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NUTRITIVE AND ANTINUTRITIVE CHARACTERISTICS OF SELECTED ETHNIC WILD PLANTS FROM SOUTH INDIA

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Wild food plants in the westernghats of India contribute significantly to the diets of tribals, especially during the famine periods. The aim of the present study was to evaluate nutritive, antinutritive and mineral characteristics of four wild plants in south India viz. *Solanum nigrum, Cissus quadrangularis, Bacopa monnieria* and *Tamarindus indica.* They were analyzed for their content of moisture, fiber, ash, protein, carbohydrates, minerals, composition of aminoacids, phytic acid, phenols and tannin. The proximate analysis of leaves included moisture 69 to 90.3%, total ash 13.2 to 19.2, and crude fiber 1.8 to 6.9 mg / g tissue. The total carbohydrates ranged from 35.5 to 68.6 and total protein 1.5 to 5.7 mg / g. All the four plants contained useful amounts of major nutrients nitrogen (1.05- 5.63%), phosphorus (0.133 – 0.29%), potassium (0.7 – 4.1%), calcium (0.19- 4.2%), magnesium (0.45 – 0.62%), sulphur (0.157 – 0.44) and Ca/ P ratio 1.2 – 18.5%. The elements such as iron (186- 1100ppm), manganese (26- 242ppm), zinc (36- 55ppm) and copper (35- 45ppm) were also present. These data indicate that the wild plants contain useful amounts of various essential nutrients that could supplement the diets of populations inhabiting the remote part of the world. The percentage of essential aminoacids in each of the plant foods were comparable with those of an ideal protein standard established by the FAO. Antinutrient factors analyzed in these species are phytic acid, tannin and phenols. Phytate ranges from 0.47 % – 0.54 % whereas tannin 0.08 mg / g tissue to 0.17 mg / g tissue and phenols 1.74 mg/ g to 5.64 mg/g tissue. The value of antinutrient factors of the plants was lower than to the value proposed by World Health Organization.

Keywords: Antinutritive; Essential; Free phenols; Minerals; Nutitive; Phytate; Tannin; Wild plants.

Introduction

The significance of wild plants in the nutrition of human populations is increasing for several reasons such as the growing populations, increasing health consciousness and consumers in general and elevating health care cost. The result is that populations will likely soon be facing food shortages that will compel them to turn with increasing urgency to indigenous, wild plants as staples[1]. The nutritional interest in some of these vegetable species stems from their rich contents of essential amino acids, vitamins and minerals. Further to their rich content of the mentioned nutrients, it is established that green leafy vegetables are the cheapest and most abundant source of proteins because of their ability to synthesize amino acids from a wide range of virtually available primary materials such as water, carbon dioxide, and atmospheric nitrogen (as in legumes). However, the presence of inherent toxic factors or anti-nutritional components in plants has been one major obstacle in harnessing the full benefits of the nutritional value of plant foods, vegetables inclusive[2]. Although the presence of these antinutritional factors is always in trace quantities, they have been established to play significant roles in the nutritional quality of food. Similarly the phytochemicals such as polyphenols in foods are thought to play important roles in human health such as cancer preventative and anti-inflammatory, radical scavenging and antioxidative activities. The most important classes of antioxidant polyphenols are the flavonoids and phenolic acids. These substances in fruits and vegetables are mostly by responsible for the antioxidant characteristics, and thus the healthy image of these foods. However, little data exist on these components, hence the present study aims at highlighting the potentials of some wild tropical leafy plants.

Materials and Methods

Plant materials: Fresh plants of *Bacopa monnieria, Tamarindus indica, Cissus quadrangularis,* and *Solanum nigrum* were collected from the wild habitat of South

India and were grown in the green house in the Department. Young and mature leaves were subjected to all analytical and biochemical analysis.

Proximate composition analysis: The leaves were analyzed for proximate composition by using standard methodologies. Moisture and ash were determined according to AOAC[3]. Crude fibre content was determined by the method described by Pearson[4]. Carbohydrates and reducing sugar were determined by the method of Nelson[5]. Crude protein was obtained by multiplying the total nitrogen content by a factor value proposed by pearson[6].

Amino acid analysis: The samples were hydrolyzed in 6 N HCl for 18 hours at 110°C. The hydrolysate was filtered and analyzed by HPLC. Since tryptophan is destroyed during hydrolysis, the method involving the hydrolysis of samples in 5 N NaOH was used for tryptophan[7].

Mineral analysis by atomic spectroscopy: The major and minor nutrients were estimated from the leaf tissue by Atomic Spectroscopy[8].

Antinutritional factor analysis: A quantitative analysis of tannins was carried out using a spectrophotometic method using Folin- Dennis reagent[9]. Extraction was done with methanol / water. Tannic acid was used to prepare the standard graph. Total phenol content of leaf tissues were estimated by the method of Mayr *et al*[10]. The total phenols/g tissue was calculated from the standard graph. Phytic acid content was determined by the method of Ravindran and Ravindran[11].

Table 1. The amino acid content (mg / g tissue) of four wild plants

	Bacopa	*Tamarindus*	*Cissus*	*Solanum*
Leucine	5	6.9	8	7.2
Histidine	2.4	3.5	2.1	2
Arginine	7.1	9.3	6.7	5.7
Aspartate	9.9	11	12.9	10.3
Tryptophan	2.4	1.2	2	1.7
Serine	4.6	6.1	4.2	3.7
Glycine	8.4	9.2	5.1	4.5
Proline	9.2	11.9	6.4	5.6
Glutamate	12.1	15.7	11	9.1
Alanine	6	4.3	5.8	5.4
Cystine	4.7	2.4	6	5.4
Methionine	0.7	0.85	0.94	0.63
Valine	5.1	4.7	6.4	5.6
Isoleucine	6	4.4	5.4	4.5
Lysine	4.9	6.2	6	5.4
Tyrosine	5.2	5.7	4.2	3.9
Phenylalanine	9.1	4.95	8.8	5.6
Threonine	3.7	2.9	2.4	3.5
Tot. Essential Aminoacid %	43.57	40.38	46.71	46.62
Tot. Non Essential Aminoacid %	56.43	59.62	53.29	53.38

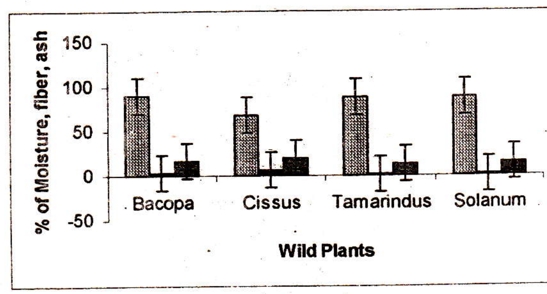

Fig.1. Distribution of moisture, fiber and ash content in the local plants.

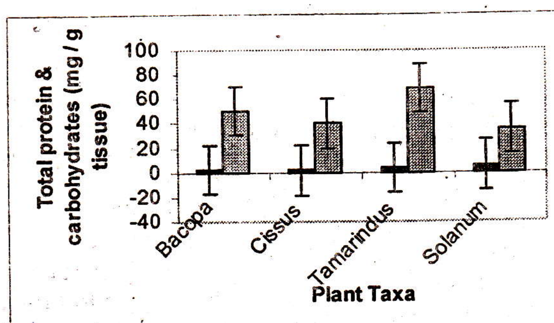

Fig.2. Distribution of protein and carbohydrates in the ethnic plants.

Table 2. Mineral content in the wild plants.

	N%	P%	K%	Ca%	Mg %	S%	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)
Bacopa	2.02	0.153	1.8	0.19	0.62	0.44	1100	242	38	36
Tamarindus	2.31	0.133	0.70	1.95	0.46	0.157	887	68	55	45
Cissus	1.05	0.229	2.5	4.19	0.64	0.157	186	55	36	38
Solanum	5.63	0.319	4.05	1.15	0.45	0.365	720	26	52	35

Results and Discussion

Proximate composition: Moisture content in leaves of *Bacopa* was highest (90.3%) and lowest in *Cissus* (69%). Moisture contents of these species under study were not differed significantly from each other. The crude fiber content was highest in *Cissus* (6.9%) and lowest in *Tamarindus* (1.82%). The fiber contents of all studied plants were higher than the value of fibers in seeds of chick pea varieties[12] (Fig. 1). The involvement of dietary fiber in lowering the blood cholesterol level has been reported[13]. This observation indicates that wild food plants are good sources of crude fiber. The crude protein content (1.48 to 5.8 mg/ g tissue) was comparable with the value of legumes[14]. *Solanum* had the highest (5.8mg/g), followed by *Tamarindus* (3.5mg/g) and *Bacopa* (2.74mg/g). Total carbohydrates exhibited general agreement with values of other cultivated food plants (35.5 mg/g to 68.6 mg/g). There were significant differences in total carbohydrate contents of the species (Fig. 2). The ash content of the samples analyzed varied between 13.2 to 19.2%. The highest ash content was found in *Cissus* (19.2%), and lowest in *Tamarindus*, however, these species are not significantly different for their total ash content (Fig. 1).

Amino acid composition: Amino acid profile of the species is given in the Table 1. It is observed that glutamate and aspartate are the abundant amino acids followed by leucine. Lysine and phenylalanine are essential amino acids necessary for the synthesis of new protein for growth and repair. The total essential amino acid in the species ranges from 40.38 % to 46.71 %. These are comparable with values obtained from oil seeds which ranged between 33.3 and 53.6%. The total neutral, acidic and basic amino acids values suggest that the proteins are probably acidic in nature. The present results are compared with the aminoacid requirement pattern as recommended by WHO/FAO[15]. Therefore, the TLFs can be considered as good diet that can provide the required essential aminoacids.

Mineral content: Iron, which plays a major role in the formation of haemoglobin, was highest in *Bacopa* 1100ppm and lowest in *Cissus* (186ppm) (Table 2). Since the iron from wild food plants is readily absorbed compared with that of cereal, consumption of cereal diet fortified with wild plants, would therefore contribute significantly to the prevention of anemia which is wide spread in developing countries. The calcium (Ca) concentration is reasonably distributed among the samples. *Cissus* recorded the highest (4.19%) and *Bacopa* (0.19%) the lowest value. Phosphorus (P) value ranges from 0.133 in *Tamarindus* to 0.319% in *Solanum*. Phosphorus along with calcium in the body contributing to the blood formation and supportive structure of the body. Low Ca / P ratio facilitates decalcination of Ca in the bone leading to low Ca level in the bone while high Ca / P ratio helps to increase the absorption of Ca in the small intestine. The leaf samples are good source of magnesium (Mg). Mg is required for bone formation and it is also an activator of many enzyme systems. Potassium (K) content ranged from 0.7% to 4% whereas sodium (Na) between 2.1% - 0.3%. The ratio of Na / K (recommended ratio less than one) in the human body is of great concern for regulation of high blood pressure[16]. The Na / K ratio for the leaf samples is ideal. Copper (Cu)

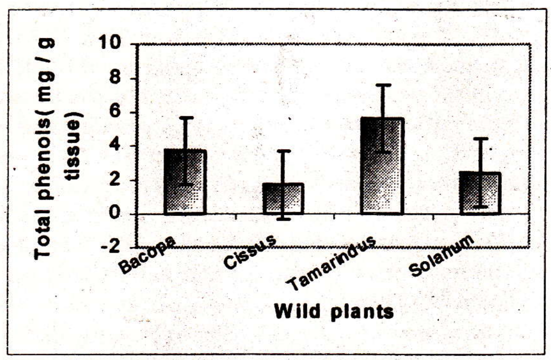

Fig. 3a. Total Phenol content in the wild plants.

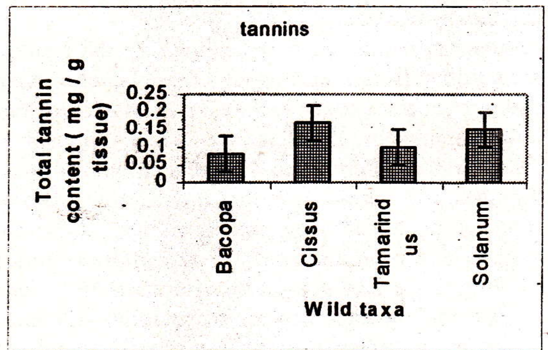

Fig. 3b. Total Tannin content in the wild plants

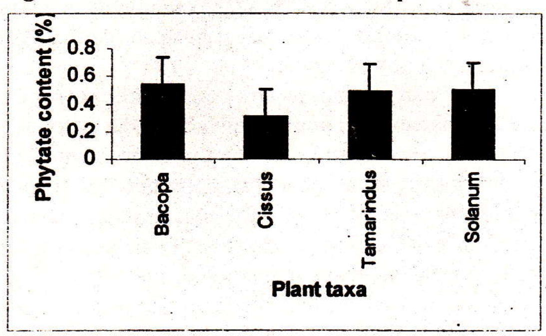

Fig.3c. Total Phytate content in the wild plants.

content varied from 35 ppm to 45 ppm, zinc (Zn) from 36 ppm to 55 ppm, manganese (Mn) from 26 to 242 ppm. Cu, Zn and Mn are essential components of numerous enzymes that catalyze oxidative - reduction reactions and is required for collagen synthesis and iron mobilization[17]. The divalent cations Mg^{++}, Mn^{++} are cofactors for many enzymes[16]. The three SODs Zn, Cu and Mn are protective against oxidative stress by scavenging superoxide anion to H_2O_2 and thus averting cellular damages[16]. Thus, these elements indirectly and additionally function as antioxidant. Therefore, the wild species can be ideal sources of the mineral supplement in the daily diet. The divalent cations Mg^{++}, Cu^{++} are cofactors for many enzymes. Molybdenum is a cofactor for xanthine oxidase and aldehyde oxidase.

Antinutrients: Fig. 3a, b and c portraits the results of antinutritive factors such as total free phenolics, tannin and phytic acid. Phytate is found in most of the cereals, pulses and seeds. It acts as the primary phosphorus reservoir accounting up to 85% of total phosphorus in legumes and cereals. Phytate has a strong binding capacity, readily forming complexes with multivalent cations and proteins. Most of the phytate mineral complexes are insoluble at physiological pH. Hence, phytate binding renders poor bioavailability of minerals to humans and animals. In the present study phytic acid contents ranged from 0.49 % to 0.54 % and this is comparable with that of some of the commonly consumed vegetables. Cooking of leaves significantly effective in reducing the phytate content[18].

Plants produce an array of phenolic compounds like free phenolics, tannins which have the potential to react with proteins and other cytoplasmic components. In some cases the subsequent reaction between them are highly appreciated since they add flavour, taste and appearance of the product. However, from the nutritional point of view, the main concern with phenols in dietary proteins is the way in which they decrease its digestibility and nutritive value by decreasing the activity of digestive enzymes such as amylase, trypsin, lipase and also reduce the absorption of vitamin B_{12}. The total free phenolics of the species (1.74 to 5.64 mg / g tissue) appear to be higher when compared to commonly cultivate leafy vegetables. The tannin content ranges from 0.08 mg / g tissue to 0.17 mg / g tissue. In nutritional point of view, the higher content of both total phenolics and tannin are not desirable to human consumption. But recently, the phenolic constituents of various plants have shown potential medicinal properties, including antioxidant activities[19].

The traditional leafy vegetables have been integrated in a community's culture for use as food over a long span of time. The present study indicates that these vegetables are good source of nutrients with valuable minerals and essential amino acids compared to the introduced varieties, and are also important in food security. Further studies are warranted to determine the phytochemicals present in the plant which are lethal to mammals. Furthermore, the presence of toxic substances reduces the usefulness of these non cultivated food plants.

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