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Proximate Composition and Glycemic Index of Pupuru Meal: A Staple Cassava Based Diet of Ondo Indigenes

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Abstract

Glycemic index (GI) is a parameter commonly used for ranking foods based on their ability to raise the levels of blood glucose. This study was aimed at determining the proximate composition and the glycemic index of Pupuru. Proximate analysis was done using standard methods. A total of eight rats were divided into two groups with four in each. Group 1 was fed on glucose (2g) while group 2 was fed on cooked pupuru (2g). Blood glucose levels were determined at 0, 30, 60, 90, and 120 minutes. The area under the curve was determined from a graph of blood glucose level against time using trapezoid method; this was then used in calculating the glycemic index. Pupuru contained carbohydrates (80.67%), protein (5.34%), ash (0.25%), moisture (11.34%), fat (0.65%) and crude fiber (1.67%). The glycemic index of pupuru was estimated to be 86.0% respectively. Pupuru is a high glycemic food attributed to its high carbohydrate content.

Keywords: *Pupuru; Glycemic Index; Proximate Composition; Blood Glucose; Diabetes; Cassava; Nutrition*

Introduction

The role of nutrition in the maintenance of life at all phases and stages cannot be over-emphasized. Foods contain nutrients which are essential to the growth and survival of organisms [1]. Proximate analysis of foods is defined as the elementary nutrient composition of foods in terms of protein, moisture, fat, fiber, ash (minerals) and carbohydrate [2]. Glycemic index (GI) is an index for classifying foods based on the increase in blood glucose levels which occurs after the consumption of foods relative to a standard food (glucose or white bread) [3]. The glycemic impact of foods depends on specific factors such as the type of starch in the food (amylose versus amylopectin), physical entrapment of the starch molecules within the food, fat and protein content and organic acids or their salts in the meal [3]. The foods with GI range between 55 or less are termed low GI foods, those between 56 - 69 are termed medium while high GI foods are those that are 70 and above [3]. Information on the glycemic index of foods is necessary for the prevention, management and the treatment of diseases like diabetes, cardiovascular disease (CVD) and some types of cancer and obesity [4]. It has been discovered that the processing, preparation and cooking methods have an effect on the glycemic index of foods [5].

Pupuru is a staple diet made from cassava (*Manihot esculenta* Crantz) and is consumed mainly by people living in the riverine areas of the western, southern, eastern and the middle belts of Nigeria, where it is also known as "Ikwurikwu". The processing of pupuru emanated

from the Ilaje people of the Riverine area of Ondo State, Nigeria [6,7]. Pupuru is made from cassava and has been found to contain high amounts of carbohydrate, but lower contents of protein and antinutrients [8]. Pupuru is fermented traditionally by soaking cassava in water for about three to five days to become soft after which the wet mash is packed into sack and dewatered in a mechanical press. The fibers are then handpicked from the mash and are molded into ball or circular shape and placed over fire to smoke dry. The outer covering is then scraped off with knife and the inner white component is sieved into pupuru flour [9].

There is high incidence of diabetes in recent times; hence, the knowledge of glycemic index of foods will enable individuals to make valuable decisions as regards the foods to be consumed. This will in turn lead to the prevention of type 2 diabetes and better management of diabetes on the long run. This study is a novel one as there has not been any report whatsoever on the glycemic index of pupuru in the literatures. The information obtained in this study will serve as a veritable tool that can be employed in making informed decision about the consumption of pupuru.

Aim of the Study

The aim of this study was to determine the proximate composition and the glycemic index of pupuru meal.

Methodology

Preparation of pupuru meal

Raw pupuru flour was bought from Ondo State and poured in a boiling water and was allowed to cook on medium heat until it formed a solid meal.

Proximate analysis

Pupuru meal sample was taken for proximate analysis. The dry matter, moisture, ash, crude fat, crude protein (Nitrogen x 6.25) and crude fibre contents were determined in accordance with the standard methods of AOAC [10]. The amount of carbohydrate in the sample was estimated based on the net difference between the other nutrients and the total percentage composition.

Experimental animals

Eight Wistar albino rats having body weights between 125 to 200g were purchased from an animal house in Ile Ife, Nigeria and were used for the study. The rats were allowed to acclimatize under standard photoperiodic conditions in a clean cage for two weeks in animal house. They were fed with feed and water only for those two weeks.

Experimental design

After acclimatization, the rats were grouped into two, with four rats in each group. The rats were fasted for 14 hours over the night, and their fasting blood glucose levels were determined with Accu-chek glucose meter and test strips.

- Rats in group 1 were fed with 2g glucose.
- Rats in group 2 were fed with 2g of pupuru meal.

The blood glucose levels of rats in both groups were determined with glucometer at time intervals of 30 minutes, 60 minutes, 90 minutes and 120 minutes after food.

Determination of the glycemic index of pupuru

Total blood sugar level was determined from each of the blood samples with a portable glucometer (Accu-Chek). For glycemic index data, area under the blood glucose curve was calculated as the incremental area under the blood glucose response curve ignoring the area

beneath the fasting concentration. This can be calculated geometrically by applying the Trapezoid rule [11]. The areas under curve for the blood glucose level elicited by pupuru meal and standard glucose solutions were calculated using the trapezoid method [11]. A graphical plot of blood glucose concentration against time was used for the calculation using the method described by David [12]:

$AUC = Conc_2 + Conc_1\ 2 \times (t_2 - t_1)$.

The values obtained were then used to determine the glycemic index of pupuru using the formula below as described by Brouns F., *et al* [13]:

$$G.I\ of\ Test\ Food = \frac{AUC\ of\ test\ food}{AUC\ of\ control\ food} \times 100$$

Where AUC = Area under the curve.

Statistical analysis

Data were analyzed using one-way analysis of variance (ANOVA) with the help of computer software. Data were presented as mean ± standard deviation. Statistical significance was set at $p < 0.05$.

Results

Proximate composition of pupuru

The result of the proximate analysis of pupuru meal is shown in table 1. As revealed in the table, pupuru meal has a high carbohydrate (CHO) content while other nutrients were present in minute amounts.

Sample	Ash (%)	Moisture (%)	Crude fat (%)	Crude fiber (%)	Protein (%)	CHO (%)
Pupuru meal	0.25 ± 0.03	11.34 ± 0.17	0.65 ± 0.01	1.67 ± 0.16	5.34 ± 0.24	80.67 ± 2.13

Table 1: *Proximate composition of Pupuru meal.*

Values are expressed as Mean ± SD of three determinations.

Blood glucose concentrations at various time intervals

The blood glucose levels of the rats fed on the reference (glucose) and test food (pupuru meal) at 0, 30, 60, 90 and 120 minutes are shown in table 2. As depicted in the table, there was a significant ($p < 0.05$) increase in the blood glucose level of all the rats fed on both the reference and test food after 30 minutes and 60 minutes whereas the blood glucose level declined significantly ($p < 0.05$) after 90 and 120 minutes respectively. The mean glycemic tolerance curves for the reference food (glucose) and pupuru meal are shown in figure 1a and 1b respectively.

Samples	Blood glucose level at 0 mins (mg/dl)	Blood glucose level at 30 mins (mg/dl)	Blood glucose level at 60 mins (mg/dl)	Blood glucose level at 90 mins (mg/dl)	Blood glucose level at 120 mins (mg/dl)
Group 1 fed with glucose (2g)	90.00 ± 5.00^a	104.00 ± 3.50^a	111.50 ± 6.50^a	89.25 ± 2.63^b	76.50 ± 2.50^b
Group 2 fed with Pupuru meal (2g)	62.00 ± 5.00^b	73.00 ± 4.00^b	100.50 ± 0.50^b	91.50 ± 2.50^a	84.50 ± 3.50^a

Table 2: *Blood glucose level of the rats fed on the reference and test food (Pupuru meal) at different intervals.*

Values are expressed as Mean ± SD; values with superscripts $^{a, b}$ represent statistically significant difference at $p < 0.05$.

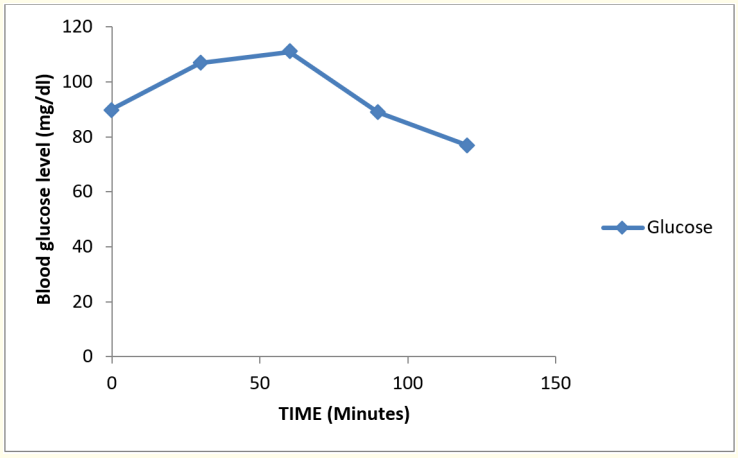

Figure 1a: *Mean glycemic tolerance curve for reference food (glucose).*

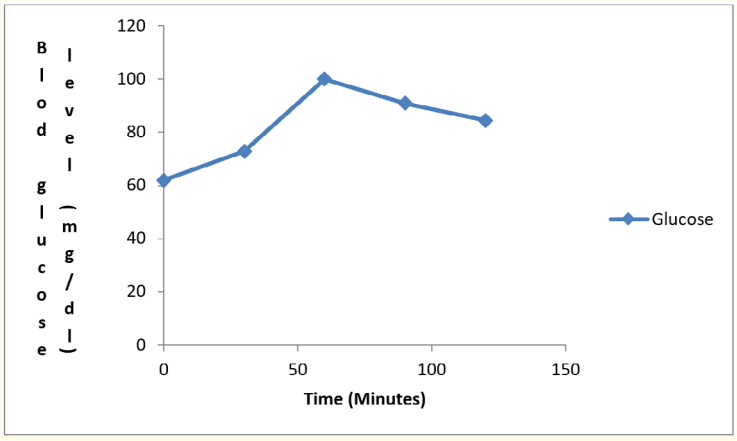

Figure 1b: *Mean glycemic tolerance curve for Pupuru meal.*

Glycemic index of pupuru

The glycemic index of pupuru as shown in table 3 below was estimated to be 86%.

Discussion

Food processing methods such as boiling, blanching, steaming, stewing, frying etc have been known to be vital in improving digestibility, increasing nutrient bioavailability and also minimizing food-borne diseases [14]. Proximate analysis of food is used to describe the basic nutrient composition of foods in terms of protein, moisture, fat, fibre, ash (minerals) and carbohydrate [2].

Results from the proximate composition analysis in this study revealed that pupuru meal contained carbohydrate, ash, moisture, crude fat, crude fibre and protein. However, pupuru contained highly significant amount of carbohydrates compared to other nutrients. Carbohydrates are very vital for the maintenance of life in both plants and animals [15]. They are one of the three main energy sources in food,

others being protein and fat. The consumption of carbohydrates by man and animals leads ultimately to the production of energy through the process of respiration. Glucose is also utilised as a substrate in animals for the synthesis of other substances needed for growth [16].

The ash content; which is a reflection of the mineral contents preserved in food is low in pupuru meal. The moisture content of pupuru was found to be relatively low. The low moisture content would therefore hamper the growth of spoilage microorganisms and boost shelf life; since the moisture content of a food substance is an indication of its shelf-life [17]. Pupuru meal contains very minute amounts of fat and crude fibre as revealed in the results, hence it is a very poor source of both.

Pupuru sample has a crude protein value of 5.34%. Proteins are one of the macromolecules that are also utilized as a substitute for energy production when other energy sources are in limited supply. They are the building block units and food protein is needed to make vital hormones, important brain chemicals, antibodies, digestive enzymes and necessary elements for the manufacture of DNA. Some proteins are involved in structural support, while others are involved in bodily movement, or in defense against germs [18].

Ogbuji and David-Chukwu [19] conducted a similar study on the proximate composition of some cassava based foods like garri and fufu, and found out that the carbohydrate content of fufu is 80.84% while that of garri is 84.88% which is both higher than the result of the carbohydrate content of cooked pupuru obtained in this study (80.67%). However, pupuru contained a higher protein (5.34%) and fiber (1.67%) content than that of garri and fufu respectively. The moisture content of cooked pupuru was found to be lower than that of fufu whereas garri contained a higher lipid content compared to both fufu and cooked pupuru [19]. The discrepancies in the proximate compositions of these cassava based staple foods might be attributed to the processing methods, soil factors climatic factors and different cassava cultivars used in preparing these foods.

The estimated glycemic index of pupuru meal is 86% which is a high GI value as depicted on the glycemic scale (low G.I < 55, moderate G.I = 56 - 69, high G.I = 70 and above) [3]. Other high glycemic foods as reported in the literatures are garri (92.36%) [19]; potato products (109%), honey (87%) [3]. Glycemic response can be influenced by some other factors such as quantity of the carbohydrate food eaten, amount of carbohydrate in the food, nature of the monosaccharide present in the food and other food components (fat, protein and dietary fibre, anti-nutrient and organic acids) [20].

It has been reported that addition of fat and protein to carbohydrate-containing foods has the potential to reduce the glycemic response and lower the overall glycemic index [21,22]. As suggested in several studies, the mechanisms by which these nutrients affect blood glucose concentration have been adduced to the fact that high levels of protein produces greater gastric inhibitory peptide (GIP) and insulin responses. This consequently results in a lower postprandial glucose peak and a reduced glycemic response from high-GI foods [23]. Furthermore, it is has been proven that the glycemic index of vegetable-based foods is lower than the glycemic index of non-vegetable based food products [24]. The consumption of high glycemic index foods has been implicated in contributing to a higher risk of coronary heart disease [25-27] and type 2 diabetes [28]. Information on the glycemic index of foods is therefore necessary in planning carbohydrate-based foods for individuals with diabetes [29].

Conclusion

Pupuru can be categorised as a high glycemic food; and as such its consumption should be limited by diabetics and those at risk. It is highly recommended that it should be consumed with highly proteinous diets and vegetables in order to reduce its glycemic load. Moreover, a further study on the effect of processing methods and fortification with proteins and vegetables on the glycemic index of pupuru is recommended.

Declaration

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