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Nutritional potential of some underutilized leafy vegetables of Assam: A review

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Abstract
Vegetables are the important component of balanced human diet and also the main factors in achieving global nutritional security by providing nutrients, vitamins and minerals. The growth in vegetable production has increased substantially and this was mainly due to development of hybrids, adoption of improved production and protection technologies long with large scale cultivation by the farmers. However, this remarkable growth in vegetable sector was contributed by only few major vegetables. The diverse agroclimatic condition of India is suitable for growing different underutilized vegetable crops yet not much attention is given on these crops, because of inadequate scientific knowledge on their nutritional potentials. The underutilized leafy vegetables are important source of balanced human diet as they provide different valuable micronutrients, vitamins and minerals. Underutilized leafy vegetables have local or regional importance, but they are not explored commercially and thereby they lack national or global recognition. The underutilized vegetable crops are the plant species that are traditionally used for culinary or for medicinal purpose. Underutilized or indigenous vegetables are characterized by a high nutritional value compared with commercially important major vegetables like tomato and cabbage (Keatinge *et al.*,2011). Most of the leafy vegetables used by local people of Assam are indigenous and are not known their potential value. In this context, there is an urgent need to take up research on genetic resources exploration, management, utilization and improvement of underutilized vegetable crops to ensure food and nutritional security for future and also to increase the income of rural people which will finally contribute the national economy.

Keywords: Indian mustard, path coefficient analysis

Introduction
With the annual population growth rate of 1.8%, the demand for food, feed and biofuel in the world is growing day by day. It is projected that to cater the food demand of whole world, the production of agriculture has to increase by 70% by the year 2050. Therefore, there is a huge potential to explore the underutilized crops as food source. In the year 2017-18 from an area of 10,249 hector, India produces 18, 7474 MT of vegetables and this amazing achievement was contributed by only few major vegetables like brinjal, cauliflower, cabbage, peas, onion etc. India has the advantage of having a varied argo climatic situation which allows to grow more than 60 cultivated and about 30 lesser-known vegetable crops. Even though the underutilized vegetables have the tremendous potential to contribute to livelihood improvement, nutritional security and environment sustainability, the research and cultivation of these crops on commercial basis is still very narrow.

Different underutilized vegetables like *Amaranthus spinous*, *Chenopodium album*, *Hibiscus sabdariffa* L, *Rumex asetose*, *Globin's coronaria* etc are embedded with vitamins, amino acids, minerals, protein, dietary fibre etc. have high antioxidant activities and hence can effectively address the issues related to malnutrition and nutritional security. Apart from creating stability to the eco system these underutilized vegetables can be a help in increasing the economy of the rural poor. Diverse agro climatic conditions of India permit to grow more than 60 cultivated and about 30 lesser-known vegetable crops, not much attention has been given on underutilized vegetables known. Besides their importance, limited use of underutilized vegetables is due to lack of availability of planting materials, lack of marketing and lack of information on recommended production technique of these crops. Therefore, there is an urgent need for genetic resources exploration, management, utilization and improvement of underutilized vegetable crops with a view to ensure nutritional security for future. The climate and soil of India are favourable for the production of different underutilized vegetable.

It also generates the employment and also increase the income of rural people and finally it could contribute the national economy.

Importance of underutilized vegetables

The underutilized vegetables are not only packed with protein, essential vitamins, micronutrients, and other Phyto-nutrients etc but many of these vegetables have a better nutritional value compared to major commercial vegetables (Keatinge *et al*., 2011) [1]. As the traditional crops typically do not meet modern standards for uniformity and other characteristics they have been neglected by breeders from the private and public sectors. But the traditional varieties have an immense potential to contribute to the world food production for their biotic resistance, tolerance to abiotic stress, yield and quality. Underutilized vegetables are rich source of nutrients including vitamins, minerals and other health promoting elements including high antioxidant activity which help in the diversification of diet leading to more balanced source of micronutrients. Apart from creating stability to the eco system underutilized vegetables can be a help in improving economic condition of the rural poor.

Nutritional and medicinal values of underutilized vegetables

***Amaranthus spinosus*:** *Amaranth spinosus* an annual or short-lived perennial plant distributed worldwide in warm humid regions. It is very nutritive and very fast-growing crop the leaves and tender stems. Amaranthus leaves have been reported to contain 17.5-18.3% protein (dry-weight basis) of which 5% is lysine, an essential amino acid that is lacking in most diets based on cereals and tubers. Amaranthus is a rich source of protein and dietary fibre (Shukla *et al*., 2010) [2] and is also an important source of Vitamins, especially pro-vitamin A, vitamin C, K and folate. Amaranthus spp. contains 3 times more vitamin C calcium, iron and niacin than spinach and 18 times more vitamin A, 20 times more calcium and 7 times more iron compared to lettuce. Amaranthus leaves possess strong antioxidant properties which are due to the presence of carotene and micronutrients *viz*., sodium, copper, manganese, chloride along with phenolic compounds. Antioxidants help in the prevention of diseases such as cancer, arteriosclerosis and ageing by scavenging free radicles. Among the group of flavonoids, quercetin has been reported to be strong antioxidant. It has been found to chelate metals, scavenge oxygen free radical and prevent oxidation of low-density lipoprotein in vitro studies. Vegetable Amaranthus is recommended as a good source of fibre for patients with constipation.

Chenopodium album or Bathua is a weedy annual herb erect, branched, strong-smelling which is fast-growing. It grows almost all types of soil which is rich in nitrogen including wastelands. The mean values for carbohydrates, protein and fibre in the shoots were 7.0, 29.2 and 36.5 (g/100g) respectively. The calcium, potassium and magnesium content of shoots were 18,213.2, 49,028.6 and 13,821.5 (mg/1000g) respectively. Sodium was 68.0 (mg/100g) immature plants. The microelements of Fe, Zn, Cu in the young shoots were 120.4, 23.0 and 9.1 (mg/1000g) respectively. The measurements for vitamin C were 5.2 (mg/100g) while β-carotene measured 68 (µg/100g) in mature plants respectively. It contains fair amount of iron (Faber *et al*. 2011) [5]. *Chenopodium album* contains high number of amino acids, leucine, isoleucine, lysine and vitamin C (Pande and Pathak; 2010) [6]. It Contains fibre (4–6 g/100 g) along with high iron content (Yadav and Sehgal; 2002) [7].

***Alternanthera sessilis*:** Locally known as Matikaduri in Assamese, as well as sessile Joy weed and dwarf copperleaf in English. Several Asian nations, including Sri Lanka, use it as a vegetable. The plant grows naturally, but it is also cultivated for food, herbal remedies, as an aesthetic plant (red variation, as a hedging plant), in the aquarium trade (though it only grows submerged for brief periods), and as chicken feed. The leaves, blossoms, and tender stems are eaten as vegetables in Karnataka, Andhra Pradesh, and Tamil Nadu. The leaves and young shoots are consumed as vegetables in some parts of Southeast Asia. The plant's medicinal uses as a herbal remedy include diuretic, cooling, tonic, and laxative effects. It has been applied to the management of haemorrhoids and dysuria. The plant is also said to be good for the eyes, and it is a component of both Kajal and therapeutic hair oils.

Centella asiatica, also referred to as Indian pennywort and Asiatic pennywort, is a member of the flowering plant family Pinaceae and herbaceous perennial plant. It is indigenous to the Asian wetlands. Both a culinary vegetable and a medicinal plant, it is employed. Although clinical efficacy and safety have not been independently verified by science, *C. asiatica* has been used in traditional medicine to treat a variety of diseases and minor injuries. Topical use may cause contact dermatitis and skin irritation. It may make you feel sleepy after you consume it. When consumed for a prolonged period of time, the herb may have negative effects on liver function. The ability of C. asiatica to absorb and move metals from root to shoot when grown in heavy metal-contaminated soil makes it a viable Phyto-extraction technique in the context of Phyto-remediation.

Roselle (*Hibiscus sabdariffa* L.) *Hibiscus sabdariffa* commonly named as “red sorrel” or “roselle” is a member of malvaceous family. It is a well-known medicinal plant with more than 300 species that are found in tropical and subtropical areas all over the world. Roselle contains organic acids including citric, malic, tartaric and all hydroxy citric acids. The plant contains beta carotene, vitamin C, protein and total sugar. Roselle, having various medically important compounds called photochemical, is well known for its nutritional and medicinal properties. Many parts of Roselle including leaves, fruits and roots are used in various foods items.

Roselle has been used as a traditional medicine for illnesses for years and is more than just a pretty crop. It is well-known for its palatable leaves and fleshy calyces, which are used to make salad dressings, tea, juices, jams, jellies, ice cream, and several other items. Due to its high vitamin C and anthocyanin content, fresh roselle calyces are gathered in various nations to make pro-health beverages. However, in Bangladesh, roselle calyces and leaves are consumed as vegetables, and the plant's fibre is utilised as a replacement for jute. Roselle is renowned for its superior nutritional and therapeutic qualities. The nutritional examination of Roselle calyces revealed that they contain significant amounts of calcium, iron, niacin, and riboflavin. It contains antioxidants, anthocyanins which acts as free radical scavengers and inhibit lipid peroxidation. Consumption of roselle products such as fresh juice, tea, jam, jelly or in the form of capsule rich in

anthocyanin protect human body from the harmful reaction of free radical by antioxidant activity. Roselle is a multipurpose crop and has great potential to increase the income of farmers, producers, processors of Bangladesh by fetching higher market price both from export and local market. Nutrient contents of different parts of roselle plants are presented in Table 1.

Table 1: Nutrient contents of different parts of Roselle plant

Nutrients	Calyxes	Seeds	Leaves
Protein (g)	2	28.9	3.5
Carbohydrates (g)	10.2	25.5	8.7
Fat (g)	0.1	21.4	0.3
Vitamin A (I.E.)	-	-	1000
Thiamine (mg)	0.05	0.1	0.2
Riboflavin (mg)	0.07	0.15	0.4
Niacin (mg)	0.06	1.5	1.4
Vitamin C (mg)	17	9	2.3
Calcium (mg)	150	350	240
Iron (mg)	3	9	5

***Rumex acetosa*:** or garden sorrel is an annual winter leafy vegetable. The herbaceous perennial common sorrel has stems that emerge from a short underground one and reaches a height of around 1 m. The leaves are big, oblong, and 10-15 cm long. They have a sour flavour.

Table 2: Average chemical composition values of three wild edible plants

Parameters	*Rumex acetosella* L.	*Rheum ribes* L.	*Rumex scutatus* L.
Moisture (%)	80.79 ± 2.13	91.84 ± 2.89	83.68 ± 1.81
Total ash (%)	22.32 ± 1.70	7.32 ± 1.47	8.02 ± 0.42
N (%)	2.82 ± 0.06	3.47 ± 0.04	1.39 ± 0.06
Crude protein (%)	17.60 ± 0.40	21.69 ± 0.27	8.66 ± 0.39
pH	4.86 ± 0.12	5.91 ± 0.32	6.06 ± 0.52
Crude fibre (%)	26.42 ± 2.16	36.68 ± 3.60	29.84 ± 1.33

Table 3: Mean values of mineral compositions of three wild edible plants

Minerals	*Rumex acetosella* L.	*Rheum ribes* L.	*Rumex scutatus* L.
Na (g/kg)	1.19 ± 0.02	0.76 ± 0.02	0.44 ± 0.14
Mg (g/kg)	2.23 ± 0.07	8.42 ± 0.36	3.47 ± 0.24
K (g/kg)	36.65 ± 0.67	21.76 ± 0.43	12.70 ± 0.12
Ca (g/kg)	3.91 ± 0.61	20.02 ± 0.23	16.14 ± 0.15
P (g/kg)	2.67 ± 0.11	2.68 ± 0.09	3.27 ± 0.18
S (g/kg)	1.56 ± 0.09	1.30 ± 0.02	1.77 ± 0.07
Mn (mg/kg)	20.47 ± 2.38	76.08 ± 1.25	64.83 ± 3.81
Fe (mg/kg)	316.33 ± 11.74	217.08 ± 13.85	330.49 ± 12.87
Cu (mg/kg)	32.08 ± 0.95	47.58 ± 3.86	10.11 ± 1.89
Zn (mg/kg)	14.07 ± 0.31	61.84 ± 9.28	16.68 ± 0.63
Cr (mg/kg)	Nd	0,18 ± 0,05	0.67 ± 0.21
Cd (mg/kg)	0.17 ± 0.04	0,16 ± 0,03	Nd
Co (mg/kg)	0.97 ± 0.15	0.71 ± 0.15	1.20 ± 0.08
Pb (mg/kg)	Nd	0,44 ± 0,05	Nd

Glebionis coronaria

Commonly known as Crown Daisy, is the flowering plant species of daisy family and is inherent to Mediterranean region. Crown Daisy is a leafy vegetable. Other common names include Chrysanthemum greens, Garland chrysanthemum, Crown daisy etc. It is an annual plant which has hairless and erect stem and form numerous compound branches. It possesses yellow ray florets which are grouped in small flower heads and aromatic or bipinnately lobed leaves. It has high content of chlorogenic acid, flavonoids, carotene, potassium, minerals and vitamins along with antioxidants which has long term benefits for human health.

Table 1: Biochemical characteristics of *Glebionis. coronaria* var. *coronaria*

Parameters	Average value
Dry matter, %	18.10 ± 2.27
Total sugars, %	17.45 ± 1.46
Carotene, mg %	2.69 ±1.56
Ascorbic acid, mg %	172 ±34.44
Phosphorus, %	0.113 ±0.027
Calcium, %	0.853 ±0.515
Ash, %	5.62 ±1.03
Tannins, %	4.68 ±2.06
Titratable acidity, %	3.93±1.71
Fats, %	3.97 ±1.95

Developing Underutilized Vegetable Crops: Strategies

Domestication of potential wild species through homestead cultivation should be encouraged for avoiding overexploitation from natural sources. In addition to providing market access through a marketing network for perishables, support is needed for planting material distribution and multiplication. Vegetable crops that are underutilized are nutrient-dense and well-suited to low input horticulture. Increased research and development in these areas will significantly improve human wellbeing in terms of food security and nutrition. National programmes focusing on their conservation and usage should target a small number of species for in-depth research and development in underutilised vegetable crops. Both species and crops that are crucial for subsistence farming and those with the potential to become cash crops need more attention in research. Diverse ethnic populations mostly cultivate/manage underutilised vegetable crops using traditional farming methods. Increased effort is needed to record indigenous knowledge, for example through ethos-botanical investigations. Such emphasis will help tap value additions as much of native diversity is put to multipurpose uses. Strategies need to be worked out particularly at national and regional levels to develop and make available promising selections/varieties, overcoming constraints of production of good seed material, planting material, in-vitro/tissue cultured material etc. This would boost production, meeting local needs, promoting domestic markets and thereby, enhance income generation of small farming communities. Systematic local specific crop planning in accordance with agro-climatic suitability of the region need to be done and rapid expansion of infrastructure facilities with priority on market development, transport and communication needs to be done. The yield and quality of these crops are poor which hamper the productivity. Hence, some criteria need to be developed for commercial exploitation of underutilised vegetable crops. The criteria maybe high productivity, market demand, freedom from serious insect pest and diseases, easier postharvest management, high nutritive value and availability of production. At the very onset, there is a necessity to make the farming community aware about the nutritional importance of unexploited vegetable crops, i.e., fruits, vegetables and medicinal plants. For this, extension agents can organize special awareness camps/campaigns, exhibition, etc., at micro and macro level conveying theme of unexploited horticultural crops. Similarly, use of mass media like radio, TV, newspaper and other printed literature can play an effective role in creating awareness among the farmers. For proper exploitation and better economic returns from underutilized vegetable crops emphasis should be given on developing processing units in this area. It would also provide employment opportunities to the rural folk. Genetic erosion is very serious problem in Underutilised vegetables. And many land races will become extinct if these are not conserved soon. Likewise, efficient production technology and post-harvest management are necessary to make the commercial cultivation of non-traditional horticultural crops feasible. Malnutrition among the people of these rural areas will be greatly reduced because to the availability of underutilised vegetable crops.

Conclusion

Underutilized vegetables embedded with rich nutrient potentials along with ability to stand against adverse climatic conditions may prove boon to all concerns - growers, consumers and environmentalists, provided that they are tamed properly. Despite their acknowledged value, underutilised vegetables are sometimes not used to their full potential due to a shortage of planting materials, a lack of knowledge about their nutritional and therapeutic benefits, or a lack of information on the methods used to grow them. To maintain future food and nutritional security, it is necessary to start a programme on genetic resource investigation, management, usage, and enhancement of underutilised vegetable crops. Underutilized vegetables are crucial to India's national economy. India's climate and soil are ideal for growing a variety of underused veggies. As a result, the Indian government has been making efforts to promote the underutilised veggies. To enhance the production of underused vegetables, some GOs and NGOs have been working on development programmes. Finally, it might be said that it is underused.

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