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TECHNICAL SHEET ON DATA MANAGEMENT FOR THE CENTER'S HEALTHY AND SUSTAINABLE FOOD PROGRAM OF COTE D'IVOIRE: GLYCAEMIC INDEX AND LOAD VALUES OF STAPLE FOODSTUFFS

Kouamé Adam Camille [1*], N'Dri Yao Denis[2], Amani N'guessan Georges [2]

[1]*National Centre for Agricultural Research (CNRA), Bouaké Regional Office, P.O. box 633 Bouaké 01, Bouaké, Côte d'Ivoire*

[2]*Department of Food Science and Technology, Laboratory of Food Biochemistry and Tropical Products Technology, Nutrition and Food Safety Section; University Nangui Abrogoua; 02 BP 801 Abidjan 02, Abidjan, Côte d'Ivoire.,*

Correspondence Author: Kouamé Adam Camille

ABSTRACT

There is currently an increased global interest in the published glycaemic index (GI) and glycaemic load (GL) values of foods. At the same time, the Center's Healthy and Sustainable Food program of developing countries such as Côte d'Ivoire, have unfortunately, very limited data on our choices for diet. Thus, the study therefore aimed at finding the GI and GL (two nutrition indicators) of the main food staples in Côte d'Ivoire. Such data would be of prime importance for the policy makers of the Ivorian Ministry of Health and Public Hygiene in order to promote the sustainable consumption by the healthy consumers.

KEYWORDS: ***Cote d'Ivoire, Foodstuffs, glycaemic Index, glycemic Load, sustainable consumption***

I. INTRODUCTION

The food we eat determines how healthy we are; however, our food may do more harm than good. The Center's Healthy and Sustainable Food program of developing countries, such as Côte d'Ivoire, have, unfortunately, very limited data on choices for diet. Yam (tubers), plantain (fruits), cassava (roots) and maize (cereals) are considered as the main carbohydrate sources in Ivorian diets (**Amani and Kamenan, 2003**) and the determination of the glycemic responses of these foods in the calculation of the glycemic index and glycemic load is therefore necessary given its role in the dietary management of sugar-related diseases. These data would be of paramount importance to decision makers at the Ivorian Ministry of Health and Public Hygiene, which is constantly promoting sustainable consumption by healthy consumers. These data led to the publication of an article in the Journal Nutrients in 2015 (**Kouamé *et al.*, 2015**) " Glycaemic index and load values tested in normoglycemic adults for five staple foodstuffs: pounded yam, pounded cassava-plantain, placali, attieke and maize meal stiff porridge.

II. MATERIAL AND METHODS

1. Reference methods

The glycemic index protocol was based on FAO recommendations (**FAO/WHO, 2010**) and ISO 26642: 2010 **(ISO/FDIS 26642:2010; 2010)**. Randomization was established according to the suggestions of Brouns (**Brouns *et al.*, 2005**).

2. Subjects

50 healthy subjects (23 women and 27 men)
Mean Age: 28 years,
Mean BMI: 21.5 kg/m^2,

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Mean fasting blood glucose: 4.6 mmol/L,
Mean HDL: 0.4 mmol/L.

3. Design
Randomized cross-over study,
7 tests periods.

4. Methodology
After overnight fasting, subjects ingested either 50 grams of Glucose pur anhydre or test foods.
The glycaemia were observed for 2 hours.
Blood was sampled at 0 (time of ingestion of the product), 15, 30, 45, 60, 90, 120 min.

5. Calculation of glycemic index and glycemic Load
GI = (iAUC test food/iAUC reference food) × 100 **(Figure 1)**
with iAUC = Incremental AUC ignoring area under the baseline (**method C, Figure 2)**.
We recommend calculating GI as the mean of the individual ratios
GL = (GI × grams of CHO in the typical serving size/100)

6. Evaluation of calculating area under the curve (AUC) for determining glycemic index (GI) values of foods
Figure 1 illustrate the calculation of incremental AUC (**Brouns et al., 2005**).

7. Experimental Diets
7.1: Pounded yam or yam *fufu*
For pounded yam production, the tubers were peeled, cut into pieces and boiled until soft. The water is then drained off and the pieces pounded in a wooden mortar and pestle until stiff glutinous dough is formed, usually taking 15–30.

7. 2: Attieke (a fermented cassava couscous)
The fresh mash is fermented for two or three days, mechanically squeezed in order to remove as much water as possible, granulated, sun-dried before sieving and finally steamed to get the final product *attieke*

7.3: Pounded plantain or plantain fufu (pounded cassava mixed with pounded plantain).
Split the bananas in half and remove the core from the banana. Do the same for the cassava. Wash them and boil them in a litre of water for 40 minutes. Drain off the water and allow to cool. Then pound the bananas and cassava separately in a mortar, making sure you get a lump-free paste. Finally, mix the banana and manioc and pound them to obtain a smooth consistent paste. Make balls and serve in a dish
F4: Maize meal stiff porridge or cabatôh.
This is a traditional Ivorian recipe from a classic starchy staple made from corn dough boiled in water until it forms a stiff porridge-like paste. It is also known as cabatôh or tôh de mais and is made from cornmeal. The maize meal is prepared as follows: flour of maize (1.2 kg) obtained by pounding whole grains in a mortar, is poured into boiling water (3 L) and stirred until a solid paste is formed.
F 5: Placali (a fermented cassava paste)
Cassava are peeled, crushed and mixed with a small amount of fermented cassava. The paste obtained is fermented for one to two days and then sieved to remove fibers. The fermented dough is transformed into a gel called “placali” after simmering

III. RESULTS AND DISCUSSION
Proximate composition, blood glucose response and glycaemic index/load to test meals (Table 1, 2, 3, 4 and 5)

IV. NUTRITIONAL ADVICE AND RECOMMENDATIONS
- Yam (tubers), plantain (fruits), cassava (roots) and maize (cereals) are all excellent sources of carbohydrates. These are high energy foods.
- The majority of GI values of these meals (with the exception of attieke) is identified as high GI. These foods are not suitable or adequate meals for type II diabetics. That is why, on the basis of food consumption per day in respect to GL < 80, the consumption of placali, pounded cassava-plantain, pounded yam, attieke and maize meal stiff porridge should be limited to 1554 g, 500 g, 751 g, 207 g

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and 313 g per day respectively regardless of their respective GI in order to avoid metabolic disturbance related to their overconsumption

- Consumption of attieke could minimize postprandial blood glucose spikes, in spite of high GL and potentially have benefit in the management and prevention of some chronic diseases.

This information is intended as a guide only. It should not replace individual medical advice. If you have any concerns about your health, or further questions, you should contact your health professional.

FIGURES, TABLES AND REFERENCES

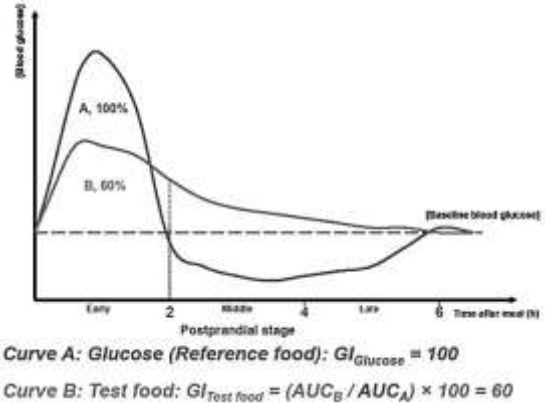


Figure 1: Glycemic responses demonstrate the definition of GI

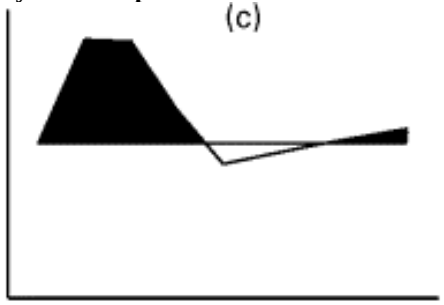
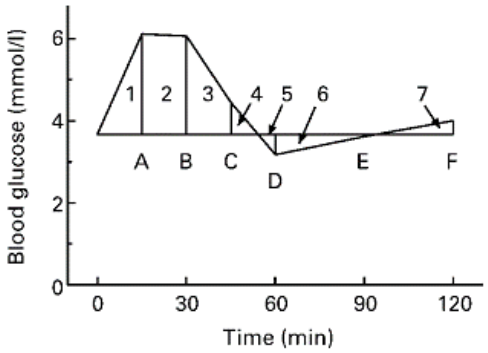


Figure 2: Method to determine iAUC. ;



1: A/2 X 15 = 1.22 X 15 = 18.30 mmol X min/L;
2: (A/2 + B/2) x 15 = (1.22 + 1.195) x 15 = 36.23 mmol x min/l;
3: (B/2 + C/2) x 15 = (1.195 + 0.385) x 15 =23.70 mmol x min/l;
4: (C^2/(C - D)) x 15/2 =[0.593/(0.77 + 0.50)] x 7.5 = 3.50 mmol x min/l; 5 and 6: area below baseline not included, =0;
7: [F^2/ (F - E)] x 30/2 = [0.109/ (0.33 + 0.06)] x 15 = 4·19 mmol x min/l;

Incremental AUC =18.30 + 36.23 + 23.70 + 3.59 +4.19 =86·0.
Figure 1: Calculation of incremental area under the curve

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Table 1. Pounded yam (*foutou igname*)

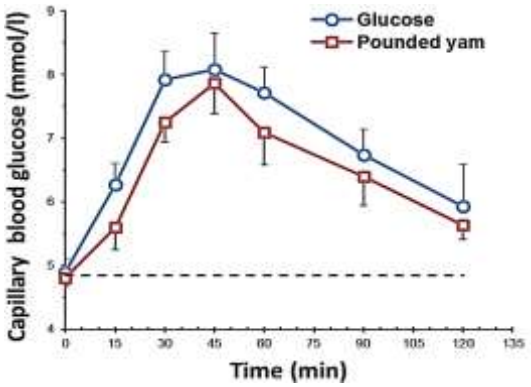
Food Samples		
Moisture (g/100 g)		71.0 ± 0.0
Ashes (g/100 g)		0.8 ± 0.0
Total Dietary Fiber (g/100 g)		0.6 ± 0.2
Proteins (g/100 g)		1.5 ± 0.0
Lipids (g/100 g)		0.8 ± 0.0
Available CHO (g/100 g) *		25.3 ± 0.1
Energetic Value (kcal/100 g) **		114.3 ± 0.4
Blood Glucose Response		 Evolution of glycaemia after ingestion of test foods Values are the mean change in blood glucose (BG) with their standard deviation represented by vertical bars
GI [1] (Glucose = 100) [1]	Mean	85
	SE	4
	Category	high
GL [2] (per Experimental Portion Size)	Mean	22
	SE	1
	Category	high

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Table 2. ***Placali***

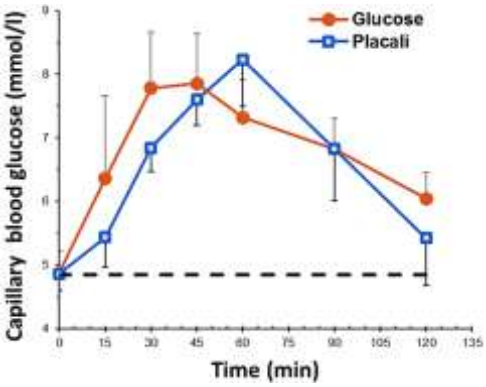
Food Samples		
Moisture (g/100 g)		81.0 ± 0.0
Ashes (g/100 g)		0.8 ± 0.0
Total Dietary Fiber (g/100 g)		1.6 ± 0.1
Proteins (g/100 g)		0.8 ± 0.0
Lipids (g/100 g)		0.0 ± 0.0
Available CHO (g/100 g) *		15.8 ± 0.1
Energetic Value (kcal/100 g) **		66.5 ± 0.5
Blood Glucose Respon		 Evolution of glycaemia after ingestion of test foods Values are the mean change in blood glucose (BG) with their standard deviation represented by vertical bars
GI [1] (Glucose = 100) [1]	Mean	106 [a]
	SE	5
	Category	high
GL [2] (per Experimental Portion Size)	Mean	17 [de]
	SE	1
	Category	medium

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Table 3. Pounded cassava-plantain (*foutou banane*

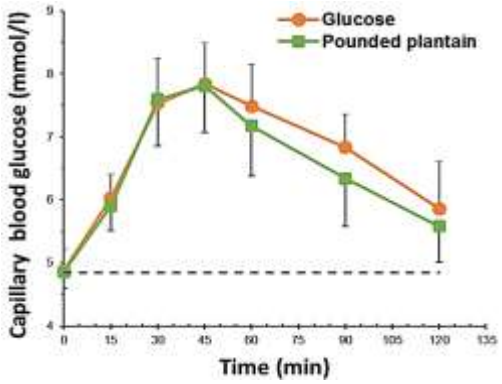
Food Samples		
Moisture (g/100 g)		68.3 ± 0.2
Ashes (g/100 g)		0.2 ± 0.0
Total Dietary Fiber (g/100 g)		0.6 ± 0.0
Proteins (g/100 g)		1.7 ± 0.0
Lipids (g/100 g)		0.4 ± 0.0
Available CHO (g/100 g) *		28.8 ± 0.2
Energetic Value (kcal/100 g) **		125.4 ± 0.3
Blood Glucose Response		
		Figure. Evolution of glycaemia after ingestion of test foods Values are the mean change in blood glucose (BG) with their standard deviation represented by vertical bars
GI [1] (Glucose = 100) [1]	Mean	91
	SE	4
	Category	high
GL [2] (per Experimental Portion Size)	Mean	26
	SE	1
	Category	high

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Table 4. Maize meal stiff porridge (*Toh de maîs*)

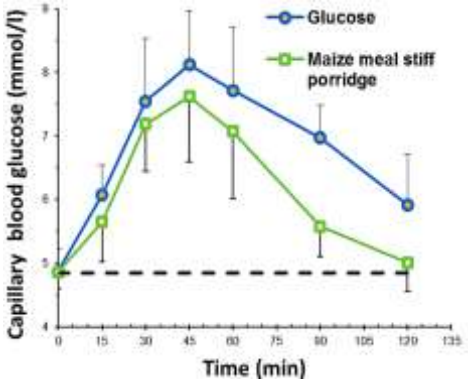
Food Samples		
Moisture (g/100 g)		73.4 ±0.4
Ashes (g/100 g)		1.1 ± 0.1
Total Dietary Fiber (g/100 g)		1.5 ± 0.1
Proteins (g/100 g)		2.2 ± 0.1
Lipids (g/100 g)		0.2 ± 0.0
Available CHO (g/100 g) *		21.6 ± 0.4
Energetic Value (kcal/100 g) **		97.0 ± 1.2
Blood Glucose Response		
		Figure. Evolution of glycaemia after ingestion of test foods Values are the mean change in blood glucose (BG) with their standard deviation represented by vertical bars
GI [1] (Glucose = 100) [1]	Mean	74
	SE	5
	Category	high
GL [2] (per Experimental Portion Size)	Mean	16
	SE	1
	Category	medium

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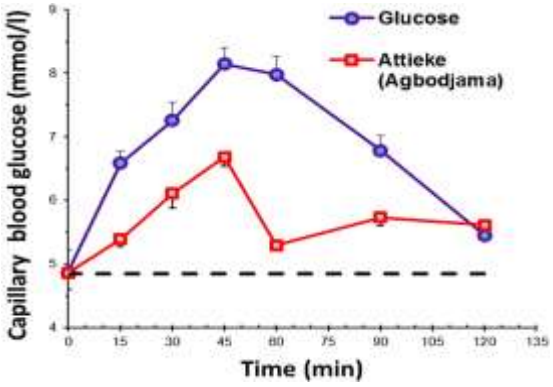
Table 5. ***Attieke***

Food Samples		
Moisture (g/100 g)		51.2 ±1.7
Ashes (g/100 g)		0.7 ± 0.0
Total Dietary Fiber (g/100 g)		0.2 ± 0.0
Proteins (g/100 g)		0.4 ± 0.0
Lipids (g/100 g)		1.3 ± 0.0
Available CHO (g/100 g) *		46.2 ± 1.7
Energetic Value (kcal/100 g) **		198.1 ± 6.6
Blood Glucose Response		
		Figure. Evolution of glycaemia after ingestion of test foods Values are the mean change in blood glucose (BG) with their standard deviation represented by vertical bars
GI [1] (Glucose = 100) [1]	Mean	63 [c]
	SE	2
	Category	medium
GL [2] (per Experimental Portion Size)	Mean	29 [b]
	SE	1
	Category	high

[1] Level of glycaemic indexes (GIs) were classified according to high (>69), medium (56–69 inclusive) and low (<56) GI

[2] Level of glycaemic loads (GLs) were classified as high (≥20), medium (>10 to <20), and low (≤10) GL; 3 glucose was used as reference food and was defined as 100.

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