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Nutritional potentiality and antinutritional properties of *Telfairia occidentalis* from Côte d'Ivoire

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Abstract

The present study sought to valorize *Telfairia occidentalis* in Côte d'Ivoire for a more recurrent use and to determine the biochemical and nutritional characteristics of the powdered almonds of this plant, then to determine the phytochemical compounds and the anti-nutritional factors as well as the chemical characteristics of the oil extracted from the almonds. Regarding the biochemical and nutritive composition of *Telfairia occidentalis* almond powder, the results showed that the powders were low in moisture (2.83 ± 0.28 %). Lipids and proteins were very important (35.62 ± 0.06 % and 29.15 ± 0.03 %) respectively. The most present amino acids were: Methionine (3.7 mg/100 g), Cystine (4.44 mg/100 g), lysine, aspartic acid, leucine and arginine varied from 0.15 to 0.37 mg/100 g. Several phytochemicals were measured in the powder of *Telfairia occidentalis* almonds. The results indicated that polyphenols were 272.68 ± 0.46 mg/100 g, flavonoids were 8.32 ± 0.3 9 mg/100 g, tannins were 165.09 ± 0.19 mg/100 g and alkaloids were 1.1 ± 0.1 %. The powder also contained some anti-nutritional factors such as phytates (49.39±0.71 mg/100 g) and oxalates (43.5 ± 0.86 mg/100 g).

Keywords: Pumpkin; Almond; Powder; *Telfairia occidentalis*

1. Introduction

Africa has a great diversity of food plants [1], and the various local species play an important role in economic, social and cultural development. Plant seeds take an important part of the human diet and are generally considered good food [2]. Seeds have nutritional and calorific values that make them important in diets as good sources of protein and edible oils [3]. Seeds are therefore potential raw materials for local industries [4]. In view of the increasing demand for proteins and lipids, the search for a new food source that can be used for both consumption and industrial applications is necessary, hence the interest in fluted pumpkin.

Indeed, the fluted pumpkin (*Telfairia occidentalis*) is one of the most popular leaf and seed vegetables of the cucurbit family grown for human consumption. It is native to West Africa but is mainly found in its cultivated form in various parts of southern Nigeria, where the leaves, shoots and seed core are valuable ingredients in soups [5]. Fluted pumpkin seeds are valuable both as an oil seed (54 %) and also as a source of protein (27 %) with a fairly well-balanced amino acid composition [6]. In view of its dietary importance, this plant, which is widely consumed in the sub-region, is unfortunately not known in Côte d'Ivoire. This study therefore aims to valorise *Telfairia occidentalis* in Côte d'Ivoire with a view to its more recurrent use and thus enable the population to diversify their daily diet.

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The aim of this work will be specifically to determine the biochemical and nutritional characteristics of *Telfairia occidentalis* almond powder, then to determine the phytochemical compounds and anti-nutritional factors of the almond powder and the chemical characteristics of the oil extracted from the almonds.

2. Material

2.1. Plant material

The biological material used in this work is composed of mature fruits of *Telfairia occidentalis* collected in the town of Yakassé Attobrou (Adzopé) during the harvest period from October to November. These fruits were transported to the laboratory (Abidjan, Côte d'Ivoire) for analysis. Once at the laboratory, the mature fruits of *Telfairia occidentalis* were cut with a knife. The seeds were then manually extracted from the pods, washed with distilled water and sun-dried for a fortnight.

2.2. Physico-chemical analysis

Once the seeds were dried, they were dehulled and oven dried for 48 hours at 70 °C. The oven-dried seeds were then crushed in a MOULINEX type blender and ground to a fine powder. Finally, using an AFNOR 250 µm sieve, the powder obtained was sieved and then packed in jars and kept in the refrigerator at 4 °C before the various analyses.

The AOAC method [7] was used to determine the moisture content after drying at 105 °C for 24 hours. The AOAC method [7] was also used in the determination of acidity, ash content, and fat extraction for the determination of lipid content. The method described by Dufour et *al* [8] was used to determine the pH and that of AOAC [9] using Kjeldahl, the protein content. The extraction of sugars was done by the method described by Martinez-Herrera et *al* [10], then the determination of total sugars was done by the method of N'Guetta [11], then that of reducing sugars was done by the method of Yao et *al* [12].

Amino acids were determined by HPLC. The instrument used was the Waters Alliance HPLC, model e 2695, equipped with a 48-sample automatic sampling system and a p2895 pump system. Amino acid separation was performed using two columns in series, of the lichrocart 125-4 cartridge type containing a Lichrospher 100 RP18 column. The length of each column was 12.5 cm and the particle diameter was 5 µm. A pre-column of the same type was placed at the beginning of each column. Detection is done using a Waters 2475 spectrofluorometer. Excitation was at 340 nm and emission at 450 nm.

The determination of the total carbohydrate content was done by the difference method:

$$\% \text{ carbohydrate} = 100\ \% - (\ \% \text{ moisture} + \% \text{ ash} + \% \text{ fat} + \% \text{ protein}\ )$$

The energy value was calculated by applying the heat coefficients of Atwater and Rosa [13]:

- 1 g carbohydrate provides 4 calories;
- 1 g of protein provides 4 calories;
- 1 g of lipid provides 9 calories

The determination of phytochemicals in *Telfairia occidentalis* seeds powder was done by the method of Harborne [14] for the determination of flavonoids and alkaloids. The determination of phenolic compounds was done by the spectrometric method described by Capannesi et *al.* [15] after extraction of phenolic compounds by Rhaman and Punja [16]. Tannins were determined by the method of Bainbridge et *al.* [17], phytates by the method of Joutei et *al.* [18] and oxalates by the technique of Onwuka [19].

3. Results

3.1. Biochemical parameters

The biochemical and nutritive composition of *Telfairia occidentalis* kernel powder is presented in Table I. The results showed that the powders were low in moisture 2.83 ± 0.28 % with a dry matter (97.16 ± 0.28 %). Lipids and proteins were very high (35.62 ± 0.06 % and 29.15 ± 0.03 % respectively). The total sugar content was 3.51 ± 0.05 %, reducing sugars 31.61 ± 0.17 mg/100g, acidity 25.79 ± 0.22 meq/100g and ash 4 %. The energy value was 550 Kcal.

Table 1 Biochemical and nutritional characteristics of *Telfairia occidentalis* kernel powder

Parameters	Content (%)
Dry matter	97.16 ± 0.28
Moisture	2.83 ± 0.28
Protein	29.15 ± 0.03
Fat	35.62 ± 0.06
Carbohydrate	28.40
Ash	4 ± 00
Total sugars	3.51 ± 0.05
Reducing sugars (mg/100 g)	31.61 ± 0.17
Acidity (meq/100 g)	25.79 ± 0.22
pH value	5.77 ± 0.02
Energy value (Kcal)	550

Mean ± standard deviation, n = 3

Table II showed the amino acid composition of *Telfairia occidentalis* kernel powder. The most present amino acids were: methionine (3.7 mg/100 g) and cystine (4.44 mg/100 g). Lysine, aspartic acid, leucine and arginine varied from 0.15 to 0.37 mg/100 g.

Table 2 Amino acid composition of *Telfairia occidentalis* kernel powder

Amino acids	Content (mg /100 g)
Methionine	3.7
Cystine	4.44
Lysine	0.3
Aspartic Ac. Aspartic acid	0.15
Leucine	0.21
Arginine	0.37

3.2. Phytochemicals and anti-nutritional factors of *Telfairia occidentalis*

Several phytochemicals were measured in the powder of *Telfairia occidentalis* kernels (Table III). The results indicated that polyphenols, Flavonoids, Tannins and Alkaloids were 272.68 ± 0.46 mg/100 g, 8.32 ± 0.3 9 mg/100g, 165.09 ± 0.19mg/100 g and 1.1 ± 0.1 % respectively. As for the anti-nutritional factors of *Telfairia occidentalis* kernel powder, the results indicate that Oxalates and Phytates varied from 43.5 to 49.4 mg/100 g.

Table 3 Phytochemicals in *Telfairia occidentalis* kernel powder

Parameters	Content (mg/100 g)
Polyphenols	272.68 ± 0.46
Flavonoids	8.32 ± 0.39
Tannins	165.09 ± 0.19
Alkaloids	1.1 ± 0.1
Oxalates	43.5 ± 0.86
Phytates	49.39 ± 0.71

Mean ± standard deviation, n = 3

4. Discussion

With regard to the study of the nutritional composition of *Telfairia occidentalis* fluted pumpkin seeds, the low moisture content of its powder of 2.83 ± 0.28 % is less than 12 %. This result showed that the powder could be safe from the development of some microorganisms when well preserved. Indeed, according to Aryee et *al.* [20], a moisture level higher than 12 % would favour the growth of certain microorganisms. The moisture level of food is a measure of stability and susceptibility to microbial contamination [21]. The lipid content of *Telfairia occidentalis* gave 35.62 ± 0.06 %. As a good source of lipids, the seeds of the fluted pumpkin would play an important role in the world of food production in food industries. The protein content of the *Telfairia occidentalis* seeds powder sample was quite high (29.15 %) and higher than the seeds of some fruit's rich in plant proteins: *Amaranthus vividis* (24 %), *Moringa oleifera* (20.72 %) and *Lasianthera Africana* (15 %) [22]. Given the increasing demand for protein due to the population explosion and the soaring prices of conventional protein foods, *Telfairia occidentalis* seed powder could be considered as a potential source of protein.

The carbohydrate content of the sample was by difference to the other component expressed as a percentage and gave 28.40 %. *Telfairia occidentalis* seeds powder can be considered as a source of carbohydrates although its available carbohydrate content does not compare well with conventional carbohydrate sources such as cereals with 72-90g/100g of samples. The energy value (550 kcal) of the *Telfairia occidentalis* seeds powder was high. This powder could therefore be a good source of energy. The ash content of the fluted pumpkin seeds powder was low (4 %) in the present study and may partly reflect the mineral composition according to Oyoyede [23].

Telfairia occidentalis seeds are also a source of essential and non-essential amino acids. The amino acids present were methionine (3.7 mg/100 g), cystine (4.44 mg/100 g), lysine (0.3 mg/100 g), aspartic acid (0.15 mg/100 g), leucine (0.21 mg/100 g) and arginine (0.37 mg/100 g). The human body produces about half of the amino acids essential for protein synthesis. The other amino acids, about ten, cannot be synthesized by the body itself. They must be supplied by the ingested food, they are called exogenous amino acids or more often, essential [24]. The absence of even one of the amino acids may make it impossible to synthesize certain essential proteins such as hormones and enzymes. *Telfairia occidentalis* is therefore a food to recommend as it could provide a share of the body's amino acid needs.

Also, phytochemical analysis of *Telfairia occidentalis* seeds powder showed the presence of alkaloids, flavonoids, polyphenols and tannins. The analysis revealed that *Telfairia occidentalis* seeds powder was rich in polyphenols (272.68 ± 0.46 mg/100 g) and tannins (165.09 ± 0.19 mg/100 g) but poor in flavonoids (8.32 ± 0.39 mg/100 g) and alkaloids (1.1 ± 0.1). These secondary metabolites are known to have a antimicrobial activity [25], suggesting possible uses of *Telfairia occidentalis* seed powder for medicinal purposes [26]. Polyphenols are a variable group of compounds that include salicylic acid and rosmarinic acid. Polyphenols are generally strongly antibacterial, antioxidant, anti-inflammatory, antiseptic and anti-viral, and are found in plants such as basil, cinnamon, thyme, winter green, rosemary and mints. As for tannins, they are astringent polyphenolic compounds, making them useful for tightening loose tissue, such as that found in varicose veins, and for drying secretions. Several studies have shown important biological effects of tannins such as antioxidant or radical scavenging activity as well as inhibition of lipid peroxidation and lipoxygenases in vitro [27]. Flavonoids are polyphenolic compounds found in a wide variety of plants. They impart a yellow or white pigment to flowers and fruits and have a wide range of activity [28]. Flavonoids are particularly useful for maintaining healthy circulation and some are antioxidants, while others are anti-inflammatory, anti-viral or capillary strengthening [29]. The flavonoid content of *Telfairia occidentalis* seeds powder (8.32 ± 0.39 mg/100g) was lower than the flavonoid value of *Citrus limon* [30]. The last phytochemicals (alkaloids) play a very important role in the metabolism and functional activity of the body. They are an integral part of plants used in herbal medicine. Many plants that contain alkaloids are medicinal plants [31].

Telfairia occidentalis plant has also been reported to contain anti-nutritional compounds [32]. This study indicates that the oxalate content of 43.5 ± 0.86 mg/100 g in *Telfairia occidentalis* seeds powder was low and unlikely to cause toxicity problems as it is well below the toxic levels (2.5 g/kg) according to the work of Adewoye et *al.* [33]. Oxalate is a concern because of its negative effect on mineral availability, causes mouth irritation and interferes with the absorption of divalent minerals especially calcium by forming insoluble salts. The presence of phytates in food can bind certain essential minerals in the digestive tract and can lead to mineral deficiencies. The phytate composition of *Telfairia occidentalis* seeds powder (49.39 ± 0.71 mg/100 g) was significant. This powder, consumed over a long period of time, could decrease the bioavailability of minerals and could cause adverse effects on digestibility [34]. However, this amount of anti-nutritional compounds (phytates and oxalates) will decrease with all the technological treatments that *Telfairia occidentalis* seeds will undergo before their actual consumption. Indeed, anti-nutritional factors in plant food products can be reduced by many technological processes such as fermentation, boiling, steaming and roasting [35].

5. Conclusion

The objective of this work was to contribute to the valorisation of *Telfairia occidentalis* in Côte d'Ivoire for a more recurrent use and thus to allow the population to diversify their daily diet. This involved the determination of the biochemical and nutritional characteristics of the almond powder, phytochemicals and anti-nutritional factors. This was followed by the determination of the chemical characteristics of the oil extracted from the almonds. At the end of this study, we can say that the almond powder of *Telfairia occidentalis* had an important biochemical and nutritional composition. It was rich in protein, lipids, carbohydrates and a high energy value. The most important amino acids present were Methionine and Cystine. *Telfairia occidentalis* was a potential source of natural antioxidants through the presence of several phytochemicals such as polyphenols, Flavonoids, Tannins and Alkaloids. The oil extracted from the seeds was an oil rich in precursors (linoleic and linolenic acids) of essential fatty acids and would be important for human consumption and industrial use as it had a high saponification value. The high saponification value suggests the potential of the oil in the production of liquid soaps and shampoos.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors have not reported any conflicts of interest.

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