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A review: Underutilized wild edible plants as a potential source of alternative nutrition

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Abstract

Today, it has been a big challenge to provide safe, healthy and nutritious source of food for poor income group and undernourished population of the developing world. Due to scarcity, high cost and unreliable supply of healthy food in the developing and underdeveloped countries have resulted in the find out the cheap and alternative source of healthy and nutritious food. Some of the underutilized wild edible plants (such as *Canavalia, Mucuna*, *Rhynchosia*, *Afzelia, Brachystegia* and *Detarium* for example) have been analyzed and found to possess high nutritional value. Review of literature available revealed that most of the plant species are a good source of nutrition and some have medicinal properties. Use of underutilized wild edible plants helps in the fight to malnutrition associated problems and increasing the health status of the rural population. This review also focused on commercial exploitation of the underutilized wild edible plants such as a source of dietary supplement, for new food formulations, bio fortification, and in product development.

Keywords: Underutilized, wild edible plants, potential source, alternative, nutritional value

1. Introduction

Global food security and economic growth now depends on a declining number of plant species. In human history, 40-100,000 plant species have been regularly used for food, fibers, shelter, industrial, cultural and medicinal purposes [1]. However, only a small number of plants are widely used. The remaining plant diversity is underutilized [1, 2]. Underutilized plants contribute immensely to family food security and serve as means of survival during times of drought, famine, shocks and risks [3]. They can also supplement nutritional requirements due to their better nutritional value [4, 5].

With alarming increase in human population and depletion of natural resources, it has been felt necessary to explore the possibility of use of new plant resources having potential for food, fodder, energy and industrial uses.

Many neglected and underutilized species are nutritionally rich and adapted to low input agriculture. The erosion of these species can have immediate consequences on the nutritional status and food security of the poor [6]. Their enhanced use can bring about better nutrition and fight hidden hunger. For example, many underutilized fruits and vegetables contain more vitamin C and pro-vitamin A than widely available commercial species and varieties.

The use of plants has long been an intimate part of local cultures and traditions. Many neglected and underutilized species play a role in keeping alive cultural diversity associated with food habits, health practices, religious rituals and social exchanges. Focusing attention on neglected and underutilized species is an effective way to help a diverse and healthy diet and to combat micronutrient and deficiencies, the so-called ‘hidden hunger’ and other dietary deficiency particularly among the rural poor and the more vulnerable social groups in developing countries. In reality, local communities have used these plant species for generations but the current loss of local knowledge means that their traditional uses are being forgotten. Many underutilized species can make an important contribution to a better diet for local communities.

2. Ethnobotanical observations on underutilized wild edible plants

A) At International Level

Ahmad and Javed [7] conducted research on selected underutilized plant species in Ayubia National Park, Pakistan. They found six most prominently used medicinal and food species viz. *Adhatoda vasica*, *Artemisia scoparia*, *Galium aparine*, *Amaranthus viridis*, *Hedera nepalensis* and *Urtica dioica* that gain little attention in scientific research and also by local community, were selected as underutilized species. Diversity of the neglected and underutilized crop species of Benin (West Africa) was studied by Dansi *et al* [6]. They reported 41 neglected and underutilized crop species (NUCS) among which 19 species were identified as of priority base on 10 criteria among which included their extent and degree of consumption.

Abubakar *et al.* [8] studied sixty underutilized flowering plant species as vegetable from the field in the Federal Capital Territory (FCT) Abuja of Nigeria. Osewa *et al.* [9] investigated uses of neglected and underutilized plant species in akinyele local government area of Oyo state, Nigeria. Tebkew *et al.* [10] recorded 33 underutilized wild edible plants in the Chilga district, northwestern Ethiopia. Of the recorded plants, 45% were trees. Fruits (76%) were the most frequently used plant parts.

B) At National Level

Nayagum *et al.* [11] recorded 27 species of less known wild edible fruits with their local name, habit and uses. Singh and Gupta [12] and Jain and Sinha [13] studied life support species used by rural people under extreme environment condition. Sundriyal and Sundriyal [14] reported six plant species of underutilized wild edible plants as a food *i.e. Machilus edulis*, *Spondias axillaris*, *Elaeagnus latifolia*, *Diploknema* *butyracea*, *Baccaurea sapida* and *Eriolobus indica*. A survey of less known wild edible plants used by Gujjar tribe of district Rajori, Jammu and Kashmir state was carried out by Rashid *et al.* [15]. Bhatt *et al.* [16] reported that flowers and buds of *Crotalaria tetragona* are cooked as vegetable and used in garnishing of local food preparation especially in non-vegetarian recipes in the north-eastern hill region of India.

Diversity of underutilized vegetable crop species in Manipur, North- East India was documented by Singh *et al*. [17]. Terangpi *et al.* [18] reported *Gnetum gnemon* and *Rhynchotechum ellipticum* as less known plants. These plants were used by Karbi ethnic group in Assam, Northeast India. Deb *et al.* [19] documented 41 species of underutilized crops of three districts of Nagaland (India).

3. Nutritional value of underutilized wild edible plants

A) At International Level

Onweluzo *et al.* [20] studied on isolation and characterization of protein of some lesser known tropical legumes i.e. *Afzelia africana, Brachystegia eurycoma, Detarium microcarpum* and *Mucuna flagellipes*. The proteins of *Detarium microcarpum* and *Mucuna flagellipes* contain more of high molecular weight globulins. Protein profile of *Afzelia africana* legumes shows a predominance of albumin. Sena *et al*. [21] analyzed nutrient components of some famine food plants of the republic of Niger. They studied nutrient content leaves of *Ziziphus mauritiana*, *Ceratotheca sesamoides*, *Moringa oleifera*, *Leptadenia hastata*, *Hibiscus sabdariffa*, *Amaranthus viridis* and *Adansonia digitata.*

Barminas *et al*. [22] studied mineral composition of six non-conventional leafy vegetables i.e. *Moringa oleifera, Adansonia digitata, Colocasia esculenta, Corchorus tridens, Cassia tora* and *Amaranthus spinosus*. They found highest iron content in *Amaranthus spinosus* and *Adansonia digitata* as compared to the commonly used Nigerian vegetables. Freiberger *et al.* [23] investigated the nutritional role of wild underutilized plants in the Nigerian diet. Dolezal *et al*. [24] investigated chemical composition of less- Known wild fruits i.e. chokeberry (*Aronia melanocarpa*), Cornelian cherry (*Cornus mas*), Barberrry (*Berberis vulgaris*), Scarlet firethorn (*Pyracantha coccinea*), Russian olives (*Elaeagnus angustifolia*), Mayhaw (*Crataegus monogyna)*, Rowan berry (*Sorbus aucuparia*), Madlar (*Mespilus germanica)*, Rose hips (*Rosa canina*) and Sloe berry (*Prunus spinosa*). Pugalenthi *et al.* [25] studied the nutritional potential of an underutilized legume *Mucuna pruriens* var. *utilis* and current state of its utilization as food/feed for both human beings and livestock throughout the world.

Bhat and Karim [26] studied Nutritional Potential of Wild and Underutilized Legumes. Aberoumand [27] investigated nutritional and bioactive components of an under exploited food plant *Alocasia indica.* Its stem is consumed as vegetable in some part of Iran. Ng *et al.* [28] studied five underutilized wild vegetables namely *Limnophila aromaticoides, Ceratopteris thalictroides, Crassocephalum crepidioides, Etlingera elatior* and *Monochoria vaginalis* and were analyzed for nutritional value, phenolic components and antioxidant activities. These wild green were found to have high fibre (11.3 - 19.8 g / 100g) and ash (13.0 - 17.6 g / 100g) contents as compared to commercialized species, *Brassica juncea*. Osamudiamen and Afolabi [29] evaluated proximate composition, physicochemical properties and mineral elements of the seed and oil of *Chrysophyllum albidum.*

B) At National Level

Maikhuri [30] studied nutritional value of some lesser known wild food plants and their role in tribal nutrition in North India. They studied *Alpinia malaccensis, Angiopteris evecta, Calamus tenuis, Cyathea gigantea, Dendrocalamus hamiltonii, Dioscorea bulbifera, Pinanga gracilis, Sphenoclea zeylanica,* and *Wallichia densiflora.* They reported that *Dendrocalamus hamiltonii, Dioscorea bulbifera and Cyathea gigantea* forms the most important part of their diet. The maximum food energy was obtained from *Dioscorea bulbifera* (21.28 mj kg^{-1}) and minimum from *Wallichia densiflora* (6.7 mj kg^{-1}). *Sphenoclea zeylanica* was found to be rich in all minerals as compared with the other plants.

The dried bamboo shoots are reported to contain energy 302 kcal, protein 25.3 g, fat 3.3 g, fibre 9.5 g, carbohydrate 42.8 g, calcium 208 mg, phosphorus 569 mg, iron 12.5 mg, riboflavin 0.09 mg and niacin 3.8 mg per 100 g [31]. Duhan *et al.* [32] studied nutritional value of some non-conventional plant foods of India. They studied thirteen non-conventional foods including fruits, leaves and grains consumed in various parts of the Indian subcontinent and were analysed for their nutritional value. Khejri (*Prosopis cineraria*) beans, Pinju (*Capparis decidua*) and Kachri (*Cucumis* spp.) contained considerable amounts of protein (15–18%). Kachri was rich in fat (13%). Bhakri (*Tribulus terrestris*), Gullar (*Ficus glomerata*) and Peehl (*Salvadora oleoides*) were found to be rich sources of calcium. Gullar contained about 15 times the amount of calcium present in wheat. Phosphorus content of Santhi (*Boerhavia diffusa*), Khejri beans, Bhakri, Pinju and Lehsora (*Cordia dichotoma*) were noticeable. Zinc was present in high amounts in Peepalbanti (*Ficus religiosa*) and Gullar; as was iron in Santhi and Bhakri and manganese in Santhi. Besides iron, zinc and calcium, Pinju contained appreciable amounts of β-carotene and vitamin C. However, *Boerhavia diffusa* contained high amounts of oxalic acid.

Rao [33] has worked on nutrient composition of some less familiar oil seeds of Andhra Pradesh. Seeds of *Xanthium strumarium*, *Guizotia abyssinica*, *Nicotiana tabacum* and *Allium cepa* were found to be good sources of protein and fat. Analysis of lesser known pulses of genus *Canavalia* and genus *Mucuna* showed that the seeds of investigated materials contained higher amounts of crude protein, crude fat and energy content when compared with most of the commonly consumed Indian pulses. They were rich source of minerals such as Na, K and Ca [34, 35]. Bhargava *et al.* [36] analyzed different edible parts of seven bamboo species for their nutrient contents viz., total carbohydrates, proteins, vitamins C and minerals. It was found that among all the edible parts, total carbohydrate content was highest in the seeds of *Bambusa arundinacea* (38.0%), proteins in the seeds of *Dendrocalamus strictus* (13.54%) and vitamin C in the seeds of *Bambusa arundinacea* (50mg/100g).

Siddhuraju *et al.* [37] studied chemical composition and nutritional characteristics of seeds of *Mucuna pruriens*. They found mature seeds contained 314.4 g/kg crude protein, 51.6 g/kg crude fiber, 67.3 g/kg crude fat, 41.1 g/kg ash, and

525.6 g/kg carbohydrates. Potassium, phosphorus, and calcium registered higher concentrations compared with the most commonly consumed pulses. The globulins and albumins together constituted the major storage proteins (22.7 g/100 g of seed flour). Sankhala *et al.* [38] studied less familiar leaves consumed by the tribals of Udaipur region. They studied proximate composition, iron, calcium, β-carotene, vitamin-C and oxalic acid contents of leaves of *Portulaca oleracea*, *Boerhavia diffusa*, *Commelina benghalensis*, *Amaranthus* spp., *Chenopodium album*, *Vigna catjang*, *Moringa oleifera*, *Cassia tora* and *Trianthema monogyna*.

Kala and Mohan [39] studied nutritional and anti-nutritional potential of genus *Mucuna*. They found higher amounts of crude protein and crude lipid when compared with most of the commonly consumed pulses. The fatty acid profiles revealed that the seed lipids contained a higher concentration of palmitic acid and linoleic acids. Amino acid profiles of *Mucuna pruriens var. pruriens* revealed that the seed protein contained relatively higher levels of certain essential amino acids and rich in minerals such as potassium, calcium, magnesium, phosphorus, iron and manganese. Anti-nutritional substances such as total free phenolics, tannins, 3, 4- dihydroxyphenylalanine, phytic acid, hydrogen cyanide, trypsin inhibitor activity, oligosaccharides and phytohaemagglutinating activity were investigated.

Mohan and Kalidass [40] described the nutrition and antinutritional value of 23 unconventional wild edible plants. These plants were analyzed for proximate and mineral composition, starch, vitamins, *in-vitro* protein digestibility (IVPD), *in-vitro* starch digestibility (IVSD) and certain antinutritional factors. The tubers of *Kedrostis foetidissima* and stem of *Caralluma pauciflora* contain higher contents of crude protein. All 23 wild edible plants appeared to have a higher level of iron content compared to recommended dietary allowances (RDA) of NRC/NAS [41] for infants, children and adults.

Nazarudeen [42] studied nutritional composition of some lesser - known fruits used by the ethnic communities and local folks. They reported 218 species of wild edible fruit plants from forest of Kerala. Out of 218 wild edible fruits, 10 fruits based on their individual merit and desirability were analyzed for their nutritional value and compared with 10 common cultivar fruits. Paulsamy *et al*. [43] studied nutritional properties of *Elaeagnus kologa* which is underutilized edible and endemic fruit plant in Nilgiris of the Western Ghats.

Vadivel and Pugalenthi [44] evaluated effect of various processing methods on the nutritional value, antinutritional compounds, biological value and protein quality of dehulled seeds of an under-utilized tribal food legume, *Tamarindus indica*. Murthy and Emmanuel [45] studied nutritional and antinutritional properties of the underexploited wild legume *Rhynchosia bracteata* Benth. They investigated that legumes contained higher amount of crude protein, crude fat, ash and nitrogen free extractives constitute 20.18, 6.16, 6.12 and 61.31% respectively. The legumes are rich in magnesium, iron potassium and phosphorous. Antinutritional factors such as total free phenols, (3.76%) tannins (0.29%), L -DOPA (0.51%), hydrogen cyanide (0.066%) and phytic acid (0.18%) are present in variable quantities in legumes.

Under - utilized food legume *Rhynchosia Cana, Rhynchosia filipes*, *Rhynchosia rufescens* and *Rhynchosia suaveolens* were analyzed for proximate composition, mineral profiles, vitamins, fatty acid profiles, amino acid profiles of seeds, protein digestibility and antinutritional factors. The crude protein ranged from 14.28 - 19.40%, crude lipid 3.28 - 4. 41%, total dietary fibre 6.39 - 8.44%, ash 2.80 - 3.50% and carbohydrate 60.29 - 72.51% [46]. Kunwar *et al.* [47] studied relative importance of 49 underutilized plant species by using relative importance (RI) technique. They divided plant species in to six categories based on consumption. They found 22 plant species appeared in multiple use categories, while the rest were characterized by single used category.

Jain and Tiwari [48] studied nutritional value of some traditional edible plants used in emergency i.e. during scarcity of food by Gond and Sahariya tribes of central India. Tresina and Mohan [49] find out the proximate composition, mineral profile, vitamins, protein fractions, fatty acid profiles and amino acid profiles of total seed protein, *in vitro* protein digestibility and antnutritional potential of legume *Mucuna*. Kalita *et al.* [50] evaluated Nutritional Potential of Five Unexplored Wild Edible Food Plants from Eastern Himalayan Biodiversity Hotspot Region (India). The studied unexplored wild food plants namely, *Piper pedicellatum* C. DC (leaves), *Gonostegia hirta* (Blume ex Hassk.) Miq. (Leaves), *Mussaenda roxburghii* Hook.f (leaves), *Solanum spirale* Roxb. (Leaves and fruits) and *Cyathea spinulosa* Wall. ex Hook. (Pith portion and tender rachis) from East Siang District of Arunachal Pradesh Northeast (India) for ascertaining their suitability for utilization as supplementary food. Khomdram *et al.* [51] studied Nutritional composition of two underutilized wild edible fruits of *Elaeagnus pyriformis* and *Spondias pinnata.*

4. Conclusion

From the ongoing research worldwide, and with the current database it is evident that underutilized wild edible plants possess high nutritional value. These plants were used to various cuisine and to flavour, garnish, or complement other foods. These plant species were good source of vitamins and minerals, but have now become less important. Most of this traditional knowledge only survives in the memory of the elderly and is now in danger of vanishing. This paper attempts to compile and disseminate that knowledge in order to help maintain cultural traditions and facilitate research into food history and new food sources.

These plants should be explored further for overcoming protein - energy malnutrition, particularly in the developing world. Application of modern processing methods along with incorporation of traditional knowledge will definitely provide a substantial base for the commercial exploitation of these plants for developing new foods (or for biofortification), as well as for use in the pharmaceutical industry. Application of modern biotechnological methods might provide sufficient support to develop transgenic plants with less antinutrients or toxicological factors in the underutilized wild edible plants. Still, a wide gap in our knowledge exists with regard to exploring the actual gene pool, in evaluating beneficial secondary metabolites, phytochemicals, and other nutritional features in these underutilized wild edible plant resources.

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