

# Glycemic Index of Selected Nigerian Foods for Apparently Healthy People

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## Abstract

**Background:** The relevance of obesity and hypertension as an important public health challenge is increasing worldwide. This research work was carried out to determine the Glycemic index of bean products.

**Methods:** Four beans products (Beans served with stew, Akara, Moinmoin and Ofuloju) from the same cowpea specie (*Vigna unguiculata*) with different processing methods (boiling, steaming, frying) were evaluated. 50 g Oral glucose-D was used as standard food. Mineral analysis and Glycemic index were determined using standard method.

A total of ten (10) healthy volunteers were used in the study. The volunteers consisted of three (3) males and seven (7) females. Sociodemographic, Body Mass Index (BMI) of the subjects were assessed using a structured questionnaire and weighing scale respectively. A total of four bean products namely, Beans served with stew, Akara, Moinmoin and Ofuloju were given to the subjects after which blood sample was collected using a glucometer (on-call-plus).

**Results:** The result of the socio economic characteristic shows that the age of the subjects ranged from 23-30 years, Height ranged from 1.57 - 1.48 m, weight ranged from 45-56 kg while their BMI were between 20.27 - 23.81 kg/m<sup>2</sup>. The result of the mineral analysis showed that Moinmoin had the highest iron content (5.7) while Akara had the lowest content (0.02), Akara had the highest Magnesium content (3.5) while beans served with stew had the lowest Magnesium content (2.9). Beans served with stew had the highest zinc (0.05) while Akara had the lowest zinc content (0.02). The Glycemic Index (GI) of beans served with stew was 56, Akara was 44, Moin-moin was 41 while Ofuloju was 54.

**Conclusion:** The GI results revealed that bean product can be consumed with restriction.

**Keywords:** Glycemic index; Bean; Body mass index

## Introduction

Glycemic index [1] is the increment area under blood glucose response curve of 50 g carbohydrate, portion of a test food expressed as a percent of the response of the same amount of carbohydrate from a standard food taken by the same subjects [2]. It is usually determined by measuring the effect of 50 g available carbohydrate as test food on blood glucose when compared with that of a control food which is usually glucose of white bread [3]. Glycemic Index (GI) of food has been classified as 0-50 low, 56-59 as medium and >70 as high [4].

Low post prandial glucose concentration diets are with a reduced risk for the development of diabetes mellitus, obesity and cardiovascular disease [5]. Foods that raise blood sugar and steadily give continuous energy are low Glycemic index food while high Glycemic index foods includes a sharp rise in blood glucose, which declines within a short time [6]. The concept of Glycemic index has been developed to supplement information available on the chemical composition of foods given in food tables [4]. Wolever [7] reported that the GI of a food, as listed in the Glycemic Index Table is a significant determinant of glycaemic responses of mixed meals consumed by normal subjects.

Food legumes are important source of protein in developing countries [8]. Legumes contain 2-3 times more protein than cereals and are also good source of dietary carbohydrate [9]. Grains legumes, especially cowpeas are widely consumed in Nigeria [9]. Different processing methods such as boiling, steaming, frying, soaking, dehulling and grinding are often combined to produce different products that are eaten as snacks or main meal [10].

Cowpea (*Vigna unguiculata*) is an important source of plant protein in West Africa unlike other legumes such as soybeans and groundnut which is oil protein seeds; cowpea is starch protein seeds offering a wider pattern of utilization than any other legume in West Africa [11]. Cowpea serves as a cheap leguminous plant belonging to the fabaceae

family. It originated from Africa and is now widely grown in Africa, Latin America and Southeast Asia and in the Southern United State [12]. Cowpea, like other grain legumes is an important foodstuff in tropical countries [13] because of its use mainly as a grain crop, a vegetable or fodder for animals. Cowpea is highly valued for its ability to tolerate drought and high protein content of about 25% [14]. These qualities make it a choice crops for catering the food security needs of societies. Nutrient provided by cowpea make it extremely valuable where many people cannot afford protein from animals sources such as meat and fish [15].

Glycemic index of food is of growing interest public health research. It helps to guide the general public on type of food consumed. Majority of foods consumed are high in Glycemic index including beans [16,17]. Little or no information is available on Glycemic index of processed beans products. Beans are widely consumed in Nigeria by different categories of people [3].

The availability of different bean products in the South west agricultural zone of Nigeria especially Abeokuta in Ogun state makes local bean products useful for the control of post prandial rise of blood glucose. There is need for more research into the Glycemic index of our locally consumed foods in order to produce data that can

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effectively enable the use of Glycemic index along with other dietary recommendation in the treatment and prevention of diseases.

## Aims and Objective

The study aims at determining the Glycemic index of selected Nigerian foods for apparently healthy people

## Materials and Methods

The raw cowpeas (*vigna unguiculata*) used were purchased from Kuto market in Abeokuta city, Ogun state, Nigeria. Cowpeas used were prepared using standard local culinary method obtainable in Nigeria.

### Preparation of foods

**Glucose:** Glucose D manufactured by Evans (Nigeria) limited was used. 50 g glucose already measured and packed in sachet was dissolved in 250 mmol of clean drinking water. This solution was served to each of the ten healthy volunteers.

- Prepared bean products
- moin-moin
- Akara
- Beans served with stew
- Gbegiri
- Ofuloju Served with stew

**Beans:** Beans seed were sorted, soaked for (15-20 min) in cold water then the hull was removed from the beans manually to remove the seed coat and then wet milled into paste to produce beans paste.

**Moin-moin:** Moin-moin is a gelled product made by steaming wet milled beans. 700 g of whole beans were soaked in excess water for 20 mins, washed and dehulled. The dehulled seeds were grounded with 170 g or 6 table spoons fresh pepper, 600 g onions and 150 g crayfish. Thereafter, the paste was poured into a bowl, mixed and 100 ml of palm oil with seasonings to taste were added. The mixture was stirred with the addition of 4 L of water and wrapped with banana leaves and steamed for about 1½ hours to cook.

**Akara:** 5 milk cups (handy measure) of whole beans were soaked in excess water for 20 mins, washed and dehulled. The dehulled seeds were grounded; air was incorporated into the cowpea paste with a whisked for 30 mins, adding a small quantity of water allowing the paste to become thick. Frying salt was added to the mixture. Onion and pepper were added to the mixture. The small balls (approximately 25 g) were fried in deep hot fat for 3 mins to balls which were golden brown and crisp.

**Gbegiri:** Soaked cowpeas were removed and dehulled, cooked until it was soft (about 1 hour) after which it was mashed using a wooden spoon. Water was added to obtain desired thickness; the ingredients were added. It was then cooked until taste.

**Ofuloju:** Whole beans were soaked in excess water for 20 mins, washed and dehulled, the dehulled seeds were grounded. Air was incorporated into paste to make it very light; it was covered with leaves. It was cooked and served.

**Subjects:** Ten healthy human subjects, aged between 23 and 30 years (7 females and 3 males) were selected from students of Moshood

Abiola Polytechnic, Ojere, Nigeria. They were clinically normal, non smokers and non diabetic. The subjects were appraised verbally and they gave verbal consent.

### Method of data collection

The questionnaire was sectionalized as follows: personal data such as age, sex, socio demographic characteristics.

**Anthropometric measurements:** A Heightometer was used to measure the subjects' height and the subjects' weight was measured using a bathroom weighing scale. The reading was done in triplicates to the nearest 0.1 kg to ensure accuracy and the average weight was determined. Body Mass Index was calculated as weight in kg divided by squared height in metre and compared with the WHO scale [18].

**Glycemic index calculation:** Glycemic index was calculated from the blood glucose response curve at 0-180 min, the control and test foods of each subject, the incremental area under the blood glucose response curve (IAUC) for a 50 g carbohydrate portion of each test food and control food (glucose) [19]. Values were expressed as mean and standard error.

**Proximate analysis:** Chemical Analysis on zinc, copper and magnesium were determined on ofuloju, akara, moinmoin, gbegiri and bean with stew using a standard method [1].

### Protocol and determination of blood glucose test of food meals

**Determination of blood glucose:** The blood glucose was determined using the method described by Wolever [7]. Subjects' blood sample was collected through finger print using a hypodermic needle and lancets; the blood sample was placed on a test strip which was inserted into calibrated glucometer which gave direct reading after 45 seconds. Based on glucose oxidase assay method [20], the determination of glucose level was done at intervals i.e 0 (fasting level), 30, 60, 90, and 120 mins.

The finger tips of the subject were wiped clean using cotton wool already dipped in methylated spirit. An already sterilized lancet was used to prick the cleared area from the subject's finger. A glucometer strip which has been inserted into glucometer was used to collect the blood sample from the fingertip and the glucose content is read on the glucometer. A dry cotton swap was given to the volunteer to stop the flow of the blood by adding pressure. Data collected per meal per subject were used to draw a glucose response curve with time and area under the curve was calculated as glucose AUC. The Area Under the Curve (AUC) was calculated to reflect the total rise in blood glucose levels after eating the test mean.

The G1 rating (%) was calculated by dividing the AUC for the body by the AUC for the reference food (Same amount of glucose) and multiplying by 100. The average of the G1 rating from all the ten subjects was then published as G1 of that food.

$$GI = \frac{(\text{Post prandial blood Glucose area of test food})}{(\text{Post Prandial blood Glucose area of reference food})} \times 100$$

**Available carbohydrate:** Available carbohydrate is defined for GI testing purpose as: The sum of starch plus sugars, including sugar alcohols and other slowly absorbable sugar derivatives. A total of 5 diets were analyzed to the starch and sugars which give the 50 g available carbohydrates of the diets. The results were used to calculate the amount in grams of the food to be given to the volunteers.

## Method of data analysis

**GI calculations and statistical analysis:** The incremental Area Under the Blood Glucose Response Curve (AUC), [21] was calculated geometrically as follows:

For times  $t_0, t_1, \dots, t_n$  the blood glucose concentrations are  $G_0, G_1, \dots, G_n$  respectively:  $X = i$

$iAUC = A_x$  where  $A_x$  the AUC for the  $X_{th}$  time interval (i.e between  $t_{x-1}$  and  $t_x$ )<sup>n</sup> from the first time interval (i.e  $X = 1$ ): if  $G_1 > G_0$ ,  $A_1 = (G_1 - G_0)X(t_1 - t_0)/2$

Otherwise,  $A_1 = 0$

If  $G_x > G_0$  and  $G_{x-1} > G_0$ ,  $A_x = \{(G_x - G_0)/2\} (G_{x-1} - G_0)/2X (t_x - t_{x-1})$

If  $G_x > G_0$  and  $G_{x-1} > G_0$ ,  $A_x = [G_x - G_0]/2 (G_0 - G_{x-1}) X(t_x - t_{x-1})/2$

If  $G_x > G_0$  and  $G_{x-1} > G_0$ ,  $A_x = [G_{x-1} - G_0]/2 (G_{x-1} - G_x) X(t_x - t_{x-1})/2$

If  $G_x > G_0$  and  $G_{x-1} > G_0$ ,  $A_x = 0$

GI value was calculated as the IAUC for food expressed as a percentage of the mean iAUC of the reference, food (glucose). Glucose was considered as 100%.

Statistical analysis was carried out using statistical analysis software package (SPSS version 16.0). Multiple comparisons between glucose responses in areas are achieved by analysis of variance (ANOVA) and Pearson's correlation. The weight and height of the subject of the subject were used to calculate their body mass index.

## Glycemic load

The Glycemic Load (GL) of a specific food portion is an expression of how much impact or power the food will have in affecting blood glucose level. These were calculated by taking the percentage of carbohydrate content per portion and multiply it by its glycemic index value.

## Result

Table 1 contains Anthropometric data of the volunteers. A total of ten (10) subjects were used in this research study according to the World Health Organization Recommendation for minimum subjects. This was made up of three (3) males of seven (7) females. Table 1 presents the results of the socio economic characteristics of the subjects. The age of the volunteers ranged from years 23-30 years. The weight was found to be between forty five (45) kg – Fifty six (56) kg. The height of the subjects ranged from 1.48 – 1.57 m. The Body Mass Index (BMI) of the female subjects ranged from 20.27-23.81 kg/m<sup>2</sup> while the male subjects ranged from 21.25–24.24 kg/m<sup>2</sup>. The volunteers fasting blood glucose

Volunteers	Sex	Weight (kg)	Height (m)	Height (m <sup>2</sup> )	Age yrs	BMI (kg/m)	FB (mmol)
1	F	51	1.53	2.34	27	21.79	5.3
2	M	51	1.54	2.37	21	21.52	4.5
3	F	50	1.48	2.1	25	23.81	3.1
4	F	52	1.54	2.37	24	21.94	4.7
5	F	49	1.52	2.31	30	21.21	3.4
6	F	45	1.49	2.22	24	20.27	5.9
7	F	48	1.52	2.31	28	20.78	5.9
8	M	56	1.52	2.31	23	24.24	6.2
9	F	49	1.53	2.34	23	20.94	6.2
10	M	53	1.57	2.45	27	21.63	6.4

Table 1: Anthropometric characteristics of the subjects.

ranged from 59 mmol–87 mmol. Levels were within the normal range.

Table 2 reveals the mineral content of the tested diet. It shows that Moin-Moin had the highest Iron content (5.7 mg) while Akara had the lowest Iron content (0.02 mg), Akara had the highest Magnesium content (3.5 mg) while Beans with stew had the lowest magnesium content (2.9 mg), and Boiled beans had the lowest Zinc content (0.15 mg) while Akara had the highest Zinc content (0.2 mg).

Table 3 shows that the available carbohydrate and Glycemic load of the four tested diets.

The available carbohydrate and Glycemic load of the foods are shown in table 3. The available carbohydrate and Glycemic load of Akara had the highest sugar content (3.7 g) while boiled beans had the lowest sugar content (2.5 g). Akara had the highest total available Carbohydrate/100 g (30.0 g) while boiled beans had the lowest total available Carbohydrate/100 g (15.0 g). Also Ofuloju had the highest GL (24.6 g) while moin-moin had the lowest GL (12.71 g).

Table 4 shows the Glycemic index of tested diet. The Glycemic index of tested food shows that boiled beans with stew had the highest IAUC of food (56.01 ± 0.67) while moin-moin had the lowest IAUC of food (41.14 ± 0.61). The Glycemic index of the tested food shows that boiled beans with stew had the highest GI of food (56.01 ± 0.67) while moin-moin had the lowest (41.14 ± 0.61).

## Discussion

Plant foods are consumed by man; they are generally processed. The processing methods include cooking, boiling, frying, steaming, baking, autoclaving. These treatments might have led to their high Glycemic indices [6]. Processing the seed removes the fiber-rich outer bran and the vitamin and mineral rich inner germ leaving endosperm. These treatments cause reduction in particle size and faster gelatinization of starch, thereby increasing the GI. The health implication of the GI of the processed foods is that it could cause a fast and short-lived rise in blood sugar, with the result that one is looking in energy. Legumes produce relatively low Glycemic responses in both healthy individuals and diabetic person [22]. The component present in legumes, particularly the soluble dietary fiber and the nature of the starch can influence the rate by which glucose is released from starch and consequently absorbed from the small intestine. This makes it suitable for use in controlling post prandial rise of blood glucose levels. Bean served with stew had the highest GI among all the meals. It has a GI value of 56.01 ± 0.67

	Iron	Magnesium	Zinc
Boiled Beans With stew	4.3	2.9	0.05
Akara	0.02	3.5	0.2
Moin-Moin	5.7	3.2	0.15

Table 2: Proximate analysis of the mineral contents of the test diets.

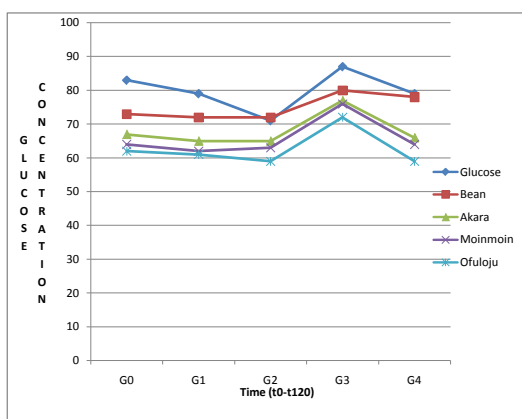
Tested Diets	Starch (%)	Sugar (%)	Total Available CHO/100 kg	Supply Weight of 50 kg Aval CHO	Serving Size	Avail. CHO/ Serving Size	GI	G/L
Beans	12.5	2.5	15.0	333.33	180	27.0	65.01	15.12
Akara	26.3	3.7	30.0	166.66	180	54.0	43.70	23.59
Moin-moin	14.4	2.8	17.2	290.69	180	30.90	41.14	17.71
Ofuloju	21.6	3.6	25.2	198.41	180	45.3	54.40	24.6
Glucose			50.00					

Table 3: Available carbohydrate and Glycemic load of the tested diets.

which is intermediate. Boiled beans served with stew had intermediate classification (56) and (54) respectively while Akara and moin-moin had low GI (43) and (41) respectively (Figure 1).

This trends observed in the results revealed that different processing methods can influence the Glycemic index of the beans products.

The fibre could be responsible for decreasing post prandial glucose by increasing viscosity of the digestible and reduce gastric emptying time. Other factors like the raffinose oligosaccharide component [23], which are not digested in the gastrointestinal tract, and the structure of starch and fiber present in digested in the gastrointestinal tract, and the structure of starch and fiber present in the seeds after processing could be responsible for the low GI. Low Glycemic index diets are important in the management of hyperglycemia and hyperinsulinemia because they have a high satiety effect and therefore can reduce the likelihood of excessive consumption of calories. Adebambo [24] reported GI of 54 for beans presented either as boiled or as dehulled and blended. Also Adebambo [24] comparing bean, with potatoes noted those 4 hours after blood glucose concentrations were still above the basal level suggesting a very slow digestion rate. The fasting blood glucose of the volunteers were found to be within the normal range through the course of this research as supported by Adebambo [24] who reported the normal fasting blood sugar in Africans. The present study has several limitations. For instance, a high Glycemic value of a mixed meal could be the result of consuming a large amount of refined grain (high GI) or one that includes a variety of whole-grain nutrient-dense CHO, insoluble fiber that are high in CHO and still moderately high in GI, therefore, the GL values of mixed meals, are in themselves, not very informative. Another limitation is that the subjects were healthy adults and the glycemic responses of the leguminous foods of adults living with conditions such as obesity, in the context of the present study are not known. Therefore the results are only applicable to healthy adults and not those living with diseases, and future research should also focus on obese adult segment of the Nigerian population.



Means of glucose concentration as affected by meals at 30 minutes interval for 2 hours

Figure 1: Means of glucose concentration as affected by meals at 30 mins interval 2 hrs.

Test diet	IAUC of food	IAUC of glucose	GI of food	Classification	p value
Bean	56.01 ± 0.67a	99.9 ± 0.1b	56 ± 0.19a	Intermediate	0.76
Akara	43.70 ± 0.61b	99.9 ± 0.1b	44 ± 0.15b	Low	0.59
Ofuloju	54.40 ± 0.67a	99.9 ± 0.1b	54 ± 0.39a	Intermediate	0.57

Means with different letters are statistically significant

Table 4: Glycemic index of the food products.

## Conclusion

The results of this study support the consumption of cowpea (*Vigna unguicalata*). The different processed beans product analyzed in the present study elicited low GI and GL values. Boiled beans served with stew and Ofuloju had intermediate classification of (56 ± 0.19) and (54 ± 0.39) respectively.

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