GLYCEMIC RESPONSES OF PREMATURE VARIETIES OF PLANTAIN MEALS

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ABSTRACT

The Glycemic response of three varieties if premature plantain (Musa paradisiacal) were assessed using thirty-five healthy subjects. The post prandial serum glycose concentration over a period of 3hr were determined half-hourly. Blood glucose curves were constructed to calculate the glycemic index of the test foods. The results revealed that the premature plantain meals from the three varieties had moderate glycemic indices (55 to 70). The glycemic indices of premature boiled plantain (pbp) and premature plantain flour (ppf) meals did not show very significant difference at ($p < 0.05$) from the three varieties. However, the premature boiled plantain meals had significantly $p > 0.05$ lower glycemic load (GL) when compared to the premature plantain flour meals the concept of the glycemic load can be best used for the fine-tuning post prandial responses after focusing on total carbohydrate.

Key Words: Premature plantain, glycemic index, blood glucose diabetes.

INTRODUCTION

Glycemic index (GI) ranks food on how it affects the blood sugar levels. It measures the relative area under the post prandial glucose curve of 50g of digestible carbohydrate compared with 50g of standard food either glucose or white bread whose GI is 100 and 70 respectively (Foster-Powell k. 2002). According to Wolever et al, 2003 foods high in protein do raise blood sugar level at moderately lower rate.

Whenever, a carbohydrate rich food is eaten, digested into blood system glucose level may be elevated. However, not all carbohydrate foods elicit the appearance of glucose and insulin in the blood at the same rate. This is because blood sugar (glucose) that is delivered to the cells through out the body via blood stream is partially derived from the carbohydrate in food consumed. Thus a diet with a low GI typically lowers the blood sugar levels on moderate scales while food with a high GI may cause sugar levels to increase more than desired, Bertein, 2000 and Brand-Miller 2003). However, determining the glycemic indices of food is important because it gives an awareness and helps to control blood sugar levels. This helps to prevent insulin resistance, type – 2 diabetes, concerns and helps to maintain a healthy body mass (Willert et al, 2002).

Musa paradisiacal (plantain) belongs to the natural order plantagiceae, which contains more than 200 species, 30 of which have been reported to be domestic use (FAO, 1990). Plantain is one of the highly nutritious food that is consumed in the world. When cooked it extremely low in fat, cholesterol and salt but high in starch. Plantain is very rich in potassium and is good for the heart which prevent hypertension and heart attack (Samuekson, 2005). It is also rich in magnesium and phosphate. Plantain is a good source of vitamins A, B and C which helps to build immunity against various diseases, maintain vision and healthy skin (Samuelsen, 2005).

When cooked, unriped plantain is very good for diabetic patients. The taste and texture depends on it stage of ripeness. Consuming fat or protein diet with carbohydiates influences the gastrointestinal transit time and produce a highly glycemic response (Onwuka and Omuka, 2005).

The glycemic indices of unriped processed plantains have been determined (Ayodele et al, 2010). This study aim is to determine the glycemic index, load, glycemic response of premature varieties plantain meals in non-diabetic healthy volunteers.

Material and Methods

Subjects and Anthropometric measurement. Thirty-five subjects aged between 20 and 32

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Table 1 Anthropometry of control and test subjects.

Para Meter	Control Group	Test A Pbp	Ppf	Subject B Pbf	Ppf	Groups C Pbp	Ppf
Age (years	22.01± 6.73	26.00± 0.81	22.03±0.92	20.02±0.92	20.83±0.91	24.83±0.41	26.54±0.45
Height (cm)	182.00± 6.92	169.32± 10.1	182.0±16.85	164.37±10.12	168.82±10.10	125.11±7.63	16+38±3.8
Weight (kg)	67.82± 6.69	60.01± 7.01	67.82±6.16	60.00±7.03	60.00±7.02	66.02±0.36	64.00±2.36
Bm(kg/m^2	20.32± 2.23	2089± 1.31	20.50±2.19	20.89±1.29	20.88±132	21.55±064	2386±0.641.11

Values are the means ± standard mean (SEM) of 5 individuals premature boiled plantain (pbp) per group premature plantain flour (ppf).

Table 2 proximate analysis of processed premature of the three varieties meals on dry weight percent food samples.

A	Lipid	Ash	Fiber	Crude Protein	Carbohydrate	Moisture
Pbp	1.33±0.72	1.63±0.32	0.81±00	3.13±0.02	3678	56.8±0.08
Ppf	0.59±0.01	2.00±0.00	0.94±0.00	1.00±0.05	62.16	33.50±0.49
(B)						
pbp	1.45±0.21	1.73±0.31	0.84±0.00	3.25±0.02	35.52	57.21±0.05
Ppf	0.40±00	3.03±0.23	0.85±00	0.920±0.21	61.70	28.06±0.32
C						
Pbp	1.40±0.20	1.64±0.33	0.81±00	3.13±0.02	3628	56.80±0.08
Ppf	0.51±0.10	2.01±00	0.94±0.00	0.91±0.05	62.16	33.51±0.49

Values are the means ± standard errors of means (SEM) of fives (5) determinants

years (20 male and 15 female) were randomly selected from students of the University of Uyo, Akwa Ibom State, Nigeria. They were clinically normal, non-smokers and non diabetic. The subject were appraised verbally and they gave their informed consent. The subjects were arranged into seven groups. Body weight was taken (to the nearest 0.5kg). Height was measured (to the nearest 0.1cm) with the subject standing erect position against a vertical scale of portable stadiometer and with the head positioned leaned on the wall. Body mass index (BMI) of the subject was calculated as weight in kilogram divided by squared height in meter (wt kg/ht (m^2)).

Collection of sample

Two bundles of three varieties of plantain were collected from the following location in Akwa Ibom State of Nigeria Local names in bracket as they were identified by a botanist from the University of Uyo.

Sample A (Odourosuk) from Attai Obio Offot, Itu L.A.G.

Sample B (Okoyo) from Effiat Offot, Uyo L.G.A

Sample C (Eba-Oboikpa) from Nwut Usung Itam, Itu L.G.A. They were all confirmed to belong to the species called Musa Paradisiacal L. the three

varieties were separated and processed for experimented meals.

flour. The flour was sieved and stored in air tight container kept at room temperature (25^0c).

The premature plantain flour meal was prepared by stirring continuously 225gm flour from each variety in a pot of 250ml boiling water until well cooked to form a thick smooth brown paste.

Both premature plantain flour meals were served to the listed group with a bowel of (soup) made up of tomatoe sauce (containing fresh pepper, tomatoe onion grounded to a smooth paste mixed with 100ml of soya-oil) and 48g of boiled goat meat as eaten in Akwa Ibom State of Nigeria Culture.

Table 3 Available carbohydrate in 100gm of each variety processed premature plantain meals and the serving sizes used for glycemic index determination.

Food sample	Available carbohydrate 100g processed food (g)	Serving size of processed (g)
Sample A		
Pbp	42.24	138.24
Ppf	82.33	66.55
Sample B		
Pbp	36.17	136.55
Ppf	72.25	64.54
Sample C		
Pbp	40.25	137.44
Ppf	70.31	63.80

Proximate Analysis

Each of the three varieties (A,B and C) of the premature plantain was analyzed for moisture content, ash, crude protein and crude fiber by the AOAC (1983) method.

Preparation of Meals

a. Premature boiled plantain meal (pbpm). Freshly harvested premature plantain from each of the samples (A, B and C) paradisiacal L. bundles were peeled and 5kg of each varieties were cut into (10mm. long) and boiled in 5 L of water containing 1gm of salt for 1.30 mins. each

b. Premature plantain flour (ppf). Premature plantain from each samples of (A,B and C) paradisiacal L were separately peeled, sliced and sun-dried to a constant weight and ground into

Experimental Design

The 35 subjects were divided into seven groups. Group 7 served as control and were ministered 50gm of glucose in 300 distilled water.

Table 4 Glycemic index and glycemic load of processed varieties plantain meals

A	GI	GL
Pbp	55.46 ± 5^a	19.72 ± 0.42^b
Ppf	56.36 ± 3^a	35.00 ± 0.32^c
B		
Pbp	54.71 ± 3^a	19.40 ± 0.22^b
Ppf	56.40 ± 4^a	35.25 ± 0.24^c
C		
Pbp	54.67 ± 2^a	19.48 ± 0.32^b
Ppf	56.20 ± 4^a	35.49 ± 0.24^c

Values are the meant ± standard error of means (SEM) of five individual per group. Means with the same superscript are not significantly different (polios).

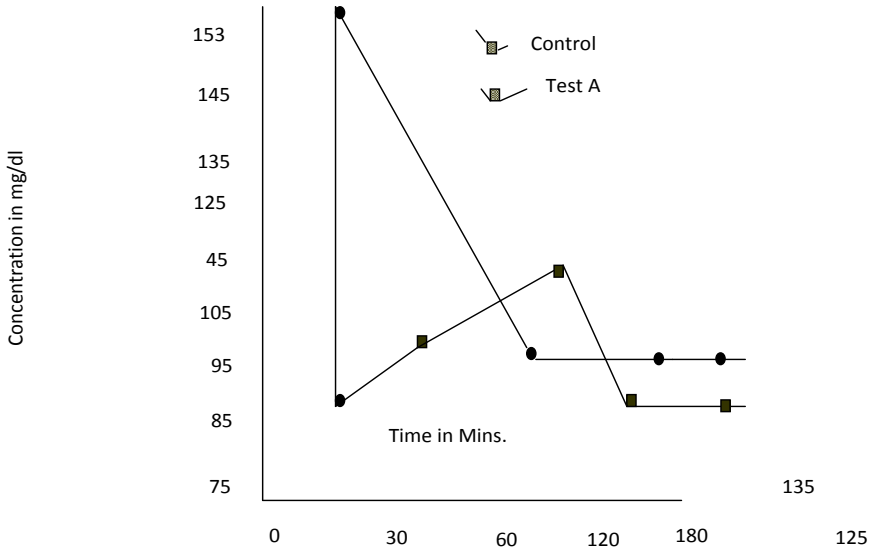

Fig. 1 Blood Glucose response in premature boiled plantain variety A and control (glucose D)

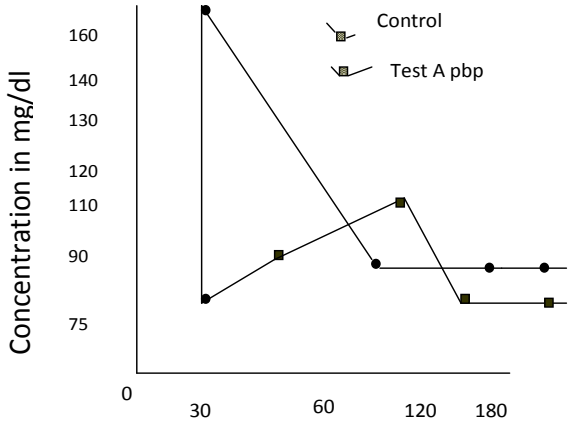

Fig. 2. Graphical representation showing the glucose response area for blood premature flour plantain variety A and control (glucose D)

Group 1-6 were given single meal of six test meals different day.

Group 1-2 sample A of pbp and ppf
Group 3-4 sample A of pbp and ppf
Group 5-6 sample C of pbp and ppf

The serving size was determined by calculating the quantity of the test food that will give 50gm carbohydrate when eaten (Ayodele, et al 2010). Blood samples were collected before feeding (0 mins.) and at 30, 60, 120 and 180 min. after the meal was given. The subjects were not allowed to perform strenuous activities on the day of GI determination (Ayodele et al 2010);

Determination of blood glucose

All subjects for the study fasted overnight according to Ayodele et al 2010. Their blood samples were collected through finger prick using a hypodermic needle or lancets. Each blood sample was placed on a test strip which was inserted into a calibrated glucometer (Accu-check/one touch) which gave direct readings after 45 seconds based on glucose. Oxidase

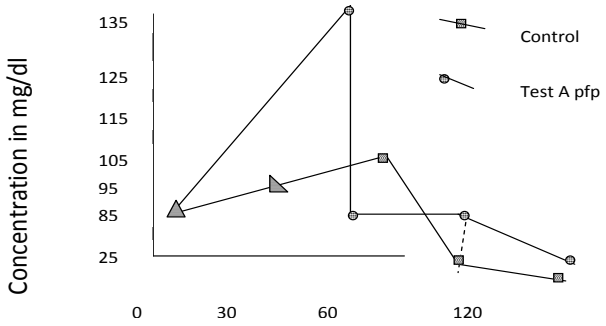

Fig 3 Graphical representation showing the glucose response area for premature boiled plantain variety B and control (glucose)

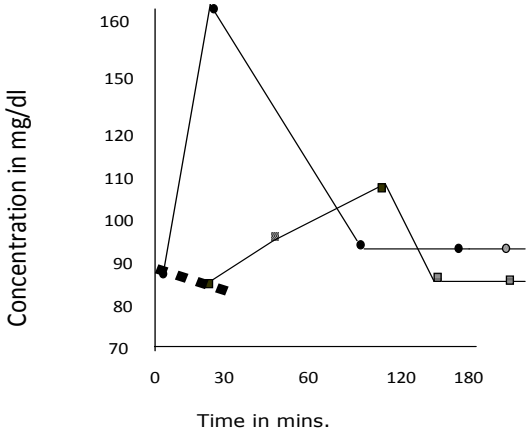

Fig. 4 Blood glucose response in plantain flour variety B (glucose D)

assay method. The determination of glucose level was done at intervals ie 0 (fasting level) 30 mins, 60 mins, 120 mins and 180 mins. (Willett et al, 2002).

Glycemic Index Determination

Changes in blood glucose concentration were calculated separately for each post meal period for each species by using the blood concentration before meal (time 0) as a baseline. Postprandial responses were compared for maximum increase and incremental area under the glucose curve for each food. The integrated area under the postprandial glucose curve was calculated by trapezoidal method (Wolever et al, 1987). Area increments under the curves for three species were determined for the 3 hour period after the meal the relative glycemic index of each food was calculated as percentage of the mean of individual area under the glucose response curves (Wolever, et al, 1987).

Statistical Analysis

Statistical analysis was done by SPSS 15 statistical programme comparisons between test foods (pbp) premature boiled plantain and (ppf) premature plantain flour for the species (A,B and C) and control were done by the student's t test ANOVA and Duncan multiple range tests were used to measure significant difference among the GI of tested foods. Statistical significant was set at $P<o.05$

RESULTS

The anthropometry of control and that of test subjects are represented in table 1. The volunteers were aged between 21.00±0.82 to

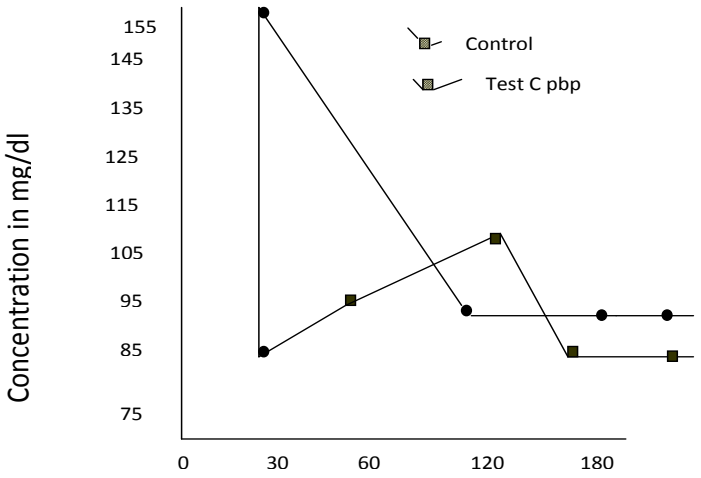

Fig. 5 Blood glucose response in premature boiled plantain variety C and control (glucose D)

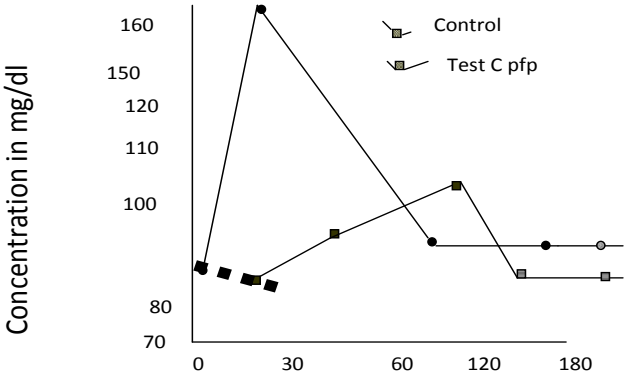

Fig. 6 Blood glucose response in premature flour plantain flour variety C and control (glucose D)

26.74±0.42. Their estimated body mass index (BMI) were 20.32±2.23 to 22.86±1.11kg/m^2.

The proximate analysis of the processed premature varieties plantain meals are shown in table 2.

The percentage carbohydrate contents ranged from 32.82% in pbp variety C to 62.16% ppf variety A Pbp of sample C to the lowest carbohydrate content while ppf in sample B had the highest value. Pbp of sample B had lipid value of 4% while fibre content was found to be highest in ppf sample A value of 11% processing affected the proximate contents. Boiling (moist heat treatment) increased moisture in the boiled premature plantain. However, moisture reduced premature plantain flour. The dried product had more carbohydrate content but moisture content had an inner effect on carbohydrate content. Fiber was highest in the premature plantain flour for all the samples than in boiled processed forms.

Table 3 shows the available carbohydrate content in 100g of the processed meals and the sizes containing 50g available carbohydrate in each of the varieties of the premature plantain. The premature plantain flour meals had highest available carbohydrate in the processed meal which premature boiled plantain had the highest serving size.

The GI of the six processed premature plantain meals are represented in table 4 and figure 7. The GI ranges from 55 for premature boiled plantain varieties to 57 for premature plantain flour meals. The GI showed no significant different among the three varieties used for the study. The premature plantain flour (ppf) groups of the three varieties had glycemic load (GI) of 35 while the premature boiled plantain (pbp) had the lowest 19. The pbp meals had a significantly lower GI when compared to the ppf meals

Figures 1-6 represents the blood glucose response curves for the processed premature plantain meals of the three sample studied.

DISCUSSION

A small peak of blood glucose at 60 minutes was observed for all the test foods of the three samples accompanied by a gradual decline in plasma glucose. The control group showed that the blood glucose rose to a peak at 30 mins and declined rapidly at 90 mins until 180 mins in comparison the subjects who at the premature processed plantain meals had the blood glucose values rose to a small peak after it for the processed foods with a more gradual decline in blood glycose.

The rate, magnitude and duration of the rise in blood glucose that occurs after a meal or food is consumed can be influenced by different factors. The glycemic response is affected by the composition of the food consumed, the amount that is consumed and the health of the consumer (Bahado, Sigh et al, 2000). Consuming sugar alone, such as in sugar sweetened soft drink will cause blood glucose to increase rapidly. The more carbohydrate consumed at one-time, the greater the glucemic response as observed in the study. And consuming carbohydrate in a meal containing fat, protein and/or fiber will slow the rise in blood glucose and is confirmed in the present study fiber forms viscous solution that slow glucose absorption from intestine (ADIA, 1997). The physical form of food, degree and type of processing affect glycemic response (Manders et al, 2005).

The glycemic index of food that contains fiber and protein as well as carbohydrate is about half that is carbohydrate alone. The glycemic index is also influenced by the type of starch (amylase of amylopectin) in the food. The way the food is processed, the physical structure of the food and other macronutrients in food also affect the glycemic index (powell and miller, 1995). The effect of moist heat treatment showed that faster rates of digestion were achieved with premature boiled plantain (pbp) meals of all varieties used in the study. Cooking of plantain allowed the starch granules to swell, gelatinize and increase availability to amylase digestion and thereby increasing starch digestibility (Bahado-sigh net al, 2006). The premature plantain flour test meals were swallowed without chewing. Chewing is said to reduce particle size and increase the surface area of exposure and facilitates amylase digestion of carbohydrates (Omeregie and Osagie, 2008).

There was no glycemic index difference among the test foods for all varieties studies. Which implies that the greater the changes of the physical form of meal, the higher the glycemic responses (Wolever *et al*, 1986). Roasted unriped plantain meal had been confirmed to show lesser glycemic response because unripe plantain starches have only small concentration of free sugar and rapidly digestible starch (Ramdath *et al*, 2004).

The slow digestion of premature starch granule (eg amylase: amylopectin ratio) and its physical association with plant cell wall (fiber) could contribute to reducing total starch gelatinization. The insoluble pectins also known as protopectin present in the unripe fruit is transformed to soluble pectin during the course of ripening. The ripening occurs after maturation. The premature may therefore contain more insoluble pectin than the mature which is ready for ripening. The difference between activities for ripe and unripe fruits is thought to be due to inhibitors present in their unripe fruits, although their nature is not known (Bi ale and Young, 1964). The study conducted with premature plantain might have contained more insoluble pectins and yet to be confirmed.

CONCLUSION

The glycemic responses is influenced by type of starch and the way food is processed. The three varieties of premature plantain meals studied had moderate glycemic indices. The premature boiled plantain meals had lower glycemic load when compared to the premature plantain flour meals. The knowledge of an effective processing methods for dietary staples to control and

reduce hyperglycemia is essential in the treatment of diabetes. Also diet management is very crucial to control spikes in blood glucose levels

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