PROXIMATE COMPOSITION, GLYCEMIC INDEX AND POST PRANDIAL BLOOD GLUCOSE RESPONSES OF NON-DIABETIC INDIVIDUAL TO BREADFRUIT *(Artocarpus altilis)*

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ABSTRACT

The study assessed the proximate composition, glycemic index (GI) and post prandial blood glucose response on non-diabetic individual to fried and boiled breadfruit (Artocarpus altilis). It is an experimental study that involved ten (10) apparently healthy subject selected conveniently from department of Nutrition and Dietetics, The Federal Polytechnic Ilaro. The proximate analysis was conducted using standard analytical methods. Fasting blood glucose level of the subject was determined with the use of one touch basic glucometer, and the subjects were fed with the control (75g of glucose dissolved in 250ml of water) and experimental sample (the quantity of the fried and boiled sample that gives 75g available carbohydrate) on a separate day. The post prandial blood glucose levels of the respondents were taken at 15minutes intervals over a period of 2 hours. Using the values obtained, Incremental area under the curve was determined using trapezoidal rule and the glycemic index values were calculated. Statistical Analysis was done using spss version 20.0. The fried sample had a significant higher ($p< 0.05$) carbohydrate, total ash and crude fat content while the boiled sample was found with the significantly ($p< 0.05$) higher moisture content, crude fiber and crude protein. Slight increase in the post prandial blood glucose was observed at 15 min and 30 min in both samples which latter dropped at 60 min, 90 min and 120 min in an irregular manner. In conclusion breadfruit is rich nutritionally with moderate glycemic index. More awareness on its health benefits is hereby recommended.

Keywords: *Bread fruit, Post prandial blood glucose, proximate composition*.

Introduction

The breadfruit tree (*Artocarpus altilis*) is a tropical South Pacific tree that bears fruit similar to the mulberry. The prickly green food is often considered a fruit when ripe, but a vegetable when unripe. Like potatoes, breadfruit is starchy. Breadfruit is versatile and may be used in a variety of ways, including baking, steaming, frying, sautéing, and adding it to soups and stews (Oyetayo *et al.*, 2006).

Breadfruit is not only a staple crop in many region of the globe, but it's also a nutritious powerhouse. This tropical tree crop known as African breadfruit (Treculia Africana pecne) has been classified into family Moraceae, genus Treculia. About 50 genus/subgenus groups and over a thousand species make up this family. Seeds and buds may be used to grow this plant. This nutritious tree fruit is produced commercially and consumed as a vegetable in Nigeria's humid South Eastern ecological zone and Cameroon's humid rain forest.

The indigenous people of Indonesia and the Pacific Islands have long utilized the fruit pulp as a liver tonic and a cure for liver cirrhosis and hypertension, just to name a few of the breadfruit's purported medical and health advantages. However, there is little scientific data to back up these applications. Prenylated phenolic chemicals, which have anti-inflammatory effects, are abundant in breadfruit. In particular, several studies have shown that chemicals found in breadfruit might alleviate rheumatic and muscle discomfort. Since raw ingredients and food processing techniques are readily available in rural Nigeria, breadfruit seeds may be used to supplement the country's low protein food intake (Ariyo *et al.*, 2015). Vegetable oil (10%), protein (17%), carbohydrates (40%), minerals and vitamins (Oyetayo *et al.*, 2006) are also abundant in the seed. The seed may be used to make a variety of tasty treats, including as porridge. It was also proposed that the act may be used to create pastries, weaning meals, morning cereals, drinks etc.

Commercial breadfruit chip production has begun in Trinidad and Barbados, and uses the softer variety of the fruit. Pinnate lobes are deeply carved into the big, thick leaves. Dominica and Trinidad canned some breadfruits and sent them to London and New York. Vitamin and mineral content in breadfruit is around average, and it's rather low in fat. The unripe fruit, along with the rest of the tree, contains a milky, sticky latex. Some prepare it as porridge with other grains like sorghum; others roast it and sell it as a snack with palm kernels at roadside stands. Because of its adaptability, breadfruit is a vital part of conventional agro forestry systems.

People with diabetes may benefit from eating breadfruit. Consumption of African breadfruit has been linked in certain studies to a decrease in blood sugar. Breadfruit's dietary fiber may also help to slow the digestion and absorption of sugar from other foods. When consumed regularly, breadfruit may lower levels of bad cholesterol (LDL) and raise levels of good cholesterol (HDL) in the body (Sa'Eed, 2016). Consuming breadfruit on a regular basis has been linked to several health benefits, including a decreased risk of colon cancer, reduced blood pressure, and less asthmatic symptoms. Both saturated and unsaturated fatty acids, including the essential omega-3 and omega-6 fatty acid, may be found in abundance in breadfruit.

Consuming foods like breadfruit that are abundant in dietary fiber may causes blood glucose to increase more slowly and to a lower maximum than eating meals high in quickly digested and absorbed carbs. Thus this study was conducted post prandial blood glucose response of non-diabetic individual to a meal produced from breadfruit and the glycemic index of the meal was also calculated.

Materials and Methods

Study area

The study was conducted in Dietetic Kitchen of Nutrition and Dietetics department, The Federal Polytechnic Ilaro, Ogun State.

Selection of the study participants

Ten (10) healthy and non-diabetic subjects (six females and four males) were recruited from The Federal Polytechnic Ilaro. The selected subjects visited the Nutrition and Dietetics kitchen of The Federal Polytechnic Ilaro on three separate days to consume either a control meal (glucose) or a test meal (boiled and fried breadfruits). They were asked to fast overnight of the test day which was separated by one week in order to check carry over effect. The subjects were supervised during the experiment and the mean of the values obtained was determined.

Test food preparation and test procedures

Two food which comprises of two matured breadfruits (*Artocarpus altilis*) were tested. They were prepared in two different ways as follows;

- Boiled breadfruit
- Fried breadfruit

The boiled test food sample was prepared by washing the matured breadfruit under running tap water, peeled and cut into slices. The slices were boiled at 100ºC in an aluminum pot for 20 minute in little quantity of water and a pinch of salt for thirty minute.

The fried test food sample was prepared by washing the breadfruit under running water, peeled and cut into slices. The slices were deep fried at 150ºC. The breadfruits were turned occasionally until slightly golden brown. All test food samples were cooked at room temperature for about five minutes.

Raw bread fruit
↓
Washing
↓
Peeling

Washing

Boiling Frying

Figure 1: Production of the samples

Reference food standard (Glucose)

The method used for measuring and calculating the glycemic index (GI) of the food was in accordance with WHO/FAO recommendation. Glucose was used as reference food. 75g glucose (Glucose-D) was made up with 250ml water. Subjects were given 250ml of water to drink with test foods. Feeding was completed within 15 minutes on all the feeding days. Blood samples were obtained from the antecubital vein at 0 min, 15, 30, 45, 60, 90 and 120 minutes after the consumption of the samples. The blood glucose was determined by Gluco Dr. and AccuCheck glucometer.

Test procedure/ experimental design

The subjects were asked to observe an overnight fasting for 10-12 hours from a day before the test day to the morning of the test day. On the test day, the research subjects arrived at the laboratory in the morning and they were allowed to rest for 30 minute before starting the test procedure. Thereafter, the fasting blood glucose of the entire study participants were determined and recorded. The reference food (glucose solution) was administered to the study participants and the post prandial blood glucose was determined at 30, 60, 90 and 120 minute using a glucometer. The test was conducted on each of the samples (reference food, boiled sample and fried sample) on a separate day, with two days interval.

Blood glucose determination

The pre and post pandial blood glucose was determined using Gluco Dr. and AccuCheck glucometer. A drop of blood was applied to a disposable test strip that had undergone chemical treatment and inserted into an electronic blood glucose meter. The meter detects the response between the test strip and the blood and displays it in mg/dl or mmol/l.

Calculation of glycemic index

The glycemic index was calculated by dividing the area under the curves for glucose responses in giving test meal by area under the curve for the glucose response in glucose meal multiplied by 100. The area under the curve of both the test meal and the reference meal was calculated using tripizodial rule. The final glycemic index for each test food was calculated as the mean from the respective averages GIs of the ten (10) individual research participants. The following formula was used:

$$GI = \frac{\text{Area under the curve for glucose response in given test meal}}{\text{Area under the curve for the glucose response in glucose meal}} * 100$$

Proximate analysis

The breadfruit was harvested fresh, boiled/fried and analyzed according to standard procedure. The proximate analysis of the samples was determined using the method described by AOAC (2003).

Ethical consent

Ethical approval was obtained from ethical committee of The Federal Polytechnic Ilaro, Ogun State. The subjects were also informed about the nature and what the study was all about and their written informed consent was obtained before the experiment was conducted.

Data analysis

The mean and standard deviation of the data obtained from proximate analysis was computed using statistical package for social science (spss v.20.0). Student T test was used to determine the significant between the mean value.

Results

Table 1 present the mean and standard deviation of the proximate composition of the samples (fried bread fruit and boiled bread fruit). Significant difference ($p < 0.05$) was observed between all the proximate compositions of the samples. Specifically, the fried sample had a significantly higher crude protein (1.94±0.03%), carbohydrate (47.535±0.09%), crude fiber (8.63±0.01%), total ash (1.91±0.03%) and crude fiber (19.21±0.02%) while the boiled sample had a higher moisture content and the difference was significant ($P < 0.05$)

Table 1: Proximate composition

Sample	Moisture content (%)	Crude protein (%)	Carbohydrate (%)	Crude fiber (%)	Total ash (%)	Crude fat (%)
Fried	20.78±0.04	0.82±0.03	47.535±0.09	3.69±0.02	1.91±0.03	19.21±0.02
Boiled	77.71±0.04	1.94±0.03	16.92±0.03	8.63±0.01	0.7±0.03	0.17±0.01
t	1457.7	39.59	450.17	274.29	42.78	1055.87
p-value	0.00*	0.01*	0.00*	0.00*	0.01*	0.00*

**Significant at p< 0.05*

Table 2 presents the total carbohydrate, available carbohydrate, dietary fiber, and the quantity of sample consumed by the study population. The available carbohydrate was gotten by subtracting the dietary fiber from total carbohydrate and the quantity of the sample that gives 75g of the available carbohydrate was consumed by the study population.

Table 2: Weight of test foods fed to volunteer

S/N	Test food	Total CHO (g/100g)	Dietary fiber (g/100g	Available CHO (g/100g	*Quantity of sample fed (g)
1	Fried sample	47.535±0.09	3.69±0.02	43.85	171.0
2	Boiled sample	16.92±0.03	8.63±0.01	8.29	903

*Total CHO = Total carbohydrate; Available CHO = Available carbohydrate, * quantity of sample that provide 75g of Available CHO.*

The figure 2 presents the mean incremental blood glucose response of the respondent on glucose (Reference food), fried sample and boiled sample. The post prandial blood glucose response of each of the sample (control, fried and Boiled) was evaluated on a separate day respectively.

As presented in figure 2, the mean fasting blood glucose level of the study population before the glucose solution was consumed was 145mg/dl. At 15minutes, it increases to 198.2mg/dl. At 30 minutes, the blood glucose response decreases to 160.2mg/dl. The blood glucose response remains constant at 45 minutes. 60 minutes after, it increases to 154mg/dl. At 90 minutes, there was a decrease in the blood glucose response to 134mg/dl and to 127mg/dl at 120 minutes

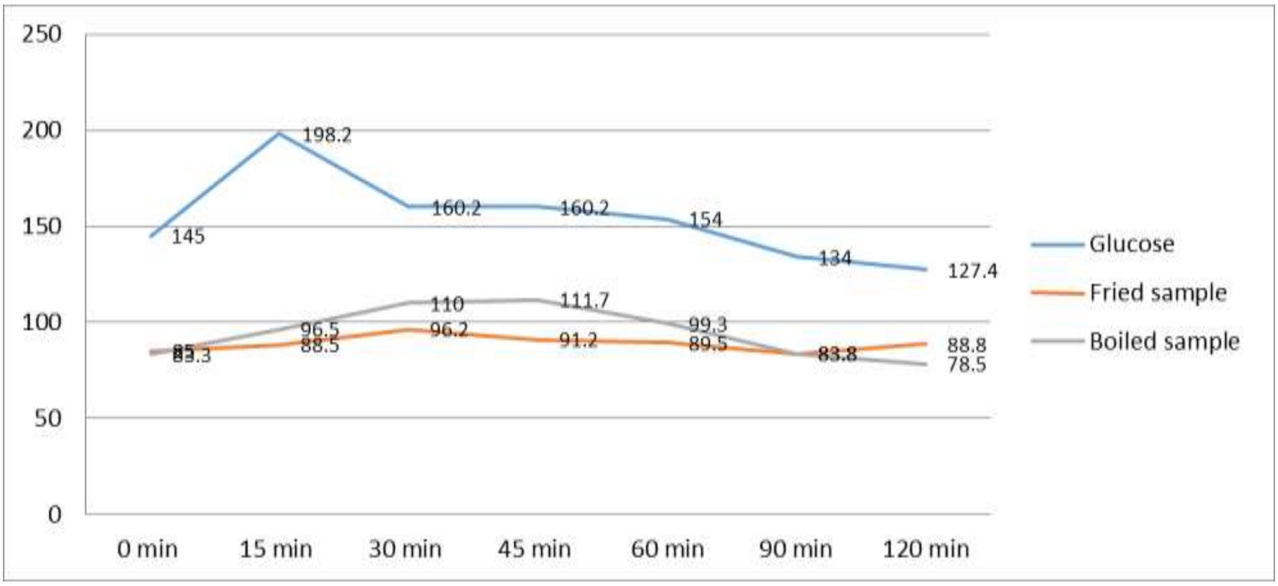

Fig2: Mean incremental blood glucose level of the respondents.

Also the fasting blood glucose of the study participants on the second day was found to be 85mg/dl. Thereafter the post prandial blood response to the fried sample was determined. At 15 minutes, the post prandial blood glucose increases slightly to 88.5mg/dl and to 96.2mg/dl at 30 min. At 45 minutes, it decreases to 91.2mg/dl and to 89.5mg/dl after one hour. There was also a decrease in the post prandial blood glucose at 90 minutes to 83.8mg/dl and slightly increase was observed at 120 minutes to 88.8mg/dl.

For boiled sample, the mean fasting blood glucose value was discovered to be 83.3mg/dl. At 15 minutes, it increases to 83.3mg/dl. The blood glucose response increases at 30 minutes and 45 minutes to 110mg/dl and 111.7mg/dl respectively. At 60, 90, 120 minutes, the blood glucose response decreases to 99.3mg/dl, 83.8mg/dl and 78.5mg/dl respective.

Table 3: Glycemic index and incremental area under the curve of the food samples

Sample	Incremental area under the curve	Glycemic index value
Glucose solution	16,158.14	100
Boiled sample	9984	62
Fried sample	9190	57

Table three (3) presents the value of the incremental area under the curve for the glucose solution and the test samples (boiled and fried bread fruit) as well as the glycemic index of the samples. The incremental area under the curve for glucose solution, boiled sample and the fried sample was found to be 16,158.14, 9984 and 9190 respectively while the glycemic index was found to be 100, 62 and 57 respectively.

Discussion

The present study assesses the proximate composition, glycemic index and post prandial blood glucose responses of non-diabetic individual to breadfruit *(artocarpus altilis)*. Significant difference ($p< 0.05$) was observed between all the proximate compositions of the samples. Specifically, the fried sample had a significantly higher crude protein, carbohydrate, crude fiber, total ash and crude fiber while the boiled sample had higher moisture content and the difference was significant ($P < 0.05$). The value of the protein content of the cook sample in the present study was discovered to be lower than the value reported by Davidson *et al.*, 2016 and Okorie *et al.*, 2010. This variation may be attributed to the factor like; the cooking time, cooking procedures and the temperature at which the sample was cooked. This assertion was investigated by Oulat *et al.*, 2013, in a study conducted on effect of cooking time on the proximate and mineral composition of bread fruit grown in Abijan, Cote D'ivoire and increase in cooking time was discovered to reduce the protein content of the breadfruit sample. Various researchers (Ohishi *et al.*, 2003, Akaerue and Owuamanam, 2010, Nzewi *et al.*, 2011) have also give credence to this. Moreover, the protein content of the fried sample was found to be significantly ($p< 0.05$) lower than that of the boiled sample and this may be due to increase in cooking temperature as frying require higher temperature than cooking.

The moisture content of the fried sample was found to be significantly ($p< 0.05$) lower than that of the boiled sample. About 50 % reduction in the moisture content was observed between boiled sample and the fried sample. The differences in the moisture content can be due to the effect of heat on the sample as well as the loss of moisture as a result of evaporation from the fried sample (Irie *et al.*, 2004). Higher moisture content observed in the boiled sample indicate higher perishability of the boiled sample compared with the fried sample as well as the lower shelf life of the sample (Ariyo *et al*., 2015; Ejikeme *et al*., 2010; Nzewi *et al.*, 2011). Conversely, reduced moisture content discovered in the fried sample will reduce the likelihood of microbial proliferation and enzymatic deterioration which can hasten the spoilage of the sample.

Carbohydrate content of a food present or show the quantity of useful energy in a food. The carbohydrate content of the fried sample (47.535±0.09) was found to be significantly ($P< 0.05$) higher than that of the boiled sample (16.92±0.03). Similar trend was reported by Ariyo *et al.,(* 2015) in a study conducted on Nutritional and anti-nutritional composition of raw, boiled and roasted african breadfruit (*artocarpus altilis*) pulp. Higher carbohydrate content discovered in fried sample compared to the boiled sample can be attributed to or due to the leaching of the of soluble sugars in to the boiling water (Baiyeri *et al.*, 2011). Moreover, decrease in the protein and increase in the carbohydrate with the increase in temperature can be attributed to the action of Glucogenic amino acids that are broken down to glucose and increase the carbohydrate composition of the sample (Wagle and Ashmore, 1961)

Dietary fiber perform so many function like prevention of constipation, occurrence of heart related disease, diabetes mellitus, hypercholesterolemia etc. In the present study, significant difference was observed between the crude fiber content of the two samples. The boiled sample had the higher fiber content and the difference was significant ($p< 0.05$). However, the fiber content in of the boiled sample in the present study is higher than the value reported in some previous studies (Ariyo *et al.*, 2015, Oulat *et al.*, 2013 and Okorie *et al.*, 2010). Also the fried sample had significantly higher ash content than the boiled sample. The reduction or loss in the ash content of the boiled sample can be due to the leaching of the nutrient into the cooking water as well as the duration of cooking as opined by Okorie, 2010. Higher ash content of the fried sample implies that the sample will be very rich in mineral compare with the boiled sample. Furthermore, the fat content of the fried sample was found to be higher than that of the boiled sample. This can be specifically due to the frying process the sample was exposed to. However, the fat content of the boiled sample in the present study was lower than the values reported in other previous studies; Okorie, 2010; Ariyo *et al.*, 2015 and Oulat *et al.*, 2013)

The present study also evaluates the post prandial blood glucose response of the non-diabetic individual to the samples (reference food, fried and boiled sample) using a total number of 10 non-diabetic individual. The mean fasting blood glucose level of the study population before the glucose solution was consumed increases slightly at fifteen (15) minute after it was consumed and reduces slightly at thirty (30) minute. It remains constant at 45 minute, increases at sixty (60) and ninety minute and decreases at 120 minute. Also the fasting blood glucose of the study participants on the second day was found to be 85mg/dl. Thereafter the post prandial blood response to the fried sample was determined. At 15 and 30 minutes the post prandial blood glucose increases slightly to 88.5mg/dl and to 96.2mg/dl at 30 min. At 45 minutes, it decreases to 91.2mg/dl and to 89.5mg/dl after one hour. There was also a decrease in the post prandial blood glucose at 90 minutes to 83.8mg/dl and slightly increase at 120 minutes to 88.8mg/dl. Similar trend was observed in boiled sample, the mean fasting blood glucose value was discovered to be 83.3mg/dl and the values increases at 15 minute, 30 minute and 45 minute and decreases slightly at 60, 90 and 120 minutes.

Using the mean value of the blood glucose response to the sample, the incremental area under the curve of each of the food samples was calculated using a trapezoidal rule and the value obtained was used to calculate the glycemic index of the samples. The incremental area under the curve for glucose solution, boiled sample and the fried sample was found to be 16,158.14, 9984 and 9190 respectively while the glycemic index was found to be 100, 62 and 57 respectively. i.e. the glycemic index of the boiled sample was found to be 62, while that of fried sample was found to be 57. Though, limited work has been done on the glycemic index of bread fruit but the value gotten in the present study is very close to values reported by other researchers. Ragone, (2018) reported that breadfruit has a glycemic index that can be rated as low to moderate when cooked which falls between 47 to 72. The low to moderate glycemic index of breadfruit discovered in the present study shows that this staple food will help in preventing the occurrence of disease like coronary heart disease, help in regulating food intake by increasing the felling of fullness and also help in regulating glucose and lipid metabolism (Rizkalla *et al.*, 2022). Due to its low to moderate glycemic index, breadfruit will also play an important role in improving insulin sensitivity which will help in reducing the risk of type II diabetes. Breadfruit has also been reported by Erland *et al.*, (2023) to have a property of resistant starch. This implies that it has the ability to resist enzyme breakdown during digestion which also contribute to its low glycemic index and for better control of diabetes mellitus.

Conclusion

Significant difference ($p < 0.05$) was actually observed in the proximate properties of the two samples. The moisture content, crude protein and crude fiber of the boiled sample was significantly higher than that of the fried sample while the carbohydrate, total ash and crude fat composition of fried sample was also significantly higher than that of the boiled sample. Slight increase in the post prandial blood glucose was observed at 15 min and 30 min in both samples which latter dropped at 60 min, 90 min and 120 min in an irregular manner. The two sample were discovered to have moderate glycemic index

Recommendation

Breadfruit has a moderate glycemic index. It is also rich nutritionally thus; public and media enlightenment and sensitization should be conducted to educate different communities on the health benefit of this under-utilized staple food, in particular on how diseases like diabetes mellitus can be managed using indigenous food like breadfruit.

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Appendix

Calculation of Area Under the Curve Using Trapezoidal Rule

Glucose solution

$$\int_a^b f(x)dx \cong \frac{b-a}{2n}[f(x_o)+2(f(x_1)+f(x_2)+\cdots+f(x_5))+f(x_6)]$$

$$=\frac{120-0}{2*7}[145+2(198.2+160.2+160.2+154+134)+127]$$

$$=\frac{120}{14}[145+2(806.6)+127]$$

$$=\frac{120}{14}(1885.2)$$

Boiled sample.

$$\int_a^b f(x)dx \cong \frac{b-a}{2n}[f(x_o)+2(f(x_1)+f(x_2)+\cdots+f(x_5))+f(x_6)]$$

$$=\frac{120-0}{2*7}[83.3+2(96.8+110+111.7+99.3+83.8)+78.5]$$

$$=\quad \frac{120-0}{2*7}[83.3+2(501.6)+78.5]$$

$$=\frac{120}{2*7}[1164.8]$$

=9984.

$$\text{GI} = \frac{\textit{Area under the curve for glucose response in the given meal}}{\textit{Area under the curve for the glucose response in glucose meal}} * 100$$

$$=\frac{9984}{16{,}158} \quad *100$$

= 62

Area under the curve for the fried sample

$$\int_a^b f(x)dx \cong \frac{b-a}{2n}[f(x_o)+2(f(x_1)+f(x_2)+\cdots+f(x_5))+f(x_6)]$$

$$=\frac{120-0}{2*7}[85+2(88.5+96.2+91.2+89.5+83.8)+88.8]$$

$$=\quad \frac{120-0}{2*7}[85+2(449.2)+88.8]$$

$$=\frac{120}{2*7}[1072]$$

=9190.

$$\text{GI} = \frac{\textit{Area under the curve for glucose response in the given meal}}{\textit{Area under the curve for the glucose response in glucose meal}} * 100$$

$= \frac{9190}{16,158} * 100$

= 57