Original Research Article

Nutritive Compounds Contained In Some Mucilaginous Plants Consumed In Côte d' Ivoire

ABSTRACT

Aims: To assess the nutritive compounds contents in different edible parts of nine mucilaginous food plants (MFPs) from Côte d'Ivoire**.**
Study Design: MFPs edible parts were dried and nutritive compound analyzed.
Place and Duration of Study: The study was conducted in Laboratory of Biochemistry and Food Sciences, Biosciences Unit, at Felix Houphouet-Boigny University between January and December 2014.
Methodology: The acquirement of the plants has been done in 3 big regions (Tonkpi, Bélier and District of Abidjan) of Côte d'Ivoire. To achieve this study, 100 kg of fresh fruits and masts of the species *I. gabonensis, I. wombolu* and *B. mannii* have been collected to the farmer in the region of the Tonkpi. A same quantity of leaves, calyx and flowers of *B. buonopozense* has been harvested in the region of Belier. As well as 100 kg of leaves of *C. olitorius*, *M. arboreus*, *A. digitata* and varieties tomi and koto of *A. esculentus* have been collected to the Gouro market in the District of Abidjan. So a biochemical characterization of the kernels (IG and IW), leaves (CO, AD, MA and BB), fruits (BM and AE) and flowers (BB) has been achieved.
Results: The results reveal richness in nutritive components of the studied food plants. The ash contents are consisted between 2.5±0.14% and 10.70±0.07% and are raised more in the leaves and the fruits of A. esculentus. The leaves, flowers and fruits also expressed the best concentrations in polyphenols of 116.40±2.11 to 521.76±5.13 mg/100 g DM. These same parts showed the best concentrations in proteins especially leaves (10.06±0.85% to 12.69±0.64% DM). The mucilaginous food plants provided some contents in carbohydrates varying from 10.33±0.04% to 60.64±0.71%. The concentrations in lipids are generally weak below 6% but very strong (55.79±1.45% and 75.99±2.25%) in the kernels of Irvingia spp, providing thus big calorific value (567.90±4.07 and 689.98±1.41 kcal/100 g DM). The fibers are recovered in important quantity in the leaves of all studied species (28.5±0.55% to 36.5±0.42%).
Conclusion: MFPs valorization could contribute to ensure the nutritional safety to Ivorian populations.

Keywords: mucilaginous food plants, nutritive characteristic, Côte d'Ivoire.

1. INTRODUCTION

The importance of the non ligneous foodstuffs in the food of the African populations is incontestable [1]. In a lot of countries, the food plants assure more than 80% of the food needs of the populations [2]. They are precious sources of nutriments, especially in farming environment where, they contribute to the satisfaction of the needs in proteins, minerals, vitamins, fibers, lipids, as well as to the contributions in functional constituents for the consumers well being [3]. In their big majority, the leafy vegetables are all year present on the markets, even during the periods of soldering. They play an inescapable role in the strategy of the food security of the populations and contributing thus to the nutritional balance and procuring by their sale, non negligible incomes to the families [4, 5, 6]. In Africa, the food habits of the populations knew changes bound to the life styles imposed by the setting process of the persons and the extraordinary development of the African cities [7]. Therefore, it lands more and more the linked problems of health to the non balanced food diets. In addition to the illnesses of deficiencies, the metabolic illnesses as obesity, diabetes, arterial high blood pressure and cancers become public health problems whose handling remains very heavy for persons and for the structures of health [8]. The promotion of some non ligneous forestry products and their integration in the food diets become inescapable for a good health and well being; it's the case of the mucilaginous food plants. Indeed, these plants, in addition to their richness in essential nutrients, constitute important sources of indispensable metabolites to a good health [9] thanks to their organoleptic properties, cut hunger, regulation of the blood sugar, tension, cholesterol and some parameters of homeostasis [10, 11]. The mucilages that they contain make them the primary commodities in the food of the populations of several regions of Cote d'Ivoire [12]. These plants can replace also some synthesis food additives whose abuse would be dangerous for health. Mucilage is a complex carbohydrate with a containing highly branched structure of variable proportions of L-Arabinose, D-Galactose, L-Rhamnose and D-xylose and of galacturonic acid [13, 14]. The possibilities of use of the mucilaginous plants are numerous. Mucilages are used in the agroalimentary, pharmaceutical and cosmetic domains [15, 16, 17, 18]. Concerning the food habits of the populations of numerous regions, the mucilaginous plants act as agent of swelling in the local culinary preparations [12]. They are also used in the flocculation and the decanting of numerous local drinks [19]. In the struggle against poverty and the pauperization of the populations of the villages and some African cities, the mucilaginous plants can constituted a non negligible source of incomes [20]. Therefore, the objective of this study is to contribute to a better valorization of the mucilaginous food plants, exits of the Ivorian flora, by a biochemical characterization of the different edible parts.

2. MATERIAL AND METHODS

2.1 Vegetable material

The biological material is constituted of different edible parts of 9 mucilaginous plants exits of Ivorian flora. It's notably about *Irvingia gabonenesis* (IG), *Irvingia wombolu* (IW), *Bombax buonopozense* (BB), *Adansonia digitata* (AD), *Beilschmiedia mannii* (BM), *Corchorus olitorius* (CO), *Myrianthus arboreus* (MA) and varieties of koto and tomi of *Abelmoschus esculentus* (AE). The kernels (IG and IW), leaves (CO, AD, MA and BB), fruits (BM and AE), calyx and flowers (BB) that constitute the parts consumed by several populations of Cote d'Ivoire have been collected (Table 1). These plants have been authenticated by the Centre National de Floristique (CNF) of the University Felix HOUPHOUET-BOIGNY.

Table 1: Some mucilaginous food plants of Ivorian flora

Designation	Family	Local name	Edible parts
Irvingia gabonensis (Aubry Lecomte)	Irvingaceae	Kaclou, Kplé	kernels
Irvingia wombolu (Vermoesen)	Irvingaceae	Kaclou, Kplé	kernels
Bombax buonopozense (P.Beauv)	Bombacaceae	Kapokier	calyx, leaves, flowers
Corchorus olitorius(Linn)	Tiliaceae	Kplala	Leaves
Adansonia digitata (Linn)	Bombacaceae	Baobab	Leaves
Myrianthus arboreus (P.Beauv)	Cecropiaceae	Tikliti	Leaves
Beilschmiedia mannii (Meisn)	Lauraceae	sran	Fruits
Abelmoschus esculentus(Linn) var. tomi	Malvaceae	Gumbo baoule	Fruits

Abelmoschus esculentus (Linn) var. koto	Malvaceae	Gumbo dioula	Fruits

2.2 Samples processing

The acquirement of the plants has been done in 3 big regions (Tonkpi, Bélier and District of Abidjan) of Cote d'Ivoire of January 2013 to December 2014. To achieve this study, 100 kg of fresh fruits and masts of the species *I. gabonensis, I. wombolu* and *B. mannii* have been bought to the farmer in the region of the Tonkpi. A same quantity of leaves, calyx and flowers of *B. buonopozense* has been harvested in the region of Bélier. As well as 100 kg of leaves of *C. olitorius*, *M. arboreus*, *A. digitata* and varieties tomi and koto of *A. esculentus* have been bought to the Gouro market in the District of Abidjan. In each of the regions, the different products have been collected to 3 farmers or sellers.

2.3 Treatment of the mucilaginous plants

The fruits of *Irvingia* have been stocked several days then the seeds have been ground to isolate the kernels. As for the fruits of *B. mannii*, they have been cut in small pieces (less than 5 mm of thickness) before drying. In return, the fruits of *A. esculentus* (gumbo) have been cut in gill, whereas the leaves, the calyx and the flowers were sorted, cleaned and drained before being dried. After drying, plants parts collected have been reduced in powder with a grinder of Heavy Duty mark.

2.4 studied parameters determination methods

2.4.1 Dry matter content

The method used for dry matter determination is the one described by [21] that consists to put to dry a sample until the obtaining of a constant mass. Thus, 10 g of sample has been weighed in a known mass capsule (m_0). Then the capsule containing the sample (m_1) has been placed in an oven (Memmert, Germany) at 105°C until constant weight. After cooling in desiccators, the capsule is weighed again (m_2). The content in dry matter has been expressed in percentage of mass as follows:

$$\text{Dry matter (\%)} = [(m_2 - m_0)/ (m_1 - m_0)] \times 100$$

m_0: mass (g) empty capsule
m_1: mass (g) capsule + sample
m_2: mass (g) capsule + sample after desiccation.

2.4.2 Ash content

The method used for ashes determination is the one described by [21] that consists to incinerate a sample until the obtaining of white ashes. Thus, 5 g of sample has been weighed in an incineration capsule in china of known mass (m_0). Then the capsule containing the sample (m_1) has been placed in a muffle furnace (PYROLABO, France) and incinerated to 550°C during 24 h. After calcinations and cooling in desiccators, the capsule is weighed again (m_2). The ash content has been expressed in percentage of mass as follows:

$$\text{Ash (\%)} = [(m_2 - m_0)/ (m_1 - m_0)] \times 100$$

m_0: mass (g) empty capsule
m_1: mass (g) capsule + sample before incineration.
m_2: mass (g) capsule + sample after incineration.

2.4.3 Lipids content

The contents in fat matters have been determined according to the method described by [22] and using the Soxhlet as extractor. Thus, 10 g of sample ground have been placed in a cartridge of extraction in cellulose and gulp by cotton. The cartridge has been introduced in the reservoir of a Soxhlet then the extraction of oil has been achieved by a system of flux and reflux of solvent with 300 mL of hexane. After 7 h of extraction, the solvent has been recovered with the help of a rotary evaporator (HEIDOLPH). The ball initially weighed and containing oil has been weighed to determine the mass of oil extracted. The content in fat matters has been expressed in percentage of mass as follows:

$$\text{Lipids (\%)} = (m / m_E) \times 100$$

m: mass (g) of oil extracted
m_E: mass (g) of sample ground

2.4.4 Proteins content

The raw proteins have been determined according to the method of Kjeldhal [21] from the dosage of the total nitrogen. In a matras of mineralization containing 1 g of sample, have been added a pinch of the catalyst successively (selenium) and 20 mL of concentrate sulfuric acid. The mineralization has been achieved, to 400°C during 2 h, in a digester (BUCHI). After cooling to the ambient temperature, mineralized it has been decanted in a vial sized up of 100 mL and completed with distilled water. To a solution of 10 mL of mineralized, are added 10 mL of NaOH 40% (p/v) and the mixture has been placed in the distiller's reservoir. The extension of the distiller's refrigerator has been dived in a ball

containing 20 mL of boric acid added of a mixed indicator (red of methyl + green of bromocresol). The distillation has been achieved during 10 min until the obtaining of a purple distillate. The distillate has been measured out by a solution of sulfuric acid 0,1N until the green turn. A white has been achieved with the distilled water. The content in total proteins has been expressed in

$$\textbf{Proteins (\%)} = [(V_1 - V_0) \times 14 \times 6.25] \times 10 \times m_e$$

percentage of mass as follows:

V_0: volume (mL) of sulfuric acid (0,1N) added to white.
V_1: volume (mL) of sulfuric acid (0,1N) added to sample.
m_e: mass (g) of sample ground

2.4.5 Total and reducing sugars content

2.4.5.1 Extraction of the ethanosoluble sugars

The ethanosoluble sugars are extracted according to the method described by [23]. A trial hold of 1 g of sample has been diluted in 10 mL of ethanol (80%; v/v). To the gotten mixture have been added 2 mL of zinc acetate (10%; p/v) and 2 mL of oxalic acid (10%, p/v). The mixture has been centrifuged then at 3000 rpm for 10 min. The cheek has been taken with 10 mL of ethanol (80%; v/v) centrifuged then again at 3000 rpm for 10 min. The supernatant has been decanted in a vial of 50 mL and the excess of ethanol evaporated to the sand bath during 10 min. Then the gotten solution has been completed to 50 mL with the distilled water.

2.4.5.2 Total sugars content

Total sugars content has been determined according to the method to the phenol-sulphuric as described by [24]. 100 µL of ethanosoluble sugars extracted have been introduced in a test glass then 0.9 mL of distilled water, 1 mL of phenol 5% (p/v) and 5 mL of concentrate sulfuric acid have been successively added. After agitation then cooling of the tube, the absorbance has been read to the spectrophotometer (PG INSTRUMENTS) at 490 nm, against a white. The determination of the quantity of total sugars has been achieved from a range of glucose solution mother (1 mg/mL) realized in the same conditions that the test.

2.4.5.3 Reducing sugars content

The quantification of reducing sugars has been achieved according to the method of [25]. To 1 mL of sugars ethanosoluble extract contained in a test glass has been added 0.5 ml of distilled water and 0.5 mL of DNS solution. The whole has been heated to the boiling bath, during 5 min. After cooling, 2 mL of distilled water has been added then the absorbance of the solution has been read to the spectrophotometer (PG INSTRUMENTS) at 540 nm, against a white. Range standards established in the same conditions that the test from a solution mother of glucose (1 mg/mL) permitted to determine the quantity of reducing sugars.

2.4.6 Carbohydrates

Carbohydrates content has been determined by difference according to the following formula [26]:

% Carbohydrates = 100 - (% Lipids + % proteins + % Ash + % fibers)

2.4.7 Fibres content

The raw fibres regroup the cellulose, some hemicelluloses and the lignine. The contents in raw fibres have been determined by the method of [27]. So, 1 g of sample (m) has been carried to boiling point in 50 mL of sulfuric acid (1,25 N) then in 50 mL of sodium carbonate (1,25N) during 1 h. The gotten residual is dried to 105°C during 8 h (m_1) incinerated then to 550°C during 3 h (m_2). The content in total raw fibres expressed in percentage of dry matter has been determined by the formula**:**

$$\textbf{Fibres (\%)} = [(m_1 - m_2)/ (m \times DM)] \times 100$$

DM= Dry matter

2.4.8 Polyphenols content

Polyphenols content was determined using the method reported by [28]. A quantity (1 g) of dried powdered sample was soaked in 10 mL of methanol 70% (w/v) and centrifuged at 1000 rpm for 10 min. An aliquot (1 mL) of supernatant was oxidized with 1 mL of Folin-Ciocalteu's reagent and neutralized by 1 mL of 20% (w/v) sodium carbonate. The reaction mixture was incubated for 30 min at ambient temperature and absorbance was measured at 745 nm by using a spectrophotometer (PG Instruments, England). The polyphenols content was obtained using a calibration curve of Gallic acid (1 mg/mL) as standard.

2.4.9 Energy value

The theoretical calorific value of the samples of plants has been calculated from the specific coefficients for proteins, lipids and carbohydrates [26].

Energy value (kcal/100g DM) = (% Proteins x 2.44) + (% carbohydrates x 3.57) + (% Lipids x 8.37)

The results of ash, fibres, proteins, lipids and carbohydrates contents were expressed on dry matter basis (DM).

2.5 Statistical analysis

All the analyses were performed in triplicate and data were analyzed using the software SPSS (SPSS 16.0 for Windows, SPSS Inc.). It consisted in a variance analysis (ANOVA) to 1 criteria of classification (parts of the plants). The averages have been compared by the test of Newman Keuls at 5%. A principal components analysis (PCA) has been achieved also and the coordinates of the individuals of the PCA have been used for an ascending hierarchical clusters analysis (AHC) at 1500 by STATISTICA 7.1 (StatSoft). The 2 groups descended of the AHC have been characterized either by their richness in energy, lipid, protein and fibre, either by a wealth in polyphenols, reducing sugar and carbohydrates. The PCA also permitted to structure, to distribute and to regroup the similar individuals.

3. RESULTS

All biochemical parameters differentiate ($p < 0.001$) the food resources studied (table 2 and 3). Indeed, the dry matter contents are consisted between 15.40±1.11% and 94.70±0.15%. The kernels provide dry matters contents more than 91%. To the level of the ash contents, the averages fluctuate between 2.15±0.14% and 10.70±0.07% of dry matter. The table 2 shows that the leaves of *A. digitata* (10.70±0.07%), *M. arboreus* (10.01±0.61%) and *B. buonopozense* (8.40±0.12%) and the fruits of *A. esculentus* (10.02±1.24% to 10.30±0.68%) are provided more in ashes.

The presence of polyphenols is also various in the studied samples ($p < 0.001$). However, the kernels contain the weakest contents in polyphenols (<100 mg/100 g DM), whereas the fruits of *B. mannii* (439.86±0.56 mg/100 g DM), the leaves of *A. digitata* (375.96±0.90mg/100 g DM) and the different parts of *B. buonopozense* (436.39±0.50 in 521.76±5.13 mg/100 g DM) are some well provided.

The samples of studied mucilaginous food plants present variable carbohydrates contents ($p < 0.001$). The kernels of *I. wombolu* contain the weakest carbohydrates content (10.33±0.04%) whereas the fruits of *B. mannii* are the more of them provided (60.64±0.71%). In return, the leaves of *B. buonopozense* (1.12±0.33%) and the fruits of the variety *koto* of *A. esculentus* presents less non polymerized sugars (1.67±0.41%) that the other samples that have 2.44±0.36% to 8.10±0.55%. Some of these carbohydrates have reducing properties. The table 2 shows that the reducing sugars are less present in the kernels (0.49±0.35% and 0.60±0.09%) but more concentrated in the flowers of *B. buonopozense* (3.76±0.05%).

Concerning the fat matter, the kernels provide contents of 55.79±1.45% and 75.99±2.25%, superior to the values descended of the samples of fruits, leaves and mucilaginous flowers that oscillate between 0.62±0.74% and 5.79±0.84% (table 3).

With an average of 5.25±0.15%, the kernels are statistically less provided in proteins that the other analyzed food resources. The strongest contents in proteins are observed in the leaves that contain 10.06±0.85% to 12.69±0.64%. To the level of the fibres, the contents vary from 29.55±0.15% to 36.50±0.51% in the fruits, leaves and mucilaginous flowers, but they are statistically more reduced in the kernels (11.6±1.18% and 4.53±0.89%).

From their biochemical composition, the samples of kernels present a calorific value (567.90±4.07 and 689.98±1.41Kcal/100 g DM) superior to flowers, fruits and leaves value that varies from 185.44±0.36 to 246.81±1.73 Kcal/100 g DM (table 3).

Table 2: Biochemical composition of mucilaginous food plants consumed in Côte d'Ivoire.

Edible parts	DM	TCE	TPT	TST	TSR
	(% FM)	(%DM)	(mg/100 g DM)	(%)	(%)

Kernels	**IG**	94.70±0.15^{A}	2.66±0.17^{H}	16.34±0.43^{I}	2.44±0.36^{I}	0.60±0.09^{J}
	IW	91.60±0.23^{B}	2.15±0.14^{I}	71.82±1.09^{H}	4.27±0.67^{F}	0.49±0.35^{K}
Fruits	**AE-*koto***	16.98±0.75^{H}	10.30±0.68^{B}	118.38±0.75^{G}	1.67±0.41^{J}	1.47±0.86^{E}
	AE-*tomi*	18.56±0.25^{G}	10.02±1.24^{C}	116.40±2.11^{G}	8.10±0.55^{A}	0.78±0.44^{H}
	BM	89.24±0.57^{C}	3.50±0.13^{G}	439.86±0.56^{C}	5.74±0.34^{E}	2.17±0.72^{B}
Leaves	**AD**	20.87±0.18^{E}	10.70±0.07^{A}	375.96±0.90^{D}	3.53±0.78^{G}	1.21±0.31^{G}
	CO	15.40±1.11^{I}	6.11±0.91^{E}	171.38±1.50^{E}	6.93±0.22^{D}	1.61±0.59^{D}
	MA	19.25±1.69^{F}	10.01±0.63^{C}	151.90±3.75^{F}	3.12±0.98^{H}	1.25±0.02^{F}
	BB	21.79±0.23^{D}	8.40±0.12^{D}	482.05±0.37^{B}	1.12±0.33^{K}	0.67±0.47I
Flowers	**BB-*calyx***	16.89±0.62^{H}	6.20±0.75^{E}	521.76±5.13^{A}	7.21±0.64^{C}	1.76±0.63^{C}
	BB-*flower*	18.96±0.37^{FG}	5.02±0.24^{F}	436.39±0.50^{C}	8.03±1.01^{B}	3.76±0.05^{A}
	F	41886.98	6098.43	4705.77	218613.9	6307.75
	p_{-value}	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**

Means in column with no common letter differ significantly (P<0.001) for each plant parts. Data are represented as means ± SD (n=3). F, statistical value of ANOVA ; p_{-value}, probability value of ANOVA ; DM, dry matter content ; TCE, ash content; TST, total sugars content ; TSR, reducing sugars content ; TPT, polyphenols content.

Table 3: Biochemical composition of mucilaginous food plants consumed in Côte d'Ivoire

Edible parts		TGT (%)	TMG (%)	TPR (%)	Fibres (%)	VEN (Kcal/100g DM)
Kernels	**IG**	24.7±0.33^{I}	55.79±1.45^{B}	5.25±0.15^{J}	11.6±1.18^{I}	567.90±4.07^{B}
	IW	10.33±0.04^{J}	75.99±2.25^{A}	7.00±0.08^{H}	4.53±0.89^{J}	689.98±1.41^{A}
Fruits	**AE-*koto***	45.33±0.47^{F}	3.74±0.09^{D}	9.63±0.33^{E}	31±0.71^{F}	216.58±6.11^{E}
	AE-*tomi*	43.56±0.11^{G}	1.61±0.67^{F}	8.31±0.96^{F}	36.5±0.51^{A}	189.24±2.08^{I}
	BM	60.64±0.71^{A}	0.62±0.74^{H}	5.69±1.25^{I}	29.55±0.15^{H}	235.54±7.83^{D}
Leaves	**AD**	42.7±0.12	2.71±0.11^{E}	10.06±0.85^{D}	33.83±0.73^{E}	199.65±1.04
	CO	46.89±0.88^{E}	5.79±0.84^{C}	12.69±0.64^{A}	28.52±0.55	246.81±1.73^{C}
	MA	40.22±0.36^{H}	1.56±0.20^{F}	11.81±0.69^{B}	36.4±0.42^{B}	185.44±0.36^{J}
	BB	49.31±0.94^{B}	1.12±0.82^{G}	10.94±0.53^{C}	30.25±0.09^{G}	212.09±2.44^{G}
Flowers	**BB-*calyx***	47.26±1.05^{D}	1.01±0.54^{G}	9.63±0.01^{E}	35.9±0.20^{C}	200.65±8.06^{H}
	BB-*flower*	48.61±0.44^{C}	2.73±0.05^{E}	7.88±0.66^{G}	35.76±0.19^{D}	215.60±4.01^{F}
	F	51878.65	285856.57	21301.71	36824.27	54722.64
	P-value	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**

Means in column with no common letter differ significantly (P<0.001) for each plant parts. Data are represented as means ± SD (n=3). F, statistical value of ANOVA ; p_{-value}, probability value of ANOVA TMG, lipid content ; TGT, carbohydrate content; TPR, protein content ; VEN, energy value.

3.1 Biochemical contents variability

The principal components analysis has been done while considering the first two factors (F1 and F2) that express the biggest part of the variability (79.14%). The projection of the biochemical contents and the parts of studied plants is presented on the figure 2. This representation regroups the kernels around the strongest lipoids contents (55.79% and 75.99%)

and calorific value (567.90 and 689.98 Kcal/100 g DM); whereas the leaves are the biggest sources of proteins (10.06% to 12.69%). Concerning the samples descended of the flowers, they provide the strongest carbohydrates contents (reducing sugars and carbohydrates) and polyphenols content. In return, the fruits are more concentrated in carbohydrates constituent (total sugars, reducing sugars, carbohydrates) and polyphenols, either in proteins. The classification of the samples in the figure 3 confirms this structuring. Besides, it reveals that the leaves are not all more concentrated in proteins and fibres; nor all fruits in carbohydrates and polyphenols.

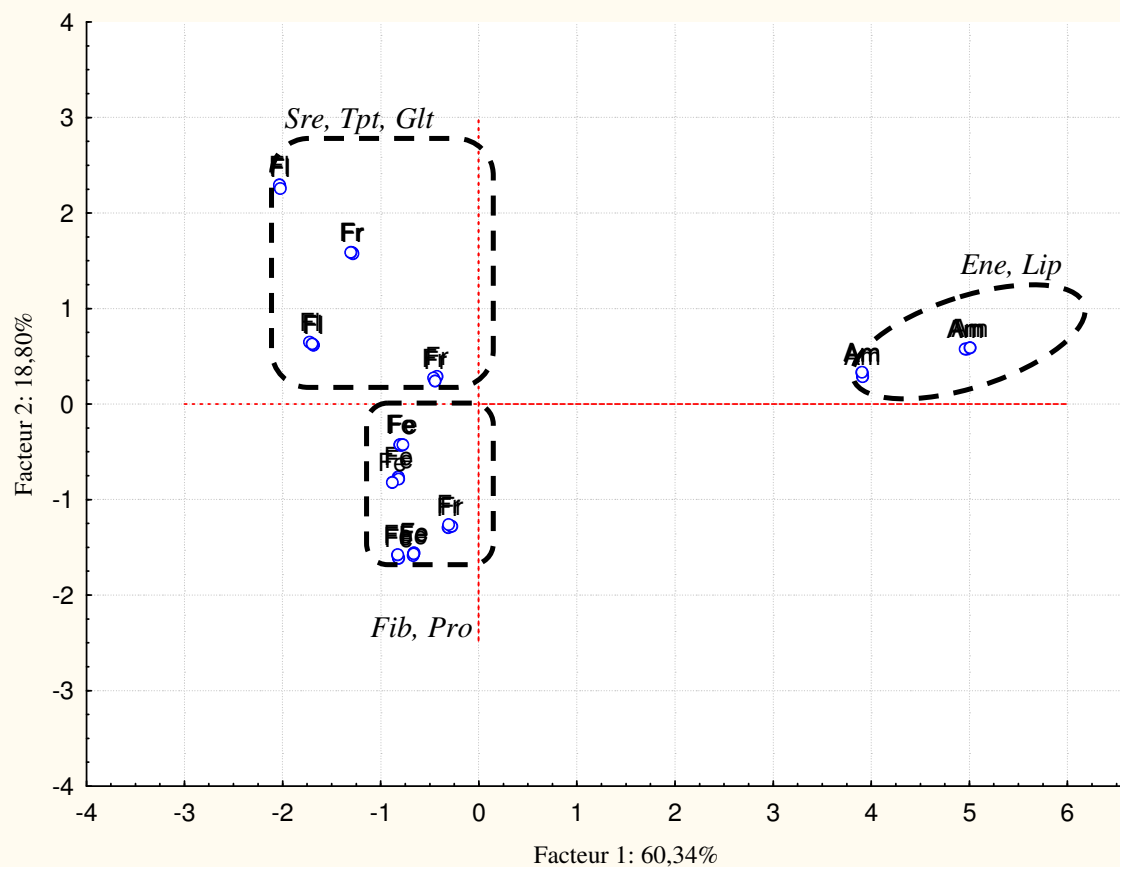

Figure 2: Regrouping of the biochemical contents and edible parts of the mucilaginous plants in the plan formed by the factors F1 and F2 of the principal components analysis.

Fr, fruits ; Fe, leaves ; Fl, flowers ; Am, kernels ; Fib, fibres ; Pro, proteins ; Sre, reducing sugar ; TPt, polyphenols Ene, energy ; Lip, lipids

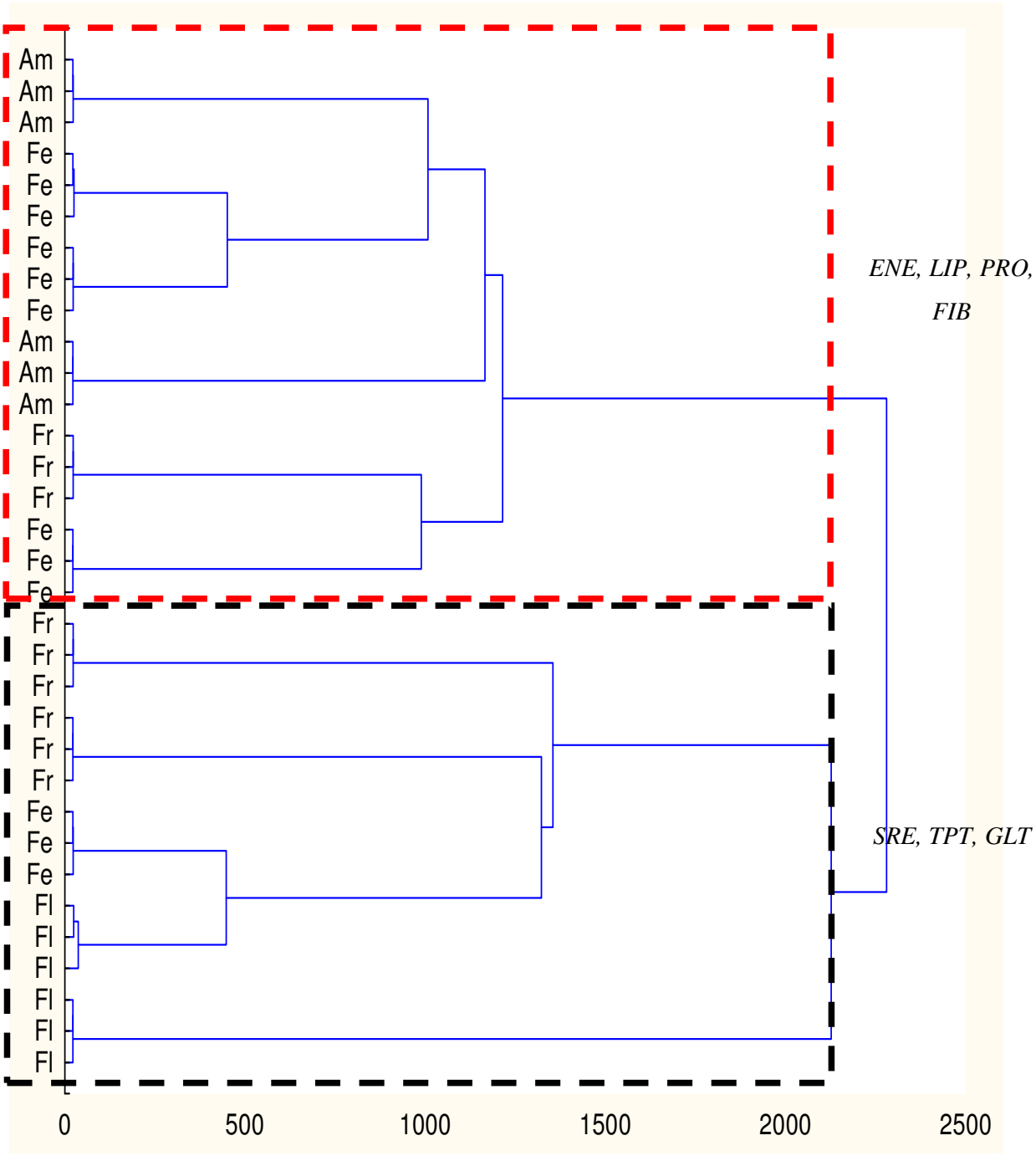

Figure 3: Dendrogram representing ascending hierarchical classification of the parts of the mucilaginous plants according to the biochemical contents.

Fr, fruits; Fe, leaves; Fl, flowers; Am, kernels

4. DISCUSSION

The kernels of *Irvingia* and the fruits of *B. mannii* distinguished themselves by a strong content in dry matter superior to 89% of the fresh matter contrarily to leaves, flowers and fruits of *A. esculentus* at which weak contents (20.87%) have been found. These last contain strong contents therefore in water. The strong contents in dry matters could be bound to an important presence of organic molecules in the samples. [29] found some contents in water similar to ours in the leaves of *B. buonopozense* (78.85%) and the fruits of *A. esculentus* (80.85%). This wealth in water would be favorable to a big sensitivity to the biologic and physicochemical agent's actions of deterioration [30, 31]. In return, to the level of the leaves of *M. arboreus* (19.25%), [12] found more dry matters contents (36%).
The studied leaves (6.11% to 10.70%), the fruits of *A. esculentus* (10.30% and 10.02%) presented the most important ash contents. [32] found some concentrations in the fruits of *A. esculentus* near of ours (9.63%) while [33] discovered bigger ashes proportions in the leaves of *M. arboreus* (16.4%). It's right to indicate that the ashes gotten after incineration of the organic matter are essentially constituted of minerals. It results some that the samples rich in ashes could present considerable quantities of minerals. It's especially plausible than the terminal parts of the plants, notably leaves and fruits, are preferential zones of mineral accumulation [34].

The study also shows that the leaves, the fruits and the flowers are more concentrated in polyphenols, especially to the level of *B. buonopozense* (436.39 to 521.76 mg/100g DM), *A. digitata* (375.96 mg/100 g DM) and *B. mannii* (439.86 mg/100 g DM). For the leaves of *C. olitorius* (171.38 mg/100 g DM), [35] found more elevated contents (244.20 mg/100 g DM). This character is an important advantage in the valorization of the plant food resources. Indeed, polyphenols are important antioxidant agents that protect the biologic macromolecules against the deterioration. Thus, they fight efficiently against the ageing and the intervening of cancerous cells [36, 37]. The food base on mucilaginous plants could provide to the needs in polyphenols of the organism and reinforce population's health.

Carbohydrates are more concentrated in the leaves, fruits and flowers in the proportions of 40.22% to 60.64% DM. The kernels provided less elevated contents (10.33% and 24.70% DM) in accordance with those found (15.77% to 38.54% DM) by [38]. The contents gotten in total sugars (6.93% DM) and reducing sugars (1.61% DM) in the leaves of *C. olitorius* are extensively lower to those (respectively 43.35% and 39.76% DM) of [39].

The majority of the parts of mucilaginous food plants provided some contents in fat matters lower to 6% DM as well as confirmed by [29] on the fruits of *A. esculentus* (0.40%) and the leaves of *B. buonopozense* (0.70%). However, the studied kernels generally presented contents more than 55% of fat matters. This observation has been confirmed by several previous works [40, 41, 42]. The lipids being indispensable to the organism of by their implication in the cerebral functions and their role in the absorption of the fat-soluble vitamins [43, 44], the important contents in fat represent an advantage for a valorization of the kernels in the oleaginous path like peanut and palm oil.
The leaves, fruits and studied mucilaginous flowers provided some contents relatively in protein in the order of 10.06%. [45] got some contents (11.2%) in the leaves of *A. digitata* near of ours. In return, [46] had bigger concentrations (20.06%) to the level of the leaves of *C. olitorius*. The good proportions could be beneficial to the populations because proteins are essential to the formation and to the repair of the bodily tissue as well as antibodies production, to the functioning and to the growth of the cells [47]. Also, [48] showed the interference of the agricultural techniques with the contents in protein because the use of nitrogenous manure during production could influence the concentrations.
The leaves, fruits and flowers of this study expressed some contents in fibres confirmed by the results gotten by [33] on some mucilaginous plants. The found contents are raised relatively and are located in the order of 29%. In fact, the gluey aspect of sauces, phenomenon valued by several consumers, is the work of mucilage produces by the fibres. These fibres play an important role in the metabolism of the lipids and carbohydrates. They reduce the risks of constipation, of cancer of the settler and especially of blood sugar by lowering the intestinal absorption of the glucose [10, 49, 50]. The fibres also warn the absorption of a cholesterol excess [11].
The kernels generate the biggest energy values. Our results are in conformity with those of [51] on the energizing tendency of some plants consumed by the populations. The consumption could be recommended therefore at the time of intense muscular activities. To the contrary, leaves, flowers and fruits have weak energy values, corroborative the deductions of [52] and [53] on most mucilaginous food plants. However [54] found a very weak energy values for *M. arboreus* (83.52 Kcal/100g). So, the consumption of mucilaginous food plants could be often beneficial to the adult population's victims of metabolic illnesses as the arterial high blood pressure, the hyperglyceamia and the hypercholesterolemia [55].

5. CONCLUSION

The study on the biochemical factors of some mucilaginous food plants of Cote d'Ivoire reveals that the leaves, the fruits and the flowers are richer in ashes, carbohydrates, proteins, polyphenols and fibres, with however, weak contents on dry matters and energy values. To the look of the different assets of the biochemical factors, the consumption of these parts would be important for the human health. They could permit to fight against the diabetes, the arterial high blood pressure, the cancer, the obesity and the illnesses of senile origin. The kernels provided relatively raised contents in lipids and energy values also. They would be able recommended in the food diets of people exercising some activities to strong caloric needs. The classifications done from the PCA and AHC regrouped the mucilaginous food plants in 2 tendencies, on the one hand, the group of the parts judged rich in lipids, energy, proteins and fibres and on the other hand, the parts judged rich in polyphenols, reducing sugars and carbohydrates. This classification would orient the population's consumers in the better satisfaction of their needs in nutriments.

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