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Determination of the Glycemic Indices of Three Different Cassava Granules (Garri) and the Effect of Fermentation Period on Their Glycemic Responses

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Abstract: Three Garri samples (A, B, C) from the same cassava specie (Manihot utillsima) produced at different fermentation time (24, 48 and 72 h) were evaluated for Glycemic Indices (G.I). Oral glucose-D was used as standard food. Proximate analysis including the dietary fibre and glycemic carbohydrate were determined using standard methods. Result showed that dietary fibre decreased with length of fermentation giving values as 15.75, 10.85 and 7.60 for 24, 48 and 72 h respectively. Glycemic carbohydrate increased with length of fermentation giving values as 63.57, 69.11 and 73.05 for 24, 48 and 72 h respectively. Fermentation time affected the glycemic indices of the foods. The G.I values increased from 62, 67 and 73 for 24, 48 and 72 h respectively. Results showed that sample A and B were intermediate GI foods while sample C was a high GI food. The mean glycemic responses of the samples showed significant difference ($p>0.05$). The co-efficient of variation for the standard food was 26%.

Key words: Glycemic index (G.I), glucose, cassava, garri, blood glucose, fermentation, IAUC

INTRODUCTION

Glycemic Index (G.I) is used to classify foods based on their blood glucose raising potential. According to FAO/UN (1997), glycemic index is defined as the incremental 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 subject.

When carbohydrate food is eaten, the sugar (glucose) from the food breaks down during digestion and gives energy. After eating, blood glucose rises: The rate at which the food is able to increase the blood glucose is called the glycemic response while the glycemic index is the measurement of the foods glycemic response as compared with the glycemic response of a standard food (glucose GI = 100 or while bread GI = 71) by same subject(s) Foster-Powel and Brand-miller (1995).

Glycemic response can be influenced by some factors such as how much food is eaten, amount of carbohydrate in the food, nature of the monosaccharide present in the food, other food components (fat, protein and dietary fibre, anti nutrient and organic acids). The tuber-roots of cassava (*Manihot esculenta crantz*) are very valuable source of food energy for millions of people in the tropic especially in sub-Sahara Africa where it ensure food security for large number of people living under unpredictable socio political and ecological circumstances (Sanni, 2001). These tubers can be traditionally processed into various forms, one of which is toasted granules, garri (Sanni, 2001). Cassava is processed through many stages before the final product, garri, is produced. It is speculated that processing can affect the G.I values of foods. Fermentation is a major processing step in garri production. The objective of this study therefore is to determine the glycemic indices of different garri produced from same cassava species but at different fermentation time and to establish the effect of varying fermentation period on the glycemic responses on human subjects.

MATERIALS AND METHODS

Fresh cassava (Manihot utillsima) tubers of Nwaocha family were uprooted by local women at Eziobodo community in Owerri of Imo state. It was followed by steps in garri production as described in Fig. 1 below in line with method used in Coursey (2003).

Proximate analyses: All the chemicals and equipments used for the proximate analyses were domiciled at the department of Food Science and Technology, in Federal University of Technology, Owerrri. The methods used for the proximate analyses, except dietary fibre, were as described by AOAC (1990). The method used for determination of dietary fibre content was as described in FAO/UN (1997).

Determination of glycemic responses of volunteers: The procedures for determination of glycemic responses of volunteers were as described by Wolever *et al.* (1990).

Following 12 h overnight fast, volunteers ate 50 grams available carbohydrate portions of the standard/ reference good (glucose D) and the garri varieties at random on different days. The standard food was repeated three times in each subject and their mean

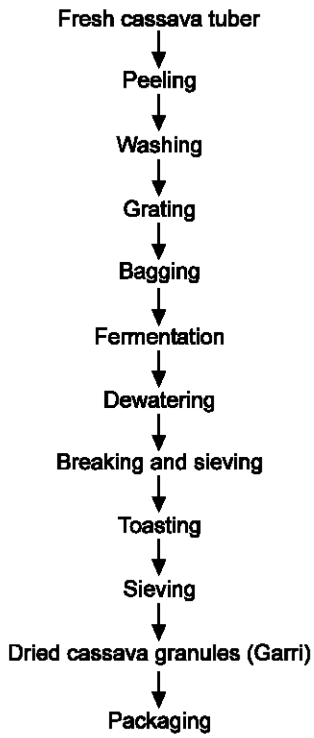

Fig. 1: Steps in garri processing

IAUC' value was calculated as the IAUC of the glucose. Table water was given to each of the volunteers so that total meal volume is greater than 400 ml to stimulate stomach emptying and reduce the variability of glycemic responses. The foods were consumed within 10-15 minutes and the volunteers were asked to remain seated for the duration of the test. Finer prick capillary blood samples were taken from volunteers using blood lancets before eating the meals (0 min) and at 15, 30, 60, 90 and 120 min intervals after consumption of the meals. Whole blood glucose were measured by dropping the volunteers blood at each of the intervals in a test strip and inserting at the test spot of a glucometer (a one touch basic system glucometer) and reading taken immediately. Incremental Area under Curve (IAUC) was measured geometrically using the data obtained from the blood glucose concentration-time graph ignoring area beneath the fasting level (Wolever *et al.*, 1990).

Determination of glycemic index: The IAUC for the garri verities were expressed as percentage of the IAUC of the glucose (standard food). The consumption of the standard food was repeated three times and the IAUCs were calculated. The mean + SD and the coefficient of variation (100 x SD/ mean) were determined. The GI for each subject was calculated as:

$$G.I = \frac{\text{IAUC of test food}}{\text{Mean IAUC of standard food}} \times \frac{100}{1}$$

Table 1: Results of proximate analyses of garri

Constituent nutrients	Percentage compositions Sample A	Sample B	Sample C
Crude protein	4.02	3.94	4.10
Crude fibre	2.30	2.35	2.45
Dietary fibre	15.75	10.85	7.80
Fat	1.25	1.25	1.30
Mineral ash	0.50	0.74	0.90
Moisture	12.61	11.76	10.60
Glycemic carbohydrate	63.57	69.11	73.05

Average of two determinations

Table 2: Mean blood glucose responses (mg/L)

Time (min)	Standard food	Sample A	Sample B	Sample C
0	0.9367	0.8550	0.8767	0.8350
15	1.1317	0.8483	0.8433	0.8933
30	1.3583	0.7967	0.9400	1.0033
45	1.4250	0.8817	0.9917	1.0750
60	1.5350	0.9617	1.9533	1.1400
90	1.2750	1.0267	1.1317	1.2017
120	1.1900	1.0667	1.1700	1.2167

RESULTS AND DISCUSSION

Mean blood glucose response (mg\L): Table 2 showed the mean blood glucose responses of the standard food (glucose D) and that of the test foods {gari fermented for 24 hours (sample A), gari fermented for 48 hours (sample B) and gari fermented for 72 hours (sample C)}. The mean glycemic response of glucose was significantely different from that of the test foods which was suspected to have resulted from the fact that glucose which is the primary form of carbohydrate (energy) moves striaght into the blood stream unlike the other test foods which takes time to first digest into their primary form of carbohydrate before they are absorbed into the blood steam. The table also showed that the glycemic responses also increased with lenght of fermentation i.e it is directely corelated to the lenght of fermentation. The sample C had the highest glycemic response among the test foods which was suspected to have resulted from the lenght of fermentation (action of microbes on the starches in the tuder-root) which favoured the amount of monosaccharides that could be formed from the starch in the food and thus its speed of digestion in the body i.e the glycemic response. Table 1 showed decrease in fibre, protein and fat with length of fermentation. This favours increase in formation of alcohols and subsequent increase in glycemic responses. This is in line with Onyeka (2002) who stated that a mole of alcohol will give more energy than a mole of fatty and or protein foods. Matthew and Alfred (2006) stated that alcohol passes through the stomach rapidly, with little change, unlike starch which is normally retained in the stomach, for more thorough digestion while protein requires more time for gastric emptying. Table 1 also showed increase in the glycemic (digestible) carbohydrate with length of fermentation

Table 3: G.I values for the foods

Volunteers	Sample A	Sample B	Sample C
1	60.1428	64.2426	67.6321
2	63.2356	63.9321	65.3129
3	65.3672	68.2011	75.2022
4	59.8325	67.5823	78.3921
5	61.1010	65.3720	69.4055
6	64.3294	73.8729	82.7704
Mean G.I	62.3348	67.2005	73.1192

which could be as a result of decrease in the fibre content due to degradation of Resistant Starches (RS1) (Matthew and Alfred, 2006). Table 2 also showed that oral glucose caused rapid increase in blood glucose level of the volunteers after 15 min of consumption but started reducing after 60 min unlike the other food samples (test foods) which showed very slow rate of increase in blood sugar after 15 min of consumption and was gradually but steadily increasing the blood glucose response.

Glycemic index: The glycemic indices of the garri sample were directely correlated with the glycemic responses of the food. The garri processed for 24, 48 and 72 h had the glycemic indices of 62, 67 and 73 respectively. In line with GI scale rating, the garri, produced from the cassava fermented for 24 and 48 h were intermediate glycemic foods while the garri produced from the cassava fermented for 72 h is a high glycemic food (Brand-miller *et al.*, 2003). This could imply that fermentation increases the glycemic indices of the garri with time. The differences in their GI were all significant. The reason could be as a result of the corresponding increase in their mean glycemic responses since they are positively correlated. Ihekoronye and Ngoody (1985) stated that maltose is formed in one stage of fermentation of starch which is further converted to D-glucose when hydrolyzed in aqueous solution i.e. starch-dextrin-maltose-glucose. Hence, increases in fermentation period, may bring about formation of more glucose and subsequent increase in the rate of digesting and absorbing the food (glycemic response) and increase in glycemic index.

Blood glucose curves: The curves of the mean glycemic responses of the food in Fig. 2 showed that the oral glucose caused rapid and thus very high increase in the glycemic response of the volunteers but started decreasing from 60 min which could indicate complete absorption of glucose in a short time. However, the test foods showed gradual but steady increase in the glycemic response of the volunteers throughout the whole exercise.

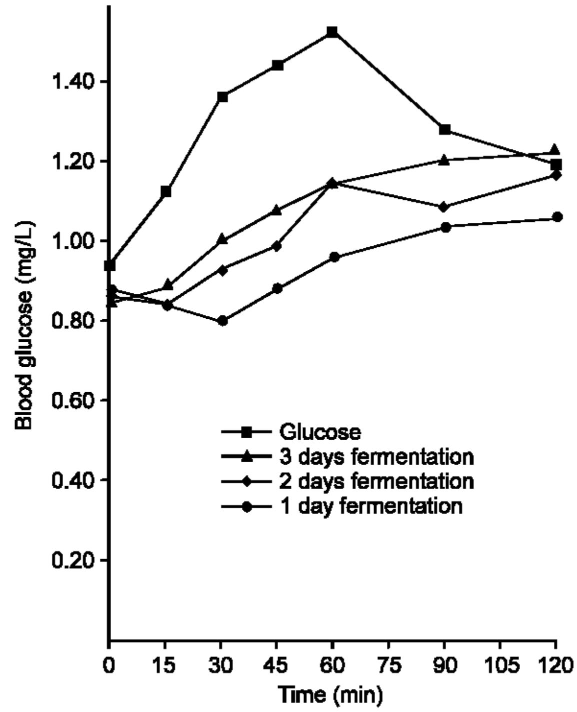

Fig. 2: Blood glucose curves of six non diabetic normal subjects after consumption of oral glucose, garri fermented for; a day, two days and 3 days

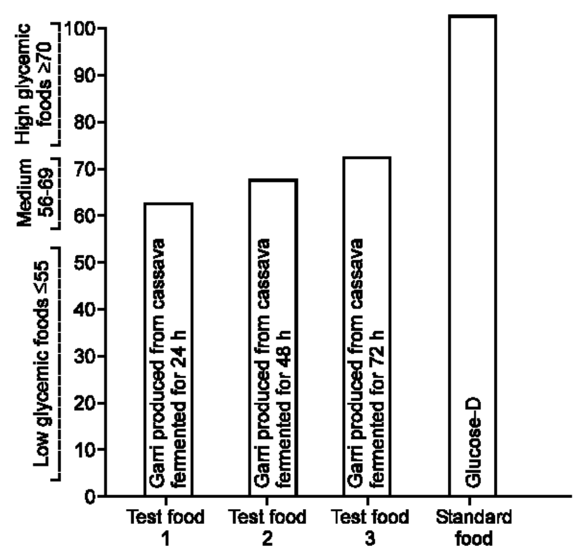

Fig. 3: Bar charts of the glycemic index of the foods

Bar charts: The bar chart of the foods GI showed that glucose had the highest glycemic index while the GI of the other foods increased with length of fermentation.

Conclusion and recommendation: The glycemic index of the garri produced from cassava fermented for 24 h, 48 and 72 h, were 62, 67 and 73 respectively. This implies that the garri fermented for 24 h and 48 h were intermediate glycemic foods while the garri fermented for 72 h is a high glycemic food. The glycemic responses of the foods were positively co-related with length of fermentation in the food. Following the method of Brand-miller *et al*. (2003), garri fermented for 24, 48 and 72 h will move glucose approximately 1.6 (100/62), 1.5 (100/67) and 1.4 (100/23) times slower into the blood than straight glucose.

The garri produced after 72 h fermentation is thereby recommended for consumers in want of immediate energy while garri produced after 48 h fermentation is recommended for consumers in need of gradual but steady energy. The garri fermented for 48 h is preferred against that of 24 h due to the level of cyanide; longer fermentation time will favour lower cyanide content (Sanni, 2001). To avoid obesity and some health related diseases, the garri from cassava fermented for 72 h can best be consumed if made into garri balls ('eba') and consumed with melon ('egwusi') soup rich in fat instead of vegetable soup as fat is known to reduce the rate of absorption of carbohydrate food by trapping sugar molecules whereas vegetable speeds up the rate of digestion by providing excess water that facilitates digestion in the small intestine (FAO/UN, 1997).

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