Characterization and Evaluation of Ivorian Food Consumed and their Influence on Regulatory Bodies: Case of Rats (Wistar)

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ABSTRACT---- ***The concentrations of macronutrients and minerals Ivorian dishes were determined by standard analytical (AOAC methods. The result obtained are express in percentage fw for moisture and percentage dw, ash, proteins, lipids, crude fibers, carbohydrates and minerals. The moisture content ranges from 72.44-89.33 g/100g fw. Carbohydrates contents 57.55-63.11 g/100g dw. Lipids 9.76-18.14 g/100g dw. Proteins 13.43 -16.34 g/100g dw, fibers 5.31 - 7.47 g/100g dw. This study revealed that a high consumption in accordance with official recommendations of the FAO. Minerals, Iron were ranged from 3.66-13.83 mg/100g dw; calcium 5.34 - 13.70 g/100mg dw , zinc 0.04 t-0.06 g/100g dw. All values of nutrient and minerals obtained through these foods were insufficient to help the functioning of the body. Other foods sources could help to address them. In biometric case, kidney weight of these animals is all lower than the control (0.69 g) with the exception of those fed with the same food that is RsG rats. End then do not cause functional abnormalities of these organs compared to those fed which are consumer at other area and control diet of rats. The foods could adequately contribute to dietary intake in most of recipes. The study carried out good physical impact through rats regulators bodies. Majority of dishes based on cereals, tubers, but poor in animal product can led to micronutrient because of the presence of antinutritional factor that reduce minerals bioavailability. In fact, these foods In conclude these foods good qualities through biochemical and physiological study.***

Keywords--- macronutrient; minerals; dishes; Ivorian; biometric; regulators bodies

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1. INTRODUCTION

The food is a basic human need in good health (FAO, 2004). In fact, a diet should provide the appropriate quantities of nutrients. However pathologies are observed in the population due to supply or food habits (WHO, 2003). Moreover, a well-conducted power can reduce the incidence of nutritional diseases (Birlouez-Aragon, 2005; Bertière et al, 2006), Improve the quality of life influence the natural aging (WHO, 2003 Stevenson et al., 2007). Many nutritional diseases such as: obesity, diabetes, cancer, cirrhosis, kidney disease, cardiovascular disease (Lathan, 1979 Nicolet, 1995), remain a serious public health problem in Côte d'Ivoire (Herberg, *et al.*, 1985 De Onis, (2000) Lathan, (2001); Bobby *et al.*, 2002). Malnutrition is a very serious health problem to human. Malnutrition affects 842 million people with 798 million in developing countries (FAO, 2002, 2004). In Côte d'Ivoire, despite the abundance and diversity of food products (FAO, 2003), malnutrition persists causing many functional disorders of vital organs (Ouedraogo, 2008). Côte d'Ivoire, despite its food diversity is not exempted from nutritional problems. Aquavo and Adou, 2008 showed that the prevalence of nutritional pathology is hight in Côte d'Ivoire, especially in the vulnerable groups of population. Chronic malnutrition level is 34% with preponderance in northeast of 46.6% and southwest with 41.1%. Vitamin A deficiency affects 26.9% of children under 5 years old. In addition, 67.4% of these children suffer from iron deficiency. An evaluation of chemical

composition of dishes and there functional impact is therefore very important in public health for fight against malnutrion.

The aim of this study was to characterize and evaluate the substantial benefit of Ivorian foods consumed (North, Central and West), there impact on regulator organs through a biochemical study and animal experiments.

2. MATERIALS AND METHODS

Schemes: This study was conducted in three endemic areas of Côte d'Ivoire: North, South and West. This study was carried out in three respectively communities where, chronicle malnutrition is experiencing a boom. Thus, hospitals environments are placed definitive diagnosis of morbid states were observed in the population. Three Ivorian dishes was prepared made from local produce are the *Cabatoh* sauce *Dah* (CsD, North) , the *Foutou* yam sauce *Gouagoussou* (FsG, Center) and rice with gravy seed (RsG, West) Côte d' Ivoire (Dally *et al*., 2010). This study took place in October 2009 to February 2010;

Characterization of samples of food:

She focused on the recommended official methods (AOAC, 1998) to determine the level of components such as humidity expressed in g/100g fw, ash, protein and fat g/100g dw. The humidity (g/100g fw) is determined after heating the sample (2g) until a constant weight in an oven maintained at 105°C for 4 hours. The ash (g/100g) is determined by incinerating a sample (1g) placed in a muffle furnace (LMF4, Bamford, Sheffield UK) maintained at 550°C for 5 hours. Proteins expressed in g/100g dw (% total nitrogen x 6.29 and the fibers were expressed in g/100g dw KHEDJAHL obtained by using an organic solvent (ether) boiling between 40 and 60°C. (Onyeike and Archu 2002). Finally g/100g dw expressed as carbohydrates are obtained by difference (AOAC, 2000). In the mineral mg/100g dw expressed as: iron, zinc and calcium are obtained by atomic absorption spectrophotometry (Elmer, Model 2380, USA) (Agte *et al*, 1995). 1g sample in triplicate cremated dry in a muffle furnace at 550°C for 5 hours. The mineral is extracted from ash by adding 20 ml of HCl 2.5 and mineral content was determined using the atomic absorption spectrophotometer.

Constitution of consignments of animals and experimentation:

Twenty eight (28) rats were used because of seven (7) systems. Animal experimentation was done according to the model (AFASS, 2002). It lasted 16 days including 2 days of adaptation to Ivorian food. During the 14 days of the experiment, animals were fed every two days with the three meals of the study and a control diet (reference). The experiment was conducted under the conditions of temperature and relative humidity. The animals were weighed at the start of the experiment and at intervals of two days at the end of the experiment day 14). The animals are then sacrificed and the various regulators organs (liver and kidney) of the carcass are removed and weighed. Organ weight was expressed as a percentage of live weight of the animal obtained during the last weighing. The live weight of bodies is determined by the following formula. Relative organ weight (liver or kidney) is the ratio of the weight of the body by the body weight of the animal.

Statistical Analysis

The analysis of data was done using the STATISTICA 6.0 software. Comparison of means was made of variance using the Newman-Keuls test with a significance level set at 5%.

Table I: Characterization of food type consumed in Côte d'Ivoire

	CsD	FsG	RsG
Humidity g/100 fw	82,72 ± 1,00^{b}	72,43 ± 1,52^{a}	89,33 ± 1,52^{a}
Glucids g/100g dw	59,99 ± 2,20^{a}	63,11 ± 0,40^{a}	57,55 ± 5,49^{a}
Lipids g/100 dw	13,04 ± 0,60^{b}	9,76 ± 0,26^{a}	18,14 ± 0,54^{a}
Protéins g/100g dw	16,34 ± 0,22^{c}	13,43 ±0,35^{a}	15,84 ± 0,32^{b}
Fibers g/100g dw	5,31 ± 0,40^{a}	7,47 ± 0,15^{b}	5,31 ± 0,07^{a}
Ash g/100g dw	5,32 ±2,97^{a}	6,23 ± 0,27^{a}	4,62 ± 0,70^{a}
Calcium mg/100g dw	5,34 ± 0,27^{a}	10,43 ± 0,15^{b}	13,70 ± 0,10^{b}
Iron mg/100g dw	13,83 ± 0,60^{b}	3,53 ± 0,09^{a}	3,66 ± 0,07^{a}
Zinc mg/100g dw	0,06 ± 0,00^{a}	0,04 ± 0,01^{a}	0,04 ± 0,01^{a}

Each value is the mean ± SD of three determinations and calculated on the basis of rate of fresh material for moisture and dry matter for the other components of the food sampled.
a, b, c show a significant difference p ≤ 0.05 between two means within the same row. Proteins are calculated with the conversion factor of 6.25 which is nitrogen. Carbohydrates are calculated by difference.
fw: fresh weigtr; dw: dry weigtr

Table II: Relative weight of vital organs (liver and kidney) of rats fed with food Ivorian

	Control rats	CsD	FsG	RsG
Kidney weight (g)	0,69 ± 0,15[b]	0,57 ± 0,07[b]	0,47 ± 0,15[a]	0,69 ± 0,15[c]
Liver weight (g)	3,94 ± 0,93[a]	3,01 ± 0,57[a]	2,69 ± 0,51[a]	3,37 ± 0,72[a]

Each value is the mean ± standard deviation 21rats fed with food types tested and the control (casein). After analysis of variance, classification averages for weight balance kidney or liver is performed using the test Newmann-Kheul. The carrying medium along different letters on the same line is not significantly equal.

a, b, show a significant difference p ≤ 0.05 between two means within the same row.

CsD: *Cabatôh* sauce *dah*; **FsG**: *Foutou* yam sauce *gouagouassou* ; **RsG**: Rice sauce palm seed.

3. RESULTS AND DISCUSSION

Ivorian dishes are rich in water with concentrations from 72.43±1.52-89.33±1.52g/100g fw (Table I). All these foods are also rich in carbohydrates from 57.55±5.49-63.11±0.4 g/100g dw. Indeed these contents are statistically defferent at P ≤ 0.05. These high levels could be explained by the high amounts of water applied in the preparation of these dishes. Also the values obtained with CsD and RsG foods are greater than value obtained with rice and tomato sauce 78.01±4.12 g/100g fw and rice with peanut sauce 78.82±0.38 g/100g fw obtained by Kana *and al*., (2008) cooked in Douala, Cameroon. Carbohydrates analysis showed no statistical difference between them [P ≥ 0, 05]. The highest rate was observed with food FsG central Côte d'Ivoire with 63.11±0.40 g/100g dw the lowest rate is observed with RsG (West) 57.55±5.49 g/100g dw. The carbohydrates contents of these foods from 57.55±5.49-63.11±0.40 g/100g dw. These high carbohydrates contents are explained by the share provided by the staple food by contributing to the sauce in the composition of the food (Fotso *and al.*, 1994; Solomon *and al*., 2005). Ponka *and al*. (2005) obtained 63, 20±2.56 g/100g dw on Corn chaff consumed in a malaria endemic area in Cameroon dishes. These values are not significally different at p≥0.05. All these foods have carbohydrates content in accordance with official recommendations of the FAO (2003) from 50-55%. Indeed carbohydrates are the main substrate for vigorous activity and lipids are the preferred substrate for moderate intensity activities Akinhanmi *et al*., (2008).

Proteins and lipids exhibit are respectively from 13.43±0.35-16.34±0.22 and 9.76 ± 0.26-18.14±0.54 22 g/100 dw. The values of these elements are all different from each other p ≤ 0.05. CsD food is richer in protein followed by RsG and finally FsG. The RsG is richer in lipids with 18.14 ± 0.54 g/100g dw than CsD. The protein content of the food is from 13.43±0.35-16.34±0.22g/100g dw. These values are consistent with the protein of the official recommendations (FAO, 2003) indicating that the level of protein required for a balanced food, is between 12 - 15%. It should also be noted that the quantity obtained show a significant difference between them [p ≤ 0.05]. Also the higher protein contents was observed in the CsD put (16.34±0.22g/100g dw) followed by RsG (15.84±0.32 g/100g dw) finally FsG (13.43±0.35g/100g dw. However, the protein value obtained is similar to that obtained with rice in tomato sauce (15%) by Mbanya *and al*., (2003) in Cameroon. These quantities obtained on the Ivorian dishes are statistically different p ≤ 0.05 but each value is very close to the recommended values in the case of a control diet formulated by Fotso *and al*., 1994.

Lipids are less represented in the FsG Centre. Identified and classified by large areas of traditional consumption plans, it appears that they all have high levels in water. Lipid content obtained from 9.76 ± 0.26 -8.14±0.54 g/100g dw. They are all significantly different from each other. The RsG is much richer in this component with 18.14±0.54 g/100g dw followed by CsD (13.04±0.60) and FsG (9.76±0.26 and 9.76 ± 0.26 g/100g dw). All values are well below the official recommendations of the FAO (2003), which is between 30 and 35 g/100g. Hecberg *and al*. (1985) obtained for a reference speed value lipid 18g/100g dw. These foods have a very high proportion in carbohydrate content compared to the lipids and proteins.

Fibers in these Ivorian foods from 5.31±0.40 -.47±0.15 g/100g dw. The dishes Centre FsG is much richer in fibers than food from the CsD North and West RsG. Fibers content of the food from 5.31±0.40-7.47±0.15 g/100g dw. The fibers content of these foods are very low overall compared to many other dishes cooked from the leaves of Moringa in various Senegalese dishes (N'dong *et al*., (2007). Or, the fibers are very important for protecting the body against the bowel cancer, diabetes, cardiovascular diseases (Ponka *et al*., 2005) and facilitate cellular hydration (AfASS, 2002).

Mineral content in ash of the Ivorian food is included for calcium from 5.34 ± 0.27-13.70±0.10 mg/100g dw; Iron from 3.53 ± 0.09-13.70±0.10 mg/100g dw; for zinc from 0.04±0.01-0.04±0.01 mg/100g dw. All these zinc obtained values on these dishes showed no significant difference between the foods consumed except for the majority of iron in the CsD in the North. Iron better prevails in the CsD with 13.83±0.60 mg/100g dw. than the other two dishes. Calcium more represented in the RsG and FsG respectively 13.7±0.10 and 10.43±0.15 mg/100g dw. Zinc is poorly represented in these dishes with values ranging between 0.04±0.01 and 0.06 ± 0.00 mg/100g dw. However the level of calcium is higher in both RsG and FsG in Côte d'Ivoire. Minerals obtained on these foods harvested in these different areas of Côte d'Ivoire are generally very low compared to many other dishes sampled consumed in Douala, Cameroon Kana *et al*., (2008). Moreover, these minerals could be detected by an augmented consumption of animal products that happen to be good sources of minerals (Sop *and al*., 2008). However, in addition to the required levels of protein, they should be well digested and contain different essential in balanced proportion amino acids (Adian *and al*, 2007. Taiwo *and al*, 2008). These aspects reflect the nutritional quality of these foods but hide various nutritional diseases in the population living in Côte d'Ivoire. However the analysis of nutritional regulators organs suffered no damages. in effect cooking the food some of the minerals and soluble fibers pass in sauces. These antioxidants are essential component in the fight against the oxidation of tissue processes. Justin *et al*., 2015 confirms that antioxidant in fruits and vegetables may provide a substantial benefit in reducing desease incidence Majority dishes based on cereal, tubers and legumes but poor in animal products. Foods are prepared to fight against antinutritional factor that reduce minerals bioavallability.

The biometric study focus on the kidney weight of animals fed by the Ivorian foods are significantly different between them $p \leq 0,05$ but inferior or equal to the weight of kidney of control animals (0.69±0.15 g) (Table II). Only the weight of the kidney of rats fed by RsG food showed no significant difference with that of rats fed by the control diet (casein). Also, the weight of the livers of these rats fed by the Ivorian food showed no significant difference at $P \geq 0.05$ between themselves and with that of the rats fed with control diet (3.94±0.93 g). This biometric study performed on rats fed by these Ivorian foods didn't reveal any damages on the livers**.** Kidney weight of rats fed with the same food is between 0.47±0.15 and 0.69±0.15 g. The weight values obtained with these kidneys these dishes fed rats differ from one another and with the weight of rats fed the control diet fed rats. All weight values obtained are lower than that of the control fed rats dishes. These observations confirm the results obtained by Bouafou *and al.* (2008) on rats ingested diets (mixture of fish meal only). The Kidney weight increased than control animals could be attributed to increased activity imposed by substances contained in the food and hardly metabolizable **(**Adrian *and al***.,** 1991**)**. The weight of the regulatory organs of animals fed with Ivorian foods remains normal with any major physiological deformations**.** These observations attested the integrity of these analyzed organs and the safety of the food consumed by rats (Seronie *and al*., 2004; Seyrek *and al.*, 2004; Klevay, 2005).

4. CONCLUSION

This study shows the good quality of Ivorian food. These dishes contain low quantities of minerals are rich in carbohydrates. The protein and fats contained in these foods are consistent with recommended values by FAO. Besides, these dishes are not necessarily the source of many nutritional problems observed in the Ivorian population, having proven their safety on regulatory organs (liver and kidney). Regarding the results obtained through is study, these dishes could be encouraged for nutritional purposes. Thus, to help fighting functional imbalance in the population, therefore, diversification of these dishes could help eliminating such deficiencies observed on each food consumed.

5. RÉFERENCES

[1] Adrian J., Rabache M. and Fragne R.,. Technical nutritional analysis. Principle of technical *Ed: Lavoisier* TEC et DOC, Paris, pp. 451-6478, 1991.

[2] Afass, Dietary fiber: Definition of nutrition claim. Contribution of the special committee of experts. Human nutrition, 62p, 2002.

[3] Agte V.V. Gokhale, M.K., Paknikar K.M and Chiplonkar S. Assessment of peral millet versus rice-based diets for bio-availability of four traces metal. *Journal of Plants Foods for Human Nutrition*. Vol. 48, pp. 151-155, 1995.

[4] Akinhanmi T.F., Atasie V.M., Akintokun P.O). Clinical composition and physicochemical proprieties of Cashew (*Anarcadium occidental*) oil and cashunut shell liquid. *Journal of Agricultural, Food and Environmental Sciences*.,vol. 2, pp.1934-1939, 2008.

[5] AOAC, Official technology of analysis Arlington, VA; Association of Official Analytique Chemits., vol.16, no 2, pp. 23-34, 1998.

[6] AOAC). Determination of carbohydrates by difference. *Journal of food composition and Analysis.*, vol. 11, pp. 89-96, 2000.

[7] Aquavo M.V. and Adou M.D.P. Food fortification to prevent control iron deficiency in Côte d'Ivoire. Http// www.gabonews.ga/actuality, 2008.

[8] Bertiere M.C., Coudray B. and Poisson D. Feeding the elderly in a precarious situation. gerontological care. *Masson, Paris* (France), vol. 60, pp. 24-27, 2006.

[9] Birlouez, A.I. Role of nutrition on aging eyes. Médecine et nutrition facteur des risques. Edition Simarre, vol. 41, no 3: 234-239, .2005.

[10] Bobby J. Aaron R.P. and Vimal D.R. Prevalence of nutrition in rural Kamata, South India: a comparison of anthropometric indicator. *Journal of Health and Nutrition*. 3: 239-244, , 2002.

[11] Bouafou K.G.M., Zanou-Tchoko V., Konan B.A., Kouamé K.G. Study of the nutritional value of the flour dried in the arts growing maggots. Ivorian *Journal of Science and Technology* , vol.12, no 215-225, 2008.

[12] Dally T., Meité A., Kouame K.G., Bouafou K.M.M. and Kati-Coulibaly S. Nutritional efficiency of three meals Ivorian: cabatoh and dah sauce ; pounded yam and gouagouassou sauce and rice with groundnut sauce. *Journal of Applied Biosciences* vol. 33, pp. 2084-2090, 2010.

[13] De Onis M.. Measuring nutritional statuts in relation to mortality. Buletin. World Health Organization, vol.10, pp. 1271-1274, 2000.

[14] Klevay M.L. Medical examination in nutrition surveys. Symposium: history and legacy of the interdepartmental committee on nutrition for national defense (national development. *Journal of nutrition*. Vol. 135, pp. 1266-1267, 2007.

[15] FAO, (2002). Food and nutrition in Africa, a reference for use by teachers of agriculture. Rome, pp. 217-292.

Montpellier cedex, France, pp. 246-262, 2003.

[16] FAO. Evaluation of dietary fat and consumption trends. Laboratory of Tropical Nutrition, center of ORSTOM 34032 *Montpellier cedex*, France, pp. 246-262, 2003.

[17] FAO. State of Food and Agriculture. Collection FAO (35). Rome , pp. 244-264, 2004.

[18] Fotso M., Mbome I.I.,and Treche S. Improving the nutritional quality of pounded banana and boiled flour corn, cassava and yam with soy supplementation. specifications agriculture ORSTOM holdings. Vol. 41, no 559, pp. 369-370, 1994

[19] Hecberg S., Duplin H., Papaz L. and Galan P. Public health and nutrition: pp.51, 1985.

[20] Justin R. L., Jacob J. P, GA.M., Comnor A. L., Andrew R. G., Rachel A. U., Brett A. H. G. S., Richard A.R. and Kim L O. The antioxidant and DNA repair activities. *Journal of Food research*, (5): 9-18, 2015.

[21] Kana Sop M.M, Gouado I., Motor Teugoua C. ,Simriga M., Fotso M., and Ekoe M.. Mineral content in some Cameroonian household foods eaten in Douala. *African Journal of Biotechnology*. Vol. 7 no 17, pp. 3085-3091, 2008.

[22] Lathan M.C. Human nutrition in tropical Africa. FAO, Rome. Pp. 11-103, 1979.

[23] Lathan M.C. Nutrition in developing countries. *Edition* : FAO 518p, ., 2001.

[24] Mbanya J.N.C., Mfopou J.K., Sobngwi E., Mbanya D.S.N. and Ngogan J. Y. Metabolic and hormonal effects of live common African diets eaten as mixed meals: The Cameroon study. *European Journal of clinical nutrition*.,vol. 57, pp. 580-585, .2003.

[25] N'dong M., Wade S., Dossou N., Guiro T.A., Gnong D.R. Nutritional value of Moringa Oleifera, study of the bioavailability of iron, effect of enrichment of various traditional Senegalese dishes with leaf powder. African *Journal of food Agriculture Nutrition and Development*. Vol. 7, no 3, pp.1684-5374, 2007.

[26] Nicolet C. Notebook preparation in pharmacy. Nutrition and dietetic 2nd Edition: *Masson*; Paris milan Barcelone p 75, 1995.

[27] OMS. Dietetic nutrition and prevention of chronic diseases. Geneva: rapport of a joint WHO/FAO expert consultation 16 au 20 April, 2003.

[28] Oneyka E.N. and Archu G.N. Chemical composition of selected Nigerian oil seed and physicochemical of the extacts. *Food chemistry.* Vol. 77, pp. 431-437, 2002.

[29] Ouedraogo F. Acceptability and effectiveness of food supplements offered by a local NGO in Niger. *Journal of Applied Biosciences*. Vol. 56 pp. 4089-4096, 2008.

[30] Ponka R., Fokou E., Leke R., Fotso M. Souopgui J., Achu B.M., and Miapo T.P.F. Methods of preparation and nutritional evaluation of diches consumed in a malaria endemic zone in Cameroon (Ngali II). *African Journal of Biotechnology*. Vol. 4, no 3; 273-278, .2005.

[31] Seronie S., Vivien M., Garnier M.C. and Hadj A.A. Determination of creatinine, place and state of analytical test standardization of calibration. *Annals of Clinical Biology*, vol. 6, no 2, pp. 165-175, .2004.

[32] Seyrek I. Dietetic, nutrition and diagnostic of disease, lesson from contrasted world. *Journal of clinical Investigation*, vol. 67, pp. 1072-1080, 2004.

[33] Solomons D). Major risk in food, systemic ecology : Nègre Robert. *Edition Marketing* (Paris). Vol. 19, pp. 311-318, .2005.

[34] Sop K.M.N., Gouando I., Tangwa M., Souriga M., Fosto M. and Ekoué T). Mineral content in some Cameroonian household foods eaten in Douala. *African Journal of Biotechnologie,* vol. 5, no17, pp. 3085-3091, .2008.

[35] Stevenson C., Doherty G., Bamett J., Muldoon O.T. and Trew K. Adolescent's view of food and eating: identifying barriers to health. *Journal of Adolescence*. Vol. 30 , pp. 417-434, .2007.

[36] Taiwo M., Taylor J.P., Events M.C., Kenna M). First elements of nutrition. extract from the lecture under the TB committee FAO in Côte d'Ivoire, . 2008.