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Nutritional Analysis of Ten Underutilised Wild Edible Plants of Wayanad

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ABSTRACT

Eating a diet rich in green vegetables also offers numerous health benefits. Wild edible plants are important in the life of tribal populations. While these foods are not widely accessible, locally, they are of great relevance for nutrition and food security. The present study was aimed to assess the nutritional quality of often inexpensive, easily accessible, and lesser-known vegetable plants for a healthy diet. The plants taken as study materials are *Diplazium esculentum, Talinum portulacifolium, Alternanthera sessilis, Alternanthera bettzickiana, Pteridium aquilinum, Cissus discolor, Persicaria chinensis, Cyathula prostrata, Cucumis prophetarum,* and *Solanum torvum*. The present work revealed that all of the selected plants might be considered nutritionally rich food sources.

INTRODUCTION:

Plants are considered essential for food and nutrition for the entire world. The traditional knowledge of dietary food practices has a long history of human nutrition. Wild plants have been the mainstay of the human diet for centuries. Wild edible plants refer to the plant species that are not cultivated or domesticated but are accessible from natural habitations and used as food. These plants have an important role to play in poverty, eradication, the security of food availability, diversification of agriculture, and alleviation of malnutrition. According to the Food and Agricultural Organization (FAO, 1995) reports, at least one billion people are thought to use wild food in the diet.

Many of the neglected and underutilized species are nutritionally rich and adapted to low input in agriculture. With an alarming increase in the human population and depletion of natural resources, it has been necessary to explore the possibility of the use of new plant resources having potential for food, fodder, energy, and industrial uses. Ethnobotany is increasingly recognized as an important subject for conservation and sustainable development. The traditional knowledge system in India is fast eroding due to a steady decline in human expertise capable of recognizing various medicinal plants. Much of this wealth of knowledge is becoming lost as traditional culture is gradually disappearing because it is mostly oral (Hamilton, 1995).

In India, a large number of tribal communities have been living in our forest lands for thousands of years. The survival of these tribal communities is dependent on the stability or balance of natural systems. According to the Indian State of Forest Report (ISFR), 2015, the total forest cover is 79.42 million hectares, which is 24.16 % of the total geographical area. The tribal people are very close to nature and have traditional hereditary knowledge of consuming wild plants and plant parts viz leaves, fruits, shoots, tuber, etc. as a source of food. Edible wild fruits also play a very vital role in supplementing the diet of the people. These plants are rich in minerals and carbohydrates. They provide minerals like sodium, potassium, magnesium, iron, calcium, phosphorus, etc. They also contribute immunity to many diseases and are often used in different formulations of 'Ayurveda' in Indian Folk Medicine.

Food plants received the earliest attention of mankind compared to the other various kinds of plants, and this leads to the search for the nutrient composition of food plants. Indigenous knowledge of wild edible plants is important for the sustainable utilization of these plant species (Sawian *et al.*, 2007). Through traditional knowledge, tribal people know what to eat

and what not to eat. Here the present study emphasizes ten such underutilized plants, which are commonly used by tribal communities of Wayanad. The plants selected for the study include *Diplazium esculentum*, *Cyathula prostrata*, *Talinum cuneifolium*, *Alternanthera sessilis*, *Alternanthera bettzickiana*, *Cucumis prophetarum*, *Pteridium aquilinum*, *Cissus discolor*, *Persicaria chinensis*, and *Solanum torvum.*

MATERIALS AND METHODS:

Plant Materials

Ten plants are used in the present study, namely *Diplazium esculentum*, *Cyathula prostrata*, *Talinum cuneifolium*, *Alternanthera sessilis*, *Alternanthera bettzickiana*, *Cucumis prophetarum*, *Pteridium aquilinum*, *Cissus discolor*, *Persicaria chinensis*, and *Solanum torvum.* These plants were collected from the Wayanad district of Kerala. All of these are rapidly growing tropical plants. In the case of *Solanum torvum* and *Cucumis prophetarum*, fruits were selected for the study, whereas leaves were taken from the rest of the plants.

Nutritional Analysis

Fresh leaves and fruits from selected plants were collected, and the various nutritional and antinutritional parameters were estimated using standard procedures.

Moisture content

Moisture content was determined gravimetrically. Five grams of the sample was weighed and taken in a pre-weighed Petri plate. The sample was dried at 80^0C in a hot air oven. After 24 hours, the sample was weighed again, and the difference in weight was determined (AOAC, 1984) The percentage of moisture was calculated by the following formula:

$$\% \text{ of moisture} = \frac{(\text{Fresh weight} - \text{Dry weight}) \times 100}{\text{Weight of the sample taken}}$$

Estimation of Total Carbohydrates

One gram of the fresh sample was taken and ground using 10 ml distilled water. Anthrone reagent was prepared using 200 mg anthrone powder in 100 ml of concentrated H_2SO_4, filtered using cheesecloth and centrifuged at 10,000 rpm for 10 minutes (Anthrone method). Collected the supernatant and made up to 20 ml by distilled water and added 4 ml anthrone

reagent and kept in a boiling water bath for 10 minutes. Absorbance was measured at 620 nm. Blank used was 1 ml distilled water + 4 ml anthrone reagent (Hedge and Hofreiter, 1962).

Total Proteins

One gm of fresh tissue was homogenized in phosphate buffer (pH 7). The homogenate was filtered and centrifuged at 5,000 rpm for 10 minutes. The supernatant was made up to known volume by the buffer. One ml of this solution was taken, added with an equal amount of 10% trichloroacetic acid, and kept in the refrigerator for 15 minutes after thorough shaking. This mixture was then centrifuged at 10,000 rpm for 10 minutes. The upper layer was decanted, and the pellet was dissolved in a known volume of 0.1N NaOH. An aliquot was pipetted and made up to 1 ml using 0.1 N NaOH. Then 5 ml of copper sulfate solution (reagent C) was added to it, followed by the addition of 0.5 ml FolinCiocateau reagent (reagent D). Mixed well and kept for 30 minutes in the dark at room temperature. Absorbance was measured at 670 nm against the blank (Lowry *et al*., 1951).

Estimation of Chlorophylls and Carotenoids

One gram tissue was homogenized in 10 ml of 80 % acetone. It was then filtered and centrifuged at 5,000 rpm for 5 minutes. The supernatant was collected and made up to known volume. One ml aliquot was made up to 5 ml by adding 4 ml acetone. Absorbance was read at 645, 663, 652, and 490 nm against 80% acetone as blank. The chlorophylls and carotenoids were determined using the standard formula (Arnon, 1949).

Estimation of Total Lipids

About 5gm of the sample was extracted in a mixture of chloroform and methanol (20:10), made up to 25 ml, filtered, and poured into a separating funnel. To the solution, distilled water, chloroform, and sodium carbonate were added and shaken well. The chloroform layer was evaporated, weighed, and the percentage of total lipids was calculated. The mixture was separated into two layers; after complete separation, the bottom layer was eluted in a pre-weighed petri dish, and the weight was noted. The solution was kept in an oven to dry. Weight was noted after complete drying. The difference in the weight indicated the amount of lipid present in the extracted samples (Bligh and Dyer, 1959).

Estimation of Total Aminoacids

The total amount of free amino acids was estimated, as reported by Moore & Stein, 1948. One gm of fresh samples was collected and boiled on 80% methanol for 10 minutes, followed by grinding using a motor & pestle and filtered it out, and centrifuged the filtrate at 750 rpm for 10 minutes. Collected the supernatant and made up to known volume by 80% methanol. An aliquot of 0.1 ml of the extract was measured and added 4.9 ml of ninhydrin reagent. After shaking and heating in a boiling water bath for 10 minutes, tubes were cooled under running tap water, and the absorbance was read at 570 nm.

Estimation of Reducing sugars

The estimation of reducing sugars was done by the dinitrosalicylic acid method **(**Miller,1972). One gm tissue was homogenized in 10 ml distilled water. The homogenate was filtered and centrifuged at 10,000 rpm for 10 minutes. The supernatant was collected and made up to known volume. An aliquot was taken, made up to 3 ml, and 2 ml of DNS reagent was added. The mixture was kept in a boiling water bath for 10 minutes and then cooled. The absorbance at 540 nm was measured against an appropriate blank.

Estimation of Ascorbic acid

The amount of ascorbic acid was calculated by extracting the sample in 4% oxalic acid and titrating the extract against the 2,6 dichloro phenol indophenol dye until the endpoint where the pink color appears that persists for a few minutes. The amount of dye consumed is equivalent to the amount of ascorbic acid present in the samples. Standard Ascorbic acid solution was used as the reference, and the amount of ascorbic acid in the sample was calculated using the standard formula (Sadasivam and Manickam, 2008).

Estimation of Thiamine

One gm of fresh leaf sample was ground in 5ml ethanolic NaOH and filtered. The solution was centrifuged at 5000 rpm for 5 minutes and made up to 10 ml. Pipetted out 1ml of the sample and added 0.1% potassium dichromate solution to it. The absorbance was read at 630 nm. A mixture of ethanolic NaOH and potassium dichromate solution was used as the blank **(**Koche, 2011).

Estimation of Riboflavin

Riboflavin content was determined according to the method of Indian Pharmacopoeia (1996), with slight modification. To 5gm of sample powder, 150ml of glacial acetic acid was added. The solution was boiled for 5 minutes and then cooled. Then 30ml of 0.1 M sodium hydroxide solution was added and diluted to 500 ml with distilled water. The solution was filtered. Absorbance was measured at 444 nm. Water was used as a blank.

Estimation of Niacin

Accurately weighed 2 gm of the fresh sample was ground thoroughly in a mortar and pestle with about 10 ml of distilled water. Ground samples were centrifuged at 3000 rpm for 10 minutes. The supernatant was transferred into a conical flask for titration purposes. Added about a few drops of phenolphthalein and titrated with 0.1N NaOH until the endpoint is reached (Thomas and Olufunke, 2012). Here 1 ml of 0.1 N NaOH is consumed for every 0.0123 g of nicotinic acid present in the sample.

Anti-nutritional Analysis

Estimation of Phenol

About 1gm of tissue was weighed and boiled in 10 ml of 80% methanol. Homogenized and filtered the solution using cheesecloth and centrifuged the homogenate at 10,000 rpm for 10 minutes. Collected supernatant and made up to 10 ml by 80% methanol. An aliquot of 0.1 ml sample was made up to 3ml by adding an 80% sodium carbonate solution. The solution was kept in a boiling water bath for 2 minutes and centrifuged at 5000 rpm for 5 minutes. Collected the supernatant, and absorbance was measured at 650 nm against an appropriate blank (Malick and Singh, 1980).

Statistical analysis

The values are expressed as mean ± SE. A value of $P < 0.05$ was considered significant.

RESULTS AND DISCUSSION:

The present study was intended to assess the nutritional quality of ten underutilized plants which are commonly used by tribal communities of Wayanad, namely *Diplazium esculentum, Cyathula prostrata, Talinum cuneifolium, Alternanthera sessilis, Alternanthera bettzickiana, Cucumis prophetarum, Pteridium aquilinum, Cissus discolor, Persicaria chinensis,* and

Solanum torvum. Diplazium esculentum (Athyriaceae), also called 'Vegetable fern,' is an edible fern found throughout Asia. The tribal communities of Wayanad called it 'Charuli.' The boiled young fronds are used as a vegetable (Huxley, 1952). The Assam people use this plant as a vegetable, which stimulates digestion (Sen & Ghosh, 2011).

Cyathula prostrata (Amaranthaceae) is a genus of medicinal and ornamental plants. It was distributed in Asia, Africa, and America. The plants are often used in traditional medicine. The leaves of these plants were cooked and eaten as vegetables. Mubo Adelo Sonbare, 2015, studied the pharmacognostic and free radical scavenging activity of *Cyathula prostrata*. *Talinum portulacifolium* (Talinaceae) is a herbaceous succulent plant whose common name in Kerala is 'Sambarcheera,' which consists of edible leaves. The leaves are used raw or cooked (Facciola, 1998). The plant has many therapeutic values like anti-ulcerogenic, antidiabetic, antimicrobial, and antioxidant activities. The plant *Talinum portulacifolium* is used as a green leafy vegetable due to its rich vitamin A and mineral content (Anon, 2014).

Alternanthera sessilis (Amaranthaceae) is known by several common names, including 'Ponnamkanni' (in Malayalam), 'Ponnanganni' (in Tamil), and 'Ponnagantiaaku' (in Telugu). The leaves and young shoots are consumed as vegetables in certain regions of southeast Asia (Grubben *et al.*, 2004). *Alternanthera bettzickiana* is commonly known as 'Kattuponnankkanni' in Malayalam. It is native to South America. It was harvested from the wild for its edible leaves, which may aid anemic children. The whole plant is useful in purifying and nourishing blood (Ruffo, 2002).

Cucumis prophetarum (Cucurbitaceae) is commonly known as 'attanga' in Malayalam. Tribes use the fruits in mature or miniature stages. The mature fruits are eaten raw or cooked (Ruffo *et al.*, 2002). The immature fruits can be pickled (Facciola, 1998). *Pteridium aquilinum* (Dennstaeditaceae) is also known as 'Eagle fern.' These plants were found in temperate and subtropical regions. It was widely used as a cooked vegetable. *Cissus discolor* (Vitaceae), commonly known as 'Vallimaruma' in Malayalam, is native to South East Asia and Indonesia. The young shoots and leaves, which are pleasantly acidic, are eaten as a vegetable with other vegetables. It is used to treat stomach troubles and is also applied to itching sores (Sawmliana, 2003).

Persicaria chinensis, 'Chorakam' in Malayalam (Polygonaceae), is widespread across China, Japan, the Indian subcontinents, Indonesia, Malaysia, and Vietnam. The plant is harvested

from the wild for local use as both food and medicine. The plant is antiscorbutic, tonic, vulnerary (Chopra *et al.*, 1986).

Solanum torvum ('Chunda' in Malayalam), belonging to the family 'Solanaceae,' is also known as Wild Eggplant, Turkey berry, and Prickly nightshade. The fruits are eaten raw or cooked. Yahara *et al*. (1996) reported that *S. torvum* fruits are moderate inhibitors of glucosidases that provide a prospect for antidiabetic agents.

Nutritional analysis

Various nutritional factors such as Carbohydrates, Protein, Total chlorophylls, Carotenoids, Reducing sugar, Vitamin C, Vitamin B_2, Vitamin B_3, and Vitamin B_1 were estimated in the selected plants, and the results were analyzed using statistical tools and are shown in Table no. 1.

Table No.1. Nutritional analysis of the selected plants

Nutritional Parameters	**Selected Plants**									
	Diplazium esculentum	***Talinum portulacifolium***	***Alternanthera sessilis***	***Alternanthera bettzickiana***	***Pteridium aquilinum***	***Cissus discolor***	***Persicaria chinensis***	***Cyathula prostrata***	***Cucumis prophetarum***	***Solanum torvum***
Carbohydrate (mg/g)	71.47 ± 1.06	57.6 ± 0.02	59.00 ± 0.34	73.30 ± 0.48	74.50 ± 0.43	75.61 ± 0.13	48.6 ± 0.28	34.03 ± 0.19	34.13 ± 0.02	54.73 ± 0.31
Reducing sugars (mg/g)	0.04 ± 0.02	0.002 ± 0.00	0.15 ± 0.04	0.15 ± 0.04	0.02 ± 0.00	0.04 ± 0.28	0.64 ± 0.37	0.06 ± 0.00	0.49 ± 0.28	0.12 ± 0.06
Chlorophyll a (mg/g)	1.01 ± 0.11	3.34 ± 1.92	1.62 ± 0.33	1.62 ± 0.036	1.41 ± 0.02	0.50 ± 0.03	1.14 ± 0.08	1.02 ± 0.01	0.01 ± 0.05	0.02 ± 0.00
Chlorophyll b (mg/g)	1.23 ± 0.19	O.10 ± 0.00	1.28 ± 0.01	1.50 ± 0.003	1.02 ± 0.01	0.50 ± 0.03	1.91 ± 0.05	1.11 ± 0.06	0.01 ± 0.05	0.01 ± 0.00
Total	1.71 ±	0.50 ±	0.91 ±	1.17 ±	1.61 ±	0.02	1.21	1.01	0.02 ±	0.03

chlorophyll (mg/g)	0.16	0.03	0.05	0.03	0.03	± 0.01	± 0.01	± 0.01	0.01	± 0.12
Carotenoids (mg/g)	0.32 ± 0.03	0.10 ± 0.00	0.23 ± 0.01	0.20 ± 0.01	0.15 ± 0.08	0.23 ± 0.01	0.15 ± 0.08	0.01 ± 0.00	0.03 ± 0.01	0.02 ± 0.13
Proteins (mg/g)	2.65 ± 0.41	3.24 ± 0.01	2.09 ± 0.03	0.69 ± 0.01	0.32 ± 0.06	0.88 ± 0.11	1.21 ± 0.12	1.22 ± 0.11	0.24 ± 0.023	2.40 ± 1.38
Amino acids (mg/g)	1.15 ± 0.66	0.20 ± 0.11	1.17 ± 0.67	1.18 ± 0.68	0.01 ± 0.00	0.79 ± 0.46	1.12 ± 0.70	0.25 ± 0.14	1.17 ± 0.68	0.13 ± 0.07
Thiamine (mg/g)	0.18 ± 0.00	0.25 ± 0.14	0.29 ± 0.16	0.56 ± 0.32	0.27 ± 0.15	0.02 ± 0.00	0.46 ± 0.26	0.03 ± 0.00	0.01 ± 0.00	0.28 ± 0.01
Riboflavin (mg/g)	3.20 ± 1.74	7.01 ± 0.01	12.64 ± 0.72	7.22 ± 0.41	4.11 ± 2.37	3.17 ± 0.40	5.32 ± 0.37	9.00 ± 1.00	3.03 ± 0.19	0.09 ± 0.05
Ascorbic acid (mg/g)	5.41 ± 0.03	4.89 ± 0.3	0.15 ± 2.90	1.03 ± 0.27	0.23 ± 0.13	2.68 ± 1.55	3.04 ± 0.14	0.11 ± 0.06	2.80 ± 1.16	2.6 ± 1.50
Niacin (%)	0.01 ± 0.00	0.45 ± 0.02	0.01 ± 0.00	0.54 ± 0.00	0.20 ± 0.11	0.43 ± 0.00	0.31 ± 0.50	0.12 ± 0.57	0.09 ± 0.05	0.48 ± 0.05
Lipids (%)	0.07 ± 0.02	0.041 ± 0.02	0.05 ± 0.02	0.04 ±0.02	0.04 ± 0.02	0.03 ± 0.01	0.98 ± 0.56	0.03 ± 0.01	0.03 ± 0.01	0.04 ± 0.27

Among the ten selected plants, the highest carbohydrate content was found in *Cissus discolor* (75.61 ± 1.30 mg/g), followed by *Pteridium aquilinum* (74.50 ± 11.40 mg/g), *Alternanthera bettzickiana* (73.30 ± 1.48 mg/g), and the lowest in *Cyathula prostrata* (34.30 ± 0.02 mg/g). The commonly used leafy vegetable *Amaranthus dubius* (Amaranthaceae) has a carbohydrate content of 83.00 mg/g (Leung *et al*., 1968), which is greater than that of all the selected

plants. Even though the selected plants contain lower amounts of carbohydrates compared to *A. dubius*, the present study shows that all of them are good sources of carbohydrates. *Persicaria chinensis* has the highest amount of reducing sugars, and the least amount was observed in *Talinum portulacifolium* (0.002 ± 0.00 mg/g).

The chlorophyll content in the diet increases iron levels in human blood (Vivek *et al*., 2013). Chlorophyll can also counteract toxins and inhibit the activities of cancer-causing elements (Ferruzzi and Blakeslee, 2007). Plants are the efficient suppliers of chlorophyll to humans. In the present study, the total chlorophyll content was highest in *Diplazium esculentum* (1.71 ± 0.16 mg/g), while it was comparatively lower in *Cissus discolor* and *Cucumis prophetarum* (0.02 ± 0.01 mg/g). Protein is an important nutritional factor in the diet. Proteins are needed to build and repair tissues. In this study, the protein content was significantly higher in *Talinum portulacifolium* (3.24 ± 0.00 mg/g) compared to the other plants.

Vitamins and minerals are considered essential nutrients. The deficiency of vitamins leads to adverse effects on the metabolism of the human body, and they are essential for humans in trace amounts. Thiamine, riboflavin, niacin, and ascorbic acid are water-soluble vitamins. Thiamine plays a crucial role in carbohydrate metabolism and its conversion to energy by body cells. The deficiency of thiamine leads to a disease called beriberi (Lonsdale, 2006). Among the selected plants, the highest amount of thiamine was observed in *Alternanthera bettzickiana* (0.56 ± 0.32 mg/g), followed by *Persicaria chinensis* (0.46 ± 0.26 mg/g) and the lowest in *Cucumis prophetarum* (0.01 ± 0.00 mg/g).

Riboflavin is a water-soluble vitamin, and poor riboflavin status interferes with iron handling and contributes to the etiology of anemia when iron intakes are low (Powers, 2003). The amount of riboflavin was highest in *Alternanthera sessilis* (12.64 ± 0.72 mg/g) while it is lower in *Solanum torvum* (0.09 ± 0.05 mg/g). Vitamin B_3 (Niacin) is a key mediator of neuronal development and survival in the central nervous system (Gasperi *et al*., 2019). The niacin content was higher in *Alternanthera bettzickiana* (0.54 ± 0.00 %).

Vitamin C plays an important role as an anti-oxidant and in collagen synthesis (Drouin *et al*., 2011). Hussain *et al*. (2016) reported that a sufficient amount of Vitamin C in the diet is important for the body as its deficiency causes scurvy disease. *Diplazium esculentum* (5.41 ± 0.03 mg/g) has the highest ascorbic acid content compared to the other selected plants. The dietary lipids are involved in transport the four fat-soluble vitamins (Vitamin A, D, E & K) and assist in their absorption in the small intestine. In this study, the lipid content was found

to be higher in *Persicaria chinensis* (0.98 ± 0.50 %), followed by *Cucumis prophetarum* (0.23 ± 0.01 %) while lower in the other selected plants.

The moisture content of the plants was estimated gravimetrically, and the results are represented in Fig no.1. The plant *Cucumis prophetarum* has the highest moisture content (94%). Plants with high moisture content are more prone to perishability (Fennema and Tannenbaum, 1996).

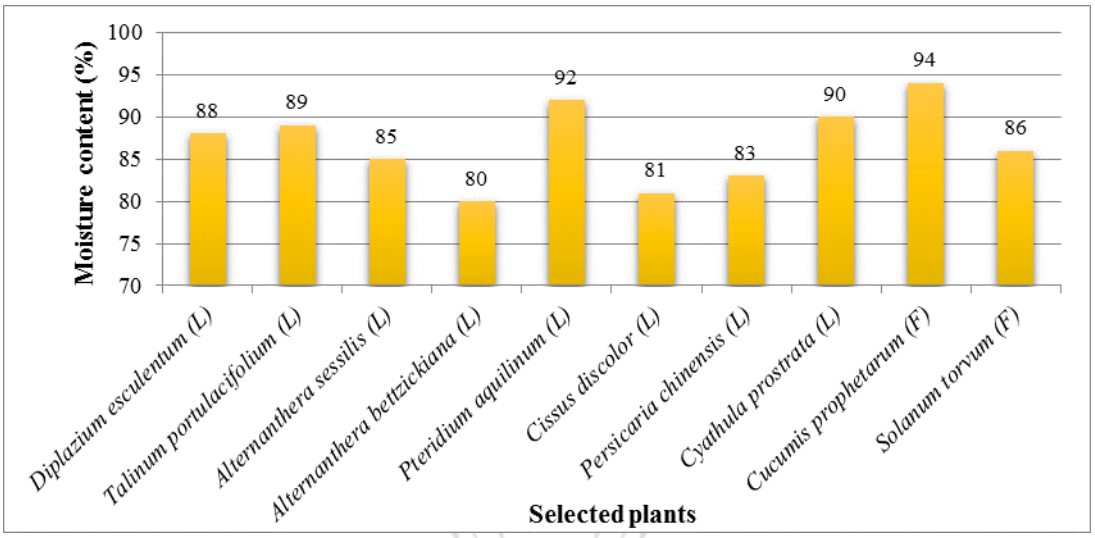

Figure No. 1: Moisture content of the plant parts selected

Anti-nutritional analysis

The anti-nutritional factors are those substances generated in natural food substances by the normal metabolism of species and by different mechanisms, such as inactivation of some nutrients, diminution of the digestive process, or metabolic utilization of feed, which exerts effects contrary to optimum nutrition (Thangaraj, 2016). Phenolic compounds are considered as anti-nutritional components in the diet since they adversely affect protein digestion (Martínez-Valverde, 2000). The phenol content is comparatively higher in *Alternanthera sessilis* and lower in *Talinum portulacifolium* (Table 2). However, all the selected plants contain only a minute quantity of phenol.

Table No. 2: Phenol content in the selected plants

Selected Plants (L/F)	Conc. of Phenol (mg/g)
Diplazium esculentum (L)	0.008 ± 0.004
Talinum portulacifolium (L)	0.0001 ± 0.00
Alternanthera sessilis (L)	0.009 ± 0.01
Alternanthera bettzickiana (L)	0.006 ±0.01
Pteridium aquilinum (L)	0.002 ± 0.001
Cissus discolor (L)	0.002 ± 0.001
Persicaria chinensis (L)	0.004 ± 0.002
Cyathula prostrata (L)	0.004 ± 0.002
Cucumis prophetarum (F)	0.002 ± 0.001
Solanum torvum (F)	0.006 ± 0.003

CONCLUSION:

Green vegetables have an important role in a healthy diet. Many of the neglected and underutilized wild plants are nutritionally rich. The present study reveals the nutritional importance of some inexpensive, easily accessible, and lesser-known vegetable plants for a healthy diet. The results of the study revealed that the selected plant materials contain various nutritional factors in sufficient amounts, while antinutrients are present only in minute quantities. While these foods are not widely accessible locally, they are of great relevance for nutrition and food security. Hence these may be cultivated and utilized as food sources. Since wild edible plants are less susceptible to diseases, they can be grown easily without the application of pesticides.

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