

Detailed Analyses of *Nymphaea* Seeds Consumed in the Senegal River Valley

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How to cite this paper: Ayessou N.C., Diop M.B., Gueye F.K., Bassène, C and Mbaye, M.S. (2024) Detailed Analyses of *Nymphaea* Seeds Consumed in the Senegal River Valley. *Food and Nutrition Sciences*, 15, 695-700.
<https://doi.org/10.4236/fns.2024.158044>

Received: May 19, 2024

Accepted: August 17, 2024

Published: August 20, 2024

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Abstract

Physicochemical investigations were performed on seeds of *Nymphaea lotus* and *N. micrantha* consumed in the Senegal River valley. They revealed a composition similar to that of cereals. In order to estimate their intrinsic quality, the determination of their amino acid, fatty acid and monosaccharids profiles was done. The results indicate that monosaccharides are represented specifically by saccharose (7%) and glucose (0.67%); a predominance of stearic acid and linoleic acid as unsaturated acids (24.86%); arachidic and palmitic acids as the only saturated acid found (11.12%); a good ratio of unsaturated/saturated acid (2.23); a lack of oleic acid, linoleic, palmitoleic, myristic, caprylic acids; a poor-quality index protein due to low quantity amino acids. Nevertheless, all essential amino acids are present in the seeds. The *Nymphaea* sp grains consumed by the populations around the Senegal River valley offer an interesting nutritional quality linked to fatty acids and carbohydrates.

Keywords

Nymphaea, Seeds, Composition

1. Introduction

Around the Senegal river's valley, the consumption of several forms of *Nymphaea* sp seeds is based on local knowledges that haven been highlighted [1]. It appears that local populations use the seeds of both *N. micrantha* and *N. lotus* as substitute for cereals during lean seasons. On the other hand, nutritional analyses re-

2.2. Amino Acids Profile

A sample of 15 mg was hydrolysed in 450 ml of 4 M sulfonic methane acid (Sigma Aldrich, Saint Quentin Fallavier, France) and 50 ml of Norleucine (standard Merck) 25 mmol/ml. The tube was degassed under a flow of nitrogen and then introduced into the device with hydrolysis PIERCE reactive for 120 min at 150°C. Acid neutralization is done with 450 ml of NaOH 4 N and transferred in a phial gauged and completed by 5 ml of Citrate of sodium (pH 2.2). The homogenous solution was filtered by Sartorius's filter 0.45 mm. A Biochrom 30+ amino acid analyzer (Serlabo Technologie, Entraigues, France) was used. A standard solution of Sigma Brand Amino Acids containing 18 amino acids (2.5 mmol/ml each except L-cystine 1.25 mmol/ml) was used for comparison (AA-S18, Sigma Aldrich, Saint Quentin Fallavier, France). Internal calibration using a Norleucine standard allowed for precise analysis. The signal was analyzed via EZChrom software and the LOD used was 9p moles.

2.3. Sugar Composition

Sugar profile was determined by Dionex DX600 HPLC HPLC equipped with pulsed amperometric detector (Dionex, Sunnyvale, CA) and a CarboPac MA1 column (4 × 250 mm; 7.5 µm, Dionex, Sunnyvale, CA). Extraction solution was 80% ethanol and stationary phase si acolon of CarboPac MA1 (4 × 250 mm; 7.5 µm). The mobile phase was 0.6 to 0.8 N of NaOH solution, with a 0.4 mL/min constituted the mobile phase. Standards markers were obtained from Sigma-Aldrich1 (St. Louis, MO, USA).

2.4. Fatty Acid Profile

Fatty Acid Methyl Ester profile was determined using chromatographic gaz Shimadzu QP2010 (GC-MS), helium as mobile phase, temperatures of 280°C, one microliter of injected sample, constant pressure of 100 kPa. After separation, a database was used to compare mass spectra, peaks and retention in order to identify fatty acids.

3. Results and Discussion

Table 1 presents the profile of organic matter in seeds of *Nymphaea* sp. The sugar content is represented specifically by glucose (0.67%) and saccharose (7%). The total value of sugar is very low regarding the carbohydrates's one wich is 76.07 in average [2] while crude fibers value found in such *N. lotus*, *N. pubescens* or *N. micrantha* is 5.08% [3]. It can be deduced from these values that *Nymphaea* seeds are essentially made up of starch *i.e.* about 63.32%. Fatty acid of *Nymphaea* sp seeds show a predominance of stearic acid and linoleic acid as unsaturated acids (24.86%). In this oil, arachidic and palmitic acids are the only saturated acid found (11.12%) and results are also in accordance with *N. lotus* [3]. The ratio of unsaturated/saturated acid is 2.23. More amount of unsaturated fatty acid than saturated ones offer a nutritional advantage for the population. In fact, it is

recommended to have a minimum ratio UNS/SA of 0.45 or a best value over than 1 [6]. In fact, a good ratio helps to maintain lipid and glycemic metabolic homeostasis [7]. Usually linoleic acid is the predominant fatty acids in the extracted oils samples. In *Nymphaea* sp seeds consumed in Senegal, this level of linoleic acid is 11.2 g/100g oil which is similar to the results found by Aliyu *et al.* [3] in *N. lotus*.

Many fatty acids are not detected such as oleic, linoleic, palmitoleic, myristic, caprylic acids. Previous researches also showed that Myristic acid was absent in *Nymphaea lotus* seeds oil [4]. Nevertheless, the absence of oleic acid is deplorable because it is a fatty acid that participates in the fight against the development of atherosclerosis and the lowering of cholesterol in the blood [3].

The amino acids profile revealed a low total value (8%) which is very low compared to previous results on *N. lotus* (73.82%) and *N. pubescens* seeds (70.70%) [4] and WHO standard references [8]. Then it is no need to calculate quality index protein. This low value of total amino acids highlights that *Nymphaea* sp consumed in Senegal have a poor protein quality and can't provide sufficient amino acids to population's diet. Nevertheless, all essential amino acids are present in the seeds.

As it was shown by Gueye *et al.* (1), *Nymphaea*'s seed can be assimilated to cereals, taking into account their energy, protein, lipid and carbohydrate content. Considering the way they are consumed, these seeds are good substitutes for rice and millet couscous, which are very much part of the diets of people in the Senegal river's valley. *Nymphaea* seeds also help to diversify the diet. In this respect, a possible domestication is conceivable for a control of the production and its availability to fight against food insecurity.

Table 1. Amino acids, carbohydrates and fatty acid profile of *Nymphaea*'s seeds.

Amino Acids content (g/100g DM)		Sugar content (g/100g DM)	
Ala	0.56 ± 0.05	Glucose	0.67 ± 0.03
Asp	1.36 ± 0.14	Fructose	<0.1
Arg	0.26 ± 0.05	Saccharose	7 ± 0.04
Cys	0.34 ± 0.01	Sorbitol	0.003 ± 0.00
Try	0.67 ± 0.03	Glycerol	<0.001
Glu	1.07 ± 0.33	Total	7.67 ± 0.01
Gly	0.23 ± 0.04	Fatty acid profile (g/100g oil)	
His	0.35 ± 0.01	Linoleic acid	11.21
Ile	0.14 ± 0.12	Stearic acid	13.65
Leu	0.15 ± 0.01	Arachidic acid	7.6
Lys	0.34 ± 0.03	Palmitic acid	3.52
Met	0.27 ± 0.03	Caprylic acid	nd
Phe	0.33 ± 0.05	Myristic acid	nd

Continued

Pro	0.02 ± 0.01	Palmitoleic acid	nd
Ser	0.15 ± 0.03	Oleic acid	nd
Thr	0.25 ± 0.02	Linolenic acid	nd
Tyr	1.04 ± 0.05	Lauric acid	nd
Val	0.40 ± 0.03	Behenic acid	nd
total	8.23 ± 0.05		

Nd: not found.

4. Conclusion

Nymphaea's seeds consumed do really bring nutriments to population during lean season and might be more promoted. In addition to its energy intake as a cereal, it is a good quality source of fatty acids that can be beneficial to consumers.

Acknowledgements

The authors thank CEA AGRISAN who supported this work through the project "VALONUS".

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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