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Physico-chemical, biochemical properties of garba with tuna and rice eggplant sauce: Two local dishes consumed in Côte d'Ivoire

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Abstract

Tuna with garba and rice with eggplant sauce are two local dishes sold and consumed in the streets of Abidjan in Côte d'Ivoire. These dishes are accessible and available at any time in public spaces. However, their consumption by different segments of society raises many questions at their nutritional contribution. Thus, this study consisted in determining the physicochemical, biochemical and nutritive characteristics of these foods. Indeed, the physico-chemical analysis reveals that rice with eggplant sauce has a good value in protein, which is equivalent to (12.45%), in carbohydrate (72.38g/100g), in energy value (380.9 Kcal/100g), in minerals (Ca, K, P, Mg, Na, Cl, Se, Cu, Zn and Mn), in amino acids, in vitamins A, D, E and K and in omega 6 and 3. However, this dish is deficient in lipids (4.62g/100g), iron (0.054 mg/kg), chromium (0.005 mg/kg) and antioxidant compounds. Regarding the tuna with garba, it reveals a good profile in carbohydrates (69.26 g/100g), lipids (9.26 g/100g), fiber (3.02 g/100g), energy value (395.8 Kcal/100g), omega 6 and 3, some minerals (Ca, K, P, Mg, Na, Cl, Se, Cu, Zn and Mn) and also in vitamin A, D, E and K. As far as antioxidant compounds are concerned, there are some insufficiencies as well as some trace elements such as iron and chromium respectively 0.043 mg/kg and 0.0042 mg/kg. Although these dishes are sometimes full of good profiles to cover certain nutritional needs, they have deficiencies and deficiencies in some elements. On other hand, the consumption of these foods should be occasional and sometimes supplemented with fruits and vegetables, as well as physical activities.

Keywords: street food, tuna with garba, rice eggplant sauce, nutritive value

Introduction

In developed countries, street food has become, thanks to the development of the agri-food industry (including fast food), the support of the modernization of food. It is therefore an axis contributing to the formalization of food behavior [1]. In Africa, the street food sector has invaded areas of high economic activity and high population concentration [2].The street food sector is therefore often informal in the sense that these micro-businesses are formed spontaneously and do not meet official regulatory obligations. The term "street food" refers to a sector producing food and beverages suitable for consumption, cooking, and/or sale only on the street and in similar public places [3]. Street food is playing an increasing socio-economic role in all African cities. Indeed, this sector has become a phenomenon of modern societies, allowing more than 80% of urban populations to meet their nutritional needs [4].

In Côte d'Ivoire, this type of food is widespread and is part of the daily eating habits of millions of city dwellers [5]. They are consumed by all. These foods occupy important places in the nutritional choice. Among these dishes found in restaurants in Côte d'Ivoire, we can cite tuna with garba and eggplant sauce with rice. These dishes are popular with Ivorians and are often prepared with raw materials [6]. Garba is based on cassava semolina (attiéké), fried tuna, fresh chili, tomato, fresh onion and sometimes accompanied by mayonnaise and culinary broth (maggi cube) [7]. Unlike rice, which is a cereal of the genus Oryza that is grown in tropical, subtropical and warm temperate regions for its starch-rich fruit. It is the first cereal in the world intended for human consumption [8]. It is accompanied by different sauces according to the customer's taste. These street meals are one of the most essential meals for the Ivorian population [9]. Thus, due to their popularity and high frequency of consumption throughout the country, there is a data deficiency in the resulting cooked dishes. This deficit promotes, rightly or wrongly, the existence of prejudices between the diet with these different dishes and certain metabolic pathologies.

In order to make these healthy and sustainable diets available, accessible, affordable, safe and attractive, changes in food systems are needed. Hence the interest of our study to assess the biochemical impact of these local street foods on consumer health.

Material and Methods

Material

The biological materials used in this study are constituted of two dishes consumed in the district of Abidjan. These dishes are rice eggplant sauce (RES) and tuna with garba (TWG). The dish of rice eggplant sauce was bought in restaurants of different communes while the dish of tuna garba was bought in garbadromic of different commune.

Fig 1: Dish of rice eggplant sauce

Fig 2: Dish of tuna with garba

Methods

Nutritive properties

Proximate composition of dishes of rice eggplant sauce and tuna with garba

The methods used for sample treatment and analysis (moisture, ash, titratable acidity, fibers, protein and lipids) were carried out following official analytical method recommended by [10].

Moisture was determined by drying in an oven at 105 ºC during 24 h to constant weight. Total nitrogen was determined according to the Kjeldahl method and converted into proteins using factor 6.25. Ash was determined by gravimetric of incinerated sample, in muffle at 550 °C. Fibers were determined according to the technique described by [10] using sulfuric acid. Lipids were extracted by the Soxhlet technique with hot solvent (hexane) and afterwards were determined by gravimetric. Total sugar was determined by method of [11] and reducing sugar was analyzed according to the method [12] using 3.5 dinitrosalycilic acids (DNS). The total carbohydrate content was calculated by using the equation: 100 - (% moisture + % proteins + % lipids + % ash) [13]. Energy value was determined by calculation from fat, carbohydrate and proteins content using the Atwater's conversion factor; 4.0 kcal/g for protein, 9.0 kcal/g for fat and 4.0 kcal/g for carbohydrate [13].

Minerals Analysis

Minerals contents were determined by ICP-MS (inductively coupled argon plasma mass spectrometer) method as described by [14]. Dried powdered samples (5 g) were burned to ashes in a muffle furnace (Pyrolabo, France). The ashes obtained were dissolved in 10 mL of mixing of HCl/HNO_3 and transferred into 100 mL flasks and the volume was made up using deionized water. The mineral composition of each sample was determined using an Agilent 7500c argon plasma mass spectrometer. Calibrations were performed using external standards prepared from a 1000 ppm single stock solution made up with 2 % of nitric acid.

Anti-Nutritional Factors

As for anti-nutritional factors, the oxalates content was determined using the method describe [15] using potassium permanganate. Phytate contents were determined using the method describe [16].

Study of Vitamins Content

The fat and water soluble vitamins content were determined according to the method described [17]. Five (5) grams of samples were placed in 100 mL volumetric flask and 50 mL of distilled water was added. The pH of the mixture was adjusted to 4.5 and then the solution was delipidated with a solution of sulphuric ether and petroleum ether. The resulting new mixture was filtered and neutralized to a pH of 6.9. The resulting solution was lyophilized and the lyophilisate was reduced to a minimum volume of 30 mL. The determination of vitamins content was performed after the calibration of each vitamin to its standards. The mobile phase consisted of acetonitrile (55 mL), tetrahydrofuran (37 mL) and water (8 mL) at a flow rate of 1.5 mL/min. Ten (10) µL of each sample was injected and the compounds were detected at a wavelength of 325 nm. The content of Vitamin C of samples was determined by titration in accordance of the method described by [18]. 10 g of each sample were soaked for 10 min in 40 mL of metaphosphoric acidacetic acid (2%, w/v). The mixture was centrifuged at 3000 rpm for 20 min and the supernatant obtained was diluted and adjusted with 50 mL of bi-distilled water. Afterwards, 10 mL of the mixture was titrated to end point with dichlorophenolindophenol (DCPIP) of concentration 0.5 g/L.

Determination of Amino Acids

The extraction of total amino acids was carried out according to the modified method [19]. 1 g of powder of delipidated sample prepared in 10 mL of 6N HCl was dried at 110 °C in oven for 24 h then under a nitrogen flow. The dry residue was taken up again in 10 mL of 0.2 N of sodium citrate at a pH of 2.3. The homogenized mixture was centrifuged at 3000 rpm during 25 min at 0 °C. The collected supernatant was filtered using a Whatman paper No. 4 and then through a millipore filter of 0.45 µm of diameter (Sartorius AG, Goëttingen, Germany). The treated supernatant was stored at -20 °C prior to analysis. The amino acid composition of the samples was determined after hydrolysis by 6 M HCl with 1 % of phenol at 150 °C for 60 min. The solvent used was a solution of sodium acetate (45 Mm; Ph 5.9) and a mixture of 30 % of sodium acetate (105 mM, pH 4.6) and 70 % of acetonitrile. The detector was selected at 280 nm.

Determination of fatty acids

The method used was those [20] using direct acid transmethylation. Fatty acid methyl esters were prepared using boron trifluoride reagent in an excess of 14 % of methanol (BF3/MetOH). The analysis of the methyl esters was carried out on a gas chromatograph. This apparatus is equipped with a flame ionization detector and a column, with the oven temperature programmed to increase from 60 to 325 °C at a rate of 1 °C/min. The temperature of the injector has been set to 275 °C and those of the detector was to 325 °C. The pressure of the nitrogen at the inlet, used as carrier gas, varies from 6.90 to 47.6 Kpa. The flow rate was maintained at 1 cm/min and the dead time was 1 min 15s (hydrogen 40 cm/s). Peak identification was carried out using reference fatty acid methyl esters by comparing the retention distances of each peak on the chromatogram with those obtained from the standards.

Antioxidant properties

Evaluation of nutritional compounds

Polyphenols content was determined by spectrophotometric method using Folin Ciocalteu's as the method described [21].Concerning the flavonoid content, it was evaluated using the method reported [22]. For the tannins content, the method described [23] using vanillin reagent permitted its determination.

Antioxydant activity assay

The antioxidant activity assay was carried out in accordance with the method described [24] using the 2, 2-diphenyl-1-pycrilhydrazyl (DPPH). To do it, 1 mL of 0.3 mM of DPPH solution prepared in ethanol was added to 2.5 mL of sample solution (1 g of dried powdered sample mixed in 10 mL of methanol). The whole was filtered through a Whatman paper N° 4 and was allowed to react for 30 min at room temperature. Absorbance values were measured with a spectrophotometer (PG Instruments, England) set at a wavelength of 415 nm. The average absorbance values were converted to percentage antioxidant activity using the following formula:

$$(\%)\ \text{Scavenging activity} = [(A0 - A1) / A0)] \times (100)$$

Statistical Analysis

The analyses were performed in triplicate and data were expressed as mean ± standard error (SEM). Data were analyzed using EXCEL and GraphPad 8.4.2. Differences between means were evaluated by Student test. Statistical significant difference was stated at $p < 0.05$.

Results

Result of Proximate Composition of Tuna with Garba and Rice Eggplant Sauce Dishes

The results of proximate composition of the dishes of tuna with garba (TWG) and eggplant rice sauce (RES) are recorded in Table 1. The statistical analysis revealed some significant difference between the tuna with garba dish and the rice with eggplant sauce dish in all parameters. The parameters are higher in RES than TWG at the level of moisture, pH, carbohydrate, proteins and ash content. The moisture content are 10.25 ± 0.67 and 29.24 ± 2.29 respectively for tuna with garba dish and rice eggplant sauce dish. The pH values are 5.1 ± 0.02 and 6.15 ± 0.03 respectively for tuna with garba and rice eggplant sauce. The carbohydrate content 72.38 ± 0.19 and 69.26 ± 0.12 for garba with tuna and rice eggplant sauce. Protein content of garba with tuna and rice eggplant sauce are respectively 8.85 ± 0.03 and12.45 ± 0.1. For ash content, the content in garba with tuna and rice eggplant sauce are respectively 2.12 ± 0.03 and 2.52 ± 0.05. Concerning the content in titratable acidity, reducing sugars, total sugars, fat, fiber and energy value; statistical analysis revealed that the content are higher in tuna with garba dish regarding to rice eggplant sauce dish. The value are included between 1.01 ± 0.01 meq/100g and 395.8 ± 0.26 Kcal/100 g respectively for titratable acidity and energy value.

Table 1: Proximate composition of the different dishes

Dishes Parameters (g/100 g DM)	TWG	RES
Moisture (FM)	10.25 ± 0.67^{b}	29.24 ± 2.29^{a}
pH	5.1 ± 0.02^{b}	6.15 ± 0.03^{a}
Titratable acidity(Meq/100g)	1.01 ± 0.01^{a}	0.2 ± 0.01^{b}
Reducing sugars	39.09 ± 0.38^{a}	32.14 ± 0.41^{b}
Total sugars	59.85 ± 0.44^{a}	53.14 ± 1.07^{b}
Carbohydrate	69.26 ± 0.12^{b}	72.38 ± 0.19^{a}
Proteins	$8.85 \pm 0{,}03^{b}$	12.45 ± 0.1^{a}
Fat	9.26 ± 0.01^{a}	4.62 ± 0.02^{b}
Fiber	3.02 ± 0.02^{a}	0.27 ± 0.02^{b}
Ash	2.12 ± 0.03^{b}	2.52 ± 0.05^{a}
Energy value (Kcal/100 g)	395.8 ± 0.26^{a}	380.9 ± 0.24^{b}

Values followed by different letters in the same column are statistically different (α= 0.05). The values correspond to the mean ± standard erreur of three independent measurements (n = 3) TWG: tuna with garba; RES: rice eggplant sauce

Minerals Composition of Tuna with Garba and Rice Eggplant Sauce Dishes

The results of the mineral composition of the two diet are presented in Table 2. Statistical analysis revealed that the content in calcium, sodium, phosphorus, chlorine, iron, zinc, copper, selenium and manganese are higher in rice eggplant sauce dish regarding to tuna with garba dish. The content are included between 0.054 ±0.00 mg/kg and 6768 ± 3.79 mg/kg respectively for iron and chlorine. Concerning the content in magnesium and potassium, they are higher in tuna with garba dish. The content in magnesium are 641 ± 0.58 mg/kg and 365 ± 0.58 mg/kg for respectively in tuna with garba dish and rice eggplant sauce dish. For potassium, the content are 3723 ± 6.08 mg/kg and 2234 ± 1.15 mg/kg for respectively tuna with garba dish and rice eggplant sauce dish. For chromium and Iron, statistical analysis revealed that they are no significant difference in the content of two dishes. The values are respectively (0.0042 ± 0.00 mg/kg; 0.005 ± 0.00 mg/kg) and (0,043± 0, 00 mg/kg and 0,054 ± 0, 00 mg/kg) for respectively tuna with garba dish and rice eggplant sauce dish.

Table 2: Minerals Composition of Tuna with Garba and Rice Eggplant sauce dishes

Parameters (mg/kg DM)	TWG	RES
Calcium	1519 ± 0.58^{b}	2585 ± 3.21^{a}
Magnesium	641 ± 0.58^{a}	365 ± 0.58^{b}
Potassium	3723 ± 6.08^{a}	2234 ± 1.15^{b}

Sodium	4460 ± 2.89[b]	4512 ± 1.15[a]
Phosphorus	1357 ± 1.53[b]	2310 ± 0.58[a]
Chlorine	6690 ± 1.15[b]	6768 ± 3.79[a]
Iron	0.043 ± 0.00[a]	0.054 ± 0.00[a]
Zinc	8.16 ± 0.02[b]	15.8 ± 0.42[a]
Copper	0.973 ± 0.00[b]	2.86 ± 0.02[a]
Selenium	4.44 ±0.02[b]	5.43 ± 0.02[a]
Manganese	3.29 ± 0.07[b]	7.15 ± 0.02[a]
Chromium	0.0042 ± 0.00[a]	0.005 ± 0.00[a]

Values followed by different letters in the same column are statistically different (α= 0.05).The values correspond to the mean ± standard erreur of three independent measurements (n = 3). TWG: tuna with garba; RES: rice eggplant sauce

Vitamins Content of Tuna with Garba and Rice Eggplant Sauce Dishes

Figure 1 shown the results of vitamins content of different dishes.

Statistical analysis revealed that there was no significant difference between the levels of vitamin A, vitamin D and vitamin K in the TWG and RES dishes, whereas the levels of vitamin E were significantly different at $p<0.05$ in the TWG and RES dishes.

The vitamin D contents are 5.72 ± 0.015 and 5.22 ± 0.01 mg/kg bw respectively for rice with eggplant sauce and tuna with garba dish.

Those of vitamin E are 24.76 ± 0.03 and 17.26 ± 0.015 mg/kg bw respectively for RES and TWG. For vitamin K, the contents are 1.99 ± 0.015 and 2.29 ± 0.015 mg/kg bw respectively for RES and TWG dish. The vitamin A content are 2.36 ±0.025 mg/kg bw and 2.43 ±0.01 mg/kg bw respectively for RES and TWG. Concerning vitamin C, the contents are 0.7 ± 0.02 and 1.1 ± 0.01 respectively for RES and TWG dish.

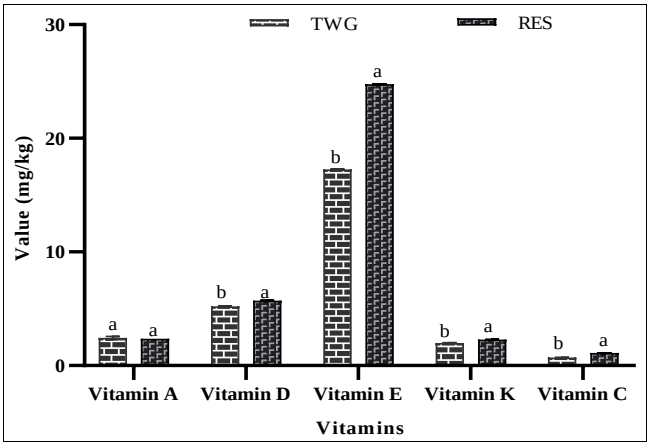

Fig 3: Vitamins content of rice eggplant sauce and tuna with garba dish Column graph followed by different letters are statistically different (α= 0.05). TWG: tuna with garba; RES: rice eggplant sauce dishes.

Amino acid composition of the different dishes

The amino acid composition of different dishes are shown in Table 3. Significant difference was observed at all parameters at $p<0.05$.

Analysis of result revealed that the content of tyrosine and methionine are higher in TWG dish while the content of phenylalanine, tryptophan, lysine, isoleucine and threonine are higher RES dish.

These high content are comprised between 133.1 ± 1.07 mg/100 g and 990.43 ± 1.46 mg/100 g respectively for tryptophan and threonine in RES dish.

Table 3: Amino acid composition values of the different dishes

Parameters(mg/100 g)	TWG	RES
Phenylalanine	689.33 ± 6.06[b]	712.23 ±2.11[a]
Tyrosine	358 ± 1.53[a]	322.27 ± 0.93[b]
Tryptophan	119.5 ± 0.76[b]	133.1 ± 1.07[a]
Methionine	320.3 ± 1.01[a]	297.83 ± 1.30[b]
Lysine	157 ± 1.53[b]	205.2 ± 2.42[a]
Isoleucine	466.53 ± 0.21[b]	501.13 ± 1.04[a]
Threonine	880.2 ± 1.00[b]	990.43 ± 1.46[a]

Values followed by different letters in the same column are statistically different (α= 0.05). The values correspond to the mean ± standard erreur of three independent measurements (n = 3) TWG: tuna with garba; RES: rice eggplant sauce dishes.

Fatty Acid Content of Tuna with Garba and Rice Eggplant Sauce Dishes

The results of the fatty acid composition are reported in Table 4. Gas chromatography (GPC) analysis revealed the presence of palmitic, stearic, oleic, linoleic (omega 6) and linolenic (omega 3) acids in the different dishes. Statistical analysis revealed that stearic, oleic, linoleic and linolenic acid content is higher in the RES dish while palmitic acid content is higher in the TWG dishes. The palmitic acid content is 2.61 ± 0.41 g/100 g and 1.8 ± 0.06 g/100 g for TWG and RES dishes respectively. The high fatty acid content in RES dishes ranges from 2.45 ± 0.05 g/100 g to 38.20 ± 1.62 g/100 g for stearic acid and linoleic acid respectively.

Table 4: Fatty acid of the different dishes

Parameters (g/100g)	TWG	RES
Palmitic acid	2.61 ± 0.41[a]	1.8 ± 0.06[a]
Stearic acid	1.9 ± 0.12[b]	2.45 ± 0.05[a]
Oleic acid	29.4 ± 0.78[b]	38.20 ± 1.62[a]
Linoleic acid	21.9 ± 0.55[b]	28.63 ± 0.94[a]
Linolenic acid	10.70 ± 0.26[b]	12.70 ± 0.69[a]

Values followed by different letters in the same column are statistically different (α= 0.05).The values correspond to the mean ± standard erreur of three independent measurements (n = 3) TWG: tuna with garba; RES: rice eggplant sauce dishes

Nutritional, Antinutritive and Antioxidant Content of Tuna with Garba and Rice Eggplant Sauce Dishes

The content of antinutritional and antioxidant compound are shown in Table 5. Concerning the content of antioxidant compounds, the statistical analysis reveals a significant difference with very high contents in the RES dish of compounds phenolics and flavonoids at $p < 0.05$. The contents of phenolic compounds are 1.32 ± 0.02 and 2.81 ± 0.03 g/100 g DM respectively for the TWG and RES dishes. Those of flavonoid contents are 0.13 ± 0.01 and 0.3 ± 0.01 g/100 g DM respectively for TWG and RES dishes. DPPH contents are 32.82 ± 0.10 and 21.14 ± 0.61 g/100 g DM

respectively for TWG and RES dishes. For antinutritional compound, while phytate content did not differ significantly between the two dishes, tannin and oxalate content differed significantly between the two dishes. The content varied from 0.11 ± 0.01 to 10.94 ± 0.37 respectively for tannin in TWG dish and oxalate in TWG dish.

Table 5: Composition of antinutritive and antioxidant values of the different dishes

Parameters (g/100 g DM)	TWG	RES
Compounds phenolics	1.32 ± 0.02^b	2.81 ± 0.03^a
Flavonoids	0.13 ±0,01^b	0.3 ± 0.01^a
DPPH (%)	32,82 ± 0,10^a	21.14 ± 0.61^b
Tanins	0,11 ± 0,01^b	0.15 ± 0.01^a
Phytates	2.9 ± 0.17^a	3.42 ± 0.11^a
Oxalates	10.94 ± 0.37^a	9.17 ± 0.09^b

Values followed by different letters in the same column are statistically different (α= 0.05). The values correspond to the mean ± standard deviation of three independent measurements (n = 3) TWG: tuna with garba; RES: rice eggplant sauce dishes.

Discussion

The study of nutritional characteristics of tuna with garba and rice eggplant sauce dishes consisted in evaluating the impact of the consumption of these foods on Ivorian population using nutritional parameters. Concerning the proximate composition, the result shows that the content of carbohydrate, proteins and ash are higher in rice eggplant sauce than tuna with garba. This high content of these nutrients is an advantage for the consumers of rice eggplant sauce. Indeed, the proteins are an important component of the body. They are necessary in synthesis of body tissue, the maintenance of body structure, the renewal of muscle tissue and their participation in many physiological processes such as immune response. The high protein content of rice-eggplant sauce is correlated to the content of amino acids, which is also very high and whose proper balance is necessary for the synthesis of hemoglobin [25]. Regarding the carbohydrate content of rice eggplant sauce, the high value obtained testifies that its consumption can meet the body's glucose requirements and satisfy its energy needs [26, 27, 28]. Regarding the low protein and ash content of tuna with garba fish, the low values suggest that its consumption over a long period could lead to public health problems such as protein-energy malnutrition (PEM) and kwashiorkor, stunted growth in children, the development of deficiencies in essential minerals including iron, and cause death in these children in the long run [29, 30].

The results showed high fat contents in both foods, but with higher proportions in the tuna garba dish. This high fat content is an advantage to the transfer of fat-soluble vitamins for better absorption in the enterocytes [31, 32]. This high fat content of the different diets is correlated with the content of essential fatty acids, which is very high in the tuna garba dish. The relatively low fat content of the RES dish presages the positive impact of its consumption. In addition, the high levels of reducing sugars, total sugars, energy value and fiber content of tuna with garba dish show that its consumption could impact negatively the body of consumer. In fact, reducing sugars, total sugars and fats contribute to increase the energy value. However, an energy value higher than the body's needs could lead to numerous diseases such as obesity, cardiovascular and coronary diseases, etc [33].

Minerals can be defined as substances that are essential for the proper functioning of the body. The results obtained show that the content of major minerals (calcium, magnesium, potassium, phosphorus, etc.) is high in both dishes while the content of trace elements (iron, zinc, chromium and selenium) is higher in the RES dish. The major minerals could protect the body against arterial hypertension, maintain the osmotic balance, and intervene in the mechanism of intestinal absorption of glucose and the improvement of the protein retention during the growth phase [34, 35]. On the other hand, trace elements are beneficial for the proper functioning of immune system, reducing of fatigue, protection of cells against oxidative stress, ensure the normal functioning of nervous system and normal psychological functions [36].

The different methods of studying the vitamin content revealed higher levels in the RES dish compared to TWG dish. This high content of fat-soluble vitamins, vitamin C and carotenoid is an advantage to recommend this dish in the diet of Ivorian population. In fact, vitamin are nutritive component without energy value, present in the diet in small quantities and essential for growth, maintenance of the body in good health, reproduction and functioning of the body [32]. An adequate intake could neutralize potential reactive oxygen species damage to cellular tissues and modulate immune cell function by regulating redox-sensitive transcription factors and affect cytokine and prostaglandin production [37]. However, a consumption of these foods could be favorable to health and avoid certain deficiencies for the consumer and prevent the development of a large number of pathologies, such as osteoporosis, eye diseases, degenerative and cardiovascular as well as some cancers [38, 39].

Antioxidants are molecules that are naturally present in many foods and have the function of capturing free radicals. The results showed higher levels of phenolic compounds and flavonoids in the RES dish, while the TWG dish had the highest DPPH content. This content of antioxidant compounds suggests the good that could be obtained by the consumption of these foods. In fact, antioxidants compounds have well-established properties and a link with the inhibition of oxidation both in the dietary (lipid oxidation) and physiological (oxidative stress) domains [40]. Therefore, regular consumption of these foods could be beneficial for consumers. However, the important presence of anti-nutritional compounds in these dishes could constitute a major nutritional problem for consumers, since they reduce the bioavailability of certain minerals and therefore problems of nutritional deficiencies. Consequently, regular consumption of these foods could reduce the energy balance of the food [41].

Conclusion

The present study on two dishes sold in Côte d'Ivoire revealed advantages and deficits in nutritional parameters. The rice dish with eggplant sauce showed many advantages in terms of its nutritional composition. This food can be consumed by all segments of society including adolescents, youth, adults and pregnant women. The tuna garba dish on the other hand, has shown many nutritional deficits. This suggests that its regular consumption could lead to many dysfunctions in the body. In order to improve the nutritional quality of these foods, it would be wise to improve the process of preparation to increase the bioavailability of

nutrients.

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