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Research Article

Consumption Frequency and Proximate Composition of Some Carbohydrate Foods Most Consumed in Abidjan (Côte d'Ivoire)

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Abstract

Excessive consumption of carbohydrate foods can lead to diabetes and its complications. This work aims to reveal the carbohydrate foods most consumed in Abidjan (Côte d'Ivoire) and evaluate their nutritional value. A food consumption survey was carried out in 5 communes of the district of Abidjan (Cocody, Port-Bouët, Marcory, Abobo, Yopougon) with 50 people per municipality. The proximate composition of the most consumed foods was evaluated. The results had showed that rice and *attieke* are the most consumed national foods with respectively 47.67% and 31.54%. *Gari* and *akassa* were the most consumed non-national foods with respectively a proportion of 25.45% and 21.54%. At least 5 time a week, 84.23% and 54.84% of respondents had respectively eaten the rice and *attieke*. Sometimes, 33.33 and 64.59% of respondents had respectively consumed *gari* and *akassa*. Rice, *attieke*, *gari* and *akassa* contained high carbohydrates levels respectively 90.30%, 94.79%, 97.45% and 87.30%, low lipids (0.50 to 2.60%), protein (0.88 to 9.16%), ash (0.41 to 1.16%) and fiber (0 to 9.17%). On the base of 50 g available carbohydrate portion, *akassa* had given the most energy and had no fiber followed by rice, *gari* and *attieke* with respectively. 0.32, 5.19 and 1.10% of fiber. Rice, *attieke*, *gari* and *akassa* could quickly raise blood glucose. They need to be limited or avoided on a low-carb diet and classified as foods to eat in moderation because their regular consumption could promote diabetes.

Keywords: Carbohydrate foods; National foods, Non-national foods; Consumption frequency; Proximate composition; Abidjan

1. Introduction

Crops that were less affected by extreme weather like cereals (such as wheat, barley, millet, and sorghum) and tubers (such as yams) slowly became popular throughout Africa and have remained important staples in the African diet today [1]. These foods contain high carbohydrate level. That is the case of Ivorians whom diets are carbohydrate based and most families plan their meals around it. Foods high in carbohydrates are an important part of a healthy diet. Carbohydrates provide the body with glucose, which is converted to energy used to support bodily functions and physical activity. Carbohydrates are the main energy source in most human diets, making up about 40-80% of our calorie intake play an enormous role in human physiology [2]. Despite the energy value of carbohydrates, their physiological effects on human health differ from each other [2]. Carbohydrate quality is important; some types of carbohydrate-rich foods are better than others**.** Indeed, the energy contents and digestibility of different carbohydrates differ. According to [3], the healthiest sources of carbohydrates are unprocessed or minimally processed whole grains, vegetables, fruits and beans. They promote good health by delivering vitamins, minerals, fiber, and a host of important phytonutrients. Unhealthier sources of carbohydrates include white bread, pastries, sodas, and other highly processed or refined foods. These items contain easily digested carbohydrates that may contribute to weight gain, interfere with weight loss, and promote diabetes and heart disease. These carbohydrate foods elicit a quicker response from insulin than others [4]. An excessive consumption of these foods will cause hyperglycemia, which in the long term will lead to diabetes [5] and other metabolic diseases.

Some studies have reported on the relationship between blood sugar levels and some carbohydrate foods consumed in Ghana [6] and Côte d'Ivoire [7]. For [6], five major Ghanaian staples such *fufu* (plantain and cassava), *banku* (corn and cassava), *Tuo Zaafi* (corn) and *kenkey* (corn) should be considered in recommendations for diabetics because their showed low to moderately high glycemic index. For [7], *Attieke* (agbodjama) had a high glycemic index (29) while placali (17) and maize meal stiff porridge (16) had medium glycemic index. The glycemic load of pounded cassava-plantain and pounded yam are 26 and 22 [8] have showed that pounded yam with eggplant sauce, cassava paste with granulates palm nut sauce and rice with groundnut sauce must be consumed moderately in a diet. Indeed, glycemic index value (GI) of pounded yam with eggplant sauce and cassava paste with granulates palm nut sauce were high ranging to 94 to 86 respectively, while those of rice with groundnut sauce were low (GI = 45). Nevertheless, the glycemic loads of the all these foods are high with the values of 47, 43 and 23 (g) for pounded yam with eggplant sauce, cassava paste with granulates palm nut sauce and rice with groundnut sauce respectively.

In Côte d'Ivoire, some carbohydrate foods are more consumed than others. If their glycemic index and glycemic loads are high, they could be increased the cases of diabetes in the country. The aim of this work is to reveal the carbohydrate foods most consumed in Abidjan (Côte d'Ivoire) and evaluate their nutritional value.

2. Materials and Methods

2.1 Data collection of consumption survey

A consumption survey was conducted from 26 August to 26 September 2019 in five municipalities (Cocody, Port-Bouet, Marcory, Abobo and Yopougon) in Abidjan (Côte d'Ivoire). These five municipalities were chosen

taking into account their cosmopolitan character, their high population density and their social and food diversity. Sample consisted of men and women randomly selected. In each town, the interviews were conducted individually in French with 50 participants (young, adults and senior). The questions were about the food habits and the frequency of consuming these foods.

2.2 Sample for analysis physicochemical characterization

National foods (white rice cooked and *attieke*) and non-national foods (*gari* and *akassa*) were purchased in the *big market of Abobo, Abidjan (Côte d'Ivoire).* This market is one of the most populated areas where we find all kind of traffic, traders from several African countries. *Attieke* is a fermented cassava couscous. *Gari is* cassava root, dried and ground into a flour. *Akassa* is *maize*-based *fermented dough.* The samples (*attieke*, *gari* and *akassa*) were purchased from randomly selected four sellers. They were packaged in closed containers for analysis. The rice was cooked at home (1 kg of rice for 1.5 l of water).

2.3 Biochemical characterization and energy value

Moisture, ash, proteins, lipids and total fiber, were determined by AOAC method [9]. The amount of carbohydrates was determined by difference as follows:

Total carbohydrates (%) = 100 – (% moisture +% proteins +% lipids +% ash) (1)

The energy value was determined by [10] formula using [11] coefficients.

Energy value (kcal)= (4 x% proteins) + (4 x% total carbohydrate) + (9 x% lipids) (2)

2.4 Portion of food consumed

The portion of food consumed on the base of 50 g of available carbohydrate were determined according to the following formula:

Weight portion (g)= (50 × 100)/(Total carbohydrate-Fiber).

2.5 Data analysis

Consumption survey data were collected and analyzed with IBM SPSS software version 22 for windows where data were subjected to descriptive statistics for calculation of frequencies. Results of biochemical characterization are presented as the average ± standard deviation, and the differences among foods were assessed by one-way analysis of variance followed by Duncan's New Multiple Range Test using Statistica 7.1 (StatSoft).

3. Results

3.1 Characteristics of the respondents

The study population consisted of 39.4 to 68.6% of men and 31.4 to 60.6% of women from diverse ethnic origins and aged up to 12 years old; 0 to 3.4% of them had diagnosed diabetes, 0 to 7.4% obese and 0 to 10.2% having high arterial pressure (Table 1).

3.2 Food habits of the respondents

Figure 1 presented the national carbohydrate dishes preferentially consumed by respondents. The rice and *attieke* are national foods the most consumed with respectively 47.67% and 31.54%. Next come the *pounded cassava-plantain* (11.83%), *foufou* (4.30%), *toh jaune* (2.15%), *placali* (1.79%) and *pounded yam* (0.72%). Among non-national foods (Figure 2), *gari* is the most consumed with a proportion of 25.45% followed by *akassa* (21.54%), *dokounou* (17.56%) and *abolo* (14.70%).

3.3 Frequency of food consumed by selected subjects

Table 2 presents the consumption frequency of rice, *attieke*, *gari* and *akassa*. All respondents ate rice and 0.36% had never or rarely eaten *attieke*. At least 5 time a week, 84.23% and 54.84% of respondents had

respectively eaten the rice and *attieke*. Concerning *gari* and *akassa* respectively 66.67 and 34.41% of respondents consumed them rarely or never. *Gari* is more consumed than *akassa*.

3.4 Proximate composition of selected foods

The proximate composition of analyzed foods is shown in Table 3. Some significant differences ($p < 0.05$) were observed in the proximate composition of foods. The moisture content of the foods varied between 728 ± 0.5% and 86.55 ± 0.45%. *Akassa* had the high moisture content. However, the lowest water content was observed in the *gari*. *Gari* contained high ash level (1.03 ± 0.15%) following by *akassa* (1.02 ± 0.02%), *attieke* (0.51 ± 0.04%) and rice (0.41 ± 0.08%). For lipid contents, a significant difference was observed between *attieke* (2.60 ± 0.77%), *akassa* (2.52 ± 0.2%), rice (1.65 ± 0.11%), and *gari* (0.50 ± 0.43%). The protein contents of food were significantly different with a high value in *akassa* (9.16 ± 0.30%) followed by rice (7.64 ± 0.08%), *attieke* (2.10 ± 0.01%) and *gari* (0.88 ± 0.06%). The carbohydrate contents are statistically different in all the foods studied with 97.45 ± 0.41% for *gari*, 94.79 ± 0.77% for *attieke*, 90.30 ± 0.45% for rice and 87.30 ± 0.6% for *akassa*. The highest fiber content was observed in *gari* (9.17 ± 0.80%) followed by *attieke* (2.05 ± 0.4%) and rice (0.59 ± 0.01%). *Akassa* does not contain fibers (0%).

3.5 Weight of ingested foods and proximate composition of foods per 50 g available carbohydrate hydrate

The weight and proximate composition of ingested foods per 50 g available carbohydrate hydrate is shown in Table 4. For 50 g available carbohydrate, the amount of *akassa* to ingest was the highest (425.83 g) following by rice (180.31 g), *attieke* (131.05 g) and *gari* (61.08 g). The portion of *akassa* mostly contained water (368.56 g) as rice (124.58 g) and *attieke* (77.14 g). The rice and the *akassa* contained high protein level respectively 5.24 g and 4.26 g but very little fiber 0.32 for rice. All four test foods had low lipid content 0.28 to 1.45 g. The energy value of *akassa* was the highest (234.01 kcal), following by that of rice (226.6 kcal), *gari* (225.28 kcal) and *attieke* (221.52 kcal).

Variables	**Sub variables**	**Proportion of the respondents (%)**				
		Abobo	**Cocody**	**Yopougon**	**Port-Bouet**	**Marcory**
Gender	Male	58.8	39.4	68.6	66.7	52.5
	Female	49.2	60.6	31.4	33.4	47.5
Ethnic Groups	Akan	59.3	69.1	60	76.5	65
	Krou	15.3	11.7	14.3	13.7	7.5
	Gour	13.6	00	17.1	00	5
	Northern Mande	5.1	11.7	00	7.8	20.5
	Southern Mande	6.8	7.4	8.6	2.0	2.5
Age	12-18	22	20.2	2.9	13.7	20
	19-30	49.2	67.0	65.7	35.3	57.5
	> 31	28.8	12.8	31.4	51	22.5
Personal history illness						
Diabetes	Yes	3.4	2.1	00	2	00

	No	96.6	97.9	100	98	100
Obesity	Yes	6.8	7.4	00	00	00
	No	93.2	92.6	100	100	100
High blood pressure	Yes	10.2	7.4	2.9	00	5
	No	89.8	92.6	97.1	100	95

Table 1: General characteristics of the respondents.

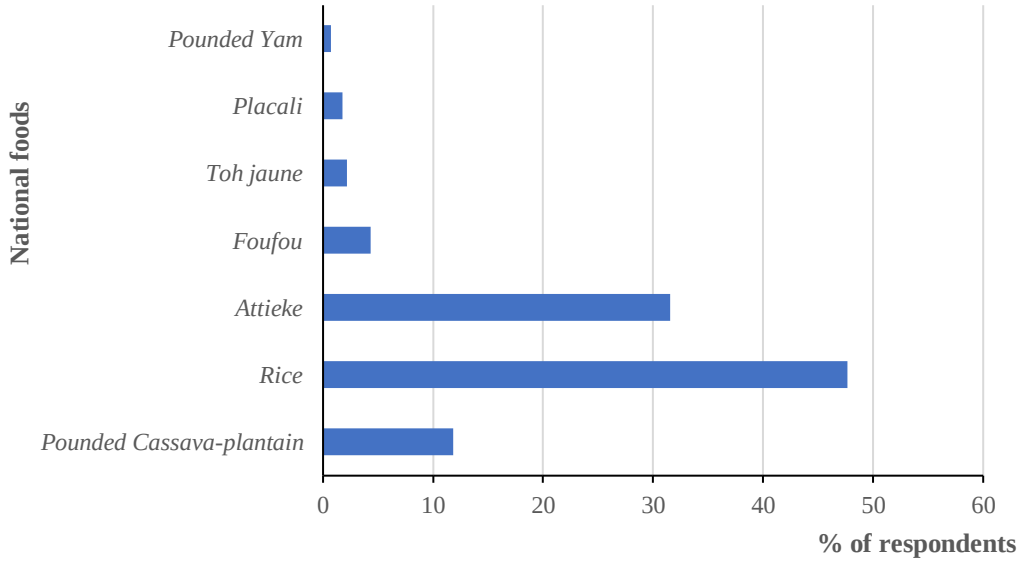

Figure 1: National carbohydrate dishes.

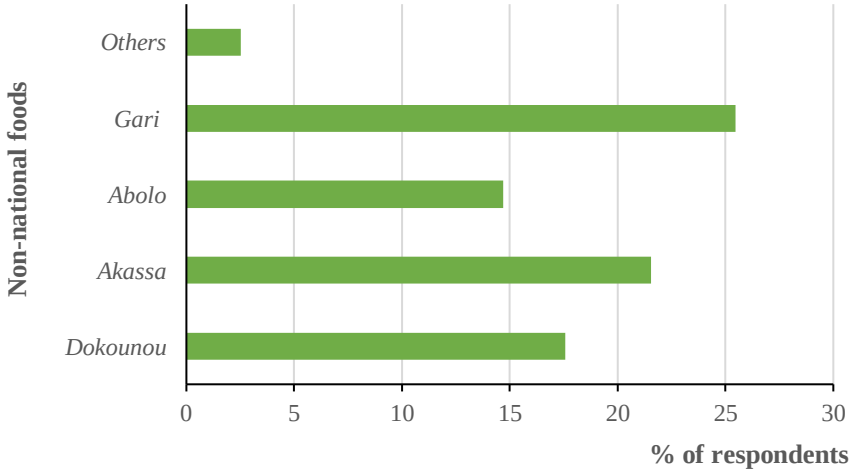

Figure 2: Non-national carbohydrate dishes.

Frequency	**Rice**	***Attieke***	***Gari***	***Akassa***
5-7 time a week	84.23	54.84	0.36	1.08
3 to 4 time a week	9.68	30.11	2.19	11.47
Once or twice a week	3.94	12.54	1.79	15.77
Once or twice a month	2.15	2.15	29.03	37.28
Rarely or never	0	0.36	66.67	34.41

Table 2: Frequency of food consumed by selected subjects (%).

Parameters	**Tested foods**			
	Rice	***Attieke***	***Gari***	***Akassa***
Moisture (% of fresh matter)	69.09 ± 0.68^{b}	58.86 ± 0.81^{c}	7.28 ± 0.5^{d}	86.55 ± 0.45^{a}
Ash	0.41 ± 0.08^{d}	0.51 ± 0.04^{c}	1.16 ± 0.15^{a}	1.02 ± 0.02^{b}
Lipid	1.65 ± 0.11^{c}	2.60 ± 0.77^{a}	0.50 ± 0.43^{d}	2.52 ± 0.2^{b}
Protein	7.64 ± 0.08^{b}	2.10 ± 0.01^{c}	0.88 ± 0.06^{d}	9.16 ± 0.30^{a}
Total carbohydrate	90.30 ± 0.6^{c}	94.79 ± 0.77^{b}	97.45 ± 0.41^{a}	87.30 ± 045^{d}
Fiber	0.59 ± 0.01^{c}	2.05 ± 0.40^{b}	9.17 ± 0.80^{a}	0^{d}

Values are means ± standard deviation of triplicates (n=3). Values in the same line with the different superscript are significantly different ($P < 0.05$).

Table 3: Proximate composition of the test foods (% of dry matter).

Parameters (g)	**Tested foods**			
	Rice	***Attieke***	***Gari***	***Akassa***
Weight of ingested food	180.31 ± 0.68^{b}	131.05 ± 0.81^{c}	61.08 ± 0.5^{d}	425.83 ± 0.45^{a}
Moisture	124.58 ± 0.68^{b}	77.14 ± 0.81^{c}	4.45 ± 0.5^{d}	368.56 ± 0.45^{a}
Ash	0.23 ± 0.08^{d}	0.28 ± 0.04^{c}	0.66 ± 0.15^{a}	0.60 ± 0.02^{b}
Lipid	0.92 ± 0.11^{c}	1.40 ± 0.77^{b}	0.28 ± 0.43^{d}	1.45 ± 0.2^{a}
Protein	4.26 ± 0.08^{b}	1.13 ± 0.01^{c}	0.50 ± 0.06^{d}	5.24 ± 0.30^{a}
Fiber	0.32 ± 0.01^{c}	1.10 ± 0.40^{b}	5.19 ± 0.80^{a}	0^{d}
Energy value (Kcal)	226.6 ± 0.22^{b}	221.52 ± 0.33^{d}	225.28 ± 0.76^{c}	234.01 ± 0.4^{a}

Values are means ± standard deviation of triplicates (n=3). Values in the same line with the different superscript are significantly different ($P < 0.05$).

Table 4: Weight of ingested food and proximate composition of foods per 50 g available carbohydrate.

4. Discussion

The consumer survey focused on a population with more men than women. The majority of people were young people between the ages of 19 and 30. These people were mostly "Akan". According to [12], the "Akan" are the most numerous in the Ivorian population. Rice and *attieke* are the national carbohydrate foods that these people consume the most. These results could be explained by the fact that rice and *attieke* are staple foods of the Ivorians. These foods are generally eaten for lunch and dinner in most households. *Gari* and *akassa* are the most consumed non-national carbohydrate foods. However, it is rarely consumed. But often once or twice a month. *Akassa* is also consumed among others in Benin, Togo, Nigeria, a little in Mali. It is of Beninese origin where it is consumed four times a week. It is a dish very appreciated by Africans [13].

The water contained in *akassa* is greater than that of cooked rice which is itself greater than that of *attieke* and *gari*. These results could be explained by the culinary techniques applied to these foods. Indeed, these techniques can either increase or decrease the water contained in foods. Preparation of *akassa* and rice requires the incorporation of water. That increase the water level in these foods. Both the *attieke* and the *gari*, which are made from cassava, certainly contain water, but high proportion of the water was removed from the *attieke* during pressing. As for *gari*, the step of pressing and roasting over high heat is believed to be the cause of this low water content. The amount of water contained in *akassa* (86.55%) is similar to that found by [14]. According to his studies, *akassa* is made up of 86.90% water.

Rice, *attieke*, *gari* and *akassa* are rich in carbohydrate (87.30 to 97.45%) and poor in lipids, proteins, fibers and ashes. These foods are made from tubers (*attieke* and *gari*) and cereals (rice and *akassa*). Indeed, *attieke* and *gari* are prepared from the cassava tuber which is rich in starched and poor in lipids, proteins and ash [15]. Thus, the derived dishes will have a very high carbohydrate content. *Akassa* is a preparation made from corn. According to [16], corn is a food low in lipids, ash and protein but high in carbohydrates. The preparation of *akassa* goes through various processes such as cleaning, soaking and sieving operations, which further reduce the content of these nutrients [14]. Some nutrients are solubilized by the water used in the process [14]. Losses of soluble protein increase with prolonged soaking. Indeed, [17] reported that prolonged soaking can result in loss.

The low nutrient content of rice could be explained by the mechanical treatments allowing to obtain the white rice and which lead to losses of lipids, proteins, dietary fibers, vitamins of the group B and vitamin E as well as the loss of main minerals such as magnesium, potassium or manganese particularly abundant in the germ, pericarp and aleurone layer [18]. Consumed alone, these dishes could cause nutritional imbalance and an increase of the glycemia because of their low fiber content (0 to 9.17%). For these reasons, [19] undertook work to fortify *attieke* with yeasts capable of increasing protein contents by up to 10.5% without significantly affecting organoleptic qualities.

For 50 g available carbohydrate, the amount of *akassa* to ingest was the highest (425.83 g) following by that of rice (180.31 g), *attieke* (131.05 g) and *gari* (61.08 g). These portions mostly contained water, low protein, lipid and fiber levels. The glycemic responses of these foods could be very high. Indeed, according to [20], there is a close relationship between foods in which more than 80% of the energy intake comes from their carbohydrates and the considerable rise in postprandial blood sugar. Also, rice, *attieke*, *gari* and *akassa* contain

starch, more precisely amylopectin, which are easy to digest [21]. Indeed, *attieke* contains 83% amylopectins, *gari* 75%, rice 75% and *akassa* 78.5 to 80% [22]. Thus, regular consumption and high amount of these foods may cause short-term, significant peaks and hyper-glycemic long-term deterioration of glucose homeostasis.

Due to the lack of fiber and its gelatinous texture, *akassa* may have the highest glycemic index and glycemic load. Indeed, according to [23], with high starch gelatinization, starch is more digestible, digestion is more rapid and high glycemic index. That was confirmed by the work of [24] who had effectively shown glycemic index value of 92.30 and glycemic load of 46.15 for *akassa*. The glycemic index and glycemic load of rice are also high according to [25] with respectively 69 and 30. [7] had found for *attieke*, a glycemic index of 63 and 29 for glycemic load. With *gari* sample containing 12.61% of water and 63.57% of available carbohydrate, glycemic index was 62.33 [26]. This decrease of the glycemic index in *attieke* and *gari* may be derived from their dietary fiber content. According to [27], the fiber could be responsible for decreasing post prandial glucose by increasing viscosity of the digestible and reduce gastric emptying time. [28] and [29] have shown that the eating habits with high glycemic load can lead to a high glycemic response and insulin resistance. In the absence of adequate insulin delivery, these foods would certainly overwhelm the sugar metabolic system. They are thus not considered suitable or adequate meals for type II diabetics.

5. Conclusion

This study had showed that among the available carbohydrate foods in Abidjan rice and *attieke* were the most consumed national foods and *gari* and *akassa* the most consumed non-national foods. All respondents ate rice regularly and 99.64% the *attieke* while most of them consumed rarely *gari* and *akassa*. Rice, *attieke*, *gari* and *akassa* contained high available carbohydrates and water contents, low lipids, protein, ash and, fiber. On the base of 50 g available carbohydrate portion, *akassa* had given the most energy and had no fiber followed by rice, *gari* and *attieke* with respectively. 0.32, 5.19 and 1.10% of fiber. Rice, *attieke*, *gari* and *akassa* are high-glycemic foods and need to be limited or avoided on a low-carb diet.

Conflicts of Interest

No conflicts of interest have been registered on this work to the best of our knowledge.

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