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BIOCHEMICAL AND NUTRITIONAL CHARACTERISTICS OF *MYRIANTHUS ARBOREUS* PULP AND ALMONDS FLOURS FROM COTE D'IVOIRE

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ABSTRACT

The aim of this study was the determination of the biochemical and nutritional characteristics of *Myrianthus arboreus* pulp and almonds. Results showed that the fruits of *Myrianthus aboreus*, possessed enormous nutritional and energetic potential due to its biochemical composition. In fact, they contain satisfactory proportions of carbohydrates, fat and protein, both in the pulp and in almonds. In addition, phosphorus, potassium, calcium and magnesium, essential for the body were encountered. The most important amino acids were aspartic acid (0.66 ±0.01 to 17.26 ±0.05 mg/100g), cysteine (3.42 ±0.02 to 5.62 ±0.03mg/100g), isoleucine (1.12 ±0.1 to 6.3 ±0.05 mg/100g), methionine (0.2 ±0.01 to 2.58 ±0.06 mg/100g) and serine (5,15 ±0,05 to 5,59 ±0,03mg/100g). These nutrients would therefore give them advantages for their application in the food industry. Finally, taking into account their lipid content, the almonds of *Myrianthus aboreus* would constitute a good source of exploitable lipid.

KEYWORDS: *Myrianthus arboreus ;* seeds, mineral content, boiled; pulp and almonds; amino acid; charasteristics.

I-INTRODUCTION

Myrianthus arboreus is a fruit plant being a part of spontaneous food botanical species. In Africa, this plant covers mainly regions Guinéo-Congolaises extending from the Sierra Leone to the Gabon (Dewitt, 1966). However, contrary to leaves, whose nutritional importance was revealed by several authors (Bonnéhin, 2000; Kouamé et *al* ., 2008), very few studies were led on fruits of *M. arbreus*. The first results obtained related to biochemical composition. In fact, Leung et *al.* (1986) achieved the richness of its seeds in both lipid (33%) and protein (23%). Moreover, in Côte d'Ivoire, only the work of Katou et *al.*, (2017) was able to highlight this potential. The oil extracted from *M. arboreus* seeds by these authors highlights its richness in polyunsaturated fatty acids. Indeed, with approximately 70% coverage of the world oil market, vegetable oil has an economic value of 32 billion Euro (Anonyme, 1998), it plays a very important role in the economy of the agriculture and agri-food sector (Ika, 2005). Hence the value of oilseeds, including *Myrianthus arboreus*. Recent research has shown that the oils extracted from *Myrianthus arboreus* seeds can be an alternative for the diversification of lipid sources. So, aim of this study is the determination of the biochemical, and nutritional characteristics of the *Myrianthus arboreus* pulp and almonds produced in Côte d'Ivoire

II-MATERIAL AND METHODS

II-1-Material

The biological material used in this work consists of ripe mature fruits picked in the region of tonkpi exactly in the city of Danané (Côte d'Ivoire). These fruits were transported after the pickings in the Laboratory of Biocatalysis and the Bioprocesses of the Nangui Abrogoua University (Abidjan, Côte d'Ivoire).

II-2-Methods

II-2-1-Collection and Preparation of Samples

Myrianthus arboreus fruit that served as sample for analysis were collected from the city of Danané (Côte d'Ivoire). Transported in the laboratory in bags in jutes and confined in tubs placed in an airy room among which the temperature and the relative humidity were respectively 27 °C and 82%. The fruits were transported the same day of their collection in plantations. The seeds were separated manually from flesh of the fruit. The seeds were washed with distilled water and one part (about 1 kg) was dried at sun (30-35°C) for a week (dried seeds, DS). A second part (1 kg), was boiled in water (100°C) for 30 min (boiled seeds, BS). The seeds of all parts were then dried in the steam room ventilated at 55°C during 48 hours. These seeds were ground into flours using Moulinex blender. The different flours DS and BS were stored in polythene bags and kept in refrigerator at 4°C until used for analysis.

II-2-2-Proximate analysis

Crude protein content was calculated from nitrogen (Nx6.25) obtained using the Kjeldahl method by AOAC (1990). The determination of the total amino acids of *Myrianthus arboreus* almonds powder was carried out using the ISO 13903 standard method (2005) or the ninhydrin method. Fat content was determined by continuous extraction in a Soxhlet apparatus for 8 h using hexane as solvent (AOAC, 1990). The dry matter content of almonds and pulp powders was determined using the AOAC (1990) method. The method described by Dufour et *al.* (1994) was used to determine the pH of *Myrianthus Arboreus* powder. Ash was determined by incinerating in a muffle furnace at 550ºC (AOAC, 1990). Method described by Dubois *et al.* (1956) was used to determine total sugars. Total carbohydrate content was calculated as 100% minus the sum of moisture, protein, fat and ash contents (Rand *et al*., 1991). The caloric energy value was determined by calculation from fat, carbohydrate and protein contents using the Atwater"s conversion factors; 4 kcal/g for protein, 9 kcal/g for fat and 4 kcal/g for carbohydrates and expressed in calories as described by Ihekeronye and Ngoddy (1985).

All minerals were determined by scanning electron microscopy/energy dispersive X-ray spectrometry (SEM/EDS).

II-2-3-Statistical Analysis

The analyses were carried out in triplicate and data were expressed as mean ± standard deviation. Analysis of variance (ANOVA) followed by Newman Keels range test to show, at the level of 5 %, was usednto compare means followed by standard deviation (STATISTICA 7.1 software)

III-RESULTS

III-1-Biochemical composition

The biochemical composition of the various powders studied was mentioned in (Table 1). The results showed that dry matter (88.75 ±0.47 to 90 0.85%), fat (2.24 ±0.4 to 45.02 ± 0.68%), protein (13.62 ± 0.62 to 25.38 ± 1.23%), carbohydrates (17.54 ± 0.25 to 70.68± 0.32%), total sugar (0.49 ±0.06 to 0.55 ±0.11%), were very high for all the powders studied (pulp, dried almonds and water-fired almonds). These levels were significantly different at the 5% threshold. While, the pH of these powders do not vary to the 5% threshold.

Table 1: Biochemical composition of pulp, dry and water-cooked seeds powders of *Myrianthus arboreus.*

Parameters	**Powder (mg/100g)**		
	pulp	**Dry seed**	**Seed boiling in water**
Dry matter	88.75 ± 0.47[a]	90 ± 0.85[b]	88.95 ± 1.91[a]
Fat	2.24 ± 0,4[a]	45.02 ± 0.68 [b]	44.98 ± 3.75 [b]
Crude protein	13.62 ± 0.62[a]	25.38 ± 1.23[c]	24.05 ± 1.28[b]
Total carbohydrate	70.68 ± 0,32[b]	17.54 ± 0.25[a]	17.63 ± 0.13[a]
Total sugars	0.55 ± 0.11[a]	0.50 ± 1.56[a]	0.49 ± 0.06[a]
pH	4.14 ± 0.91[a]	4.16 ± 0.21[a]	4.16 ± 0.49[a]
Caloricenergy (Kcal/100 g)	168± 0.91[a]	566.98± 1.08[b]	574.1± 1.2[c]

Average ± standard deviation, n = 3; on lines, affected by different letter are significantly different at the threshold of 5 % according to the test of Duncan.

III-2-Mineral content

The proportions in mineral contents of the various powders were shown in (Table 2). The most important were magnesium (86.26 ±0.01 to 340.58 ±0.16 mg/100g), potassium (123.42± 0.02 to 422.62 ±1.15 mg/100g), calcium (38.15 ±0.15 to 130.59 ±0.03 mg/100g), phosphorus (101 ±0.25 to 348.27 ±0.77 mg/100g) and manganese (4.62± 0.01 to 15.82 ±0.08 mg/100g). *Myrianthus arboreus* almond powder minerals were statistically above the 5% threshold of the fruit pulp powder, but this analysis showed that ash levels (0.66 ±0.02 to 2.27 ±0.06%) were low.

Table 2: ***Mineral composition of the pulp and flour of Myrianthus arboreus seeds.***

minéral composition	Powder (mg/100g)	
	pulp	almonds
Ash	0.66 ± 0.02[a]	2.27± 0.06[b]
Phosphorus	101 ± 0.25[a]	348.27 ± 0.77[b]
Potassium	123.42 ± 0.02[a]	422.62 ± 1.15[b]
Magnesium	86.26 ± 0.01[a]	340.58 ± 0.16[b]
Calcium	38.15 ± 0.15[a]	130.59 ± 0.03[b]
Zinc	2.9 ± 0.06[a]	10.44 ± 0.11[b]
Sodium	1.12 ± 0.1[a]	11.3 ± 0.05[b]
Iodine	3.65±0.06[a]	13.56±0.56[b]
Copper	0.66±0.005[a]	2.26±0.04[b]
Iron	0.65±0.04 [a]	6.64±0.01[b]
Manganese	4.62± 0.02[a]	15.82± 0.08[b]

Average ± standard deviation, n = 3; on lines, affected by different letter are significantly different at the threshold of 5 % according to the test of Student.

III-3-Amino acid content

Table 3 presents the amino acid spectra of the powders of almonds and pulp of *Myrianthus arboreus*. The most important amino acids were aspartic acid (0.66 ±0.01 to 17.26 ±0.05 mg/100g), cysteine (3.42 ±0.02 to 5.62 ±0.03mg/100g), isoleucine (1.12 ±0.1 to 6.3 ±0.05 mg/100g), methionine (0.2 ±0.01 to 2.58 ±0.06 mg/100g) and serine (5,15 ±0,05 to 5,59 ±0,03mg/100g). The amino acid content of the powder of the almonds was statistically higher than the 5% threshold of the flour of the fruit pulp of *Myrianthus arboreus*.

Table 3: Amino acids composition of the powders of almonds and pulp *Myrianthus arboreus*.

Amino acid composition	Powder (mg/100g)	
	pulp	almonds
Aspartic acid	0.66 ± 0.01[a]	17.26 ± 0.05[b]
lysine	1 ± 0.00[a]	4.27 ± 0.01[b]
cysteine	3.42 ± 0.02[a]	5.62 ± 0.03[b]
Methionine	0.26 ± 0.01[a]	2.58 ± 0.06[b]
serine	5.15 ± 0.05[a]	5.59 ± 0.03[b]
Alanine	2.9 ± 0.01[a]	2.44 ± 0.01[b]
Isoleucine	1.12 ± 0.1[a]	6.3 ± 0.05[b]
Leucine	4.62± 0.02[a]	7.82± 0.08[b]

Average ± standard deviation, n = 3; on lines, affected by different letter are significantly different at the threshold of 5 % according to the test of Student.

III-4- Rate of oil extraction

The various extraction methods used in this work, notably the Soxhlet method using hexane, Foch method, mechanical press extraction and cooking method, yielded yields ranging from 28,45 to 45,02 %. The Soxhlet method using hexane was the best with an oil extraction rate of 45.02 ± 3.75%, followed by Foch (40.34 ±0.68%), followed by mechanical press extraction (38.67 ±0.18%). Finally, the cooking method had a rate of (28.45 ±0.36%). These results were statistically different from the 5% threshold (Figure 1).

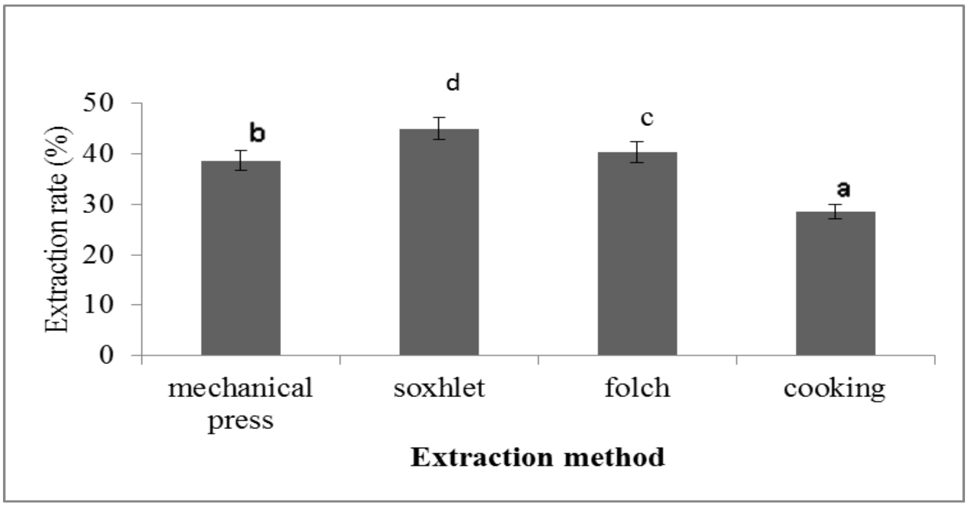

Figure 1: Different extraction methods of *Myrianthus arboreus* oil

DISCUSSION

The various nutritional elements contained in the pulp and almonds were analysed. Values ranging from 13.62 to 25.38% statistically different in protein, were obtained respectively. This content (25.38%) in almonds is close to 24.11% from *C. carvi* seeds (Segura-Campos et *al.* 2014), higher than that of cereals (Silveira et *al.* 2014), but lower than *Pinus pinea* seeds content (Nergiz and Donmez, 2004). The pulp content (13.62%) was similar to *Pachira aquatica* seeds (Oliveira et *al.* 2000). The proteins in the samples studied contain the majority of the essential amino acids (methionine, cysteine, aspartate, serine). Since the nutritional value of a protein source depends on its ability to grant the body the amino acids necessary for its growth as well as those essential for the renewal of body proteins (Gueguen and *al.*, 2016), these almonds could be considered as a potential protein source. However, like all proteins based on plant, they have limited levels of sulphur amino acids (Tamayo et *al*. 2017). with their levels of sulphur amino acids (methionine and cysteine), powders from these almonds may be associated with those from cereals, limit to lysine for a balanced intake (Cuq, 2018).

Considered as the most important source of food energy, Carbohydrates offer variable rates, 70,68 % in the pulp against 17 % in almonds. Which would justify its consumption. This proportion of carbohydrate in almonds is superior to that of *Foeniculum vulgare Mill*. (13 %) obtained by Lazouni and *al*., (2006). Furthermore, the contents in total and reducing sugar were low in the powder of the almonds that that of the pulp. Indeed, this low content in reducing sugar could be associated with the existance of high quantity of complex sugars with long chain of glucoses (FAO, 1997). Four Methods of extraction of the oil were highlighted in this study (extraction using the soxhlet, of Folch, by mechanical press and by cooking). The yields 45,82 %, 40,34 %, 38,67 % and 28,45 % were respectively obtained. This result comes to confirm the leader place of the method using the soxhlet in the processes of extraction (Bouchra et *al.*, 2017). This yield can be bound to the capacity to extract at the same time neutral and polar lipids (Sahoo et *al.*, 2003), where as that of extraction by cooking would be due to the little raised temperature (95°C) used which would limit the liberation of the oil (Chantachum et *al.*, 2000). However, the contents in lipid obtained were superior to those of *C. vulgaris* (Ayssiwèdé et *al.*, 2011). But, they remained lower than that of *Blighia sapidia* (Dossou et *al.*, 2014), so, fruits of *Myrianthus arboreus* constituted a good source of oilseeds. The mineral elements are necessary for the health of somebody. Consequently, the their concentration have an physiological impact on the various organs and cellular mechanisms (Durlach et *al.*, 2000). So, the analysis of the mineral composition of the almonds of *M. arboreus* revealed that they contained important proportions of major minerals that were the potassium (422.62 mg/100 g), the phosphor (348.27 mg/100 g), the magnesium (348.58 mg/100 g) and the calcium (130.59 mg/100 g) as well as in trace element that were the iron (6.64 mg/100 g) and the zinc (10.44 mg/100 g). The potassium was the most abondant as in the majority of legumes (Ezeagu et *al*., 2003). The contents of various minerals obtained were superior to those of the seeds of *mucuna* (Tuleun et *al*., 2008). But they remained lower than those of the powders of *Blighia sapidia* (Dossou et *al*., 2014). In view of their important mineral concentration, the almonds of *Myrianthus arboreus* can be used in the human food for prevent and landing the deficiencies in these minerals (Hu et *al*., 2006). Furthermore, these minerals are essential for the digestion, the coagulation of the blood and especially in the fortification of bones. So, these powders could give an alternative for the mineral use (Durlach et *al*., 2000).

IV-CONCLUSION

The fruits of *Myrianthus aboreus*, possessed enormous nutritional and energetic potential due to its biochemical composition. In fact, they contain satisfactory proportions of carbohydrates, fat and protein, both in the pulp and in almonds. In addition, phosphorus, potassium, calcium and magnesium, essential for the body were encountered. The most important amino acids were aspartic acid, cysteine, isoleucine, methionine and serine. These nutrients would therefore give them advantages for their application in the food industry.

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