

Rural Fields to Urban Plates: A Case Study on the Nutrient-Rich Wild Spinach (*Celosia argentea*)

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Abstract

The wild food plants (WFPs) have been served as vital sources of food, nutrition, medicine and livelihood for rural India. In spite of the India's rich plant diversity, rapid urbanization, dietary change and increasing dependence on processed foods have contributed to declining dietary diversity, rising malnutrition and other health disorders. The study examines the significance of WFPs on daily diet, nutritional and socio-cultural practices of indigenous communities such as Soliga tribe inhabiting villages in and around MM Hills wildlife sanctuary, Karnataka. Ecological surveys, field observations, semi-structured interviews, and market assessments conducted in selected urban markets of Bengaluru documented the diversity, consumption practices, and economic value of WFPs.

The study recorded nearly 130 WFPs species that contribute significantly to household food and nutritional security and emergency famine foods for Soliga community. Indigenous knowledge associated with these species also represents an important component of socio-cultural identity and sustainable resource management. A case study on wild spinach (*Celosia argentea*) demonstrates the dual role of WFPs as both agricultural weeds and valuable nutritional resources. Although farmers incur considerable costs in controlling its spread, the species is highly nutritious, drought tolerant, easy to cultivate as garden and urban agriculture plant. More than 35 WFP species were also documented in urban markets, indicating growing consumer interest and commercialization potential.

The findings highlight the importance of integrating indigenous knowledge with biodiversity conservation, sustainable agriculture, urban farming initiatives, value-chain development, and supportive public policies. Promoting awareness, research, entrepreneurship, and inclusion of WFPs in education and food policies will facilitate their mainstream adoption, contributing to the Sustainable Development Goals, particularly Zero Hunger, Good Health and Well-being, Climate Action, and sustainable livelihoods.

Keywords: Wild Food Plants (WFPs); *Celosia argentea*; Wild Spinach; Climate Action

Background

Indigenous communities of the blue zones have much longer life expectancy than the average population over the globe. The Blue Zones include the island of Okinawa Karia, Sardinia and the peninsula of Nicoya. The people in these regions live long (more than 90 years) and experience lower rates of cancer, heart disease, and other non-communicable diseases associated with age and lifestyle factors. The reasons for increased life expectancy includes relatively low-stress lifestyles, plant-based diets, etc. The studies also revealed that unprocessed food that comes from nature is a major step in this direction.

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The concept of “Food medicine” said by Hippocrates nearly 2500 years ago has existed since ancient times. Since man has lived in close relationship with his environment for thousands of years, learning how to recognise, gather and use the products of the earth not only as food but also for medicinal purposes. The long history of human’s ability to adapt to natural environments and hunter-gatherer practices across different adaptation stages, plants have great importance in human societies. All over the world human have still depended on many wild species particularly for food and medicines [7,8]. The scarcity, high cost, and unreliable supply of healthy food in developing countries have resulted in the search for cheap and alternative sources of healthy and nutritious food.

WFPs grow naturally in forests, farmlands, deserts, roadsides, and near water bodies and streams without human care and are used as a food source by local people [3]. Wild edible plants (WFPs) are one of the alternative sources of healthy and nutritious food, and they are crucially important in supporting the global food basket. According to the World Health Organization, 80% of the world’s people depend on traditional medicine for their primary healthcare needs [7]. The WFPs are consumed daily in some form by at least one in seven people worldwide [2]. Sametime, food and nutrition security is a major challenge that our world is facing nowadays. Approximately two billion people are estimated to suffer from micronutrient deficiencies that make them more susceptible to disease, especially in rural and urban places of developing countries. The issue of food security is severe, especially in largely import-dependent countries of sub-Saharan Africa and WFPs are the essential components of many African diets even today, especially in periods of seasonal food shortage.

According to Millennium Ecosystem Assessment (2005)	Components of human well-being	Number of plant species collected	Percentage of households use
“Basic material for a good life”	Food	96	94
	Income	14	68
“Good health”	Medicinal use	118	79
“Freedom of choice and action”	Cultural reasons	26	92
	Spiritual reasons	14	99
“Good social relations with other”	Social implications	18	89

Table 1: Purpose of the collection of wild plants and consumption.

Since, India has a rich vegetation with a wide variety of plants, because of the extreme variations in geographical and climatic conditions prevailing in the country. In India 75% of the population is living in the rural areas depend on the wild resources including wild edible plants to meet their food and medicine needs. It is estimated that in India about 800 species are consumed as food plants in rural areas. Moreover, WFPs have played a very important role in human life since ancient time; they have been used for food, medicines, fibre and other purposes and also as fodder for domestic animals [3]. In search of wild edible food plants many of which are potentially valuable for human beings have been identified to maintain a balance between population growth and agricultural productivity.

As India experiencing rapid economic transitions with significant regional and socio-economic diversity. Moreover, traditional diets remain largely replaced with carbohydrate-based due to urbanization. It led to increased consumption of refined grains, fats, sugars, and processed foods, contributing to rising health risks such as obesity, diabetes, and cardiovascular diseases. In contrast, rural and indigenous communities continue to depend on locally available food resources, including cereals, millets, and WFPs, which remain integral to their food systems, nutrition, health, and livelihoods.

Of nearly 170 million people living in and around forests in India, more than half of them are tribal and depend on non-timber forest products (NTFPs) which are very important contributors to the well-being or livelihood of villagers. This knowledge is passed through

Conservation status	Total (%)
Common	25.5
Data deficient	22
Least concern	13.4
Not evaluated	12.6
Rare	8
Vulnerable	6
Locally vulnerable	3
Near Threatened	3
Locally Endangered	2.5
Endangered	2
Critically Endangered	2

Table 2: Distribution of WFPs into different conservation status based on IUCN Red Data Book.

Therefore, the present study aims at understanding the utilization and dependency pattern of WFPs amongst the various indigenous communities of India. The paper provides insights into the regional patterns of WFP distribution and consumption among rural and urban people in India.

A case study in MM Hills wildlife sanctuary

This long-term study intended examines patterns of utilization, dependency nutritional importance of wild food plants among indigenous communities in India. Mainly on their regional distribution, consumption practices, and potential role in enhancing nutrition, cultural preservation, and sustainable development. The study used ecological and socioeconomic research methods for data collection and documentation in 10 villages located in and around MM Hills wildlife sanctuary. Semi structured interviews were carried out in urban communities and vendors in five local market places in Bangalore metropolitan city.

The study revealed that WFPs are native species that grow naturally and seasonally without cultivation and form a vital component of indigenous diets across India. Nearly 130 wild plant species are consumed as food, providing essential micronutrients, medicinal benefits, livestock fodder and famine foods. Also, indigenous people perceived that WFPs are the vital sources of supplementary income representing cultural identity, traditional ecological knowledge, and sustainable resource-use practices transmitted across generations.

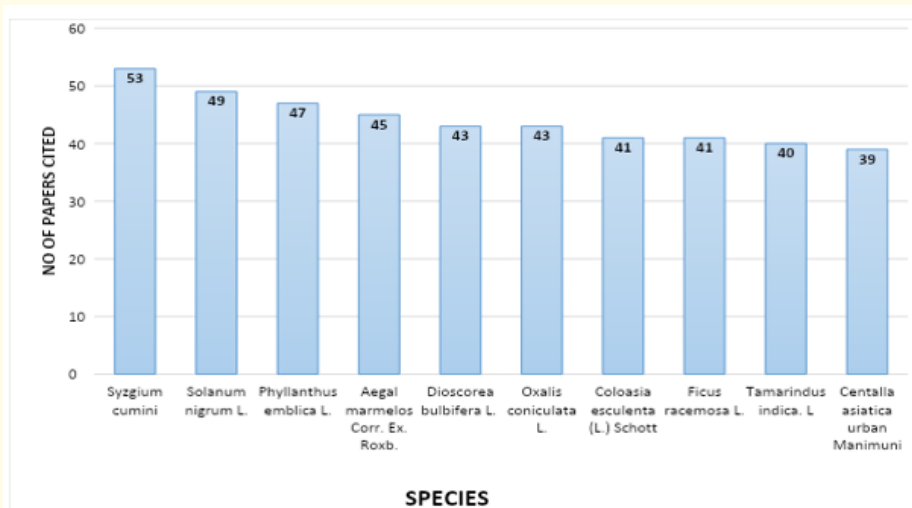


Figure 2: Top ten WFP species frequently cited.

The findings emphasize the potential of reviving and mainstreaming wild food plants to improve nutritional security, conserve biodiversity, and strengthen resilient food systems. Integrating indigenous knowledge with urban farming initiatives (kitchen garden, terrace garden etc.), value-chain development, and supportive policies can reposition WFPs as sustainable alternatives within both rural and urban diets, contributing to inclusive and climate-resilient food futures. More importantly, sustainable source for addressing malnutrition and conserve indigenous knowledge system by practicing in day today life.

A case study: *Celosia argentea* (wild spinach)

Wild spinach is an annual herb belonging to the Amaranthaceae family and grows wild in terrestrial habitats such as farmland, where it is considered as weed and in fallow land, from where it is collected to be used as fodder. It is commonly known as ‘Silver cocks comb’ and ‘Lagos spinach’.

The plant is short and bears simple and spirally arranged leaves around the stem, pinkish or silky white flowers, and black seeds. It has an enormous reproductive capacity-the seeds are produced in large numbers and these can stay dormant in soil for long. Its native range is Tropical Africa but it grows across the globe where indigenous communities use it as a wild vegetable and also as medicine.

Wild spinach as a case study, the research highlights the dual identity of WFPs as both agricultural weeds and valuable food resources. It is a common aggressive weed in farmlands of arid tropical landscapes of the country. Control of the growth of wild spinach in farmland is very challenging and incurs an economic loss. On average, farmers belonging to Soliga tribe spend around Rs.2000 per acre per year to control wild spinach in cropland.

Same time, wild spinach is widely consumed by the Soliga community of the MM Hills in Karnataka for its nutritional, medicinal, and cultural importance. Rich in beta-carotene and folic acid, low in anti-nutrients compared to spinach, and possessing documented pharmacological properties, wild spinach is easy to cultivate, drought-tolerant, and suitable for repeated harvests.



Figure 3: *Celosia argentea* (wild spinach) flower.



Figure 4: Tender leaves of *Celosia argentea* used as green vegetable.



Figure 5: *Celosia argentea* spread in farm land.

Soligas are historically and traditionally forest dwellers and were practicing shifting cultivation and later became settled in podu (villages) in Chamarajanagara district of Karnataka. They have rich traditional knowledge and cultural life linked to their natural surroundings [5]. They maintain a continuous and intimate interaction with the forest and derive most of their basic requirements from the forest till today.

It is not confined to Soliga in MM Hills, farmers in the states of south India and central India have been experiencing similar problems. At the same time, it is a common green for farmers across rural India and the knowledge of use as a vegetable has been documented across the country [2,6].

Nutrients such as beta-carotene and folic acids are high in leaves though vitamin E, Calcium, and iron are medium in leaves. Unlike spinach leaves (*Spinacia oleracea*), leaves of wild spinach have lower levels of oxalic acid (0.2%) and phytic acid (0.12%), and do not increase the risk of developing kidney stones. Compared to *Celosia argentea*, urban spinach also has a high concentration of vitamin K and Potassium which can cause harmful effects on those with reduced kidney function [4].

Antibacterial activity of wild spinach has been studied in the Hyderabad, Karnataka region and stem and root extracts have been found to provide protection against microbial pathogens [9]. The seed yields edible oil and it is generally used in eye disease like bloodshot eyes and cataracts [10].

It is also frequently used in traditional Chinese and Indian medicine for treating eye diseases and ulcers. Recent extensive studies on chemical constituent of *Celosia argentea* are also being isolated and characterized including saponins, peptides, phenol, fatty acid and amino acids. Modern pharmacological studies manifested that semen *Celosiae* possesses miscellaneous bioactivities such as hepato-protection, anti-tumor anti-diabetic anti-oxidant, etc [8].

In urban settings, it is suited to terrace gardens and it can be grown easily in small pots like a basil plant. Leaves and young shoots can be harvested repeatedly after every 20 days throughout the year. Wild spinach plant grows well in light (sandy), medium (loamy), and heavy (clay) soils, and prefers well-drained soil and heavy clay soil. It can grow in semi-shade (light woodland) or no shade. It prefers dry or moist soil and can tolerate drought. It is a good alternative to growing spinach which requires extra effort and resources. It requires a more regular structured supply chain and marketing strategies to promote as an alternative/substitute for spinach.

It is a new phenomenon that vegetable vendors sell the leaves in the urban market in small quantities in the rainy season based on customers' demand. It needs better marketing and technological intervention to harvest, process and preserve. It will be a win-win situation for farmers if they can earn money by harvesting and marketing this plant as a vegetable. In turn, it will benefit consumers who suffer from kidney stones and related health problems by having healthy fresh green that has less calcium oxalate compared to spinach.

WFPs are the potential source of micronutrients/nutrition

According to vegetable vendors and urban communities, more than 35 WFPs are sold and consumed in different seasons of the year. Majority of them greens (Wild spinach) and tubers (*Dioscorea*, *Hemidesmus*) and fruits (Wild egg plant, *Caressa*). These are the vital of micronutrients supplement and chief alternative nutrient supplement for urban communities in different seasons.

Despite global food systems producing sufficient quantities of food, malnutrition persists, underscoring the need for diversified, resilient, and sustainable diets. WFPs contribute significantly to dietary diversity, ecosystem services, and the three pillars of food security-availability, access, and utilization-while aligning with several Sustainable Development Goals, including Zero Hunger, Good Health and Well-being, Poverty Reduction, and Climate Action.

In cities, supermarkets are swamped with produce sourced from distant corners of the world, transforming shopping aisles into a year-round harvest spectacle. Our diets are calorie-rich and nutrient-poor, as a repercussion of ease of access, globalisation, industrialisation, and commercialisation of our food systems.

Despite sounding unfamiliar today, ‘Wild Food Plants’ that were part of our diets for centuries have recently gained attention due to their nutritional and health benefits. They are uncultivated greens and plants, which grow naturally in the wild and have been used for food and medicine. Even within the indigenous communities, the younger generation is quickly losing the traditional knowledge of these species in the forests and agriculture systems they inhabit, many turning to non-agriculture and quarries for their livelihoods.

The growing trend of urban agriculture, terrace gardening, and the increased interest in foraging have the scope to increase the availability of these products in urban areas. In line with the UN Sustainable Development Goals (SDGs), the development of the wild food plant sector in India has the potential to contribute to multiple SDGs, including SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), and SDG 13 (Climate Action). Wild food plants are a unique and underutilised resource that holds tremendous potential for sustainable innovation and entrepreneurship. With increasing consumer demand for wild food plants, the prospects for innovation and entrepreneurship in this sector are growing. It also stimulates the creation of new economic opportunities for small-scale producers and start-ups. It could potentially help with conservation of wild plant species, and the improvement of urban food security and nutritional security.

Creating awareness of Wild Food Plants through events and incorporating it in the school curriculum is necessary. These campaigns should target urban consumers, and other stakeholders, including farmers, policymakers, and entrepreneurs, to increase understanding of their benefits. This can include promoting the nutritional value of these plants, highlighting the cultural significance of traditional food practices, and encouraging their use in daily diets.

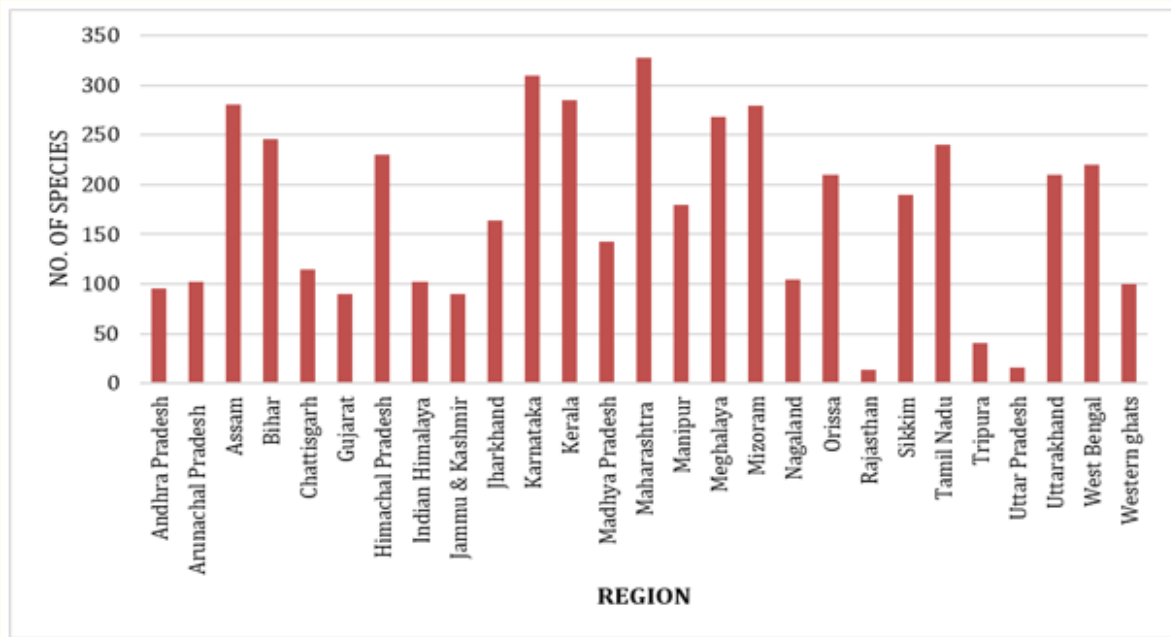


Figure 6: Top ten WFP species frequently utilised by various indigenous communities in India.

Way forward

India's ongoing dietary and economic transition reveals a growing divide between urban and rural food systems. While urbanization has increased dependence on refined, processed, and calorie-dense foods-contributing to obesity, diabetes, and cardiovascular diseases-rural and indigenous communities continue to rely on traditional diets enriched with cereals, millets, and WFPs. These contrasting trends highlight the paradox of persistent malnutrition despite overall food abundance.

WFPs play a vital role in ensuring food and nutritional security, health, livelihoods, and cultural continuity for indigenous and rural populations in India. With nearly 800 species used as food, WFPs contribute essential micronutrients, medicinal benefits, ecosystem services, and resilience during periods of food scarcity. They strengthen all three pillars of food security-availability, access, and utilization-while supporting biodiversity conservation and multiple Sustainable Development Goals, including Zero Hunger, Good Health and Well-being, Poverty Reduction, and Climate Action.

The case of wild spinach (*Celosia argentea*) illustrates the untapped potential of WFPs. Although considered an aggressive weed that causes economic losses to farmers, it is highly valued by the Soliga community for its nutritional, medicinal, and cultural importance. Its rich micronutrient profile, low anti-nutrient content compared to spinach, medicinal properties, and ease of cultivation make it a promising, climate-resilient alternative leafy vegetable for both rural and urban contexts.

Reviving and mainstreaming wild food plants like wild spinach can simultaneously address nutritional insecurity, biodiversity loss, and rural livelihood challenges. Integrating traditional knowledge with modern marketing, processing, urban farming initiatives, and supportive policy frameworks can transform WFPs from neglected weeds into valuable food resources. Promoting awareness through education, public campaigns, and institutional support will be crucial to preserving indigenous knowledge, improving public health, and building sustainable, inclusive, and resilient food systems in India.

Conclusion and Future Perspectives

Rapid urbanization and changing dietary practices coexist with persistent malnutrition and erosion of indigenous food knowledge and practices in India. As urban populations increasingly depend on processed high energy food that led to lifestyle-related diseases like obesity, in rural and indigenous communities continue to derive nutritional, cultural, and livelihood benefits from diet rich wild food plants (WFPs). These contrasting food practices emphasize the need for a balanced and sustainable approach towards food and nutritional security.

The WFPs signify as vital yet underutilized wild resource for addressing multiple challenges such as hidden hunger, rural poverty, climate change and biodiversity loss. For instance, wild spinach (*Celosia argentea*) proves that species often viewed as weeds can possess unique nutritional, medicinal and ecological value. Conserving, promoting and integrating such plants into mainstream food systems can diversify diets, boost resilience, and support sustainable livelihoods. Moreover, identifying the importance of wild food resources related knowledge and the practices and supporting policies that encourage the conservation and sustainable use. Intervention of processing, preservation and value addition of WFPs resources for urban market will be essential for addressing future food and nutritional security. By connecting wild food resources related knowledge and the practices with modern scientific research and innovation to urban market, India can alter neglected WFPs resources into valuable resources for enhancing public health, nutritional security and environmental sustainability.

The future of India's food system lies in integrating WFPs into modern agriculture, food, nutrition, and public health strategies. Enhancing research on nutritional composition, medicinal values, and climate resilience of WFPs will strengthen the wider acceptance and utilization. Promoting biotechnological, processing, preservation technological innovation and sustainable harvesting practices enhance

their commercial potential while conserving genetic diversity. Documenting indigenous knowledge system and practices, establishing community based WFPs enterprises, integrating into school midday meals and nutritional programs can significantly contribute future food and nutritional security of the country. The digital marketing platforms, urban terrace forming initiatives, awareness campaigns can further increase demand for nutritious WFPs among urban customers.

Conservation efforts should focus on protecting natural habitats and resources, empowering indigenous communities, nurturing collaborations among policymakers, farmers, indigenous communities, entrepreneurs and researchers. With continued efforts on research, education, sustainable value chains, WFPs such as *Celosia argentea* have the potential to become important components of resilient, climate-smart, future food and nutritional security in India.

Authors' Contributions

RPH and MM carried out the field study. RPH wrote draft of manuscript. RPH contributed to data analysis. RPH and SSR thoroughly revised the manuscript. All authors read and approved the final manuscript.

Disclaimer (Artificial Intelligence)

Authors hereby declare that NO AI technologies have been used during the writing or editing the manuscripts.

Competing Interests

Authors hereby declare that NO generative AI technologies such as large language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of these manuscripts.

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