



The proximate composition, glycemic index and load of brown and milled JT 11 rice variety grown in Côte d'Ivoire

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Abstract

Rice is a staple food in Côte d'Ivoire, however there is little data on its nutritional quality, especially for locally grown rice. The objective of this study was to determine the macronutrient composition, glycemic index (GI) and glycemic load (GL) of a locally rice called JT11 in the milled and whole form. The macronutrient composition was determined according to AOAC standard methods. Eleven healthy volunteers were asked to consume the reference food (glucose) and the rice after an overnight fast on separate occasions. The rice to be tested and the glucose contained 50 g of carbohydrate. Finger prick blood samples were obtained at 0, 15, 30, 60, 90 and 120 minutes after consuming each food to be tested. The glycemic response was obtained by calculating the incremental area under the curve (IAUC). The GI was calculated as the IAUC of the food to be tested / IAUC of the reference food (glucose) x 100 and the GL was calculated as the GI x amount of carbohydrate in a defined serving / 100. The results showed that whole JT 11 rice was significantly richer ($p < 0.05$) in nutrients than JT 11 milled rice. The GI of whole rice was in the medium category (64 ± 16) and the GI of milled rice was in the high category (77 ± 19). The GLs were 27 and 33 for brown rice and milled rice respectively and are classified as high. The consumption of these rice should therefore be moderate. It would be important to study the impact of the accompanying sauces on the GI of these rice as they are generally eaten with sauces and the study needs to be extended to other locally varieties.

Keywords: nutritional composition, glycemic index, glycemic load, rice JT 11

Introduction

Rice is the world's largest and most widely cultivated food crop [1]. It is consumed in different forms around the world, such as brown or whole rice, milled rice, parboiled milled rice. Rice is a daily staple food for more than half of the world's population [2]. It is a rich source of carbohydrate with substantial amounts of protein, fat, fiber, minerals, and vitamins. The composition and nutrient content of rice vary between varieties and according to the processing method [1]. In Côte d'Ivoire, rice plays an important role in both food [3] and economy. Rice ranks third in food production after yam and cassava and represents six to eight percent of food production [4]. Rice consumption continues to increase due to population growth, urbanization and changing consumption patterns and the purchasing power of the population. It was estimated in 2017 at 1, 711, 520 tons of milled rice (http://www.ondr.ci/statistique_consommation.php) or 70 kg per inhabitant. Several varieties of rice are produced in Côte d'Ivoire. However, there is a lack of knowledge about the nutritional quality of locally milled and whole rice and the glycemic index (GI) values, and the glycemic load of rice produced and consumed in Côte d'Ivoire. To promote the consumption of local rice in Côte d'Ivoire, it is therefore important to know its nutritional composition. In addition, determining the glycemic response of these foods is therefore necessary given its role in the management of pathological conditions linked to sugar such as type 2 diabetes (T2DM). Indeed, the Ivory Coast is not on the sidelines of the T2DM epidemic. The number of people suffering from T2DM is growing like everywhere else in the world [5]. Nutritional care is a cornerstone in the prevention and management of T2DM. The objective of this study was to determine and compare the proximal and mineral composition of a local rice in whole and whole form of mass

consumption as well as its glycemic index and its satiety index. The information that will be generated in this study will make it possible to promote local rice and to better plan nutritional education among the population.

Materials et Methods

Test Food

The study focused on the complete and blanched variety of local rice JT11 collected at the local market in Abidjan and transported to the Laboratory of Food Biochemistry and Tropical Products Technology (LBATPT) at Nangui Abrogoua University for the various analyzes. The rice was cooked by absorbing water in an electronic rice cooker. The Milled rice was cooked for 15 minutes in a water volume ratio of 1: 1.5. The brown rice was cooked for 35 minutes after soaking for 2 hours and in a water volume ratio of 1: 1.5. The macronutrient composition of the different rice was determined according to AOAC standard methods [6] and the total carbohydrates and the available carbohydrates were determined by differences according to the following formulas:

$$\text{Total carbohydrates (g)} = 100 - (\text{water (g)} + \text{ash (g)} + \text{protein (g)} + \text{lipid (g)})$$

$$\text{Available carbohydrates (g / 100g)} = 100 - (\text{water (g)} + \text{ash (g)} + \text{protein (g)} + \text{lipid (g)} + \text{total fiber (g)})$$

Determination of glycemic index and glycemic load

The glycemic index (GI) is based on hyperglycemia caused orally with the reference food (50 g of anhydrous glucose)

and the test food which should contain 50 g of available carbohydrates and monitoring the evolution of the blood sugar for 120 minutes. The study was performed using an international standard blood glucose testing protocol (ISO / FDIS 26642: 2010). The study participants consisted of 12 male and female volunteers recruited from students and staff at Nangui Abrogoua University, but one participant withdrew before the study was completed. All clinical procedures were performed at the Nangui Abrogoua University Medico-Social Center. The purpose and protocol were explained to the willing participants and written consent was obtained. Interested subjects were invited to complete a screening questionnaire intended to verify their state of health, including clinically abnormal glucose metabolism (fasting blood glucose <6.0 mmol / L), as well as any medical problem or any medication that may affect regulation of blood sugar, gastric emptying, body weight, appetite, and energy expenditure. Socio-demographic data, such as age, sex and anthropometric values were collected for all subjects before the start of the study (Table I). The focus was on healthy subjects, with an active lifestyle, without any diagnosed illnesses. During the study, subjects were advised to continue with their usual daily activities without any change in their physical activities. Glucose (50 grams of pure anhydrous glucose dissolved in 250 ml of water) was used twice as a standard food. Subjects tested each food and the reference food twice in a random order of separate days, with at least one day gap between measurements to minimize carryover effects. Subjects started in the morning after a 12-hour night fast. Fasting capillary blood samples were taken at 0 min and the food to be tested was consumed immediately. Additional blood samples were taken 15, 30, 45, 60, 90, and 120 minutes after the start of the meals. Blood was drawn using a finger prick. Blood sugar was measured using a calibrated glucometer. Blood glucose values for each time point greater than 2 h were used to calculate the incremental area under the curve (IAUC) for each subject and each test individually. The incremental area under the blood glucose response curves to the tested and reference foods was calculated geometrically using the trapezoid rule, ignoring the area below the baseline. The IAUC value of each tested food consumed by each subject was expressed as a percentage of the average IAUC glucose for the two repeats of the reference food (glucose) consumed by the same subject: $IG = (IAUC \text{ test food} / IAUC \text{ reference food}) \times 100$. The GI of each food was then calculated as the mean value for all subjects consuming that food. If any subject's individual GI values were greater, or less than 2 standard deviations of the group mean, the GI was considered outliers and was excluded from the analysis. The glycemic load (GL) of a typical serving of each food was calculated using the formula below (7):

$$GL = (GI \times \text{grams of carbohydrate in typical serving} / 100).$$

Statistical analyzes

Data were reported as mean \pm standard deviation. All the measurements were carried out at least three times depending on the parameter studied. ANOVA was used to analyze the mean of the samples. The least significant difference was used to determine exactly where the differences occurred, at a 5% significance level. The data on GI and GL were analyzed according to the method

recommended by ISO / FDIS 26642: 2010. IAUC and IG / GL were calculated using Microsoft Excel ® 365. All statistical analyzes were performed using the XLSTAT version 2021.1 statistical program.

Results and Discussion

The demographic and clinical characteristics of the participants are shown in Table I. There were seven men and four women. The mean age was 22.5 ± 3.8 years, and the body mass index was 23.1 ± 1.5 Kg / m². The mean fasting blood glucose was 4.49 ± 0.38 mmol / L.

The macronutrients and available carbohydrates contained in milled rice and brown rice of the local variety JT11 are contained in Table 2. The levels of protein, fat and fiber were significantly higher in brown rice than in milled rice ($p < 0.05$). The levels of available carbohydrates were significantly higher in milled rice than in brown rice ($p < 0.05$). This study showed that brown rice is richer in nutrients than milled rice as shown by other authors (8, 9). This would be due to the processing of transformation of the latter. In fact, milling rice results in a significant elimination of nutrients and starch thus becomes the main component of milled rice [10].

The mean areas of the incremental surface under the curve (IAUC), the glycemic index and the glycemic load of the different rice are presented in Table 3. The glycemic index of milled rice JT 11 was estimated at 77 ± 19 and that of brown rice was 64 ± 16 . They were statistically different at $P < 0.05$. The glycemic load of brown rice was 27 and that of milled rice was 33. The mean glycemic responses of the reference food and the test foods are shown in Figure 1. The results showed that the glycemic response after ingestion of the reference food (pure glucose) is higher than that obtained after ingestion of the different rice. The reference food, milled rice and brown rice reached their peak blood sugar at 45 minutes with respective blood sugar levels of 7.96 ± 0.03 mmol / L; 6.67 ± 0.71 and 5.72 ± 0.33 mmol / L. Determination of the glycemic index (GI) and glycemic load (GL) of the two rice showed that the whole rice JT 11 ranked in the category of foods with a medium glycemic index ($55 < GI < 70$) while milled rice JT 11 was classified in the category of foods with a high glycemic index ($GI > 70$). However, both rice had high GLs ($GL > 20$). Such a study on GI and GL is important because rice is widely consumed in Côte d'Ivoire and given the growing number of people suffering from T2DM and metabolic diseases. It should be noted that the GI is very variable depending on the variety and the technological treatment [10-13]. This is because different varieties of rice grown in different geographic regions may exhibit different physicochemical characteristics such as grain morphology, water absorption, cooking time, macronutrients, dietary fiber, and amylose content and may therefore present different GI values [12]. Variations in the GI of rice have also been attributed to the nature of the processing as well as the form in which it is consumed, including the side dishes of rice meals [13]. This study is unique in its kind in Ivory Coast because it is the first time to our knowledge that the GI and GC of local rice commonly consumed by the population have been determined. However, it would be important to study the glycemic response of these rice with the accompanying sauces that are usually consumed.

Table 1: Demographic and clinical characteristics of the subjects studied (n = 11)

| Characteristics | Mean ± SD |
|--------------------------------------|-------------|
| Age (years) | 22.5 ± 3.8 |
| Male (n) | 7 |
| Female (n) | 4 |
| Height (cm) | 1.7 ± 0.1 |
| Weight (kg) | 64.9 ± 4.5 |
| Body mass index (Kg/m ²) | 23.1 ± 1.5 |
| Fasting blood glucose (mmol/L) | 4.49 ± 0.38 |

Table 2: Macronutrient content of cooked milled and brown JT 11 rice (g/100 g dry matter)

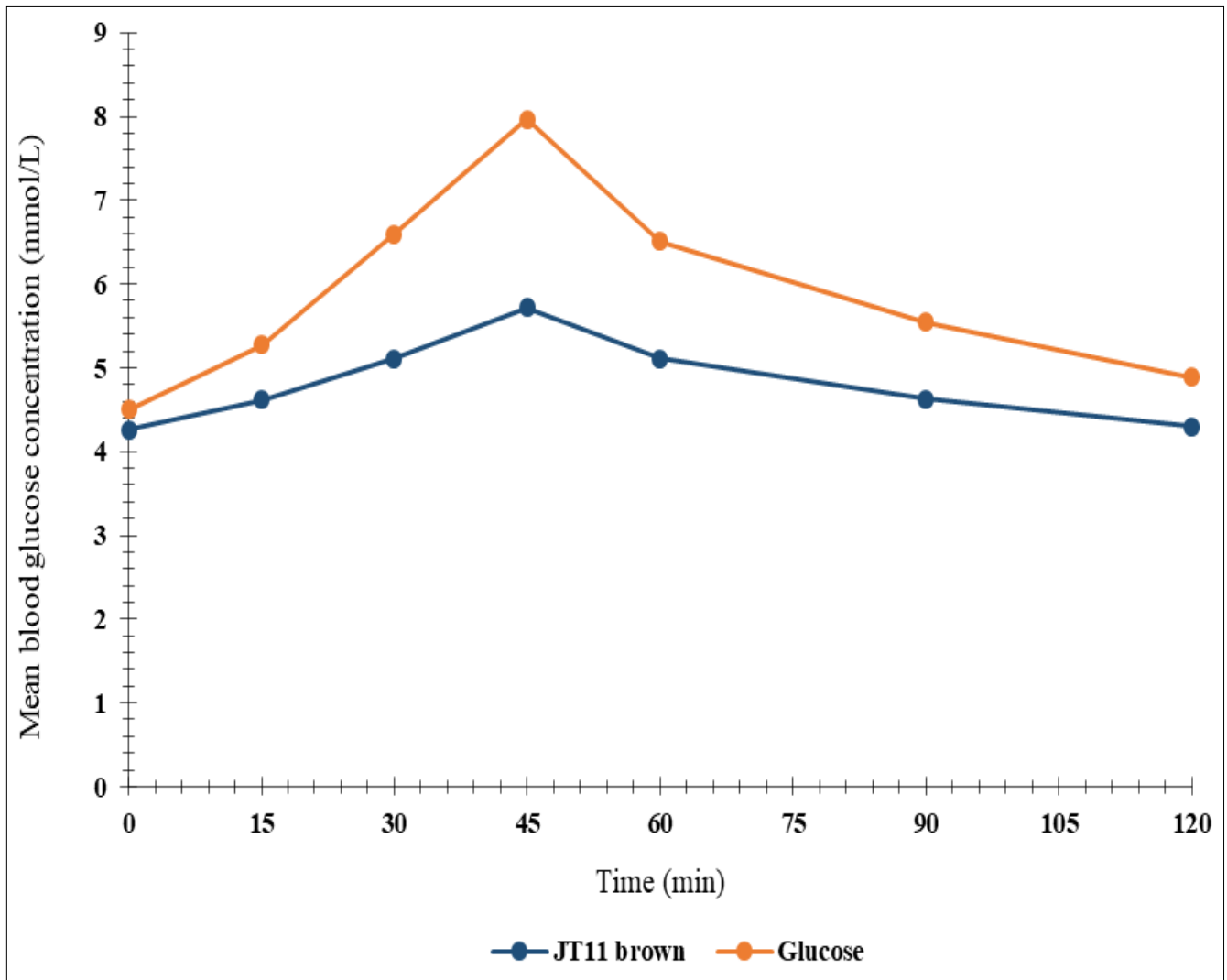
| Rice | Protein (g) | Fat (g) | Fibre (g) | Carbohydrate (g) | Available Carbohydrate (g) | Energy ¹ (kcal) |
|-------------|--------------------------|--------------------------|--------------------------|---------------------------|----------------------------|----------------------------|
| Milled JT11 | 1.05 ± 0.07 ^b | 0.38 ± 0.01 ^b | 0.54 ± 0.01 ^b | 97.92 ± 0.09 ^b | 96.92 ± 0.10 ^b | 396.40 ± 0.01 ^b |
| Brown JT11 | 2.10 ± 0.14 ^a | 1.40 ± 0.14 ^a | 1.57 ± 0.01 ^a | 95.37 ± 0.01 ^a | 93.80 ± 0.00 ^a | 399.34 ± 0.67 ^a |

1 Energy derived based on 1 g protein = 4 kcal, 1 g fat = 9 kcal, 1 g carbohydrate = 4 kcal and 1 g fibre = 2 kcal ; Values with the same letters in a column are not significantly different at the 5% level

Table 3: Mean IAUC, GI and GL of milled and brown JT 11 rice

| Rice | IAUC mmol/l min | GI* (Mean SEM) | GI classification | GL | GL classification |
|--------------|-----------------|----------------|-------------------|----|-------------------|
| Milled JT 11 | 53 ± 8 | 77 ± 19 | High | 27 | High |
| Brown JT 11 | 64 ± 12 | 64 ± 16 | Medium | 33 | High |

IAUC, incremental area under the curve ; GI, glycemic index ; GL, glycemic load ; *Reference GI (glucose) = 100



a

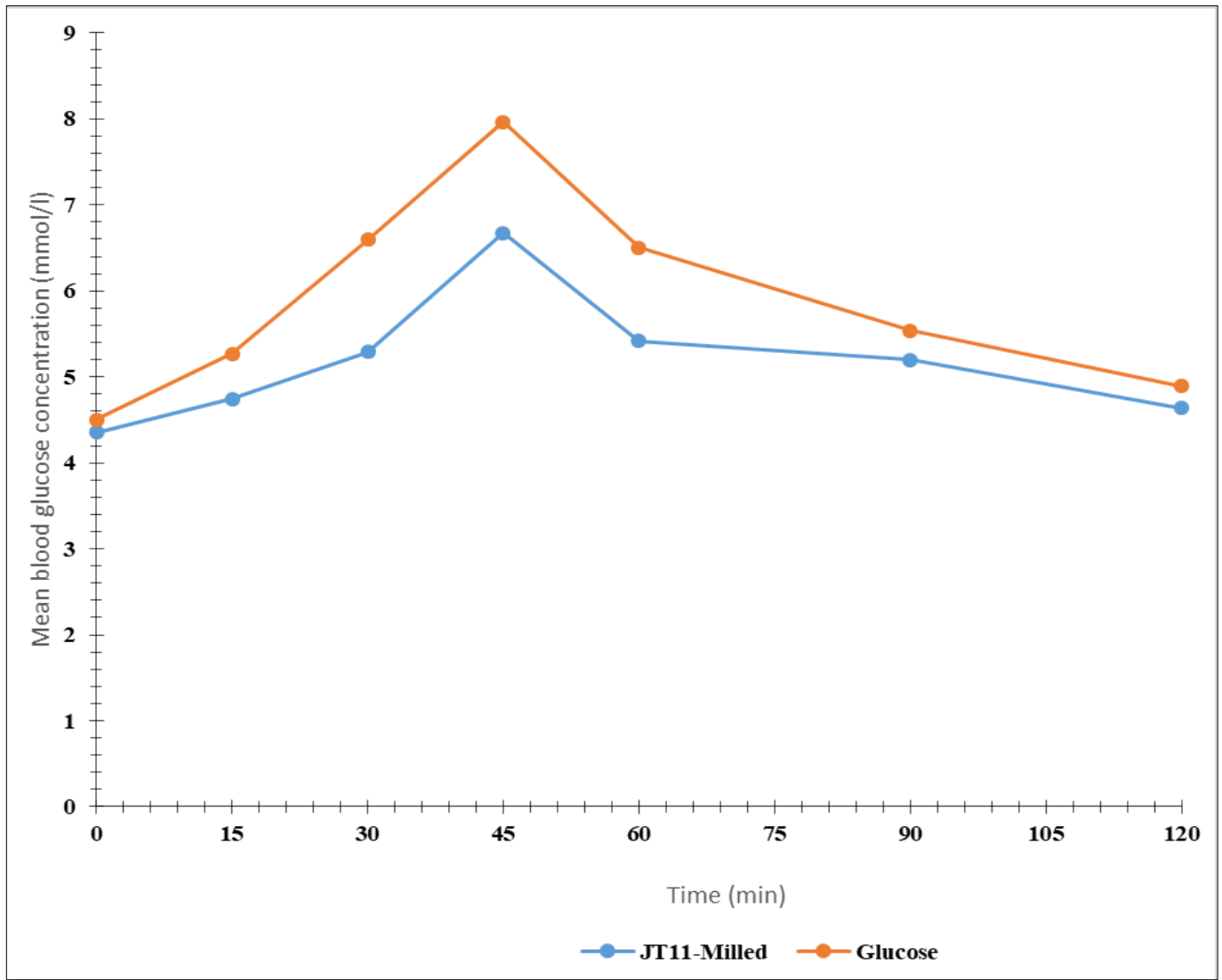


Fig 1: (a-b) Mean glycemic response (mmol/l) of milled and brown JT 11 rice

Conclusion

This study on local rice commonly consumed in Côte d'Ivoire showed that depending on the technological treatment, the rice had a variable GI but high GL. This rice should be consumed in moderation to prevent the occurrence of metabolic diseases such as T2DM. It would also be important to study the impact of side sauces on the glycemic response of rice.

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