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Full Length Research Paper

A study of blood glucose response and glycemic index of food for diabetics and non-diabetics

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This study was carried out to determine the blood glucose response and glycemic index of food for diabetics and non-diabetics. The subjects comprised of 10 diabetics and 7 non-diabetics. The results of the physical characteristics showed that the diabetic subjects were on the average older (age bracket between 51 and 70years) than the non-diabetics (18 and 23years) . The Body mass index (BMI) values indicated that over 90% of the diabetics were obese while the non-diabetics were on the average normal. Results also showed that the blood glucose response of the diabetics were significantly higher (P<0.05) than that of the non- diabetics. When fed on the test diets ("okpa" and "moin–moin"), the blood glucose response was significantly reduced when compared to bread diet for both diabetics and non-diabetics. The results further indicated that the blood glucose response was better with "okpa" than with "moin–moin", suggesting that "okpa" is a better diet for diabetic patients. The glycemic index values for "okpa" and "moin–moin" were 78 and 38 respectively for the non-diabetics while the values were 59 and 66 respectively, for the diabetics indicating that "okpa" is a better diet for the diabetics.

Key words: Glycemic index, diabetics, blood glucose response, bread, okpa and moin - moin.

INTRODUCTION

Glycemic index according to Allen (1997) is simply a ranking of foods, based on their immediate effect on blood glucose. It is a physiological measure of how fast and to what extent a carbohydrate food affects blood glucose levels. Jenkins and Jenkins (1986) reported that the carbohydrate exchange list which have regulated the diets of most diabetics do not reflect physiological effect of foods and are therefore not sufficient for controlling blood glucose. The work showed that it is not the amount of carbohydrate rather its rate of digestion and absorption that determines the physiological response of the body, hence complex carbohydrate is ranked, compared to glucose, by glycemic index.

Diabetes mellitus is a degenerative disease and if not properly managed will lead to a lot of complications. Dietary factors (fibers and glycemic load/index) may affect plasma adinopectin through modulation of blood glucose, because a diet rich in some types of fiber could lower glucose concentrations (Qi et al., 2003) whereas a diet high in glycemic index may increase blood glucose (Hangander et al., 1988; Jenkins et al., 19987). This calls for dietary modification of the patient's diet to suit the disease condition. Glycemic index was conceived as a tool for the dietary management of type II diabetics. Sugars have been identified to cause a more rapid rise in blood sugar levels than complex carbohydrates (Brand-Miller et al., 2003).

The utility of the glycemic index in managing diabetics is fraught with controversy. However, despite the numerous controversies as reported by Jenkins and Jenkins (1986), there is still strong support of the glycemic index, expounding the virtues of a low glycemic index diet for promoting weight loss and good health. The American Dietetic Association (ADA) reviewed the evidence of glycemic index as a nutrition therapy intervention for diabetics and acknowledged that low glycemic index foods may reduce postprandial blood glucose levels, and asserted that there is sufficient evidence of long term benefit to recommend using low glycemic index diets as a

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primary strategy in meal planning (Asp, 1996).

The use of legumes as food source is now emerging as a major nutritional ingredient and is recommended as a low fat source of proteins, carbohydrates, fiber and other nutrients with the fiber having a preventive effect on some types of cancer, aiding the metabolism of diabetics and helping dieters satisfy their appetites without over-loading on calories (Enwere, 1998).

Therefore, the objectives of this study were to investigate the blood glucose response of diabetics and non diabetics (control) fed white bread (control) or steamed cake prepared from cowpea (moin - moin) and bambara nut (okpa) and to determine the glycemic index of the steamed cakes (moin - moin and okpa).

MATERIALS AND METHODS

Materials

The raw materials used for this study were two legumes (cowpea and bambara nut) and white bread (which served as the control). The legumes were purchased at Umuahia main market, Umuahia, Abia state while the bread was purchased at Mr. Biggs restaurant, Rumuola, Port Harcourt, Rivers state.

Processing and production of steamed

cakes Moin – moin

The cowpea seeds were sorted washed in cold water twice its volume to remove foreign materials. After that, they were peeled to remove the testa, to avoid black spots on the moin - moin. The seeds were wet-milled into a paste. Other ingredients used include onions, salt (to taste), red palm oil, two maggi cubes and two table spoonful ground crayfish. These ingredients were thoroughly mixed together in a bowl and water was added as required to meet the consistency as traditionally prepared. The mixture was immediately put into containers (for the desired shapes) and steam cooked for 30 min.

Okpa

The bambara groundnut seeds were sorted and oven dried at $80^{O}C$ to reduce the anti – nutrients (Onimawo and Akpojovwo, 2006), milled into flour and then reconstituted. The same ingredients used for moin moin were also added mixed thoroughly together in a bowl as was done with moin moin. It was put into containers (for the desired shapes) and also steam cooked for 30min.

Experimental procedure and test meals

Ten (10) diabetics (aged 51 - 70 years) and seven (7) non diabetics (control, aged 18 - 23 years) made of males and females were used for the study. Previous studies did not differentiate the effects of age on plasma glucose response (Reaven, 2003). The diabetics were those who regularly attend the Diabetic clinic of the University of Port Harcourt Teaching Hospital, Rivers state, Nigeria.

The subjects (diabetics and controls) who fasted from 12 mid night, reported at the hospital at 7 am. Blood samples were collected from the subjects using a syringe before the meals were administered.

Three slices of bread (which contained 50 g carbohydrate) were given to the subjects. After intake of the bread, they were allowed to take some water and their blood samples collected at 30 min interval for a period of 2 h.

On the second day, the diabetic subjects were divided into two of five members each while the non diabetics subjects were split into two of three and four members each. Among the diabetics, one group was fed okpa and the second group was fed moin-moin. Similarly, among the non diabetics, one group was fed okpa and the other with moin – moin. The blood samples of the subjects were also collected after 30 min interval. A self assessment questionnaire was used to collect the subjects' personal characteristics including general knowledge of their health conditions.

Proximate analysis

Moisture content, ash, ether extract, crude protein, crude fiber and carbohydrate were determined using AOAC (1980) method. The samples were designated samples A, B, C, D, E and F for dry cowpea, bambara nut flour, peeled and wet-milled cowpea, white bread, steamed cake (moin- moin) and steamed cake (okpa). Carbohydrate was determined by simple difference. Crude protein was determined as percentage nitrogen x 6.25 using a micro Kjedahl distillation unit (AOAC, 1980).

Blood analysis

The blood samples were analyzed using a glucometer (GLUCO TREND -2, made in Germany) to determine the fasting blood glucose (FBG) levels and the postprandial blood sugar level of the subjects.

Determination of glycemic index

The glycemic index was calculated using the method described by FAO (1998) as the incremental area under the blood glucose response curve of a 50 g carbohydrate portion of the test food expressed as a percent of the response to the same amount of carbohydrate from a standard food taken by the same subject.

Data analysis

The responses were noted and the data obtained were analyzed using frequency distribution, percentages, means and standard deviations. Also t - test and Analysis of Variance (ANOVA) were used and significance judged at $P<0.05$.

RESULTS AND DISCUSSION

Proximate composition

Proximate composition of the cooked and uncooked samples of the legumes "bambara nut and cowpea" and the white bread sample (Table 1) showed that the crude fiber content of samples D, E and F made from bambara nut were very much lower than those of samples A,B and C made from cowpea. This agreed with the result obtained by Oguntona and Akinyele (1998). This may be attributed to the removal of the testa from cowpea samples during processing. Also the percentage carbohydrate composition of sample D was higher than that of

.

Table 1. Proximate composition of the cooked and uncooked bambara nut and cowpea.

50g sample %	A	B	C	D	E	F
Moisture	9.16	10.76	64.20	12.85	56.48	46.40
Ash	3.40	4.30	2.2	2.38	2.60	3.40
Ether	2.65	4.70	8.75	12.65	13.80	25.70
Crude protein	22.40	20.26	10.14	9.55	12.51	11.38
Crude fiber	1.90	5.15	1.68	1.05	1.02	0.95
Carbo-hydrate	60.49	54.83	13.03	61.52	13.59	12.17

Sample A = Dry cowpea (black-eyed pea)
Sample B = Bambara nut flour
Sample C = Peeled and wet milled cowpea
Sample D = White bread
Sample E = Steamed cake (moin – moin) from cowpea
Sample F = steamed cake (Okpa) from bambara nut

Table 2. Mean blood glucose response of the subjects to bread intake (mol/dl).

	Controls		Diabetics	
Period	N	Mean ± SD	N	Mean ± SD
FBG	7	4.21±0.33	7	6.87±2.01
30min	7	4.73±0.71	7	8.91±2.60
60min	7	4.73±0.36	7	12.80±3.19
90min	7	4.63±0.40	7	12.96±4.94
120min	7	4.30±0.44	7	12.36±4.53

that of sample E with sample F having the least.

Physical characteristics

The characteristics of the subjects used for the study indicated that the mean age of the control (20.57 ± 1.51yrs) was lower than that of the diabetics (58.14 ± 7.95yrs). This agreed with reports that old age (>45yrs) is one of the major risk factors of type II diabetics (Flourence and Yeager, 1999). Also the mean BMI of the diabetics (27.78 ± 2.46) was higher than that of thecontrols (21.29 ± 2.29). This indicates that high BMI (24 kg/m^2) is another risk factor of diabetics (Callen et al., 2003). This result is in agreement with the report by Lyare (2000) that type II diabetics usually appears in middle aged to elderly patients who are often overweight

Blood glucose response

The blood glucose responses of the diabetics and control subjects to bread intake (Table 2 and figure 1) shows that the fasting blood glucose (FBG) of the diabetics (6.87 ± 2.01mol/dl) was higher than that of the control (4.21 ± 0.43mol/dl). This is expected since diabetics have been known to metabolize glucose at a slower rate. The blood glucose responses to white bread administered after the various time intervals showed that even after 120 min, the blood glucose levels of the diabetics were still high compared to that of the controls. This confirmed the high rate of glucose intolerance in diabetics reported by Florence and Yeager (1999).The blood glucose responses of the subjects to moin–moin intake (Table 3 and figure 2), showed that the FBG levels of the diabetics (7.56 ± 3.59 mol/dl) were higher than those of the controls (4.35 ± 0.13 mol/dl). A critical look at the FBG after the intake of moin–moin by the subjects showed that the FBG values of the diabetic were lower than their FBG after bread intake. These differ-rences were also noticed even at the various time intervals. The blood glucose of the diabetics rose so fast after the bread intake as compared to the rise after the moin–moin administration. The continued rise of the blood glucose even after 90 min of bread intake indicated that white bread is not a good diet for diabetics as it caused a faster rise in blood glucose levels. Furthermore, the individual blood glucose responses of the subjects to okpa intake (Table 4, Figure 3) showed that the FBG levels of the diabetics (6.08 ± 0.91 mol/dl) was also higher than that of the controls (3.97 ± 0.58 mol/dl). The FBG responses were lower when okpa was administered, which may be attributed to the higher crude fiber content of bambara nut than cowpea (moin–moin) (Table 1) (Onimawo, 1998). This trend was also noticed in the blood glucose responses at various time intervals. After 60 min of administration of moin–moin and okpa on the controls, blood glucose responses were comparable that is, 5.20 ± 0.29 mol/dl and 5.40 ± 0.80 mol/dl respectively while the blood glucose responses of compared to moin-moin (11.84 ± 3.29 mol/dl), the blood glucose response of the diabetics fed with okpa (7.78 ± 1.06 mol/dl), was significantly lower indicating that okpa was a better diet for diabetics.

Table 3. Mean blood glucose response of the subjects to moin–moin intake

	Controls		Diabetics	
Period	N	Mean ± SD	N	Mean ± SD
FBG	4	4.35±0.13	5	7.56±3.59
30min	4	4.70±0.18	5	9.00±3.47
60min	4	5.20±0.29	5	11.84±3.29
90min	4	4.75±0.24	5	11.70±2.50
120min	4	4.48±0.36	5	10.96±2.44

Glycemic index of moin–moin and okpa

From Table 5 and Figure 4, the glycemic index of okpa,

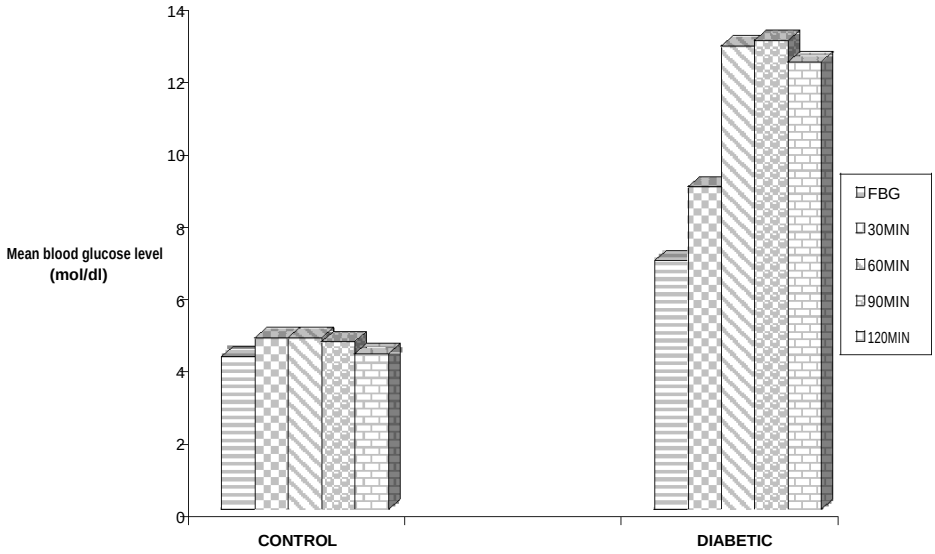

Figure 1. Blood glucose response to bread intake

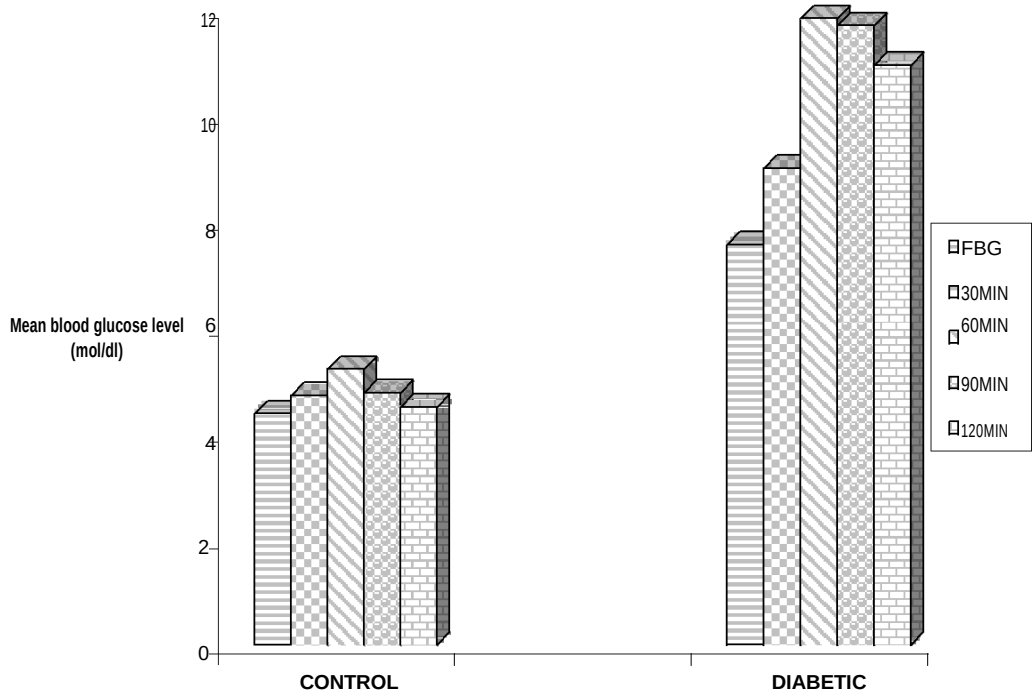

Figure 2. Blood glucose response to moin–moin intake.

obtained from this study for the diabetics (59) was lower than that obtained, for the controls (77). Similarly, the glycemic index of moin–moin, was found to be lower in than the controls, than in the diabetics. Both the glycemic

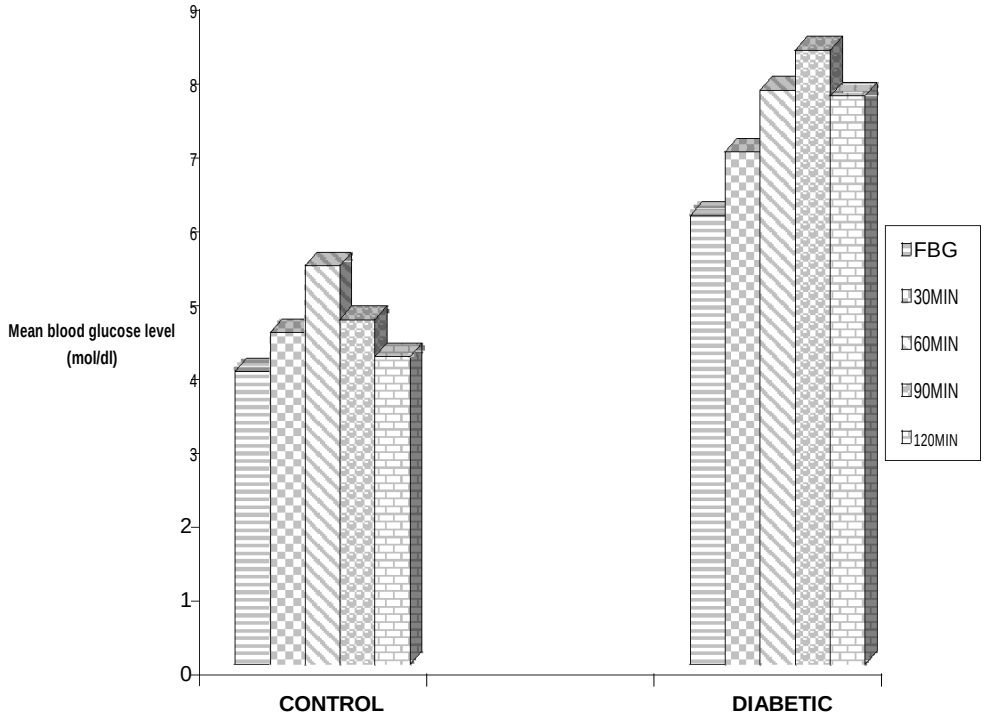

Figure 3. Blood glucose response to okpa intake.

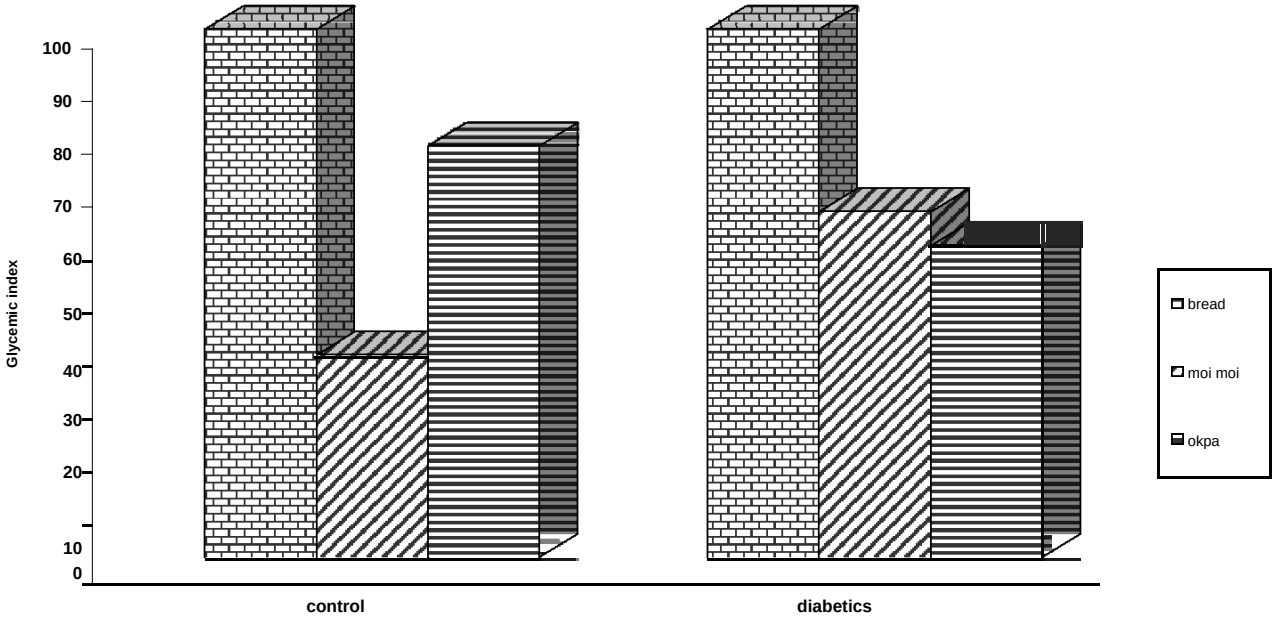

Figure 4. Glycemic indices of bread, moin–moin and okpa.

indices of okpa and moin–moin were lower than the glycemic index of bread (100).

The lower values of glycemic index and blood glucose response obtained from okpa for the diabetics implies

Table 4. Mean blood glucose response of the subjects to okpa intake

	Controls		Diabetics	
Period	**N**	**Mean ± SD**	**N**	**Mean ± SD**
FBG	3	3.97±0.58[a]	5	6.08±0.91 [a]
30min	3	4.50±0.20[a]	5	6.94±0.75 [a]
60min	3	5.40±0.80 [a]	5	7.78±1.06 [ab]
90min	3	4.67±0.15 [a]	5	8.32±1.10[b]
120min	3	4.17±0.15 [a]	5	7.7±1.14 [ab]

Values with similar superscripts arranged vertically are not significantly different from each other (p = 0.05)

Table 5. Glycemic indices of moin–moin and okpa.

	Control subjects	Glycemic index	Diabetics subjects	Glycemic index
1	**Okpa**			
A	Control A	87[a]	Diabetic B	76[a]
B	Control B	135[b]	Diabetic D	47[b]
C	Control C	68[c]	Diabetic K	39[c]
D			Diabetic M	70[d]
E			Diabetic L	64[e]
	Mean ± SD	**77.94±12.95**		**59.13±15.76**
2	**Moin – moin**			
A	Control D	59[a]	Diabetic A	59[a]
B	Control E	179[b]	Diabetic C	64[b]
C	Control F	33[c]	Diabetic J	75[c]
D	Control G	23[d]	Diabetic H	108[d]
E			Diabetic L	63[b]
	Mean ± SD	**38.33±18.7**		**65.5±7.44**

Glycemic index of bread was taken to be 100 (6)
Values with similar superscripts arranged vertically are not significantly different from each other (P=0.05)

that okpa is a better diet for the diabetics than moin–moin

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