Nutritive compounds from leaves of *Moringa oleifera* L. and beans of *Vigna unguiculata* W. for improvement of the meal deriving with new shoots of *Borassus aethiopum* M. in Côte d'Ivoire.

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***Abstract** - The nutritive compounds of the shoots of Borassus aethiopum M. consumed in Côte d'Ivoire is not yet revealed whereas popularization of this plant's basis food recipes is planned. The current study investigates the nutritive parameters of new shoots of Borassus aethiopum M., leaves of Moringa oleifera L. and beans of Vigna unguiculata W. in order to improve their valorization. Initially, samples of Palmyra are processed into meal, while powders are produced from those of Moringa and Cowpea. Then, seven nutritive traits performed from these derived products allow comparison of the studied food resources. The work showed a great divergence (P<.01) between the samples relating to the whole parameters. Thus, the leaflets powder of Moringa is more provided in ash (4.19±.05 g/100 g), lipids (8.35±.01 g/100 g) and fibers (5.74±.01 g/100 g) than samples resulting from Cowpea and Palmyra. On the other hand, the powder of Cowpea beans highlights the greatest proteins content (27.24±.13 g/100 g); whereas the meal deriving from shoots of Palmyra represents the most significant source of carbohydrates, either fermented (84.10±.11 g/100 g) or unfermented (83.79±.10 g/100 g). The meal of Palmyra is also richer in soluble sugars (5.19±.01 to 5.23±.01 g/100 g), moister (9.90±.03% to 10.03±.04%) and has the most significant caloric energy value (315.03±.10 to 315.41±.10 kcal/100 g).*

The new shoots tubers, leaves and beans of respective Palmyra, Cowpea and Moringa plants are with diverse nutritive composition. Their uses in composite food formulations could contribute in preservation of the biodiversity, to ensure food safety for populations and to address the poverty and wilderness concerns.

Key words: Palmyra new shoots tubers, Moringa, Cowpea, meal, nutritive compounds.

I. INTRODUCTION

Borassus aethiopum Mart, known as Palmyra, is a wild palm tree [1] within the plant family of Arecaceae. It is met in the tropical areas of Asia and Africa, especially in the sub-Saharan environment. In Côte d'Ivoire, Palmyra is mainly located in the central region where it represents a sentry against the wilderness projection. This palm tree is one of the unwoody forest products and can reach 20 to 30 m of height [2]. It allows uses in technology [3], traditional medicine [4, 5] and is recommended in the reafforestation to curb the wilderness projection [6]. It is also used in food [7, 8]. Thus, in Côte d'Ivoire, several farmers utilize the Palmyra at the adult stage for production of palm wine, a fermented drink resulting from its sap [9]. However, this production usually involves destruction of the plant phloem or heart. Nevertheless, palm wine production is practicable from other organs such as the unopened inflorescences of the palm trees [10]; with advantage in maintaining the plant's life. Unfortunately, the destruction of the plant heart during the palm sap production results in its earlier and systematic death [11] threatening the biodiversity. Besides, many populations use the new shoots of Palmyra, resulting from the germination of seeds, for food purposes. Facing all the ecological risks incurred, this way of valorization seems to be a real alternative in the plant's uses, and could ensure its survival and popularization, with significant value-added at nutritional, economical and therapeutical levels. Indeed, Palmyra trees provide numerous fruits each year, the most part of which are unutilized and go rotten before germinating [11, 12]. Several research tasks have been performed concerning these fruits. Thus, from the fruit pulp, Ezoua *et al.* [9] produced a juice richer in soluble sugars, especially sucrose, glucose and fructose. Diby *et al.* [13] also obtained fruit pulp nectar which could possibly undergo alcoholic fermentation. Other researches accounted pectins resulting from the Palmyra fruits. Each fruit encloses two or three seeds generating potentially new growths after germination.

The young Palmyra shoots are tuberous and edible foods highly valued by the local populations as energeous food resource [14]. They are often processed into flour for the preparation of porridge or local *fufu* [8]. The flour of Palmyra is richer in starch and can undergo alcoholic fermentation after hydrolysis with the gastric juice deriving from *Archachatina ventricosa* as mentioned by Niamké *et al*. [2]. Other attempts revealed the preventive effect provided by the consumption of young shoots of Palmyra against the gastro duodenal ulcers and the sickly fever [15, 16]. Yet, as the most of starchy foods, the young shoot tubers of Palmyra would be with lower proteins, mineral elements and vitamins contents. In this case, meals prepared on those tubers basis should be improved with other local edible vegetable sources, particularly with cowpea (*Vigna unguiculata* Walp) and moringa (*Moringa oleifera* Lam) which have ability to correct the nutritional deficiency, referring to the recommendations of the *codex alimentarius* [17]. The cowpea contains high quality proteins in significant contents of 23% to 25% [18, 19]. Regarding with moringa, the nutritional interest is related to the leaflets which have good minerals and vitamins properties (El Massry *et al.*, 2013) [20]. Moreover, they contain the 8 or 9 human essential amino acids [21], accounting cowpea as an exceptional case of the plant kingdom.

Considering their food interest, the development of composite dishes with Palmyra new shoots basis, improved with the moringa leaflets and the cowpea beans, could benefit to populations. However, it is highly vital to control the nutritive compounds of these three food raw materials before any formulation. The running study is a comparative investigation about the nutritive components of the flour deriving from new shoots tubers of *Borassus aethiopum* Mart, and powders of leaflets of *Moringa oleifera* Lam and beans of *Vigna unguiculata* Walp, collected from the Ivorian flora, for their fitting development.

II. MATERIAL AND METHODS

2.1 Plant material

The plant material consisted in the flour processed from new shoots tubers of Palmyra, and powders of moringa leaflets and cowpea beans.

2.2 Methods

2.2.1 Sampling

The samples were collected between August and December 2015 from three localities, especially Toumodi, Dimbokro and Didiévi, in the Centre Region which remains the natural ecological zone accommodating with Palmyra in Côte d'Ivoire and where large quantities of cowpea and moringa are also produced. Three (3) retailers of Palmyra shoot tubers and cowpea beans were considered for each town. Thus, 30 kg of tubers and 10 kg of cowpea beans were perceived from each retailer, giving total of 270 kg of Palmyra tubers and 90 kg of cowpea beans. In addition, 50 kg of fresh leaflets of moringa were collected from two (2) sites for each town, 25 kg/site, leading to 150 kg (50 kg x 3) of leaflets. Once acquired, the samples have been conveyed to the laboratory for analysis. At the laboratory, a pool was constituted by mixing samples deriving with each plant species. Then, 250 kg of shoots tubers, 75 kg of cowpea beans and 75 kg of moringa leaflets were deducted, sorted, washed with distilled water and processed according to diagrams of Fig. 1 and 2.

2.2.2 Preparation of the flour from Palmyra new shoots tubers

The production of the Palmyra flour is presented at Fig. 1. The new shoots tubers were thirstly washed with water then drained. They were heated with boiling distilled water for 15 minutes. Then, tubers were peeled and carved into approximate 5 mm thickness pieces. These pieces were rinsed with distilled water then set out into 2 batches. One batch was put into a tank containing water for fermentation. The tank was hermetically closed and preserved from ambient temperature during 24 h **[22]**. After fermentation, the tubers pieces were strained and placed in a ventilated oven (Minergy Atie Process, France) for 6 h of continuous drying at 65 °C. The unfermented second batch of tubers pieces was also dried under the same conditions. After drying, the pieces of Palmyra tubers were ground using a hammer mill (Forplex).

2.2.3 Preparation of the powders from Moringa leaflets and Cowpea beans

As soon as they reached the laboratory, moringa leaflets were manually separated from their petiole then sorted to take out the damaged ones. They were then disinfected for 5 min with chlorinated water (50 mL of 8% sodium hypochlorite in 30 L of distilled water). After rinsing with distilled water and straining for 30 minutes, leaflets were put into a tank for 24 h of fermentation. Then, leaflets were put to ambient drying at 30 °C for 10-14 days out of the sun before being powdered. Regarding with Cowpea, beans were washed and soaked in distilled water for 5 h, drained, strained and taken to sprouting at 30 °C during 48 h. Then, the seeds were dried at 40 °C in an oven (Minergy Atie Process, France) for 96 h. The resulted malt was sprout out, heated for 15 min in boiling distilled water and taken to fermentation for 24 h in a hermetical tank containing distilled water. After fermentation, the Cowpea beans were taken out, strained, roasted then dried at 50 °C in the oven for 24 h before grinding (Fig. 2).

For resulting in homogeneous particles size from all samples, flour and powders were filtered using sieves with 250 µm diameter. The final filtered flours and powders were put in polyethylene hermetic bags and kept into a dry place until the analyses.

2.2.4 Determination of the nutritive compounds

The nutritive assessment concerned the contents of moisture, proteins, lipids, carbohydrates, ash and fibers. The caloric energy values of the meals were also calculated.

A. Moisture content

The moisture content was determined by drying 5 g of meal at 105 °C in an oven till constant weight upon a two-digit scale. The weight loss after ovening allowed deduction of the water content [23].

B. Proteins content

The proteins content was based on the total nitrogen of each meal sample according to Kjeldhal method. Thus, 1 g of meal was mineralized at 400 °C for 2 h, with adding of concentrated sulfuric acid and potassium sulfate catalyst. The outcome solution was diluted with distilled water and sodium hydroxide was added to, then, distilled for ten min. Thereafter, the distillate collected in a flask containing boric acid and methylen bromocresol reagents, was taken to titration of the total nitrogen with a 0.01 N sulfuric acid solution. A factor of 6.25 was used to convert the total nitrogen into proteins content [23], according to the equation (1) hereafter.

$$\textbf{Proteins content (g/100 g) = Total nitrogen content (g/100 g) x 6.25}$$

C. Lipids content

Lipids were quantified by solvent extraction using hexane and Soxhlet device for 7 h **[23]**. The hexan-oil mixture resulted from the extraction was separated with a rotavapor and the sample's weight difference before and after the essay stated on the lipids content.

D. Ash content

The ash contents were determined by incineration in an electric muffle oven. Five grams of sample were beforehand carbonized on a Bunsen burner, and then placed into the oven at 550 °C for 12 h. Thereafter, the white derived residue was weighed expressed in ash percentage.

E. Fibers content

The determination of the crude fibers percentage consisted in treatment of 2 g of meal with 50 mL of 0.25 N sulfuric acid and 50 mL of 0.31 N sodium hydroxide and filtration of the outcoming solution upon Whatman paper. The residue was dried for 8 h at 105 °C then incinerated at 550 °C for 3 h into ovens [23]. The crude fibers content was deducted according to the equation (2) below:

$$\text{Crude fibers content (\%)} = (W_1 - W_2) \times 100 / W_e$$

With W_1, weight of the residue ovened (g); W_2, ash weight after incineration (g); W_e, weight of the essay (g).

F. Contents of Total glucides, Total soluble carbohydrates and reducing sugars

Total glucides were quantified accounting the contents derived with proteins, moisture, lipids, fibers and ash as indicated by FAO **[24]** in the following formula (3):

Total Glucides Content (%) = 100 - [Prot + Lip + Moi + Ash + Fib]

With Prot, Lip, Moi, Fib: respective contents of proteins, lipids, moisture and fibers.

Ethanosoluble glucides were extracted from 1 g of meal with 20 mL of 80% (v/v) ethanol, 2 mL of 10% (m/v) zinc acetate and 2 mL of 10% (m/v) oxalic acid. The extract was centrifuged at speed of 3,000 rpm for 10 min. The ethanol residue was evaporated from the extract upon a hot sand bath. Then, the extracted total soluble sugars were measured out with the method of Dubois *et al*. [25]. That consisted in adding 0.9 mL of distilled water, 1 mL of 5 % (m/v) phenol and 5 mL of 96% sulfuric acid into 100 µL of extract, then measuring the absorbance at 490 nm with a spectrophotometer (PG instruments). For the reducing sugars, 1 mL of extract was processed with 0.5 mL of distilled water and 0.5 mL of 3, 5- dinitrosalycilic acid [26] prior to the recording of the absorbance from the final solution at 540 nm with spectrophotometer. alibrations were performed with standard solutions of glucose and sucrose.

G. Caloric Energy value

The caloric value of nutritive energy outcoming from the meals samples was calculated using coefficients related with the main macronutrients, especially proteins, lipids and glucides [24] as stated below (4):

Caloric Energy value (Kcal/100 g) = [(2.44 x Prot) + (8.37 x Lip) + (3.57 x Glu)]

*With **Prot, Lip**, **Glu**,contents of proteins, lipids and total glucides.*

2.2.5 Statistical analysis

The data were gathered on EXCEL software and statistically investigated with Statistical Program for Social Sciences (SPSS 22.0 for Windows). The statistical test consisted in a one-way analysis of variance (ANOVA) with the type of meal assessed basis. From each parameter, means were compared using Student Newman Keuls post hoc test at 5% significance level. In addition, Multivariate Statistical Analysis (MSA) was performed through Principal Components Analysis (PCA) using STATISTICA software (version 7.1).

III. RESULTS

3.1 Moisture contents of the food resource meals

The moisture differentiates ($p<.001$) the studied meals. The flour derived with fermented new shoot tubers of Palmyra shows the greatest moisture (10.03%) whereas samples resulting from moringa are the least wet (6.98%). The samples of unfermented Palmyra tubers and cowpea beans provide 9.90% and 7.94% of respective moisture percentage (Table I).

3.2 Nutritive compounds of the studied meal samples

Table I also reveals high divergence ($p<.001$) between the samples regarding with the whole nutritive parameters assessed.

With a mean of 27.24 g/100 g, the powder of Cowpea beans are more provided with proteins, followed by leaflets powder of moringa (25.81 g/100 g). But, the flours of fermented or unfermented shoots tubers of Palmyra highlight the fewest proteins contents (3.06 and 2.71 g/100 g, respectively). The samples deriving with Palmyra also contain low lipids (1 g/100 g) compared to both of the other studied vegetables. The greatest lipids content is recorded from Moringa (4.19 g/100 g). For the ash, the powder of the Moringa leaflets gives higher content (8.35 g/100 g) than the values involving with the three other raw materials. The mean of ash contents from Cowpea samples is 3.32 g/100 g, when flour samples of Palmyra reveal lower than 0.8 g of ash per 100 g. Also, Moringa is richer in fibers (5.74 g/100 g) than Palmyra and Cowpea, which contain means of fibers contents included between 1.23 g/100 g and 1.73 g/100 g (Table I). On the other hand, the Palmyra flour either fermented or not is strongly provided in glucides, with contents of more than 80 g/100 g; whereas 100 g of powders from Moringa leaflets and Cowpea beans record respective glucides content of 48.93 g and 57.76 g. Moreover, the ethanosoluble glucides are more present in the flours resulting from fermented and unfermented Palmyra tuber samples (5.19 g/100 g and

5.23 g/100 g, respectively) compared to both powders from Cowpea (4.10 g/100 g) and Moringa (3.02 g/100 g). However, the Palmyra samples are with only between 0.57 g/100 g and 0.60 g/100 g of reducing soluble sugars; the greatest reducing sugar content deriving from Cowpea (2.85 g/100 g).

Accounting overall nutrients assessed, the shoots tubers flours of Palmyra are more caloric. They provide energy values about 315kcal/100 g, which is higher compared to 272.73kcal/100 g and 289.58kcal/100 g recorded for Moringa leaflets and Cowpea beans, respectively (Table I).

The data of the flours processed for the new shoots of Palmyra reveal slight increase of the undergoing 24 h fermentation for the contents of proteins (2.71 to 3.06 g/100 g) and glucides (83.79 to 84.1 g/100 g); while dropping is recorded with lipids (1.11 to 0.92 g/100 g), ashes (0.76 to 0.66 g/100 g) and fibers (1.73 to 1.23 g/100 g) as shown in Table I.

3.3 Gathering of the samples according to the nutritive constituents

The Principal Components Analysis is achieved with two components (F1 and F2) providing eigen-values superior to 1 and expressing 99.85% of the full variance related to the overall parameters studied. Thus, F1 expresses 86.56% of variance. It is mainly drawn positively with the moisture, the total glucides, the total soluble carbohydrates and the caloric energy value but negatively with the contents of proteins, lipids, ash and fibers. The F2 component displays 13.28% of variance and is significantly linked to the reducing sugars content with a positive correlation (Table II). The projection of the biochemical traits and the trials into the F1-F2 factorial draw shows 3 groups of samples. Indeed, the samples from Palmyra have high values of total glucides, total soluble carbohydrates, moisture and caloric energy. Regarding with Moringa, the samples record more significant contents of ash, fibers and lipids. For the Cowpea beans powder, more values are obtained from the proteins and reducing sugars (Fig. 3).

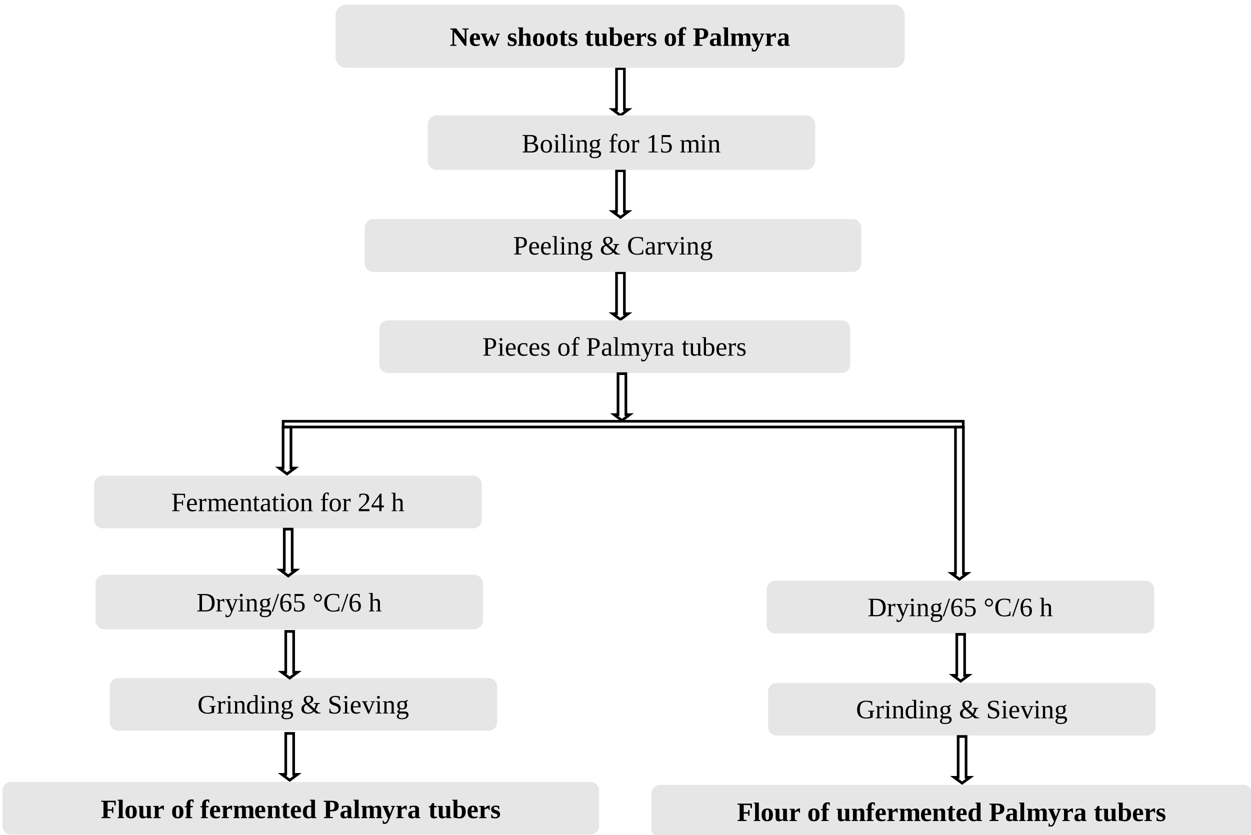

FIGURE 1: PROCESSING FOR PRODUCTION OF FLOURS FROM NEW SHOOT TUBERS OF *BORASSUS AETHIOPUM* MART (PALMYRA)

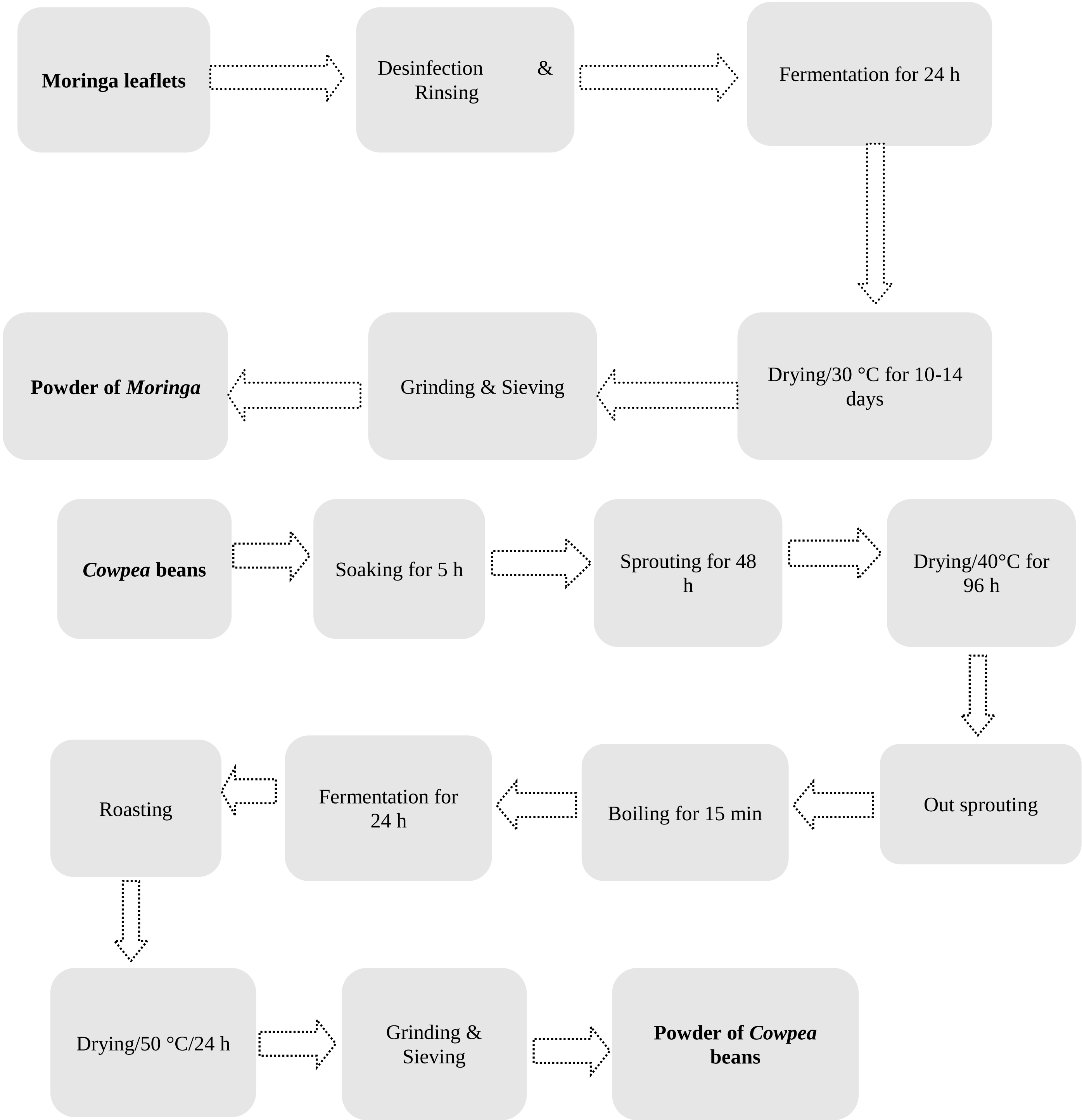

FIGURE 2: PROCESSINGS FOR PRODUCTION OF MEALS FROM LEAFLETS OF *MORINGA OLEIFERA* LAM (MORINGA) AND BEANS OF *VIGNA UNGUICULATA* WALP (COWPEA BEANS)

TABLE 1
NUTRITIVE COMPOUNDS OF SAMPLES DERIVED FROM THE FLOUR OF NEW SHOOTS TUBERS OF *BORASSUS AETHIOPUM* MART AND THE POWDERS PROVIDED BY LEAFLETS OF *MORINGA OLEIFERA* LAM AND OF BEANS OF *VIGNA UNGUICULATA* WALP.

Meal sources	Parameters								
	Moisture (%)	**Prot** (g/100g)	**Lip** (g/100g)	**GluT** (g/100g)	**TSC** (g/100g)	**Rsu** (g/100g)	**Ash** (g/100g)	**Fib** (g/100g)	**CEV** (kcal/100 g)
BAMNF	9.90±0.03[b]	2.71±0.09[d]	1.11±0.02[c]	83.79±0.10[b]	5.23 ±0.01[a]	0.60±0.01[c]	0.76±0.00[c]	1.73±0.04[b]	315.03±0.10[a]
BAMF	10.03±0.04[a]	3.06±0.09[c]	0.92±0.01[d]	84.10±0.11[a]	5.19±0.01[b]	0.57±0.00[d]	0.66±0.02[d]	1.23±0.04[c]	315.41±0.10[a]
MOL	6.98±0.02[d]	25.81±0.09[b]	4.19±0.05[a]	48.93±0.10[d]	3.02±0.00[d]	1.61±0.00[b]	8.35±0.01[a]	5.74±0.01[a]	272.73±0.24[c]
VUW	7.94±0.02[c]	27.24±0.13[a]	2.02±0.05[b]	57.76±0.08[c]	4.10±0.01[c]	2.85±0.00[a]	3.32±0.10[b]	1.72±0.03[b]	289.58±0.61[b]
F	9659.7	54770.28	4635.12	120035.37	46725.78	223223.63	15981.7	14517.64	1263.73
P-value	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**

BAMNF, Unfermented *B. aethiopum* Mart; **BAMF,** fermented *B. aethiopum* Mart; **MOL,** *M. oleifera* Lam; **VUW,** *V. unguiculata* Walp.
F, value of the ANOVA statistical test; **P-value,** value of the probability test of the ANOVA.
Prot, Lip, TGlu, TSC, RSu, Fib: respective contents of proteins, lipids, total glucides, total soluble carbohydrates, reducing sugars and fibers; **CEV,** caloric energy value.

TABLE 2
MATRIX OF EIGENVALUES AND CORRELATIONS BETWEEN THE NUTRITIVE COMPOUNDS OF THE MEAL SAMPLES STUDIED AND BOTH F1 AND F2 FACTORS OF THE PRINCIPAL COMPONENTS ANALYSIS.

Factors	F1	F2
Eigenvalues	7.79	1.2
Variance (%)	86.56	13.28
Cumulative variance (%)	86.56	99.85
Moisture Content	**0.99**	-0.11
Proteins Content	**-0.91**	0.41
Lipids Content	**-0.97**	-0.25
Total Glucides Content	**0.99**	-0.17
Total Carbohydrates Content	**0.99**	0.05
Reducing Sugars Content	**-0.65**	**0.76**
Ash Content	**-0.97**	-0.23
Fibers Content	**-0.86**	-0.5
Caloric Energy value	**0.98**	0.2

Bold values are statistically significant.

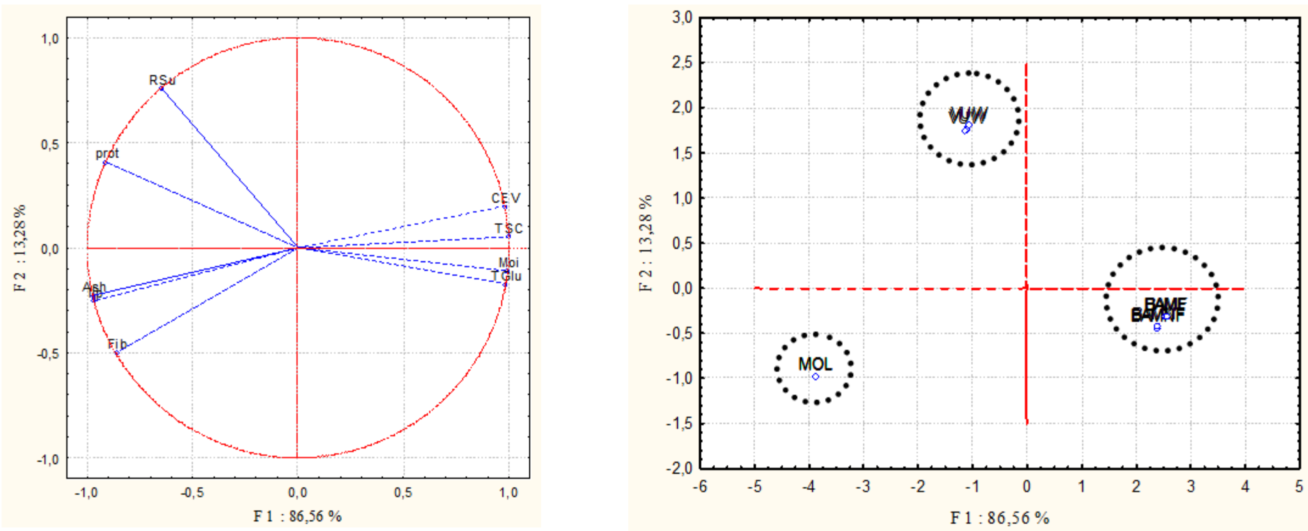

FIGURE 3: CORRELATIONS BETWEEN THE F1-F2 FACTORIAL DRAW RESULTING WITH THE PRINCIPAL COMPONENTS ANALYSIS AND THE NUTRITIVE COMPOUNDS (A) AND THE MEAL SAMPLES (B) OF THE STUDIED FOOD RESOURCES.

Moi, Prot, Lip, TGlu, TSC, RSu, Fib: respective contents of moisture, proteins, lipids, total glucides, total soluble carbohydrates, reducing sugars and fibers; **CEV:** Caloric energy value. **BAMF,** fermented *B aethiopum* Mart; **BAMNF,** unfermented *B. aethiopum* Mart; **MOL,** *M. oleifera* Lam; **VUW,** *V. unguiculata* Walp.

IV. DISCUSSION

The maximal mean of moisture contents resulting with the meals studied is 10. The moisture of the meals is thus lower than 12%, the limit value of moisture allowed for good preservation of the foods products **[27]**. So, the current meals could be kept for long after processings.

The study shows most important source of proteins with the powder of Cowpea beans. The significant protein trait of the Cowpea was already mentioned by Tchiégang and Kitikil **[28]** and Ayssiwede *et al.* **[29]** with respective report of 26.9% and 26.48%. However, from the attempts of Adenipekun and Oyetunji **[30]**, the ungerminated Cowpea beans can be with lower proteins content (23%). In fact, the germination and fermentation processes involve with many changes in grains biochemical parameters caused by the production of growing enzymes **[31]** and the fermenting flora **[32].**That also results in increasing of the moisture and dropping of the lipids and fibers contents.

The Moringa leaflets have lower proteins than the Cowpea beans, but moringa is more provided than a large number of vegetables leaflets consumed in Africa, such as *Albelmoschus esculenta*, *Ipomea batata* and *Manihot esculenta* which give respective proteins contents of 9.19%, 15.52% and 23.39% **[33]**. According to Ali **[34]**, the edible plants whose proteins contents provide beyond 12% of the caloric energy value, represent precious proteins sources. Thus, the Moringa leaflets and Cowpea beans could support the food safety with significant contribution to the proteins dietary required for the populations, particularly for the children of less than 5 years old and the pregnant and nursing women **[35]**. They could especially improve the proteomic value of food recipes such as dishes formulated with Palmyra shoots flour basis. Indeed, the flour of Palmyra tubers is rather lower with proteins, corroborating observations of Niamké *et al*. **[2]**. For the populations, the edible shoots tubers of Palmyra are comparable to most of the starchy foods, namely yam, cassava and potato, with few proteins and lipids **[36]**, but whose glucides contents ensure more than 80% of the caloric energy value. Thus, consumption of Palmyra tubers could provide much caloric energy to support the muscular system during physical efforts **[37]**.

The Moringa leaflets have expressed the most important lipids contents. Nevertheless, compared to the glucides and proteins, all the samples analyzed contain few lipids, as other tubers and vegetables, like cassava (4.09%) and potato (2.63%) characterized by Zoro *et al*. (2013) **[33]**. The powder deriving from Moringa also records the greatest amount of fibers. But, the whole samples investigated for the current work have low fibers compared to the data reported with similar raw materials by Ali *et al*. **[14]** for Palmyra (6.10%), El Sohaimy *et al*. **[38]** for Moringa (11.23%) and Mune *et al*. **[39]** with Cowpea (5.75%). From these authors, the samples did not undergo any fermenting nor germinating process. So, they were not concerned with any degradation of cellulose or hemicellulose that might be causable by the activation of the cellulases and hemicellulases enzymes **[40]**. The germination and fermentation undergone by Cowpea beans, Palmyra tubers and Moringa leaflets in our study could have increased the bioavailability of their fibers.

With the ash contents, the most significant values derive from *Moringa* (8.35%), followed by Cowpea (3.32%). Such a character deals with mineral traits of these two food products, especially the *Moringa* leaflets which are famous for their great mineral concentration. Tchiégang and Kitikil **[28]** and El-Massry *et al*. **[20]** found comparable amounts (7.92 g to 8.09 g) of ash within 100 g of Moringa. The Moringa leaflets could have interest in mineral nutrients concerns for supporting the metabolic reactions accounting with fatty, proteomic or starchy foods **[41]** among which Palmyra tubers.

For the caloric energy values, means are between 272.73 and 315.41 kcal/100 g, and the Palmyra flours represent the most important source of energy due to the great glucide trait. Their consumption could significantly contribute to the energy requested for the populations, especially during intense efforts.

V. CONCLUSION

The study shows greatest proteins content for the beans powder of *Vigna unguiculata*. The powder resulting from leaflets of *Moringa oleifera* is more provided in fibers, minerals and presents rather significant content of proteins. The flour processed from the new shoots of *Borassus aethiopum* is characterized by high glucides contents. However, the fermentation improves its contents of proteins and ash. Regarding with the variable nutritive traits of the meals studied, food formulations on Palmyra shoots tubers basis improved with Moringa leaflets and Cowpea beans could be planned to succeed in a greater value added to these raw materials. Thereafter, domestication and valorization in food issues of the new shoots of Palmyra could support preservation of the biodiversity and the food safety and fight against poverty for populations. It could also reduce the fast desertification in Côte d'Ivoire.

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