu (Pounded Yam)

Tubers of yam whose specie is called "Amula"in Benue State, was sliced and cooked until they softened. It was pounded in a mortar using a pestle to a smooth dough.

Preparation of yam Amala

The yam tuber were cut into pieces and parboiled at 80^{o} c for 5mins, then it was sun dried for 3 days and then ground into browned flour. The yam flour was then stirred in boiled water until a thick smooth paste is obtained called Amala.

Preparation of Reference Food

Glucose (50 g) was dissolved in 300 ml of portable water before drinking.

DETERMINATION OF GLYCEMIC INDEX

Determination Of Glycaemic Index: The area under curve was determined using trapezoid method of different time intervals. A plot of concentration against time was used for the calculation, Area under the curve (AUC) = $(Conc_2 + Conc_1)/ 2 \times (Time_2 - Time_1)$.

Determination of Glycaemic Index: The sum of area under curve for each test food was divided by the sum of area under curve for standard glucose and multiplied by 100. The value obtained is the glycaemic index and the formula is given below: Glycaemic index (GI) = AUC of test food/AUC of standard glucose *100 .[9]

Ethical Consideration

Ethical approval was obtained from the Benue State University Teaching Hospital Makurdi and Health Research Ethics Committee(HREC) reference number is BSUTH/MKD/HREC/2013B/2017/0003. Informed consent was obtained verbally and in writing or both from the participants. Only consenting individual was recruited. Confidentiality was ensured throughout the study. Number code was allotted to each participant and result obtained from the blood analysis for the study was kept confidential.

Laboratory Analysis: Blood sample was collected at 0, 30, 90,120 minutes for glucose via venepuncture. Four millilitres of blood sample was obtained from the median cubital vein after disinfection of ante-cubital vein area. Blood sample for glucose was obtained in fluoride oxalate bottles. Blood samples were separated, aliquoted and analysed. Glucose assay was carried out using glucose oxidase method and was analysed immediately after sample collection.

Statistical Analysis.

Data analysis was done using the statistical package for social sciences (SPSS) for windows version 21. Significance was set at $P<0.05$. Comparison between Diabetic and healthy subjects were made using paired student t-test with mean expressed as mean ±SD

RESULT

An analysis of the characteristics of the subjects studied showed that there was no significant difference between the diabetics and the healthy participants except in basal medical index. (Table 1)

A review of the glycaemic index for diabetic group as shown in table 2 shows that the glycaemic index for diabetic Group after intake of Pounded Yam, Amala, Garri and Fufu were 80.95%, 69.32%, 84.08% and 97.04% respectively. More so, the glycaemia index of Amala was significantly lower (<0.05) than pounded yam, garri and fufu while the glycaemic index of pounded yam was significantly lower (<0.05) than garri and fufu. Similarly in table 3, the glycaemic index for apparently healthy group after intake of pounded Yam, Amala, Garri and Fufu was 80.81%, 71.63%, 80.59% and 94.81% respectivelyas shown. The glycaemic index of Amala was significantly lower (<0.05) than pounded yam, garri and fufu. The glycaemic index of pounded yam was significantly lower (<0.05) than fufu.

Figure 1, shows a graphical representation of glycaemic responses of diabetic and healthy participants after intake of dough foods. In healthy group the reference glucose and fufu peaked at one hour after meal intake more than other meals while in diabetic subjects after intake of all dough foods except amala, the postprandial glucose remained elevated beyond two hours. On the other hand, after the intake of amala, pounded yam and garri the blood glucose returned to pre-prandial level at or before two hours but on intake of fufu the blood sugar remained elevated for both diabetics and healthy subjects.

Table 1: Characteristics of Subjects Studied (Mean±SD)

Variables	Diabetics (N=30)	Non-Diabetic Subjects (N=26)	P-Value
Age	52.50±4.27	52.50±7.41	0.924
Weight	65.50±3.0	64.50±4.20	0.750
Height	1.60±0.027	1.62±0.037	0.534
BMI	25.50±0.86	24.4±1.10	0.036*
Waist Circumference	109.5±33.52	110.75±18.71	0.963
Hip Circumference	97.25±2.36	118.25±1.1	0.052
Waist- Hip Ratio	1.12±0.01	0.94±0.01	0.326

** Significant at P <0.05*

Table 2: Mean Glucose Concentration Values for Diabetic Group after Intake of Pounded Yam, Amala, Garri and Fufu (Mean±SD)

Time (mins)	Pounded Yam (N=30)	Amala (N=30)	Garri (N=30)	Fufu (N=30)	Reference Glucose (N=30)
0	5.70±0.40	5.93±0.36	6.09±2.34	6.87±1.01	5.75±0.39
30	6.95±0.60	6.42±0.57	7.75±2.88	9.16±1.65	9.51±0.41
60	8.75±0.44	8.12±0.71	9.24±4.46	10.32±2.64	11.98±0.52
90	9.03±0.66	6.92±0.86	8.96±3.16	10.45±2.22	10.37±0.63
120	8.91±0.87	5.65±0.49	8.73±3.19	10.53±2.06	10.01±0.64
AUC	32.04±2.12	34.31±1.85	33.37±11.92	38.60±7.55	39.73±2.03
GI %	80.75±5.53[ab]	69.32±6.06[ab]	84.08±20.11	97.04±17.48	

** Significant at P <0.05 a=significantly different from garri b=significantly different from fufu*

Table 3: Mean Glucose Concentration Values for Apparently Healthy Group after Intake of Pounded Yam, Amala, Garri and Fufu (Mean±SD)

Time(mins)	Pounded Yam (N=26)	Amala (N=26)	Garri (N=26)	Fufu (N=26)	Reference Glucose (N=26)
0	3.83±0.30	4.13±0.21	4.25±0.60	3.93±0.34	4.10±0.50
30	5.20±0.27	4.87±0.52	4.63±0.65	5.47±0.36	6.33±0.42
60	6.00±0.16	4.95±0.50	5.38±0.56	8.40±1.39	8.27±0.43
90	5.23±0.38	4.18±0.27	5.80±0.64	5.27±1.27	6.30±0.61
120	4.02±0.28	4.08±0.31	4.65±0.33	5.47±0.34	4.20±0.49
AUC	20.36 ±1.00	18.03±1.48	20.25±1.96	23.91±1.49	25.29±1.48
GI %	80.81± 6.69 [b]	71.63±8.2[a,b]	80.59±11.72	94.81±7.67	

** Significant at P <0.05 a=significantly different from garri b=significantly different from fufu*

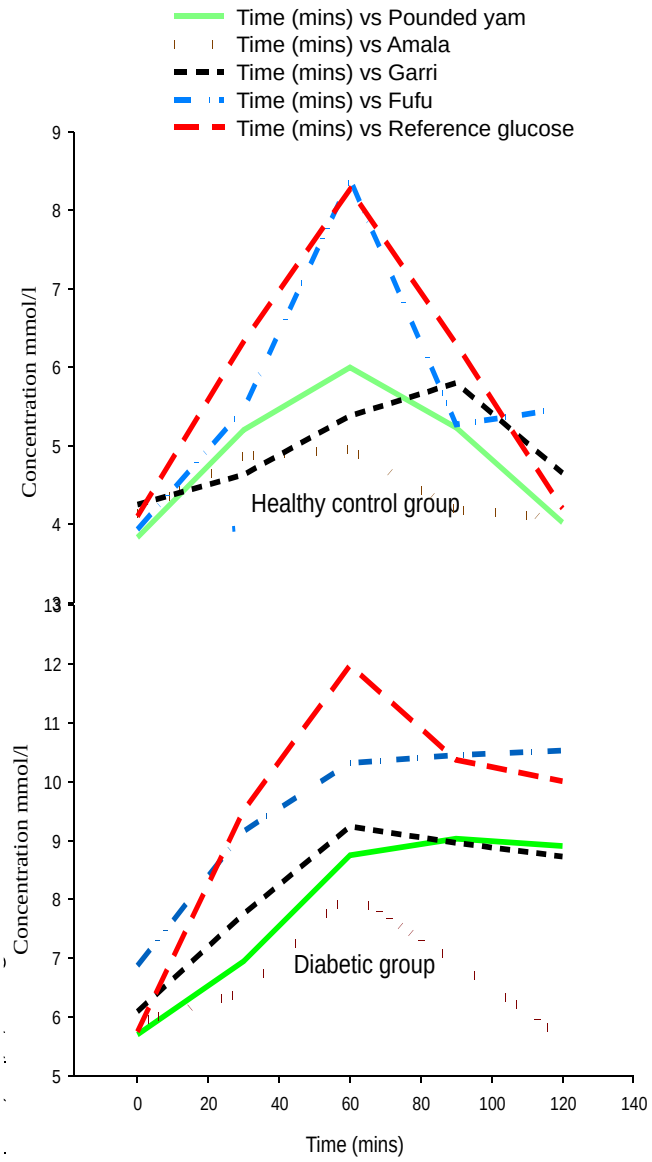

Figure 1. Graphical Representation of Glycaemic Responses of Diabetic and Healthy Participants After in Take of Fufu, Garri, Amala and Pounded Yam

DISCUSSION

In this study the glycaemic index for diabetic group after intake of pounded yam, amala, garri and fufu were 80.95%, 69.32%, 84.08% and 97.04% respectively. But The glycaemic index for apparently healthy group after intake of pounded yam, amala, garri and fufu are 80.81%, 71.63%, 80.59% and 94.81% respectively. Among the test food studied cassava meals had higherglyceamic index both in diabetic subjects and non-diabetic subjects than the yam meal with amala having the lowest glycaemic index.

All cassava test foods showed high glycaemic index and may not be healthy for diabetic subjects when eaten in sizable portions. Similar work done by Omoregie and Osagie shows that fufu and garri's glycaemic indices were 98.60 and 82.25.[10] Ogbuji and David-Chukwu in their study showed glycaemic index of fufu and garri to be 84 and 92 respectively in healthy individuals while Chinagorom *et al* in their study showed glycemic index of garri to be 101.4.[11,12] Ihediohanma 2011, determined the glycemic indices of three different cassava granules (Garri) showed that the G.I. values increased from 62, 67 and 73 for 24, 48 and 72-hour fermentation respectively.[16] In all these studies glycaemic indices were shown to be greater than 70 which indicates high glycaemic index. Though, many of these studies were carried out on healthy subjects, but they were in agreement with this study where glycaemic index of cassava was shown to be high both in diabetics and healthy subjects.

The yam products test foods (amala and pounded yam) were shown to have a high glycaemic index in diabetic subjects. In healthy participants however, amala showed an intermediate glycaemic index (69.3%) while pounded yam showed high glycaemic index (80.8%).Another work done by Fasanmade *et al*, showed that amala in healthy subjects and diabetics produced 36.12% and 50.09% respectively.[13] Then Jimoh *et al*, on the other hand found the glycaemic index of amala in healthy subjects to be 31.8 which is low glycaemic index.[14] Both studies were however done in south west of Nigeria while the index study was carried out in Makurdi, Benue State, North central Nigeria a state that is the major producer of varieties of yams in Nigeria. The specie of yam studied were not

mentioned in both studies as there are several species of yam in Nigeria and hence variation in starch content of various species of yam may have differed. In Cote d'voire glycaemic index values of yams commonly consumed was observed to vary across a considerable range from 51-70. According to the official classification made by Brand-Miller *et al*. as reported by Kouassi NK *et al*, yams commonly consumed in Cote d'Ivoire can be classified in low GI ('Kponan': 51, 53), intermediate GI ('Assawa': 54, 56 and 'Kangba': 60, 66) and high GI ('Yaobadou': 67, 70).[15] This may also explain why the glycaemic index of amala differed from other studies. Therefore, cassava and yam products' glycaemic index according to the index study is high in both healthy and diabetic subjects.

CONCLUSION

Glycaemic index for diabetic group after intake of pounded yam, amala, garri and fufu are 80.95%, 69.32%, 84.08% and 97.04% respectively. But the glycaemic index for apparently healthy group after intake of pounded yam, amala, garri and fufu are 80.81%, 71.63%, 80.59% and 94.81% respectively. Cassava meals had higher glycaemic index both in diabetic subjects and non-diabetic subjects than the yam meal with Amala having the lowest glycaemic indices.

Recommendation

Commonly available dough foods from cassava and yam eaten in Nigeria may be significantly contributing to increase in metabolic syndrome and diabetic mellitus prevalence in Nigeria. It may also be contributory to poor glycaemic control among the diabetics. Therefore, advocacy on control of portion size intake of these foods among the healthy populace should be undertaken .Intake of these may not be encouraged among diabetics.

More studies are needed to evaluate possibilities of producing dough food from other starchy foods of less glycaemic index in Nigeria or developing culinary or agricultural method that may reduce their glycaemic indices. This will proffer a good dietary alternatives for the diabetics and susceptible individuals that are accustomed to eating these dough foods. This may help in achieving good glycaemic control and satisfaction concurrently.

Proper characterisation of various species of yam should be undertaken to enable appropriate glycaemic indices to be established specifically for the various species of yam present in our environs since the carbohydrate content of the various species of yam may differ significantly.

Also future studies of glycaemic index of yam and cassava should be specific on the specie of plant used in the studies. This will be more useful in sub-classification of these food products according to their various glycaemic indices.

Limitation

Intra-individual differences in carbohydrate handling as well as satiety factor which is a key player in dietary modification was not addressed by this work. It would have been ideal to keep the patients in the same environment at least 3 days to the test but this was not practicable. A longitudinal study of several years is required to establish a direct association of these foods with metabolic syndrome in our society.

Conflict of interest: None declared

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