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Amino Acid and Fatty Acid Profile of Twenty Wild Plants Used as Spices in Cameroon

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Abstract The amino acids and fatty acids of twenty wild plants used as spices which were collected in Cameroon were investigated. The most important of total non-essential amino acids (TNEAA) contents have been found in *A. daniellii* (52.04%), *C. frutescens* (50.53%), *D. psilurus* (56.22%), *H. gabonii* (fruit) (58.81%), *P. brazzeana* (59.11%), *S. melongena* (59.78 %) and *X. aethiopica* (56.78%), respectively. Concerning the levels of the essential amino acids (EAA), all had EAA contents of at least 30% except *E. giganteus* (17.85 %), *S. melongena* (27.05 %), and *T. tetraptera* (15.85 %). For WHO protein standard, Lysine was considered as the first limiting amino acid (LAA) for *A. daniellii* (1.54%), *P. brazzeana* (16.35%) and S. *striatinux* (40.19 %). In addition, Meth+Cys were the second LAA for *D. psilurus*, *E. giganteus*, *S. melongena*, *S. zenkeri* (fruit), *T. tetraptera*, *X. aethiopica* (non detected); *H. gabonii* (fruit) (29.2%), *M. myristica* (6%), *M. whitei* (8.8 %) and *P. guineense* (39.2%), respectively. Spices which contained a large amounts of the essential fatty acids (ω – 3) were found in *C. frutescens* (31.98%), *F. leprieuri* (40.07 %), *H. gabonii* (fruit) (34.84 %), *M. whitei* (54.77%), *P. umbellatum* (39.25%), *S. melongena* (34.23%), *S. zenkeri* (fruit) (35.68%), and *T. tetraptera* (33.64%), respectively. Furthermore, (ω – 6) were found in *D. psilurus* (49.29%), *H gabonii* (bark) (47.91%) and *F. xanthoxyloides* (43.79%). In addition, (C22: 6n3) were *S. zenkeri* (bark) (20.45%) and *X. aethiopica* (30.10 %). These results show that tropical edible plants could contribute significantly to the diets of indigenous population in sub-Saharan Africa and should provide their public health.

Keywords: *spices, amino acid, fatty acid, wild plant, WHO*

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1. Introduction

Balance diet intake can provide our needs for energy and body building; all power is based on the principle of food metabolism for our well-being. Furthermore, the habits can to take diet renders the population of developing countries to consume a balanced family dishes made with a basic food (cereal, tuber) rich in energy and sauce. Different parts of plants are widely used as spices and / or ingredients in the preparation of many dishes in many countries like Cameroon. Besides its primary role which is the flavoring, spices can be a significant source in nutrients like proteins, amino acids, minerals and vitamins [1,2,3]. Associated with water, proteins constitute the major part of our body weight. Essential amino acid (EAA) deficiency induces the slowdown of growth and development in children, gives diseases and causes the destruction of cells in adults. Among these amino acids, some are bioactive (histidine, lysine, isoleucine, leucine, valine, threonine, and phenylalanine + tyrosine) and other are antioxidants (histidine, methionine + cysteine) [4]. Fats are essential for a balanced diet because of the physiological role play in the nervous system and in the transportation of fat-soluble vitamins (vitamins A, D, E and K). Essential to the growth of children, vegetable oils are also taken into consideration, fats are also necessary for the maintenance of good health among others. These oils are composed largely of unsaturated fatty acids USFA (ω-3 and ω-6) that help to reduce the risk which incur the cardiovascular disease [5,6,7,8]. In a context of fighting against deficiencies in food, it is important to estimate the nature and amounts of micronutrients ingested by the people of traditional foods [9]. Hence the purpose of this part of the study is to determine amino acid and fatty acid profile of some wild plants used as spices in Cameroon.

2. Material and Methods

2.1. Plant Material

Spices were collected in West Cameroon or either purchased in local markets of Bafoussam and Douala cities in Cameroon, then transported to Ngaoundere. Twenty different spices were harvested and purchased (see Table 1). Once taken to laboratory, the spices were cleaned and dried using a solar dryer shell for seven days. Dried spices were then powdered using an electric grinder (Culatti, Polymix, France) through a 500 µm sieve.

Table 1. Name and parts of the spices used in the study

Botanical name	Common name	French name	Family	Used parts
Aframomum daniellii	Bastered melegueta	Maniguette sucrée	Zingiberaceae	Fruit
Capsicum frutescens	Bird pepper	Petit pigment rouge	Solanaceae	Fruit
Dichrostachys glomerata	Sickle bush	oreilles de souris	Mimosaceae	Fruit
Dorstenia psilirus		Remèdes des serpents	Moraceae	Root
Echinops giganteus	Giant japanese butterbur	Racines tubéreuse	Asteraceae	Root
Fagara leprieuri	Prickly ash	Grappe odoriférante	Rutaceae	Fruit
Fagara xanthoxyloïdes		Bouche béante	Rutaceae	Fruit
Hua gabonii	Garlic tree	Fruit de l'arbre de l'ail	Huacaceae	Fruit
Hua gabonii	Garlic tree	Ecorce de l'arbre de l'ail	Huacaceae	Bark
Mondia whitei	White ginger	Racine sucrée	Periplocaceae	Root
Monodora myristica	Calabash nutmeg	Fausse noix de muscade	Annonaceae	Almond
Pentadiplandra brazzeana	Joy perfume tree	Liane blanche	Pentadipandraceae	Root
Piper guineense	Black pepper (Ashandi)	Poivre sauvage	Piperaceae	Fruit
Piper umbellatum	Cordoncillo		Piperaceae	Flower
Scleria striatinux		Racine de chaume	Cyperaceae	Fruit
Scorodophleus zenkeri	Divida (African)	Fruit de l'arbre à l'ail	Caesalpinaceae	Fruit
Scorodophleus zenkeri	Divida (African)	Ecorce de l'arbre à l'ail	Caesalpinaceae	Bark
Solanum melongena	Aubergine	Aubergine	Solonaceae	Fruit
Tetrapleura tetraptera	Aidan tree	Fruit à 4 ailes	Mimosaceae	Fruit
Xylopia aethiopica	Ethiopian pepper (African)	Poivre d'Éthiopie	Annonaceae	Fruit

The obtained powders were finally sealed in polyethylene bags for better conservation they were stored at 4°C in refrigerator until analysis is carried out.

2.2. Amino Acid Determination

The samples were hydrolyzed under vacuum at 110 °C for 24 h in a Pico-Tag apparatus (Waters, Milford, MA, USA) in the presence of 6N HCl containing 0.1% Phenol, then recovered by water ultra-pure and deposited on an auto tap-parser-420 trademark Applied Biosystems (Applera Corp., Foster City, CA, USA). The derivation to phenyl isothiocyanate (PITC) was made in pre column. The separation of amino acids was made on a channel high performance liquid chromatography (HPLC) (Applied Biosystems model 172 A: Corp, Foster City, CA, USA) with a column of phase reverse PTC RP-18 (2, 1 * 220 mm) series 238638, lot no. 02 M 9-40531 Brownlee (Applied Biosystems model 172 A: Corp, Foster City, CA, USA). Solvents used for this analysis are acetate Na 45 mM pH 5.90 (A) and 30% acetate Na 105 mM pH 4.60 and 70% acetonitrile (B), and the detection was made at 254 nm. The acquisition and exploitation of the results were made by the Model 600 Data Analysis System software (Applied Biosystems, Applera Corp., Foster City, CA, USA). Tryptophan was not determined.

2.3. Chemical Score

This index is one of the parameters for assessing the nutritional value. The chemical index was calculated according to the method used by Chavan *et al.* [10] using the following equation:

$$\text{Chemical score (CS)} = \frac{(\text{mg of essential amino acid per g of test protein})}{\left(\begin{array}{l}\text{mg of the same essential amino acid}\\ \text{per g of protein in requirement pattern}\end{array}\right)} \times 100.$$

The requirement pattern suggests by the FAO/WHO/UNU [11] for children of 1-2 years old was used for this purpose: Histidine = 1.8 g/100g protein; Isoleucine = 3.1 g/100g protein; Leucine = 6.3 g/100g protein; Lysine = 5.2 g/100g protein; Methionine + cysteine = 2.5 g/100g protein; Phenylalanine + tyrosine = 4.6 g/100g protein; Threonine = 2.7 g/100g protein ; and Valine = 4.1 g/100g protein.

2.4. Fatty Acids Determination

Fatty acid methyl esters were prepared by the method of Ackman [12] using the reagent to the concentration of 8% boron trifluoride in methanol (BF_3/MetOH). About 100 mg of oil sample were weighed in a screw test tube 10 mL. Then 1.5 mL of hexane and 1.5 mL of BF_3/MetOH were added. Then the tube tightly closed under nitrogen and has been stirred vigorously, and heated to 100 °C for 1 h. After cooling to ambient temperature, 2 mL of distilled water and 1 mL of hexane were added and stirred under nitrogen. After resting, the upper phase was recovered in a tube under nitrogen. The lower phase extraction was repeated twice on using 1 mL of hexane.

Phase hexane (methyl esters) have been collected and washed with 2 mL of distilled water, dried on anhydrous sodium sulfate. The solvent was evaporated under nitrogen. Hexane has been added to bring up concentration of methyl esters in a suitable concentration (5 mg/mL) analysis by gas chromatography. This analysis was performed on a chromatogram Peri 2000 (Perichrom, Saulx-les-Chartreux, France) equipped with a flame ionization detector. The separation was made on a capillary column (25 mm in length, diameter 0.25 mm, film thickness is 0.5 µm) lined with polyethylene glycol (Perichrom) Terephthalic acid-doped. The detector and injector temperatures were set at 260 °C. The program used for analysis as follows: maintained at the start at 70 °C for 2 min, the column has been to 180 °C (39.9 °C/min) and maintained during 8 min at this temperature, then it undergoes a second phase of warming up to 220 °C (3 °C/min) for 45 min. The cooling is carried out at the rate of 39.9 °C/min. The identification of the peaks was carried out using a standard of fatty acid supplied by Supelco (Bellefonte, USA): PUFA 1 (vegetable source). Winlab 3 (Perichrom, Saulx-les-Chartreux, France) software has allowed the integration of the chromatograms.

2.5. Statistical Analysis

All experiments were conducted in triplicate. The variances of the data analysis and the comparison of means using Duncan multiple comparison test conducted in using statistics software Statgraphics 5.0 (Manugistics, Rockville, Maryland, USA, 1997) [13]. Statistical significance was accepted at a level of $p<0.05$.

3. Results and Discussion

3.1. Total Proteins and Non-essential Amino Acids Composition

Table 2 shows the total proteins and their different compositions in non -essential amino acids. These results indicated that all the analyzed parameters varied significantly ($p < 0.05$) between the spices. Furthermore, it may be remarked that the total protein levels ranged from 4.82% (*D. psilurus*) and 13.61% (*M. myristica*) [14]. These values are lower than those found in the wild sea bass (*Dicentrarchus labrax*) which varies from 18.74% to 21.79% [15]. This table presents also the results of the non-essential amino acid (Aspartate + Aspargine, Glutamate + Glutamine, Serine, Alanine, Proline, Arginine and Glycine). It appears also that, serine in spices *E. giganteus*, *M. myristica*, and *S. zenkeri* "bark", - alanine in spices *E. giganteus*, *S. zenkeri* "fruit" and *T. tetraptera*, - proline in *F. leprieuri* and *P. umbellatum*, - arginine in *F. leprieuri*, *P. umbellatum*, *P. brazzeana* and *T. tetrapleura* were unable to reach the limit of detection. On the other hand, the aspargine and aspartate values ranged from 0.88% (*S. zenkeri* "fruit") to 17.65% (*S. melongena*). Aspartic acid, which occurs as a physiological compound in the mammalian pituitary and testis, has a role in the regulation of the release and synthesis of LH and testosterone [16].

Table 2. Total protein content (g/100g DM) and Non-essential amino acid composition (g/100g protein) of Spices

Spices	Total Protein * (NX6.25)*	Aspartate	Glutamine	Serine	Alanine	Proline	Arginine	Glycine	TNEAA
A. daniellii	8.53±0.99^{cd}	11.62±0.04^{e}	19.51±0.03^{p}	6.92±0.03^{f}	6.00±0.06^{d}	4.53±0.03^{i}	3.46±0.04^{i}	10.6±0.07^{k}	52.04
C. frutescens	9.44±0.75^{def}	14.98±0.04^{k}	11.47±0.03^{d}	6.39±0.08^{d}	8.33±0.03^{g}	7.85±0.03^{p}	1.51±0.06^{d}	9.20±0.04^{h}	50.53
D. glomerata	8.61±0.44^{cde}	0.89±0.03^{a}	1.28±0.06^{b}	14.59±0.06^{n}	13.17±0.04^{n}	4.11±0.03^{h}	6.96±0.03^{m}	18.67±0.04^{o}	41
D. psilurus	4.82±0.15^{a}	15.70±0.06^{l}	21.37±0.06^{r}	7.13±0.04^{h}	7.47±0.03^{e}	3.19±0.03^{g}	1.36±0.07^{c}	11.78±0.03^{l}	56.22
E. giganteus	5.88±0.31^{b}	15.02±0.01^{k}	27.73±0.04^{s}	ND	ND	0.44±0.03^{b}	0.23±0.04^{a}	38.71±0.08^{r}	43.42
F. leprieuri	6.41±0.25^{b}	13.86±0.03^{i}	20.82±0.08^{q}	8.57±0.04^{l}	ND	ND	ND	21.32±0.04^{p}	43.25
F. xanthoxyloïdes	7.98±0.10^{c}	9.17±0.01^{b}	13.29±0.04^{g}	5.55±0.04^{c}	9.93±0.01^{l}	8.25±0.03^{q}	2.70±0.06^{g}	8.50±0.06^{f}	48.89
H. gabonii (fruit)	6.15±0.65^{b}	17.06±0.03^{m}	16.44±0.04^{l}	7.30±0.03^{h}	8.23±0.04^{f}	7.35±0.03^{n}	2.43±0.04^{e}	10.31±0.06^{j}	58.81
H. gabonii (bark)	10.16±0.40^{f}	12.85±0.01^{h}	12.99±0.06^{e}	7.25±0.03^{h}	9.28±0.04^{j}	2.53±0.03^{f}	4.60±0.04^{l}	9.28±0.06^{h}	49.5
M. myristica	13.61±0.16^{h}	15.69±0.04^{l}	18.49±0.03^{o}	ND	6.93±0.03^{c}	5.90±0.06^{k}	4.05±0.03^{k}	7.30±0.06^{c}	51.06
M. whitei	4.73±0.05^{a}	11.13±0.03^{d}	7.16±0.03^{c}	4.18±0.07^{b}	8.69±0.03^{i}	7.58±0.06^{o}	3.09±0.03^{h}	7.72±0.04^{d}	41.83
P. brazzeana	11.27±0.14^{g}	9.32±0.04^{c}	14.75±0.04^{i}	9.86±0.03^{m}	0.77±0.03^{a}	1.10±0.03^{d}	ND	7.17±0.04^{b}	35.8
P. gunineense	8.52±0.23^{cd}	15.05±0.04^{k}	16.86±0.03^{n}	7.06±0.03^{g}	9.68±0.08^{k}	6.82±0.03^{l}	3.64±0.04^{j}	9.66±0.03^{i}	59.11
P. umbellatum	11.29±0.06^{g}	11.68±0.03^{e}	17.31±0.06^{n}	6.56±0.03^{e}	1.16±0.04^{b}	ND	ND	27.87±0.03^{q}	36.71
Scleria striatinux	9.50±0.21^{ef}	12.01±0.06^{f}	14.19±0.06^{h}	6.62±0.04^{e}	8.55±0.06^{h}	7.03±0.03^{m}	1.11±0.04^{b}	8.99±0.03^{g}	49.51
S. melongena	4.93±0.21^{a}	17.65±0.06^{o}	16.33±0.03^{k}	8.48±0.06^{k}	8.37±0.04^{g}	8.78±0.03^{r}	0.17±0.03^{a}	13.18±0.06^{n}	59.78
S. zenkeri (fruit)	12.17±0.74^{g}	12.25±0.03^{g}	15.82±0.01^{j}	3.32±0.03^{a}	ND	0.73±0.01^{c}	14.17±0.03^{n}	8.09±0.04^{e}	46.29
S. zenkeri (bark)	13.97±0.12^{h}	0.88±0.01^{a}	0.31±0.03^{a}	ND	12.93±0.04^{m}	1.36±0.01^{e}	1.06±0.03^{b}	3.64±0.04^{a}	16.54
T. tetraptera	4.96±0.28^{a}	14.47±0.04^{j}	19.46±0.03^{p}	7.64±0.04^{i}	ND	0.24±0.04^{a}	ND	42.34±0.04^{s}	41.81
X. aethiopica	7.92±0.30^{c}	17.52±0.04^{n}	16.78±0.03^{m}	8.11±0. 03^{j}	6.98±0.01^{c}	4.79±0.06^{j}	2.60±0.07^{f}	12.25±0.06^{m}	56.78

*Source: Abdou Bouba et al. (2012). Mean values that have the same superscripts letters in the same column are not significantly different at the 5% level; Mean ± standard deviation; n = 3. ND = Non Detected

Asparagine provides for a particular type of amine transamination in the liver and participates in the control of the metabolic functions of brain and central nervous system cells as well as the treatment of its [17]. Glutamate and glutamine were most abundant in all studied spices. The same observation was made by Bei-Zhong *et al*. [18] on nine samples of soybean in China. In our samples, concentrations ranged from 0.31% (*S. zenkeri* "bark") to 27.73% (*E. giganteus*). Glutamic acid is an exciting neurotransmitter for the central nervous system, the brain and the spinal cord. It serves as fuel for the brain and helps to correct the physiological imbalances in the body. Glutamine is the amino acid which is more abundant in muscles; its presence allows the building and maintaining muscle tissue. Glutamine struggles against the muscle hypertrophy which may appear after a period of prolonged rest or diseases such as cancer and AIDS [19]. The content in serine, in other spices varies from 3.32% (*S. zenkeri* “fruit”) to 14.59% (*D. glomerata*). It is an amino acid necessary for the development of the muscles and the maintenance of the immune system. It is important in the formation of RNA and DNA from the cells. Alanine values ranged from 0.77% (*P. brazzeana*) and 13.17% (*D. glomerata*). It plays an important role in the transfer of nitrogen in the body; as well as glucose that the body uses as energy and strengthens the immune system producing antibodies. It also regulates toxic substances discharged in their inherent energy need muscles. The percentage of proline fluctuates between 0.24% (*T. tetraptera*) to 8.78% (*S. melongena*). This amino acid is to improve the texture of skin by facilitating the production of collagen and slowing the aging process and is used in curative treatment to avoid the problems of cartilage, tendons, muscle of the heart [20]. Arginine varies with contents that are set between 0.17% (*S. melongena*) and 14.17% (*S. zenkeri* “fruit”). Arginine is considered to be the "natural Viagra" that increases blood flow in the penis [20]. This acid also delays the growth of cancerous tumors by increasing the immune system and helps the detoxification of the liver by neutralizing ammonia and reduces the toxicity of alcohol. Also, it is frequently used in the treatment of infertility in men. The content of glycine in spices varied from 3.64% (*S. zenkeri* “fruit”) to 42.34% (*T. tetraptera*). Furthermore, Glycine retards muscle degeneration, it improves the glycogen storage and thereby releases glucose to meet the energy needs. It is also developing an excellent scaring function. Contrary to the results obtained by Chavan *et al*. [10] on pea Beach to the Canada (54.1% to 51, 7%) we note that our values are low in general.

3.2. Essential Amino Acids Composition

The essential amino acid content (EAA) of each 20 spices summarized in Table 3. The total amounts of EAA ranged from 15.85% (*T. tetraptera*) and 79.81% (*S. zenkeri “fruit”*). Furthermore, these results were higher than those obtained by Jiyu *et al*. [21] on certain cultivars of *Myrica rubra* (27.83 to 29.91%) in China and on *Riconodendron heudelotii* and *Tetracarpidium conophorum* (up to 33 %) in Cameroon by Tchiegang *et al*. [22]. So, it concluded from these values that the spice *S. zenkeri* (fruit) could be a good source of protein supplement in essential amino acids.

Table 3 also shown that the distinction of the spices on the basis of their total namely; essential amino acid content as follows: - spices with a very high content of total amino acids have a value of 79.81% (*S. zenkeri “fruit”*), - the total essential amino acids spice relatively high with *P. brazzeana* (57.94%), *M. whitei* (50.46%) and *S. zenkeri* (bark), - spices with intermediate levels represented by *F. xanthoxyloides* (42.63%), *S. melongena* (41.51%), *M. myristica* (41.67%), *H. gabonii “bark”* (41.31%), *C. frutescens* (40.27%), *D. glomerata* (40.33%), *A. daniellii* (37.35%), *P. umbellatum* (35.42%) and *F. leprieuri* (35,33%), - Spices with average grades of *D. psilurus* (32%), *P. guineense* (31.93%), *H. gabonii* (fruit) (30.84%), *X. aethiopica* (30.96%) and *S. striatinux* (27.05%), - and spices to low levels of essential amino acids by *E. giganteus* (17.85%) and *T. tetraptera* (15.85%). In addition, when comparing the levels than the sources of plant proteins such as safflower seeds (15.13%) [23], pea (42.18% and 41.3%) [21] and the nuclei of *Myrica rubra* (27.83 to 29.21%), respectively [10], its realized that certain levels of proteins of our spices have essential amino acids with lower percentages and others high.

Table 3. Essential amino acid composition (g/100g protein) of spice

Spices	E A A	Histidine	Valine	Met + Cys	Threonine	Isoleucine	Leucine	Phe + Tyr	Lysine	TEAA/TAA
A. daniellii	37.35±50.18^{g}	ND	9.81±0.04^{m}	20.69±0.04^{l}	1.94±0.04^{a}	4.83±0.04^{d}	ND	ND	0.08±0.01^{a}	0.72
C. frutescens	40.27±0.14^{h}	2.06±0.01^{e}	2.23±0.04^{h}	4.38±0.07^{e}	6.39±0.04^{f}	6.82±0.06^{i}	7.68±0.07^{i}	5.63±0.04^{h}	5.08±0.06^{f}	0.8
D. glomerata	40.33±0.28^{h}	ND	ND	ND	ND	9.73±0.03^{m}	3.89±0.06^{d}	11.45±0.04^{l}	15.32±0.06^{q}	0.98
D. psilurus	32±0.05^{e}	0.86±0.03^{c}	7.92±0.04^{l}	ND	5.95±0.01^{e}	8.8±0.07^{l}	ND	3.92±0.06^{c}	4.55±0.03^{e}	0.57
E. giganteus	17.85±0.02^{b}	ND	ND	6.72±0.06^{f}	2.35±0.03^{b}	ND	ND	ND	8.78±0.03^{n}	0.41
F. leprieuri	35.33±0.14^{f}	0.72±0.01^{b}	ND	7.18±0.03^{g}	ND	12.9±0.01^{o}	4.83±0.03^{e}	ND	9.8±0.03^{o}	0.82
F. xanthoxyloïdes	42.63±0.07^{k}	1.61±0.04^{d}	0.83±0.04^{f}	7.72±0.07^{i}	3.14±0.04^{c}	6.69±0.04^{g}	11.83±0.03^{o}	5.33±0.04^{g}	5.47±0.04^{g}	0.87
H. gabonii (fruit)	30.84±0.13^{d}	ND	2.57±0.03^{i}	0.73±0.04^{b}	ND	6.07±0.03^{e}	7.84±0.06^{j}	5.77±0.08^{i}	7.91±0.04^{l}	0.53
H. gabonii (bark)	41.31±0.14^{i}	4.54±0.04^{i}	0.65±0.06^{e}	3.31±0.01^{d}	9.56±0.07^{h}	7.7±0.04^{k}	3.27±0.03^{c}	5.1±0.03^{f}	7.08±0.07^{k}	0.83
M. myristica	41.67±0.31^{j}	9.55±0.06^{k}	2.15±0.03^{g}	0.15±0.01^{a}	ND	6.51±0.03^{h}	7.89±0.01^{j}	8.9±0.03^{k}	6.49±0.06^{i}	0.82
M. whitei	50.46±0.07^{m}	1.58±0.05^{d}	0.22±0.03^{c}	0.22±0.01^{a}	6.44±0.07^{f}	4.06±0.01^{c}	6.4±0.07^{f}	14.44±0.04^{m}	17.1±0.04^{r}	1.21
P. brazzeana	57.94±0.06^{n}	7.55±0.06^{j}	0.41±0.04^{d}	36.22±0.04^{n}	ND	10.45±0.03^{n}	ND	2.46±0.07^{b}	0.85±0.03^{b}	1.62
P. gunineense	31.93±0.08^{e}	0.08±0.01^{a}	6.09±0.06^{j}	0.98±0.04^{c}	4.16±0.03^{d}	6.45±0.04^{h}	8.08±0.04^{k}	ND	5.4±0.06^{g}	0.53
P. umbellatum	35.42±0.28^{f}	ND	ND	7.28±0.03^{h}	6.79±0.06^{g}	0.14±0.01^{a}	0.085±0.01^{a}	17.31±0.03^{n}	3.81±0.07^{d}	0.96
Scleria striatinux	41.51±0.14^{ij}	2.43±0.03^{f}	0.13±0.04^{b}	20.33±0.03^{k}	2.31±0.03^{b}	3.92±0.04^{b}	2.85±0.03^{b}	7.45±0.04^{j}	2.09±0.04^{c}	0.84
S. melongena	27.05±0.11^{c}	3.73±0.04^{h}	0.09±0.01^{ab}	ND	ND	7.24±0.04^{j}	9.68±0.04^{m}	0.53±0.03^{a}	5.78±0.06^{h}	0.45
S. zenkeri (fruit)	45.62±0.28^{l}	10.7±0.06^{l}	ND	ND	ND	8.76±0.03^{l}	9.79±0.03^{n}	4.04±0.03^{d}	12.33±0.06^{p}	0.98
S. zenkeri (bark)	79.81±0.14^{o}	3.18±0.04^{g}	ND	11.11±0.03^{j}	39.41±0.04^{i}	13.59±0.04^{p}	6.64±0.04^{g}	ND	5.88±0.06^{h}	4.83
T. tetraptera	15.85±0.07^{a}	ND	ND	ND	ND	ND	7.23±0.03^{h}	ND	8.62±0.04^{m}	0.38
X. aethiopica	30.96±0.02^{d}	3.17±0.03^{g}	7.27±0.08^{k}	ND	ND	ND	9.1±0.04^{l}	4.45±0.06^{e}	6.97±0.07^{j}	0.55

Mean values that have the same superscripts letters in the same column are not significantly different at the 5% level; Met = methionine; Cys = cysteine, Phe = phenylalanine; Tyr = tyrosine; Mean ± standard deviation; n = 3. ND = Non Detected.

Table 3 also was shown that the levels of essential amino acids of the different studied spices. Except lysine, others amino acids could not be detected in certain spices because of the lower sensitivity of the device used for this purpose. Also, the hisditine could not be detected in the spices *A. daniellii, D. glomerata, T. Tetraptera, H. gabonii «fruit», E. giganteus and P. umbellatum,*- valine in *D. glomerata, E. giganteus, F. leprieuri, P. umbellatum,* *S. zenkeri 'fruit and bark' and T. tetraptera*,- also, methionine and cysteine not detected in *D. glomerata*, *D. psilurus*, *P. umbellatum, S. melongena, S. zenkeri "fruit", T. tetraptera and X. aethiopica*, - threonine in *D. glomerata, F. leprieuri, H. gabonii «fruit», M. myristica, P. brazzeana, S. melongena, S. zenkeri "fruit", T. tetraptera and X. aethiopica*, - isoleucine in *E. giganteus, T. tetraptera* and *X. aethiopica*, - leucine in *A. daniellii, D. psilurus*, and *P. brazzeana*, - and the phenylalnine and tyrosine in *A. daniellii, F. leprieuri* and *E. giganteus, P. guineense, S. zenkeri* "bark" and *T. tetraptera*.

However, the values of the hisditine in the other various spices range from 0.72% (*F. leprieurii*) to 10.7% (S. zenkeri "fruit"). Furthermore, Histidine is used in the treatment of cardiovascular disease with physiological antioxidant role it plays on the free radicals (hydroxyl radical and Singlet oxygen) [24]. According to WHO, the daily need in this amino acid is 12 mg/Kg or 840 mg to 70 Kg of body weight. Also, Methionine plus cysteine, have values that lie between 0.15% (*M. myristica*) and 36.22% (*P. brazzeana*). It is important to mention also that methionine acid is an antioxidant with high sulphur content [25], that helps prevent deficiencies of hair cells, skin, and nails. Furthermore, this amino acid protect against greasy clusters around the liver and the arteries that cause obstructions. It promotes detoxification of harmful agents such as lead and other heavy metals. Also, Cysteine, works as a powerful antioxidant to eliminate harmful toxins [25]. Therefore, these two sulfur amino acid deficiency would cause physiological disturbances, even the risks of contracting degenerative diseases [4]. Valine values oscillate between 0.09% (S. *melongena*), and 9.81% (*A. daniellii*). Medically, this amino acid is used in the treatment of liver diseases, gall bladder and promotes the intellectual liveliness [25]. The results also indicated that the value of threonine varied from 1.94% (*A. daniellii*) to 39.41% (*S. zenkeri* "bark"). Also, this amino acid permits to maintain the balanced intake of proteins in the body and is also an important part in the formation of dental enamel, the collagen and elastin. The amounts of isoleucine in the studied spices range from 0.14% (*P. umbellatum*) to 13.59% (*S. zenkeri* "bark"). In the deficiency, the isoleucine causes physical and mental disorders. For leucine, values were included between 0.08% (*P. umbellatum*) and 11.83% (*D. glomerata*). Leucine plays with isoleucine and valine to promote muscle function, skin and bones [20]. Phenylalanine plus tyrosine have values that fluctuate between 0.53% (*S. melongena*), and 17.31% (*P. umbellatum*). In addition, it is recognized that the phenylalanine is used by the brain to produce norepinephrine, a chemical that transmits signals between nerve cells. Also, it promotes alertness and vitality, regulates human mood and reduces the pain. This acid also used in the treatment of arthritis, depression, painful menstruation, migraine, obesity, the Parkinson's disease and schizophrenia [20,26]. The levels of lysine, which is an amino acid in different spices ranged from 0.08% (*A. daniellii*) and 15.32% (*D. glomerata*). These results revealed that individual amino acid varies in general from 10.7% (histidine) to 39.41% (threonine). The proteins are considered good nutritive value if their essential amino acid profile is higher than the reference level required by at least pre-school children (2-5 years that need most of these amino acids) due to inability of the human body to synthesize FAO/WHO/UNU [11] has recommended that pre-school children need a minimum of 34, 35, 25, 28, 66, 63 and 58 mg/g protein for Thr, Val, (Met+Cys), Ile, Leu, (Phe+Tyr) and Lys, respectively, in their protein diet [27]. In this respect, taking alone, all spices were deficient of some essential amino acids. For instance, it is recommended to use these spices in the mixture to equilibrate this balance.

3.3. Chemical Score

The chemical score proves to be a powerful tool to assess the nutritional value of a protein because it reflects the ability of the analyzed protein or food protein to contain of the essential amino acids, i.e. not synthesizable by the human body. The results cited in Table 4, shown that the chemical score index varied significantly ($p < 0.05$) between various essential amino acids for each of the spices. Furthermore, the chemical index of the histidine of the studied spices varied from 0.57 (*A. daniellii*) to 545.55 (*S. zenkeri* "fruit"). The valine oscillated between 0.00 (*D. glomerata*) and 203.75 (*A. daniellii*), methionine + cysteine, it fluctuated between 0.20 (*S. zenkeri* "fruit") to 564.44 (*P. brazzeana*), then for threonine, with values ranged between 0.22 (*S. zenkeri* "fruit") and 537.92 (*S. zenkeri* "bark"). The chemical score index of isoleucine varied from 0.25 (*X. aethiopica*) to 253.77 (*S. melongena*), while that of the leucine fluctuated between 0.10 (*P. brazzeana*) and 271.57 (*S. zenkeri* "bark"), and as the phenylalanine, more tyrosine which also ranged from 0.06 (*S. zenkeri* "bark") to 268.97 (*P. umbellatum*) and finally the chemical index of lysine whose values lie between 1.56 (*A. daniellii*) and 397.78 (*T. tetraptera*).

Furthermore, it is important in the same table to noted that: - histidine was the first limiting amino acid for some spices (*A. daniellii, D. glomerata, Echinops gigateus, P. umbellatum* and *T. tetraptera*), and also the second limiting amino acid for others (*D. psilurus, F. leprieuri, F. xanthoxyloides* and *P. guineense*); - While Valine was the first limiting amino acid for some spices (*C. frutescens, D. glomerata, Echinops gigateus, F. leprieuri, F. xanthoxyloïdes, H. gabonii (bark), M. whitei, P. guineense, S. Striatinux* and *S. zenkeri* (fruit and bark) and it was considered as the second limiting amino acid for: *P. brazzeana* and *S. melongena;* **-** In addition the other spices were *D. glomerata, D. psilurus, S. melongena* and *S. zenkeri* (fruit), Meth+Cys were the first amino acids and the second for others spices (*H. gabonii* (fruit), *M. myristica* and *M. whitei*); - Concerning threonine, it is the first limiting amino acid for *D. glomerata, F. leprieuri* and *H. gabonii* (fruit) and represented the second for *A. daniellii* and *Echinops gigateus;* - In respect of the isoleucine, it was the major limiting amino acid for the spices: *Echinops gigateus, T. tetraptera* and *X. aethiopica*; - Leucine meanwhile, was the first limiting essential amino acide for: *A. daniellii, D. psilurus, Echinops gigateus* and *P. brazzeana* and it was the second one in the: *D. glomerata, H. gabonii* (bark), *P. umbellatum, S. zenkeri* (bark) and *T. tetraptera*; - while In spices *A. daniellii, Echinops gigateus, F. leprieuri, P. brazzeana, S. zenkeri* (bark) and *T. tetraptera*, Phe+Tyr were the first limiting essential amino acid and the second limiting amino acid of *S. zenkeri* (fruit) and *X. aethiopica*; - About the lysine, it was the first limiting amino acid in *A. daniellii* and the second for: *C. frutescens* and *S. Striatinux*.

Based on these results, it concluded that certain of spices used in this study could be qualified as a good source of protein because the quality of protein in food was determined by the content of amino acids especially the essential amino acids [20]. However, to be effective consumption of the mixture of these spices is recommended to cover the needs for essential amino acid.

Table 4. Chemical score of spices (%)

Spices	Histidine	Valine	Meth + Cys	Threonine	Isoleucine	Leucine	Phe+ Tyr	Lysine
A. daniellii	ND	239.27	827.6	71.85	155.81	ND	ND	1.54
C. frutescens	114.44	54.39	175.2	236.66	220	121.90	122.39	97.69
D. glomerata	ND	ND	ND	ND	313.87	61.75	248.91	294.62
D. psilurus	47.77	193.17	ND	220.37	283.87	ND	85.22	87.5
E. giganteus	ND	ND	268.8	87.04	ND	ND	ND	168.85
F. leprieuri	40	ND	287.2	ND	416.13	76.66	ND	188.46
F. xanthoxyloïdes	89.44	20.24	308.8	116.30	215.81	187.77	115.87	105.19
H. gabonii (fruit)	ND	62.68	29.2	ND	195.81	124.44	125.43	152.12
H. gabonii (bark)	252.22	15.85	132.4	354.07	248.39	51.90	110.87	136.15
M. myristica	530.55	52.44	6	ND	210	125.24	193.48	124.81
M. whitei	87.77	5.36	8.8	238.52	130.97	101.59	313.91	328.85
P. brazzeana	419.44	10	1448.8	ND	337.10	ND	53.48	16.35
P. gunineense	4.44	148.54	39.2	154.07	208.06	128.25	ND	103.85
P. umbellatum	ND	ND	291.2	251.48	4.52	1.35	376.30	73.27
Scleria striatinux	135	3.17	813.2	85.55	126.45	45.24	161.95	40.19
S. melongena	207.22	2.19	ND	ND	233.55	153.65	11.52	111.15
S. zenkeri (fruit)	594.44	ND	ND	ND	282.58	155.39	87.83	237.12
S. zenkeri (bark)	176.66	ND	444.4	1459.63	438.39	105.39	ND	113.08
T. tetraptera	ND	ND	ND	ND	ND	114.76	ND	165.77
X. aethiopica	176.11	177.32	ND	ND	ND	144.44	96.74	134.04
FAO/WHO/UNU [2007] reference pattern	1.8	4.1	2.5	2.7	3.1	6.3	4.6	5.2

Mean values that have the same superscripts letters in the same column are not significantly different at the 5% level; Met = methionine; Cys = cysteine. Phe = phenylalanine; Tyr = tyrosine; Mean ± standard deviation; n = 3.

3.4. Fat and Fatty Acid Composition

The characterization and levels of fatty acids of oils of 20 studied spices recorded in Table 5 and Table 5 continued. This tables shown that these oils formed by the chain of fatty acids ranged from 8 to 24 carbons. Saturated fatty acids varied rare in our spices (C8: 0, C12: 0, C13: 0, C16: 0, C17: 0, C18: 0, C22:0). Caprylic acid (C8), described as partially volatile, presented in only two spices with 18.74% for *E. giganteus* and 6.56% for *S. melongena*. On the other hand, the C10 (capric acid) was much in *H. gabonii* (fruit) with a content of 49.9%. The presence of these fatty acids with short chain (C6 to C10) in relatively high quantities and the development of fairly strong odors have been demonstrated on *Morinda citrifolia* [28]. Indeed, these short-chain acids were highly volatile and could be released by intracellular lipase during technological treatments.

Table 5. Fats content (g/100g DM) and fatty acid composition of spices as g/100g DM of total fatty acids

Spices	Fats content*	C8	C10	C12	C13	C14: 1n9	C16	C16 : 1n9C	C17	C18
A. daniellii	23.1 ± 0.43^{l}	ND	ND	ND	2.73±0.10^{b}	2.42±0.04^{a}	ND	17.52±0.12^{f}	ND	ND
C. frutescens	11.09 ± 0.16^{e}	ND	ND	ND	ND	ND	ND	20.94±0.02^{i}	ND	ND
D. glomerata	11.25 ± 0.35^{e}	ND	ND	ND	ND	ND	ND	17±0.08ef	ND	ND
D. psilurus	15.33±0.63^{h}	ND	ND	4.57±0.99^{b}	ND	5.37±0.46^{b}	ND	16.14±0.48^{cd}	ND	ND
E. giganteus	12.24±0.28^{f}	18.74±0.28^{b}	1.39±0.28^{a}	ND	ND	ND	ND	12.34±0.25^{b}	ND	ND
F. leprieuri	32.14±0.14^{m}	ND	ND	ND	ND	ND	ND	31.58±0.56^{m}	ND	ND
F. xanthoxyloïdes	19.21 ± 0.76^{j}	ND	ND	ND	ND	ND	ND	19.86±0.28^{h}	ND	ND
H. gabonii (fruit)	16.96 ± 0.23^{i}	ND	49.9±0.13^{b}	ND	ND	ND	ND	13±0.28^{b}	ND	3.83±0.14
H. gabonii (bark)	2.19 ± 0.21^{a}	ND	ND	ND	ND	ND	ND	26.21±0.28^{l}	ND	ND
M. myristica	53.36±0.14^{o}	ND	ND	2.21±0.15^{a}	ND	ND	ND	ND	ND	ND
M. whitei	4.16 ± 0.14^{b}	ND	ND	ND	ND	ND	7.62±0.44^{b}	ND	ND	ND
P. brazzeana	6.15 ± 0.16^{c}	ND	ND	ND	ND	ND	ND	26.7±0.21^{l}	ND	ND
P. gunineense	20.31 ± 0.46^{k}	ND	ND	ND	ND	ND	ND	24.74±0.34^{k}	ND	ND
P. umbellatum	5.98 ± 0.26^{c}	ND	ND	5.89±0.41^{b}	ND	ND	ND	15.51±0.15^{c}	ND	ND
Scleria striatinux	17.39±0.79^{i}	6.56±0.36^{a}	5.39±0.01^{b}	ND	ND	ND	ND	16.74±0.42^{de}	ND	ND
S. melongena	7.14±0.33^{d}	ND	7.24±0.28^{c}	ND	1.28±0.14^{a}	ND	ND	26.93±0.56^{l}	6.4±0.20	ND
S. zenkeri (fruit)	1.95 ± 0.24^{a}	ND	ND	ND	ND	ND	ND	18.57±0.28^{g}	ND	ND
S. zenkeri (bark)	3.65 ± 0.21^{b}	ND	ND	ND	ND	5.61±0.28^{b}	5.89±0.14^{a}	23.41±0.14j	ND	ND
T. tetraptera	5.64 ± 0.32^{c}	ND	ND	ND	ND	ND	ND	22.77±0.85^{j}	ND	ND
X. aethiopica	33.69±0.72^{n}	ND	ND	ND	ND	ND	ND	10.13±0.14^{a}	ND	ND

*Source: Abdou Bouba et al. (2012). Mean values that have the same superscripts letters in the same column are significantly different at 5%; Mean ± standard deviation; n = 3. ND = Non Detected

Table 5. Continued (g/100g DM)

Spices	C18: 1n9t	C18 : 2n9C	C18 : 2n6C	C18 : 3n3	C20	C20 : 1	C22	C22 : 1n9	C22: 6n3	C24: 1n9
A. daniellii	ND	3.47 ± 0.01^{bc}	25.69 ± 0.65^{e}	9.37 ± 0.26^{b}	ND	ND	ND	ND	8.29 ± 0.14^{b}	ND
C. frutescens	ND	4.94 ± 0.04^{ef}	31.76 ± 0.08^{h}	31.98 ± 0.05^{g}	8.54 ± 0.11^{gh}	ND	ND	ND	ND	ND
D. glomerata	ND	8.62 ± 0.17^{h}	23.15 ± 0.20^{d}	26.09 ± 0.69^{f}	9.87 ± 0.56^{i}	ND	6.23 ± 0.17^{c}	6.68 ± 0.66^{c}	ND	ND
D. psilurus	ND	6.74 ± 0.11^{g}	49.29 ± 1.42^{n}	ND	5.95 ± 1.27^{cd}	ND	ND	ND	13.5 ± 0.42^{d}	ND
E. giganteus	ND	3.62 ± 0.28^{bc}	36.88 ± 0.45^{k}	23.6 ± 0.19^{e}	3.91 ± 0.14^{b}	ND	ND	ND	ND	ND
F. leprieuri	ND	4.83 ± 0.80^{e}	18.97 ± 0.56^{c}	40.07 ± 0.60^{k}	4.77 ± 0.28^{bc}	ND	ND	ND	ND	ND
F. xanthoxyloïdes	ND	3.27 ± 0.08^{b}	43.79 ± 0.48^{l}	24.08 ± 0.08^{e}	8.96 ± 0.56^{hi}	ND	ND	ND	ND	ND
H. gabonii (fruit)	ND	5.59 ± 0.28^{f}	17.93 ± 0.07^{b}	34.84 ± 0.76^{ij}	ND	ND	4.03 ± 0.04^{a}	3.95 ± 0.42^{a}	13.17 ± 0.49^{d}	ND
H. gabonii (bark)	3.65 ± 0.28^{b}	ND	47.91 ± 0.28^{m}	16.42 ± 0.14^{d}	6.26 ± 0.14^{d}	ND	ND	ND	ND	ND
M. myristica	ND	ND	ND	ND	2.45 ± 0.14^{a}	ND	ND	ND	ND	ND
M. whitei	ND	ND	32.9 ± 0.56^{i}	54.77 ± 0.99^{l}	ND	ND	ND	ND	ND	ND
P. brazzeana	ND	3.98 ± 0.28^{d}	35.97 ± 0.1^{j}	26.96 ± 0.28^{f}	6.39 ± 0.28^{ef}	ND	ND	ND	ND	ND
P. gunineense	ND	2.45 ± 0.35^{a}	39.5 ± 0.70^{k}	14.74 ± 0.08^{c}	5.8 ± 0.28^{cd}	ND	ND	12.76 ± 0.08^{d}	ND	ND
P. umbellatum	ND	3.84 ± 0.05^{bc}	30.08 ± 0.11^{g}	39.25 ± 0.21^{k}	5.43±0.14cd	ND	ND	ND	ND	ND
Scleria striatinux	ND	3.68 ± 0.37^{bc}	28.26 ± 0.28^{f}	34.23 ± 0.14^{hi}	5.19 ± 0.14^{cd}	ND	ND	ND	ND	ND
S. melongena	5.25 ± 0.28^{c}	8.12 ± 0.14^{h}	28.82 ± 0.28^{f}	ND	7.59 ± 0.28^{fg}	ND	4.85 ± 0.28^{b}	ND	5.59 ± 0.13^{a}	ND
S. zenkeri (fruit)	6.57 ± 0.14^{d}	ND	18.18 ± 0.14^{bc}	35.68 ± 0.28^{j}	2.16 ± 0.14^{a}	3.48±0.28	ND	5.19 ± 0.11^{b}	11.29 ± 0.15^{c}	ND
S. zenkeri (bark)	2.27 ± 0.07^{a}	ND	13.03 ± 0.04^{a}	26.69 ± 0.05^{f}	4.91 ± 0.07^{bc}	ND	ND	ND	20.45 ± 0.07^{e}	ND
T. tetraptera	ND	ND	ND	33.64 ± 0.42^{h}	5.96 ± 1.55^{cd}	ND	ND	ND	11.9 ± 0.28^{c}	ND
X. aethiopica	ND	ND	17.55 ± 0.42^{bc}	6.72 ± 0.11^{a}	ND	ND	3.86 ± 0.08^{a}	3.87 ± 0.03^{a}	30.1 ± 0.07^{f}	22 .81±0.04

Mean values that have the same superscripts letters in the same column are significantly different at 5%; Mean ± standard deviation; n = 3. ND = Non Detected.

N-heptadecanoic acid (C17: 0) was not naturally present in vegetable oils even if amounts were observed in *S. striatinux*. The lauric (C12: 0) which is found mainly in seeds with oils are called lauric as oil of coconut or palm kernel. It also varied at a few levels of our spices (*D. psilurus, M. myristica*, *P. umbellatum*).

Nevertheless, the high levels of unsaturated fatty acids in long-chain found at least in all the spices. It's the case of: C18:2n9C, C18:2n6C, C18:3n3 which these levels varied significantly ($p<0.05$). Contrary to the other unsaturated fatty acids, fatty acid C18:1n9t, C22:1n9, C22: 6n3 and C24:1n9 varied and were not found in all the spices. In general, the unsaturated fatty acids belong on the diet plan in three main series: the ω-3 and ω-6 and ω-9. The ω-3 founded primarily in fish oils and certain vegetable oils while the ω-6 is founded primarily in vegetable oils. They play a significant role in the development and functioning of the brain [29].

Palmitic acid (C16: 1n9) which is ω-9 varied considerably between the spices. The highest content was encountered in *F. leprieuri* (31.58%) while the spices such as *M. myristica* and *M. whitei* were not detectable. However these values have proved to be lower than those found in olive oil which characterized by a high content fatty acid C18: 1n9C (72%). Monounsaturated fatty acids allow the reduction of LDL cholesterol in serum and as such plays a protective role in several cardiovascular diseases [23]. C18:2n9C fatty acid was presented in all the spices except *T. tetraptera* and *D. psilurus* which presented the highest content (49.29%) followed by *H. gabonii* "bark" (47.91%), *F. xanthoxyloides* (43.79%) and *P. guineense* (39.5%), then the spice having average grades with *E. giganteus* (36.38%).

Fatty acid C24: 1n9 is not common. It was located only in *X. aethiopica* (22.81%). It could be considered not only as a nutritional fatty acid but also share nutraceutical polyunsaturated long-chain according to its structure. Consumption of fatty acid to long strings such as arachidonic acid, precursor of prostaglandins has an antiplatelet effect [30].

In general, the ω-3 fatty acids play an important role in the development and maintenance of the human bodies, especially of the brain and which involved in the prevention of various diseases such as cardiovascular, psychiatric, neurological, dermatological diseases and rheumatic disorders [7,29,31,32]. The ω -3 fatty acids are essential nutrients for humans because it cannot be manufactured and then recommended daily, doses which range between 0.18 and 10.15 g/day. In our spices, the ω-3 fatty acids were fatty acid C18:3n3 and C22: 6n3. The content of fatty acid C18:3n3 varied significantly ($p < 0.05$) between the spices. Particularly rich in ω - 3 spices were: *M. whitei* (54.77%), *F. leprieuri* (40.07%), *P. umbellatum* (39.25%), *S. zenkeri* "fruit" (35.65%), *H. gabonii* (fruit) (34.84%), *T. tetraptera* (33.64%), *C. frutescens* (31.98%). While the fatty acid C22:6n3 were presented of eight of the studied spices. The higher content was *X. aethiopica* (30.1%) and the smallest content is the *S. striatinux* (5.59%). It is important to recall that the main dietary sources of these fatty acids are usually fish and marine products. Especially, the consumption of fatty acids (Eicosapentaenoic Acid: C20: 5ω - 3 and acid docohexaenoique: C22: 6ω-3) induced a decrease in triglycerides due to a reduction in the production of LDL, and sometimes, an increase of HDL [29,33]. For this reason, the spices rich in ω - 3 spices could be considered as an alternative source in ω - 3 such as *M. whitei*, *X. aethiopica*, *F. leprieuri*, *P. umbellatum*, *T. tetraptera*, *S. zenkeri* (fruit), *H. gabonii* (fruit) to complement the consumption of ω-3 from fish and marine products. It was a good new source of ω - 3 in our diet [34]. In addition it has been shown that there is a positive correlation between unsaturated fatty acids and lower cholesterol level in the plasma [12].

Linoleic acid (C18:2n6) still called ω - 6 is an essential fatty acid, and its content in our spices varies significantly ($p < 0.05$). Almost all spices have this fatty acid. The highest levels were found in *D. psilurus* (49.29%), *H. gabonii* (bark) (47.91%), *F. xanthoxyloides* (43.79%) and the lowest value was found in the *S. zenkeri* (bark) (13.03%). These values are similar to those founded in olive oil with 53.0% [28] and in the goat milk [8]. Oils rich in linoleic acid are important for human health. These oils reduce atherosclerosis by interaction with HDL in blood [Necmettin *et al.*, 2006] and the cholesterol levels of 10% with a maximum effect for a ratio of PUFA/SFA close to [35]. Some polyunsaturated fatty acids such as linoleic acid and arachidonic acid known as vitamin F are required for the growth and protection of the skin. These essential fatty acids deficiency would result in a skin condition such as alopecia and edema. This vitamin F is incorporated, about 5%, in some dermatological creams, especially in tanning lotions. This shows that certain spices such as *M. whitei*, *F. leprieuri*, *D. psilurus*, *H. gabonii* (bark), *F. xanthoxyloides* could be used in cosmetics [36].

4. Conclusions

With a view to improve the nutritional status and enhance natural resources in use, only the analysis of some nutrients of spices allowed retaining in a general way that, almost, all the spices powder analyzed are considered as nutritional resources. Nevertheless, *S. zenkeri* (bark), *P. brazzeana* and *M. whitei* are sources of essential amino acids whose levels are high. While spices *P. brazzeana*, *A. daniellii*, and *S. striatinux*, with a large percentage of sulphur amino acids therefore, could be spices to antioxidant potential, while spices *M. whitei*, *D. glomerata* and *S. zenkeri* (fruit) are shown to be rich in lysine which is an essential amino acid in the younger ones. Consumption of the spice mixtures could be a source of protein and essential amino acid supplement. Spices also can be a supplementary source of essential fatty acids (*D. psilurus*, *H. gabonii* "bark", *F. xanthoxyloides*) and especially in ω-3 other than fish oil and marine products (*M. whitei*, *F. leprieuri*, *P. umbellatum*). *X. aethiopica* which its high content in oil and long-chain polyunsaturated fatty acids which may have a role in addition to their nutritional importance in reducing the risk of cardiovascular disease contraction. Special attention must be given to spices characterized by a high content ω-3, ω-6 and methionine plus cysteine antioxidant role it plays in order to reduce and for their interest in reducing the risk of chronic diseases. It can be concluded in the light of these results that tropical edible plants found in Cameroon could contribute significantly to the diets of indigenous population in sub-Saharan Africa and thereby should provide their public health.

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