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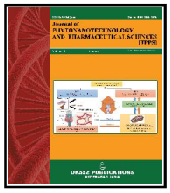

Review Article : Open Access

Underutilized vegetables crops for improved nutrition and health: A review

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Abstract

Vegetables are crucial for a balanced human diet and global nutritional security as they provide essential nutrients, vitamins, and minerals. In spite, varieties, hybrids, and production technologies are good; many underutilized vegetable crops are needed to be considered. These underutilized crops, which are not grown commercially or traded widely, suffer from limited availability of planting material, lack of awareness regarding their nutritional and medicinal importance. India's climate and soil are favorable for producing various underutilized vegetables. The government has taken steps to promote their importance. Hence, increasing production of underutilized vegetables can alleviate nutritional problems, create employment, boost rural incomes, and contribute to the national economy as well if considered scientifically and pro-policy manners.

1. Introduction

Agriculture is under increasing pressure to produce greater quantities of food, feed and biofuel on limited land resources for the projected nine billion people on the planet by 2050. It is estimated to increase agricultural food production by 70% by 2050 to cope with an estimated 40% increase in world population. As economies develop, there is generally an increased demand for calories and protein derived from animal products (Keyzer *et al*., 2005). Vegetables are the best sources for meeting the calorie demands in future. Underutilized cucurbits are now getting boost because of their nutritive and medicinal value including antioxidant properties. This includes vegetables like sponge gourd, wild cucumber, spine gourd, pointed gourd, ivy gourd, sweet gourd, *etc*. Due to inadequate policy measures no systematic efforts have been made on estimating the area and production of these crops.

2. Underutilized traditional crops are important for sustainable food production and nutritional security

In contrast to the above-mentioned major staple crops, underutilized, undervalued or neglected crops also branded development opportunity crop (Kahane *et al.,* 2013). Minor crops that are already cultivated, but are underutilized regionally or globally given their still relatively low global production and market value (Ochatt and Jain, 2007). Some of these crop species may be widely distributed globally, but are restricted to a more local production and consumption system. Many of these traditional crops grown for food, fiber, fodder, oil and as sources of traditional medicine play a major role in the subsistence of local communities and frequently are of special social, cultural and medicinal value.

Figure 1: Under exploited vegetable crops.

With good adaptation to often marginal lands, they constitute an important part of the local diet of communities providing valuable nutritional components (Table 1), which are often lacking in staple

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crops. Many traditional or indigenous vegetables are characterized by a high nutritional value compared with global vegetables like tomato and cabbage (Keatinge *et al*., 2011). As source of essential vitamins, micronutrients, protein and other phytonutrients, traditional vegetables and underutilized legume crops such as mungbean have the potential to play a major role in strategies to attain nutritional security. Apart from the provision of essential vitamins, many of the vegetable crops included in home garden kits are known to be naturally nutrient dense. Many examples where under exploited vegetable crops are given top priority. Community-based seed conservation and multiplication has been used in the Philippines as an approach to enhance the adoption of nutrient-dense traditional vegetables (Ebert *et al*., 2013). Regional high value commercial crops (HVCC) program of the Department of Agriculture to ensure the availability of high quality traditional vegetable seed for home garden and commercial production was done.

Apart from their commercial, medicinal and cultural value, traditional vegetables are also considered important for sustainable food production as they reduce the impact of production systems on the environment. Many of these crops (Figure 1) are hardy, adapted to specific marginal soil and climatic conditions (Hughes and Ebert, 2013). This is the case; for example, in the southern part of Rajasthan, India where due to the harsh climatic conditions, only robust, drought-tolerant traditional vegetables with short growth cycles such as *Cucumis melo* var. *agrestis* (Kachri) can survive and produce food.

The main reasons why some of the vegetable crops remained under exploited in spite of their potential nutritional facts are: Underestimation of their potential use; non-availability of their complete botanical information; inadequate research on their commercial exploitation; lack of knowledge on their nutrition value and potential and fast disappearance of ecosystem and habitat destruction.

3. Under exploited vegetables for nutrition

The under exploited vegetable crops group wise are mentioned below for their nutritional importance.

3.1 Underutilized cucurbits

Underutilized cucurbits (Table 2 and Figure 2) are now getting boost because of their nutritive and medicinal value including antioxidant properties. This includes vegetables like sponge gourd, wild cucumber, spine gourd, pointed gourd, ivy gourd, sweet gourd, tasle gourd, chow chow, *etc*. Most of them are important minor vegetables of Northern, Eastern and Southern India. Due to inadequate policy measures, no systematic efforts have been made on estimating the area and production of these crops.

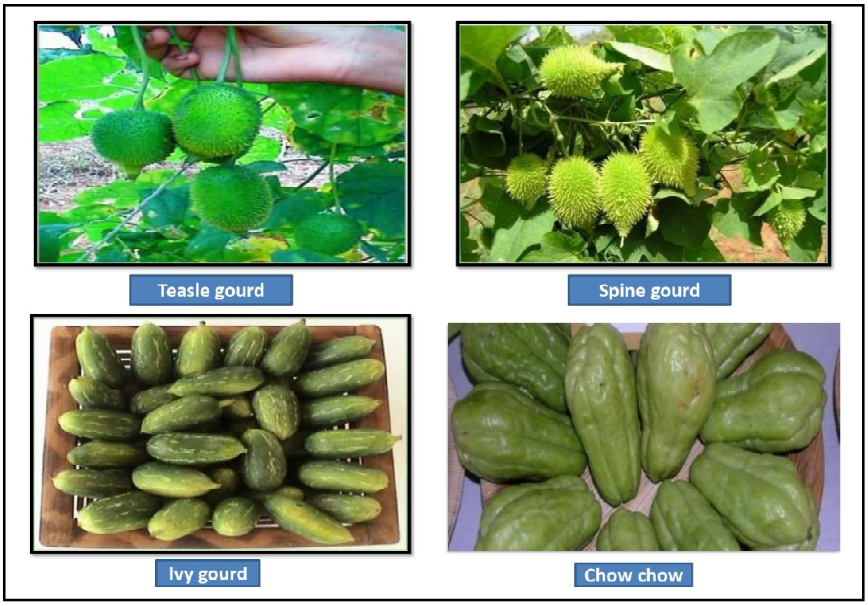

Figure 2: Some of the under exploited cucurbits.

3.2 Nutritional importance of under exploited cucurbits

Sweet gourd is a rich source of β-carotene and lycopene, Bitter gourd is a good source of vitamin C, Spine gourd is a rich source for protein, Ivy gourd leaves are better source of vitamin A (4036 mg/ 100 g), vitamin C (13 mg/100 g), Chow chow is rich in calcium.

3.3 Underutilized leguminous crops

The legume family, Fabaceae is the third largest family of flowering plants with approximately 650 genera and nearly 20,000 species. Legumes (Table 2 and Figure 3) can biologically fix nitrogen, adding annually up to 60 to 100 kg N/ha/year to the soil. Among legumes, beans are very important as vegetable in the immature stage as well as the seeds are staple food crop in the mature stage. Besides French bean, vegetable pea, there are several beans grown on a very limited scale in different parts of the country. Beans are also very important source of protein when compared to other foods.

3.4 New addition of some of the solanaceous vegetables

3.4.1 Tree tomato

Perennial shrub, grown in the backyards in Meghalaya and Sikkim. Tree tomato is a small, tender 2-3 m tall tree, egg shaped berries with pointed ends in cluster near the young shoots. Examples are: The long-stalked, pendent fruit, colour- solid deep-purple, orange or yellow, or red-and-yellow.

Pulp of the fruit - light orange and the seeds are black. Tree tomato is consumed as delicious chutney when raw or after roasting and peeling off the skin. More widely and effectively deployed to address malnutrition, poverty and economic prosperity. Rich in vitamins, minerals and other health promoting factors including high antioxidant activity. Diversification of diet leading to more balanced source of micronutrients. Resistance to several biotic and abiotic stresses. Reduce the risk of over-reliance on very limited number of major crops. They provide a broad spectrum of crops to improve productivity and global food security and to meet new market demands.

Table 1: Various nutritional compounds and their health benefits in under exploited vegetable crops

S. No.	Crop	Compound	Health benefits
1.	Asparagus	Asparagine	Antidiuretic
2.	Basella	Saponin	Fight against cancer
3.	Broccoli	Sulphoraphane	Reduces risk of cancer
4.	Brussels sprout	Sulphoraphane	Anticancerous
5.	Elephant foot yam	Omega-3 fatty acids	Fight depression, anxiety and improve eye sight
6.	Horse radish	Glucosinolates	Lower blood pressure, build strong bones and stimulate healthy digestion
7.	Pigeon pea	Lycine, cystine and arginine	Antiinflammatory, weight loss, prevent anaemia and maintains blood pressure
8.	Spine gourd	Methanol	Anticancerous, antimicrobial and antibacterial properties
9.	Ivy gourd	Glucose-6-phosphatase	Antidiabetic
10.	Leek	Diallyl disulfide, diallyl trisulfide, allyl propyl disulfide	Flavonoid antioxidants
11.	Jerusalem artichoke	Levulose	Sweetening agent for diabetics
12.	Globe artichoke	Polyphenols	Helps in digestion

Table 2: List of underexploited cucurbits and leguminous vegetables

Underexploited cucurbit vegetables		Underexploited leguminous vegetables	
Common name	**Botanical name**	**Common name**	**Botanical name**
Oriental pickling melon	*C. melo* var. *conomon*	Broad bean	*Vicia faba* L.
Long melon	*C. melo* var. *utilissimus*	Winged bean	*Psophocarpus tetragonolobus* (L.)
Snap melon	*C. melo* var. *momordica*	Indian bean	*Dolichos lablab* (L.) Sweet
Spine gourd	*Momordica diocia*	Sword bean	*Canavalia gladiate* L.
Sweet gourd	*M. Cochinchinensis*	Lima bean	*Phaseolus lunatus* L.
Teasle gourd	*M. Subangulata* subsp. *renigera*	Jack bean	*Canavalia ensiformis* L.
Bird bitter gourd	*M. Charantia* var. *muricata*	Vegetable soybean	*Glycine max* L.
Balsam apple	*M. balsamina*	Vegetable cowpea	*Vigna unguiculata* L.
Pointed gourd	*Trichosanthes diocia*	Yard long bean	*Vigna unguiculata* var. *sesquipedalis*
Snake gourd	*T. cucumerina*		
Ivy gourd	*Coccinia grandis*		
Chayote	*Sechium edule*		
Wild cucumber	*Cylanthera pedata*		
Round melon	*Praecitrullus fistulosus*		

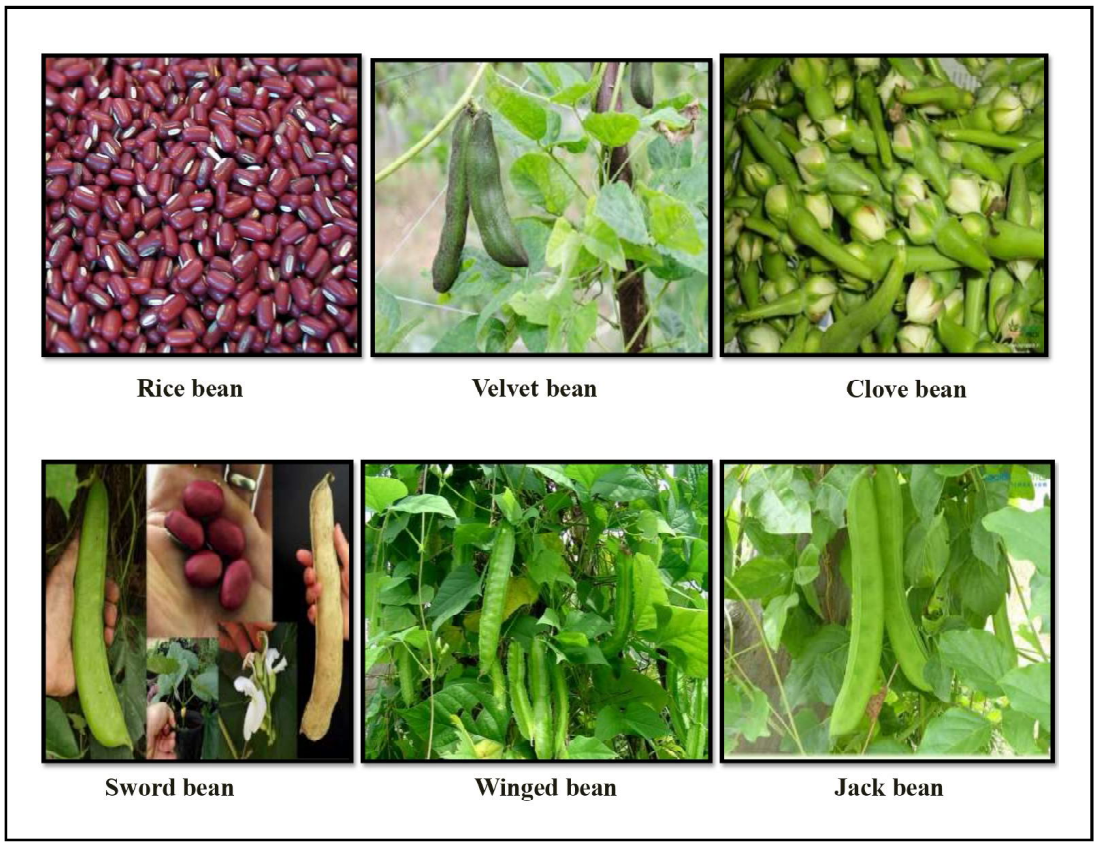

Figure 3: Underexploited leguminous vegetable crops.

Certain under exploited leafy vegetables such as Indian spinach, indian sorrel, water spinach, bathua sag, drumstick, curry leaf, lettuce, asparagus, kale, brussel sprout, broccoli, Chinese cabbage and leek hold greater promise for nutrition (Table 3 and Figure 4).

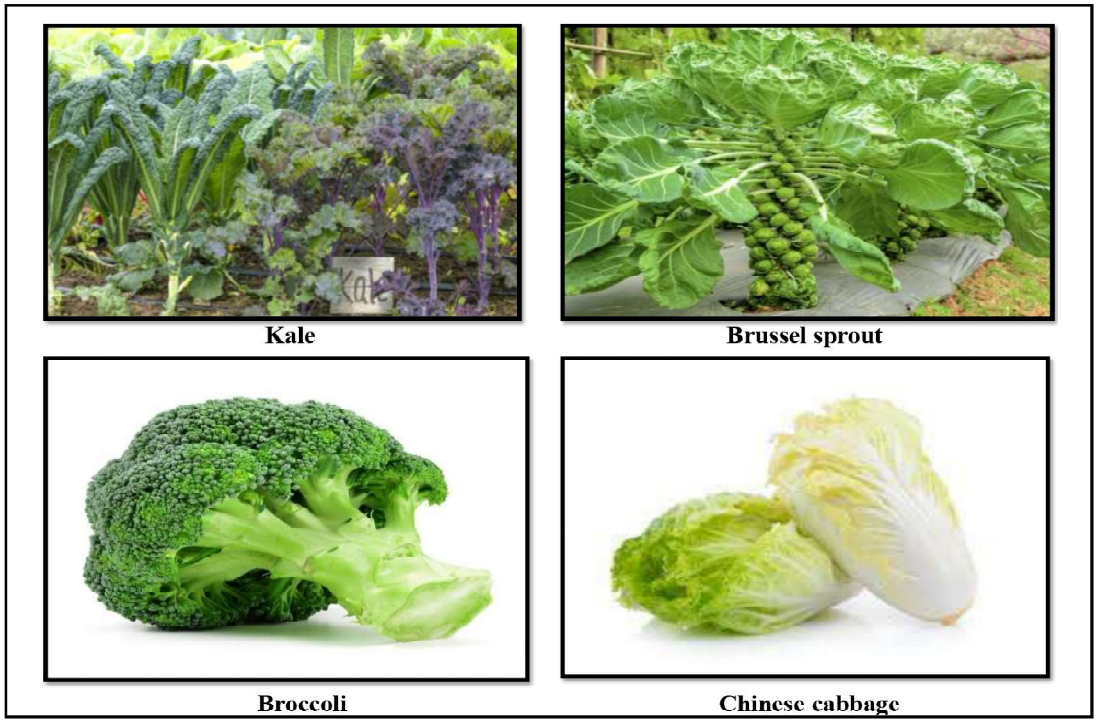

Figure 4: Some of the lesser known leafy vegetable crops .

Table 3: List of lesser-known leafy vegetables

Common name	Botanical name
Indian spinach	*Basella alba, B. ruba*
Indian sorrel	*Hibiscus sabdariffa*
Water spinach	*Ipomea aquatica*
Bathua sag	*Chenopodium album*
Drumstick leaves	*Moringa oleifera*
Curry leaf	*Murayya koenigii*
Lettuce	*Lactuca sativa*
Asparagus	*Asparagus offcinalis*
Leek	*Allium porrum*

3.5 Examples of underutilized vegetables and legume crops with nutri rich potential

Not all traditional and underutilized crops can simply and easily be turned into commercial success stories. Significant research, breeding and development efforts are needed to convert existing local landraces of carefully selected, promising crops into varieties with wide adaptation and commercial potential (Stamp *et al*., 2012). An overview of breeding efforts and application of biotechnology tools such as micropropagation, molecular marker studies and genetic transformation for the improvement of underutilized crops has recently been provided by Ochatt and Jain (2007); Jain and Gupta (2013). Access to genetic diversity of selected crops, either *in situ* or *ex situ*, is a pre-condition for success. Two underutilized traditional vegetable crops amaranth and drumstick tree and the underutilized legume crop. Mung bean are highlighted and briefly described. The highlighted crops are well represented in AVRDC's gene bank with substantial inter and intra specific genetic diversity and all three crops already have demonstrated their potential for wider adoption and commercial exploitation.

Description of the some of the crops is given below:

3.5.1 Sweet gourd (*Momordica cochinchinensis* L.)

The fruit of sweet gourd has blunt thorns all over the skin. Its male and female plants are separate. Fruits are rich in protein, vitamin C and vitamin A. Fruits and leaves are having medicinal properties to cure ulceration, lumbago and fracture of bone. Roots are rich in saponin and bessisterol which may be used in pharmaceutical industries. Seeds are used to treat swelling, ulcer and abscesses.

3.5.2 Karchikai (*Momordica cymbalaria* L.)

Karchikai is rich source of vitamin C, fibre, β-carotene, iron and calcium. It is having medicinal properties such as antidiarrhoel, hepatoprotective, antidiabetic, nephroprotective, antiallergic, antimicrobial, *etc*. The calcium content of Karchikai is 3 times higher than that of bitter gourd, whereas, the ascorbic acid content of is 2 times higher than that of bitter gourd.

***Euryyale ferox* (Water lily)**

Figure 5: Water lilly.

3.5.3 Water lily (*Euryyale ferox* L.)

E. ferox grown in ponds and other water bodies is considered one of the most viable sources of their diet (Figure 5) and income.

3.5.4 Yongchack/Tree bean (*Parika roxburghii* L.)

Nutritious pods of *P. roxburghii* (Figure 6) are consumed as staple legume vegetable. The *Parkia* pods are available in the market from December until March every year. The consumptions start from the tender light green pods when it is about 30 cm long until maturity. It is used as a supplementary food source and is consumed fresh, raw, or sundried during off seasons. It provides better food and livestock as a multifunctional crop and serves as valuable and dependable income-generating primary products for growers and users. The quality of proteins of Parkia's mature seed is not limited by any of the essential and semi-essential amino acids, and this is a unique feature of this tree bean among legumes. Besides this, it also contains protein, minerals, and fatty acids.

3.5.5 Velvet bean (*Mucuna pruriens* L.)

M. pruriens (Figure 6) is considered one of the most preferred legume vegetable in tribal people of U. P. and Bihar. It is having been reported to contain the toxic compounds L-dopa and hallucinogenic tryptamines, and anti-nutritional factors such as phenols and tannins. It is a minor food crop. Raw velvet bean seeds contain approximately 27% protein and are rich in minerals. During the 18th and 19th centuries, *Mucuna* was grown widely as a green vegetable in the

foothills and lower hills of the eastern Himalayas and in Mauritius. Both the green pods and the mature beans were boiled and eaten. *M. pruriens* root are bitter, thermogenic, anthelmintic, diuretic, emollient, stimulant, purgative, febrifuge and toxic. The seeds are found to have antidepressant properties in case of depressive neurosis when consumed and formulations of the seed powder have shown promise in the management and treatment of Parkinson's disease (Eze *et al.*, 2017).

Figure 6: Yongchak and Velvet bean.

3.5.6 Amaranth (*Amaranthus* spp.)

Amaranth (*Amaranthus* spp.) is widely grown as a leafy vegetable and for grain production in many tropical countries in Africa, Central and South America, Mexico and parts of Asia. Amaranth is a very nutritious leafy vegetable, both in raw and cooked form. The nutritional value of this crop is comparable to spinach, but much higher than cabbage and Chinese cabbage (Ebert *et al*., 2011). Amaranth is increasingly gaining importance both for household consumption and commercial production in Africa and Asia. There is a good market potential for this crop, both in the high-price and low-price segments.

3.5.7 Drumstick tree (Moringa spp.)

The Moringaceae family comprises 13 species that fit into three broad life forms with distinct geographic origins. Most parts of the drumstick tree are edible. The leaves and flowers are eaten as salad, as cooked vegetables, or added to soups and sauces or used to make tea. The young, tender pods known as drumsticks are highly valued as a vegetable in Asia and also are pickled. Fried seeds taste like groundnuts. The root bark has a pungent taste similar to horseradish and is used as a condiment. Dried leaf powder is a good option to supplement diets of children and pregnant and lactating women. For example, moringa leaf powder is added to a soybean and groundnut/ peanut paste to form an energy-dense supplemental food known as ready-to-use food for treatment of severe acute malnutrition (Jilcott *et al*., 2010).

Moringa has a high nutrient density and is rich in many essential micronutrients and vitamins as well as antioxidants and bioavailable iron. It excelled among 120 species of Asian traditional vegetables tested for their content of micronutrients and phytochemicals, antioxidant activity (AOA), and traditional knowledge of their medicinal uses. Moreover, it is easy to grow, has excellent processing properties, and good palatability (Yang *et al*., 2006). The Moringa family is rich in glucosinolates and isothiocyanates. Isothiocyanates are highly reactive compounds that inhibit mitosis and stimulate apoptosis, a physiological process eliminating DNA-damaged, unwanted cells in human tumor cells, and are therefore important to human health (Ulrichs, 2010). A dramatic reduction in skin papillomas was observed following ingestion of moringa seedpod extracts (Bharali *et al*., 2003). Greater use of moringa has good potential in the fight against hunger and malnutrition in the developing world by improving nutrition and health of the rural and urban poor, increasing incomes of smallholder farmers, and enhancing environmental services by controlling soil and wind erosion.

3.5.8 Mungbean (*Vigna radiata* var. *radiata*)

Mungbean is relatively important legume crops in South and Southeast Asia, but is also known and grown in Africa and the Americas on a still relatively small scale. It is a good source of dietary protein with high contents of folate and iron compared with many other legume crops. As it is a short duration legume, it fits well into the fallow period between rice-rice, rice-wheat, rice-potato-wheat, maize-wheat, cotton, and other cash crop cropping systems in use across the Indo-Gangetic plain. Broadening the genetic base by selecting parents from diverse cultivated and interspecific backgrounds is of great importance to achieve productivity gains (Nair *et al*., 2012).

3.5.9 Lotus (*Nelumbo nucifera* L.)

Lotus seeds (Figure 7) have a high nutritional value, although different culture environments and varieties can yield distinct contents of each nutrient. Lotus seed is not only rich in proteins, carbohydrates, and fats, but also contains particularly large amounts of trace elements, including calcium, phosphorus, iron, vitamin VB, VC, and VE (Wu *et al*., 2005). In addition, lotus seed core is rich in alkaloids such as non-crystalline alkaloid N-9, liensinine, and isoliensinine, as well as biologically active ingredients, including rutin, hypericum

glycosides, and flavonoids, among others. Lotus seed germination is an important method to improve its nutritional quality. After germination, crude protein and fat levels in the endosperm significantly increase; ash and moisture contents show no significant change; the contents of other ingredients besides phytic acid significantly increase; total phenol, tannin and catecholamine amounts decrease significantly.

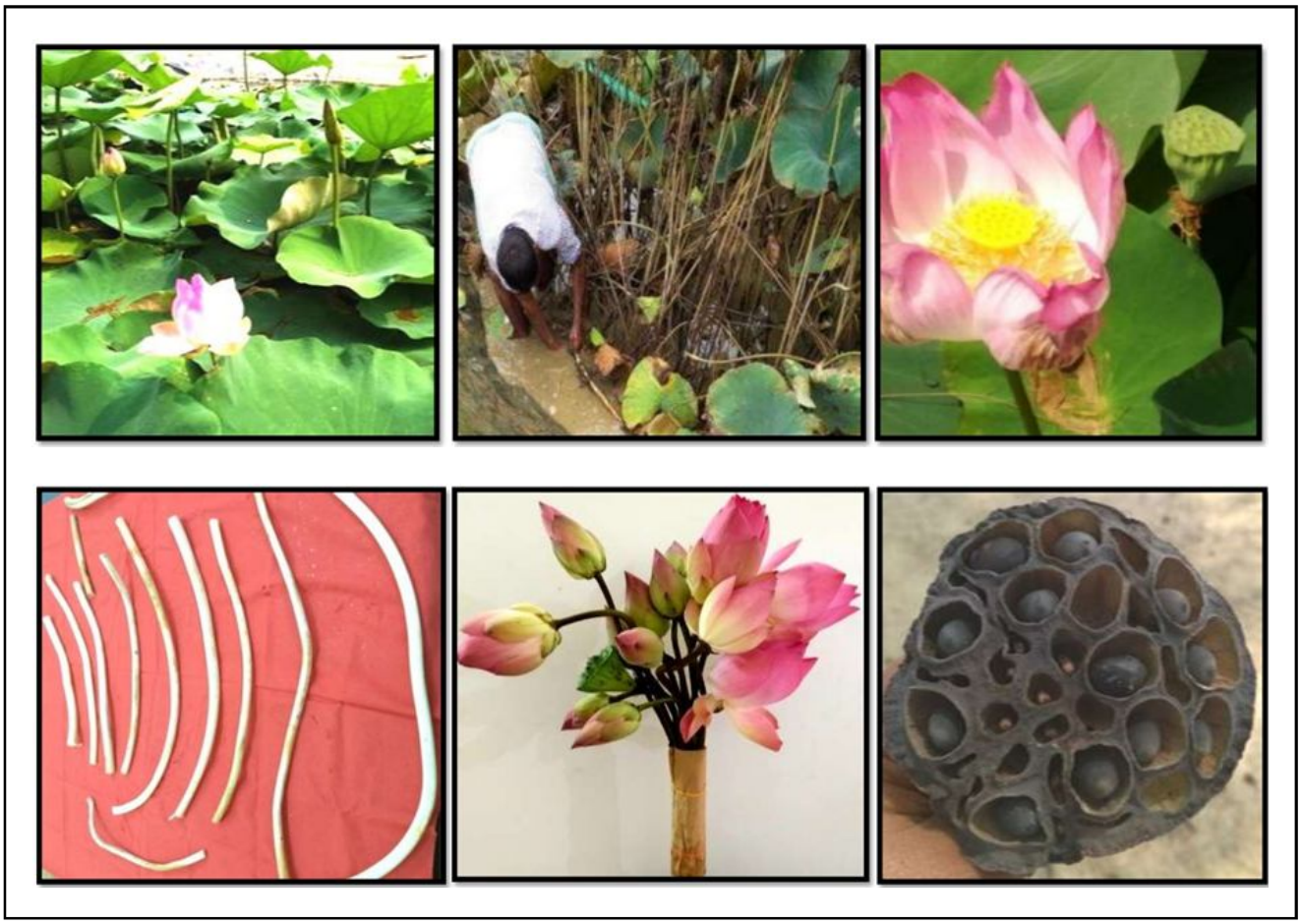

Figure 7: Lotus.

3.5.10 Tree bean (*Parkia roxburghii* G.)

Among the numerous less familiar foods used by the local communities in Northeast India, is a tree legume, commonly known as tree beans (*P. roxburghii*) and various vernacular names by the local communities in the region. Of the several plants grown, *P. roxburghii* is considered nutritious. Protein content of the pod ranged from 12.1% in tender to 18.8% in mature pods. Like any other grain legumes, protein content of the kernels (28.8%) was much higher than the pods. Though, the fat content of *P. roxbrughii* kernel was lower than oilseeds such as groundnut (42%). It was higher than other grain legumes such as cluster bean or soybean (20%). Maturity of the pods led to an increase in protein and fat content accompanied by a decrease in the ash as well as carbohydrate content. Globulin to albumin ratio was very less (1.6), thereby indicating higher amounts of albumins (8.14%) to compare with the globulins (13.05%). Higher amounts of albumins indicate more protein digestibility and higher content of sulphur containing amino acids which means more nutritive values as these are the limiting amino acids in legumes (Singha *et al.*, 2021).

3.5.11 Sweet gourd (*Momordica cochinchinensis* L.)

The fruit of sweet gourd has blunt thorns all over the skin. Its male and female plants are separate. Fruits are rich in protein, vitamin C and vitamin A. Fruits and leaves are having medicinal properties to cure ulceration, lumbago and fracture of bone. Roots are rich in saponin and bessisterol which may be used in pharmaceutical industries. Seeds are used to treat swelling, ulcer and abscesses.

3.5.12 Folic acid content of underutilized vegetables

Underutilized vegetables (Table 4) are rich source of folic acid, which is commonly referred to as folate. Folic acid is involved in the multiplication and maturation of cells, and its deficiency results in certain types of anemia especially in infants and in pregnant women. Recent researchers have associated it with the reduced risk of cardiovascular disease. Earlier studies revealed that diets with higher folic acid reduced the risk of colon cancer. Folic acid is crucial in foetal development in the early weeks of pregnancy, hence, nutritionists recommend that woman of child bearing age should consume the recommended amount (400 µg/day) of folic acid by taking a healthy balanced diet that includes vegetables.

Table 4: Folic acid content in some of underutilized vegetables (µg per 100 g edible portion) (Source: Pandey *et al.*, 2014 with modifications)

Underutilized vegetables	Folic acid (µg per 100 g)
Amaranth	149.00
Cluster bean	144.00
Ivy gourd	55.00
Colocasia	94.00
Curry leaf	93.00
Mint	114.00
Yam	17.50
Snake gourd	15.50
Spinach	123.00

3.5.13 Water spinach (*Ipomea aquatic* Forsk)

I. aquatica is commonly called Water spinach. It is grown commercially and one of the popular green leafy vegetables (Prasad *et a*l., 2008). All parts of the young plant are edible, but the shoot tips and younger leaves are comparatively used more. Stems take relatively more time than leaves to cook. Ipomea aquatic has been seen to be a good source of plant fibers, vitamins. It has natural antioxidants and can be used as a food supplement or pharmaceutical and medical industries. Drying is the most ancient method of preserving foods. Even today, hundreds of variants are being used to dry particulate solids, pastes, continuous sheets, slurries, or solutions; thus, drying provides the most diversity among food process engineering unit operations (Patil *et al*., 2014). Drying means the ‘‘removal of water’’ and is considered the most common and economical preservation method for many fruits and vegetables in many countries. Despite there being so many drying methods, which are traditional and primitive, there is a constant need to apply advanced techniques in drying with the objectives of increasing productivity and obtaining closer control of the process to achieve a product quality.

Table 5: Health benefits of underutilized and under exploited vegetables

Crop	Compound
Asparagus	Asparagine
Basella	Saponin
Broccoli	Sulphoraphane
Brussels sprout	Sulphoraphane
Elephant foot yam	Omega-3 fatty acids
Horse radish	Glucosinolates
Pigeon pea	Lycine, cystine and arginine
Spine gourd	Methanol
Ivy gourd	Glucose-6-phosphatase
Leek	Diallyl disulfide, diallyl trisulfide, allyl propyl disulfide
Jerusalem artichoke	Levulose
Globe artichoke	Polyphenols

3.5.14 Health benefits of underutilized and under exploited vegetables

Majority of under exploited vegetable crops (Table 5) are rich sources of compounds that help in increasing immunity or curing ailments. Many compounds are well appreciated in foods or pharma sector.

4. Conclusion

Under exploited vegetable crops are hardy, adapted to specific marginal soil and climatic conditions and can be grown with minimal external inputs. These underutilized vegetables embedded with rich nutrient potentials along with ability to stand against adverse climatic conditions. They are important to fight with malnutrition. Underutilized vegetables boon to all concerns growers, consumers and environmentalists, provided that they are domesticated properly. There is great potential for a number of currently underutilized crops to play a major role in a more diversified and sustainable food production system. However, there must be greater investment in long term research and breeding programs and improved seed supply sources for these crops to ensure they can be competitive in the marketplace. Research and breeding of underutilized fruit and vegetable crops are clearly underfunded compared with the few main staple crops.

Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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