Advanced Herbal Medicine, Summer and Autumn 2019; 5(2): 21-32

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Proximate, mineral, and vitamin composition of *Anthocleista djalonensis* A. Chev

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Received: 16 July 2019 Accepted: 12 October 2020

Abstract

Background and aims: The aim of this study is to assess the nutritional composition of *Anthocleista djalonensis* as an important medicinal plant used to manage many diseases.

Methods: The proximate features, mineral content, and vitamin composition in *A. djalonensis* leaves were examined according to the standard analytical methods. Proximate composition includes crude protein, crude fat, crude fibre, carbohydrates, moisture content, and ash content, while minerals such as macro-elements (phosphorus, calcium, potassium, sodium, magnesium,) and micro-elements (iron, manganese, copper, zinc) were determined using flame photometer and atomic absorption spectrophotometer. The evaluated vitamin composition includes vitamin A, C, E, and B_{12}.

Results: The results obtained for proximate composition showed that moisture content had the highest amount (59.71 g/100g), followed by crude protein (23.41 g/100g), crude fibre (9.51 g/100g), carbohydrate (4.72 g/100g), ash content (1.67 g/100g), and crude fat (1.04 g/100g). Mineral content showed that for macro elements, potassium had the highest amount (0.59%), followed by calcium (0.54%), magnesium (0.36%), and phosphorus (0.25%), while the least value was recorded for sodium (0.06%). Forthe micro-elements, the highest detected amount was for iron (0.175%), while copper had the least value (0.004%). The result indicated for vitamins showed that ascorbic acid (vitamin C) (3.58 mg/100g) had the highest concentration, followed by retinol (vitamin A) (1.67 mg/100g) and cobalamin (vitamin B_{12}) (1.02 mg/100g), while tocopherol (vitamin E) (0.49 mg/100g) had the least concentration.

Conclusion: The result indicated that *A. djalonensis* has nutrients and vitamins which could be used to enrich our food so as to augment the shortage of essential minerals and vitamins in our body.

Keywords: *Anthocleista djalonensis*, Proximate, Mineral, Vitamin, Nutritional.

Original article

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Introcuction

Medicinal plants usually contain some substances which are important in the synthesis of pharmaceutical drugs[1]. They are main components for the formulation of pharmaceutical drugs[2]. The use of natural products from indigenous plants for ethno-medicinal and nutritional purposes has grown tremendously among scientists to search for bioactive compounds that are medicinally oriented to man[3]. Medicinal plants are mainly used to strengthen the body immune system because they are known to have many essential and nutritional elements[4]. The medicinal importance of a plant is coupled through the nutrients, non-nutrients, and phytochemicals[5]. Proximate composition of plant samples contributes to the total acceptability of plant materials as good sources of food in general nutrition. *Anthocleista djalonensis* belongs to the Longaniaceae family. It is usually found in the wild life around Southeastern Nigeria. The species can be distinguished based on its habitat, colour, flora, and spines. *A. djalonensis* grows in secondary forests, with few spines with parallel prongs. This plant is one of the most precious ones that are used for medicinal purposes. All plant parts are known to contain a variety of phytochemicals exhibiting medicinal values [6]. Proximate analysis is a major nutrient determinant which includes crude fibre, protein, fat, moisture, ash, and total carbohydrate[7]. Proximate analysis is a nutrient-based analysis also called “conventional analysis” in which the main components, i.e., protein, fat, carbohydrate, and ash are determined other than the amino acid, minerals, fatty acids, and monosaccharides[8]. Herbal Plants contain some bioactive compounds that are capable of giving a characteristic colour, odour, and pungencies, while others give the plant its medicinal, nutritional, protective, and poisonous efficacies [9]. In the rural and less urban areas, people mostly depend on herbal medicine which relates with their socio-cultural and religious background which orthodox medicine neglects[10]. Recently, the world's population depend more on herbal medicine to meet their nutritional and medicinal needs[11]. Proximate, mineral, and vitamin analysis of the plants gives a medicinal stance that helps to dictate the medicinal composition of the sample. In this view, there is a pressing need to evaluate the nutritional status of *A. djalonensis*, which is also a source of herbal medicine usually used in the treatment of various health complications such as diabetes and stomach complaints along with being used as an antipyretic and pain killer.

Methods

Plant material

Fresh leaves of *A. djalonensis* were collected in May 2019 at the central nursery of Forestry Research Institute of Nigeria located on Latitude 7 ^{o} 23′ N and Longitude 3^{o}51′ E. The plant was identified at the taxonomy

section of the institute. Then it was dried at room temperature, milled using a milling machine, and kept in a jar, ready for further use.

Proximate analysis

The leaves of *A. djalonensis* were analyzed for proximate composition using AOAC methods[12].

Crude protein (CP) determination

Crude protein was determined using the Micro Kjeldahl Method where 1 g of the plant sample was digested using 10ml concentrated H_2SO_4 with 2 copper tablets as catalysts inside the Kjeldahl digestion tubes, and digestion was done for 2h. This was followed by the distillation of the digest into 15ml HCl and then the distillate was titrated with standard NaOH solution and the obtained percentage of nitrogen content was multiplied with a factor of 6.25 to get the percentage crude protein.

Crude fibre determination

2 g of the plant sample was mixed with 0.25 N sulfuric acid (100 ml) in a flask, the mixture was heated under reflux for 1 h on a water bath and the filtered residue was then transferred into a fibre flask after which 0.313 N sodium hydroxide solution (100 ml) was introduced and heated under reflux for 1 h again. A fibre sieve cloth was then used to filter the mixture followed by the addition of 10 ml of acetone, and the residue was washed with hot water (50 ml) and then transferred into a crucible, which was followed by oven drying at 105^{o}C and cooling in a desiccator. Thereafter, it was weighed and ashed in a muffle furnace at 550 ^{o}C for 4h, after which it was cooled in a desiccator and weighed. Besides, the percentage of crude fibre was calculated using the following formula:

$$\%\text{Crude Fibre} = \frac{W_1 - W_2}{\text{Weight of sample}} \times 100$$

[Eqs 1]

W_1- Weight of sample residue after oven drying

W_2- Weight of sample residue after ashing

Moisture content determination

Moisture content was determined on wet basis by heating to a constant weight in an oven. The weight of an empty crucible was measured (Wo), then 1g of the chopped leaves samples was placed on the crucible and the weight was taken (W1). The sample was then oven dried at 105^{o}C to the constant weight and cooled in a desiccator, and the weight was taken (W_2). The percentage of moisture content was calculated as follows:

$$\%\ \text{Moisture} = \frac{W_1 - W_2}{W_1 - W_0} \times 100$$

[Eqs 2]

W_0–Weight of empty moisture container

W_1 –Weight of moisture container with sample

W_2- Weight of moisture container and oven dried sample to the constant weight

Ash content determination

The ash content was determined by heating 1 g of the powdered sample in a muffle furnace set at 550 ^{o}C, the sample was left to cool in a desiccator, and the weight was measured. The percentage of ash content was calculated as follows:

$$\% \text{ Ash} = \frac{W_2 - W_0}{W_1 - W_0} \times 100$$

[Eqs 3]

W_0–Weight of empty container

W_1 –Weight of container with sample

W_2- Weight of container with sample turned ash

Crude fat determination

The crude fat was determined by soxhlet extraction with petroleum ether. 1 `g of the powdered sample was transferred into the extraction thimble and then plugged with a cotton wool lightly. Then, thimble was placed in the extractor fitted with a reflux condenser and a 250 ml soxhlet flask. The soxhlet flask was previously dried in an oven, cooled, and measured in weight (W_0). After that, the flask was filled to three quarters of its volume with petroleum ether and the sample refluxed until the completion of the fat extraction, after which the extracted fat containing flask was removed and dried to a constant weight (W_1) at 105 ^{o}C. The percentage of fat content was calculated as follows:

$$\% \text{ Fat} = \frac{W_1 - W_0}{\text{Weight of sample}} \times 100$$

[Eqs 4]

Carbohydrate determination

Carbohydrate was determined by difference where subtraction of the percentage values for moisture, crude protein, fat, crude fire and ash from 100 gave the carbohydrate content.

$$\text{Carbohydrate (g/100g)} = [100 - (\%\text{M} + \%\text{CP} + \%\text{ Fat} + \%\text{CF} + \%\text{ Ash})]$$

[Eqs 5]

Mineral analysis

The mineral content was described according to the standard biochemical method. 1 g of the powdered samples was digested on wet basis using 9ml of freshly prepared aqua regia (65 % nitric acid and 37% HCl in 1:3 ratio). The mixture was gently boiled in a water bath at 95^{o}C for 5 h until the samples were dissolved completely. Filtered and deionized water was used to make up to the standard volume. The respective minerals were analyzed using Atomic Absorption Spectrophotometer (Buck Scientific 210VGP) by Uddin et al[13].

Vitamin composition

The vitamin composition present in the leaves of *A. djalonensis* was determined using the standard method described by [14, 15]. The vitamins to be determined include A, C, E, and B_{12}.

Data analysis

Quantitative data were expressed as mean±standard deviation of triplicate measurement; Microsoft Excel 2010 was used for data analysis.

Results

Proximate

The results indicated in Table 1 are obtained for the proximate constituents of *A. djalonensis* leaves. The results revealed the presence of proximate composition in considerable amounts. The highest amount was detected for moisture content (59.71 g/100g), followed by protein (23.41 g/100g), fat (1.04 g/100g), fibre (9.15 g/100g), ash content (1.67 g/100g), and carbohydrate (4.72 g/100g).

Table 1. Proximate composition of *A. djalonensis* leaves

Parameter	Concentration (g/100g)
Protein	23.41±0.09
Fat	1.04±0.12
Fibre	9.51±0.87
Ash	1.67±0.43
Moisture	59.71±0.67
Carbohydrate	4.72±0.78

Results are expressed as Mean ± Standard deviation of triplicate measurements.

Minerals

Results from the macro-elements analysis show that potassium (0.59%) gave the highest concentration, followed by calcium (0.544%), magnesium (0.363%), phosphorus (0.25%), and sodium (0.063%). However, considerable levels were obtained for the micro-elements (Table 2).

Table 2: The amount of the minerals in *A. djalonensis* leaves

Minerals	Concentration (%)
Macro Elements	
Sodium (Na)	0.063±0.003
Potassium (K)	0.59±0.02
Calcium (Ca)	0.544±0.004
Magnesium (Mg)	0.363±0.03
Phosphorus (P)	0.25±0.03
Micro Elements	
Iron (Fe)	0.175±0.004
Manganese (Mn)	0.015±0.002
Copper (Cu)	0.004±0.001
Zinc (Zn)	0.011±0.002

Results are expressed as Mean ± Standard deviation of triplicate measurements.

Vitamin composition

The vitamins examined in this study include fat soluble vitamins (vitamin A and E) and water soluble vitamins (vitamin C and B_{12}). In the results obtained (Table 3), vitamin C had the highest levels (3.58 mg/100g), followed by vitamin A (1.67 mg/100g), vitamin E (0.49 mg/100g), and vitamin B_{12} (1.02 mg/100g).

Table 3: Vitamin composition of *A. djalonensis* leaves

Vitamins Composition	
Vitamins	**Concentration (mg/100g)**
Vitamin A (Retinol)	1.67±0.19
Vitamin C (Ascorbic Acid)	3.58±0.74
Vitamin E (Tocopherol)	0.49±0.67
Vitamin B_{12} (Cobalamin)	1.02±0.53

Results are expressed as Mean ± Standard deviation of triplicate measurements.

Discussion

Proximate composition

Proximate composition of medicinal plants plays a vital role in harnessing their nutritional importance [16]. The proximate composition of *A. djalonensis* leaves as expressed in Table 1 reveals high content of moisture (59.71g/100g) and of protein (23.41 g/100g). Moderate concentrations were reported for fibre (9.51g/100g) and carbohydrate (4.72 g/100g), while there is low concentration for fat (1.04 g/100g) and ash (1.67g/100g). The moisture content (59.71 g/100g) of the leaves reveals that *A. djalonensis* is a rich source of water for the cells of the body [17]. The high moisture content suggests that the leaves sample should be well dried or else it will deteriorate fast if left unprocessed for a very long period [18]. The observed high moisture content of *A. djalonensis* leaves corroborates the result also reported by Achi et al [19] whose study indicated a high moisture content (104.53%) for *Ficus capensis* leaves. However, there is a contrasting low value of 6.70 % for the moisture values of *A. djalonensis* as reported by Achi et al. [20]. Also, the same author reported contrary values for carbohydrates (48.88%) as against the low levels reported in this study (4.72 g/100g). The value reported for fibre for *A. djalonensis* is moderately high (9.51 g/100g) compared to the one reported for fibre in *Ficus capensis* leaves by Achi et al. (4.77 %) [19]. Plants with high fibre contents are used to treat obesity, diabetes, cancer, and gastrointestinal disorders. Such plants also help reduce constipation and therefore enhance frequent elimination of bowel content. Fibre helps in the prevention of the coronary heart disease, hypertension, constipation, and diabetes [21, 22]. The low value (1.04%) reported for fat is moderate and adequate for consumption without any threat implications. The consumption of excess fat is implicated in some cardiovascular diseases such as myocardial infarction, stroke, and atherosclerosis[23]. The fat content reported by Muhammad et al. [24] is very high in both the dried leaves (5%) and fresh leaves (0.5%) compared to that reported in this study. The low amount of fat reported showed that *A. djalonensis* is not a rich source of lipids [25]. The highest value (23.41 g/100g) was reported for protein among the proximate parameters assessed in this study, and this is contrary to the findings of Chinedu [26], who reported a very high protein value (0.61 %) for the leaves of *Euphorbia hyssopifolia*. In

addition, the protein content obtained in the study is extremely lower compared with the findings of Eze and Obinwa [27], which is extremely higher for *Amaranthus caudatus* leaves with 20.29% and for *Manihot utilisima* leaves with 24.88 %. The high protein content and low fat content reported in this study for *A. djalonensis* have been previously reported by some authors for some common related medicinal plants [28, 29]. This suggests that the leaves may not really be a rich source of protein. The low ash content reported shows that the mineral content of the plant will be very low.

Minerals

Intakes of minerals (inorganic nutrients) are important for the maintenance as well as physiological, physicochemical, and metabolic processes of human life [30]. Minerals are needed in so many ways for normal functioning of the body [31]. Some are needed in large quantities (Macro-elements), while others are elements needed in minute quantities (Micro-elements). The macro-elements include sodium, potassium, calcium, magnesium, and phosphorus, while the micro-elements include iron, copper, zinc, and manganese [31]. The macro-elements are needed in amounts higher than 100 mg/dl, while micro-elements are needed in amounts less than 100 mg/dl [32]. The importance of these mineral elements has been well recognized in humans, animals, and plants [33]. Dietary potassium (K) reduces human blood pressure, which is a good indicator to lowering of the risk of stroke. The result indicated for potassium shows that it has a very high level compared to other elements examined in this study. The level of potassium (0.59%) reported in *A. djalonensis* is synonymous to the findings of Olaniyi et al.[34] for *crescentia cujete* leaves. The levels reported for potassium by Awotedu et al.[35] for *A. indica* (5.12%) to *P. biglobosa* (1.14%) and *L. guineensis* (1.17%) are very high compared to the value (0.59%) reported in this study. Magnesium remains a good enzyme activator, cofactor, and co-enzyme. It forms part of the constituents of bones and teeth [32]. Magnesium value obtained for the leaves of *A. djalonensis* (0.363 %) is on the high side compared to the ones reported for the leaves of *Leea guineenis* by Ajiboye et al. (0.147) [36]. Meanwhile, the value obtained for phosphorus (0.25%) corroborates the findings of Ajiboye et al [36]. Moreover, all the micro-elements obtained by the author are very low compared to that reported in this study. Akpabio [37] also reported a very low value for magnesium in *Terminalia catappa* seeds (0.0264%). Excessive intake of sodium may increase high blood pressure and have an adverse effect on target organs. It may also increase seizures and at times cause death [38, 39]. The result reported in this study shows that the sodium level (0.063%) is comparable to the findings of Awotedu et al. [35] for *Azadirachta indica* leaves (0.06%), while it is higher for *Parkia biglobosa* and *Leea guineensis*. However, all the other macro-elements reported by the authors are on the high side compared with this study. The leaves of *A. djalonensis* also show a

considerably high amount of calcium (0.544%). The result obtained for *Guiera senegalensis* (219.03ppm) by Mohammed[40] is lower than that reported in this study. Anuforo et al. [41] reported similar lower values for calcium. Calcium helps in the formation of bones and teeth as well as in the regulation of nerve and muscle cells [42, 43]. It helps in the activation of a large number of enzymes[32,42]. Excessive calcium level leads to cardiac dysfunction and failure, while calcium deficiency affects dentition of both children and adults [44]. Iron functions as haemoglobin in the transport of oxygen [42]. The value of 0.175 was obtained for iron. The iron content is high compared to the findings of Akpabio[37], who reported 375mg/100g for almond seeds. However, Dashak and Fali [45] reported a low iron content for Benni seeds (50mg/100g). Sadrzadeh and Saffari [46] reported that high iron content has been linked to some neurological disorders like Alzheimer, Parkinson, and type-1 neuro degeneration, which accumulate iron in the brain. All other microelements are indicated in considerable amounts and are active co-enzymes and cofactors [32].

Vitamin Composition

Some vitamins are usually required in very small quantities. They are usually grouped into fat soluble vitamins (A, D, E and K) and water soluble vitamins (B and C). The fat soluble vitamins can be found in the liver and the adipose tissues, while the water soluble ones are usually eliminated from the body. Vitamin C possesses an antioxidant character and has the potential for maintaining the connective tissues, facilitating the absorption of dietary iron from the intestine, and healing wounds[47]. Contents of vitamins A and C are adequate to supplement other dietary sources. Vitamin A helps in the treatment of eye problem, while lack of vitamin C causes scurvy and gingivitis. Vitamins E and C are important antioxidants which protect the outer membranes from oxidative stress/damage[48]. The recommended dietary allowance of vitamin C for adults is 45 mg/day [49]. *A. djalonensis* leaves contain ascorbic acid (vitamin C), tocopherol (vitamin E), retinol (vitamin A), and vitamin B_{12}, which are recommended as good dietary supplements and antioxidants and are also essential for clear vision. The highest value obtained for vitamin C is (3.58mg/100g), followed by vitamin A (1.67mg/100g), vitamin E (0.49mg/100g), and vitamin B_{12} (1.02mg/100g). The value obtained is on the high side compared to the one reported by Achi et al. [18] for all the comparable vitamins analyzed in *Ficus capensis* leaves. The vitamin C content obtained in this study (3.58mg/100g) is lower compared with that reported for three of the *Musa* species reported at different maturity stages by Ogbonna et al. as immature (4.75mg/100g), green mature (4.72mg/100g), and ripe (5.60mg/100g) (50). The values reported by Achikanu et al. [14] were higher in vitamin A for all the common leafy vegetables: *Ficus capensis* (25.22 mg/100g), *Solanum melongena* (94.54mg/100g), *Mucuna pruriens* (64.82mg/100g), *Solanum*

macrocarpon (92.45mg/100g), *Solanum nigrum* (54.99 mg/100g), *Moringa oleifera lam* (108.48mg/100g), *Solanum aethiopicum* (94.66 mg/100g), and *Cridoscolus acontifolius* (63.31 mg/100g) than that reported in this study as 1.67mg/100. Retinol is said to play a major role for gene expression, immune function, normal cell growth, and vision in the preservation of epithelial cell operations [51]. The levels reported in this study for tocopherol (vitamin E) (0.49 mg/100g) are higher when compared with the findings of Duru et al. [52] or fully matured and not darkened fruit (0.29mg/100g), but the values are lower when compared with half darkened fruit (0.58 mg/100g) and fully darkened fruit (0.90 mg/100g). Thus, *A. djalonensis* possesses moderate levels of vitamins, which are comparable with common medicinal plants used in polyherbal formulations.

Conclusion

The proximate composition, mineral analysis, and vitamin screening suggest that *A. djalonensis* is an herbal plant that is nutritionally important having considered the mineral elements, vitamins, and the proximate constituents it contains. Carbohydrate, fibre, lipid, ash, moisture, and protein are favourable and compared nutritionally with most consumed medicinal plants. The presence of all these vitamins is a good index for *A. djalonensis* as a very good nutritional plant and a good dietary supplement for human being, and moreover, it can be a very good disease preventive plant.

Conflict of Interest

The author declares no conflict of interest.

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