IJFANS
International Journal of Food
And Nutritional Sciences

olume 3, Issue 6, Oct-Dec 2014, www.ijfans.com e-ISSN: 2320-7876

INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES

IMPACT FACTOR ~ 1.021

Official Journal of IIFANS

IJFANS International Journal of Food And Nutritional Sciences

INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES

e-ISSN 2320 –7876 *www.ijfans.com*
Vol.3, Iss.6, Oct-Dec 2014

Research Paper *Open Access*

EFFECTS OF FOOD INTAKE HIGH-CARBOHYDRATE DIET TYPE IVORIAN ON ANTHROPOMETRIC CHANGES AND POSTPRANDIAL METABOLIC RESPONSES IN HEALTHY SUBJECTS

Gbakayoro Jean Brice[1*], Brou Kouakou[1], Abodo Jacko Rhedoor[2], Gbougouri Grodji Albarin[1] and Tiahou Gnomblesson Georges[3]

[1] Laboratory of Nutrition and Food Safety, Faculty of Science and Food Technology, University Nangui Abrogoua, Abidjan, Ivory Coast, [2] Endocrinology Diabetes Nutrition, CHU yopougon, Abidjan, Ivory Coast,
[3] Laboratory of Biochemistry, Medical Sciences Faculty, University Alassane Ouattara, Bouaké, Ivory Coast

[*]Corresponding author: jb.gbakayoro@aodci.org

Received on: 30th August, 2014 **Accepted on: 10th December, 2014**

ABSTRACT

The aim of this study is to show whether certain dietary habits of the poorer populations in Ivory Coast could be the cause of the occurrence of metabolic diseases. The work was to determine the postprandial glycemic responses of staple foods consumed in Côte d'Ivoire (rice, semoulina of cassava or *attiéké*, gel of corn flour or *toh*, mashed banana pulp plantain and cassava or banana *foutou*, mashed pulp yam or yam *foutou*). Ten (10) groups of twelve (12) participants were randomly assigned in a parallel or a normal-carbohydrate diet (RNG) or high-carbohydrate diet based those cited above food while respecting the balance protidic and lipid. Changes in BMI (body mass index) and waist circumference was followed. The influence of these foods on serum lipids (total cholesterol, HDL-cholesterol, LDL-cholesterol, triglycerides) and blood pressure was also evaluated. The results showed that the five foods studied, high-carbohydrate diet based yam *foutou* (RHG-Fi) and high-carbohydrate diet based banana *foutou* (RHG-Fb) can be considered as potential risk factors for onset metabolic syndrome and metabolic diseases. These RHG-Fi and RHG-Fb showed higher postprandial glycemic responses (P = 0.05), led to a rapid increase in BMI at P = 0.05 (BMI respectively from 23.9 kg/m^2 ± 0.5 to 30.4 kg/m^2 ± 0.9 for the RHG-Fi, 24.1 kg/m^2 ± 0.3 to 29.5 kg/m^2 ± 0.9 for the RHG-Fb). They also led to a much faster abdominal obesity P = 0.05 (waist 80 cm respectively from ± 1.3 to 100.5 ± 0.8 cm for men and 70 ± 0.9 to 85 cm ± 0.7 cm in women during the RHG-Fi, from 80 cm to 99 cm in men and 70 cm ± 1.5 to 83 ± 1.3 cm in women during the RHG-Fb) and they are the cause of dyslipidemia P = 0.05 (increase in LDL-cholesterol of 0.35 g/l in the RHG-Fi and 0.29 g/l in the RHG-Fb; a increased triglycerides 0.55 g/l during the RHG-Fi and 0.41 g/l during the RHG-Fb and a decrease in HDL-cholesterol of 0.12 g/l during the RHG-Fi and 0.15 g/l during the RHG-Fb) after a period of testing 12 weeks. These should therefore be foods consumed and moderate frequency quantity (a maximum of 150 g ± 10 g, 3 times per week with 2 day intervals between days making these foods). They could only be sources of carbohydrates to the body instead of potential risk factors for occurrence of metabolic diseases.

Key words: eating habits, obesity, diabetes, metabolic syndrome, dyslipidemia

INTRODUCTION

Metabolic diseases (diabetes, hypertension, and obesity) are the leading causes of morbidity and mortality worldwide, taking the lives of more people than the sum of all other causes combined. Of 57 million registered worldwide in 2008, 36 million or 63% of deaths were due to non-communicable diseases including cardiovascular disease, diabetes, cancers ... (WHO, 2011). Diabetes in particular has become in recent years an epidemic of more than 382 million people in 2013 and 316 million glucose intolerant, people at high risk of the disease. According to projections by the International Diabetes Federation, the number of diabetics could exceed 471 million in 2035 an increase of almost 90 million in 20 years (IDF, 2013). Formerly called "diseases of the rich", available data show that nearly 80% of deaths from these diseases occur in countries with low or intermediate especially in countries of Asia and sub-Saharan Africa revenues (Popkin, 2002). The main causes of occurrence of these diseases are particulary heredity, bad eating habits, physical inactivity and especially abdominal obesity (Delpeuch 2004; Boutayeb et *al*, 2006). The occurrence of these metabolic diseases is gradual and silent way over several years passing first through a much better known under the term "metabolic syndrome" transitional phase of metabolic disorders. This transitional phase is often characterized by abdominal obesity (waist circumference greater than 88 cm abnormally high in women and 102 cm for men) combined

with two other markings insulin resistance (fasting glucose between abnormally high 1.10 g/l and 1.25 g/l), a high blood pressure, greater than 13/8 mm Hg; serum dyslipidemia with high triglyceride level, higher than 1.5 g/l, low HDL-cholesterol, less than 0,5 g/l (IDF, 2006). Many studies (Ben et *al*, 2002, Popkin, 2004. Raynaud, 2009, Avignon, 2012) indicate the westernization of diet also called the "nutrition transition" as one of the main causes of the occurrence of these diseases in developing countries. Though these works have focused on the nutrition transition, few studies have evaluated the effects of some specific food to African on the occurrence of these diseases. However, most traditional diets in our developing countries are energy-dense and are based on starchy foods basic cereal roots and tubers (Maire et *al*., 2002). The hypothesis tested is whether a significant and regular consumption of traditional foods Ivorian could lead the development of metabolic diseases. It is specifically:
- Determine the postprandial glycemic responses of foods
- Evaluate the influence of high- carbohydrate diets based on certain foods (yam, plantain, cassava, rice, maize) on body mass index and waist circumference
- Determine the influence of high-carbohydrate diets based on these foods on serum lipids (HDL-Chol, LDL-Chol, triglycerides, total cholesterol) and blood pressure.

MATERIAL AND METHODS

MATERIAL

BIOLOGICAL MATERIAL

The biological material used in this study consists of rice (*Oryza sativa*); cassava (*Manihot esculenta*) particularly cultivar "Yacé" varieties and IM 89 IM 93 572 TMS30 used in making *attiéké*; maize (but Zeas) used to manufacture the *toh*; the yam variety kponan (*Dioscorea rotundata cayenensis*) used for the preparation of yam *foutou*; Plantain (*Musa spp*) used in the preparation of banana *foutou*.

STUDY POPULATION

Table 1 shows the baseline characteristics of the study participants. None of the variables differed between the two groups consuming the normal-carbohydrate diets or high-carbohydrate diets based on the same carbohydrate food (P = 0.05), 62% of subjects who completed the study were women. Participants subject to normal-carbohydrate diet were on average 11 per group [10-12], with a mean age of 31.4 years [29-34 years], a mean body mass index of 23.62 kg/m^2 [23.2 to 23.9 kg/ m^2], an average waist size of 80.52 cm [80.1 to 80.9 cm] in men and 70.5 cm [70.1 to 70.9 cm] in women. The metabolic balance means characteristic of these subjects was a fasting glucose of 0.91 g/l [0.78 to 0.98 g/l], a total cholesterol of 1.52 g/l [1,18 - 1.77 g/l], a triglyceride 0.97 g/l [from 0.87 to 1.05 g/l], a HDL-cholesterol 0.82 g/l [0,69 - 0.93 g/l], LDL-cholesterol of 1.11 g/l [1.04 to 1.16 g/l], a systolic blood pressure of 12.38 mm Hg [12.1 to 12 , 6 mm Hg] and diastolic blood pressure by 8.7 mm Hg [8.1 to 9.3 mm Hg]. Participants subject to high-carbohydrate diet were on average 11 per group [11-12], a mean age of 32.4 years [28-37 years] and an average body mass index of 23.78 kg/m^2 [22 , 2 to 24.2 kg/m^2], an average waist size of 80.74 cm [80.2 to 81.3 cm] in men and 70.9 cm [70.5 to 71.2 cm] in women with a fasting glucose of 0.88 g / l [0.76 to 0.97 g / l], a total cholesterol of 150 mg/dl [1.12 to 1.79 g/l], a triglyceride 1.00 g/l [from 0.89 to 1.09 g/l], a HDL-cholesterol 0.83 g/l [from 0.71 to 0.94 g/ l], an LDL cholesterol of 1.08 g/ l [1.03 to 1.18 g/l], a systolic blood pressure of 12.6 mm Hg. [12,2- 12.8 mm Hg] and diastolic blood pressure of 8.52 mm Hg [7.9 to 9.6 mm Hg].

METHODS

PREPARATION OF FOOD CONSUMED

RICE

Rice (*Oryza sativa*) is sorted, washed and then overturned in boiling water at 100 ° C (1 Kg of rice to 2 liters of water). After a cooking time of 20 to 25 min, it is served and weighed to be consumed by the study participants.

SEMOULINA OF CASSAVA OR *ATTIÉKÉ*

Attiéké is a semoulina of cassava pulp (*Manihot esculenta*) fermented and steamed. For this study, *attiéké* used was purchased "ready to eat" in markets common Adjamé, Yopougon, Kumasi, Port-Bouet, Cocody, situated in the district of Abidjan.

GEL OF CORN FLOUR OR *TOH*

Toh is the gel obtained from corn flour (*zeas mays*) mixed with cold water (2 kg of flour to half liter of water) to obtain a homogeneous mixture which is spilled into two liters of boiling water at 100°C. The mixture turned regularly with a wooden spoon for 10 to 15min. Meanwhile, corn meal is added gradually to the boil, stirring continuously until a consistent gel.

MASHED BANANA PULP PLANTAIN AND CASSAVA OR BANANA *FOUTOU*

Banana *foutou* is mashed pulp plantain crafted in two thirds by plantain (*Musa spp*) and the third by cassava (*Manihot esculenta*). The cultivar "Bonoua" and IM84 and TMS4 varieties (2) 1425 cassava varieties used in the preparation of banana *foutou* while the triploid AAB cultivar Horn 1 is that of plantain used (CNRA, 2005). Plantain is chosen at a stage of ripening "green shift" (according to a color scale established by IRFA, 1980 for the assessment of the stages of ripening bananas commercially accepted). The pulp of plantain and cassava are cooked in boiling water at 100 ° C for about 25 minutes. After firing, they are ground together with a mortar pestle kitchen to get the mashed, then weighed using a scale food prior to consumption.

MASHED PULP YAM OR YAM *FOUTOU*

Cosettes of yam kponan variety (*Dioscorea* *rotundata cayenensis*) are cooked for 20 to 25minutes in boiling water at 100 ° C and then crushed with a mortar pestle kitchen to get a mashed.

BIOCHEMICAL CHARACTERIZATION OF FOODS STUDIED

The moisture content was obtained by drying the sample in an oven at 105°C for 24hours (925-10 method, AOAC, 1990). The solids content was arbitrarily deducted from the humidity. The ash content was determined after ashing at 550°C oven for 24 hours (Method 923-03, AOAC, 1990). The fat content was determined by the method of SOXHLET using hexane as a solvent (BIPEA 1976). The protein content was determined by the determination of total nitrogen in samples according to BA 4C-87 method (AOCS, 1990) Kjeldahl. The total carbohydrate content was determined by difference (Egan et al, 1981.) Using the formula: % Total Carbohydrate = 100% -% fat -% protein -% ash -% moisture. The dietary fiber content was determined according to the method BIPEA (1976) using sulfuric acid. The energy value was determined using the coefficient of Atwater and Rosa (1899).

DETERMINATION OF POSTPRANDIAL GLYCEMIC RESPONSES OF FOODS STUDIED

Ten (10) volunteers regardless of sex between 22 and 28 years, healthy subjects were recruited. Subjects under medical prescription were excluded. On the test day, subjects were fasted for 12 hours. Each subject consumed a portion of cooked rice, *attiéké*, *toh*, yam *foutou* and banana *foutou* containing 50 g carbohydrate digestible. He was asked on the one hand not to practice unusual physical activity and also to keep a normal diet and avoid taking vegetable and alcohol the night before the test. The first measurement at t = 0, the capillary fasting glucose, is taken before meal ingestion. The subjects placed in a quiet ingested food tested for 15 min.

HIGH-FOOD CONSUMPTION OF TRADITIONAL CARBOHYDRATE BASED IVORIAN AND METABOLIC SYNDROME

This analytical study comparative case-control began with the signing of a consent form for each subject. Inclusion criteria were age at least 18 years, a normal body mass index [BMI = weight (kg)/T (m) 2)] between 18 and 25, a normal waist (less than 88 cm for women, less than 102 cm for men). Participants with a sign of metabolic syndrome (waist circumference greater than 102 cm for men size 88 for women, dyslipidemia, impaired fasting glucose, blood pressure greater than 8.13), with a metabolic disease (diabetes , hypertension, obesity ...) or other nutritional diseases (irritable bowel syndrome, gastroesophageal reflux ...) were excluded. The study took place during a period of 12 weeks from June 4 to August 31, 2012.

EXPERIMENTAL PROTOCOL

For each of the studied food (rice, *toh*, *attiéké*, banana *foutou*, yam *foutou*), two parallel groups of twelve (12) participants each were assigned to either a diet with normal carbohydrate or high carbohydrate. Of a total of 120 participants who started the study (ten teams of twelve), 113 have completed it. A stratified randomization is used by blocking within strata to ensure that each group contains the same number of women as men. Participants subject to different preparations have been educated on the calculation of their energy needs based on gender, weight, size, activity level ... but also calculate calories obtained from foods studied in terms the average composition of carbohydrates, lipids and proteins. No specific physical exercise program has been recommended. It was asked the various groups to respect diet and lifestyle measures. To create the habit, participants were taken to consume the foods taxed once daily either at lunch or at dinner.

Participants assigned to normal-carbohydrate diets have just been taken to consume food to satisfy their energy needs while respecting food balance (55% of dietary intake provided by carbohydrates or an average of 150g of carbohydrate foods, 30-35% from fat, 12-15% from protein) as was shown during their sessions of instruction and have a normal intake of fruits and vegetables without alcohol abuse. Participants assigned to the high carbohydrate diet were taken to consume 150 g of carbohydrate foods more than their calculated need carbohydrate (ie 300g of carbohydrate foods). However, it was asked to satisfy the lipid and protein balance and avoid the consumption of certain lipid and protein foods that can also alter the metabolic balance. Several visits to the various homes have been made to ensure proper compliance with the measures of food and recommendations by the subjects. An average of four visits per week was conducted during the first two weeks of the study and two others during the ten weeks.

ANTHROPOMETRY MEASUREMENTS

Weight (in kg) was measured by scales (SECA brand) and waist circumference (WC) in cm umbilical level standing by to tape weekly. The body mass index (BMI) was calculated by dividing body weight (kg) by the square of height (in meters).

BLOOD SAMPLE PREPARATION

3.5 ml samples of blood were collected once a month in the morning, after 12 to 14 hours of fasting were stored between 2 and 8°C in tightly stoppered tubes protected from light and then transported to the laboratory for the determination of the concentrations of triglycerides, total cholesterol, HDL-cholesterol, LDL-cholesterol.

DETERMINATION OF LIPOPROTEINS, CHOLESTEROL AND TRIGLYCERIDES

The dosage of high density lipoprotein and very low density lipoprotein (HDL-cholesterol and LDL-cholesterol) was made by the direct method and with selective detergents accelerator without pretreatment of the specimen. The respective concentrations of LDL-cholesterol and HDL-cholesterol were read at 546 nm and 660 nm. Triglycerides were assayed by the method of Fossati and Prencipe (1982). The cholesterol was assayed by the enzymatic method described by Allain et *al*. 1979. Blood pressure (in mm Hg) was measured each week after standing for 10 min by an electronic tensiometer (OMRON mark). Data were entered into the EpiData 3.1 and analyzed by SPSS statistics 19, to significance level software 5%.

RESULTS

BIOCHEMICAL CHARACTERIZATION OF STAPLE FOODS IN IVORY COAST

The analyzes performed on the different types of food (rice, *attiéké*, *toh*, banana *foutou*, yam *foutou* (kponan) and yam *foutou* (Florido)) gave an average of the results that are reported in table 2. This table shows that yam *foutou*, banana *foutou* and *attiéké* are high in total carbohydrates and exhibit superior to those obtained from the analysis of rice and *toh* energy values. The study on determination gave values in carbohydrates which are respectively 88.37 ± 2.20 g/100g; 83.25 ± 4.40 g/100g; 87.11 ± 1.1 g/100g; 81.8 ± 2.11 g/100g for *attiéké*, banana *foutou*, yam *foutou kponan* and yam *foutou florido* and 69.44 ± 2.24 g/100g; 73.70 ± 3.27 g/100g for *toh* and rice. As for the energy values, they are of 385.52 ± 6.43 kcal/100g; 413.89 ± 8.64 kcal/100; 369.78 ± 6.26 kcal/100; 372.94 ± 7.1 kcal/ 100g for *attiéké*, banana *foutou*, yam *foutou kponan* and yam *foutou florido* and 339.20 ± 7.1 kcal/100; 341.48 ± 10.3 kcal/100g for *toh* and rice. However, starchy foods have levels of relatively middle fibers (2.05 ± 0.35 g/100 g, 2.34 ± 1.05 g/100 g, 4.13 ± 0.91 g/100 g, 4, 40 ± 0.64 g/100g *attiéké* respectively, the banana *foutou*, yams *foutou kponan* and yam *foutou florido*, *toh* compared to having a high fiber content (6.56 ± 0.53 g/100 g) and rice which has a low fiber content (0.59 ± 0.11 g/100g). water contents and ash were significantly higher in these starchy foods while fat content and protein are higher or lower in both starchy foods than in cereal.

POSTPRANDIAL GLUCOSE RESPONSE OF FOODS TRADITIONAL CARBOHYDRATE BASED IVORIAN

The results of postprandial glucose Ivorian traditional foods studied presented in figure 1 show that the starchy foods namely yam and banana *foutou* cause higher than those from cereals studied postprandial glycemic response rice and *toh*. Generally, whole foods lead to a spike in blood sugar after about an hour of consumption with values ranging to 1.55 g/l ± 0.35; 1.53 g/l ± 0.11; 1.51 g/l ± 0.87; 1.49 g/l ± 0.65, 1.39 g/l ± 0.17 respectively for the yam *foutou* (Fi), banana *foutou*, *toh* rice, *attiéké* (*Att*).

EFFECTS WITH NORMAL GLUCOSE AND HYPER-CARBOHYDRATE DIETS ON CHANGES IN BODY MASS INDEX OR BMI

Figure 2 shows the effect of carbohydrate diets with normal and high carbohydrate on body mass index. This figure indicates that the normal-energy diets (RNG) maintain body weight to normal over a long period (varying between 24 and 25 kg/m^2 after 12 weeks), while the high-carbohydrate diet based on yam *foutou* (RHG - Fi), the high-carbohydrate diet of banana *foutou* (RHG-Fb), the high-carbohydrate diet based on *attiéké* (RHG-Att), the high-carbohydrate diet based on rice (RHG-Rz) the high-carbohydrate diet based on *toh* (RHG-To) all lead to a significant and progressive increase in BMI (P = 0.05), ranging from 23.9 kg/m^2 ± 0.5 at the beginning of intervention to 30.4 kg/m^2 ± 0.9 after surgery. The RHG-Fi, RHG-Fb and RHG-Att result in more rapid increase in BMI compared to RHG and RHG-Rz-To on the same experimental period regimes.

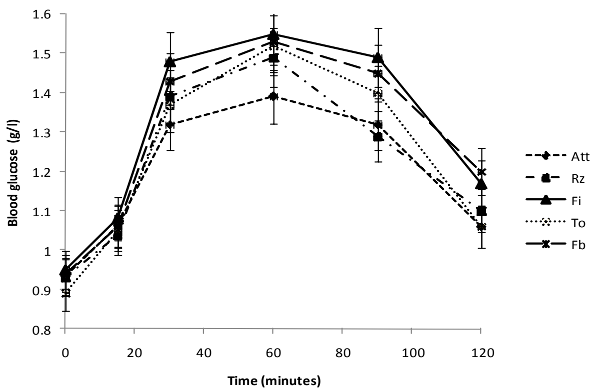

Figure 1: Evolution of postprandial blood glucose after consumption of some traditional carbohydrate foods Ivorian. Att = *Attiéké*, Rz = Rice, Fi = yam *Foutou*, To = *Toh*, Fb = banana *foutou*.

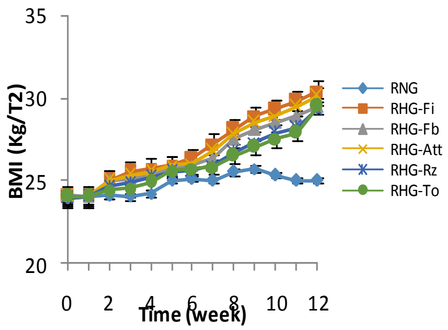

Figure 2: normal-carbohydrate diets, high-carbohydrate diets and changes in Body Mass Index.

RNG = normal-carbohydrate diet, RHG-Fi = high-carbohydrate diet based yam *foutou*, RHG-Fb = high-carbohydrate diet based banana *foutou*, RHG-Att = high-carbohydrate diet based *attiéké*, RHG-Rz = high-carbohydrate diet based rice, RHG-to = high-carbohydrate diet based *toh*.

Table 1-Baseline characteristics of the subjects in the study

Type of diet		**Diet based rice**		**Diet based *toh***		**Diet based *attiéké***		**diet based yam *foutou***		**diet based banana *foutou***	
energy value		Normal	high	Normal	high	Normal	high	Normal	high	Normal	high
number of subjects		11	12	11	11	10	12	12	11	12	11
Age (year)		32±5[a]	37±3[b]	34±4[b]	30±5[a]	33±1[a]	28±5[a]	29±2[a]	31±5[a]	29±4[a]	36±3[b]
Body mass index (Kg/m^2)		23,9±2,1[c]	24,2±1,4[cd]	23,8±1,7[c]	24,3±1,4[cd]	23,2±1,9[c]	24,1±1[cd]	23,7±1,1[c]	24,1±04[cd]	23,5±1,6[c]	22,2±1,4[e]
Men Waist (cm)		80,1±0,2[f]	80,8±0,5[g]	80,5±0,3[g]	80,7±0,4[gh]	80,9±0,5[h]	81,3±0,1[i]	80,3±0,1[f]	80,2±0,5[f]	80,8±0,6[gh]	80,7±0,4[gh]
Women Waist (cm)		70,1±0,3[j]	70,9±0,7[k]	70,9±0,3[kl]	70,7±0,5[k]	70,4±0,2[j]	71,2±0,3[l]	70,9±0,4[k]	70,5±0,7[k]	70,2±0,1[l]	71,2±0,5[k]
Fasting blood glucose (g/l)		0,98±0,02[m]	0,9± 0,07[n]	0,91± 0,07[mn]	0,89± 0,06[mn]	0,78± 0,1[p]	0,76±0,3[p]	0,98±0,3[m]	0,97±0,1[m]	0,93±0,5[mn]	0,91±0,3[mn]
Total cholesterol Blood (g/l)		1,62±0,12[q]	1,63±0,22[q]	1,69±0,07[q]	1,65±0,12[q]	1,77±0,19[q]	1,79±0,31[q]	1,38±0,19[r]	1,35±0,31[r]	1,18±0,18[s]	1,12±0,42[s]
Blood triglycérides (g/l)		0,95±0,11[a]	0,97±0,27[a]	0,99±0,49[a]	1,01±0,19[a]	1,02±0,31[a]	1,07±0,22[a]	0,87±0,37[b]	0,89±0,17[b]	1,05±0,12[a]	1,09±0,16[a]
HDL-Cholesterol Blood (g/l)		0,69±0,12[c]	0,71±0,19[c]	0,93±0,19[d]	0,94±0,2[d]	0,84±0,37[g]	0,87±0,29[g]	0,85±0,13[g]	0,80±0,22[g]	0,81±0,20[g]	0,86±0,19[g]
LDL-Cholesterol Blood (g/l)		1,04±0,19[f]	1,09±0,11[f]	1,10±0,09[e]	1,18±0,11[d]	1,14±0,10[d]	1,03±0,17[c]	1,11±0,11[e]	1,09±0,09[f]	1,16±0,10[d]	1,04±0,15[f]
blood pressure	Systolic blood pressure (mm Hg)	12,5±0,3[a]	12,8±0,1[b]	12,2±0,7[c]	12,9±0,2[b]	12,5±0,6[a]	12,2±0,3[c]	12,1±0,6[c]	12,8±0,1[b]	12,6±0,2[a]	12,3±0,5[c]
	Diastolic blood pressure (mm Hg)	8,2±0,4[ad]	8,5±0,1[a]	9,3±0,1[b]	7,9±0,5[d]	9,1±0,1[b]	8,4±0,3[a]	8,1±0,5[a]	9,2±0,1[b]	8,8±0,1[ab]	8,6±0,3[ad]

Mean values on the same line indexed by the same letters are not statistically different at P < test 0.05

Table 2- Biochemical characterization of some Ivorian many foods consumed

	Biochemical parameters						
	Humidity (%)	**Cendres (g/100g)**	**Total carbohydrates (g/100g)**	**Fibers (g/100g)**	**Fat (g/100g)**	**Protein (g/100g)**	**Energy value (Kcal/100g)**
Rice	69,97 ±0,03[b]	0,34 ±0,01[a]	73,70 ±3,27[a]	00,59 ± 0,11[a]	01,76 ±0,04[a]	07,71 ±0,24[c]	341,48 ±10,30[a]
Attiéké	58,50 ±0,13[a]	0,57 ±0,01[a]	88,37 ±2,20[c]	02,05 ± 0,35[b]	02,64 ±0,05[b]	02,07 ±0,02[a]	385,52 ±06,43[c]
Toh	92,05 ±0,17[c]	1,54 ±0,05[b]	69,44 ±2,24[a]	06,56± 0,53[d]	02,32 ±0,03[b]	10,14 ±0,15[d]	339,20 ±07,87[a]
Banana *foutou*	76,16 ±0,19[b]	2,14 ±0,08[c]	83,25 ±4,40[b]	02,34± 1,05[b]	04,75 ±0,22[c]	09,52 ±0,07[d]	413,89 ±08,64[d]
Yam *foutou* (*kponan*)	77,56 ±0,06[b]	1,75 ±0,01[b]	87,11 ±1,17[c]	04,13± 0,91[c]	01,06 ±0,07[a]	02,95 ±0,05[a]	369,78 ±06,26[b]
Yam *foutou* (*Florido*)	71,69 ±0,07[b]	3,19 ±0,03[d]	81,80 ±2,11[b]	04,70± 0,64[c]	02,50 ±0,02[b]	05,81 ±0,07[b]	372,94 ±07,10[b]

Mean values on the same line indexed by the same letters are not statistically different at P < test 0.05

EFFECTS OF NORMAL-CARBOHYDRATE DIETS, HYPER-CARBOHYDRATE ON CHANGES IN WAIST

The results of the study of the influence of normal-carbohydrate and carbohydrate diets on the hyper waist schemes are shown in figures 3a and 3b. The normal-carbohydrate diets (RNG) have not resulted in any significant increase in waist circumference (WC) among both men and women during the twelve-week intervention. WC increased by 1.9 cm (70 to 71.9 cm) in women and 3 cm (80-83 cm) in men. As against, high-carbohydrate diets all but caused a significant gradual increase (P < 0.5) of the WC during the same experimental period. High-carbohydrate diets starchy including RHG-Fi, RHG-Fb and RHG-Att caused a more rapid increase in the WC that high carbohydrate diets in cereals (RHG-Rz and RHG-To) among both women (Figure 3a) than in men (Figure 3b). WC increased by 15 cm (70 cm ± 0.9 0.7 ± 85cm) for women and 25.5 cm (80 cm ± 1.3 to 100.5 ± 0.8 cm) in men under RHG-Fi system; 13 cm (70 ± 1.5 to 83 ± 1.3 cm) in women and 19 cm in men subjected to RHG-Fb diet; 11 cm as well among women (70 cm ± 1.7 to 81 ± 1.9 cm) than men (80 cm ± 1.1 to 91 ± 1.6 cm) submitted to RHG-Att diet, 5 cm (70 cm ± 1.7 0.3 ± 85cm) in women and 5.5 cm (80 cm ± 1.4 to 85.5 ± 1.2 cm) in men subject to the system RHG -RZ; 4 cm (70 cm ± 2.1 to 74 ± 1.9 cm) in women and 5 cm (80 cm ± 1.7 1.3 ± 85cm) in men in the RHG-To.

EFFECTS OF CONSUMPTION OF HYPER-CARBOHYDRATE DIETS ON CHANGES IN SERUM LIPIDS AND BLOOD PRESSURE

The effects of RHG-Fi diets, RHG-Fb, RHG-Att, RHG-Rz and RHG-To on concentrations of LDL-cholesterol, HDL-cholesterol, triglycerides, total cholesterol, and systolic and diastolic blood pressure are shown in figures 4, 5, 6, 7 and 8. The blood concentrations of LDL-cholesterol increased significantly (P < 0.05) during exposure to RHG-Fi diets (+ 0.35) and RHG-Fb (+ 0.29) with a cumulative increase of 0.01 to M1 (1st month of experience), 0.09 + M2 (2nd month of experience) and 0.25 for M3 (3rd month of experience) for the RHG-Fi and + 0, 03 M1, M2 + 0.11 and 0.15 + M3 for RHG-Fb. However, RHG-Att, and RHG-Rz-To Diet had no significant effect on the levels of these serum lipids. There is an inverse correlation between changes in the concentration of HDL-cholesterol and RHG-Fi diets (- 0.12) and RHG-Fb (- 0.15) over response time. The concentration increases blood HDL-cholesterol in a first time (M1) and then decreases from +0.08 to - 0.05 and - 0.15 to M2 and M3 during the RHG-speed and Fb + 0.1 ; - 0.1 and - 0.15 respectively M1, M2 and M3 during RHG-Fi system. The RHG-Att diets and RHG-Rz and RHG-To have no significant effect on levels of HDL-cholesterol (P < 0.02).

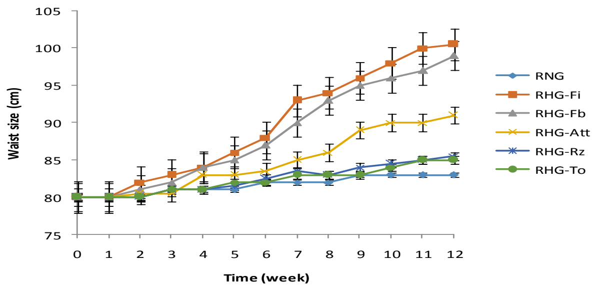

Figure 3a

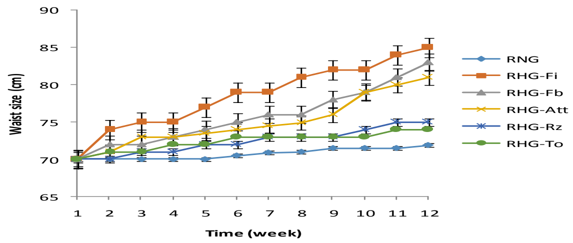

Figure 3b

Figure 3: normal-carbohydrate diets, high-carbohydrate diets and evolution waist size in women (Figure 3a), normal-carbohydrate diets, high-carbohydrate diets and evolution waist size in men (Figure 3b).
RNG = normal-carbohydrate diet, RHG-Fi = high-carbohydrate diet based yam *foutou*, RHG-Fb = high-carbohydrate diet based banana *foutou*, RHG-Att = high-carbohydrate diet based *attiéké*, RHG-Rz = high-carbohydrate diet based rice, RHG-to = high-carbohydrate diet based *toh*.

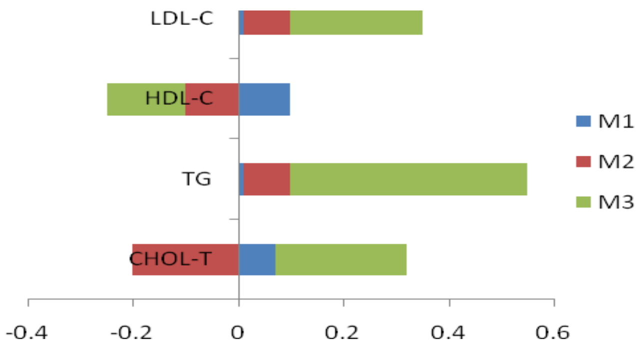

Figure 4a

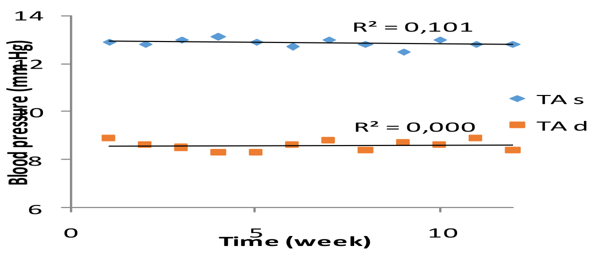

Figure 4b

Figure 4: Evolution of the concentration of some serum lipids (Figure 4a) and blood pressure (Figure 4b) in the RHG-Fi. M1 = 1 month; M2 = 2 months; M3 = 3 months; TAs = systolic blood pressure; TAd = diastolic blood pressure.

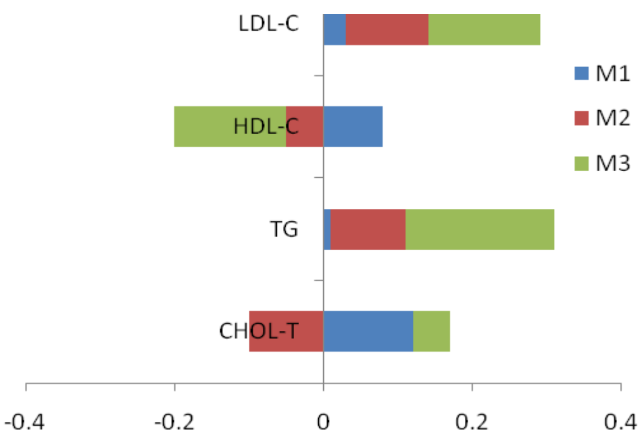

Figure 5a

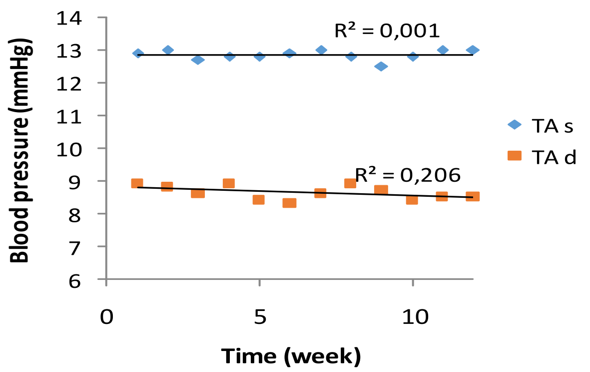

Figure 5b

Figure 5: Evolution of the concentration of some serum lipids (Figure 5a) and blood pressure (Figure 5b) in the RHG-Fb. M1 = 1 month; M2 = 2 months; M3 = 3 months; TAs = systolic blood pressure; TAd = diastolic blood pressure.

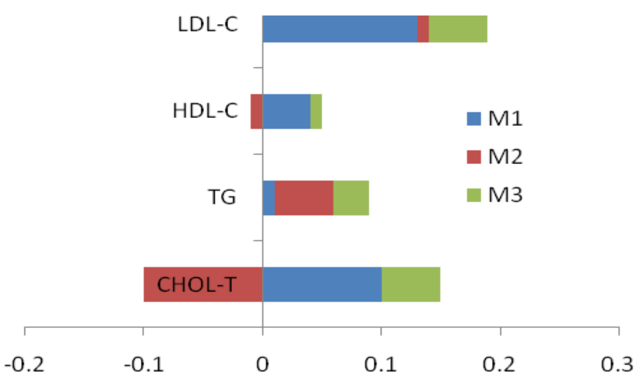

Figure 6a

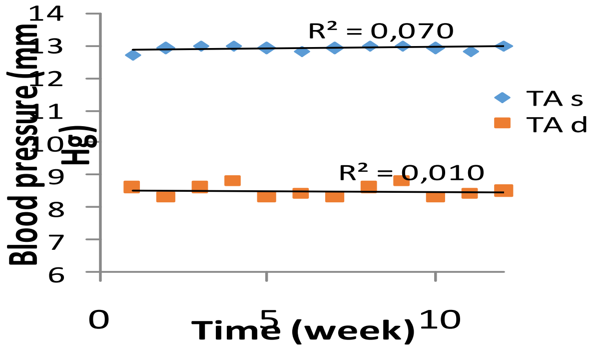

Figure 6b

Figure 6: Evolution of the concentration of some serum lipids (Figure 6a) and blood pressure (Figure 6b) in the RHG-Att. M1 = 1 month; M2 = 2 months; M3 = 3 months; TAs = systolic blood pressure; TAd = diastolic blood pressure.

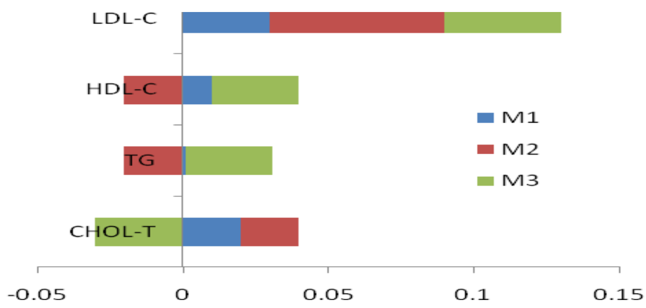

Figure 7a

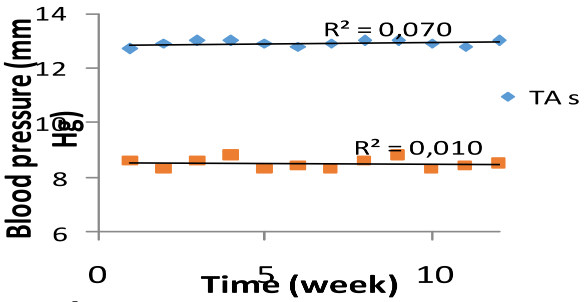

Figure 7b

Figure 7: Evolution of the concentration of some serum lipids (Figure 7a) and blood pressure (Figure 7b) in the RHG-Rz. M1 = 1 month; M2 = 2 months; M3 = 3 months; TAs = systolic blood pressure; TAd = diastolic blood pressure.

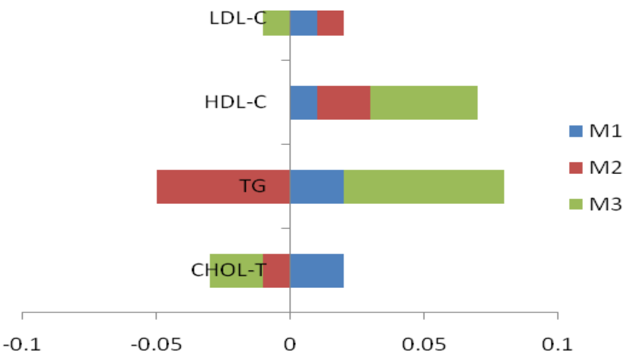

Figure 8a

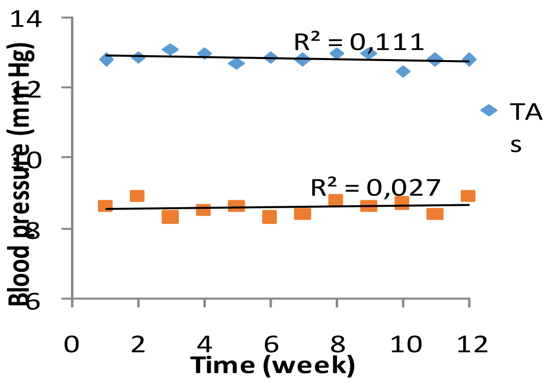

Figure 8b

Figure 8: Evolution of the concentration of some serum lipids (Figure 8a) and blood pressure (Figure 8b) in the RHG-To. M1 = 1 month; M2 = 2 months; M3 = 3 months; TAs = systolic blood pressure; TAd = diastolic blood pressure.

Concentrations in blood triglycerides increased significantly ($P < 0.01$) with RHG-Fi diets (+ 0.55) and RHG-Fb (+ 0.41). It rose to 0.01 +; + 0.09; + 0.45 respectively M1, M2 and M3 in the RHG-Fi and + 0.10; + 0.11; + 0.2 respectively M1, M2 and M3 with the RHG-Fb regime. For cons, the RHG-Fi diets, RHG-Fb, RHG-Att, RHG-Rz and RHG-To have no significant effect ($P < 0.1$) on Concentrations of total blood cholesterol and blood pressure (systolic and diastolic)

DISCUSSION

Determine this study aimed to assess whether the consumption of some traditional staples in the Ivory Coast, was related to the risk of the metabolic syndrome. For this, we have found foods commonly consumed carbohydrate base in Ivory Coast on which a physicochemical characterization was performed. The results obtained in this part of the work showed that starchy foods (yam *foutou*, banana *foutou*, *attiéké*) were significantly higher in total carbohydrates and higher than foods from cereals energy values (rice, *toh*). These results are not surprising, especially as FAO (1998); Gnakri (1993); Amani et *al*. (2007) and Assemand et *al*. (2012) showed that these staples of part of the Ivorian population are rich in starch and are excellent sources of energy. On the effect of consumption of these foods on metabolic syndromes, the key findings of this study show that the high-carbohydrate diets based on starchy namely high-carbohydrate diet based yam *foutou* (RHG-Fi) the high-carbohydrate diet based on banana *foutou* (RHG-Fb) and high-carbohydrate diet based on *attiéké* (RHG-*Att*) result in faster than those from cereals such as weight gain diet high-carbohydrate rice (RHG-Rz) and high-carbohydrate diet based *toh* (RHG-To). In fact, these diets passed the body mass index of women and men in this study of 24 $kg/m^2 \pm 1.10$ to 30 $kg/m^2 \pm 0.95$. This index can show whether a person is obese or overweight. And its evolution is related to food consumption. Also, the chemical characterization of foods studied showed that those will have high energy values. The study was done without any particular physical activity practice, he created an imbalance in the long term energy balance (imbalance between energy intake and energy expenditure). It is possible that it is the interaction of all these factors would explain this rapid increase in BMI caused by the consumption of these foods. These results confirm those of French et *al*., 2001; Saelens et *al*., 2003; Popkin et *al*., 2005 showed that the energy density of foods consumed and the level of physical activity are key factors in the development of obesity. Also, the work of Johnson (2008); McCaffrey (2008), Papagiannidou (2013) have shown that dietary habits based on the consumption of foods with high density energy result in the accumulation of body fat leads to obesity. One might think that the participants who served as a model in this study, they were subjected to long term these foods would be exposed to the occurrence of the metabolic syndrome. Regarding glucose, the aim was to show the effect of food on postprandial glycemic studied response. The results obtained showed that starchy foods have postprandial glycemic responses higher than those from cereals studied. Given the large proportion of carbohydrates in these foods, we are led to say that the hyperglycaemic effect depends on the quality of the food. Thus, several studies including Jenkins et *al*. (1981) demonstrated that the nature of the starch and the preparation of foods or may be of major importance in the postprandial glycemic response. In this present study, starch-based food starches seem more digestible and therefore more easily hydrolysed by enzymes compared to starches from other types of food and native starch. It is therefore possible that it is the rate of conversion of starch to glucose by these foods digestible enzymes, specifically, alpha-glucosidase, which may explain the increase in postprandial blood glucose after ingestion and during the duration of the experiment. Our results agree with those of Thorne and Thompson (1983) Durgadevi and Nazni (2012) and Bahado Singh et *al*. (2006) showed that the glucose absorbed from food was affected by the physiological and nutritional factors including starch digestibility. The glycemic index is a concept that allows the classification of carbohydrates according to their physiological behavior based on their impact on the concentration of serum glucose. It largely depends on the rate at which carbohydrates are digested in the small intestine. The results of the study with the banana *foutou* made from plantain ripening stage "green shift", revealed an increase in the glycemic index indicating absorption of simple sugars that are present in bananas such as sucrose, glucose and fructose. The presence of these sugars may be due to a pre-hydrolysis by endogenous amylase during ripening (Dadzie et *al*, 2009; Kouamé, 2010). Our results appear to be comparable to those published by Bahado-Singh et *al*. (2006). Indeed, these authors showed that the change in the physiological state of the food, from green to ripe, increases the glycemic index of this one. However, several other factors, including the source and the class of carbohydrates, resistant starch, amylose and amylopectin, the fiber content and baking, may also influence the glycemic index. Thus, regular consumption and high amount of these foods may cause short-term, significant peaks and hyper-glycemic long-term deterioration of glucose homeostasis. These results are in agreement with those of Ludwig (2002) and McKeown et *al*. (2004) have shown that the eating habits with high glycemic load can lead to a high glycemic response and insulin resistance. The RHG-Fi and RHG-Fb with GI and high CG schemes could be considered as risk factors for onset of relatively larger than the RHG-Rz diets and RHG-To type II diabetes. Regarding the waist, it is an indicator used to assess the changes in body composition and is used to measure the distribution of fatty acids in the gut. The results from this experiment show that the RHG-Fi and RHG-Fb schemes result in a significant increase in waist size. This induced obesity may be due to the fact that these diets would promote greater accumulation of triglycerides in visceral adipose tissue (Kusminski et *al*., 2009). Indeed, participants' exposure to RHG-Fi and RHG-Fb regimes resulted in excessive accumulation of fatty acids in adipose tissue especially visceral adipocytes (Ginsberg et *al*., 2009). This accumulation is the result of a positive energy balance resulting from the interaction of many factors including energy-dense food (Galgani et *al*., 2008 Phillips et *al*, 2010) and physical inactivity (Hussey et *al* ., 2007; Ekelund et *al*, 2012). Such schemes could be considered true risk factors for metabolic diseases because they cause abdominal obesity faster is the main criterion for diagnosis of metabolic syndrome (Lord et *al*, 2006. Saaristo et *al*., 2008; Peter, 2009). The results on the effect of diets on the blood lipid profile showed that the RHG-Fi and RHG-Fb result in lower HDL cholesterol and increased LDL-cholesterol and triglycerides. These observed changes in the concentrations of serum lipid can be explained by the insulin resistance. This insulin resistance is driven by a progressive increase in size after prolonged exposure to these diets. Indeed, Steppan et *al*, 2002; Altomonte, 2004; Kusminski et *al*., 2005; Despres et *al*., 2006; Bogdan et *al*., 2008 demonstrated that the proliferation of visceral adipocytes gradually leads to the synthesis of resistin, a hormone that reduces the sensitivity of peripheral cells (adipocytes, liver, skeletal and cardiac muscles) to the action of insulin. It is probably this insulin resistance that would justify the increase in hepatic synthesis of very low density lipoproteins, thus contributing to the increase in plasma concentration of LDL-cholesterol and blood triglycerides and cholesterol Grand total. Furthermore, due to the high energy density of RHG-Fi and RHG-Fb, they could lead to long-term adverse lipid profile as shown that the work of Culberson et *al*, 2009; Denova-Gutierrez et *al*., 2010. Regarding the influence of these diets on blood pressure, the results show that they have no significant effect on systolic blood pressure and diastolic blood pressure during the 12-week period the experience. However, the increase in triglycerides and LDL cholesterol caused subsequent to the consumption of RHG-Fi and RHG-Fb schemes may eventually be true risk factors for cardiovascular disease. Indeed, many studies including those of Chait et *al*., (1993) ; Parameshwari and Nazni (2012); Miller et *al*., 2011 ; Greene et *al*., (2005) demonstrated that increased blood triglycerides which largely results from the most visceral adipocyte lipolysis is recognized as a true risk factor for cardiovascular disease .

CONCLUSION

The nutrition transition is really responsible for the occurrence of metabolic diseases in developing countries factor. However, some specific to African foods may increase the risk of these patients. Our study demonstrated that the yam and banana *foutou* have high glycemic index. Also, regular consumption and in large quantities of yam *foutou* (RHG-Fi) and banana *foutou* (RHG-Fb) quickly led to overweight, especially abdominal obesity, whose long-term consequence may be the insulin resistance. This insulin resistance is recognized as being the basis for dyslipidemia, type II diabetes and hypertension, moderate consumption (up to 150 g ± 10 g, 3 times per week with 2 days apart between days of taking these foods) of these foods is recommended for people who are among those foods eating habits. These results can be used for the purpose of prevention in the development of metabolic syndrome.

ACKNOWLEDGEMENT

We would like to express our sincere appreciation to all participants in this study.

REFERENCES

- Adiels M, Olofsson SO, Taskinen MR, Boren J.. Overproduction of very low-density lipoproteins is the hallmark of the dyslipidemia in the metabolic syndrome. Arterioscler Thromb Vasc Biol, 2008; 28:1225–1236.
- Altomonte J, Cong L, Harbaran S.. : Foxo1 mediates insulin action on apoC-III and triglyceride metabolism. J Clin Invest. 2004 ; 114:1493–1503.

- Amani G., C. Nindjin, B. N'Zué, A. Tschannen, D. Aka (éditeurs). Potentialités à la transformation du manioc (*Manihot esculenta* Crantz) en Afrique de l'Ouest, Actes de l'atelier international UAA-CSRS-CNRA-I2T, 4-7, Abidjan, Côte d'Ivoire. 2007.341p.
- AOAC, 1990. Official methods of analysis. 15th Edn. Association of Official Agricultural Chemists Washington, DC.
- Assemand Emma, Fatoumata Camara, Françoise Kouamé, Victorien Konan, Lucien P. Kouamé.. Caractérisation biochimique des fruits de plantain (Musa paradisiaca L.) variété « Agnrin » de Côte d'Ivoire et évaluation sensorielle de ses produits dérivés. Journal of Applied Bioscience. 2012.60: 4438– 4447
- Atwater W., Rosa E.,. A new respiratory calorimeter and the conservation of energy in human body. II-Physical Rev. 1899. 9, 214-251.
- Avignon A.. Transition nutritionnelle : une évolution inexorable vers les maladies une évolution inexorable vers les maladies chroniques ? Inauguration de la maison de la région Languedoc Roussignon de Casablanca. 2012.1-19.
- Bahado-Singh PS, Asemota HN, Morrison EYStA, Ahmad MH, Wheatley AO.. Food processing methods influence the glycaemic indices of some commonly eaten West Indian carbohydrate-rich foods. Brit J Nutr. 2006. 96: 476-81.
- Ben Romdhane H., Skhiri H., Khaldi R., Oueslati A..Transition épidémiologique et transition alimentaire et nutritionnelle en Tinusie. In : Sahar A.Y.(ed.), Le Bih an G. (coord.). *L'approche causale appliquée à la surveillance alimentaire et nutritionnelle en Tunisie*. Montpellier : CIHEAM, (Options Méditerranéennes : Serie B. Etudes et Recherches ; n. 41) 2002.P 7 – 27
- Ben Rhys Davies, Dietary Glycaemic Carbohydrate, Physical Activity and Cardiometabolic Health in Postpubertal Adolescents. A thesis submitted to the University of Bedfordshire, in partial fulfilment of the requirements for the degree of Doctor of Philosophy.2013
- BIPEA, Bureau interprofessionnel d'étude analytique. Recueil des méthodes d'analyses des communautés européennes. Greenville (France). 1976.160 p.
- Bogdan Manolescu, Irina Stoian, Valeriu Atanasiu, Carmina Busu And Olivera Lupescu .. Review article: The role of adipose tissue in uraemia-related insulin resistance Nephrology. 2008.13, 622–628.
- Boutayeb A..The double burden of communicable and non communicable diseases in developing countries. *Transactions of the Royal Society of Tropical Medicine and Hygiene*. 2006.100.
- Chait A, Brazg RL, Tribble DL and Krauss RM. Susceptibility of small, dense, low-density lipoproteins to oxidative modification in subjects with the atherogenic lipoprotein phenotype, pattern B. American Journal of Medicine, 1993.94, 350–6.
- CNRA, Bien cultiver le manioc en Côte d'Ivoire. 2005.1 – 4.
- Dadzie B.K. et Orchard J.E.. Évaluation post-récolte des hybrides de bananiers et bananiers plantain: critères et méthodes. Guides Techniques Inibap. 2009.1 – 57
- Delpeuch Francis, Bernard Maire.. La transition nutritionnelle, l'alimentation et les villes dans les pays en développement. Nutrition, Alimentation, Sociétés.2004.
- Denova-Gutierrez Edgar, Gerardo Huitron-Bravo, Juan O. Talavera, Susana Castanon, Katia Gallegos-Carrillo, Yvonne Flores, and Jorge Salmeron.. Dietary Glycemic Index, Dietary Glycemic Load, Blood Lipids, and Coronary Heart Disease. Journal of Nutrition and Metabolism. 2010.1 – 8.
- Despres JP, Lemieux I.. Abdominal obesity and metabolic syndrome. Nature. 2006.444:881-7.
- Durgadevi.R and Nazni.P, Comparative study of processed Amaranth grains on glycemic indices in NIDDM subjects, International Journal of Pharma Medicine and Biological Sciences, Vol. 1, No. 2, October 2012, pp:194-205, ISSN 2278 – 5221.
- Fédération Internationale du Diabète. Le syndrome métabolique. *Diabete voice*. 2006.11 – 14
- Fédération Internationale du Diabète. ATLAS du DIABÈTE de la FID 6e édition, 2013.p11
- French S, Story M, Neumark-Sztainer D, Fulkerson J, Hannan P..Fast food restaurant use among adolescents: associations with nutrient intake, food choice, and behavioral and psychosocial variables. Int J Obes.2001. 25:1823–33
- Galgani, J. E., Uauy, R. D., Aguirre, C. A. & Díaz, E. O.. Effect of the dietary fat quality on insulin sensitivity. British Journal of Nutrition.2008; 100, 471-479.
- Galgani Jose E., Cedric Moro, Eric Ravussin.. Metabolic flexibility and insulin resistance. *Am J Physiol Endocrinol Metab*. 2008; 295(5): E1009–E1017.
- Ginsberg H.N., P.R. MacCallum.. The obesity, metabolic syndrome, and type 2 diabetes mellitus pandemic: Part I. Increased cardiovascular disease risk

and the importance of atherogenic dyslipidemia in persons with the metabolic syndrome and type 2 diabetes mellitus, J. Cardiometab. Syndr. 2009; 4: 113–119.

- Gnakri Dago: Valorisation du fruit de Plantin (Musa sp). 1-caractérisation physico-chimiques de l'amidon. 2- étude nutritionnelle, métabolique et physiologique des aliments dérivés: *Foutou* et *Foufou*. Thèse de doctorat d'état ès sciences naturelles (option biochimie-nutrition); Université Nationale de Côte d'Ivoire. 1993.
- Greene, C.M.; Zern, T.L.; Wood, R.J. Maintenance of the LDL cholesterol: HDL cholesterol ratio in an elderly population given a dietary cholesterol challenge. J Nutr, 2005; 135:2793–2798.
- Hamelin Maryse Raynaud. Transition nutritionnelle. Double fardeau nutritionnel (DFN), Pôle francophone en Afrique. 2009 ; P 1- 7
- Hill Jo, Wyatt Hr. Role of physical activity in preventing and treating obesity. *J Appl Physiol.* 2005; 99 : 765-770
- Hussey, J., Bell, C., Bennett, K., O’dwyer, J. & Gormley, J. Relationship between the intensity of physical activity, inactivity, cardiorespiratory fitness and body composition in 7–10-year-old Dublin children. British Journal of Sports Medicine, 2007; 41, 311-316.
- IRFA: Institut de Recherches sur les Fruits et Agrumes. La qualité de la banane. La réglementation française et son Interprétation. 1980 ; 74 pp.
- Jenkins DJ, Wolever TM, Taylor RH, Barker H, Fielden H, Baldwin JM, bowling AC, Newman HC, Jenkins AL, Goff DV. Glycemic index of foods: A physiological basis for carbohydrate exchange. Am J Clin Nutr. 1981; 34:362-366
- Johnson L, Mander AP, Jones LR, Emmett PM, Jebb SA . A prospective analysis of dietary energy density at age 5 and 7 years and fatness at 9 years among UK children. Int J Obes (Lond).2008; 32:586-593.
- Kouamé R. N’Ganzoua, Brahima Camara, Emmanuel Dick. Evaluation des changements physico-chimiques caractérisant le mûrissement au cours de l’entreposage de trois variétés de bananes Musa spp. (AAB, cv. Corne 1 ; AAA, cv. Poyo et AA, cv. Figue Sucrée). Sciences & Nature 2010 ; Vol.7 N°2: 155 – 163.
- Kusminski Christine M., Philip G. Mcternan and Sudhesh Kumar. Role of resistin in obesity, insulin resistance and Type II diabetes Diabetes and Metabolism Research.2005
- Kusminski CM, Shetty S, Orci L, Unger RH, Scherer PE. Diabetes and apoptosis: lipotoxicity. Apoptosis, 2009; 14(12) : 1484 – 95.
- Lord J, Thomas R, Fox B, Acharya U, Wilkin T.. The central issue? Visceral fat mass is a good marker of insulin resistance and metabolic disturbance in women with polycystic ovary syndrome. BJOG. 2006; 113:1203-9.
- Lord J, Thomas R, Fox B, Acharya U, Wilkin T.The central issue? Visceral fat mass is a good marker of insulin resistance and metabolic disturbance in women with polycystic ovary syndrome. BJOG, 2006; 113 :1203-9
- Ludwig DS. Dietary glycemic index and the regulation of body weight. Lipids 38 , 2003; 117–121.
- Maire, et BLS. Transition nutritionnelle et maladies chroniques non transmissibles liées à l’alimentation dans les pays en développement. Cahiers santé. 2002; 12: 45-55.
- McCaffrey TA, Rennie KL, Kerr MA, Wallace JM, Hannon-Fletcher MP, Coward WA. Energy density of the diet and change in body fatness from childhood to adolescence; is there a relation? Am J Clin Nutr. 2008; 87: 1230-1237.
- McKeown NM, Meigs JB, Liu S, Saltzman E, Wilson PW & Jacques PF. Carbohydrate nutrition, insulin resistance, and the prevalence of the metabolic syndrome in the Framingham Offspring Cohort. Diabetes Care. 2004; 27, 538–546.
- Michael Miller, Neil J. Stone, Christie Ballantyne, Vera Bittner, Michael H. Criqui, Henry N. Ginsberg, Anne Carol Goldberg, William James Howard, Marc S. Jacobson, Penny M. Kris-Etherton, Terry A. Lennie, Moshe Levi, Theodore Mazzone and Subramanian Pennathur.. Triglycerides and Cardiovascular Disease: A Scientific Statement From the American Heart Association. *Circulation.* 2011; 123:2292-2333.
- Papagiannidou E, Tsipis A, Athanassiadou AM, Petrou E, Athanassiadou P. Dietary Energy Density, Satiety and Weight Management. 2013; 2: 585
- Peter G, Kopelman IDC, William H. Dietz Clinical Obesity in Adults and Children. Singapore: Wiley-Blackwell. 2009. 3, 512.
- Peter G, Kopelman IDC, William H. Dietz Clinical Obesity in Adults and Children, Singapore. Wiley-Blackwell. 2009; 512.
- Phillips, C. M., Goumidi, L., Bertrais, S., Field, M. R., Cupples, L. A., Ordovas, J. M., Defoort, C., Lovegrove, J. A., Drevon, C. A., Gibney, M. J., Blaak, E. E., Kiec-Wilk, B., Karlstrom, B., Lopez-Miranda,

J., Mcmanus, R., Hercberg, S., Lairon, D., Planells, R. & Roche, H. M. Gene-nutrient interactions with dietary fat modulate the association between genetic variation of the ACSL1 gene and metabolic syndrome. Journal of Lipid Research, 2010; 51, 1793-1800.

- Popkin Barry M. The shift in stages of the nutritional transition in the developing world differs from past experiences! Public Health Nutrition. 2002; 5: 205-214.
- Parameshwari.S and Nazni.P Fatty acid composition and hypolipidemic effect of Roasted Flaxseed Powder, International Journal of Pharma Medicine and Biological Sciences, Vol. 1, No. 2, October 2012, pp:150-158, ISSN 2278 – 522.
- Popkin Barry M. Transition nutritionnelle et évolution mondiale vers l'obésité. Diabetes Voice. 2004 ; 49 : 38 – 40
- Popkin Barry M. Kiyah Duffey, Penny Gordon-Larsen. Environmental influences on food choice, physical activity and energy balance. Physiology & Behavior 2005. 86 : 603 – 613
- Saaristo TE, Barengo NC, Korpi-Hyovalti E, Oksa H, Puolijoki H, Saltevo JT, Vanhala M, Sundvall J, Saarikoski L, Peltonen M, Tuomilehto J. High prevalence of obesity, central obesity and abnormal glucose tolerance in the middle-aged Finnish population. BMC Public Health; 2008. 8:423.
- Saaristo TE, Barengo NC, Korpi-Hyovalti E, Oksa H, Puolijoki H, Saltevo JT,Vanhala M, Sundvall J, Saarikoski L, Peltonen M, Tuomilehto J.. Highprevalence of obesity, central obesity and abnormal glucose tolerance in the middle-aged Finnish population. BMC Public Health, 2008; 8:423.
- Saelens BE, Sallis JF, Frank LD.Environmental correlates of walking and cycling: findings from the transportation, urban design, and planning literatures. Ann Behav Med; 2003; 25:80–91
- Simon C, Wagner A, Divita C, Rauscher E, Klein-Platat C,. Intervention centred on adolescents' physical activity and sedentary behaviour (ICAPS): concept and 6-month results. Int J Obes Relat Metab Disord, 2004; 28 : S96-S103
- Steppan Claire M. and Mitchell A. Lazar. Resistin and obesity associated insulin resistance TRENDS in Endocrinology & Metabolism Vol.13 No.1. 2002; 18 – 23.
- Thorne MJ, Thompson LU, Jenkins DJA. Factors affecting starch digestibility and the glycemic response with special references to legumes. Am J Clin Nutr; 1983; 38: 481-8.
- WHO. Rapport sur la situation mondiale des maladies non transmissibles, Résumé d'orientation. 2011.