Nutritional analysis of selected species of *Alternanthera* Forsskal (Amaranthaceae)

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*Alternanthera* Forsskal (Amaranthaceae) is an underexploited genus with potent medicinal activities exhibiting biotic and abiotic tolerance, survival with basic minimal requirements, with a palatable taste and free of insecticides or pesticides. Here, we analyzed selected species of these under-utilized plants for various nutrients to enable identification of unconventional food resources. Among the species investigated, *Alternanthera sessilis* showed high amount of energy rich nutritional factors, such as carbohydrates, proteins and lipids. High content of aminoacids and flavanoids have been observed in *A. sessilis* and *A. philoxeroides*. *Alternanthera versicolor* recorded higher amount of vitamin A while *A. tenella* showed the least. Vitamin C content was predominantly high in all the species investigated. Regarding pigment composition, highest chlorophyll content was noticed in *A. philoxeroides* followed by *A. sessilis*; the least amount in *A. tenella*. The concentration of carotene was high in *A. sessilis*. With regard to antinutritional assays, *A. sessilis* and *A. philoxeroides* exhibited only low level of phytic acid and majority of them had low tannic acid content. These two species possess high nutritional and low level of antinutritional factors. All the species studied revealed comparatively high amount of phenol. With their demonstrated nutritional qualities with low level of anti-nutritional factors, it can be suggested that *A. sessilis* and *A. philoxeroides* be included in the dietary menu along with other conventional leafy vegetables. Further, these nutritive herbs can be advocated for domestication and thereby effective utilization.

**Keywords:** Antinutritional factors, β-carotene, Chlorophyll, Dietary supplement, Herbal nutrition, Leafy vegetable, Nutraceuticals, Phenols, Phytic acid, Tannic acid, Vitamin A and C

Conventionally, food and health are strongly interrelated and traditionally, people have been using plants and plant extracts as food and also to cure various ailments⁴. Different parts of plants such as leaves, young shoots, stem, tender flowers, fruits, pods, roots, rhizome and tubers are used as vegetables. Some vegetables are under-utilized and their consumption is not widely accepted as it is considered to be poor’s diet. Many researchers have also reported nutritional composition of various types of wild edible plants being used in the developing countries⁵. All of them emphasize that analyzing locally available plants for various nutrients would enable identification of unconventional food resources. Leafy vegetables are the major component in traditional diet due to its health benefits, which is mainly because of presence of more phytochemicals with potential antioxidant properties. They are regarded as ‘nature’s antiaging wonders’ due to its medicinal properties beyond essential sustenance⁶. Specially, leafy vegetable are cooked, boiled, eaten raw or dried and stored for uses round the year. They have long been recognized most abundant sources of protein, vitamins and minerals.

In this study, we have selected *Alternanthera* Forsskal for investigation which is an under-exploited genus of Family Amaranthaceae, moderately a large family with 77 genera and over 840 species. *Amaranthus tristis* and *Alternanthera sessilis* known for their medicinal usage have been used as well as for food. Both plants have been reported to possess unique bioactive compounds that contribute to their pharmacological activities. *A. tristis* contains amarantin, isoamarantin, betaine, aminoacids and sterols⁶. There are yet other plants in Amaranthaceae which are invasive and luxuriantly growing in our locality. Among them, the species of *Alternanthera* needs special consideration as some of them viz. *Alternanthera brasiliana, A. philoxeroides* and *A. sessilis* are medicinally important and are also used as leafy vegetables,
though not extensively5-8. *A. sessilis* is used to relieve headache and dizziness. It is also used to treat snakebites and to stop blood vomiting. Young shoots and leaves are eaten as a vegetable in southeast Asia9. Hence, a thorough analysis of these neglected/under-utilized green leafy vegetables is required since they can be sources of essential components, such as flavonoids, phenolics and vitamins. Till date, *Alternanthera* spp. have not been investigated for their nutritional potentiality. Here, we analyzed the nutritional and antinutritional factors in the targeted species for their effective utilization as a potential candidate for managing nutrition deficiency.

**Materials and Methods**

**Plant material**

Selected species of *Alternanthera*, collected from different localities of Thiruvananthapuram district of Kerala State (herbarium voucher numbers prefixed with UCBD) viz. *A. brasiliana* (L.) Kuntze (Attingal, Thiruvananthapuram, Kerala; UCBD13696), *A. philoxeroides* (C. Martius) Griseb. (Nedumangad, Thiruvananthapuram, Kerala; UCBD13697), *A. sessilis* (L.) R. Br. ex DC. (Manacadu, Thiruvananthapuram, Kerala; UCBD13698), *A. tenella* Colla (Peroorkada, Thiruvananthapuram, Kerala; UCBD13699) and *A. versicolor* R. Br. (Palode, Thiruvananthapuram, Kerala; UCBD136700) served as the source plant materials for the study. They were identified by the authorities at University of Calicut and the herbarium specimens were deposited at the Herbarium of Department of Botany, University College, Thiruvananthapuram (Voucher numbers specified as above).

**Quantitative analysis of nutritional and antinutritional factors**

Fresh leaf samples locally collected from selected species were used for quantitative analysis of biochemical parameters such as total soluble proteins10, soluble sugars (Anthrone method), amino acids11, lipids12, flavanoids13, reducing sugars14, pigments15, vitamin A16 and vitamin C17 as per standardized procedures. Antinutritional factors, such as total phenol18, phytic acid19 and tannins20 were also analyzed. All the experiments were done in triplicate. The data were statistically analyzed by ANOVA and the means were compared by t-test at *P* ≤0.05.

**Results**

**Quantitative analysis of nutritional factors**

Nutritional factors estimated in the targeted species are given in Table 1. The predominant phytochemicals present in the plant were carbohydrates. High amount of carbohydrate were seen in *A. sessilis* (48±0.22 mg g⁻¹) and *A. brasiliana* (45±0.31 mg g⁻¹) and the amount of reducing sugar was also highest in them (56.12±0.20 and 81.07±0.23 mg g⁻¹, respectively). Protein content (%) in the samples varied from 2.57±0.02 to 12.70±0.25 mg g⁻¹. *A. brasiliana* recorded the highest concentration of protein (12.70±0.25 mg g⁻¹); while *A. versicolor* showed the lowest protein content (2.57±0.02 mg g⁻¹). *A. sessilis* exhibited high amount of lipid (4.64±0.06 mg g⁻¹) and maximum flavonoid content (9.15±0.06 mg g⁻¹). Total amino acid content was highest in *A. philoxeroides* (4.821±0.03 mg g⁻¹) followed by *A. sessilis* (4.33±0.01 mg g⁻¹) and *A. versicolor* (3.128±0.04 mg g⁻¹).

**Quantitative analysis of vitamins and pigments**

The results denoted that *A. versicolor* has higher amount (2.82 µg g⁻¹) of vitamin A; while *A. tenella* have the least (0.0158 µg g⁻¹) compared to other species investigated. All of them showed predominantly high amount of vitamin C (1.0317-1.275 µg g⁻¹) (Fig. 1A).

The different species analyzed varied in the amount of the green pigment chlorophyll. *A. philoxeroides*

![Table 1 — Quantitative analysis of nutritional factors in *Alternanthera* species](image)

- **Parameters analyzed**
  - Total protein (mg g⁻¹)
  - Total Carbohydrate (mg g⁻¹)
  - Reducing sugar (mg g⁻¹)
  - Lipid (µg g⁻¹)
  - Total amino acid (µg g⁻¹)
  - Flavanoid (mg g⁻¹)

- **Alternanthera species**
  - *A. tenella*
  - *A. sessilis*
  - *A. brasiliana*
  - *A. philoxeroides*
  - *A. versicolor*

- **Data**
  - [Data represents mean values of three replicates. Mean values followed by the same letter in the superscript in a row do not differ significantly based on ANOVA and t-test at *P* ≤0.05]
showed high content of chlorophyll (0.0662 µg g⁻¹) followed by A. sessilis (0.0381 µg g⁻¹), A. versicolor (0.0156 µg g⁻¹), A. tenella (0.0064 µg g⁻¹) and A. brasiliiana (0.0045 µg g⁻¹), respectively (Fig. 1B). The carotenoid content was highest in A. sessilis (0.959 µg g⁻¹) and the least value was observed in A. phlioxeroides (0.28 µg g⁻¹). In A. tenella (0.567 µg g⁻¹) and A. versicolor (0.533 µg g⁻¹) almost same quantity of carotenoid was displayed while it was 0.789 µg g⁻¹ in A. brasiliiana (Fig. 1C).

Quantitative analysis of antinutritional factors

The presence of antinutritional factors, such as phenols, phytic acid and tannic acid was analyzed in the present study. Higher concentration of phenol was found in A. phlioxeroides (0.56 mg g⁻¹) and lower in A. tenella as well as A. brasiliiana, where the phenolic content was 0.34 mg g⁻¹ and 0.298 mg g⁻¹, respectively. A. sessilis and A. versicolor exhibited same phenolic content in them (0.412 mg g⁻¹ and 0.415 mg g⁻¹, respectively). Phytic acid was more in A. versicolor (0.219 µg g⁻¹) and A. tenella (0.205 µg g⁻¹); while it was less in A. phlioxeroides (0.063 µg g⁻¹) and A. sessilis (0.032 µg g⁻¹). Low amounts of tannic acid were recorded in A. phlioxeroides (0.025 µg g⁻¹) and A. brasiliiana (0.031 µg g⁻¹) (Fig. 1D).

Discussion

Vegetables are considered to be a good source of dietary supplement on account of carbohydrates, proteins, fats, oils, etc. Out of the huge numbers of vegetables, hardly 24-26 types of vegetables are consumed by the common people globally. Recently, worldwide attention has been drawn towards the lesser known or under-utilized vegetables, widely consumed by the ethnic communities for their health benefits. Such vegetables are integral part of their diet as they get these plants in their immediate surroundings. Since both the nutritional and health are guarded by these resources, such vegetables are considered as ‘nutraceuticals’. The present study analyzed the nutritional as well as anti-nutritional factors in selected species of Alternanthera as they are available irrespective of season and information regarding their nutritional value is meager.

Nutritional analysis

Carbohydrates, fats and proteins are the essential nutrients of life. Significant variation was observed amongst different species of Alternanthera from nutritional point of view. Available carbohydrate content (%) ranged between 19±0.24 to 48±0.22. High amount of carbohydrate and reducing sugar were seen in A. sessilis and A. brasiliiana and the amount of reducing sugar was also highest in them (56.12±0.20 and 81.07±0.23 mg g⁻¹, respectively) in corroboratio with the published reports of 20.0 to
Carotenoids are organic pigments found in the chloroplasts and chromoplasts of plants attributing two important functions. First, they can contribute to photosynthesis. They do this by transferring some of the light energy they absorb to chlorophylls, which then uses this energy for photosynthesis. Second, they can protect plants which are over-exposed to sunlight. They do this by harmlessly dissipating excess light energy which they absorb as heat. In the absence of carotenoids, this excess light energy could destroy proteins, membranes and other molecules. In the present study, the carotenoid content was highest in *Alternanthera sessilis* (0.959 µg g\(^{-1}\)) and lowest in *A. phloxoides* (0.28 µg g\(^{-1}\)). It has been previously reported that as *A. sessilis* is considerably rich in iron, vitamin A and dietary fibres, contains abundant carotene and is used for curing night blindness\(^{26}\). Therefore, this nutritive herb can be effectively utilized to overcome problems associated with vitamin A deficiency.

**Antinutritional analysis**

The antinutritional factors may be defined as those substances generated in natural feed stuffs by the normal metabolism of the stuffs by the normal metabolism of the species and by different mechanism (e.g., inactivation of some nutrients, diminution of the digestive process or metabolic utilization of feed) which exert effect contrary to optimum nutrition. Wild edible plants consumed by tribal people are rich in several nutrients. However, the main problem related to the nutritional exploitation of wild edible plants is the presence of antinutritional and toxic compounds viz. phenolic compounds, phytic acid, tannins, saponins, etc. Dietary diversity is essential to reduce the effects of these anti-nutritional factors. Phenols are a group of aromatic chemical compounds with weakly acidic properties characterized by a hydroxyl (OH) group attached directly to an aromatic ring and the presence of phenols is considered to be potentially toxic to the growth and development of pathogens\(^{29}\). It is reported that phenolic compounds also been shown to possess antimutagenic, anticarcinogenic, antiglycemic and antioxidative properties\(^{30}\). Higher concentration of phenol (0.56 mg g\(^{-1}\)) was recorded in *A. phloxoides* and the amount was lower in *A. tenella* and *A. brasiliana* (0.34 and 0.298 mg g\(^{-1}\), respectively). The phenolic content was almost same in *A. sessilis* and *A. versicolor* (0.412 and 0.415 mg g\(^{-1}\), respectively). Plant materials rich in phenolics are increasingly being used in the food industry because they retard oxidative
degradation of lipids and improve the quality and nutritional value of food\(^3\). 

Phytic acid, a common storage form of phosphorus in seeds is considered as an antinutritional factor. The complexing of phytic acid with nutritionally essential elements and the possibility of interference with proteolytic digestion have been suggested for its antinutritional activity. The phosphorus in phytic acid is not nutritionally available to the monogastric animals and interferes with calcium and iron absorption\(^12\). Here, low amounts of phytic acid has been observed in different *Alternanthera* spp. Very low Phytic acid content was seen in *A. sessilis* (0.032 \(\mu\)g g\(^{-1}\)) and *A. philoxeroides* (0.063 \(\mu\)g g\(^{-1}\)) compared to other species analyzed. 

Tannins (commonly referred to as tannic acid) are water-soluble polyphenols present in many plant foods. High amount of tannins were reported in cereals and they display impaired nutritional quality, lower digestibility and reduction of food consumption\(^32\). The amount of tannic acid was low in *A. philoxeroides* (0.025 \(\mu\)g g\(^{-1}\)) and *A. brasiliana* (0.031 \(\mu\)g g\(^{-1}\)) in the present study. Similarly, low concentration of tannic acid was found in mature leaves of *Bidens biernata* (0.01 mg g\(^{-1}\)), *Smilax zeylanica* (0.02 mg g\(^{-1}\) phytic acid and 0.008 mg g\(^{-1}\) tannic acid), *Commelina benghalensis* (0.10 mg g\(^{-1}\) phytic acid and 0.1110 mg g\(^{-1}\) tannic acid) and *Garcinia indica* (0.06 mg g\(^{-1}\) phytic acid and 0.020 mg g\(^{-1}\) tannic acid)\(^33\), all of these being used as leafy vegetable. Thus, the results presented here indicate the potentiality of the two selected *Alternanthera* species *viz.* *A. sessilis* and *A. philoxeroides* as source of nonconventional foods. These herbs could be used for nutritional purposes effectively due to their demonstrated nutritional qualities and low level of antinutritional factors.

**Conclusion**

Among the species analyzed *Alternanthera sessilis* and *A. philoxeroides* possess high nutritional and low level of antinutritional factors. Hence, consumption of these leafy vegetables should be encouraged through awareness so that these plants could be included in the dietary menu to mitigate nutritional deficiency problems to some extent.

**References**


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