Original Research Article
Characterization of the physicochemical and energetic properties of *Alchornea cordifolia* leaves and fruits harvested in three regions of Côte d'Ivoire

ABSTRACT

Aims: This study aims to enhance the value of the leaves and fruits of Alchornea cordifolia by characterizing the physicochemical compounds through their dosage.
Study design: Original Research
Place and Duration of Study:this study was carried out at the Agro-valorization laboratory of the Jean Lorougnon Guédé University of Daloa between November 2023 and July 2024.
Methodology: The plant material consisted of leaves and fruits of Alchornea cordifolia harvested from three regions. Tube reactions were used to characterize ash, pH, dry matter, carbohydrates, energy values by the conventional method, proteins by the Kjeldahl method, lipids by the Soxhlet method, fibers by the Weende method, and total and reducing sugars by spectrophotometric use
Results:the samples analysed contain the highest average content of 15.11% for young leaves, 3.7% lipids, 3.9% pH, 58.69% carbohydrates and 261.63% energy value. In terms of dead leaves, 6.02% ash, 91.80% dry matter and 37.83% fibre. Mature leaves record 6.66% total sugars and 3.2% reducing sugars.

Conclusion:this database reveals the interest of using the leaves and fruits of *Alchornea cordifolia* in everyday food and not only therapeutically.

Keywords : Alchornea cordifolia, physicochemical properties, energetics, leaves and fruits

1. INTRODUCTION

Herbal treatment is coming back to the forefront, as the effectiveness of medications such as antibiotics, once considered the near-universal solution to serious infections, is declining. Bacteria and viruses have gradually adapted to medications and are increasingly resistant to them [1]. The evaluation of the physicochemical parameters of medicinal plants is a crucial step in the enhancement of natural resources and the understanding of their therapeutic potential [2]. In Sub-Saharan Africa, populations place great importance on plants involved in nutrition and health [3] ; [4]. Indeed, the family Euphorbiaceae includes *Alchornea cordifolia* (Schumach. & Thonn.) Müell. Arg. [5]. In Ivory Coast, one can find this elegant, sprawling climbing plant or shrub that thrives very well in tropical environments, in low-lying areas or forest zones. *Alchornea cordifolia*, a plant widely used in African traditional medicine, is recognized for its various medicinal properties. In Côte d'Ivoire, *Alchornea cordifolia* is traditionally used by the population through decoction or maceration for its anti-inflammatory, antimicrobial, antiparasitic, venotonic, and antioxidant properties. [6] ; [7]. According to Adeleye et al. [2], the leaves of *Alchornea cordifolia* contain tannins, alkaloids, and saponins that inhibit the growth of Salmonella typhi, Escherichia coli, and Shigella, as well as treatments for ulcers and diarrhea. The main reason is that leaves are a significant source of bioactive molecules [8].
However, despite its therapeutic use, very few studies have been conducted on the nutritional values of this plant. Through the analysis of the physicochemical parameters of the leaves and fruits of Alchornea cordifolia collected from three distinct regions of Côte d'Ivoire, the aim of this study is to contribute to the valorization of Alchornea cordifolia and to provide solid scientific foundations for its preventive and dietary use.

2. MATERIAL AND METHODS

2.1 Material

The biological material used in this study consists of leaves in different states of maturity (young, mature and dead) and fruits of Alchornea cordifolia harvested in the cities of Daloa, Séguéla and Yamoussoukro (Figure 1). Then put in plastic bags on which the stage of maturity and the sampling locality were indicated and transported to the Agro-valorization Laboratory of the Jean Lorougnon Guédé University of Daloa for physicochemical analyses.

Fig. 1. Leaves and fruits of *Alchornea cordifolia* a. young leaves; b. mature leaves; c. fruit; d. dead leaves

2.2 Methods

2.2.1Physicochemical analysis of the leaves and fruits of *Alchornea cordifolia*

2.2.1.1 Determination of the dry matter content of the leaves and fruits of Alchornea cordifolia

The method used for the removal of water from the leaves and fruits of Alchornea cordifolia is that of the AOAC [9], the principle of which is based on dehydration by drying samples in an oven until a constant mass is obtained. A quantity of five (5) grams of fresh leaves of *Alchornea cordifolia* was weighed using a balance in a crucible of known mass (M0). The assembly (crucible + powder) of mass M1 was put in the oven at 105°C (± 2°C) for 24 hours. After cooling with a desiccant, the crucible is weighed again (M2). Three tests were performed for each sample. The dry matter content was determined from the following formula:

$$\text{Humidity (\%)} = \frac{(M_1 - M_2)}{(M_{E0})} \times 100 \quad (1)$$

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

M1: Mass of the crucible + test sample (g)
M2: Mass of the entire assembly after drying. (g)
ME0: Test drive (g)

2.2.1.2 Determination of the protein content of the leaves and fruits of Alchornea cordifolia

Determination of crude protein content according to the KJELDHAL method [9]. One (1) gram of each sample of fine powder of Alchornea cordifolia leaves was heated to 400°C for 2 hours in the presence of a catalyst (selenium + potassium sulphate) and 20 mL of concentrated sulphuric acid. The residue

of the mineralization was supplemented to 60 mL with distilled water, then added 50 mL of soda (40%) before being brought to a boil in a distiller. The ammonia released was collected in an Erlenmeyer flask containing 10 mL of boric acid (4%), with the addition of a mixed indicator (methyl red + bromocresol green). The assay was carried out by a solution of sulphuric acid (0.1 N) and the crude protein content was obtained by multiplying the nitrogen content (% N) by 6.25. The nitrogen and protein levels were obtained according to the following formulas:

$$N\,(\%) = \frac{Va \times Na \times 14{,}007}{1000 \times PE} \times 100 \quad (2)$$

% N: Nitrogen content present in the sample.
Va: Volume of sulfuric acid poured (mL)
Na: Normality of sulfuric acid (0,1 N)
PE: Sample trial taking (g)

$$\text{Protein content (\%)} = \%\ N \times 6{,}25$$

2.2.1.3 Determination of the ash content of the leaves and fruits of Alchornea cordifolia

The method used to determine the residues of mineral compounds remaining after incineration of the leaves and fruits of Alchornea cordifolia was that of AOAC [10]. A quantity of 0.5 g of each sample of fine powder of Alchornea cordifolia leaves was weighed using a balance in a crucible of known mass (M0). The whole (crucible + fine powder) was heated to the muffle furnace at 650 °C (± 2 °C) for 8 hours. After cooling in a desiccator, the crucible containing the ashes is weighed and noted (M1). Three tests were conducted. The ash content was determined from the formula:

$$\text{Ash (\%)} = \frac{(M1-M0)}{(PE)} \times 100 \quad (3)$$

M1: Mass of the crucible + ashes (g)
PE: Test taking (g)
M0: Mass of the crucible (g)

2.2.1.4 Determination of reducing sugars in the leaves and fruits of Alchornea cordifolia

The quantification of reducing sugars was carried out according to the method of Bernfeld [11]. A volume of one millilitre (1 mL) of an ethanolic extract from Alchornea cordifolia powder was introduced into a test tube and successively a volume of 0.5 mL of distilled water and a volume of 0.5 mL of dinitrosalycilic acid (DNS) were added. The mixture was heated in a boiling water bath for 5 minutes and after cooling, a volume of 5 mL of distilled water was added. The optical density was thus read at 540 nm against a blank test. A calibration range using a 0.1 mg/mL glucose solution allowed the quantification of reducing sugars and the tests were carried out in triplicate.

2.2.1.5 Determination of total sugars in the leaves and fruits of Alchornea cordifolia

The determination of total soluble sugars was carried out according to the method of Dubois et al.[12]. After extraction with 80° G.L ethanol (Gay Lussac) of the free sugars contained in a quantity of 5 g from each sample of the vegetable powder, purification by solutions of lead acetate (10%) and oxalic acid (10%) was carried out. The resulting solution was evaporated in a sand bath and supplemented with 25 mL with distilled water. A quantity of one millilitre (1 mL) of the previous sugar solution was taken, followed by 1 mL of phenol (5%) and 5 mL of concentrated sulphuric acid (94-97%). After

cooling to room temperature, the reading was made at the wavelength of 490 nm on the spectrophotometer, against a standard range of 0 to 80 µg glucose. The tests were done in triplicate.

2.2.1.6Determination of the fiber content of the leaves and fruits of Alchornea cordifolia

The crude fibre content of the samples was determined using the Weende method [9]. This method consists of treating the sample at a boil with sulphuric acid and then with soda. The resulting residue was dried, then calcined and weighed. The procedure consisted of putting a quantity of 2 g of sample in a beaker containing 50 ml of 0.25 N sulphuric acid. The mixture was then brought to a boil for 30 minutes. After that, 50 ml of the 0.31 N soda was added to the boiling mixture for 30 min. After filtration, the residue was washed several times with hot distilled water until the alkali was completely removed. The resulting insoluble was dried at 105 °C for 8 hours and weighed (M1). This dry residue was incinerated at 550 °C in a muffle furnace, previously heated to 550 °C for 3 hours and the ashes were weighed (M2). The crude fibre content was given by the following relationship:

$$F\,(g/100\,g\,de\,MS) = \frac{M_1 - M_2}{Pe} \times 100 \qquad (4)$$

F : crude fibre content

M_1 : mass of the sample after 8 h of time in the oven

M_2 : dry residue after incineration at 550 °C for 3 h

Pe : Test Socket

2.2.1.7Determination of the lipid content of the leaves and fruits of Alchornea cordifolia

Lipids were determined using the Soxhlet method [9]. The fat was extracted by reflux heating and then weighed after evaporation. Fat content determination involves extracting the lipids from the sample with an organic solvent (hexane). The procedure consisted of introducing 10 g of sample into the Whatman cartridge, cotton was placed at the opening of the cartridge to prevent the sample from being carried away by the solvent during extraction. In an extraction tank, 300 ml of hexane was introduced, the tank was placed on a heating block and the connections of the various elements of the device were made. The refrigerant valve was opened and the heating unit was turned on for 6 hours.After this extraction time, the flask was removed from the Soxhlet device (made of 500 ml Pyrex France tube), and was placed in the rotary evaporator to separate the fat and solvent. Then, the whole thing (flask + fat) was dried in the oven and cooled in a desiccant for 15 minutes, then weighed. The fat content was finally determined according to the following formula:

$$MG\ (g/100\,g\ de\ MS) = \frac{(B_H - B_V)}{P_e} \times 100 \qquad (5)$$

MG : grasses fat content
B_V : mass of the empty balloon
B_H : mass of the empty flask and oil after extraction
Pe : Test Socket

2.2.1.8 Determination of the carbohydrate content of the leaves and fruits of Alchornea cordifolia

Total carbohydrates were determined by estimation using the following relationship [13].

$$Glucides\ (\%) = 100 - [cendres\ (\%\ MS) + protéines\ (\%\ MS) + lipides\ (\%\ MS) + fibres\ (\%\ MS)] \qquad (7)$$

2.2.1.9Determination of the energy value of the leaves and fruits of Alchornea cordifolia

The energy value (EV) of food comes from the three (03) macronutrients (carbohydrates, fats and proteins). It was calculated by multiplying the mean macronutrient values by the Atwater factors of 4; 4 and 9 respectively [13] according to the following expression:

VE (kcal/100 g) – [(% glucides x 4) + (% protéines x 4) + (% lipides x 9)]

2.2.1.10 Determination of the pH of the leaves and fruits of Alchornea cordifolia

pH was determined using AOAC [14]. 2.5 g of sample was weighed in a 50 ml tube and then 20 ml of distilled water added. The whole thing was centrifuged at 4000 rpm for 15 minutes, then 10 ml of the supernatant was taken from a beaker for pH measurement. The pH was measured by dipping the electrode previously calibrated with pH 4.00 and pH 7.00 buffer solutions in the 10 ml of the solution and the value was read on the pH meter display.

2.3 Statistical analysis

Statistical analysisThe statistical analysis was carried out with the Statistica 7.0 software and when a difference is observed, an HSD tuckey test is done to mark this difference at the 95% threshold ($p < 0.05$)

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Dry matter content of *Alchornea cordifola* fruits and leaves analysed

The results of the dry matter content of the leaves and fruits of Alchornea cordifolia according to the localities of Yamoussoukro, Daloa and Séguéla are presented below (Figure 2).
The highest dry matter content is obtained from the dead leaves of Alchornea cordifolia. They are 90.14% in Yamoussoukro and 92.64% in Daloa and Séguéla. On the other hand, the levels of the other three categories of samples (young leaves, mature leaves and fruit) are all less than 30% dry matter.

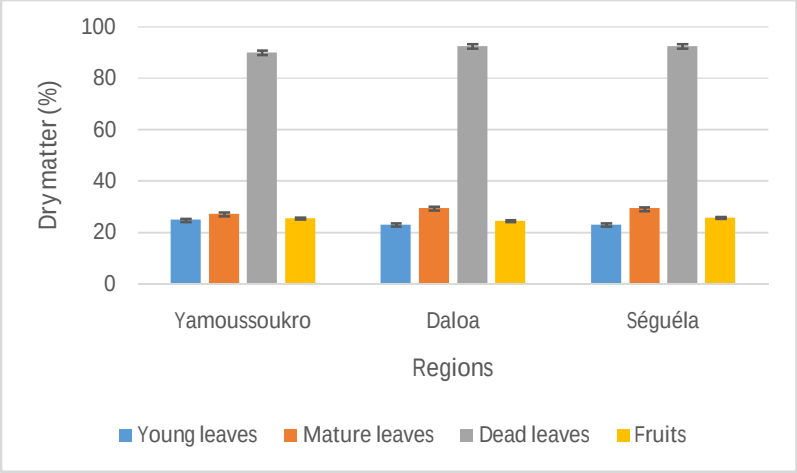

Fig. 2.Percentage dry matter content of fruits and different leaf stages of *Alchornea cordifola* according to sampling localities

3.1.2 Protein content of fruits and leaves of *Alchornea cordifola*

Figure 3 shows the protein content of Alchornea cordifola fruit and leaves as a function of sampling locations. It revealed variable protein levels in all the samples from the three locations. Concerning the locality of Yamoussoukro, mature leaves have the highest protein content (28%) followed by young leaves (25%), dead leaves (12.33%) and fruits (10%). At the level of Daloa, the young leaves (5.67%) and fruits (10%) have low levels compared to those of mature leaves (13.67%) and dead leaves (15.33%). As for the city of Séguéla, the fruits revealed lower protein contents (6%), while the young leaves and dead leaves showed average contents of 14.67 and 15.33%. Regardless of the locality and stage of ripening, the highest value was observed at the level of mature leaves (28%) in Yamoussoukro.

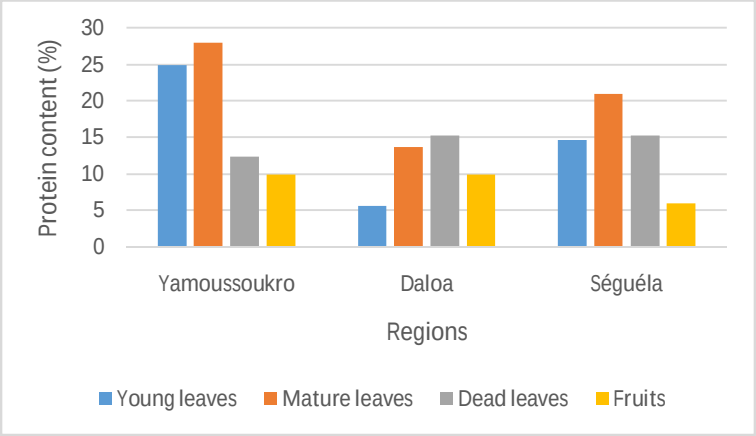

Fig. 3. Protein content of fruits and different leaf stages of *Alchornea cordifola* depending on the region

3.1.3Ash content of fruits and leaves of Alchornea cordifola

The proportions of ash obtained from the different parts of Alchornea cordifolia samples are represented according to the sampling locations in Figure 4 below. The highest ash content of young leaves was obtained in the Daloa samples (6.54%), followed by those of Séguéla (5.65%) and Yamoussoukro (4.92%). By count, dead leaves have equal contents (6.21%) for the localities of Daloa and Séguéla and 5.65% for Yamoussoukro. Variable ash contents of 3.65%, 4.17% and 4.97% were obtained with mature leaves respectively in the localities of Yamoussoukro, Daloa and Séguéla. Similarly, in the localities of Yamoussoukro (4.62%), Daloa (5.04%) and Séguéla (4.96%), the ash content obtained from the fruits remains variable.

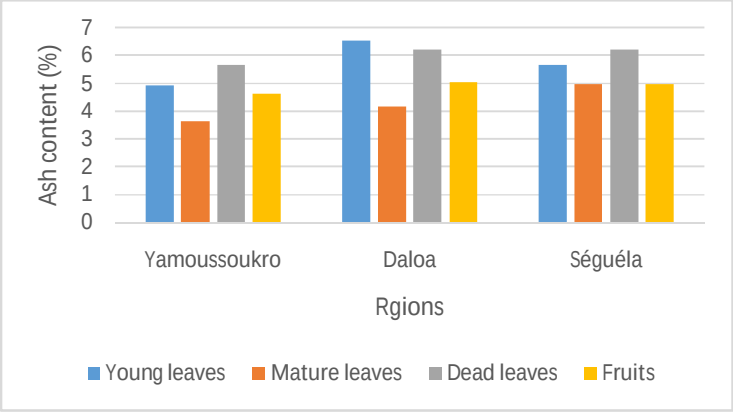

Fig. 4. Ash content of fruits and different leaf stages of *Alchornea cordifola* according to sampling regions

3.1.4 Reducing sugar content of fruits and leaves of *Alchornea cordifola*

The regions of Daloa and Yamoussoukro have the highest levels of reducing sugars specifically in mature leaves (4.4% and 3.1%) and fruits (3.9% and 2.4%). As for the locality of Séguéla, the values obtained are approximately identical in all the other samples studied (Figure 5).

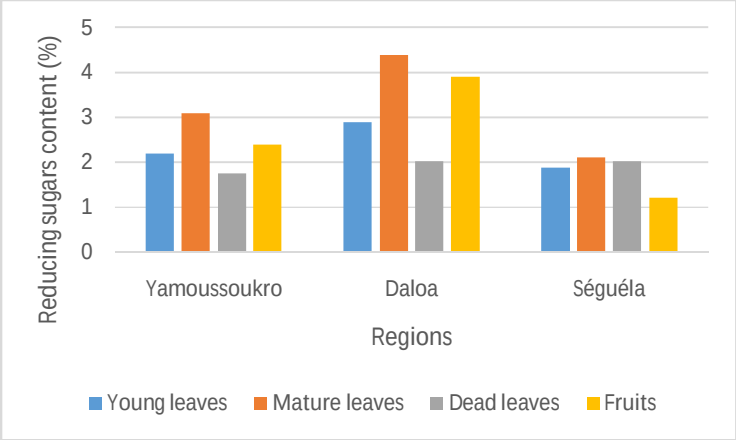

Fig. 5. Reducing sugar content of fruits and different leaf stages of Alchornea cordifola according to sampling localities

3.1.5 Total sugars content of fruits and leaves of *Alchornea cordifola*

Figure 6 shows the total sugar content of the various elements studied. Fruits have the highest total sugar contents, 8.4% in Yamoussoukro, 8% in Daloa and 5.6% in Séguéla. They are followed by mature leaves, with a content of 6.8% in Yamoussoukro, 7.71% in Daloa and 5.47% in Séguéla. As for the young leaves, those of Yamoussoukro contain 6.73%, Daloa 4.95% and Séguéla 5.13%. Dead leaves are the lowest in total sugar with 3.9% in Yamoussoukro, 5.2% in Daloa and Séguéla.

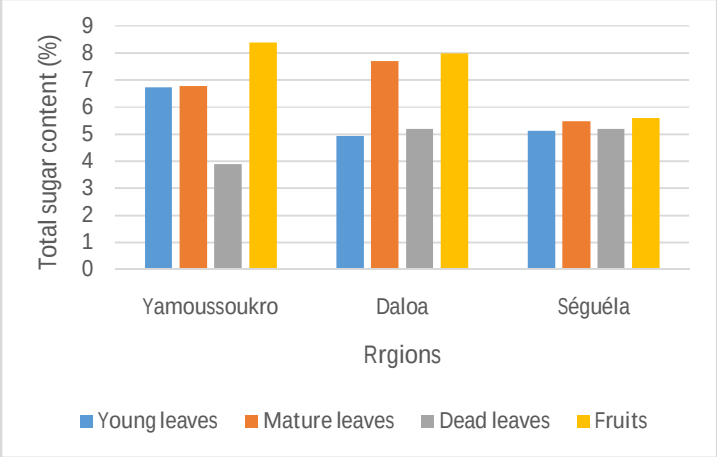

Fig. 6. Total sugar contents of fruits and different leaf stages of Alchornea cordifola according to sampling localities

3.1.6Fiber content of *Alchornea cordifola* fruits and leaves

The results of the fibre content of the leaves and fruits of Alchornea cordifolia according to the localities of Yamoussoukro, Daloa and Séguéla are presented in Figure 7 below.In each of the

sampling localities, fibrecontents are high for dead leaves (39.01% in Séguéla and Daloa ; 35.48% in Yamoussoukro), mature leaves (32.48% in Daloa, 30.86% in Yamoussoukro and 27.28% in Séguéla) and for young leaves, which vary from 21.80% to 24.04% from Yamoussoukro to Daloa. In terms of Alchornea cordifolia fruits, the fiber content is higher (28.34%) with those collected in Séguéla followed by Yamoussoukro (23.10%) and Daloa (20.76%).

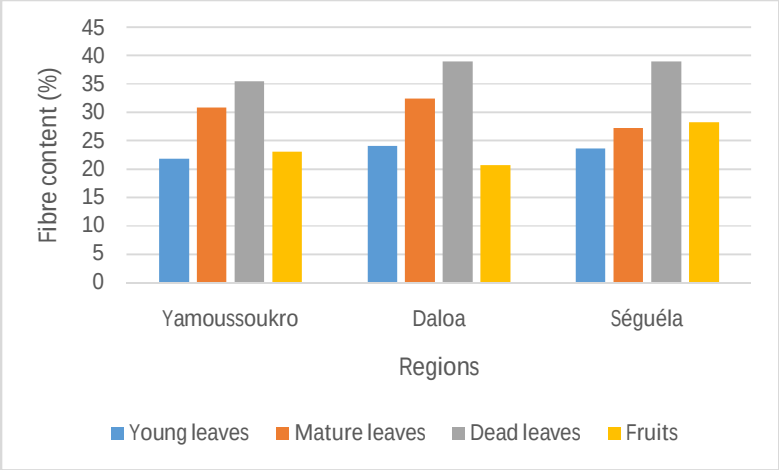

Fig. 7.Fibre content of fruits and different leaf stages of Alchornea cordifola according to sampling regions

3.1.7Lipid content of fruits and leaves of *Alchornea cordifola*

The results of Table 1 present the lipid content of the leaves and fruits of Alchornea cordifolia according to the regions of Yamoussoukro, Daloa and Séguéla. The lipid contents of mature and dead leaves have the highest values in the region of Yamoussoukro (2.27% and 2.46%). In the locality of Daloa, 8.75% of lipid levels were observed in the fruits, compared to values that did not exceed 2% in young leaves (1.08%), mature leaves (1.46%) and dead leaves (1.59%). The locality of Séguéla shows concentrations of 0.77% for fruits, 1.32% for dead leaves, 1.33% for young leaves and finally 1.52% for mature leaves.

Table 1: Lipid content of Alchornea cordifolia leaves and fruits in relation to regions

Types of leaves	Yamoussoukro	Daloa	Séguéla
Young leaves	$0,8 \pm 0,30^{c}$	$1,08 \pm 0,33b^{c}$	$1,33 \pm 0,57^{a}$
Mature leaves	$2,27 \pm 0,69^{a}$	$1,46 \pm 0,20b^{c}$	$1,52 \pm 0,57^{a}$
Leaf litter	$2,46 \pm 0,74^{a}$	$1,59 \pm 0,26^{b}$	$1,32 \pm 0,42^{a}$
Fruits	$1,58 \pm 0,03^{b}$	$8,75 \pm 0,58^{a}$	$0,77 \pm 0,15^{ab}$

The values are the means ± standard deviations (n=9). Means with different alphabetic letters on the same column are significantly different ($p < 0.05$), according to the HSD Tuckey test

3.1.8 Carbohydrate content of fruits and leaves of *Alchornea cordifola*

Figure 8 below shows the carbohydrate content of young, mature and dead leaves and fruits harvested in Yamoussoukro, Daloa and Séguéla.The carbohydrate content of fruit is higher in Yamoussoukro (60.70%), followed by Séguéla (59.93%) and Daloa (55.45%). As for the young leaves, those from Daloa, Séguéla and Yamoussoukro contain 63.67%, 54.77% and 47.47% respectively. As far as mature leaves are concerned, this content is higher in Daloa (48.20%), which rises to 45.23% in

Séguéla and 35.21% in Yamoussoukro. Finally, for dead leaves, this content remains constant in Séguéla and Daloa (38.13%), different from Yamoussoukro where it rises to 44.07%.

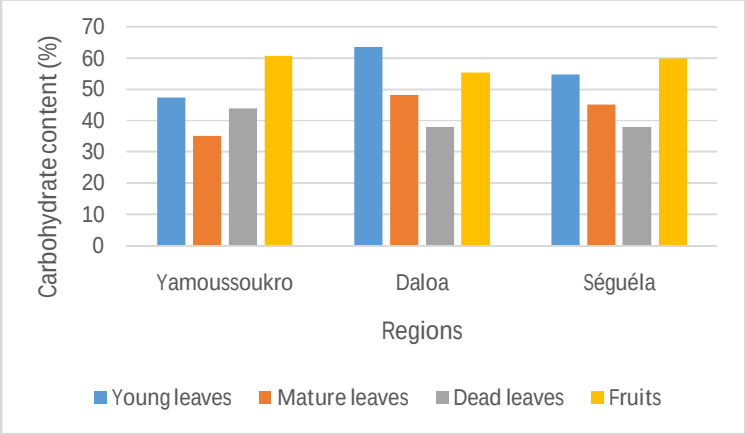

Fig. 8. Carbohydrate content of fruits and different leaf stages of *Alchornea cordifola* according to sampling regions

3.1.9 Energy content of fruits and leaves of *Alchornea cordifola*

The figure below shows the energy value of the different matrices studied. Regardless of the locality, the fruits remain the most energetic with a maximum of 295.56 kcal, followed by the young leaves (237.17 to 250.18 kcal). For mature leaves, this value varies between 213 and 225.41 kcal. Dead leaves are the poorest with a value between 184.57 and 208.02 kcal (Figure 9).

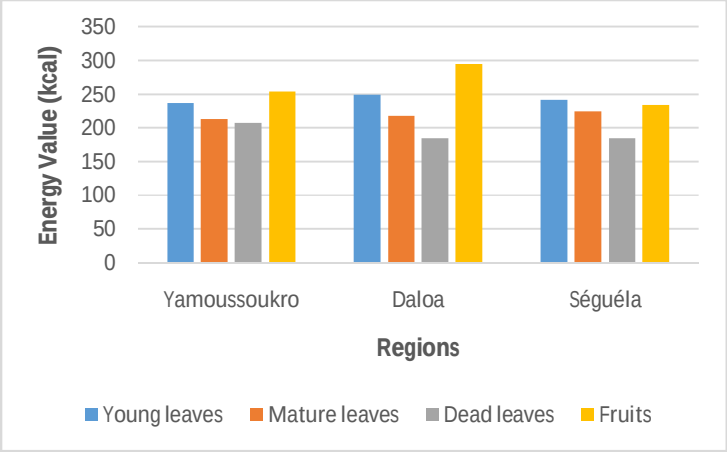

Fig. 9. Energy content of fruits and different leaf stages of *Alchornea cordifola* according to sampling regions

3.1.10 pH of the fruits and leaves of *Alchornea cordifolia*

The pH values of the fruits and leaves of Alchornea cordifola analyzed ranged from 3.8 to 4.6 for all the samples studied (Table 2).

Table 2: pH value of Alchornea cordifolia leaves and fruits according to the different regions.

	Types of leaves	Yamoussoukro	Daloa	Séguéla
pH	**Young leaves**	4,63 ± 0,10[a]	4,43 ± 0,18[a]	4,53 ± 0,05[a]

Mature leaves	4,47 ± 0,05[b]	4,30 ± 0,09[a]	4,40 ± 0[a]
Dead leaves	4,27 ± 0,13[c]	4,30 ± 0,09[a]	4,13 ± 0,05[b]
Fruits	4,20 ± 0[d]	3,90 ± 0[b]	3,80 ± 0[c]

The values are the means ± standard deviations (n=9). Means with different alphabetic letters on the same column are significantly different (p < 0.05), according to the HSD Tuckey test

3.2 Discussion

Physicochemical analyses indicate substantial variations in element concentrations, influenced by leaf and fruit categories, as well as by the geographical locations of sampling. Dry matter analyses show that young leaves and fruit contain less dry matter than mature leaves and dead leaves. These results are consistent with those obtained by Ekissi [15] for young and mature leaves of *Lippia multiflora*. In addition, the dry matter levels of the samples in this study are higher than those reported by Soro, [16] on the leaves of *Lippia multiflora* which are 24.70% for young leaves and 27.83% for mature leaves. Also, these results are lower than those obtained by de Solomo et al. [17] on the leaves of Alchornea cordifolia in DR Congo, which contain 44.34% dry matter. Variations in dry matter content can be attributed to the stage of development, the harvest period and the location of leaf collection [18] ; [19] ; [20]. According to Erukainure et al. [21], the high dry matter values obtained allow for long-term storage. According to George, [22], moisture content contributes significantly to leaf texture and promotes the maintenance of protoplasmic cell content. Finally, the high dry matter content in dead leaves could be explained by the loss of water from these leaves by evaporation, which proportionally increases this content [23].

The protein content of the different sheets analysed varies from 5.67% to 28%. These values exceed those reported by Soro, [16] for young (10%) and mature (13%) leaves, as well as those reported by Ekissi,[15] for different types of Lippia multiflora leaves (9.01% to 12.76%). They are also identical to those obtained by Oulai et al.[24] for mature baobab leaves, with an average of 18.70%. Therefore, the leaves of *Alchornea cordifolia* are an important source of protein. In addition, the protein content of the fruits is lower than that of the leaves studied; according to Rydlewski et al. [25], fruits in general do not represent potential sources of protein. The ash content, which is an index of the minerals present in living organisms, varies from 3.65% to 15.33% in the samples taken from the three sites. These values exceed those reported by Edeoga et al.[26] for Ocimum gratissimum leaves (6.88%) but do not agree with the results obtained by Ekissi [15] on wild plants of Lippia multiflora (from 9.37% to 17.31%). According to Onot et al.[27], increased ash content is correlated with the presence of a high network of mineral elements. On the other hand, the dead leaves have an average ash content of 11.22%, thus demonstrating the richness in minerals. This observation could justify the preference for the use of dead leaves to the detriment of mature and young leaves for the postpartum treatment of women, malaria, anaemia [5].

The concentrations of reducing sugars in *Alchornea cordifolia* leaves, ranging from 1.2% to 4.4%, are almost identical to those reported by Ekissi, [15] for different categories of *Lippia multiflora* leaves ranging from 1.99% to 4.04%. Indeed, the low level of reducing sugars observed in leaves can be attributed to the transfer and storage of molecules synthesized during photosynthetic processes to reserve organs, such as grains and tuberous roots [28]. In our study, the total sugar content of leaves of different stages of ripening and fruits of *Alchornea cordifolia* varying from 3.9 to 8.4% is below that obtained by Solomo et al. [17] (30.83% ±8.64) on the same species in DR Congo. For Soro, [16] this variation in content within the same species would be the cause of the distinct geographical origin of the samples of the two studies, which could be influenced by various factors such as climatic conditions...

The results indicate that the dead leaves have higher fibre contents in the three different locations (35.48%, 36.52% and 39.01%). These fibre concentrations are identical to those reported by Oulaï et al.[24] for mature baobab leaves (from 22.98% to 33.90%). Since fibre is neither digested nor adsorbed by the digestive system, it is of paramount importance for the body because it intervenes in the digestive tract, thus preventing excessive cholesterol absorption and contributing to the regulation of blood sugar levels [29]; [30]. Also, this high crude fiber content suggests that the leaves of *Alchornea cordifolia* could be a beneficial dietary supplement for people suffering from obesity, high

blood pressure and blood sugar disorders.This could explain the preference of the Ivorian population for the use of dead leaves, malaria, high blood pressure [5]
The lipid contents in the different types of leaves vary from 0.8% to 2.46%. These results are lower than those reported by Oulai et al. [24] in baobab leaves with concentrations of 6.66% and 4%, respectively. These results are also lower than those of Solomo et al. [17] obtained in Congo in the leaves of Alchornea cordifolia, which are 6.8%. This difference could be explained by the environmental factors observed within the two study areas that act on the composition of the soil, particularly on its nutrient content [31].The leaves of *Alchornea cordifolia* analyzed in this study are relatively low in lipids, which confirms the conclusions of Anihouvi, [32] in Benin which demonstrated a low lipid content of the leaves in general.
The concentrations obtained in the fruits and leaves at different stages of growth, analysed in this study, reveal that *Alchornea cordifolia* is a carbohydrate-rich plant. Indeed, these levels are close to those obtained by Oulai et al. [24] in the study of baobab leaves harvested in Abidjan (64.10% ± 0.05), Bouaké (72.86% ± 0.01), Boundiali (73.53% ± 0.05) and Man (69.29% ± 0.11). But the levels obtained are higher than those obtained by Dappah et al. [33] by studying the composition of the leaves of Corchorus olitoris, commonly known as "Pklara in Côte d'Ivoire", which contain 26.03% carbohydrates. Thus, the incorporation of the leaves and fruits of Alchornea cordifolia into the diet is an adequate source of non-starchy carbohydrates because they contain as many carbohydrates as baobab leaves, the consumption of which covers the recommended daily intake (RDI) of nutrients [34].
The energy values associated with the leaves of *Alchornea cordifolia* harvested at different stages of maturity and analysed vary from 184.57 to 242.35kcal. These values are similar to those obtained by Solomo et al.[17] by studying leaves of the same species. In addition, the leaf energy values obtained in our study are lower than those obtained by Oulai et al., 2019 on baobab leaves. Indeed, for Nga et al. [35], this energy difference could be explained by the taxonomic difference of these plants, which could also influence these contents. Similarly, the energy value of the fruits of Alchornea cordifolia studied is higher than that of some frequently consumed fruits such as avocado (155 kcal/100g), mango (64.4 kcal/100g), guava (68 kcal/100g) and orange (47 kcal/100g) according to Stadlmayr et al. [36] ; CIQUAL, [37].
The fruits of Alchornea cordifolia could therefore contribute to energy intakes in order to meet the recommended daily energy requirements in developing countries, which vary from 950 kcal for children under 12 months of age to 2710 kcal for lactating women [38].
The pH of the leaves is acidic, regardless of the locality, with values ranging from 4.13 ± 0.05% to 4.63 ± 0.10% for the different leaf stages analysed. These values are higher than those reported by Koffi et al.[39] for the leaves of Alchornea cordifolia (3.90 ± 0.05), but lower than those found in the roots and stems of the same plant (5.33 ± 0.03; 5.01 ± 0.03). This variation in pH between fruits and different types of leaves could be explained by non-identical climatic conditions and the mineral composition of the leaves [39].

4. CONCLUSION

This study made it possible to determine the physicochemical composition of the fruits and leaves of Alchornea cordifolia at different stages of maturity (young, mature and dead leaves). The characterization of the physicochemical compounds shows that the different concentrations vary on the one hand, according to the plant organs and the age of the leaves, and on the other hand, according to the environmental conditions across the regions. The results of this study show that the young leaves and fruits of Alchornea cordifolia provide a considerable source of nutrients. However, phytochemical characterization studies are needed to evaluate the therapeutic properties of the plant.

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