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Evaluation of the glycemic index of some cooked variety of rice products in Nigeria

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ABSTRACT

The glycemic index (GI) is an important parameter of food quality which compares the hyperglycemic effect of a tested meal with pure glucose. The glycomic index of different varieties of rice (*Oryza sativa*) such as white rice, brown rice and parboiled rice were determined. A group of 22 participants with the mean age, weight, height and body mass index of 24 to 62 ± 1.43 years, 63.42 ± 10.50 kg, 1.70 ± 0.0 m and 21.90 ± 2.74 kgm^{-2} were respectively selected for the study. The mean fasting blood glucose level of the participants was 84.81 ± 4.37 $mgdl^{-1}$. The mean blood glucose level at 30 and 60 min after the oral administration of 75 g glucose were 147.43 ± 11.67 and 125.95 ± 9.30 $mgdl^{-1}$, respectively. The mean glycemic response of pure glucose at 30 and 60 min were 62.62 ± 11.4 $mgdl^{-1}$ and 41.14 ± 8.932 $mgdl^{-1}$ respectively and hence, higher glycemic response for the pure glucose was obtained at 30 min. To the participants different varieties of cooked vice (white rice, brown rice and parboiled rice) boiled containing 75 g digestible carbohydrate were administered, the peak blood glucose response was obtained at 30 min. The mean glycemic response of white rice, brown rice and parboiled rice were 41.71 ± 6.17, 37.72 ± 5.11 and 35.05 ± 3.77 $mgdl^{-1}$, respectively. The glycemic responses after the consumption of cooked rice sample containing 75 g digestible carbohydrate, showed significant difference ($P > 0.05$) between cooked white rice and brown rice, cooked brown rice and parboiled rice and cooked white rice and parboiled rice. The mean GI values of cooked white rice, brown rice and parboiled rice were 66.61 ± 9.86, 60.24 ± 8.16 and 55.97 ± 6.01, respectively. Based on these GI values, it can be suggested that among the three varieties of cooked rice, the parboiled rice is a better choice for diabetes patients.

Keywords: Rice, blood glucose level, glycemic index, fiber, fasting, glucose.

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INTRODUCTION

The glycemic index (GI) is a numerical classification based on human *in vivo* chemical trails designed to quantify the relative blood glucose response to foods drinks, nutraceuticals, pharmaceuticals and any edible agents (Freeman and Lyons, 2008). The glycemic index ranks foods on how they affect blood glucose levels (Foster-Powell et al., 2002). The development of diabetes mellitus, obesity, cancer and cardiovascular disease (CVD) has been reported to be linked to high G.I foods, with regards to the treatment of these diseases (Ludwig, 2002).

Few studies have been carried out in Africa with regards to the GI of local foods which are quite different from those of the western world. For the African diabetics to benefit from the new concept of dietary management of diabetes, it is important to determine the GI of local foodstuff with the aim of identifying those with law glycemic index that can be used in formulating, diets for the diabetic subjects (Tanya et al., 1998).

Rice is a major staple food in West Africa; its consumption is rising at the rate of 4% per year. Rice is cooked mainly for human food consumed as whole grain. It is usually cooked by boiling. Food cooking methods have been shown to affect digestibility of starch in carbohydrate meals, which in turn affects glycemic response of such meals (Janette, 1985).

Several factors shown to affect gastrointestinal tract and influence postprandial glycemic individuals include

food preparation/processing (grinding, blending, cooking, drying, puffing, extrusion, canning, fiber content of foods nature of carbohydrate mainly the starch, and time/day of food consumption and chemical composition of foods) (Wolevers and Bolognesi, 1996). Glyemic index studies in foods have been shown to be important. It has practical uses in nutrition as it provides basis for the choice of appropriate diabetic diet of low glycemic food materials, desirable for blood glucose control, use of foods with low GI for both gastric surgery patients who suffer hypoglycemia and patients with carbohydrate induced hyper-bipidemia, patients with reduced absorptive capacity and it also provides data to supplement result obtained from chemical analysis of food items (David, 1984).

Rice is a major source of carbohydrate and other nutrients and is therefore important for its nutritional values. This paper evaluated the glycemic indices of variety of rice eaten in Nigeria prepared by simple boiling.

MATERIALS AND METHODS

All the chemicals were purchased from standard source unless otherwise stated. The different varieties of rice were purchased in the local Port Harcourt market.

Subjects

Healthy men and women aged between 18 and 38 years (36 males and 8 females) were selected from students and staff of the Rivers State University of Science and Technology, Port Harcourt, Nigeria. They were clinically normal non-smokers and non-diabetic. The subjects were informed verbally and they gave their informed consent.

Preparation of rice

The different types of rice (*Oryza Sativa*) varieties, brown rice, white rice and parboiled rice, were washed well in water. The rice were cooked in hot water for 30 min. Cooked rice (25 g) was taken, homogenized and for sugar and total protein moisture and soluble dietary fiber insoluble dietary fiber. To determine the GI of one of the rice variety, the participants were requested to fast for 12 to 14 h and the fasting glucose level was measured and the cooked rice containing 75 g of digestible carbohydrate was administered to them. The glucose level was measured at 30 min. The procedure was repeated for the other varieties on other days.

Determination of orally administered pure glucose

After the overnight fasting, the fasting blood glucose level was measured, then 75 g of glucose dissolved in 250 ml of water was orally administered. The blood glucose level was measured at a 50 to 60 min. The peak glucose response was considered.

Measurement of glucose level

Capillary pricked–finger blood samples were taken at 30 and 60 min after consumption of the test pure glucose or rice varieties, each blood sample was placed on a test strip which was inserted into a calibrated glucemeter (Acci–check/one touch), which gave direct reading after a second. Analysis were done in duplicate, the incremental areas under the glycemic response curve were calculated geometrically (Wolever and Jeinkins, 1986). GI was calculated by expressing the glycemic response area for the tested goods as a percentage of the mean response are of the glucose food taken by the cane subjects, the following formula was applied:

$$GI = \frac{\text{Area under the curve for 75 g carbohydrate}}{\text{Area under the curve for 75 g carbohydrate from glucose}} \times 100$$

The final glycemic index for each of test food and the glucose control was calculated as the mean fro the respective average glycemic indices of the individual.

Statistical analysis

Data were expressed as mean ± error of means. Comparisons of the glycemic response of different of varieties of vice with glycemic response of glycase were analyzed by paired t-test using MINITAB analytical package. Comparisons of glucose responses and glycemic index different of rice were analyzed by Randomized complete Block design (RCBD) using SAS analytical package.

RESULTS

Among the 44 volunteers selected for these studies, 8 were females and 36 were males. The mean age of the volunteers was 25.65 ± 1.38 years and mean body mass index was 22.10 ± 1.89 kgm^{-2}. When 75 g of glucose was orally administered to the volunteers, the blood glucose level reached the peak value at 30 min. The mean fasting blood glucose level was 85.92 ± 3.45 $mgdl^{-1}$ and the mean glucose level at 30 min was 146.59 ± 10.77 $mgdl^{-1}$. The mean peak glycemic response for glucose was 63.72 ± 10.95 $mgdl^{-1}$. Table 1 shows the proximate composition of the rice. The serving portions were calculated to supply 75 g of glucose.

When the cooked rice containing 75 g digestible carbohydrate was consumed, the peak blood glucose elevation was obtained at 30 min. The mean fasting blood glucose level was 86.22 ± 6.64 $mgdl^{-1}$ and the mean blood glucose level was 127.20 ± 6.01 $mgdl^{-1}$. The mean change in glycemic responses of cooked white rice was 42.62 ± 7.17 $mgdl^{-1}$ (Figure 1) and the mean glycemic index was 67.91 ± 9.79% (Figure 2). Ingestion of 75 g digestible carbohydrate of brown rice by the participants gave a peak blood glucose level at 30 min. The mean fasting blood glucose level was 85.12 ± 5.32 $mgdl^{-1}$ and mean blood glucose level at 30 min was 123.77 ± 6.21 $mgdl^{-1}$. The mean change in glycemic response of brown rice was 38.25 ± 6.10 $mgdl^{-1}$ (Figure 1), and the mean glycemic index was 61.23 ± 9.17% (Figure 2). When the parboiled rice containing 75% of digestible carbohydrate was consumed, the peak blood glucose level was obtained at 30 min. The mean fasting blood glucose level was 87.01 $mgdl^{-1}$ and the mean blood glucose level at 30 min was 122.12 ± 8.27 $mgdl^{-1}$. The mean change in glycemic response was 36.06 ± 4.78

Table 1. Proximate compositions of different varieties of cooked rice (white rice, brown rice and parboiled rice).

Constituents %	Cooked white rice	Cooked brown	Cooked parboiled rice
Moisture	63.30 ± 0.61	70.18 ± 0.68	65.44 ± 0.44
Total protein	1.52 ± 0.09	1.75 ± 0.15	2.15 ± 0.15
Soluble dietary fiber	0.001 ± 0.001	0.23 ± 0.002	1.84 ± 0.04
Insoluble dietary fiber	1.23 ± 0.04	1.85 ± 0.2	1.84 ± 0.04
Total dietary fiber	1.11 ± 0.04	2.06 ± 0.09	2.20 ± 0.04
Total digestible carbohydrate	25 ± 0.18	22.16 ± 0.16	22.19 ± 0.04

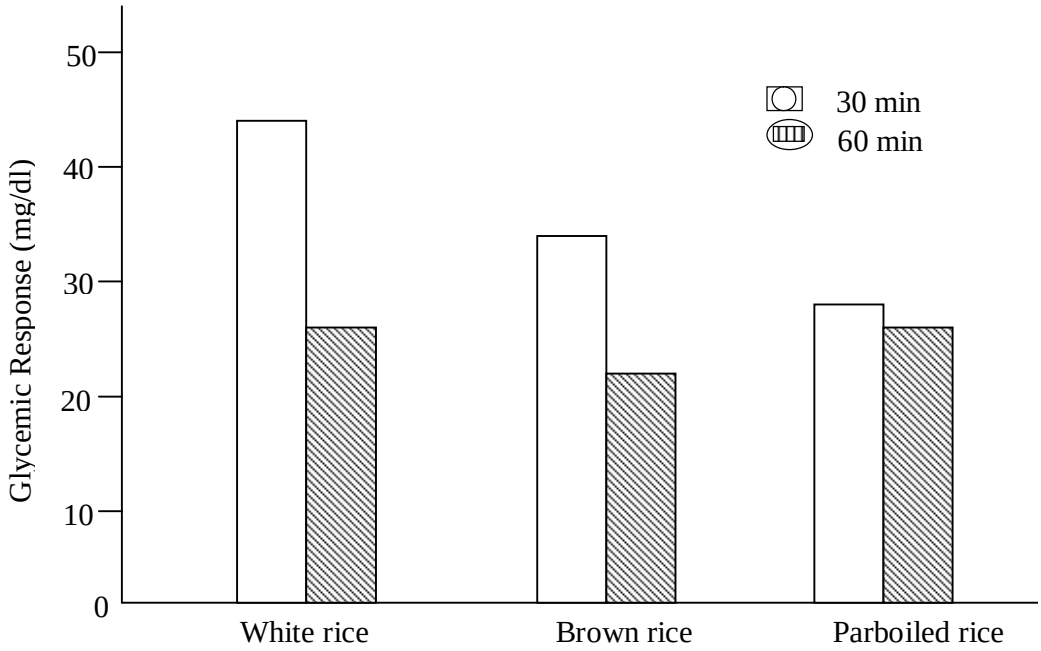

Figure 1. The mean glycemic response obtained in volunteers for different rice varieties at 30 and 60 min.

mgdl^{-1} (Figure 1) and the mean glycemic index was 56.10 ± 7.02% (Figure 2). When the glycemic response after consumption of the three cooked rice varieties were considered, cooked parboiled rice gave less glycemic response followed by cooked brown rice and white rice. Thus, the glycemic index of cooked parboiled rice was the lowest followed by cooked brown rice and white rice. When fiber contents of the three cooked rice varieties were considered, the cooked parboiled rice contained more soluble dietary fiber (0.52%) insoluble dietary fiber (1.98%) and total dietary fiber (2.10%), then the cooked brown rice (0.31, 1.98 and 2.19%) and cooked white rice (trace, 1.31 and 1.31%) (Table 1). The available carbohydrate in the foods for absorption might be made unavailable due to its soluble dietary fiber (SDF), insoluble dietary fiber (IDF) and total dietary fiber (TDF) contents. The monosaccharide released by hydrolysis and availability for absorption might be made unavailable. This could be due to the tendency of the fibers to absorb sugars and absorbed sugar released slowly. Soluble fibers slow down the digestion of starches and absorption of the glucose in to the blood stream (Mehto, 1992). The total dietary fiber content of cooked parboiled rice was higher than that of the other cooked rice. Considering the IDF contents, the cooked parboiled rice and brown rice contained some amount (1.98%) and the cooked white rice contained lower (1.31%) than other varieties. However, the TDF contents of cooked parboiled rice and brown rice varieties were closer to each other. The mean glycemic responses of cooked white rice and brown rice and parboiled rice were 42.81 ± 7.18, 38.73 ± 6.12 and 36.06 ± 4.78 mgdl^{-1}, respectively (Figure 1). This could be due to the effect of soluble fiber in these three varieties of cooked rise. The cooked parboiled rice contained highest amount of SDF (0.52%) than cooked brown rice (0.31%) and white rice (trace amount) varieties. The study showed that parboiled rice variety is a better choice for the diabetics and coronary heart disease patients. The influence of protein content on the glycemic response after the consumption of these varieties of cooked rice

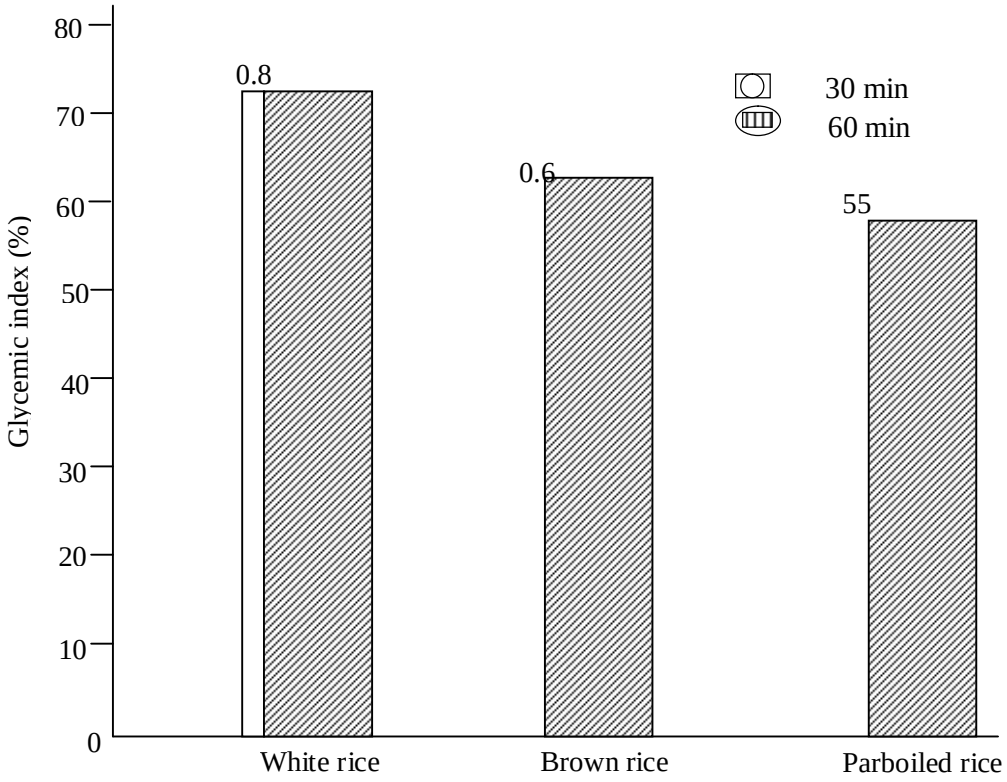

Figure 2. Mean glycemic index values of different rice varieties.

did not show any direct relationship. During cooking, heat, amount of water and cooking time, affect the GI of foods. During cooking, water and heat expand the starch granules to varying degrees. Foods containing starch that has swollen (or gelatinized) to the bursting point like boiled or baked potatoes are more easily digested and therefore have higher GIs, than foods containing starch granules that are less gelatinized like oatmeal. In this study, when degree of gelatinization of different types of cooked rice varieties were considered, higher gelatinization was observed in cooked white rice than other varieties of rice.

Conclusion

Rice varieties were prepared by cooking. They were separated administered as meals to healthy non-diabetic subjects for the purpose of determining glycemic index value of each of the rice varieties (white rice, brown rice and parboiled rice) using standard procedures. Calculated GI values per the rice varieties, were 66.61 ± 9.86 for white rice, 60.24 ± 8.16 for brown rice and 55.97 ± 6.01% for these were significant difference ($P < 0.05$) between the GI of white rice and brown rice and between white rice and parboiled rice products. The chemical composition of the rice varieties could have contributed to the substances in the carbohydrate, as glucose-maltose content of cooked rice might vary. Thus, the parboiled rice could be suitable in diabetic diet.

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