The chemical composition of oyster nut (Telfairia pedata) seeds and oil

Paolo Bondioli1,*, Liliana Folegatti2 and Gabriella Morini3

1 Freelance Expert, Milano, Italy
2 INNOVHUB-SSI-SSOG, Milano, Italy
3 University of Gastronomic Sciences, Pollenzo, Italy

Received 1 September 2020 – Accepted 23 November 2020

Abstract – In this paper, the chemical composition of Telfairia pedata seeds and oil is discussed. This crop belongs to the family of Cucurbitaceae. Unroasted seeds and oil obtained from roasted seeds were collected during a study trip in Tanzania. Oil from unroasted seeds was extracted in the lab using hexane. The seeds contain approximately 60 (% m/m) of oil and 30 (% m/m) of protein, being the remaining amount represented by crude fiber, carbohydrates and mineral constituents. The protein fraction contains glutamic acid, arginine, aspartic acid and leucine as the most representative amino acids. The fatty acid composition is a common one, being palmitic, linoleic, stearic and oleic acids, the most important fatty acids detected. No difference was found in fatty acid composition between oils extracted from roasted and unroasted seeds. On the contrary, the oil obtained from roasted seeds shows a higher concentration in sterols and tocopherols while the distribution between the different constituents remains the same.

Keywords: Telfairia pedata / oyster nut / seed composition / oil composition / roasting

1 Introduction

Looking at the vegetable kingdom, a huge number of uncommon oil crops can be found: this time, we shall discuss about the chemical composition of seeds and oils of Telfairia pedata, commonly known as oyster nut, because of the particular shape of its seeds. It is also known as Queen’s nut, Zanzibar oil vine Kouémé, Bane, Châtaigne de l’Inhambane, Liane de Joliff and is a dioecious African liana which can grow up to 30 m long, having purple-pink fringed flowers, and very large (30–90 cm × 15–25 cm), many-seeded, drooping, ellipsoid berries which can weigh up to 15 kg (Kanyua, 2016). According to the information found from different sources Telfairia pedata belongs to the family of Cucurbitaceae. It can be found in Tanzania, Isles of Zanzibar, Pemba and Mozambique and is cultivated in Central, East and Southern Africa from Rwanda and Uganda to Ethiopia and southwards through Tanzania to Zambia, Malawi, Mozambique and South

* Contribution to the Topical Issue “Minor oils from atypical plant sources / Huiles mineures de sources végétales atypiques”.
*Correspondence: paolo.bondioli1956@gmail.com

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (https://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.
2 Material and methods

2.1 Materials

The seeds with hull were obtained from a student travelling through Tanzania during year 2019. The oil from roasted seeds was purchased in a street market in the city of Morogoro (Tanzania) during the same trip.

Pictures of seeds and berries can be easily found in the web. All studies were carried out using the dehulled seed. The hull represents approximately 30% of the whole seed.

2.2 Analytical methods – Seed

2.2.1 Humidity and volatile matter:

This property was evaluated by means of weight loss in thermostatic oven set at 103 °C, using ISO 665:2000 standard.

2.2.2 Protein content

The evaluation was carried out using the classic Kjeldahl procedure and protein content was calculated after determination of total nitrogen content (N × 6.25) according to ISO 5983-1:2005 standard.

2.2.3 Oil content

A classic Soxhlet extraction using hexane, according to UNI EN ISO 659:2009 was used.

2.2.4 Crude fiber

The sample is subjected in sequence to acid and alkaline treatment. The obtained residue, dried and weighed, is then incinerated. Weight loss after incineration and ash deduction represents the raw fiber content. Reference method: UNI 22606:1992.

2.2.5 Ash content

The sample is subjected to combustion and subsequent incineration at 550 °C. At the end of the procedure, the resulting ashes are evaluated gravimetrically. Reference method: UNI 22602:1992.

2.2.6 Amino acid composition

Sample preparation (UNI 22614:1992): the sample is hydrolyzed by means of hot treatment with 6 M HCl containing 0.1% phenol were added at 110 °C for 24 hours. Sample analysis (UNI 22615:1992): the amino acid of the sample, prepared after acidic hydrolysis are separated and quantified in an amino analyzer instrument (Aminoanalyzer Biochrom Bio30+, Errecci, Milan, Italy) by means of ionic chromatography and ninhydrin colorimetric detection.

The amino acids were separated by elution on a cation exchange resin column (high pressure PEEK column packed with Ultropac 8 cation exchange resin; column length: 200 mm; column diameter: 4.5 mm; temperature: 25 °C; flow rate: 25 mL/h) and detected at 570 nm after post-column derivatization with Ninhydrin (flow rate: 20 mL/h; reaction temperature: 135 °C). The chromatograms were acquired and processed with the Clarity – Chromatography 7.1 software. The amino acid concentration was determined by external calibration using a standard mixture of amino acids (Sigma, cod. AA-S-18). The results were expressed in g/100 g sample.

2.2.7 Tryptophan content

The amino acid was analyzed by means of the same amino analyzer after basic hydrolysis, according to method UNI 22618:2000 + UNI 22620:2000.

2.2.8 Sulphated amino acids

Sulphated amino acids (cysteine and methionine) were analyzed by means of the same amino analyzer carrying out an oxidation at 0 °C with a performic acid/phenol mixture before to acidic hydrolysis, according to method UNI 22619:2000 + UNI 22621:2000. Cyst(e)ine and methionine must be oxidized to cysteic acid and methionine sulphone respectively, prior to hydrolysis.

2.3 Analytical methods – Oil

All reported analytical methods are discussed in detail by Bondioli et al. (2020):

- acidity and total acid number (T.A.N.): UNI EN ISO 660:2009 method;
- fatty acid composition: ISO 12966-2:2017 + ISO 12966-4:2015;
- sterol content and composition NGD 71:1989 + NGD 72:1989;
- tocopherol content and distribution: ISO 9936:2016.
3 Results and discussion

The gross composition of the dehulled seed is reported in Table 1. The evaluated seeds contain a very high amount of crude lipids, more than 60% and an interesting amount of protein that becomes more and more concentrated on the defatted meal, with the possibility to reach a concentration higher than 70%. As usual we also analyzed the cake to evaluate the amino acid composition that is contained in Table 2. Sulphur-containing amino acids (methionine and cysteine) were separately evaluated as well as tryptophan. From the reported data, we can say that this seed represents a very interesting source of vegetable proteins for food and feed production. A literature review did not evidence the presence of antinutritional factors in seeds.

After the evaluation of seed composition, we turned our interest to the oil sample obtained by hexane extraction of dehulled seed and on the oil sample from the market, obtained from the roasted seeds. The two samples are different in color (one is yellow, the other is dark), in flavor and in viscosity.

As expected, the fatty acid composition (Tab. 3) did not show any significant difference. Differences of approximately ±1% in relative concentration can be attributed to the different seeds used for preparation. Among the saturated fatty acids that in total reach approximately 45%, palmitic and stearic acids are in high quantity (31 and 13% respectively), while unsaturated fatty acids are represented mainly by linoleic (44%) and oleic (less than 10%). The linolenic acid was detected only in very low concentration. Just as a remark the occurrence of eicosatetraenoic acid in *Telfairia pedata* oil was already reported in a previous paper (Minzangi et al., 2015). Also, the sterol composition does not show important differences between the two samples (Tab. 4).

The most abundant sterols are beta-Sitosterol and delta 7-Stigmastenol in similar concentrations; all other common sterols are represented in the samples. It is interesting to underline that, on the contrary, the total sterol content shows huge differences. In particular, the sterol content of oil obtained from the roasted seed is double than the one from unroasted seed. The same effect can be seen on tocopherol content (Tab. 5), where the oil from the roasted seed contains a total amount of 692.2 mg/kg versus 565.1 mg/kg of the oil from untreated seed. Gamma tocopherol represents more the 98% of total tocopherol content. The higher content in oils from roasted seeds does not represent an uncommon fact: in a recent paper on walnut oil (Gao et al., 2019) Authors underlined the same difference.

According to the author’s interpretation the applied heat breaks the bonds, which link tocopherols to proteins, or

**Table 1.** Chemical composition of dehulled *Telfairia pedata* seed.

| Component           | Value (± uncertainty) |
|---------------------|-----------------------|
| Moisture, %         | 3.09 ± 0.93           |
| Crude fat, %        | 61.20 ± 1.21          |
| Protein (N × 6.25), % | 29.08 ± 1.43         |
| Crude fiber, %      | 1.00 ± 0.13           |
| Ashes, %            | 2.57 ± 0.04           |
| Carbohydrates, % (by difference to 100) | 3.06 |

Results represent the average value of two independent analyses ± uncertainty of measurement (95%).

**Table 2.** Amino acid composition of *Telfairia pedata* proteins in the seed.

| Amino acid | AA content, g/100 g seed | % relative |
|------------|--------------------------|------------|
| Asp        | 1.98 ± 0.13              | 8.27       |
| Thr        | 0.77 ± 0.06              | 3.21       |
| Ser        | 1.00 ± 0.12              | 4.18       |
| Glu        | 4.68 ± 0.56              | 19.56      |
| Gly        | 1.23 ± 0.02              | 5.13       |
| Ala        | 0.94 ± 0.03              | 3.93       |
| Val        | 1.06 ± 0.04              | 4.43       |
| Ile        | 1.01 ± 0.04              | 4.22       |
| Leu        | 1.77 ± 0.08              | 7.39       |
| Tyr        | 0.86 ± 0.05              | 3.59       |
| Phe        | 0.99 ± 0.03              | 4.14       |
| Lys        | 0.70 ± 0.02              | 2.93       |
| His        | 0.63 ± 0.01              | 2.64       |
| Arg        | 3.97 ± 0.06              | 16.59      |
| Pro        | 0.88 ± 0.26              | 4.18       |
| Cys        | 0.32 ± 0.13              | 1.17       |
| Met        | 0.49 ± 0.02              | 2.05       |
| Trp        | 0.57 ± 0.04              | 2.38       |
|            | **23.85**                | **100.00** |

Results represent the average value of two independent analyses ± uncertainty of measurement (95%).
phospholipids, which in turn causes cell damage and the consequent increase in the extractability of tocopherols. This fact is well documented but it is not valid for all oilseeds. For instance, for pumpkin seed oil a decrease after heat treatment was observed (Nederal et al., 2012), while safflower shows the same behavior as oyster nut and walnut (Tikekar et al., 2008).

Very interesting and also confirmed by literature data is the possibility to increase the sterol content by heating up the seeds (Siger et al., 2015; Slatnar et al., 2015). Actually, the high sterol content of a vegetable oil is regarded as a positive quality, thanks to the ability of phytosterols to compete for absorption with cholesterol at enteric level.

4 Conclusions

With this note we are describing in detail the characteristics of Telfairia pedata – oyster seed, in terms of seed and oil composition. The seed is very rich in oil and the yield per hectare very high so one could imagine to invest some money in the industrialization of the culture and on the harvesting of the produced seeds.

The main two fatty acid detected are palmitic and linoleic and the whole fatty acid composition does not show particular properties in comparison with other seed oils.

The cake resulting from oil recovery is rich in good quality properties and in fiber as well.
Also, an interesting tocopherol content, mainly represented by γ-tocopherol was found. Also, in the case of oyster nut seed the controlled roasting of the seed allows to recover a higher concentration of sterols and tocopherols into the oil.

Acknowledgements. This paper contains some data kindly produced by INNOVHUB colleagues Anna Cecchetti, Silvia Tagliabue and Pierangela Rovellini who kept in charge the instrumental analyses.

Conflicts of interest. The authors declare that they have no conflicts of interest in relation to this article.

References

Bondioli P, Folegatti L, Rovellini P. 2020. Oils rich in alpha linolenic acid: chemical composition of perilla (Perilla Frutescens) seed oil. OCL 27: 67. https://doi.org/10.1051/ocl/2020066.

Gao P, Cao Y, Liu R, Jin Q, Wang X. 2019. Phytochemical content, minor-constituent compositions, and antioxidant capacity of screw-pressed walnut oil obtained from roasted kernels. Eur J Lipid Sci Technol 121: 100292. https://doi.org/10.1002/ejlt.201800292.

Kanyua NP. 2016. The potential of Telfairia pedata for liquid biofuel and soap production. Thesis submitted in partial fulfillment of the requirements for the Award of the Degree of Master of Science (Chemistry) in the School of Pure and Applied Sciences, Kenyatta University, Nairobi–Kenya (11/2016). Available from https://ir-library.ku.ac.ke/handle/123456789/15358.

Minzangi K, Mpiana PT, Samvura B, Kaaya AN, Matthäus B, Kadima JN. 2015. Composition of fatty acids and tocopherols content in oilseeds of six wild selected plants from Kahuzi-Biega National Park/DR. Congo. Eur J Med Plants 8(3): 157–166.

Nederal S, Kraljic K, Obranovic M, Papesa S, Bataljaku A. 2012. Chemical composition and oxidative stability of roasted and cold pressed pumpkin seed oils. J Am Oil Chem Soc 89: 1763–1770.

PROTA4U web database. University of Wageningen. Available from www.prota4u.org.

Siger A, Kaczmarek A, Rudzinska M. 2015. Antioxidant activity and phytochemical content of cold-pressed rapeseed oil obtained from roasted seeds. Eur J Lipid Sci Technol 117: 1225–1237.

Slatnar A, Mikulin-Petkovsek M, Stampar F, Veberic R. 2015. Identification and quantification of phenolic compounds in kernels, oil and bagasse pellets of common walnut (Juglans regia L.). Food Res Int 67: 255–263.

Tikekar RV, Ludescher RD, Karwe MV. 2008. Processing stability of squalene in amaranth and antioxidant potential of amaranth extract. J Agric Food Chem 56: 10675–10678.

Cite this article as: Bondioli P, Folegatti L, Morini G. 2021. The chemical composition of oyster nut (Telfairia pedata) seeds and oil. OCL 28: 1.