

## Analytical study of the nutritional performance of some traditional dishes consumed by the Senoufo people of the Korhogo region (northern Côte d'Ivoire)

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### Abstract

The aims of this study is to contribute to promote of local dishes from our cultural heritage and especially those coming from Korhogo where they meet Senoufo people. These dishes cooked, would be full of great nutritional potential. Rice and beans leaf sauce (tchonrom sauce), pounded yam and pistachio sauce (*pistachia vera*) then cabatoh (maize) and leaf of *Adansonia digitata* sauce (loh-min sauce) which contited base of practicing dishes of Senoufo people coming from northern of Côte d'Ivoire. Physico-chemical analysis, sowed respectively: Water content; Fsp: 70,86±0,252%, Rst: 75,233±0,252 and Csl: 86,25±0,050 fM. PH recorded for these different dishes are respectively acid Fsp: 5,88±0,006; Csl: 6,44±0,338 and Rst: 7,59±0,010. Proteins gave respectively Fsp: 25,90±0,030, Rst:13,65±0,095 and Csl: 22,78±0,095g/100gdM. Fats respectively Fsp: 24,60±0,000, Rst: 25,90±0,030 and Csl: 25,90±0,030g/100gdM. Total sugar is between 27,66±0,289 and 38,39±1,151% dM. highest level is observed with Rst (38,39% dM) and Fsp (29,68% dM). Lowest value is observed with Csl: 2,73±0,689 g/100gdM. Fibers of these traditional dishes is between 14,16±0,289 and 27,66±0,289 g/100gdM. Energy value of these dishes statistically different. Therefore these value are very close to recommendation by the FAO. These dishes are showed good level mineral. Thus, calcium is between 114,58 and 143,90; iron: 30,43 and 37,68 and magnesium: 45,25 and 146,74 mg/100 g dM. All mineral values observed are closed to FAO recommendations. In conclusion you that these traditional dishes could validly contribute to the well-being and the balance of their state to the general functioning of the organism.

**Keywords:** Local dishes; Côte d'Ivoire; Senoufo; Nutritional potential; Energy

### 1. Introduction

In developed countries, monitoring the quality of food is essential, as the forms of malnutrition are numerous and their consequences measurable in terms of human lives [1]. Indeed, undernutrition is currently one of the most worrying public health issues worldwide, and one that is generally prevalent in developing countries [2]. Undernutrition and deficiency-related diseases mainly affect children whose recommended energy intake must take into account the needs related to both energy expenditure and growth [3]. Adequate nutrition is an essential condition for the proper functioning of the body [4]. In epidemiology, they make it possible to study the relationships between diet and certain pathologies in order to identify the nutrients, foods or consumption profile that are beneficial or harmful to health. The clinical assessment of food intake is part of the therapeutic management of nutrition-related diseases [5]. In Côte d'Ivoire, several studies on food and nutrition have been conducted by certain authors [6;7]. This work focused on food vulnerability, the nutritional situation and the level of food security in Côte d'Ivoire. These studies have made it possible to identify the main nutrition problems in the country and the obstacles to increasing actions in favor of nutrition, among others, the insufficiency of health infrastructures, the program to fight against the high cost of living, poor food practices,

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low processing and storage capacity and poverty. However, these studies have not primarily evaluated the nutritional quality of the traditional dishes consumed by our populations. Malnutrition, whatever form it takes, results from poor diets, lack of knowledge and resources, and harmful environments, all of which have underlying causes [8]. Furthermore, the availability of food does not in itself guarantee satisfactory food security and nutrition at the community or household level [9].

Many regions in Côte d'Ivoire, Senoufo people of Korhogo regularly use traditional dishes such as cooked rice with tchonron sauce (rct), cabatoh with loh–min sauce (csl) and pounded yam with pistachio sauce (*Pistacia vera*) "Fsp". These three typical dishes are prepared with local products [10]. Food-related difficulties remain a concern and there are many causes. These are the more or less high costs, the scientific ignorance of the nutritional values of local dishes as well as the non-existence of a scientific database of knowledge of our diets [11;12]. However, elaboration of the nutritional profile of these traditional dishes would promote them and could be a useful database in the context of more selective food practices.

## 2. Materials and Methods

### 2.1 Biological material

Three dishes are used in this study. Rice cooked with beans leaf sauce (tchonrom sauce) (rct) whose main ingredients used are bean leaves and groundnut powder; cabatoh (maize) with leaf of *Adansonia digitata* sauce (loh-min sauce) (csl) whose main basic ingredients are dried baobab leaves and pounded yam with pistachio sauce (*Pistacia vera*) "Fsp" made from pistachio kernels.

### 2.2 Chemical equipment

Chemical equipment used for analyzes are composed sulfuric acid, boric acid, nitric acids, bases such as sodium hydroxide, colored indicators (phenolphthalein, mixture of methylene red, bromocresol green, the Patton Reader indicator and a Net indicator. Organic solvents as hexan and acetone. Reagents such as pH 10 ammonia buffer, 20 % ammonium acetate, 1 % hydroxylamine hydrochloride, orthophenanthroline, catalyst pellets (95 % K<sub>2</sub>SO<sub>4</sub> and 1.5 % CuSO<sub>4</sub> and 2 % Selenium). Finally, 5 % phenol according to the methods described by [13].

### 2.3 Methods

#### 2.3.1 Study area

This study is carried out Korhogo, located, in the north of Côte d'Ivoire. 635 km from Abidjan, capital of the Savannah Poro region. Limited to the north by Mali, to the west by Boundiali, Mankono and Katiola departments, the east by Ferkessedougou department. These regions have a Sudano-Guinean climate with two seasons [14]. A city of approximately 212,546 inhabitants, it is mainly made up of Senufo peoples (61 %), Malinké, Peulh, Hausa, etc allochthones and allogenes. Senufo people represented by sub-ethnic groups: Tagbambélés, Kassembélés, Kiambabélés, Kafibélé, Fodomon-kouflo, Gbonzoro [15], Malinkés 24 % and allochthones and allogenes 15 % [16].

#### 2.3.2 Physicochemical analysis

Dry matter was obtained using the [17]. Method is based on dehydration by drying in an oven (MEMMERT, Germany), set at 105 °C until a constant weight of the sample is obtained.

$$DM (\%) = \frac{(m_o + m_e) - m_1}{m_e}$$

Humidity is obtained by calculation

$$\text{Humidity} (\%) = 100 - DM$$

Titrate acidity is calculated by the [17]. It consists of measuring the total titratable (organic acid) of a product with a standard solution of sodium hydroxide (NaOH) at 0.1N. It is determined according to the formula:

$$\text{Acidity} = \frac{N \times 105}{P}$$

**P:** mass of the sample in grams

### 2.3.3 Evaluation of chemical parameters

Fat content is determined according to the soxhlet method [18]. Method consists of dissolving the fat in the food in the organic solvent (hexane) then recovering it after evaporation at 35°C of the latter. Entire oven is brought to 80 °C for 24 hours in order to eliminate all traces of hexane. Moreover, the total sugars are obtained by the phenol-sulfuric method according to the method described by [19]. Method based on the hydrolysis of glycosidic bonds of sugars in a hot acid medium for the formation of furfural derivatives. Proteins are obtained by the Kjeldahl method [13]. Determination of the protein content comes down to the determination of the total nitrogen of the sample. This method includes a mineralization phase, a distillation phase and a hydrochloric acid titration phase. The percentage of total nitrogen is given by the expression:

$$\%N = \frac{(V_e - V_b) \times 14,00 \times N \times 100 \times d \times f}{1000m}$$

**V<sub>e</sub>:** volume (ml) of hydrochloric acid solution (0.1) used for the sample.

**V<sub>b</sub>:** volume (ml) of hydrochloric acid solution (0.1) used for the blank

**N:** normality of hydrochloric acid used for the assay

**m:** mass (g) of the test sample

**d:** dilution applied 10×

**f:** determination factor (6.25)

Total carbohydrate content in the sample is obtained by the calculation method recommended [20].

$$\text{Total carbohydrates} = 100 - \% \text{ proteins} + \% \text{ lipids} + \% \text{ fibers} + \% \text{ cinders}$$

The fibers are obtained by the Wolf 1968 method. The crude fibers in grams per 100 grams of dry matter according to the formula:

$$\text{Crude Fibers} = \frac{m_2 - m_1}{m_0} \times 100$$

Energy value (E) of each diet is calculated by the method proposed by [21].

$$E = 4 \times \text{protein} + (4 \times \text{totals carbohydrate}) + (9 \times \text{lipids})(Kcal/100g)$$

### 2.3.4 Minerals determination

Ashes of the different samples are obtained after incineration at 550 °C in a muffle furnace for 5 hours. The ashes are thus prepared according to the [13]. Minerals determination is obtained by the method described by [21].

Calcium and magnesium are obtained by complexometry while iron by the orthophenanthroline method.

### 2.3.5 Processing and statistical analysis

Data processing was performed using Excel spreadsheet. Analysis of variance (ANOVA), with the statistical software (Graph pad Prism 8.02), was used to study the difference between variables.

In the event of a significant effect at the 5 % threshold, Turkey test was launched for classification of the means. Statistical differences with a probability value less than 0.05 were considered significant. When the probability is greater than 0.05, the statistical differences are not significant.

## 3. Results

### 3.1 Analysis of physico-chemical parameters

Analyses of physico-chemical parameters (pH, acidity, water, dry matter, ash) did not show a significant difference for pH. Other parameters as (acidity, water, dry matter, ash), there is a significant difference (P<.0,05).

**Table 1** Physico-chemical analyses of three (3) typical dishes of the Senoufo people per 100gDM

Characteristics	Fsp	Rst	Csl
Ph	5.88±0.006 <sup>a</sup>	7.59±0.01 <sup>a</sup>	6.44±0.338 <sup>a</sup>
1Acidity (meq/100g)	15±5.000 <sup>a</sup>	45±5.00 <sup>b</sup>	110±0.000 <sup>c</sup>
Water content	70.88±0.252 <sup>a</sup>	75.23±0.252 <sup>b</sup>	86.25±0.050 <sup>c</sup>
Dry matter	29.46±0.404 <sup>c</sup>	24.43±0.404 <sup>b</sup>	13.75±0.050 <sup>a</sup>
Cinders	5.50±0.500 <sup>a</sup>	10.03±0.153 <sup>b</sup>	8.26±0.252 <sup>b</sup>

Each value is the average of the analysis of three trials. Different letters (a, b, or c) on the same line indicate a statistical difference ( $p \leq 0.005$ ). dM: dry Matter, Fsp: Pounded yam and chicken pistachio sauce; Rst: Cooked rice and tchonron sauce and Csl: Cabatoh and loh-min sauce

### 3.2 Analysis of biochemical parameters

Biochemical parameters of dishes (fats, proteins, total carbohydrates) did not show a significant difference for all macronutrient values dosed in these different dishes. ( $P < 0,05$ ).

**Table 2** Biochemical parameters of typical dishes of the *Senoufo* people per 100gDM

Characteristics	Fsp 100 gDM	Rst 100 gDM	Csl 100 gDM
Lipids	24.60±0.00 <sup>c</sup>	22.88±0.200 <sup>b</sup>	4.90±0.100 <sup>a</sup>
Protéins	25.97±0.030 <sup>c</sup>	13.65±0.095 <sup>a</sup>	22.78±0.095 <sup>b</sup>
Total carbohydrate	29.68±0.280 <sup>a</sup>	38.39±0.055 <sup>b</sup>	36.81±0.815 <sup>b</sup>
Total sugar	16.21±1.151 <sup>c</sup>	6.443±0.338 <sup>b</sup>	2.73±0.689 <sup>a</sup>
Fiber	14.16±0.289 <sup>a</sup>	16.16±0.289 <sup>a</sup>	27.66±0.289 <sup>b</sup>
E (Kcal)	444±1.000 <sup>c</sup>	406.20±1.200 <sup>b</sup>	282.50±2.500 <sup>a</sup>

Each value is the average of the analysis of three trials. Different letters (a, b, or c) on the same line indicate a statistical difference ( $p \leq 0.005$ ). dM: dry Matter; Fsp: Pounded yam and chicken pistachio sauce; Rst: Cooked rice and tchonron sauce and Csl: Cabatoh and loh-min sauce.

### 3.3 Characteristics of micronutrients in traditional dishes

Mineral analyses (Magnesium, Calcium, Iron) did not show a significant difference for all the micronutrient values dosed in these different dishes ( $P < 0.05$ ) with however very significant contents were observed.

**Table 3** Mineral content of typical dishes of the Senoufo people per 100gDM

Characteristics	Fsp mg/100 g	Rst mg/100 g	Csl mg/100 g
Magnesium (mg)	45.27±0.335 <sup>a</sup>	136.12±0.36 <sup>b</sup>	164.74±1.593 <sup>c</sup>
Calcium (mg)	114.580±1.043 <sup>a</sup>	146.13±1.00 <sup>b</sup>	143.90±1.845 <sup>b</sup>
Fer (mg)	35.87±0.094 <sup>b</sup>	37.68±1.396 <sup>b</sup>	30.43±0.741 <sup>a</sup>

Each value is the average of the analysis of three trials. Different letters (a, b, or c) on the same line indicate a statistical difference ( $p \leq 0.005$ ). dM: dry Matter; Fsp: Pounded yam and chicken pistachio sauce; rst: Cooked rice and tchonron sauce and Csl: Cabatoh and loh-min sauce.

## 4. Discussion

Traditional dishes made; Rice cooked with tchonrom sauce vegetables pounded yam kponan pistachio sauce and cabatoh with loh-min sauce are usually made up of water, carbohydrates, protein, fat and minerals. These results corroborate the work done by [22]. However, the proportions of the different nutrients obtained vary from one dish to another. Ingredients used to make these different basic dishes vary. Nutritional value of these dishes cannot be determined otherwise than by determining the physico-chemical and biochemical characteristics. Physico-chemical parameters studied showed the respective water contents; Fsp (70.86±0.252), rst (75.233±0.252) and Csl

(86.25±0.050). All these values remain high and induced by the quantities of water used during the preparation of these different dishes.

Furthermore, the water content recorded in these different dishes studied would be useful for the consumer, according to [23]. Water is essential for our well-being and constitutes 90 % of our body mass.

In addition, it would be essential for the transport of nutrients, hormones and enzymes in the blood. Thus it provides essential nutrients for the proper functioning of the body, regulates body temperature and eliminates waste while contributing to the proper functioning of the body. However, this high water content, would promote the development of bacteria unsuitable for consumption after poor storage of these dishes. pH recorded for these different dishes is respectively acid Fsp (5.88±0.006), Csl (6.44±0.338) and Rst (7.59±0.010). Rice cooked with tchonron sauce with a pH level that is favorable to the body because according to [24], the body's pH is between 7.2 and 7.8. Thus this dish could be recommended in order to maintain the stability of the pH of the organism. These pH values obtained would be induced by the specific ingredients provided for the preparation of these different dishes. Just like titratable acid which varies from 15±5.00 to 110±0.00 meq/100gdM. Proteins obtained give respectively Fsp (25.90±0.030 g/100gdM), Rst (13.65±0.095 g/100gdM) and Csl (22.78±0.095 g/100gdM). These values obtained are higher than those observed by [25]. This could be explained by the different choice of dishes and the drying method used in the dosage of these nutrients because [26] used the freeze-drying method. Values obtained show that the three dishes are good sources of protein. [27] suggest that the essential nutrients for the harmonious growth of the organism are proteins as well as minerals. The fats obtained are respectively Fsp (24.60±0.000% dM), Rst (25.90±0.030% dM) and Csl (25.90±0.030% dM). These values are higher than those obtained by [28]. For studied traditional dishes. These high levels obtained would be the consequence of the richness in lipids of the ingredients used for the preparation of these dishes. However the Fsp is the richest dish in lipid this would be due to the presence of pistachio in the preparation of this dish. The level of fat in this plant is 44g [29]. Total sugar values are between 2.73±0.689 and 16.21±1.151% dM. The highest value (16.21±1.151% dM) is observed with Fsp (29.68% dM), rst (38.39% dM), and the lowest value is observed with dish Csl (2.73±0.689% dM). Thus these dishes studied would be a good source of carbohydrate according to [30]. High total carbohydrate content induces high energy value and is essential for the proper functioning of muscles and the brain [31; 32]. All these dishes could contribute to food security and help to avoid the metabolic diseases observed in our contemporary societies.

Energy values obtained for these different traditional dishes are the direct consequence of their high proportion of nutrients such as lipids and carbohydrates. Different energy values observed reflect the energy that these foods could bring to the body after a meal.

Thus these could ensure the proper functioning of the body [33]. [34] revealed that energy intake would vary according to the weight, sex, age, height and level of physical activity of the individual.

The fiber potential of these traditional dishes is between 14.16±0.289% dM and 27.66±0.289% dM. The fibers are very important and would facilitate intestinal transit, moreover, they prevent many constipations. According to [35] fiber would be beneficial to the health of consumers and would facilitate the digestion of food in the colon. The Cls is the dish richest in fiber with 27.66±0.89% dM, and this can be explained by the use of maize rich in fiber for the manufacture of flour in the preparation of cabatoh. The ashes of these dishes are between 5.50±and 10.03% dM. these dishes are good sources of minerals, both calcium and magnesium because they come from the ashes, mineral parts of organic matter. The level of calcium is between 114.58 and 146.13mg/100gdM, iron between 30.43 and 37.68mg/100gdM and magnesium between 45.25 and 146.74mg/100gdM. All these mineral values observed are close to the recommendations of the [36] and could be used in the diet of children from 4 to 6 years old in order to cover their recommended nutritional needs. Calcium would cover these same needs for children for values between 600 and 700mg/day [37].

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## 5. Conclusion

Dishes Senoufo people consist of two pieces of food generally. These traditional diets are cooked rice with *tchonron* sauce (Rct), cabatoh with loh–min sauce (Csl) and pounded yam with pistachio sauce (*Pistacia vera*) “Fsp”. All these dishes come from plant and animal products found either on the markets or in the forests as (spontaneous food plants). In addition, these diets prove to be a good supplier of essential nutrients. Especially of the high levelly of nutrients obtained through the dishes compared to FAO recommendation. In addition, the levels of acid in these dishes is very favorable to contribute of good functioning of body. These traditional diets would be benefit from being popularized in a specific way in the context to fight against malnutrition then also in strengthening of the nutritional status of individuals confronted with these numerous non-communicable nutritional diseases.

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## Compliance with ethical standards

### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

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