



Nutritional Content of Underutilized Vegetable Crops: A Source for Nutritional Security and Human Health

Kumaresan Marappan ^{a*}, Vijai Ananth Arumugam ^b,
Anbarasu Mariyappillai ^a and Murali Subramani ^a

^a School of Agriculture, Vels Institute of Science, Technology and Advanced Studies,
Pallavaram, 600117, Chennai, Tamil Nadu, India.

^b School of Agricultural Sciences, Dhanalakshmi Srinivasan University, Samayapuram - 621112,
Trichy, Tamil Nadu, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Vegetables are essential to a balanced diet and are the primary force behind the achievement of global nutritional security due to their presence of nutrients, vitamins, and minerals. Vegetable crops classified as underused are those that are neither widely traded nor farmed on a commercial basis. Underutilized crop species have the potential to boost the country's economy but have not received enough attention because of a decline in focus on their production, consumption, and utilization. An examination of the literature found that most underutilized crop species are nutritious, and some even have medicinal properties. Vegetables that are underutilized may be significant locally or regionally, but they are typically not valued or approved nationally. The plant species that are traditionally used for food, fiber, fodder, oil, or medicinal purposes are the underutilized vegetable crops. Nonetheless, such species have untapped potential to provide environmental benefits,

*Corresponding author: E-mail: kummutnau@gmail.com;

economic production, nutrition, health, and food security. Using underused crops improves rural populations' health and contributes to the fight against malnutrition-related problems. Unused vegetables are a rich source of energy, fats, proteins, carbohydrates, and vitamins and minerals. These nutrients can help prevent and treat a number of illnesses, including hypertension, cancer, kwashiorkor, marasmus, night blindness, anemia, diabetes, and hidden hunger. Important underutilized vegetable crops include kale, broad beans, asparagus, amaranthus, basella, moringa, ivy gourds, globe artichokes, and others. India's soil and climate are ideal for growing a variety of underutilised vegetables. As a result, the Indian government has started to promote the underutilized vegetables. In conclusion, underutilized vegetable production can help address the shortage of per capita consumption availability and address nutritional issues while creating jobs and raising rural residents' incomes, all of which have the potential to boost the national economy.

Keywords: Underutilized vegetables; nutrition; human diet; production; national economy.

1. INTRODUCTION

As a vital source of vitamins, minerals, and other critical nutrients, vegetables are an integral part of a human diet [1]. Acknowledging their importance supports international initiatives to guarantee nutritional security in addition to addressing nutritional inadequacies. Stressing the importance of vegetables becomes apparent as India negotiates the complex web of food production, distribution, and consumption. This is a necessary first step in creating a population that is healthier and better fed. Vegetables are an important component of agricultural production in India, making up a large amount of the total output. According to the most recent data, the total agricultural production is made up of 58.73% vegetables. With 9.39 million hectares of land yielding 162.89 million tons of vegetables, the nation has accomplished remarkable results [2].

Technological developments including enhanced variety development, high-bridge production techniques, and protection technologies are responsible for the impressive increase in vegetable production. In order to reach these milestones, systematic research initiatives and broad acceptance by farmers have been crucial. Nonetheless, it's notable that a smaller quantity of important vegetable crops accounts for the majority of this notable production. It seems that underutilized vegetables are not given enough attention, even though India has a varied range of agroclimatic conditions that allow for the growth of over 60 well-known and over 30 lesser-known vegetable crops [3]. Focusing on the production and marketing of these underappreciated vegetables presents a chance to fully use India's agricultural diversity while guaranteeing a more all-encompassing and

sustainable strategy for meeting dietary needs. This change might help create a more robust and diverse agricultural environment in the nation.

Underutilized crops are plant species that have unrealized potential and might make a big difference in areas including environmental services, revenue production, health, and food security. Compared to other refined vegetables with medicinal potential, these vegetables have a higher nutritional profile. There are many underutilized vegetables because of the great variety of crops that thrive in the Himalayan and sub-Himalayan regions of India, including species of Brassicaceae, Cucurbitaceae, and Solanaceae, as well as many types of roots, beans, spices, tubers, and leafy crops [4]. Underutilized vegetables are those that are farmed primarily for personal use rather than on a huge commercial scale and are not frequently traded. These crops might feature special nutritional profiles, climate-adaptive traits, or other advantageous traits that haven't been thoroughly investigated or identified. The promotion of agricultural sustainability and nutritional variety can result in a more robust and diverse food system through the cultivation and consumption of underutilized vegetables. Underutilized vegetables contribute to the well-being of many tribal people and are a valuable natural resource in agriculturally deficient areas [3]. One effective way to help achieve micronutrient deficiency with a varied and nutritious diet is to focus on underappreciated vegetables. Native leafy greens are low-cost, high-quality food options for the underprivileged population, particularly in areas where hunger is a widespread problem, such as in several developing nations. Ascorbic acid, riboflavin, folic acid, carotene, and minerals including calcium,

iron, and phosphorus are all abundant in leafy plants [5].

2. MALNUTRITION ISSUES

Malnutrition has a negative impact on children's capacity to learn and develop into adults since it not only affects their physical look and energy levels but also has a direct impact on many elements of their mental development and functioning [6]. According to Oguntibeju *et al.* [7], malnutrition also lowers immunity against illness and makes people more vulnerable to infections and illnesses. A balanced diet that lowers the risk factor for chronic diseases including cancer, heart disorders, and strokes requires a sufficient intake of vegetables.

3. USES OF UNDERUTILIZED VEGETABLES

Underutilized vegetables are vital biological resources for the impoverished in rural areas and have the potential to improve the health of millions of people living in tribal communities. When compared to other commercially accessible species and variations, underutilized vegetables have more antioxidant activity and are richer in vitamins, minerals, and other health-promoting elements. They are mostly responsible for the diet's diversity, which produces a better-balanced supply of micronutrients. Moreover, underused vegetables can be effectively employed in a plant breeding program due to their strong tolerance to a variety of biotic and abiotic stresses [8]. Underutilized vegetables have a significant impact on rural residents' lives. They have the ability to end poverty by creating jobs and revenue, as well as by increasing the productivity and profitability of farm household labor use in both rural and urban areas. Reducing the risk of over-reliance on a very small number of important crops can be achieved by using underutilized vegetable crops. Furthermore, by increasing the variety of foods that are edible, they can support sustainable livelihoods through household food security. Additionally, they can offer a wide variety of crops to satisfy changing market demands and boost productivity as well as global food security.

4. THE VALUE OF UNDERUTILIZED VEGETABLES

Vegetable crops that are underutilized are very important for several reasons. To begin with, they play a major role in combating malnutrition by

providing an abundant supply of vital vitamins, minerals, and antioxidants. Their high nutritional density encourages greater health by supporting a diet that is more varied and balanced. These crops are essential to rural communities' economic well-being. Many families receive financial support from the production and sale of vegetables that are underutilized, which helps to reduce poverty and improves livelihoods. Furthermore, these crops are robust and sustainable choices for the development of varieties and hybrids due to their tolerance to biotic and abiotic stresses. This resilience can support food security by lessening the effects of environmental problems. Furthermore, underutilized vegetable crops have traditional and cultural value and are used for food, medicine, and other uses. Thus, encouraging and preserving the growth of these crops can support the preservation of traditional knowledge and biodiversity in the area.

Nutritional security: Vegetables that are neglected and underutilized but rich in nutrients are essential for low-input agriculture and food security. The wellbeing of underprivileged groups may suffer direct and detrimental consequences from the degradation of these species, making their preservation essential. Certain underappreciated veggies are higher in vital nutrients like pro-vitamin A and vitamin C than commercial varieties that are commonly available. Making these veggies a priority is a useful strategy for improving nutrition and preventing micronutrient deficiencies. It also addresses "Hidden Hunger," which is a problem that is particularly common among the impoverished and vulnerable social groups in rural areas of developing nations. Put simply, emphasizing neglected and underutilized vegetables not only supports dietary diversity but also makes a substantial positive impact on the general health and food security of populations confronting economic hardships.

Ecosystem stability: As a result of climate change and the depletion of land and water resources, there is an increasing demand for plants and animals that can survive in harsh conditions, such as those found on desert edges, areas with low soil, withered vegetation, or experience drought.

Cultural biodiversity: The use of plants is deeply ingrained in local customs and behaviors,

and is rooted in culture. Vegetables that are overlooked and underutilized contribute significantly to the preservation and enhancement of cultural diversity in relation to dietary customs, medical procedures, religious ceremonies, and interpersonal interactions. When these vegetables are used in customary meals or rituals, they frequently have special significance or values for a group. They add to the distinctive character of regional cuisines and are occasionally linked to symbolic or therapeutic meanings, which heightens their cultural relevance. Acknowledging and encouraging the use of these plants presents a chance to maintain and celebrate the cultural heritage ingrained in the links between communities and the plants they grow and eat, in addition to improving nutritional diversity.

Improvement in employment opportunities:

Compared to staple crops like cereals or some fruits, horticultural crops, such as vegetables, usually require more care and labor during the course of their cultivation. Their rigorous care needs, ranging from clearing the ground to harvesting, frequently call for a larger labour input, making cultivation more labour-intensive. The unemployed population can greatly benefit from this employment potential by having more opportunities to make money, which will help to reduce poverty in the nation.

Agroecological vegetable farming:

Underutilized vegetables do have a competitive advantage, particularly when there is a shortage of arable land, a labour pool that is large, and markets are close by. The average revenue of farmers who grow these veggies is typically higher than that of farmers who grow many crops. Research has indicated notable discrepancies in earnings between smallholder farmers who cultivate vegetables for sale and those who do not. In fact, farmers who cultivate vegetables for export can make up to five times more money. Increased trade and marketing activities are fostered by the integration of vegetable growers into marketplaces, which plays a vital role in the commercialization of the rural economy. In addition to giving the participating farmers more options for increased revenue, this integration can improve the economic viability of these regions. Commercialization is essential to the recovery of rural economies since it increases production per unit area and creates jobs. The need to feed

expanding cities is more urgent as urbanization keeps increasing. To address the food needs of these growing urban populations, this situation requires a shift in concentration toward urban and peri-urban agriculture production. In addition to meeting the need for food, urban and peri-urban agriculture generates jobs and stimulates the local economy in and around cities.

Production of Derived Products and By-Products:

The agriculture industry has enormous potential for generating revenue, especially through value addition. Processing vegetables to make pulps, pickles, jams, and jellies increases their value and opens doors to reducing poverty. Furthermore, producers can reduce losses by processing vegetables for foreign exchange profits and diversifying by-products like starch, chips, or crisps from extra supply. Furthermore, the climate is conducive to producing neglected vegetables used in perfumery, including medicinal crops or flowering plants, which opens up opportunities for the perfumery business globally. Governments can have a significant impact by encouraging youth unemployment and growers to work in the processing sector, which will provide value to the agricultural sector and create jobs. Such actions not only help farmers but also greatly boost employment and economic growth.

5. BENEFITS OF UNDERUTILIZED VEGETABLES FOR NUTRITION

Underutilized Vegetables have good levels of fat, protein, and carbohydrates. The amount of carbohydrates varies from 3.13 g/100 g (*Ipomoea aquatica*) to 57.24 g/100 g in *Macrotyloma uniflorum*. The protein content of *Parkia speciosa* is 27.5 g/100 g, while that of *Momordica charantia* is 0.84 g/100 g. *Vigna angularis* have fat contents ranging from 0.1 g/100 g to 13.3% in smelly beans. Underutilized vegetables and legumes have varying energy values: 346 kcal/100 g for *Vigna umbellate* and 19 kcal/100 g for (*Convolvulus aquatica*). Also, Minerals like iron, magnesium, phosphorus, potassium, salt, zinc, copper, manganese, and selenium are also abundant in underused vegetables [9]. The amount of calcium in a 100 g sample of rice beans ranges from 290 mg/100 g in bitter gourds. In bitter gourds, the magnesium content varies from 16 mg/100 g to 230 mg/100 g in rice beans. Potassium values in rice beans range from 1400 mg/100 g in rice beans to 208 mg/100 g in roselles (*Hibiscus sabdariffa*). As a

result, Underutilized Vegetables can also be helpful in supplying mineral nutrients. The human body depends heavily on mineral elements for growth and development. For example, calcium ions are essential for bone formation and are involved in the regulation of blood clotting, enzyme activity, muscle contraction, and nerve function. Osteoporosis and rachitis result from a calcium deficiency. An essential component of blood, iron is involved in both oxidation and reduction processes. A low iron level causes anemia. An element called phosphorus is required for the development of teeth and bones.

Eating underutilized legumes and veggies will provide humans with adequate mineral nutrition [10].

Vitamins are important dietary components that the body needs for a variety of vital processes. Vitamin C, or ascorbic acid, is necessary for the creation of collagen, which is a crucial component of the skin, gums, and bones. Underutilized vegetables are high in vitamin C because ascorbic acid concentrations are 12 mg/100 in roselle and 55 mg/100 g in water convolvulus [11].

Table 1. Major nutritional content of important underutilized vegetable crops

S. No.	Common name	Nutritional content	References
1.	Agathi (<i>Sesbania grandiflora</i>)	Due to their great nutritional value -which includes substantial levels of vitamin A and minerals. Protein (8.25%), carbohydrates (6.30%), ash (3.15%), fiber (2.90%) and vitamin A (89 µg RE).	Chandralekha et al.,[12]
2.	Ponnanganni Greens/Gudrisag (<i>Alternanthera sessilis</i>)	Ritch in fiber, vitamin C, riboflavin, niacin, protein, carbs, fat, and carotene. Energy (65.4 Cal), Protein (4.0 g), Fat (0.012g), Carbohydrate (0.290g), Dietary fiber (0.356 g), Ash (0.51g), Moisture (6.16 %), Iron (5.0 mg), Calcium (379mg) and Vitamin A (50mg).	Karolin, 2019 and Vijaya Vahini and Sharmila, 2023
3.	Common Purslane (<i>Portulaca oleracea</i>)	It is abundant in vital fatty acids, vitamin C, folic acid, and β carotene. Energy (16 Kcal), Carbohydrates (3.4 g), Protein (1.30 g), Total Fat (0.1 g), Potassium (494 mg), Calcium (65 mg), Iron (1.99 mg), Magnesium (68 mg), Phosphorus (44 mg) and Zinc (0.17 mg). Vitamins: Vitamin A (1320 IU) and Vitamin C (21 mg)	Kamal et al., 2014
4.	Water leaf (<i>Talinum triangulare</i>)	It contains carotenoids such as Lutein and Zeaxanthin also contain vitamins K, C, and A, as well as minerals. Fiber (16.43 %), Fat (2.23 %), Protein (11.88 %), Ash (13.29 %) and Carbohydrate (45.80 %)	Tiamiyu and Oluwafemi, [13]
5.	Water spinach (<i>Ipomoea aquatica</i>)	The plants contain fibre, carbohydrate and minerals (particularly K, Fe, Mg and Mn). Protein (2.90%), ash (1.13%), fiber (1.48%), fat (0.16%), carbohydrates (3.70%) and energy value of 30 kcal/100g. Elements including K (1.364%), Ca (0.233%), Fe (0.012%), Mn (0.004%), Zn (0.001%) and Mg (0.123%).	Umar et al., 2007 and War War Nyein, [14]
6.	Chekurmanis (<i>Sauropus androgynus</i>)	Multivitamin green, it is high in rich source of β-carotene, vitamin E, vitamin C, thiamine, riboflavin, calcium, iron, zinc and protein. Protein (22.0 g), fibre content (34 g), iron (4.50 mg), zinc (1.48 mg), niacin (69 mg), β-carotene (9250	Sheela et al., 2004 and Kalpana and Krishnapura, [15]

S. No.	Common name	Nutritional content	References
		µg/100 g) and vitamin E (15.6 mg)	
7.	Aerial yam or Air potato (<i>Dioscorea bulbifera</i>)	Moisture (26.84%), ash (7.28g), lipids (0.2032g), crude fiber (2.7942), protein (1.0 mg) and total carbohydrates (0.8721g).	Ruby, 2021
8.	Globe Artichoke (<i>Cynara scolymus</i>)	Moisture (79.60 %) Dietary fiber (6.01g) Ash (0.96g) Proteins (3.08g) Lipids (0.18g) Carbohydrates (10.17 %) and Vitamin C (13.70 mg)	Roberta et al., [16]
9.	Adzuki bean (<i>Vigna angularis</i>)	Moisture (13.3 g), ash (4.2 g), protein (23.9 g), starch (43.9 g) and total soluble sugar (8.2 g)	Deepika et al., [17]
10.	Ivy gourd (<i>Coccinia grandis</i>)	Energy (21 K.Cal), Protein (1.4g), Carbohydrate (3.4g), Fat (0.2g), Calcium (25mg) and Iron (0.9mg)	Neetu et al., [18]
11.	Bok choy (<i>Brassica rapa</i>)	Potassium (2,199 mg), Ca (289 mg), Mg (146 mg), Na (111 mg), and vitamin C (316 mg)	Pokluda, [19]
12.	Kakrol (<i>Momordica dioica</i>)	Potassium content (4.63), sodium content (1.62), calcium content (7.37), iron content (5.04), and zinc content (3.83) [14]. Carbohydrate (7.7 g), protein (3.1 g) and fat (3.1 g)	Aberoumand, [20]
13.	Sword bean or Jack Bean (<i>Canavalia gladiata</i>)	Protein (28.39%), lipid (7.84%), fiber (8.23%), ash (5.63%) and carbohydrates (49.91%)	Vadivel et al., [21]
14.	Velvet bean (<i>Mucuna pruriens</i>)	Crude protein (28.82 mg), Potassium (1,628.36 mg), Phosphorus (456.35mg), Calcium (689.45 mg), Iron (14.74 mg) and Magnesium (341.44 mg).	Chinju et al., [22]
15.	Tree Bean (<i>Parkia roxburghii</i>)	Calcium (97.47 mg), Potassium (2400 mg), Copper (2.3 mg) and Zink (2.77 mg)	Chatterjee et al., [23],[24-28]



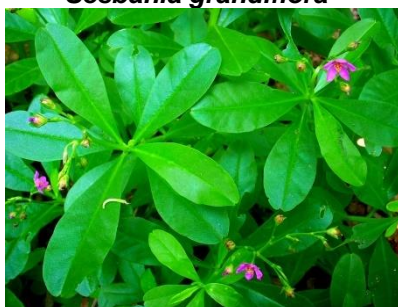
Sesbania grandiflora



Alternanthera sessilis



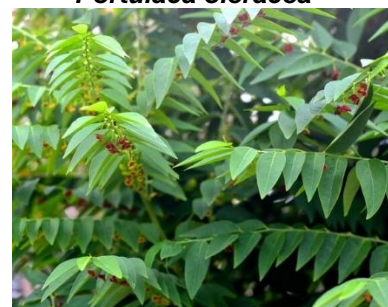
Portulaca oleracea



Talinum triangulare



Ipomoea aquatica



Sauropus androgynus

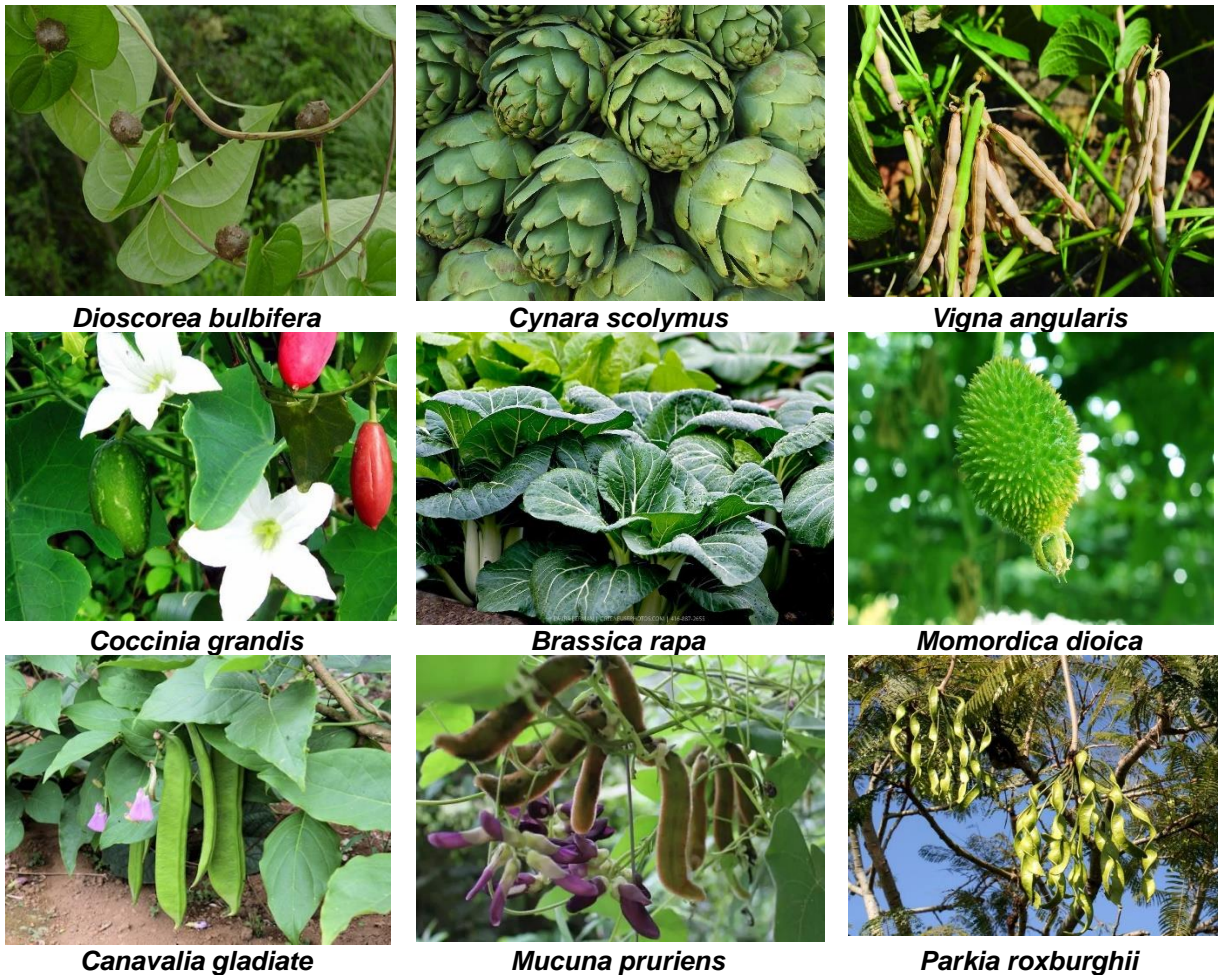


Plate 1. Important underutilized vegetable crops

6. CONCLUSION

Underutilized vegetables have a lot of unrealized wealth potential. They are resilient to harsh weather and rich in nutrients, so they can benefit growers, consumers, and the environment. It is imperative to address issues including a shortage of planting materials, knowledge of the plant's nutritional and therapeutic value, and information on cultivation methods in order to fully realize these benefits. In order to secure future food and nutritional security, initiatives centered on the investigation, management, and enhancement of underutilized vegetable crops are desperately needed. Government initiatives and development projects run by non-governmental organizations are crucial in advancing the cultivation of many underutilized vegetables in India, where the land and climate are favorable for their production.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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