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# Comparison of Chronic Wound Inpatients and Outpatients' Diets and Meals Nutrient Content in Taabo Wound Management Unit, Côte d'Ivoire

**Didier Y. Koffi[1,2,3*], Amoin Georgette Konan[1,2], Evans Ehouman[4], Bassirou Bonfoh[2]**

[1]Unité de Formation et de Recherche en Biosciences, Université Félix Houphouët-Boigny (UFHB), Abidjan, Côte d'Ivoire
[2]Centre Suisse de Recherches Scientifiques en Côte d'Ivoire (CSRS), Abidjan, Côte d'Ivoire
[3]Programme National de Lutte Contre l'Ulcère de Buruli (PNLUB), Abidjan, Côte d'Ivoire
[4]Université Nangui Abrogoua (UNA), UFR Sciences de la Nature, Abidjan, Côte d'Ivoire

Email: *didier.koffi@csrs.ci

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## Abstract

Chronic and potential non-healing wounds are a great challenge for patients, physicians, and wound care professionals and the health system. A balanced nutrition intake is essential for health as well as a speedy recovery of such wounds. The study objective was to compare chronic wound inpatients supplemented with food nutrient content with outpatients with their usual intake in a cross-sectional study. Patients' food samples were taken for chemical analyses. The protein, beta-carotene, sodium, magnesium, manganese, and potassium content prove statistically significant differences. Outpatients' diets are more diversified than inpatients' diets, and supplementation diet richest in beta-carotene and in protein. Outpatients have better dietary diversity than those who were hospitalized. The result provides insights of supplementary food as critical issues pertaining to chronic wounds management. However, analyzing bioavailability of nutrient on patients' blood may provide more knowledge in the appropriate integrated wound management.

## Keywords

Chronic Wound, Biochemistry, Nutrient Content, Wound Management, Côte d'Ivoire

## 1. Introduction

Chronic non-healing wounds tender a great challenge to patients, physicians, and wound care professionals [1]. In view of the increasing prevalence of chronic wounds due to traumatism, diabetic foot, venous, pressure ulcers, and tropical neglected diseases, their appropriate management requires significant attention [2]. Along with the basic techniques of medical, surgical treatments, and dressing; an ideal nutrition intake is essential for a speedy recovery and rapid healing of such wounds [3].

In low- and middle-income countries, nutritional problems are common in poor people whose diets are primarily based on starchy foods and plants [4]. Nutrition is a critical factor in modulating immune homeostasis and thereby the outcome of host microbe interactions. Micronutrient deficiencies produce a wide spectrum of effects ranging from clinical disorders due to severe deficiency to subtle functional impairment in subclinical deficiencies which could, nevertheless, significantly influence the health and survival of the population [5]. It is now well established that besides protein and energy malnutrition, deficiencies of several micronutrients downregulate immune responsiveness and increase morbidity and mortality due to infections particularly, among children residing in developing countries [5]. As a confounding factor, poor nutritional status of patients due to chronic malnutrition complicates and prolongs healing times of any ulceration [6]. The underlying mechanism is that patients with poor diet cannot fulfil the increased protein requirements for metabolic fuel, adding to the impaired hormonal and cellular immunity triggered by the wound [7]. This causes a double burden, further compromising wound healing of the patient [8].

Nutrition seems to be is one of the most basic of medical issues and is often ignored as a problem in the management of our chronic wound patients [9]. Unfortunately, malnutrition is widespread in our chronic wound patients in low- and middle-income countries [10]. This malnutrition stems from poor diet quality dominated by energy foods, with a low intake of protein and fruits and vegetable [11]. The other reason why this particular attention to nutritional composition takes on its importance is the food prohibitions suffered by patients suffering from chronic wounds [12]. Patients are therefore left with a diet devoid of several essential foods to compensate for their nutritional deficits, but also to provide them with the adequate nutrients for the rapid healing of ulceration [13]. In this context, it is therefore quite advisable to look at the nutritional composition of the diet of patients with chronic wounds throughout treatment. This article compares the nutritional composition of the diet of chronic wound inpatients and outpatients treated both in hospital intended to fill nutrients gaps and promote more accelerated healing. This paper provides key insights into food nutritional composition of chronic wound patient diet in Taabo, and critical issues pertaining to chronic wounds and their management. It also summarizes the challenges faced for chronic wound treatment and specified factors responsible for delayed healing.

## 2. Material and Methods

### 2.1. Study Design

Food nutrient content of chronic wounds patients' diet were evaluated in a cross-sectional study within the framework of a wound management study carried out from May 2019 to March 2021 in Ahondo health center and in the Buruli ulcer unit in Taabo [14]. Ahondo and Taabo are, in the health and demographic surveillance system (HDSS), composed of a small town, 13 villages, and over 100 hamlets. At the end of 2020, the total population was 49,000 inhabitants living in 6707 households. The Taabo department is characterized by crop production, which is the main socio-professional activity, and secondarily livestock activities. Most of the inhabitants are illiterate (72%) [15]. The population is young, as seen in most low- and middle-income countries (LMICs), and 45.5% are children under 15 years old [15]. Patients Food was collected and analyzed all along the treatment. This analysis concerned both the food consumed by the patients at home as well as the food consumed in the hospital for those who were hospitalized. In addition to that, the food analysis also considered soy-enriched dishes and orange-fleshed sweet potato dishes. This supplementary food was supposed to improve patient nutritional status and enhance wound healing rate [14].

## 2.2. Dietary Assessment

A survey on eating habits was conducted through food frequency questionnaire. Then, to monitor diet during treatment, a 24 h Recall proxy method was done at baseline and then on non-consecutive days separated by at least 2 weeks during the visit to the health center or during dressings for patients hospitalized in hospital [16]. We asked patients to recall all food eaten and beverages taken in the previous twenty-four hours prior to the interview.

## 2.3. Dietary Diversity and Selected Nutrient

The individual dietary diversity score was calculated according to FAO guides [17]. This score corresponds to the number of food groups consumed the day before the survey. Next, the state of dietary diversity was determined according to the following two indicators: 1) minimum dietary diversification: corresponding to the proportion of participants who consumed at least 5 out of 10 food groups.; 2) the level of dietary diversification, which consisted of grouping the diversity scores of the different targets into three classes: low, medium, and high, and then calculating the proportions of individuals in each class. The different classes have been defined as follows 1) low dietary diversity score: 0 to 4 food groups consumed; 2) medium dietary diversity score: 5 food groups consumed; 3) high dietary diversity score: 6 to 10 food groups consumed.

The following 8 nutrients were selected: lipids, proteins, carbohydrate, total sugars and reducing sugars, crude fiber, and mineral content of the different dishes, plus energy.

## 2.4. Biochemical Analysis

Food samples from the patients' normal diet and from supplementary food were taken and then stored at minus 20˚C. Then, the collected samples were freeze-dried to be subjected to the various analyses.

#### 2.4.1. Fat Content

The determination of the lipid content was carried out by the Soxhlet extraction method according to the AOAC standard (2000). Equation (1) is Fat content determination. It was calculated as a percentage of fat per gram per 100 grams of dry matter according to the formula:

$$\begin{aligned} &100 \text{ grams of dry matter} \\ &= \frac{(\text{balloon mass} + \text{fat matter}) - \text{mass of empty balloon}}{\text{masse ballon} + \text{test}} \times 100 \end{aligned} \quad (1)$$

#### 2.4.2. Crude Protein Content

Crude protein content was determined by the Kjeldahl method (AOAC, 2000) [18]

$$\text{Total protein}(\text{g}/100\,\text{g}) = \frac{(\text{V1} - \text{V0}) \times 14 \times 6.25}{10 \times \text{me}} \quad (2)$$

"Equation (2) is protein crude determination.

V0: volume (mL) of sulfuric acid solution (0, 1, N) used for blank testing.

V1: volume (mL) of sulfuric acid solution (0, 1, N) used for the test (sample).

Me: mass (g) of the powder sample.

#### 2.4.3. Fiber Content

Fiber levels were determined using the AOAC (2000) method [19].

$$\text{gross fibre} = \frac{\text{m1} - \text{m2}}{\text{me}} \times 100 \quad (3)$$

"Equation (3) is:

me: mass (g) of the sample taken.

m1: mass (g) of the residue obtained after filtration and drying.

m2: mass (g) of ash from incineration.

MS: Dry Matter.

#### 2.4.4. Total Carbohydrate Content

The total carbohydrate (GT) content, expressed in grams per 100 grams of sample, is given by Equation (4)

$$\text{Total carbohydrate \%} = 100 - (\text{Humidity \%} + \text{Protein \%} + \text{Lipids \%} + \text{Ashes \%}) \quad (4)$$

#### 2.4.5. Energy Value Determination

The energy value of food was obtained by multiplying the content of each macronutrient by the corresponding ATWATER index (AFNOR, 1989) defined as the metabolizable energy in kilocalories of 1 g of nutrient, whose correspondences are as follows:

1 g of protein provides 4 kcal.

1 g of carbohydrates provides 4 kcal.

1 g of fat provides 9 kcal.

The overall energy value of a food is obtained from Equation (5) which is the sum of the metabolizable energies of the carbohydrate, lipid, and protein components

$$\text{EV} = (\text{Protein} \times 4) + (\text{Carbohydrates} \times 4) + (\text{Fat} \times 9) \quad (5)$$

#### 2.4.6. Carbohydrate Extraction and Dosing Principle

It consisted of the extraction of free sugars from plant sources by ethanol and then the quantitative determination of reducing sugars by the dinitro salicylic acid (DNA) method and total sugars by the phenol-sulphuric method.

#### 2.4.7. Reducing Sugar Content

1. The content of reducing sugars was obtained by the Bernfeld method (1955) using 3,5-dinitrosalycilic acid (DNS) after extraction with 80% ethanol. The concentration of reducing sugars was determined using a calibration line DO = f [Concentration of reducing sugars], based on a range of (standard) glucose solutions. The content (T) of reducing sugars (g/100g DM) was calculated as in the case of total sugars.

#### 2.4.8. Total Sugar Content

The total sugar content was determined by the method of Dubois *et al.* (1956) after extraction in 80% ethanol. For this purpose, the extract was treated with phenol (5%, w/v) and concentrated sulfuric acid to determine the concentration of total sugars using a calibration line DO = f [Total sugar concentration], constructed from a range of sucrose solutions (standard). The total sugar content ($T$) (g/100g DM) was calculated using the "Equation (6):

$$T = \frac{50 * c * d * 100 * 0.001}{p(\text{g})} = \frac{5 * c * d}{p(\text{g})} \quad (6)$$

With:

$d$ = dilution (if necessary).

$C$ = sugar concentration in the sample.

$P$ = mass of the sample.

#### 2.4.9. Determination of Minerals

The minerals were analyzed by the X-ray fluorescence method using a MESA-50 X-ray fluorescence spectrometer. The principle of this method is based on the analysis of the radiation that will emit a sample that has been excited by X-rays. The detection limit of this X-ray fluorescence spectrometer (SFX) is 0.00002 ppm.

### 2.5. Statistical Analysis

The data entered in Kobo collect was transferred and processed with Microsoft Excel [20] to check for missing values. The final database was exported to in the R data analysis software to be analyzed and visualized with the basic function "glm" and the package "lmtest" [21]. Multiple match analysis (MCA) was performed to summarize the data and allow multiple categorical variables to be visualized in a single dimension (the Kruskal-Wallis's test was performed for more than two groups and the significance level was set at $P < 0.05$) [22].

## 3. Results

Of the 68 patients enrolled in the study, 40 were inpatients and 28 were treated as outpatients. For supplementation, 49 received complementary food composed of orange flesh sweet potatoes frites and soy-enriched dishes. The remaining 19 patients did not receive the supplementary foods but continue with their normal diet.

### 3.1. Food Groups Consumption

Of the outpatients enrolled in the study, the majority adhere to the three main daily meals; 76% eat breakfast every day, 69% eat lunch and 79% eat dinner. For intermediate meals such as snacks, barely a third of patients take the time to observe it, 29% of them have a snack at 10 a.m. A small proportion (4.4%) of patients eat an extra meal the night after dinner. As for the foods consumed, they are mainly dominated for the main meals of vegetables for sauces, protein dominated by fish and cereals mainly rice and wheat for bread. Breakfast is most often left over from the day before or bread accompanied by hot milk. Then come starchy foods dominated by tubers and plantain. Fruit is almost not eaten, as less than 10% consume it (**Table 1**).

For inpatients, their habits are modelled on food they could get. Most of them adhere to the three main meals of the day: breakfast, lunch and dinner, at 81%, 71% and 81% respectively. Barely a quarter of them take the snack. However, no inpatients eat meals at night after dinner. The main foods consumed by inpatients at their main meals are dominated by cereals, mainly rice and wheat, by vegetables for sauces, and proteins largely from fish. Then there are starchy

**Table 1.** Distribution of outpatients by food group consumption.

| Food groups | Meals | | | | | |
|---|---|---|---|---|---|---|
| | **Breakfast** | **Snack** | **Lunch** | **Snack** | **Diner** | **Night** |
| Non-consumed (%) | 24 | 71 | 31 | 78 | 21 | 96 |
| Consumed (%) | 76 | 29 | 69 | 22 | 79 | 4 |
| Salt, sugar and salty and sweet products (%) | 10 | 3 | 0 | 3 | 1 | 0 |
| Fat (%) | 0 | 0 | 0 | 0 | 0 | 0 |
| Meat, fish, eggs, and legumes (%) | 51 | 22 | 56 | 9 | 71 | 4 |
| Milk and diary (%) | 53 | 0 | 0 | 2 | 2 | 0 |
| Starchy foods and derivatives (%) | 38 | 12 | 35 | 7 | 40 | 1 |
| Fruits and vegetables (%) | 32 | 11 | 32 | 9 | 43 | 2 |
| Drink (%) | 6 | 3 | 3 | 0 | 0 | 0 |

foods, mainly tubers and plantain. Just like outpatients, almost none of them eat fruit (Table 2).

### 3.2. Dietary Diversity

From these results it clear that outpatients have a better food diversity score than inpatients, 61% of outpatients have a higher dietary diversity score (Table 3) while inpatients have 67% with lower dietary diversity score (Table 4).

### 3.3. Nutritional Properties of Dishes

The results of the biochemical analysis of these dishes are reported in Table 1 for outpatients and Table II for inpatients.

**Table 2.** Distribution of inpatients consumption of food groups.

| Food groups | Meals | | | | | |
|---|---|---|---|---|---|---|
| | Breakfast | Snack | Lunch | Snack | Diner | Night |
| Non-consumed (%) | 19 | 76 | 29 | 81 | 19 | 100 |
| Consumed (%) | 81 | 24 | 71 | 19 | 81 | 0 |
| Salt, sugar and salty and sweet products (%) | 5 | 0 | 0 | 5 | 0 | 0 |
| Fat (%) | 0 | 0 | 0 | 0 | 0 | 0 |
| Meat, fish, eggs, and legumes (%) | 62 | 9 | 28 | 2 | 33 | 0 |
| Milk and diary (%) | 2 | 0 | 0 | 0 | 0 | 0 |
| Starchy foods and derivatives (%) | 40 | 9 | 36 | 7 | 67 | 0 |
| Fruits and vegetables (%) | 28 | 9 | 38 | 7 | 52 | 0 |
| Drink (%) | 9 | 2 | 0 | 0 | 0 | 0 |

**Table 3.** Dietary diversity score of outpatients.

| Food diversity score | Distribution of outpatients | |
|---|---|---|
| | Number | Percentage |
| Low | 1 | 3.57 |
| Medium | 10 | 35.72 |
| High | 17 | 60.71 |

**Table 4.** Dietary diversity score of inpatients.

| Food diversity score | Distribution of inpatients | |
|---|---|---|
| | Number | Percentage |
| Low | 27 | 67.5 |
| Medium | 4 | 10 |
| High | 9 | 22.5 |

#### 3.3.1. Outpatients' Diet

The diet is dominated by cereals mainly rice for 62% and starchy foods such as yam for 24% and cassava for 9.5 % and beans for 5%. Fish is the most consumed animal protein present in all outpatient dishes 94% and beef meet for 6%. There is, however, a diversity of sauces consumed ranging from eggplant sauce, okra, peanuts, to palm seed and green leaves. In terms of nutritional properties, the dishes are mostly very energetic with a value ranging from 265.9 to 482 kcal and rich in total sugar with a content ranging from 0.5 to 9.7 g/100g DM. They are moderately rich in water with a concentration of 15 - 49 g/100g DM. These dishes are low in protein, with a content ranging from 0.4 to 2.28 g/100g DM of protein. At the lipid level, the content of the dishes varies from 0.25 to 41 g/100g DM of fat. At the carbohydrate level, the dishes have a hyper-carbohydrate content with a concentration ranging from 21 to 89 g/100g DM of carbohydrates. However, these dishes are rich in crude fiber ranging from 0.85 to 7 g/100g DM of fiber (**Table 5**).

#### 3.3.2. Inpatients' Diet

The dishes of patients in hospitalization are dominated by cereals in majority rice which is 67% of food consumed by inpatients followed by maize and cassava for 17% each. Fish remains the only animal protein consumed by hospitalized patients. The sauces are dominated by dried okra and peanuts. In terms of nutritional properties, the dishes are mostly very energetic with a value ranging from 100 to 361.58 kcal and rich in total sugar with a content ranging from 0.50 to 7.60 g/100g DM. They are moderately rich in water with a concentration of 15 - 49 mg/100g DM. These dishes are low in protein, with a content ranging from 0.7 to 2.2 mg/100g DM of protein. At the lipid level, the content of the dishes varies from 0.07 to 0.21 g/100g DM of fat. At the carbohydrate level, the dishes have a hyper-carbohydrate content with a concentration of up to 71.5 g/100g DM of carbohydrates. However, these dishes are rich in crude fiber ranging from 0.8 to 4.7 mg/100g DM of fiber (**Table 6**).

#### 3.3.3. Supplementation Dishes

A sample of the supplementation foods was also taken for biochemical analysis. These are 10 samples of orange-fleshed sweet potato (OFSP) fries and 10 samples of soy corn toh (*corn paste*). The results of chemical analyses of supplementary foods are recorded in **Table 7**. OFSP fries total sugars content was 9.9 g/100g DM compared to 3.6 g/100g DM for soybean toh with corn. OFSP fries are rich in water with a concentration of 52 mg/100g DM. At the macronutrient level, protein content ranging from 0.78 mg/100g DM for toh enriched with soy and 0.08 mg/100g DM for OFSP fries. At the lipid level, the fat content range from 22 mg/100g DM for OFSP fries and 2 mg/100g DM for soy toh. At the carbohydrate level, soy enriched corn toh has 75 mg/100g DM of carbohydrates and 30 mg/100g DM of carbohydrate for OFSP fries. The crude fiber with a concentration of about 5 mg/100g DM fiber was similar in the two dishes. The determination of total minerals in the different dishes including supplementation dishes consumed by patients suffering from chronic wounds allowed an analysis of the composition of the dishes in phosphorus (P), potassium (K), calcium (Ca), manganese (Mn), iron (Fe), zinc (Zn), molybdenum (Mo), magnesium (Mg) and sodium (Na) (Table 8 and Table 9).

**Table 5.** Energy value and nutrients content of the dishes consumed by the outpatients treated in the study.

| Meals | Energy and nutrients | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Energy value** kcal/100 g DM[a] | **Humidity** g/100g FM[b] | **Total Protein** g/100g DM | **Fat** (g/100g DM) | **Digestive carbohydrate** g/100g DM | **Reducing sugars** g/100g DM | **Total sugars** g/100g DM | **Crude fibres** g/100g DM | **Ashes** g/100g DM |
| White-rice-dry okra-sauce-fish | 341.62 | 26.53 | 0.55 | 13.86 | 53.67 | 0.03 | 0.8 | 2.66 | 5.39 |
| Rice-beans and meat | 265.98 | 32.15 | 1.18 | 3.5 | 57.44 | 0.01 | 1.6 | 5.30 | 5.73 |
| Pounded yam-dry okra sauce-fish | 482.15 | 24.89 | 0.54 | 13.75 | 89.06 | 0.02 | 2.2 | 7.88 | 28.24 |
| Pounded yam-eggplant sauce-fish | 309.18 | 22.75 | 0.48 | 3.5 | 68.94 | 0.2 | 2.2 | 4.81 | 4.33 |
| White-rice-peanuts sauce-fish | 354.48 | 31.05 | 0.87 | 18 | 47.25 | 0.01 | 3.9 | 2.55 | 2.83 |
| Placali-palm seed dry okra sauce-fish | 334.33 | 20.15 | 0.87 | 7.25 | 66.4 | 0.03 | 0.5 | 3.45 | 5.33 |
| Boiled yam-oil | 342.26 | 28.77 | 0.47 | 14.38 | 52.74 | 0.03 | 1.9 | 6.2 | 3.64 |
| White Rice-okra-eggplant sauce-fish | 302.85 | 34.67 | 0.68 | 10.17 | 52.15 | 0.02 | 2.4 | 1.09 | 2.33 |
| White-rice-peanuts sauce-fish | 463.05 | 29.51 | 1.03 | 41.25 | 21.92 | 0.4 | 3 | 3.61 | 6.29 |
| White-rice-eggplant sauce-fish | 297.28 | 28.12 | 0.4 | 5 | 62.67 | 0.3 | 0.7 | 2.79 | 3.81 |
| White-rice-palm seed dry okra sauce-fish | 275.92 | 43.35 | 0.7 | 12 | 41.28 | 0.04 | 0.5 | 2 | 2.67 |
| White Rice-okra-eggplant sauce-fish | 333.98 | 25.05 | 2.28 | 11.5 | 55.34 | 0.07 | 4.1 | 2.96 | 5.83 |
| Rice-leaves-sauce-fish | 367.8 | 32.55 | 0.44 | 22 | 42.01 | 0.07 | 2.12 | 4.54 | 3 |
| Attiéké-fish | 331.97 | 13.65 | 0.44 | 0.25 | 81.99 | 0.06 | 2.9 | 2.70 | 3.67 |
| Boiled yam | - | 31.03 | - | 22.5 | - | 0.1 | 0.7 | 6.66 | 4.61 |
| Pounded yam-okra sauce-fish | - | 13.15 | - | 11.25 | - | 0.09 | 0.7 | 6.31 | 10.16 |
| White Rice-leaves-sauce-fish | - | 13.15 | - | 19.13 | - | 0.1 | 6.4 | 4.76 | 29.75 |
| White Rice-eggplant-sauce-fish | - | 25.9 | - | 13 | - | 0.03 | 9.7 | 0.88 | 17.16 |
| White Rice-dry okra-sauce-fish | - | 30.2 | - | 17.25 | - | 0.01 | 1.7 | 4.84 | 4.165 |
| White Rice-leaves-sauce-fish | - | 22.2 | - | 11.5 | - | 0.09 | 5.2 | 3.07 | 3.67 |

a: DM (dried matter); b: FM (Fresh matter).

**Table 6.** Nutrients content of the dishes consumed by inpatients in the study.

| Meals | Energy and nutrients | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Energy value kcal/100 g DM[a] | Humidity g/100g FM[b] | Total Protein g/100g DM | Fat (g/100g DM) | Digestive carbohydrate g/100g DM | Reducing sugars g/100g DM | Total sugars g/100g DM | Crude fibres g/100g DM | Ashes g/100g DM |
| White-rice-dry okra-sauce-fish | 361.58 | 15.1 | 1.13 | 8 | 71.26 | 0.02 | 0.6 | 3.64 | 4.5 |
| Maize toh-dry okra-sauce-fish | 355.55 | 16.05 | 2.23 | 6.75 | 71.47 | 0.07 | 1.4 | 3.93 | 3.5 |
| Attiéké-fish | 236.74 | 49.73 | 0.68 | 7.88 | 40.95 | 0.04 | 7.6 | 4.34 | 0.75 |
| Fried rice-fish | 330.79 | 31.04 | 0.96 | 13.79 | 50.71 | 0.06 | 0.4 | 0.85 | 3.5 |
| Rice-leaves-sauce-fish | 100 | 30.75 | 0.74 | 21 | 22.99 | 0.06 | 1.2 | 4.72 | 70.5 |
| Rice-peanuts sauce-fish | 326.38 | 24.91 | 0.83 | 8.5 | 61.64 | 0.06 | 0.5 | 3.60 | 4.12 |

a: DM (dried matter); b: FM (Fresh matter).

**Table 7.** Biochemical composition of supplementation dishes.

| Meals | Energy and nutrients | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Energy value kcal/100g DM[a] | Humidity g/100g FM[b] | Total Protein g/100g DM | Fat (g/100g DM) | Digestive carbohydrate g/100g DM | Reducing sugars g/100g DM | Total sugars g/100g DM | Crude fibres g/100g DM | Ashes g/100g DM |
| OFSP Fries | 34.36 | 0.78 | 12.41 | 55.92 | 0.13 | 5.5 | 4.47 | 2.8 | 34.36 |
| Soy enriched toh | 22.80 | 0.78 | 2.5 | 75.13 | 0.2 | 3.6 | 4.75 | 1.16 | 22.80 |
| Basic diet | 28.45 | 0.56 | 12.50 | 62.45 | 0.09 | 3.1 | 3.73 | 3.66 | 28.45 |

a: DM (dried matter); b: FM (Fresh matter).

**Table 8.** Mineral content of inpatients' diet meals.

| Meals | Mineral (ppm) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | P | K | Ca | Mn | Fe | Zn | Mo | Mg | Na |
| Rice fish dried okra-sauce | 2.66 | 4.27 | 3.05 | 0.03 | 0.12 | 0.04 | 0.02 | 11.56 | 15.32 |
| Kabato-fish dried okra sauce | 1.37 | 7.66 | 3.00 | 0.01 | 0.17 | 0.02 | 0.01 | 18.26 | 21.55 |
| Attiéké-fish | 2.01 | 11.07 | 3.66 | 0.01 | 0.17 | 0.02 | 0.02 | 17.38 | 22.37 |
| Rice fish Namoukoun-sauce | 2.4 | 5.04 | 3.63 | 0.01 | 0.13 | 0.01 | 0.03 | 12.17 | 15.28 |
| OFSP fries | 4.85 | 13.82 | 7.23 | 0.03 | 0.24 | 0.35 | 0.02 | 14.2 | 15.3 |

In terms of phosphorus, rice accompanied by beans and beef has the highest content found in outpatients' diet, followed by orange-fleshed sweet potato fries accompanied by fried tomato with fish and pounded yam with okra sauce with fish in outpatients' diet. In terms of potassium, it is the pounded yam with fish dried okra sauce in outpatients' diet, then the sweet potato fries with orange

**Table 9.** Mineral content of outpatients' diet meals.

| Meals | Mineral (ppm) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | P | K | Ca | Mn | Fe | Zn | Mo | Mg | Na |
| Bean meat rice | 5.05 | 12.96 | 2.16 | 0.04 | 0.23 | 0.06 | 0.04 | 9.19 | 16.89 |
| Pounded yam-fish dried okra-sauce | 2.66 | 14.26 | 5.13 | 0.01 | 0.24 | 0.03 | 0.04 | 10.95 | 15.42 |
| Pounded yam-fish eggplant sauce | 2 | 11.01 | 1.85 | 0 | 0.14 | 0.02 | 0.03 | 11.84 | 15.95 |
| Rice fish peanuts sauce | 3.74 | 4.59 | 1.38 | 0.07 | 0.23 | 0.07 | 0.01 | 12.66 | 17.1 |
| Placali-fish dried okra palm sauce | 2.08 | 10.92 | 4.76 | 0.01 | 0.19 | 0.02 | 0.01 | 18.60 | 23.77 |
| Rice-fish gouagouassou sauce | 2.15 | 6.4 | 1.76 | 0.03 | 0.17 | 0.06 | 0.03 | 12.24 | 16.9 |
| Rice-fish eggplant sauce | 3.16 | 5.12 | 3.2 | 0.03 | 0.14 | 0.04 | 0.02 | 12.16 | 15.82 |
| Rice fish Namoukoun-sauce | 1.6 | 6.35 | 3.03 | 0.02 | 0.16 | 0.02 | 0.04 | 10.23 | 14.58 |
| Attiéké-fish | 2.70 | 9.72 | 3.67 | 0.01 | 0.17 | 0.02 | 0.01 | 16.70 | 22.77 |
| Pounded yam-fish okra sauce | 4.62 | 6.01 | 5.83 | 0.02 | 0.18 | 0.04 | 0.03 | 10.2 | 11.92 |
| Rice fish sweet potatoes leaves sauce | 2.51 | 6.28 | 2.57 | 0.02 | 0.16 | 0.05 | 0.02 | 10.53 | 13.84 |
| Rice-fish eggplant sauce | 2.55 | 5.43 | 2.77 | 0.01 | 0.14 | 0.03 | 0.03 | 11.64 | 15.37 |

flesh accompanied by the fried tomato with fish that stand out in terms of the highest content. In terms of calcium, the highest content is found in the fries of sweet potato with orange flesh accompanied by the frying of tomato with fish, then the pounded yam with okra sauce with fish found in outpatients' diet. In terms of iron, sweet potato fries with orange flesh accompanied by the frying of tomato with fish, Kabato enriched with soy, pounded yam with fish dried okra sauce and rice accompanied by beans and beef have the highest content, both in outpatients' diet. For of zinc, sweet potato fries with orange flesh accompanied by the frying of tomato with fish have by far the highest content. For magnesium, kabato with dried okra sauce in inpatients' diet and fish attiéké (*a cassava couscous*) have the highest content. Placali (*a fermented cassava paste*) with palm sauce and fish attiéké have the highest sodium content. It found in outpatients' diet (**Table 9**).

### 3.4. Comparison of Outpatient and Inpatient Supplemented Diet

Outpatients have better dietary diversity than those who were hospitalized. The protein content shows statistically significant differences ($P < 0.05$) between the different dishes. The soy-enriched corn toh being the richest in protein with a concentration of 0.79 g/100g DM of dishes followed by inpatients' diet with a concentration of 0.56%. OFSP fries are low in protein with a concentration of 0.087%. The total fat, ash and water content of the different meals show no significant difference ($P > 0.05$), (**Table 7**). There is no significant difference in the digestible carbohydrate content of the different foods consumed by the patients ($P > 0.005$) even if outpatients' diet has the highest content.

### 3.5. Comparison of the Mineral Composition of Different Dishes

At significance level P < 0.05, comparison of the mineral content of different dishes according to Kruskal-Wallis's test, revealed that no significant differences exist between the dishes for Iron, Zinc, Phosphorus, Calcium, and molybdenum. On the other hand, the dishes differ for the minerals K, Mn, Mg and Na. Thus, for Kruskal-Wallis's test P < 0.05, there is a significant difference between dishes for mineral K. Analysis confirms that at least one of the average rank values of the rice with dry okra sauce and fish in the outpatients' diet is different from the others, P-value = 0.03145 (**Figure 1**). For the mineral Mn, test confirms that at least one of the average rank values of the Rice with Bombacaceae dried leaves sauce in inpatients diet is different from the others, P-value = 0.02294, (**Figure 2**). For the

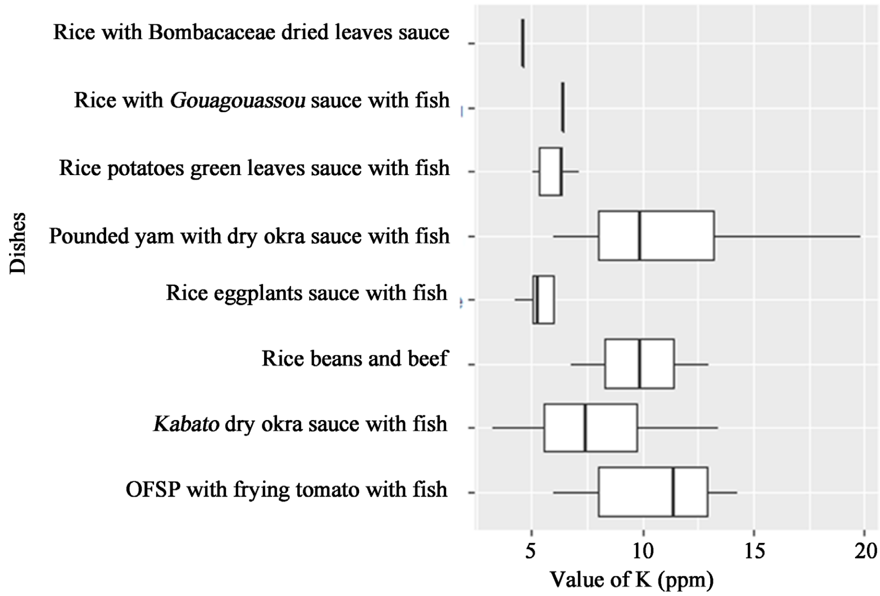


**Figure 1.** Comparison of K content of foods.

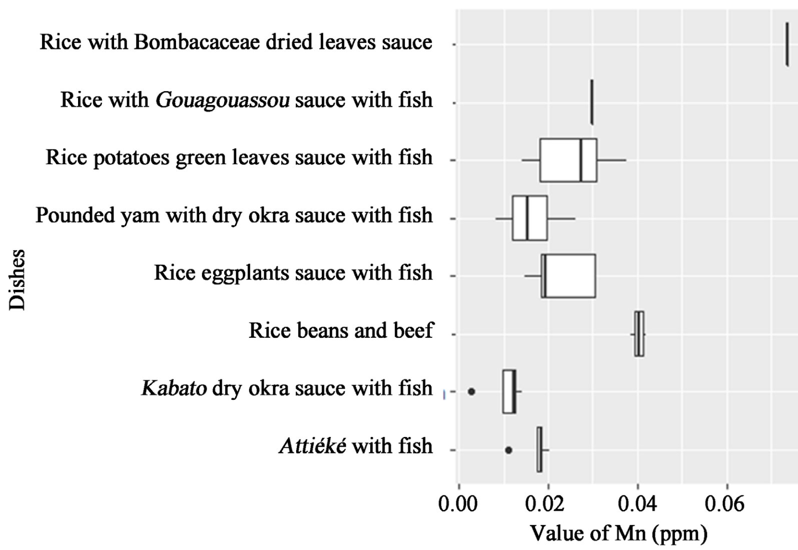


**Figure 2.** Comparison of the content of Mn dishes.

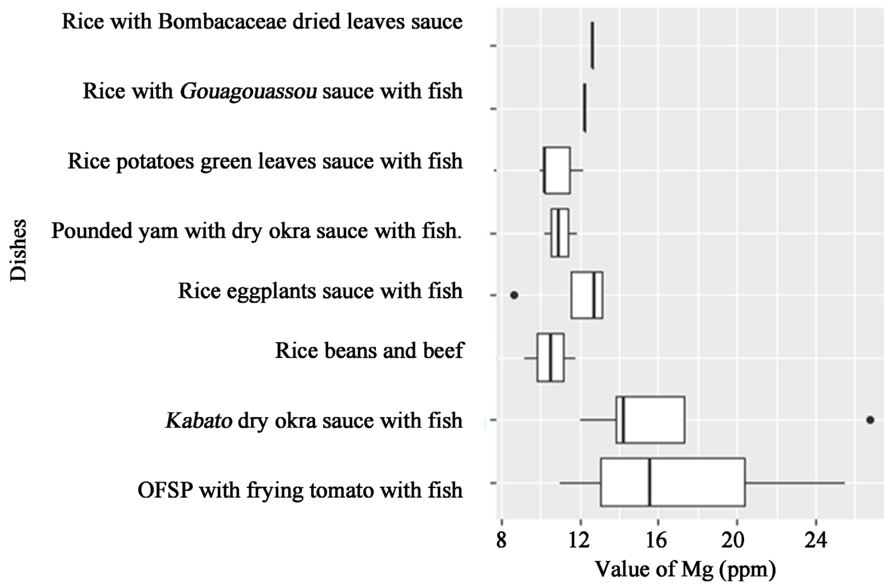


**Figure 3.** Comparison of the content of dishes in Mg.

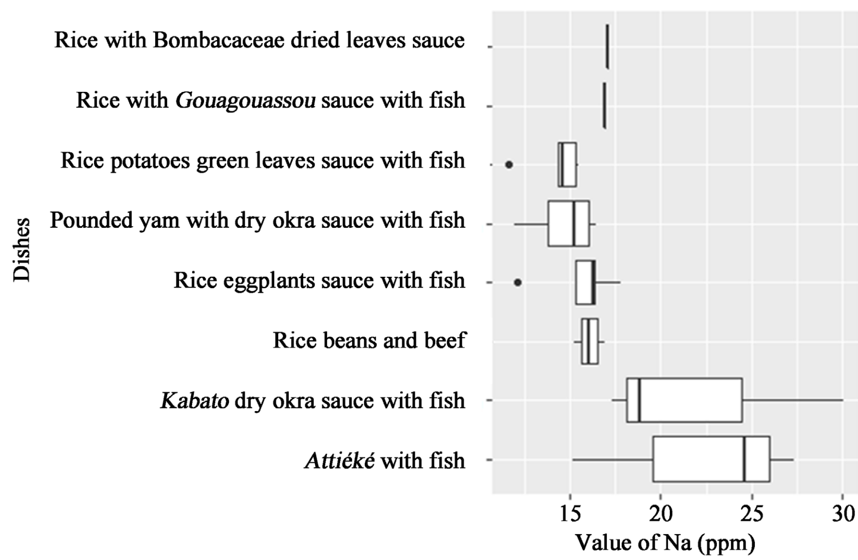


**Figure 4.** Comparison of Na content of dishes.

mineral Mg, The Kruskal-Wallis's test confirms that at least one of the average rank values for OFSP frites is different from the others, P-value = 0.03645 (Figure 3). For the mineral Na, the average rank values of the *Attieke* and fish in outpatients' diet is different from the others, P-value = 0.04103 (Figure 4).

## 4. Discussion

Chronic wound outpatient food nutrient content compared to chronic wound inpatients food nutrient content during treatment illustrate significant protein and beta-carotene differences of content between the different dishes and no significant difference in the digestible carbohydrate content of the different foods consumed by patients. The study also highlighted the higher dietary diversity score of chronic wound outpatients compare to chronic wound inpatients.

About food-group consumed and food contributing to the nutrients, 6 groups and 14 foods were collected from patients' diet. Almost all the foods [11] belong to 2 food-groups compose of meat, fish, eggs, and legumes and starchy foods and derivatives. That denote an unbalanced diet based on 2 food-groups relied on 2 foods (rice and fish) which are highly consumed by patients, with insufficient fruits consumption and low protein diversification. This finding is confirmed by Bonfoh *et al.*, 2022 [23] who highlight that in Côte d'Ivoire, specifically in Taabo's context, the diet is unbalanced and the whole family consumes the same meal made mainly with high-energy staples and little protein. Dindé *et al.*, 2017 [24] emphasized this finding by explaining that in rural Côte d'Ivoire the local food system is not diversified enough and dominated by high-energy diets and protein deficiency in their diet. This unbalanced diet is more pronounced for inpatients. Due to hospitalization, they do not have access to a large range of food, so they consume the same group of food continually. Compared to outpatients who have access to a large range of food, this could explain the great difference between the two groups of patients about dietary diversity.

This unbalanced diet could be link to the local food system as urged by Dindé but may also be link to the cultural factors, food restrictions and taboos supported by Konan *et al.*, 2019 [25] who said that the eating habits of patients with chronic wounds are often governed by deeply rooted socio-cultural food restrictions. These dietary prohibitions are imposed on most patients who use traditional medicine. Traditional therapists believe that eating certain foods could aggravate the disease and promote necrosis on the surface of the ulceration. In fact, these foods are suspected to be detrimental to the health of the patients and are presented as treatment-related measures to be observed in the quest for healing as confirm by Adjet *et al.*, 2016 [12].

The basic diet nutrients contents for out and inpatients were similar because families of inpatients were usually responsible for assuring food for patients, District Hospital could not support patient feeding as confirmed by Koffi *et al.*, 2019 [8]. Therefore, in and outpatient diet nutrient content were mostly very energetic; hyper-carbohydrate; rich in total sugar content, but low in protein, because diet was dominated by cereals mainly rice and starchy foods such as yam and cassava. Only fish was animal-protein mainly consumed, present in all dishes. Poor consumption of vegetable protein like soy and beans although available in the context of Taabo. This situation, therefore, raises the problem of nutrition education mention by Bonfoh *et al.*; 2022 [23] arguing that lack of nutritional education has a considerable impact on people's eating habits.

Regarding the mineral content of the dishes, the levels found are low for all major minerals for an adequate and sufficient intake of trace elements and micronutrients essential for a nutritional balance. This is mentioned by Trumbo *et al.* 2001 which give the references of consumption of the different minerals in the diet according to the World Health Organization and the Fund for Food and Agriculture. These results corroborate the micronutrient deficiencies and nutritional deficiencies found in the Ivorian patients as supported by Koffi *et al.* 2019a. This micronutrient deficiency is the basis of skin manifestation as supported by the writings of Doka *et al.* 2021. Insufficient intake of Fe, and Zn causes fatigue, poor growth, anemia, rickets, and impaired cognitive performance in humans as emphasized by Murphy *et al.* [26].

Indeed, the iron content of all the samples studied ranged from 0.14 ppm to 0.24 ppm, lower than 8.7 ppm of the RDI (mg/day) [27]. Iron is an important trace element in the human body, it plays a crucial role in hematopoiesis, infection control and cell-mediated immunity as mentioned Cayot; 2022 [28]. Iron deficiency has been described as the most common nutritional deficiency and estimates that iron deficiency anemia affects more than one billion people worldwide according to the WHO, 2022. The consequences of iron deficiency for a wound include anemia, decreased resistance to infection as describe by Swanson *et al.* 2003 [27] and delayed healing. The level of Zn ranged from 0.02 ppm to 0.06 ppm in all food samples was also very low than 9.5 ppm recommended daily as mentioned by Severo *et al.*; 2019 [29]. Zinc is a micronutrient essential for human growth and immune functions argued Benallal *et al.*, 2022 [30]. Zinc deficiency is thought to be responsible for poor wound healing (Medicine 2003). As for magnesium the content ranged from 9.19 ppm to 18.6 ppm was lower than 300 ppm recommended daily as confirm Yu *et al.* 2020 [31], its deficiency contributes to the aging of the skin, which can lead to a skin healing disorder, as supported by Colboc and Meaume 2018 [32]. As for calcium, it is essential for the vascular phase of healing leading to hemostasis, coagulation and fibrosis as mentioned by Démarchez 2014 [33], calcium deficiency can be the cause of hemorrhage. In our study regarding the total minerals, the daily intake of calcium ranged from 1.38 ppm to 5.83 ppm very low compared to the daily recommended dose range from 1000 ppm to 1300 ppm as describe by Cormick *et al.* 2019 [34].

Compare to the supplemented food given to patients to improve nutritional status and wound healing; the analysis found the soy-enriched corn toh being the richest in protein addition to it hyper-carbohydrate content than the basic diet. This high content of protein could come from soy, one the most vegetable protein content which could easily compensate the lack of protein in patients' diet as confirmed by Zhang *et al.*, 2021 [35]. About Orange flesh sweet potatoes, the analysis outlines it high beta-carotene content addition to it hyper-carbohydrate and total sugar content that makes it ideal in the context of wound healing as confirmed by Alam *et al.*, 2016 [36].

Comparing the diet content one to another regarding the need for wound healing as mentioned by Collins *et al.*, 2013 [37] who said that adequate protein intake is essential to the successful wound healing, in that view soy enriched dishes could be an appropriate option for wound treatment because of its high protein content. Concerning OFSP its beta-carotene content makes it an ideal food for wound healing. This argument is also supported by Van Buren *et al.*, 2022 [38], who stated that vitamin A deserves special mention regarding its effect on wound healing.

**Study limitations**

These investigations underline the high value of supplemented food nutrient content on basic diet focusing on protein, carbohydrate, lipid, sugar, and beta-carotene content, however, disregards mineral and vitamin content of dishes. This approach fails to analyze patients' blood exam researching albumin, vitamin A, iron and other micronutrients involves in wound healing which could strengthen the finding.

## 5. Conclusion

Nutrition fit to provide nutrient adapted to cover chronic wound patients' nutritional deficiency integrated into WHO-recommended wound management in West Africa could be the solution to chronic wound management in LMIC countries. Nutrition education focusing on dietary diversity and balanced diet for appropriate nutritional intake should be part of the recommendation to be given to chronic wound' patients and care givers. Moreover, our findings also indicate that nutrition with high value nutrient content regarding protein, calories and beta-carotene could be include in chronic wound protocol to improve patient nutritional status and enhance wound healing rate. This needs to be validated with a larger study, however, further study should involve analyzing bioavailability of nutrient on patients' blood may strengthen appropriate management.

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## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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