Impact of Consumption of Two Street Foods (Tuna Garba and Rice with Eggplant Sauce) on Vital Organs in the Wistar Rat (*Rattus norvegicus*)

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Authors' contributions

This work was carried out in collaboration among all authors. Author NAE did the methodology, software, formal analysis, resources, writing original project. Author NJK did the conceptualization, validation, methodology, formal analysis, data curation, resources, writing - original project. Author YRS did the term, conceptualization, project administration. Author GAB did the methodology, software. Author GFG did the validation, methodology, software. Author TBS did the conceptualization, project administration. Author KBY did the resources, writing - original version. Author AJD did the term, conceptualization, validation, writing - revision and editing, supervision, project administration. All authors read and approved the final manuscript.

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ABSTRACT

Street foods are seen as a public health problem due to lack of infrastructure and basic services, difficulty in controlling the plethora of street food sales operations due to their diversity, their mobility, and their temporary nature. The objective of this study is to show the impact of the consumption of two street foods (Garba with tuna and rice with eggplant sauce) consumed in Côte d'Ivoire on the health of the Ivorian population. To contribute to the nutritional and health security of the population, the consumption of these dishes has been demonstrated in young Wistar rats (*Rattus norvegicus*). Thus, we hypothesized that the consumption of these street foods would have a deleterious effect on consumer health. However, five days 20 young rats of male and female sexes aged 50±5 days and weighing an average of 55±5 g were acclimatized and fed on a formulated isocaloric diet rich in herring fish (*Clupea harengus*) animal protein. After the acclimatization phase, four batches of rats of five rats per cage were fed respectively with diets (DWP, CDHF, GWTF and RES). The results showed that juvenile rats fed the CDHF and RES diet gained a lot of weight (5.66 ± 0.34 g/d and 5.16 ± 0.58 g/d) while those fed the GWTF diet had a progressive, slow weight gain. (2.32 ±0.23 g/d) and batch of rats fed without protein (DWP) observed considerable weight loss (-1.07±0.06 g/d). In terms of biological value, the results demonstrate that rats fed the RES diet have a higher protein availability (84.23 ±0.02%) than rats fed the GWTF diet (54.31 ±0.06 %). It follows from this analysis that it is necessary to combine GWTF with other protein-rich foods to compensate for the nutritional deficits caused by its ingestion. In young rats fed experimental diets, biometric research on vital organs (heart, liver, spleen and kidneys) revealed no abnormalities.

ABRÉVIATIONS

RES   : Rice Eggplant Sauce
GWTF : Tuna Garba
CDHF : Control Diet Formulated with Herring Fish
DWP   : Diet without Protein

1. INTRODUCTION

A balanced diet meets a basic human need by providing the body with the nutrients and energy necessary for its growth and development [1]. Therefore, the consumption of foods of adequate nutritional quality is an important aspect of the maintenance and harmonious functioning of the body. However, due to urban activities that encourage people to eat outside the family circle with meals generally called "street food", access to these nutritious foods is hindered. The sector that produces food and beverages intended for consumption, preparation and/or sale by vendors, particularly in the streets and other comparable public spaces, is known as "street food" [2]. This type of meal is common in Côte d'Ivoire and millions of city dwellers consume it daily [3]. They are consumed by people from all walks of life. These foods play an important role in dietary decisions. Thus, the general lack of factual knowledge on the epidemiological importance of many foods sold on the streets,

poor knowledge of street vendors in basic food safety measures and insufficient public awareness of the dangers posed by certain foods have seriously impeded the deployment of an accurate science-based approach to this very serious public health and safety issue. Among these foods marketed and consumed are Garba with tuna and rice with eggplant sauce. These dishes are made with local ingredients and are consumed by city dwellers as part of their social activities [4]. These dishes are very popular with Ivorians [4]. The quality of the raw materials used in the preparation of street foods is very important, as their contamination may persist during preparation and/or cooking. Thus, the 'Garba' dish is made from cassava semolina ("attiéké"), fried poor quality tuna fish "called faux thons", fresh peppers, tomatoes, fresh onions, and is sometimes served with mayonnaise and often accompanied by cooking broth (cube maggi) [5]. Unlike rice, it is a cereal grown in tropical, subtropical and warm temperate regions due to its starchy fruit. It is the first cereal in the world intended for human consumption [6]. It is accompanied by different sauces according to the customer's taste. However, no scientific research on the nutritional impact of these foods has been carried out. In order to understand the beneficial effects and the risks associated with the consumption of these street foods, it is crucial to assess their nutritional

potential in vivo after their consumption. The in vivo study, on the other hand, is an essential process to control not only the nutritional quality of foods but also the well-being of the local population after their consumption. The current study uses young Wistar rats to study the nutritional qualities of rice with eggplant sauce and tuna Garba, as well as to assess the nutritional impact of their ingestion. So, would these street foods not have deleterious effects on the consumer? This question represents the backbone of our work.

2. MATERIALS AND METHODS

2.1 Biological Material

It consists of two dishes of Ivorian origin: rice with eggplant sauce (RES) and Garba with tuna (GWTF) and young rats of the Wistar strain (*Rattus norvegicus*) aged 50 ±5 days. These dishes were purchased from vendors in the communes of Abobo, Cocody and Yopougon in the city of Abidjan (Côte d'Ivoire). The availability of the experimental rats was ensured by the Health Biology laboratory of the UFR of pharmaceutical and biological sciences of the Félix Houphouët-Boigny University (Abidjan, Côte d'Ivoire).

2.2 Experimental Diets

2.2.1 Making flour for different dishes

These dishes were purchased from vendors in the communes of Abobo, Cocody and Yopougon in the city of Abidjan. Each type of dish was transported to the laboratory of the CeReB (Biological Resource Center) of the Pasteur Institute in Côte d'Ivoire, where they were homogenized and ground to obtain a homogeneous dish. Then, the different dishes were freeze-dried to obtain flours for the different tests.

2.2.2 Dietary components

For this study, four test diets were formulated and submitted to young rats. A positive control diet made from herring fish (*Clupea harengus*) as a protein source, as recommended by [7] and also a protein-free diet (animal and vegetable) designated as the negative control. White powder maize starch flour without gluten (Merck, Côte d'Ivoire) is the main source of carbohydrate for intake. Palm oil (Aya, Ivory Coast) for its

essential fat content was used, and the mixture of vitamins and mineral supplements, a veterinary powder (Vitaflash/batch number: 304790).

2.2.3 Formulation of the different experimental diets

The diets were prepared according to the method by [7]. For the positive control diet, in total, a quantity of 240 g of herring fish meal (*Clupea harengus*) was taken and at each quantity, 975 g of starch (Merck) weighed with a precision balance, 120 g of vegetable oil "Aya", 15g of vitamin and mineral supplement "Vitaflash" (Table 1) were added and all mixed homogeneously and cooked for 15 minutes with 1250 ml of distilled water. The protein-free diet was similarly resumed under the same hygienic conditions in the laboratory except without protein sources. For the experimental diets, namely the garba tuna diet and rice with eggplant sauce and cooked beforehand, were reheated for 5 minutes with distilled water and using the same weighing quantities required as those of the control diets without the addition of other inputs than flour for different dishes.

Gluten-free starch (merck) Palm oil Vitamin and mineral supplements (vitaflash) Agar-agar cellulose Dry matter Energy value in kcal/kg.

2.3 Nutritional and Biochemical Composition of the Different Dishes

Proximal analyzes were carried out in triplicate on the samples. This analysis included the following elements: moisture, total fat, crude protein, carbohydrates and ash. The water content was estimated by drying the samples to a constant weight at 105 °C using the oven method [8]. The determination of lipids was carried out by the Soxhlet extraction method. Ash content was determined by igniting the sample at 550 °C for 5-6 hours in a muffle until the sample was completely free of carbon particles while total nitrogen was was determined by the Kjeldahl method as described by [9] and a factor of 6.25 was used to convert the total nitrogen to the crude protein content of the samples. The total carbohydrate content was calculated by using the equation: 100 - (% moisture + % proteins + % lipids + % ash) [10].

Table 1. composition g/kg and formulation of control diets

Composition Alimentaire	MS(%)	CDHF	DWP
Protéin	16	240	0
Gluten-free starch (merck)	65	975	1215
Palm oil	8	120	120
Vitamin and mineral supplements (vitaflash)	8	120	120
Agar-agar cellulose	3	45	45
Dry matter Energy	100	1500	1500
value in kcal/kg	-	5940	5940

2.4 Composition of Batches of Rats

The nutritional evaluation of rats in vivo was carried out on 20 young rats (*Rattus norvegicus*) from the UFR Biosciences pet store of the University Félix Houphouët-Boigny (Abidjan, Côte d'Ivoire) according to the method described by [11]. The young rats were separated into homogeneous batches of four groups of five rats each, 45 ± 5 days old. The young rats weighed between 50 and 60 g on average. The average temperature of the experimental room was 25 °C to 26 °C, and the humidity percentage was 70% to 80%, with 12 hours of daylight and 12 hours of darkness. A group of five young rats were fed the control diet formulated with herring fish protein (CDHF), a group of five young rats were fed the tuna garba dish (GWTF), a group of five young rats were fed the rice dish with eggplant sauce (RES), and a group of five young rats were fed a protein-free diet (DWP). The protocol using the manipulation of animals (white rats of the wistar strain) has been submitted and approved by the ethics committee of the Pasteur Institute of Côte d'Ivoire at number N/Ref: 043-21/MSHP/CNESVS-km.

2.5 Carrying Out the Experiment

To begin the experiment, the young rats were placed individually in metabolic cages with a mesh bottom designed to separate food scraps, excrement and urine. Juvenile rats were then acclimatized for five days, during which they all received the control herringfish protein (CDHF) diet. At the end of this period, each batch of young rats was fed the equivalent diet ad libitum for 15 days. Throughout the experiment, water was provided ad libitum. During the trial, the rats' food consumption was assessed daily, and their weight gain was assessed every three days between 6:30 a.m. and 9:30 a.m. Each feed was weighed before being provided, and rejected feed was weighed the following day to establish the amount of feed consumed. For the determination of the dry matter, five g of each food were placed in the oven. The nitrogen (N) balance study consisted of collecting food and faeces from each batch of rats, drying them in an oven at 70°C for 12 hours, weighing them, grinding them into a fine powder and store them for analysis of nitrogen (N) content by the Kjeldahl method [12]. Urine was also collected in sample vials, stored in 0.1 N HCl to minimize ammonia development, and refrigerated until analysis for urine nitrogen.

2.6 Mathematical Expression of the Nutritional Parameters of Foods

After the nutritional evaluation, the parameters expressing the potentialities of the different diets were calculated using the formulas presented in Table 2.

I: amount of dietary protein ingested; Fe: protein excreted in the feces of a subject other than the one on the protein-free diet; Fpp: protein excreted in the feces of a subject on the protein-free diet; U: protein excreted in urine of a subject other than the one on the protein-free diet; Upp: protein excreted in the urine of a subject on the protein-free diet.

2.7 Organ Weights

At the end of the experiment, the juvenile rats were anesthetized and sacrificed. Kidneys, heart, liver, lungs and spleen were removed and dehumidified with absorbent paper. The organs were then weighed using a Sartorius balance with an accuracy of 0.01 g. The relative weight of the organs is represented as a percentage (%) of the total live weight acquired.

Relative organ. weight (%) = [(Organ weight/ animal weight) x 100]

Table 2. Mathematical expression of nutritional parameters

Nutritional parameters	Mathematical expression
Total dry matter intake : DMI (g/d)	DMI (g) = [Food served (g) - food refused (g)] × [dry matter rate]
Weight gain: WG (g/d)	WG (g/d) = Final weight - Initial weight / number of days
Coefficient of Food Efficiency: CFE	CFE = WG / DMI
Total Protein Intake: TPI (g/d)	TPI = DMI × % Protein of diet
Coefficient of Protein Efficiency: CPE	CPE=WG/TPI
Apparent digestibility: Da (%)	Da = (I-Fe) × 100 / I
Digestibility: Dr (%)	Dr = [I - (Fe - Fpp)] × 100 / I
Protein Retention : PR (g)	PR = I - (Fe - Fpp) - (U- Upp)
Net Protein Utilization: NPU (%)	NPU = RP × 100 / I
Biological Value: VB (%)	BV = [I - (Fe - Fpp) - (U- Upp)] × 100 / [I - (Fe - Fpp)]

2.8 Statistical Analysis

The experimental data are presented in the form of arithmetic means with standard error (m ± SEM). GraphPad Prism 8.4.2(679) program is used for statistical data analysis and graphical display (San Diego, California, USA). The one-way Anova test was used to compare the dependent variables, which was complemented by Dunnett's test as a post-test. The nonparametric Student's t test determined the difference between two values. For the expression of the results, the significance level is set at $P < 0.05$.

3. RESULTS

3.1. Nutrient Composition

The study of the proximal composition of the dishes is presented in Table 3. The result shows that the rates of humidity, ash, total proteins and total carbohydrates vary from 2.12 ± 0.03 to 72.38 ± 0.19 and are higher in the RES than in the GWTF. The fiber levels vary from 0.27 ± 0.02 to 3.02 ± 0.02 g/100 DM and the lipids of the dishes vary from 2.1 ± 0.08 to 9.89 ± 0.35 with higher contents in the GWTF dish than in the RES dish.

3.2 Nutritional Evaluation of Tuna Dishes with Garba and Rice with Eggplant Sauce

3.2.1 Weight variation in young rats fed with the dishes

Fig. 1 represents the growth curve of young rats fed with different diets. Analysis of the figure reveals two phases in the growth curves: a descending phase and an ascending phase. The ascending phase is observed in young rats fed the DWP, GWTF and RES diets by weight gains

ranging from 60.8 ±2.98 g to 145.7 ±4.63 g, while the descending phase is observed only in young rats fed the CDHF diet by weight gains ranging from 61.54 g to 45.44 g. Statistical analysis reveals a significant difference (P<0.05) in the weight gain of the young rats, with the highest weight gain being obtained in the young rats fed the DWP diet (5.66 ±0.34 g/d), followed by young rats fed the RES diet (5.16 ± 0.58 g/d), and the lowest weight gain being obtained in the young rats fed the GWTF diet (2.32 ± 0. 23 g/d) (Fig. 2).

3.2.2 Total dry matter ingested by the young rats

Fig. 3 shows the amounts of total dry matter consumed by the young rats fed with the different diets. Statistical analysis shows that the different diets were consumed with a significant difference (P<0.05). The RES diet has the highest food consumption (14.63 ±2.11 g/d), followed by the GWTF diet (11.51 ±2.19 g/d) and the DWP diet (10.12 ±0. 4 g/d), the protein-free diet (DWP) having the lowest consumption (4.83 ±0.73 g/d).

3.2.3 Food efficiency coefficient

The food efficiency coefficient of the different diets given to the rats is presented in Fig. 4. Statistical analysis reveals a significant difference (P<0.05) between all the CEA values of the different diets. The control DWP diet presents the highest CEA value (0.6 ± 0.02), followed by the RES diet (0.38 ± 0.02) and the GWTF diet (0.22 ± 0.01). The protein-free diet, on the other hand, gave a negative ACE value (-0.23 ± 0.02).

3.2.4 Nutritional parameters of different diets given to young rats

Table 4 shows the amounts of total protein ingested, the protein efficiency coefficient, the

apparent digestibility (Da), the digestibility (Dr), the biological value (BV), the protein retention (PR) and net protein used (NPU) of the different dishes submitted to young Wistar rats. The statistical analysis observed for all the parameters a significant difference ($p > 0.05$). Total Protein Intake (TPA) values were 1.37 ± 0.03 g/d; 0.95 ± 0.1 g/d and 1.67 ± 0.12 g/d respectively for young rats fed DWP, GWTF and RES diets. The protein efficiency coefficient (PEC) gave values of (4.13 ± 0.17 g/d; 2.48 ± 0.13 g/d and 3.07 ± 0.15 g/d) for the schemes (DWP, RES and GWTF) respectively. However, the batch of diet-fed (DWP) rats observed the highest CPE of (4.13 ± 0.17 g/d). The DWP, RWES and GWTF diets showed apparent digestibility (Da) rates of ($82 \pm 0.01\%$; $45 \pm 0.06\%$ and $67 \pm 0.04\%$), respectively. On the other hand, the batch of rats fed the DWP diet observed the highest rate, followed by the RES

and GWTF batch. The real digestibility (AD) of the batches of rats fed with the different control and test diets observed a significant difference at the 5% threshold. The analysis gave rates of (91 ± 0.01; $61 \pm 0.01\%$ and $75 \pm 0.03\%$) for the DWP, GWTF and RES diets respectively. Biological value (BV) values gave rates of $93.02 \pm 0.01\%$; $54.31 \pm 0.2\%$ and $84.23 \pm 0.06\%$ respectively for batches of rats fed the DWP, GWTF and RES diets. However, the batches of rats (DWP and RES) had high levels, unlike the batch of rats (GWTF) which had the lowest level. The RP levels observed were (1.01 ± 0.06; 0.28 ± 0.07 and 0.87 ± 0.11 g/d) for the DWP, GWTF and RES batches respectively. Finally, the net protein utilization (NPU) recorded respective levels of ($90.01 \pm 0.01\%$; $39.21 \pm 0.06\%$ and $68.04 \pm 0.04\%$) for the batches of rats DWP, GWTF and RES.

Table 3. Nutritional values of different diets

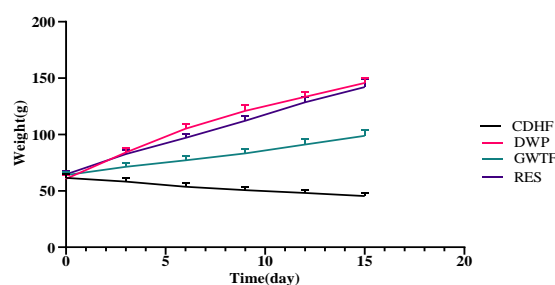| Parameters (g/100 g DM)	Diets			
	Corn meal	Herringfish powder	GWTF	RES
Moisture (%)	88.62 ± 0.33	89.78 ± 0.19	56.56 ± 1.44	71.87 ± 0.2
Fiber	0.92 ± 0.07	0.87 ± 0.01	3.02 ± 0.02	0.27 ± 0.02
Ash	1.42 ± 0.05	9.94 ± 0.82	2.12 ± 0.03	2.52 ± 0.05
Lipid	2.1 ± 0.08	9.89 ±0.35	9.26 ± 0.01	4.62 ± 0.02
Protéin	9.24 ± 0.24	63 ± 0.52	39.82 ± 0.03	56.02 ± 0.1
Carbohydrate	76.57 ± 6.73	17.21 ± 0.54	69.26 ± 0.12	72.38 ± 0.19

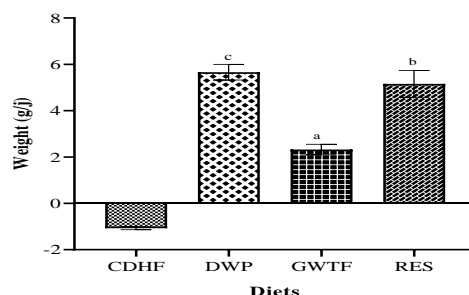**Fig. 1. Growth curve of young rats fed with tuna with Garba and rice eggplant sauce dishes**

Fig. 2. Weight gain of young rats fed different diets
Histograms with different letters (a, b, and c) reflect the significant difference ($p < 0.05$) in the weight gain of different batches of rats
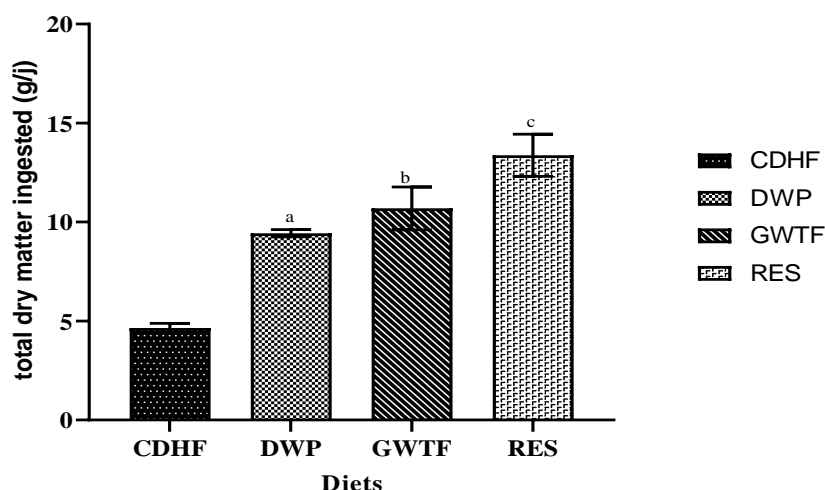
Fig. 3. Histogram showing the amounts of dry matter ingested by young rats fed the different diets
Histograms with different letters (a, b, c, and d) reflect the significant difference (p<0.05) in the amount of dry matter ingested by different batches of rat

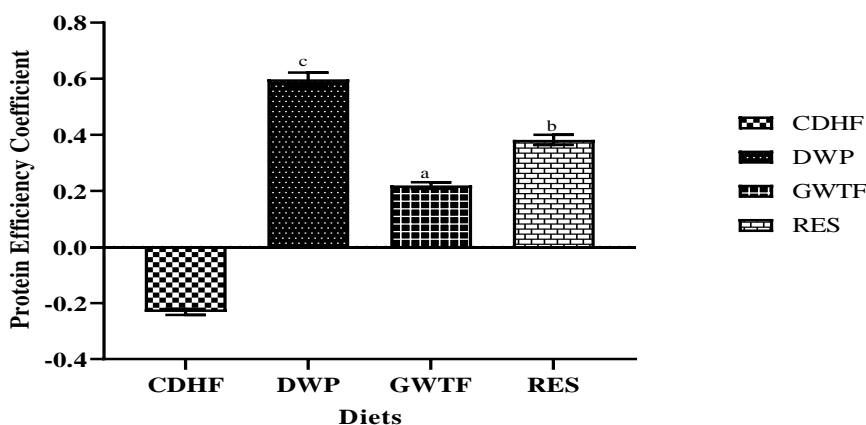**Fig. 4. Histogram showing the feeding efficiency coefficient of rats fed with the different diets**
Histograms with different letters (a, b, c, and d) reflect the significant difference (p<0.05) in the feed efficiency coefficient of different batches of rats

Table 4. Nutritional parameters of the different diets fed to young rats

Nutritional parameters	Diets			
	CDHF	DWP	GWTF	RES
Total Protein Intake	nd	1.77 ± 0.03[b]	0.95 ± 0.01[a]	1.67 ± 0.13[b]
Protein Efficiency Coefficient	nd	4.13 ± 0.19[c]	2.48 ± 0.13[a]	3.07 ± 0.15[b]
Apparent digestibility (%)	nd	82 ± 0.01[c]	45 ± 0.06[a]	67 ± 0.04[b]
Digestibility: Dr (%)	nd	91 ± 0.01[c]	61 ± 0.04[a]	75 ± 0.03[b]
Biological Value (%)	nd	93.02 ± 0.01[c]	54.31 ± 0.06[a]	84.23 ± 0.02[b]
Protein Retention (g/d)	nd	1.01 ± 0.06[b]	0.28 ± 0.07[a]	0.87 ± 0.11[b]
Net Protein Utilization (%)	nd	90.01 ± 0.01[b]	39.21 ± 0.06[a]	68.04 ± 0.04[a]

Mean values of 5 replicates followed by their standard deviations assigned the same letter do not show significant differences (p>0.05) within the same line and values assigned different letters on the same line show a significant difference (p<0.05). nd: not determined

Table 5. Relative organ weights of batches fed the different diets

	Diets			
Organs (%)	CDHF	DWP	GWTF	RES
Liver	3. 84 ± 0.10[a]	3.37 ± 0.14[a]	3.56 ± 0.42[a]	3.43 ± 0.14[a]
Heart	0.54 ± 0.02[b]	0.45 ± 0.01[a]	0.44 ± 0.02[a]	0.42 ± 0.03[a]
Rate	0.8 ±0.06[a]	0.66 ± 0.06[a]	0.73 ±0.05[a]	0.67 ± 0.03[a]
Kidneys	0.8 ± 0.06[a]	0.66 ±0.06[a]	0.73 ±0.05[a]	0.67 ± 0.03[a]
Lungs	0.92 ± 0.11[a]	0.82 ± 0.02[a]	0.92 ± 0.09[a]	0.81 ± 0.04[a]

3.3 Relative Rat Organ Weights

Table 5 shows the relative weights of young rats fed the different diets. Except for the heart of rats fed the protein-free diet (PBR), which showed a significant difference ($p<0.05$), all other organs did not observe a significant difference ($p>0.05$).

The mean values of 3 replicates followed by their standard deviations, assigned the same letter do not show significant differences ($p >0.05$) within the same line and the values assigned different letters on the same line show a significant difference ($p<0.05$).

4. DISCUSSION

Healthy and sustainable diets are based on eating practices that support all aspects of an individual's health and well-being. The present study demonstrates postprandial weight gain in young Wistar rats after consumption of Garba with tuna and rice with eggplant sauce. This is accompanied by protein digestibility and availability. Also, the consumption of these dishes did not show any abnormality in the functioning of the vital organs. Therefore, we could not confirm this hypothesis. The study on the zoo technical characteristics are excellent indicators of the nutritional efficiency of feed. [13]. However, the consumption of these foods did not show any abnormalities in the vital organs, which would be very disadvantageous for those who consume. Thus, the young rats fed the positive control diet (CDHF), the eggplant sauce rice diet and the tuna Garba diet gained weight compared to those fed the protein-free diet. This weight loss (-1.07 ± 0.06 g/d) would however be attributed to the low quantities of dry matter ingested (4.65 ± 0.24 g/d) and the absence of protein in the meal. Indeed, the lack of protein in the diet is a regulating factor of the proper functioning of the organism and would reduce hunger, resulting in a low quantity of dry matter ingested and, consequently, muscle atrophy. Similar findings were made by [14] who found weight loss in rats due to the presence of

bioactive chemicals that would chelate proteins and certain minerals in the rats' food. In addition, the respective weight gain (5.66 ± 0.34 g/d; 5.16 ± 0.58 g/d; and 2.32 ± 0.23 g/d) in batches of rats fed with the DWP, RES, and CDHF diets could be attributed to the presence of protein and fat in the different diets, which would improve palatability and promote hyperplasia in rats by causing increased energy intake, resulting in rapid weight gain. [15,16]. Moreover, the growth of rats could indicate a steady development of rodent cell metabolism [17]. These results are in agreement with those of [18] and [19] who used snail meal (*Limicolaria flammea*) and the cafeteria diet, respectively, as meals containing protein in the diet of rats. The low total quantity of dry matter ingested in the CDHF diet (4.65 ± 0.24 g/d) compared to the other diets (9.44 ± 0.18 g/d; 10.69 ±1.08 and 13.37 ±1.07 g/d) would be due to the difference in palatability of this diet on the one hand, and linked to the composition and nutritional quality of the food on the other hand. [20] studied the association between weight gain, food consumption, material composition and quality of food ingested by rats. Feed efficiency coefficients (FECs) provide the most accurate estimate of ingested food utilization efficiency for all batches of rats. The observed high batch value (DWP) (0.60 ± 0.02) indicates that the rats digested and absorbed this meal more completely. It could also be justified by the high protein content of this diet. Indeed, the consumption of a meal is influenced by various elements, including the physiological state of the organism as well as factors related to the characteristics of food such as smell, flavor and chemical composition [21]. Proteins with an ECP less than 1.5 are low protein quality, those with an ECP between 1.5 and 2 are intermediate quality, and those with an ECP greater than 2 are high quality protein, according to [22]. With regard to the criterion, the CPE contents obtained are higher than the standard established by [22]. Due to the high quality and availability of proteins and amino acids in the blood, these levels should be present. The digestibility coefficient describes the ability of a

protein to be digested by proteolytic enzymes and absorbed by the intestinal mucosa [23]. Compared to the DWP diet (82%), the batch of rats that received the garba flour had the lowest Da (45 ± 0.06%), followed by the RES (67 ± 0.04%). The very low intestinal nitrogen absorption in the batch of rats (GWTF) would be attributed to the low proportion of protein in this diet on the one hand, and the presence of high crude fiber on the other. Indeed, [24] demonstrate that dietary fiber affects in vivo digestibility by decreasing enzymatic activity in the digestive tract. In addition, fibers have a high hydration capacity and limit intestinal absorption by increasing endogenous losses [25]. Moreover, this low absorption obtained in the batch of RES rats would be due to the presence of antinutritional factors, which would influence the ileal digestibility of these proteins. [26,27]. Thus, the high rate of apparent digestibility (Da) observed in the batch of rats (DWP) would be justified by the supply of essential amino acids that this diet would contain. According to [28], an apparent digestibility of more than 70% of a food protein is useful in a child's meal. This rate corroborates and is slightly lower than those obtained by [29] in a study based on dried maggots subjected to young rats which obtained respective rates in FAS2.5, FAS5 and FAS7.5 (90 ± 0.00%, 89 ± 0.01% and 87 ± 0.01%) and higher than those obtained with the GWTF and RES regimes. According to [30] there is a good correlation between the ileal digestibility measured in rats and humans, with a higher coefficient for real digestibility (91%) compared to apparent digestibility (83%). Furthermore, all the batches of rats fed with the different diets observed a real digestibility (Dr) greater than the Da with the batch of rats (DWP) which noted a good real digestibility greater than 90%. However, these low levels would be due to the high temperature (+100 °C) applied to the food during cooking treatments, which would lead to the destruction of certain essential amino acids [31]. According to [32] a real digestibility higher than the apparent digestibility would be a good indicator for the nutritional improvement of food. The biological value of proteins in food reflects their bioavailability in the body. [33]. Except for the GWTF diet, whose BV rate is low (54.31%), all the other diets record higher rates than those obtained in [22] for soy (73%). Thus, the high levels would be due to the bioaccessibility of the proteins contained in these foods by the body. These rates corroborate those obtained by [34] ranging from 78.66 ± 1.62% to 95.57 ± 0.05%. This low level could be justified by a deficiency in lysine and tryptophan, insofar as the absence of a single amino acid limits the use of the protein in the blood. [35]. Net protein utilization is the apparent net utilization of protein, which is the difference between the amount of nitrogen retained by the animal and the total nitrogen consumed. The known crude protein content of the food is a valuable indicator. Net protein utilization refers to the ratio of amino acids converted to protein to amino acids supplied. [36]. However, the DW diet had low levels of net protein utilization (39.21%), which is below the WHO recommended standard for soy (66%). [22] for soy (66%) for a good blend of dietary protein. However, these low levels would be justified by the low levels of amino acids observed in the food. In addition, organ biometrics would make it possible to assess the safety of these diets on vital organs. Thus, the non-significance observed between the relative weights of the spleen, kidneys and lungs of the batches of rats fed with the positive control diet and the Garba and rice with eggplant sauce diets would result from the protein intake of the different diets which would participate in the proper functioning of the organs during growth. According to [37] a lack of protein during the growth phase would influence the relative mass of the organs. Furthermore, the relative weight of the liver in the batch of rats (CDHF) (3.84 ± 0.10%) unlike the batches of rats fed diets (DWP, GWTF and RES) with masses of (3.37 ± 0.14% to 3.56 ± 0.42%) would be due to the absence of proteins observed in this diet, hence the high activity that would produce this organ to keep the organism alive. Indeed, a low-protein diet would be subject to process disorders and would act significantly on organ weight. [33] which would constitute a health problem for the organism. These results are similar to those of [33] who obtained rates of (3.83 ± 0.57%).

5. CONCLUSION

The nutritional quality of a protein is determined mainly by its composition in essential amino acids. Thus, the study on young rats demonstrated the impact of the consumption of two street foods on the functioning of vital organs. Nutritional efficacy experiments on young rats have revealed the limits of consumption of these foods by Ivorians. Unlike Garba, which is slow growing, consumption of rice with eggplant sauce resulted in a significant increase in weight. In terms of nutritional digestibility, Garba demonstrated low protein retention and availability in the body, unlike rice

with eggplant sauce. In addition, the ingestion of these dishes did not lead to any malfunction of the regulatory organs of the body. However, for these recipes to be digestible, the cooking time must be reduced in order to make all the amino acids necessary for the body more available.

DISCLAIMER

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Rigaux C. Second-order Monte Carlo and Bayesian inference methods for assessing microbiological risks and nutritional benefits in vegetable processing Clémence Rigaux To cite this version: HAL Id: pastel-478 00967496 Institute of Life Sciences and Industries and the Environment (AgroParisTech); 2014.
2. Bendech MAG. Street food in Bamako, Mali: Issues and intervention approaches. Mali Public Health. 2013;3:116-8.
3. Ohiokpehai Omo. Nutritional aspect of street food in Botswana. Pakistan J Nutr. 2003;2:76-81.
4. FAO. Committee on World Food Security; 2012.
5. Konan N, Gnegoury RD, Hervé A. The landing of "false tuna" or "false fish" at the fishing port of Abidjan: A resurgence phenomenon in ICCAT data in Côte d'Ivoire. In: Tropical tunas=Tropical tunas=Tropical species. Madrid: ICCAT, Collective Volume of Scientific. 2007;60(1):180-184.
6. Abiassi HE, Eclou SD. Study on the instruments for regulating commercial rice imports in Benin. Final report. 2006;84.
7. Pawlak M, Pion R, Allez M, Bayle G, Leroux J. Influence of wheat protein supplementation with increasing doses of lysine on the free amino acid content of blood and muscle of the growing rat. Ann Biol Anim Biochim Biophys. 1968;8:30. DOI.org/10.1051/rnd:19680404
8. AOAC. Official methods of analysis of the Association of Official Analytical Chemists, Association of Analytical Chemists, Arlington. 1994;I & II:129.
9. Vlieg P. Proximate composition of New Zealand slender tuna *Allothunnus fallai*. New Zealand Journal of Science. 1984;27(4):427-433.
10. FAO. Composition of food in calorigenic nutrients and calculation of useful energy values. FAO Ed, Washington DC. 2002;30.
11. Adrian J, Rabache M, Fragne R. Technique d'analyse nutritionnelle, In Lavoisier Tec et Doc (Eds). Principes de techniques d'analyse, Paris. 1991;451-478.
12. Linden G. Principles of analysis techniques. In: DOC T et, editor. Tech Principles. of Analysis. Lavoisier, Paris. 1981;451-78.
13. Silva HJ; Marinho SMO, Silva AETM, Albuquerque CG, Moraes SRA, Manhães DCR. Protocol of measurement to evaluation of indicators of somatic development of wistar rats. Int J Morphol. 2005;23(3):227-230. DOI: org/10.4067/S0717-95022005000300006
14. Mashmoul M, Azlan A, Yusof BNM, Khaza'ai H, Mohtarrudin N, Boroushaki MT. Effects of saffron extract and crocin on anthropometric, nutritional parameters and lipid profile of rats fed a high-fat diet. J Function Foods. 2014;8:180-7. DOI: org/10.1016/j.jff.2014.03.017
15. Armani A, Mammi C, Marzolla V, Calanchini M, Antelmi A, Rosano GMC, et al. Cellular models for understanding adipogenesis, adipose dysfunction, and obesity. J Cell Biochem 2010;110:564-72. DOI: org/10.1002/jcb.22598
16. Elenga M, Tchimbakala MS, Nkokolo SA. Improving the nutritional quality of yam porridges and their efficacy in stock rats. J Appl Biosci. 2016;9819-28. DOI: org/10.4314/jab.v103i1.4

17. Koffi KA, Brice GJ, Alassane M, Kouakou B. Nutritional potential of the main traditional dishes regularly consumed in Côte d'Ivoire. World J Agric Res. 2019;7:56-60.
DOI: org/10.12691/wjar-7-2-3

18. Envin BJA, Ekissi ESG, Sea TB, Rougbo NP, Kouamé LP. Effects (*In vivo*) of the nutritional potential of snail meat Limicolaria Flammea (Müller) on wistar rats, CGC Biological and Pharmaceutical Sciences. 2020; 11(02):071-079.
DOI: org/10.30574/gscbps.2020.11.2.0108

19. Johnson AR, Wilkerson MD, Sampey BP, Troester M A, Hayes DN, Makowski L. Cafeteria diet-induced obesity causes oxidative damage in white adipose. Biochem Biophys Res Commun. 2016;473:545-50.
DOI: org/10.1016/j.bbrc.2016.03.113

20. Steve IO, Babatunde OI. Chemical compositions and nutritional properties of popcorn-based complementary foods supplemented with Moringa oleifera leaf flour. J Food Res. 2013;2:117.
DOI: org/10.5539/jfr.v2n6p117

21. Lenglet F. The process of food choice and its determinants: towards taking into account the psychological characteristics of the consumer. University of Savoie Institute of Management of the University of Savoie (IMUS) Institute for Research in Management and Economics (IREGE); 2016.

22. Friedman M. Nutritional value of protein from different food sources. A Review. J Agric Food Chem. 1996;44:6-29.
DOI: org/10.1021/jf9400167

23. Adrian J, Potus J, Poiffait A, Dauvillier P. Introduction to the nutritional analysis of foodstuffs: Biological methods on animals. Paris (France): Lavoisier. 1998;254.

24. Boisen S, Eggum BO. Critical evaluation of *In vitro* methods for estimating digestibility in simple-stomach animals. Nutr Res Rev. 1991;4:141-62.

25. Agyekum AK, N yacht CM. Nutritional and metabolic consequences of feeding pigs high fiber diets: A review. Engineering. 2017;3:716.
DOI: org/10.1016/J.ENG.2017.03.010

26. Ben SF. Characterization of the behavior of micronutrients of interest and antinutritional compounds in chickpeas and cowpea during processing (Montpellier, FRA). 2015;47.

27. Mughan PJ, Rutherfurd SM. Endogenous gut luminal proteins: Implications for the determination of ileal amino acid digestibility in humans. Br J Nutr. 2012;108:258-63.
DOI: org/10.1017/S0007114512002474

28. FAO (Food and Agriculture Organization). Evaluation of the quality of dietary proteins in human nutrition. Report of a FAQ expert consultation. flight. 92. Rome (Italy); 2013.

29. Bouafou KGM, Konan BA, Meité A, Kouame KG, Kati CS. Substitution of fish meal by dried maggot meal in the diet of growing rats: Pathological risks? Int. J. Biol. Chem. Science. 2011;5(3):1298-1303.

30. Deglaire A, Moughan PJ. Animal models for determining amino acid digestibility in humans – A review. Br J Nutr. 2012;108:15-6.
DOI: org/10.1017/S0007114512002346

31. Friedman M, Zahnley JC, Masters PM. Relationship between the in vitro digestibility of casein and its lysinoalanine and D-amino acid content. J Food Sci. 1981;46:127-34.
DOI: org/10.1111/j.1365-2621.1981.tb14545.x

32. Kamau EH, Serrem CA, Wamunga FW. Biological test on rats for the evaluation of the protein quality of soy-enriched complementary foods. J Food Res. 2017;6:35.
DOI: org/10.5539/jfr.v6n6p35

33. Kouakou EKV, Bouafou KGM, Meite A, Kouame KG, Kati-Coulibaly S. Commercial weaning meal ANAGOBAKA: What pathological risks in the diet of growing rats? Int J Biol Chem Sci 2016;10:167.
DOI: org/10.4314/ijbcs.v10i1.12

34. Disseka WK, Faulet MB, Ekissi ESG, Fagbohoun BJ, Kouame LP. Evaluation of the *In vivo* quality (wistar rats) of cereal flours enriched with sesame (*Sesamum indicum*) and moringa (*Moringa oleifera*) as a weaning food. Int J Innov Appl Stud. 2019;27:431-44.

35. Giami SY. Compositional and nutritional properties of newly developed selected lines of cowpea (*Vigna unguiculata* L. Walp). J Food Comp Anal. 2005;18:665-73.
DOI: org/10.1016/j.jfca.2004.06.007

36. Calder PC. Long-chain n-3 fatty acids and cardiovascular disease: Further evidence and insights. Nutr Res. 2004;24:761-72.
DOI: org/10.1016/j.nutres.2004.04.008

37. Moriyama T, Tsujioka S, Ohira T, Nonaka S, Ikeda H, Sugiura H, et al. Effects of reduced food intake on endpoints in toxicity studies in rats. J Toxicol Sci. 2008;33:537-47.
DOI: org/10.2131/jts.33.537