



# Wild and cultivated plant collections from marketplaces of Odisha, India and their role in livelihood support

Taranisen Panda, Nilamani Dikshit, Nirlipta Mishra, Shaik Rahimuddin, Bikram K. Pradhan, and Raj B. Mohanty

## Correspondence

Taranisen Panda<sup>1\*</sup>, Nilamani Dikshit<sup>2</sup>, Nirlipta Mishra<sup>3</sup>, Shaik Rahimuddin<sup>3</sup>, Bikram K. Pradhan<sup>1</sup>, and Raj B. Mohanty<sup>4</sup>

<sup>1</sup>Department of Botany, Chandbali College, Chandbali, Bhadrak 756 133, Odisha, India.

<sup>2</sup>ICAR- Indian Grassland and Fodder Research Institute, Gwalior Road, Jhansi-284003, Uttar Pradesh, India.

<sup>3</sup>Department of Zoology, Chandbali College, Chandbali, Bhadrak 756 133, Odisha, India.

<sup>4</sup>Ex-Reader in Botany, Plot No. 1311/7628, Satya Bihar, Rasulggarh, Bhubaneswar, 751 010, Odisha, India.

\*Corresponding Author: taranisenpanda@yahoo.co.in

**Ethnobotany Research and Applications 26:8 (2023)** - <http://dx.doi.org/10.32859/era.26.8.1-23>

Manuscript received: 17/05/2023 – Revised manuscript received: 05/07/2023 - Published: 10/07/2023

## Research

### Abstract

**Background:** Marketplaces serve as valuable sources of information regarding the interactions and relationships between people and plants. In India, the significance of marketplaces remains largely unexplored, despite the country's remarkable biocultural diversity. To address this research gap, we conducted a study focusing on the diversity of edible wild and cultivated fruits and vegetables available in both rural and urban markets within the Bhadrak district of Odisha, India.

**Methods:** We conducted a comprehensive survey of rural and urban marketplaces in the Bhadrak district of Odisha, India, covering three seasons. Data were collected from 91 informants through semi-structured interviews, key informant discussions, and direct observations. During field visits, voucher specimens were collected and photographs of marketplaces as well as the fruits and vegetables being traded were taken.

**Results:** A total of 93 species, including one species of Pteridophyte, belonging to 37 families and 74 genera, were documented from the markets in the district. Among these species, 53% were native and 47% were non-native. The families Cucurbitaceae and Fabaceae were particularly well-represented. Out of the recorded species, 22 (23.7%) were wild species. Habit analysis revealed that herbs constituted the highest proportion 41.9%, followed by trees 35.5%, Climbers 18.3%, and shrubs 4.3%. According to the majority of informants, wild fruits and vegetables were valued for both their food and medicinal properties. Commonly reported species used for both dietary and medicinal purposes included *Glinus oppositifolius* (L.) A. DC., *Ipomoea aquatica* Forrsk., *Marsilea minuta* L., *Moringa oleifera* Lam., *Syzygium cumini* (L.) Skeels, and *Tamarindus indica* L. When it came to vegetables, leaves, and stems were commonly consumed, while fruits were typically eaten raw.

**Conclusion:** The markets in the Bhadrak district offer a variety of plants, including a wide range of fruits and vegetables. Through analysis of the collected data, it has been revealed that wild fruits and vegetables play a crucial role in generating income and have the potential to become a significant supplementary livelihood option for local farming communities. It is worth noting the dual role of many plant species, serving as dietary components while also contributing to preventive healthcare practices. Market surveys serve as valuable tools for assessing food environments, and the documented food heritage holds great importance in promoting bio-conservation, environmental sustainability, and food security.

**Keywords:** Fruits, Vegetables, Crop biodiversity, Local economy, Wild and cultivated Plants, Medicinal use

## Background

The global population is expected to reach 10 billion by 2050 (Sadigov 2022), resulting in the dual burden of malnutrition: hunger at one end and obesity at the other (Abarca-Gomez *et al.* 2017; FAO, IFAD, UNICEF, WFP & WHO 2019). Addressing these challenges requires increasing food production while safeguarding the environment and biodiversity (Jacobsen *et al.* 2013). Shifting towards healthier diets (Abarca-Gómez *et al.* 2017; WHO 2019) and preserving crop biodiversity are crucial for sustainable agriculture (Díazgranados *et al.* 2020a). Throughout history, humans have cultivated over 40,000 plant species to meet their needs (Díazgranados *et al.* 2020b). However, crop biodiversity is diminishing, leading to reliance on a limited range of crop genetic diversity. Just 17 botanical families, comprising a mere 4% of all plant families, contribute to 80% of global crop production (Meyer *et al.* 2012; Hufford *et al.* 2019). Additionally, the world's food calorie intake heavily relies on only seven crops (*Oryza sativa*, *Triticum aestivum*, *Glycine max*, *Saccharum spp.*, *Solanum lycopersicum*, *Zea mays*, and *Solanum tuberosum*), making the food supply highly vulnerable (Reeves *et al.* 2016; Corlett 2016; Nic Lughadha *et al.* 2020). To combat these issues, a multifaceted global strategy emphasizing regenerative-ecological agriculture can restore both planetary and human well-being. This strategy encompasses key processes such as energy flow, soil-mineral cycles, the water cycle, ecological relationships, and human-land linkages (Massy 2017).

Global vegetable production needs to triple to meet the demand if everyone consumed a significant amount of vegetables in their diet (Badahur *et al.* 2018). However, the underconsumption of vegetables is a global problem (Kennedy 2011), leading to deficiencies in essential vitamins and minerals. Approximately two billion people suffer from malnutrition due to nutrient deficiencies, including iron, zinc, vitamin A, iodine, and folate. Insufficient vegetable consumption contributes to various health issues such as heart disease, osteoporosis, high blood pressure, diabetes, and obesity, which are associated with inadequate intake of fiber, calcium, magnesium, and antioxidants (Kennedy 2011; Muthayya *et al.* 2013). Inadequate fruit and vegetable consumption is responsible for an estimated 1.7 million deaths worldwide annually (Lim *et al.* 2012). Despite agricultural advancements, only around 18% of individuals in low- and middle-income countries meet the WHO's recommendation of consuming 400 g/day of fruits and vegetables (Frank *et al.* 2019). In India, the diet is primarily cereal-based and lacks diversity (Shankar *et al.* 2019; Tak *et al.* 2019), with low average vegetable consumption for both men (143 g/ person/day) and women (138 g/person/day) (Shankar *et al.* 2017). Household per capita consumption of fruits and vegetables in India falls significantly short (rural areas 160 g/person/day, urban areas 184 g/person/day) of the WHO target, influenced by low income, high prices, and social/geographical inequities (Minocha *et al.* 2018; Sekhar *et al.* 2017; Tak *et al.* 2019). Moreover, the Green Revolution and crop intensification have led to a decrease in dietary diversity and the loss of traditional crops providing essential micronutrients (such as iron, provitamin A, and zinc) for disadvantaged communities (Webb & Eiselen 2009). Recognizing the importance of biodiversity for food security and sustainable development, there is a growing focus on promoting underutilized traditional crops and sustainable production methods (FAO 2018; 2019).

Conserving crop wild relatives and valuable plant species is emphasized in the Aichi Biodiversity Targets and the Global Strategy for Plant Conservation (CBD 2012, CBD 2018). However, efforts to conserve useful wild plant species have not been successful (Khoury *et al.* 2019), and overexploitation remains a major cause of plant loss (Brummitt *et al.* 2015). The draft post-2020 global biodiversity framework highlights the importance of conserving biodiversity for the benefit of both the planet and people (CBD 2020). Yet, the rapid loss of locally available plants and traditional knowledge about their use and cultivation poses a significant threat to livelihoods and food security (Díaz *et al.* 2019.)

## Marketplace

Markets have existed since the dawn of human civilization and serve as locations for traders and buyers to engage in buying and selling activities (Wengrow 2008; Klemperer 2018). Standard market areas, as defined by Sinker (1964), are places where farmers can buy or sell their produce. Bestor (2001) opined that to understand a marketplace, we need to look beyond just the physical space and recognize the social institutions, including government regulations, economic policies, and societal norms, as well as the actors involved, such as vendors, customers, and intermediaries who facilitate transactions. Additionally, it is important to recognize the products and cultural meanings associated with marketplaces, including how people interact with them, the attitudes, values, and beliefs that shape them. The assumption in social sciences is that local ethnic diversity contributes to the growth and diversification of food products traded in marketplaces. This idea has been shaped by historical accounts, literature, and ethnographic studies of various markets around the world, which suggest that cultural encounters in marketplaces facilitate the expansion of trade and merchandise diversity (Maestri 2014). Markets play a crucial role in the wider community by providing employment opportunities, contributing to local economic development, and facilitating the trade of various agricultural and non-agricultural products. For instance, markets in different regions may offer staple foods such as rice, as well as spices, vegetables, fruits, meats, textiles, shoes, and other goods. The diversity of products available in markets reflects the needs and preferences of the local population and highlights the importance of marketplaces in

sustaining communities (Spencer 1940; Bestor 2001; Arman 1996; Susanti 2015; Abdullah & Andrabi 2021a; Abdullah & Andrabi 2021b). The prices of commodities in markets are typically determined through bilateral bargaining, involving face-to-face social interactions that reflect the economic realities of the local community (Widiandra & Sasana 2013; Muftiana & Maulina 2016; Haq *et al.* 2023; Haq *et al.* 2023a). Marketplaces vary in terms of their frequency and location, with some markets meeting periodically in remote areas. Different types of markets can be found across countries and regions, such as street markets in New Zealand (Kikuchi & Ryan 2007), craft markets in South Africa (Kusel & Ras 2010), and open-air Pike fish markets in the USA (Aiello & Gendelman 2008). Each of these markets serves a unique purpose and reflects the local context in which they operate.

#### Open-air market

Open-air markets, also known as local markets, farmers' markets, periodic markets, or floating markets, are important centers of trade where goods are bought and sold (Morales *et al.* 1995; Metz & Scherer 2022). These markets provide valuable information for ethnobotanical studies, offering insights into the diversity of plants (medicinal, edible, and craft materials) sold in the markets (Bye 1986; Nguyen *et al.* 2008; Bussmann *et al.* 2018; Luo *et al.* 2018; Nguyen *et al.* 2019; Rakotoarivelo *et al.* 2019; Luczaj *et al.* 2021). Taxonomists also benefit from these markets, as they can identify threatened taxa (Kasper-Pakosz *et al.* 2016). Geographers study the spatial organization and temporality of markets (Ali & Khan 2007), while economists focus on people's purchasing preferences (Brown 2003). Despite urbanization and the rise of supermarkets, open-air markets continue to be important hubs for plant commerce, serving both urban and rural communities. Many of the plants sold in these markets come from the wild. Traditional markets in rural China have retained much of their original features despite accelerated development and modernization (Rozelle *et al.* 2002; Liu *et al.* 2022). In Thailand, floating markets have adapted to changing times and now attract tourists (Pongajarn *et al.* 2018). Arikamedu, a significant Indian trading center, and harbor facilitated trade between the east coast of India and the Western world from the 1st century BC to the 7th century AD (Begley, 1983, 1993; Schmetzer *et al.* 2017). In this article, we conducted a survey on diversity of edible wild and cultivated fruits and vegetables available in rural and urban markets of Bhadrak district, Odisha, India. The use of each plant species, their role in livelihood support, and local perceptions of conservation and management are discussed.

## Materials and Methods

#### Study site

Odisha is the ninth-largest state of India by area and the eleventh-largest by population. It is located on the east coast of India with the Bay of Bengal forming its eastern and southeastern frontiers. With the eastern Ghat range of hills, almost passing through the heart of the state, high Similipala hills on its north and around 480 km of coastline on its east, Odisha having varied ecosystems from marine to semi-arid on the west provides 'niches' for diverse animal and plant communities. The entire territory lies in the tropical zone as a result of which high temperature is recorded particularly during April-May. However, the sea exercises a moderating influence over the climate of the coastal belt whereas the hill tracts experience an extreme climate. The vegetation found in this region is tropical moist deciduous forest type (Champion & Seth 1968).

Bhadrak district (20° 43'–21° 13'N and 86° 6'–87° E) is located in northeast Odisha. It spreads over 2505 km<sup>2</sup> with 1.507 million inhabitants (2011 Census). It borders the Balasore district in the north, Jajpur in the south, the Bay of Bengal and Kendrapara district in the east and Koenjhar in the west (Figure 1). The district accounts for 1.61% of the state's territory and shares 3.62% of the state's population. About 86.66 % of the inhabitants are villagers and the people are engaged in agricultural practices as their primary occupation. Being situated in close proximity to the Bay of Bengal, the district is experiencing periodic earth tremors, thunderstorms during monsoon, and dust storms in April and May.

#### Data collection

A survey was undertaken from January 2019 to April 2021 in rural and urban markets covering all the seasons of Bhadrak, a coastal district of Odisha, India. Before the field study- aims, methods, and anticipated benefits of the study were adequately explained to the informants in the local language, i.e. (Odia), due consent and cooperation were taken for the documentation of the plants used by them. The district's seven blocks (i.e., Basudevpur, Bhadrak, Bhandaripokhari, Bonth, Chandbali, Dhamnagar, and Tihidi) were visited and 91 informants (male 59 and female 32) were interviewed. Informants from different ages, professions, and educational backgrounds participated in the study. During field visits, plant samples were collected, and photographs of marketplaces and plant species were taken. Information was collected from the respondents, especially wholesale and retail sellers, local farmers, elderly people, and local healers through interviews following standard procedures (Martin 1995; Huntington 2000). The questionnaire was semi-structured, followed by free interviews, informal conversations, and direct observations (Khoja *et al.* 2022a; Khoja *et al.* 2022b). Personal interviews and group discussions carried out in the local language revealed specific information about the plants, which were further compared and

authenticated by crosschecking (Cunningham 2001). During the survey, important taxonomic parameters such as vernacular names, botanical names, family, flowering, and fruiting times were recorded from the respondents. In addition, parts used, mode of consumption, medicinal uses of the species if any, source area, gathered from the wild or cultivated, availability, preference of the consumers, and price of the vegetable or fruit in the market were also discussed with the local people. Due to the fact that the names of all wild vegetables and fruits were given by their local names, the wild vegetables and fruits were identified with the help of relevant flora of Odisha (Saxena & Brahmam 1996). The plant list was categorized according to their systematic positions following the APG IV (2016) classification system. The current nomenclature of each species was determined by referring to database Plants of the World Online. The collected data was further analyzed and presented using tables and figures.

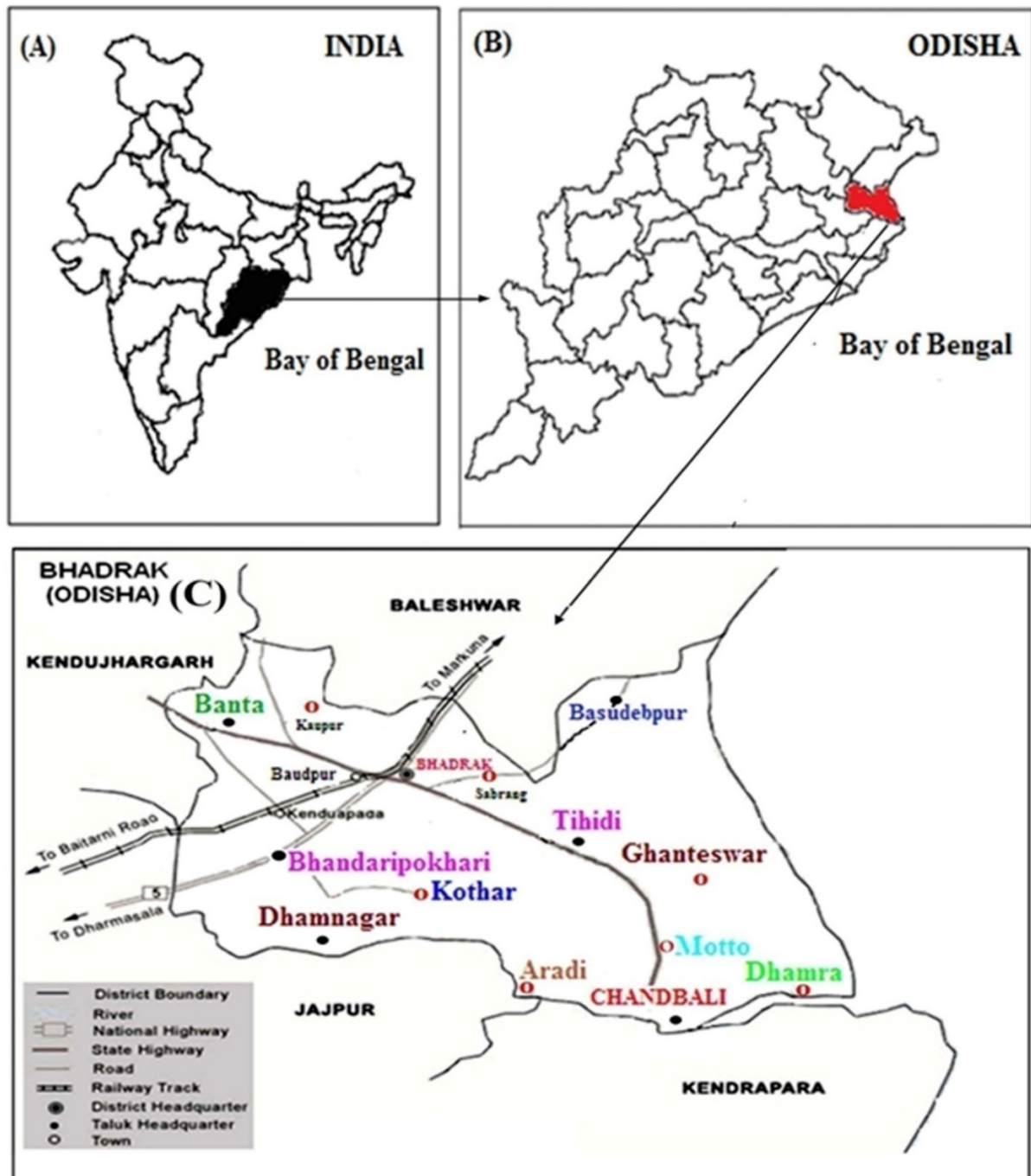


Figure 1. (A) Location of Odisha state in the eastern region of India (B) Map of the Odisha state showing Bhadrak district (C) Study area showing different blocks of the Bhadrak district



Table 1. List of fruits and vegetables collected from different marketplaces of Bhadrak district

Plant Species/ Family	Local name	Habit	Season	Uses
<i>Abelmoschus esculentus</i> (L.) Moench (Malvaceae)	Bhendi	Shrub	Rainy, summer	The fruits are used as vegetable.
<i>Aegle marmelos</i> (L.) Corr. (Rutaceae)	Bela	Tree	Summer	The burnt unripe and ripen fruits are consumed.
<i>Allium cepa</i> L. (Amaryllidaceae)	Piaja	Herb	All season	The tender shoot and bulbs are used as vegetable.
<i>Allium sativum</i> L. (Amaryllidaceae)	Rasuna	Herb	All season	The bulbs are used as vegetable.
<i>Alocasia macrorrhizos</i> (L.) G.Don (Araceae)	Sankhasaru	Herb	All season	Petiole along with stalk is cut into pieces, boiled in water and consumed in curry. Tubers are boiled in water and consumed in either in curry or in mashed form.
<i>Alternanthera sessilis</i> (L.) R.Br. ex DC. (Amaranthaceae)	Madaranga	Herb	All season	Tender shoots along with leaves are used as vegetable.
<i>Amaranthus gangeticus</i> L. (Amaranthaceae)	Nalikosala	Herb	All season	Tender shoots along with leaves are used as vegetable.
<i>Amaranthus viridis</i> L. (Amaranthaceae)	Leutia	Herb	All season	Tender shoots along with leaves are used as vegetable.
<i>Amorphophallus paeoniifolius</i> (Dennst.) Nicolson (Araceae)	Olua	Herb	Winter	Corm is cut into pieces, stir-fried in oil after eliminating their bitter taste by boiling them long time in water, and are eaten with other food.
<i>Anacardium occidentale</i> L. (Anacardiaceae)	Saitamba	Tree	Summer	The fruits are consumed as raw and also used as vegetable.
<i>Ananas comosus</i> (L.) Merr. (Bromeliaceae)	Sapuri	Herb	Summer	The fruits are consumed as raw and also used as vegetable.
<i>Annona reticulata</i> L. (Annonaceae)	Ata	Tree	Winter	The ripen fruits are consumed as raw.
<i>Annona squamosa</i> L. (Annonaceae)	Neuwa	Tree	Winter	The ripen fruits are consumed as raw.
<i>Arachis hypogaea</i> L. (Fabaceae)	Badam	Herb	Winter	The fried nuts are consumed and also used in cakes.
<i>Artocarpus heterophyllus</i> Lam. (Moraceae)	Panasa	Tree	Summer	The tender fruits are used as vegetable and ripen one is consumed as raw.
<i>Artocarpus lacucha</i> Buch. -Ham. (Moraceae)	Jeutha	Tree	Summer	The ripen fruits are consumed.
<i>Averrhoa carambola</i> L. (Oxalidaceae)	Karmanga	Tree	Rainy	The fruits are consumed as raw and also used as vegetable.
<i>Azadirachta indica</i> A. Juss. (Meliaceae)	Nimba	Tree	Summer	The flowers are used as vegetable.
<i>Basella alba</i> L. (Basellaceae)	Poi	Herb	Summer	The tender shoot with leaves is cooked as vegetable.
<i>Bauhinia acuminata</i> L. (Fabaceae)	Kanchan	Tree	Winter	The flowers are used as vegetable.
<i>Benincasa hispida</i> (Thunb.) Cogn. (Cucurbitaceae)	Pani kakharu	Climber	Rainy	The tender fruits are used as vegetable. Ripen fruits with <i>Vigna mungo</i> are used for the preparation of Badi. Ripen fruit is also offered to Devi Durga during Astami puja.
<i>Beta vulgaris</i> L. (Amaranthaceae)	Beet	Herb	Winter	The roots are used as vegetable.
<i>Borassus flabellifer</i> L. (Arecaceae)	Tala	Tree	Summer	The tender fruits are consumed as raw and ripen one is used for preparing cakes.
<i>Brassica oleracea var botrytis</i> L. (Brassicaceae)	Phulkobi	Herb	Winter	Flowering head is used as vegetable.
<i>Brassica oleracea</i> L. var. <i>capitata</i> L. (Brassicaceae)	Bandhakobi	Herb	Winter	Leaves are used as vegetable

<i>Brassica oleracea</i> var. <i>gongylodes</i> L. (Brassicaceae)	Ula kobi	Herb	Winter	The stem and the leaves are used as vegetable.
<i>Brassica oleracea</i> var. <i>italica</i> (Brassicaceae)	Brocoli	Herb	Winter	Flowering head is used as vegetable.
<i>Cajanus cajan</i> (L.) Huth (Fabaceae)	Harada	Shrub	Winter	The seeds are used as vegetable.
<i>Capsicum annuum</i> L. (Solanaceae)	Capsicum	Herb	Winter	The fruits are used as vegetable.
<i>Capsicum frutescens</i> L. (Solanaceae)	Kancha lanka	Herb	All season	The fruits are consumed as raw and also used as vegetable.
<i>Carica papaya</i> L. (Caricaceae)	Amrutabhand a	Tree	All season	The repened fruits are consumed as raw and young one is used as vegetable.
<i>Carissa carandas</i> L. (Apocynaceae)	Kerenda koli	Shrub	Winter	The fruits are consumed as raw.
<i>Chenopodium album</i> L. (Amaranthaceae)	Bathuasaga	Herb	Rainy	The tender shoot and leaves are used as vegetable.
<i>Citrullus lanatus</i> (Thunb.) Matsum & Nakai (Cucurbitaceae)	Tarbhuja	Climber	Summer	The fruits are consumed as raw.
<i>Citrus limon</i> (L.) Osbeck (Rutaceae)	Lembu	Tree	All season	The fruits are consumed as raw.
<i>Citrus maxima</i> (Burm.) Merr. (Rutaceae)	Batapi	Tree	Summer, rainy	The fruits are consumed as raw.
<i>Citrus reticulata</i> L. (Rutaceae)	Kamala	Tree	Winter	The fruits are consumed as raw and its juice is used in curry.
<i>Coccinia indica</i> Wight & Arn. (Cucurbitaceae)	Kunduri	Climber	Rainy	The fruits are used as vegetable.
<i>Cocos nucifera</i> L. (Arecaceae)	Nadia	Tree	All season	The fruits are consumed as raw and also used as vegetable.
<i>Colocasia esculenta</i> (L.) Schott (Araceae)	Saru	Herb	Winter	Tender leaves along with stalk are cooked with other vegetables. Tubers cut into pieces are boiled in water and consumed in either in curry or in mashed form mostly during the month of Kartik.
<i>Coriandrum sativum</i> L. (Apiaceae)	Dhania	Herb	Winter	The leaves are consumed as raw and also used as vegetable.
<i>Cucumis sativus</i> L. (Cucurbitaceae)	Kakudi	Climber	All season	The young fruits are consumed raw and ripen one is used as vegetable.
<i>Cucurbita maxima</i> Duchesne (Cucurbitaceae)	Boitalu	Climber	All season	Fruits, flowers and tender shoots with leaves are used as vegetable.
<i>Curcuma longa</i> L. (Zingiberaceae)	Haldi	Herb	All season	The rhizomes are consumed as raw and also used as vegetable. Leaves are used for the preparation of rice cakes.
<i>Curcuma amada</i> Roxb. (Zingiberaceae)	Amba-ada	Herb	Winter, summer	The rhizomes are used as vegetable.
<i>Daucus carota</i> L. (Apiaceae)	Gajar	Herb	Winter	The root is consumed as raw and also used as vegetable.
<i>Dioscorea alata</i> L. (Dioscoreaceae)	Khamba alu	Climbere	Winter, summer	The tubers are used as vegetable.
<i>Diospyros melanoxylon</i> Roxb. (Ebenaceae)	Kendu	Tree	Summer	The ripen fruits are consumed.
<i>Dillenia indica</i> L. (Dilleniaceae)	Owu	Tree	Rainy	The fruits are used as vegetable.
<i>Enhydra fluctuans</i> Lour. (Asteraceae)	Hidimicha	Herb	All season	Freshly collected tender shoots and leaves are eaten fried or cooked with other vegetables.
<i>Feronia limonia</i> (L.) Swingle (Rutaceae)	Kaitha	Tree	Summer	The fruits are consumed as chatni.
<i>Glinus oppositifolius</i> (L.) A. DC. (Molluginaceae)	Pitasaga	Herb	Winter, summer	Leaves along with tender shoots are consumed as vegetable.
<i>Grewia asiatica</i> L. (Malvaceae)	Phasakoli	Tree	Summer	The ripen fruits are consumed.

<i>Ipomoea aquatica</i> Forrsk. (Convolvulaceae)	Kalama saga	Climber	All season	Tender leafy shoots are eaten fried or cooked.
<i>Ipomoea batatas</i> (L.) Lam. (Convolvulaceae)	Kandamula	Climber	Winter	The fried tubers are consumed.
<i>Lablab purpureus</i> (L.) Sweet (Fabaceae)	Simba	Climber	Winter	The fruits are consumed as raw and also used as vegetable.
<i>Lagenaria siceraria</i> (Mollina) standley (Cucurbitaceae)	Laoo	Climber	Rainy	The fruits are consumed as raw and also used as vegetable.
<i>Luffa acutangula</i> (L.) Roxb. (Cucurbitaceae)	Janhi	Climber	Rainy	The fruits are consumed as raw and also used as vegetable.
<i>Madhuca indica</i> Gmel. (Sapotaceae)	Mahula	Tree	Summer	The fruits are used as vegetable.
<i>Mangifera indica</i> L. (Anacardiaceae)	Amba	Tree	Summer	The fruits are consumed as raw and also used as vegetable.
<i>Manilkara zapota</i> (L.) P. Royen (Sapotaceae)	Sapeta	Tree	Summer	The ripen fruits are consumed.
<i>Mentha spicata</i> L. (Lamiaceae)	Podina	Herb	All season	The leaves are consumed as raw and also used as vegetable.
<i>Momordica charantia</i> L. (Cucurbitaceae)	Kalara	Climber	All season	The fruits are used as vegetable.
<i>Momordica dioica</i> Roxb. ex Willd. (Cucurbitaceae)	Kankad	Climber	Rainy	The fruits are consumed as vegetable.
<i>Moringa oleifera</i> Lam. (Moringaceae)	Sajana	Tree	Fruit (Summer), leaf all season	Fruits, flowers and tender leaves are used as vegetable.
<i>Murraya koenigii</i> (L.) Spreng (Rutaceae)	Bhrusunga	Tree	All season	The tender leaves are used as vegetable.
<i>Musa x paradisiaca</i> L. (Musaceae)	Kadali	Tree	All season	The fruits are used as vegetable.
<i>Phaseolus vulgaris</i> L. (Fabaceae)	Bean	Tree	Winter	The fruits are used as vegetable.
<i>Phoenix sylvestris</i> (L.) Roxb. (Arecaceae)	Khajuri	Tree	Summer	The ripened fruits are consumed.
<i>Pisum sativum</i> Ser. (Fabaceae)	Matar	Climber	Winter	The fruits are consumed as raw and also used as vegetable.
<i>Polygonum plebeium</i> R.Br. (Polygonaceae)	Muthisaga	Herb	Summer	The leaves are cooked as vegetable.
<i>Psidium guajava</i> L. (Myrtaceae)	Pijuli	Tree	All season	The fruits are consumed.
<i>Punica granatum</i> L. (Lythraceae)	Bedana	Shrub	All season	The fruits are consumed.
<i>Raphanus raphanistrum</i> subsp. <i>Sativus</i> (L.) Domin (Brassicaceae)	Mula	Herb	Winter	The roots are consumed as raw and also used as vegetable.
<i>Solanum lycopersicum</i> L. (Solanaceae)	Tomato	Herb	Winter	The fruits are used as vegetable.
<i>Solanum melongena</i> L. (Solanaceae)	Baigana	Herb	All season	The fruits are used as vegetable.
<i>Solanum tuberosum</i> L. (Solanaceae)	Alu	Herb	All season	The tubers are used as vegetable.
<i>Spinacia oleracea</i> L. (Amaranthaceae)	Palanga	Herb	Winter	The leaves are used as vegetable.
<i>Spondias pinnata</i> (L.f.) Kurz (Anacardiaceae)	Salama	Tree	Summer	The fruits are used as vegetable.
<i>Syzygium cumini</i> (L.) Skeels (Myrtaceae)	Jamkoli	Tree	Rainy	The ripened fruits are eaten.
<i>Syzygium samarangense</i> (Blume) Merr. & L.M.Perry (Myrtaceae)	Jamrul	Tree	Summer	The ripened fruits are eaten.
<i>Tamarindus indica</i> L. (Fabaceae)	Tentuli	Tree	Summer	The fruits are consumed as raw and also used as vegetable.
<i>Trapa natans</i> (L.) Roxb. (Trapaceae)	Pani-singada	Herb	Winter	The nuts are consumed raw.
<i>Trichosanthes cucumerina</i> L. (Cucurbitaceae)	Salara	Climber	Rainy	The fruits are used as vegetable.

<i>Trichosanthes dioica</i> Roxb. (Cucurbitaceae)	Potala	Climber	Summer	The fruits are used as vegetable.
<i>Trigonella foenum-graecum</i> L. (Fabaceae)	Methi	Herb	Winter	The tender shoot with leaves are cooked as vegetable.
<i>Vigna mungo</i> (L.) Hepper (Fabaceae)	Biri	Herb	Winter	The seeds are used as vegetable.
<i>Vigna unguiculata</i> (L.) Walp. (Fabaceae)	Judanga	Climber	All season	The fruits are used as vegetable.
<i>Vigna radiata</i> (L.) R. Wilczek (Fabaceae)	Mugo	Herb	Winter	The seeds are used as vegetable.
<i>Zea mays</i> L. (Poaceae)	Maka	Herb	Winter	The fried fruits are consumed.
<i>Zingiber officinale</i> Roscoe (Zingiberaceae)	Ada	Herb	All season	The rhizomes are consumed as raw and also used as vegetable.
<i>Ziziphus mauritiana</i> Lam. (Rhamnaceae)	Barkoli	Tree	Winter	The fruits are consumed as raw and also used as vegetable.
<b>Pteridophyte</b>				
<i>Marsilea minuta</i> L. (Marsileaceae)	Sunsunia	Herb	All season	Tender leaf and petiole are used as vegetable.

## Results

### Taxonomic inventory

The data collected from the Bhadrak district revealed that the rural and urban marketplaces contain a total of 93 plant species (53% native and 47% non-native) belonging to 37 families and 74 genera. Among the 93 species, only one species was represented by Pteridophyta, while the remaining 92 plant species were angiosperms. (Table 1, Figures 2 and 3). The well-represented families in species quantity were: Cucurbitaceae (11 sp.) followed by Fabaceae (10sp.), Rutaceae and Amaranthaceae (6 sp. each). Nineteen families in the study area were monospecific, such as Basellaceae, Bromeliaceae, Cariaceae, and Molluginaceae, among others. Habit analysis showed that herbs were represented by the highest proportion with 39 species [41.9%], trees by 33 species [35.5%], climbers by 17 species [18.3%], and shrubs by 4 species [4.3%] (Figure 4). Of the reported 93 species, the contribution of cultivated plant species was highest (58 sp.; 62.3%) followed by wild (22 sp.; 23.7%) and wild -cum cultivated (13 sp.; 14%) (Figure 5).

Table 2. Price list of some wild and wild-cum cultivated fruits and vegetables collected from different marketplaces of Bhadrak district

Plant Species/ Family	Plants parts sold in market	Price in rupees/kg or piece
<i>Aegle marmelos</i> (L.) Corr. (Rutaceae)	Fruit	15-50/- per piece
<i>Alocasia macrorrhizos</i> (L.) G.Don (Araceae)	Corm	30/-
<i>Alternanthera sessilis</i> (L.) R.Br. ex DC. (Amaranthaceae)	Tender shoot with leaves	40/-
<i>Ananas comosus</i> (L.) Merr. (Bromeliaceae)	Fruit	20-50/- per piece
<i>Annona reticulata</i> L. (Annonaceae)	Fruit	80/-
<i>Annona squamosa</i> L. (Annonaceae)	Fruit	80/-
<i>Artocarpus heterophyllus</i> Lam. (Moraceae)	Fruit	100-250/-
<i>Artocarpus lacucha</i> Buch. -Ham. (Moraceae)	Fruit	100/-
<i>Averrhoa carambola</i> L. (Oxalidaceae)	Fruit	30/-
<i>Azadirachta indica</i> A. Juss. (Meliaceae)	Flower	20/- per bundle
<i>Borassus flabellifer</i> L. (Arecaceae)	Fruit	10/-per piece
<i>Carissa carandas</i> L. (Apocynaceae)	Fruit	60/-
<i>Diospyros melanoxylon</i> Roxb. (Ebenaceae)	Fruit	50/-
<i>Dillenia indica</i> L. (Dilleniaceae)	Fruit	5-10/- per piece
<i>Enhydra fluctuans</i> Lour. (Asteraceae)	Tender shoot with leaves	50/-
<i>Feronia limonia</i> (L.) Swingle (Rutaceae)	Fruit	5-10/- per piece
<i>Glinus oppositifolius</i> (L.) A. DC. (Molluginaceae)	Tender shoot with leaves	40-50/-
<i>Grewia asiatica</i> L. (Malvaceae)	Fruit	100/-
<i>Ipomoea aquatica</i> Forrsk. (Convolvulaceae)	Tender shoot with leaves	40-50/-
<i>Moringa oleifera</i> Lam. (Moringaceae)	Tender leaf and fruit	10/- one bundle leaves (about 250g. and fruits 60-80/-
<i>Murraya koenigii</i> (L.) Spreng (Rutaceae)	Leaves	50/-
<i>Phoenix sylvestris</i> (L.) Roxb. (Arecaceae)	Fruit	80/-
<i>Polygonum plebeium</i> R.Br. (Polygonaceae)	Leaves	40-50/-

<i>Psidium guajava</i> L. (Myrtaceae)	Fruit (wild variety)	40-60/-
<i>Spinacia oleracea</i> L. (Amaranthaceae)	Leaves	20-30/-
<i>Spondias pinnata</i> (L.f.) Kurz (Anacardiaceae)	Fruit	30/-
<i>Syzygium cumini</i> (L.) Skeels (Myrtaceae)	Fruit	50-60/-
<i>Tamarindus indica</i> L. (Fabaceae)	Fruit	50-60/-
<i>Ziziphus mauritiana</i> Lam. (Rhamnaceae)	Fruit	30-50/-
<i>Marsilea minuta</i> L. (Marsileaceae)	Leaves	40-50/-

#### Plant Parts usage (roots, shoots, leaves, fruits, and others)

In the marketplaces of Bhadrak district, a wide variety of edible wild and cultivated plants were collected, belonging to different food categories. These included different types of root vegetables like bulbs (*Allium cepa* L. and *Allium sativum* L.), corms (*Alocasia macrorrhizos* (L.) G. Don and *Amorphophallus paeoniifolius* (Dennst.) Nicolson), tubers (*Ipomoea batatas* (L.) Lam. and *Solanum tuberosum* L.) and rhizomes (*Curcuma longa* L. and *Zingiber officinale* Roscoe). The market also exhibited a variety of edible greens, including leaves, stems, and shoots, such as *Enhydra fluctuans* Lour., *Glinus oppositifolius* (L.) A. DC., *Ipomoea aquatica* Forrsk. and *Murraya koenigii* (L.) Spreng. Fleshy fruits, including berries or drupes, were also observed, such as *Annona squamosa* L., *Artocarpus heterophyllus* Lam., *Dillenia indica* L., *Feronia limonia* (L.) Swingle, *Grewia asiatica* L., *Mangifera indica* L., *Manilkara zapota* (L.) P. Royen, *Psidium guajava* L., *Punica granatum* L. and *Syzygium cumini* (L.) Skeels). Furthermore, seeds from plants like *Vigna mungo* (L.) Hepper and *Vigna radiata* (L.) R. Wilczek was recorded, along with nuts such as *Arachis hypogaea* L. (peanut) and *Trapa natans* (L.) Roxb. (Water chestnut). (Table 1). Participants reported that the availability of wild vegetables was seasonal, and for most of the year, they were scarce. The wild vegetables were typically not cultivated but rather gathered from various habitats, including forests, arable fields, and even anthropogenically disturbed areas like roadsides and wastelands, during seasons when they were abundant.

#### Seasonal variability and price

The availability of fruits and vegetables was found to differ from season to season with more variety in winter (Figure 6) followed by all seasons and summer. For instance, vegetables and fruits like cabbage species, *Annona reticulata* L., *Annona squamosa* L., *Averrhoa carambola* L., *Brassica* sp., *Lablab purpureus* (L.) Sweet, *Phaseolus vulgaris* L., *Pisum sativum* Ser., *Raphanus raphanistrum* subsp. *Sativus* (L.) Domin, *Spinacia oleracea* L., *Trapa natans* (L.) Roxb., *Vigna mungo* (L.) Hepper, *Ziziphus mauritiana* Lam. were dominant in winter season. Similarly, *Aegle marmelos* (L.) Corr., *Anacardium occidentale* L., *Ananas comosus* (L.) Merr., *Artocarpus heterophyllus* Lam., *Basella alba* L., *Feronia limonia* (L.) Swingle, *Manilkara zapota* (L.) P. Royen, *Mangifera indica* L., *Phoenix sylvestris* (L.) Roxb., *Tamarindus indica* L., *Trichosanthes dioica* Roxb., *Spondias pinnata* (L.f.) Kurz was frequent in summer season. *Benincasa hispida* (Thunb.) Cogn., *Coccinia indica* Wight & Arn., *Dillenia indica* L., *Lagenaria siceraria* (Mollina) Standley, *Luffa aegyptiaca* Miller, *Momordica dioica* Roxb. ex Willd., *Trichosanthes cucumerina* L., *Syzygium cumini* (L.) Skeels were commonly available in the rainy season.

In many marketplaces of the district, it was observed that farmers were selling their own products. Informants stated that vegetables like *Glinus oppositifolius* (L.) A. DC., *Ipomoea aquatica* Forrsk. and *Marsilea minuta* L. was in high demand in markets. It was noteworthy to mention that some individuals were even selling these vegetables by walking on foot in urban areas. The price of some wild and wild-cum cultivated fruits and vegetables was depicted in Table 2. The market rates for cultivated fruits and vegetables varied from market to market and season to season. Initially, the price of cultivated fruits and vegetables was high, but it gradually decreased as production continued. For example, at the beginning of production, *Brassica oleracea* var. *botrytis* L. (locally called phulkobi) was sold at rupees 100/- per kilogram. However, later on, it was sold per piece (approximately 1 kg) for only rupees 20/-. A minor variation in price was observed for wild fruits and vegetables. The market rate per kilogram for *Glinus oppositifolius* (L.) A. DC., *Ipomoea aquatica* Forrsk., and *Marsilea minuta* L. ranged from rupees 40-50.





Figure 2. a-h Fruits and vegetables from different marketplaces of Bhadrak district





Figure 3. a. Selling of fruits of *Aegle marmelos* (L.) Corr. and *Cocos nucifera* L. by a local man in an open-air market b. Selling of *Citrus limon* (L.) Osbeck c. Selling of *Basella alba* L., *Ipomoea aquatica* Forrsk. and *Marsilea minuta* L. by the local farmer d. Selling of varieties of leafy vegetables e. Selling of *Glinus oppositifolius* (L.) A. DC. and *Musa x paradisiaca* L. by the local people. f. Selling flower of *Cucurbita maxima* Duchesne and fruit of *Feronia limonia* (L.) Swingle g. Selling flower of *Azadirachta indica* A. Juss. and other leafy vegetables h. Selling of *Ipomoea aquatica* by an old man in the lane of an urban area

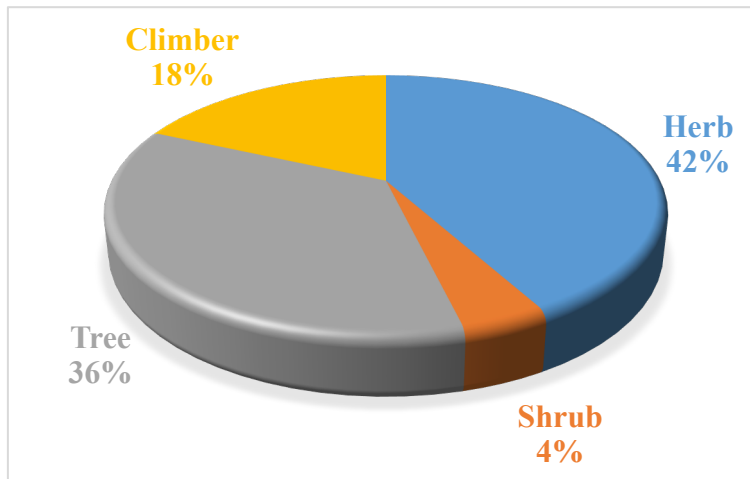


Figure 4. Habit-wise analysis

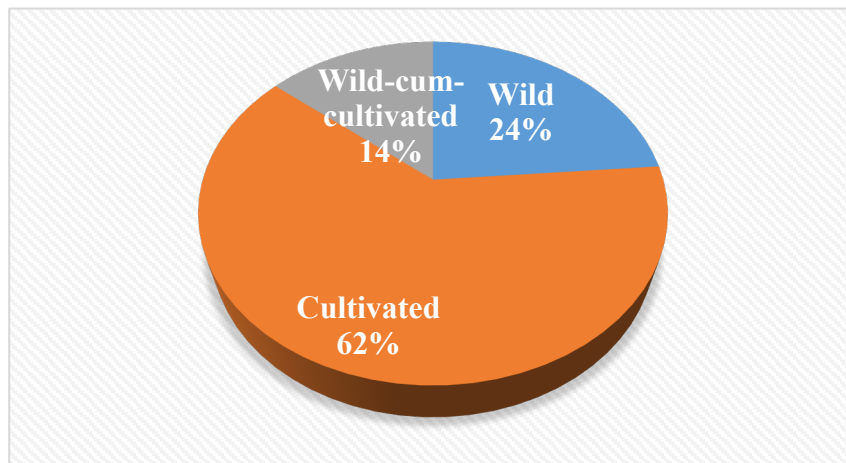


Figure 5. Distribution of wild, cultivated and wild cum cultivated fruits and vegetables in different marketplaces of Bhadrak district

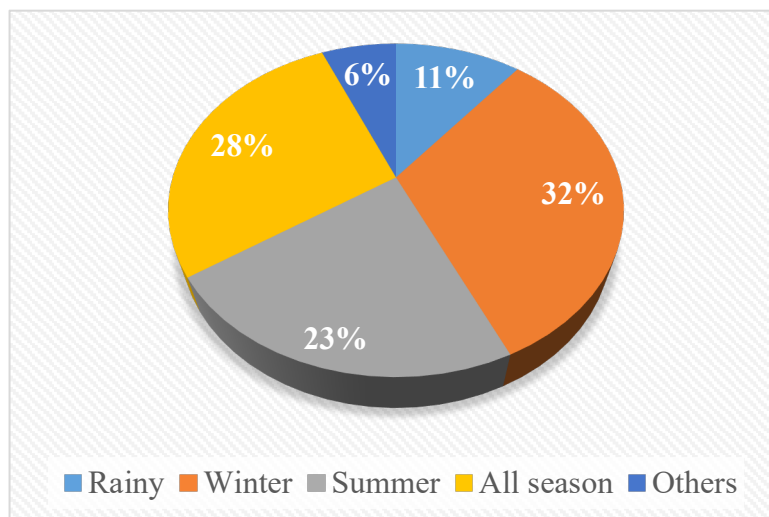


Figure 6. Availability of fruits and vegetables in different seasons in various marketplaces of Bhadrak district

**Mode of consumption**

Fruits were primarily consumed raw in the study area. Some of the most common fruits consumed by the locals included *Phoenix sylvestris*, *Tamarindus indica*, *Syzygium cumini*, and *Artocarpus heterophyllus*, among others. Additionally, the fruits of *Mangifera indica* were also dried and used as pickles. The majority of species in the area had only edible parts, while locals



consumed the leaves, flowers, and fruits of *Moringa oleifera* Lam. Similarly, the mature seed and young fruit of *Artocarpus heterophyllus* were also consumed as vegetables. In the study area, *Murraya koenigii* leaves were added to pulses and vegetables as toppings and flavor enhancers.

#### Ethnomedicinal uses

Respondents stated that some fruits and vegetables were consumed due to their preventive and curative properties. For example, fresh tender leaf of *Azadirachta indica* A. Juss. was taken orally for diabetes, applied the leaf juice topically over boils and the decoction of leaves was taken for curing skin diseases. The flowers of *Azadirachta indica* were also found to be useful for treating skin diseases. Tender twigs were commonly used as toothbrushes to maintain oral hygiene and prevent pyorrhea. Another example is the root paste of *Basella alba* L., which was taken in the morning on an empty stomach along with washed rice water for one month to cure irregular periods. The leaf of *Basella alba* was also rubbed over the affected area to alleviate irritation and swelling caused by caterpillar bites. Green fruits of *Carica papaya* L. were used for managing diabetes. *Glinus oppositifolius* was used to cure various types of skin diseases like scabies and itches. The Leaf juice of *Ipomoea aquatica* mixed with cow ghee was used for treating gonorrhoea and as a blood purifier. In cases of jaundice, a tender twig with leaves was consumed. *Mangifera indica* L. leaf juice was used to regulate diabetes, and the young shoot of the plant was used as a tooth stick for dental care. To control blood sugar, a glassful of decoction made from the leaves and fruit of *Momordica charantia* L. was consumed. *Moringa oleifera* Lam. leaves were boiled in water, and one tumbler of the decoction was taken early in the morning on an empty stomach to control diabetes. The root and bark, when combined with warm milk, were used to induce abortion, treat menstrual disorders, and manage several venereal diseases. The juice of fresh shoots and the decoction of leaves from *Marsilea minuta* L. were used to treat cough, respiratory troubles, and insomnia. The powder of the seeds and stem bark of *Syzygium cumini* (L.) Skeels were boiled with water and taken orally to alleviate stomach troubles. The seed powder was also used for managing diabetes. The slender shoot axis of *Syzygium cumini* was used as a tooth stick, and macerated dry leaves served as toothpowder for dental care. *Tamarindus indica* L. stem bark powder mixed with curd was taken in the morning to treat bleeding piles, while a paste made from the fruit and honey was used for menorrhagia. The decoction of *Tamarindus indica* stem bark was used to cure diarrhea, and a paste prepared from its seeds was applied for scorpion bites.

#### Discussion

One of the most fundamental values of plant biodiversity for human beings is supplying the world's food and nutrition security (FAO 2019; Gee *et al.* 2020). The importance of biodiversity has gradually been acquiring greater recognition in the work of international agencies, such as the Food and Agriculture Organization of the United Nations and the Commission on Genetic Resources for Food and Agriculture. Locally available wild edible plants can provide consumers with a more diverse range of nutritionally high-quality compounds (Datta *et al.* 2019) and can increase the nutrient content of poor diets (Pereira *et al.* 2011), producing health benefits (Marrelli *et al.* 2020; Mateos-Maces *et al.* 2020). India has experienced rapid economic growth in recent years, but undernutrition remains a public health problem. Despite being classified as a lower middle-income country, the burden of undernutrition in India is greater than in some low-income countries, according to the Global Hunger Index 2016 (von Grebmer *et al.* 2016). Furthermore, snacking and consuming empty-calorie foods, such as ready-to-eat processed snacks, canned snacks, and convenience foods in between meals, also contribute to the burden of malnutrition (Almoraie *et al.* 2021). The recommended fruit and vegetable intakes as per The World Health Organization (WHO 2019a), the World Cancer Research Fund (2018), the National Health Service of England (2018) and other studies (Wallace *et al.* 2020; Wang *et al.* 2021) should be at least five servings per day. However, the average consumption falls below three to four servings (Pem & Jeewon 2015; Okop *et al.* 2019).

#### Structure and periodicity of rural and urban marketplace

The market structure in India is dichotomous, consisting of rural and urban markets (Sharma & Kumar 2012). The rural and urban markets in India, including Odisha and Bhadrak district, exhibit significant differences in terms of demographic, socioeconomic, and cultural factors. These variations can influence consumer behavior, demand patterns, and marketing strategies, leading to different market structures in these regions (Sharma & Kumar 2012). The infrastructure of vegetable markets in rural and urban areas can vary based on a range of factors, including location, size, facilities, transportation options, use of technology, and frequency of market days. Rural markets are generally characterized by a predominantly open-air format, with vendors setting up stalls or simply laying out their goods on the ground. These markets may be held in a central location in the village or town. Markets in rural areas typically operate periodically, often only once or twice a week, opening in the morning and closing before sunset. The specific day(s) on which these markets are held can vary from place to place, depending on local customs and traditions. In contrast, urban markets are typically more structured, with many housed in constructed buildings or covered spaces that offer protection from the weather. However, some vendors in urban

areas may still choose to sell their goods in open markets, either alongside the road or in designated areas. This flexibility in the format of urban markets allows vendors to cater to different customer needs and preferences, while also providing opportunities for smaller-scale vendors who may not have access to formal market space. Moreover, urban markets are generally open daily from morning until 10 pm, offering a wider range of products and services to customers who visit more frequently.

#### **Diversity of fruits and vegetables**

Our study area comprised both rural and urban markets in Bhadrak district. Marketplaces around the world have been found to offer a diverse array of plant species for sale, including wild edible vegetables and medicinal plants. They also play an important role in the local economy and interaction among the people (Pemberton & Lee 1996; Xu *et al.* 2004; Franco *et al.* 2020). Usually, commodities are still bartered in some markets in inaccessible areas. Some of the wild edible plants are gathered exclusively for sale, while many others are carried to nearby rural or urban markets for getting higher returns. In our study area, we identified 93 plant species (cultivated, wild and wild -cum cultivated) consumed as fruits and vegetables. It was observed that the market availability of 'wild vegetables' is derived from both direct harvesting from the fields and cultivation using current agronomic techniques. Cucurbitaceae and Fabaceae are prominent families. This finding is consistent with Ray *et al.* (2020).

Marketplaces around the world have been found to offer a diverse array of plant species for sale, including wild edible vegetables and medicinal plants. The number of plant species recorded in the present study can be comparable with the studies of various scholars. For instance, Luczaj *et al.* (2013) documented 37 species of wild edible vegetables in eleven town markets in Dalmatia, a region on the southern coast of Croatia. Similarly, Ertug (2004) found 390 species for sale in local markets in Turkey, while Hanlidou *et al.* (2004) documented 172 medicinal plants in Thessaloniki, Greece, of which 131 taxa are of local origin. In Cyprus, Karousou & Deirmentzoglou (2011) recorded 32 cultivated and 14 wild medicinal herbs sold on 15 stalls scattered through markets. Dogan *et al.* (2013) surveyed 18 markets in Izmir and found that 46 species of wild edible plants were sold, while Nedelcheva & Dogan (2015) and Dogan & Nedelcheva (2015) found that medicinal plants are sold predominantly in Bulgarian markets, whereas more wild vegetables are sold in Turkish markets. Scholars have extensively documented the plant species sold in various Asian markets (Pemberton & Lee 1996; Xu *et al.* 2004). Shirai & Rambo (2014) reported a high diversity of wild species sold in Khon Kaen market located in north-eastern Thailand, with 60 wild species, including 54 plants and 6 mushrooms. Recently, Franco *et al.* (2020) recorded 138 taxa from Tamu Kianggeh, an open-air market in Bandar Seri Begawan, Brunei, and the nearest supermarket. Kar & Borthakur (2007) documented 29 wild vegetables from the markets of Karbi Anglong, Assam. Konsam *et al.* (2016) found a variety of wild edible vegetables, with 68 species sold in different markets in Manipur, India. The ethnobotany of open-air markets has been studied in Pakistan, Iraq, Iran, and Kyrgyzstan (Hamayun *et al.* 2003; Mati & de Boer 2011; Amiri & Joharchi 2013). African markets are mostly dominated by medicinal plants, as reported by Van Andel *et al.* (2012) and Randriamiharisoa *et al.* (2015). These studies demonstrate the importance of open-air markets as sources of both food and medicine and highlight the cultural and ecological diversity of plant use and trade across different regions.

The traditional knowledge regarding the use of wild plants continues to be practiced among rural communities in the district. People inhabiting rural areas possess extensive knowledge about local plants, especially wild fruits, and vegetables. The collection and consumption of wild edible vegetables have become an integral part of the lifestyle, particularly for rural populations with limited land resources, especially those from poorer communities (Ghorbani *et al.*, 2012). It is observed that women play a major role in the collection of plants, while selling is predominantly done by male members. In some open-air markets, women are found selling the items but their number is limited. Wild vegetables play an important role in daily life and contribute to cash income.

#### **Subsistence to livelihood**

Local communities heavily rely on wild fruits and vegetables as a significant source of their livelihood (Sundriyal & Sundriyal 2004). These communities engage in various activities related to the management and use of these plant species, including trading in local markets. These marketplaces serve as crucial spaces for the exchange of traditional knowledge about wild fruits and vegetables between sellers and buyers (Monteiro *et al.* 2010; Franco *et al.* 2020). The sale of these products provides economic benefits to local communities and helps to alleviate poverty at the local level (Delang 2006; Jong *et al.* 2007). It is worth noting that there are approximately 7,000 plant species worldwide that are cultivated or harvested for food or medicinal purposes from the wild vegetation (Ghane *et al.* 2010). Among these neglected and underutilized species, many wild species have played a relevant role in the subsistence of both hunter-gatherers and small farmers (Vazquez-Garcia 2008; Termote *et al.* 2011). These plant species not only provide food and medicinal value but also hold cultural significance to local

communities. Their use and management are critical for maintaining biodiversity in ecosystems and preserving indigenous knowledge. Respondents stated that the demand for wild edible fruits and vegetables is high, as town dwellers still prefer traditional ethnic cuisine for their daily food habits (Medhi & Borthakur 2012).

### Cultural significance

Bhadrak district offers a wide variety of indigenous produce, reflecting the region's culinary heritage. One of the signature dishes of Odisha is *Ghanta Tarkari*, traditionally prepared during Dwitbahana Puja festival between September and October. The dish is prepared using locally grown vegetables, including *Benincasa hispida*, *Cucurbita maxima*, *Cucumis sativus*, *Dillenia indica*, and *Dioscorea alata*. Ghanta Tarkari is cooked in large quantities and distributed among neighbors, making it a communal and festive meal. *Bela* (*Aegle marmelos*) also called 'Shivaduma' or 'The Tree of Shiva' is a sacred tree in Hinduism that is often offered in prayers to Lord Shiva and Parvati. This tree has been depicted in the paintings of the famous Ajanta Caves, showcasing its cultural importance in ancient times (Singh *et al.*, 2019). *Bela Pana* is a traditional and nutritious beverage made from the pulp of ripe Bela fruit in the Bhadrak district of Odisha. It is highly valued as Prasad and offered to various gods and goddesses during Pana Sankranti, celebrated on 14th April every year. The popularity of this ritual has made ripe *Bela* fruit abundant in both rural and urban markets, highlighting the region's rich cultural heritage and customs. In Hinduism, coconuts (*Cocos nucifera*) are a significant symbol of purity, fertility, and prosperity, commonly used as offerings in religious ceremonies and worship of deities (Osella & Osella, 2003; Verenkar & Sellappan, 2018; Devi & Ghatani, 2019). Therefore, the availability of coconut is observed throughout the year, both in rural and urban markets.

### Ethnomedicinal uses

The overlapping between food and medicine is well-known in traditional societies (Pieroni *et al.* 2005). Food can be used as medicine and vice versa. In the current study, *Azadirachta indica* A. Juss was used by the locals for the treatment of diabetes, dental carries and skin ailments. *A. indica* (locally called nimba) has been used as a medicinal plant in the Indian subcontinent for more than 4500 years (Kumar & Navaratnam 2013). Almost every part of *A. indica* (e.g., the stem, bark, roots, leaves, and flowers) have been used as household remedies for human illnesses. Millions of people globally use nimba twigs as a source of chewing sticks for dental hygiene (Gupta *et al.* 2017). Recent studies have confirmed the efficacy of neem leaves in controlling blood sugar levels (Gupta *et al.* 2019; Pingali *et al.* 2020). The use of leaves, bark, and flowers for the treatment of skin ailments is also reported (Vakshasya & Dixit 2018; Singh *et al.* 2021). During the survey, some respondents stated that they use neem leaf beds for patients suffering from chicken pox. Similarly, *Glinus oppositifolius* is consumed as a vegetable and is also used for the treatment of skin diseases. In India, *Glinus oppositifolius* has been used in traditional and herbal pharmacopeia for the treatment of dermatitis, itches, and skin diseases (Asok Kumar *et al.* 2009; Sheu *et al.* 2014; Ramaseshan *et al.* 2016)). The Korku tribes of Amravati in Maharashtra and the aboriginals from Gadchiroli district use the plant as vegetables (Sekharan & Jagadeesan 1997; Jagtap *et al.* 2006). Similarly, in the current study, *Ipomoea aquatica* is used both as a vegetable and as medicine. In most parts of tropical Asia, *I. aquatica* is a common food consumed by all social groups, and people have different ways of consuming it (Austin 2008; Fu *et al.* 2011). In the rural area of India, it is generally used as a green leafy vegetable (Rao & Tuhina 2002). The plant is reported to be useful for liver diseases (Badruzzaman & Husain 1992) and high blood pressure (Perry 1980). *Marsilea minuta* is used as a vegetable and is also recommended for the treatment of cough, respiratory disorders and insomnia. Similar results have been reported elsewhere (Dixit 1974; Upreti *et al.* 2009; Sen *et al.* 2011; Bachheti *et al.* 2023). In the studied area, ripe fruits of *Syzygium cumini* (L.) Skeels are sold in markets as well as along the roadside and consumed by people from all sections of society. Ripe *S. cumini* fruits are considered beneficial for health, and their seeds are regarded as one of the best remedies for controlling sugar levels. These fruits have been used for centuries as a medicinal food for patients with diabetes (Helmstadter 2008; Ayyanar & Subash-Babu 2012; Kumari & Kumar 2018; Akbar 2020). The use of *S. cumini* for toothache is also reported (Sathyavati & Janardhanan 2011).

### Conclusion

Within the past few decades, we have seen a transition in food habits and consumption patterns throughout the world. The food consumption trend exhibits a higher preference for processed and packaged foods having higher salt, sugar and fat but deficient in nutrient density and dietary diversity. The present study disclosed that the indigenous knowledge concerning the use of wild fruits and vegetables continues to be in follow among the communities of the study zone. We found that this area has a reservoir of a variety of wild edibles that have the potential to sustain rural livelihood. The dual role of many species as dietary components and in preventive health care deserves special attention. The recorded food heritage may be essential in aiming at fostering bio-conservation, environmental sustainability, food security, and above all preservation of traditional knowledge. Encouragement of nutrition gardening in all the areas feasible (e.g., home and backyard) in order to reduce the intensity of malnutrition. Schools/colleges/Universities can promote gardening to motivate students to eat fresh

and healthily. Benefits from different governmental programs can be harnessed by becoming aware of them, which can help in funding/training/setting up a nutrition garden. Nutrition gardens can be a source of generating some additional income with the surplus produce, along with promoting dietary diversity and in turn taking a step closer to food and nutrition security.

## Declarations

**List of abbreviations:** The article does not contain abbreviations.

**Ethics approval and consent to participate:** All participants provided oral prior informed consent..

**Consent for publication:** The persons shown in figures agreed that their images could be published.

**Competing interests:** Authors declare no conflict of interest.

**Funding:** This study did not receive any specific funding.

**Authors' contributions:** TP design the research, carried out the survey, and wrote the manuscript. SR and BKP helped the first author (TP) for data collection and interpreted the photographs. ND, NM, and RBM considerably contributed to the literature survey and revised the manuscript. All authors read, provided feedback, and approved the final manuscript.

## Acknowledgments

The authors are thankful to the local people concerned for their cooperation in providing information regarding the availability and uses of fruits and vegetables in Bhadrak district.

## Literature cited

Abdullah A, Andrabi SAH. 2021a. An approach to the study of traditional medicinal plants used by locals of block Kralpora Kupwara Jammu and Kashmir India. *International Journal of Botanical Studies* 6(5):1433-1448.

Abdullah A, Andrabi SAH. 2021b. Wild edible plants and fungi used by locals in Kupwara district of Jammu and Kashmir, India. *Pleione* 15(2):179-189.

Abarca-Gomez L, Abdeen ZA, Hamid ZA, Abu-Rmeileh NM, Acosta-Cazares B, Acuin C. et al. 2017. Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: A pooled analysis of 2416 population-based measurement studies in 128.9 million children, adolescents, and adults. *The Lancet* 390(10113): 2627–2642.

Aiello G, Gendelman I. 2008. Seattle's pike place market (de) constructed: an analysis of tourist narratives about a public space. *Journal of Tourism and Cultural Change* 5 (3):158-85.

Akbar S. 2020. *Syzygium cumini* (L.) Skeels (Myrtaceae). In: *Handbook of 200 Medicinal Plants*. Springer, Cham, Switzerland.

Almoraie NM, Saqaan R, Alharthi R, Alamoudi A, Badh L, Shatwan IM. 2021. Snacking patterns throughout the life span: potential implications on health. *Nutrition Research* 91:81-94.

Amiri MS, Joharchi MR. 2013. Ethnobotanical investigation of traditional medicinal plants commercialized in the markets of Mashhad, Iran. *Avicenna Journal of Phytomedicine* 3:254–71.

Ali M, Khan M. 2007 Hierarchy of periodic market centres in Shahjahanpur district, Uttar Pradesh: a geographical analysis. *Indian National Geography* 22:185–195.

APG IV. 2016. An update of the angiosperm phylogeny group classification for the orders and families of flowering plants. *Botanical Journal of the Linnean Society* 181(1):1-20.

Arman S. 1996. Diversity and trade of market fruits in West Kalimantan. In: Padoch C, Peluso NL (eds.). *Borneo in Transition: People, Forests, Conservation, and Development*. Oxford University Press, New York.

Asok Kumar K, Uma Maheswari M, Sivashanmugam AT, SubhadraDevi V, Subhashini N, Ravi TK. 2009. Free radical scavenging and antioxidant activities of *Glinus oppositifolius* (carpet weed) using different in vitro assay systems. *Pharmaceutical Biology* 47:474–82.

Austin DF. 2008. Water spinach (*Ipomea aquatica*, Convolvulaceae) a food gone wild. *Ethnobotany Research and Applications* 5:123-145.

- Ayyanar M, Subash-Babu P. 2012. *Syzygium cumini* (L.) Skeels: a review of its phytochemical constituents and traditional uses. *Asian Pacific Journal of Tropical Biomedicine* 2(3):240-246.
- Bachheti A, Bachheti RK, Husen A. 2023. *Aquatic Medicinal Plants*. CRC Press, Boca Raton, Florida, America.
- Badahur K, Dias GM, Veeramani A, Swanton CJ, Fraser D, Steinke D. 2018. When too much isn't enough: Does current food production meet global nutritional needs? *PLoS One* 13(10): e0205683.
- Badruzzaman SM, Husain W. 1992. Some aquatic and marshy land medicinal plants from HarDOI district of Uttar Pradesh. *Fitoterapia* 63:245-257.
- Begley V. 1983. Arikamedu reconsidered. *American Journal of Archaeology* 87(4):461-481.
- Begley V. 1993. New investigations at the port of Arikamedu. *Journal of Roman Archaeology* 6: 93-108,
- Bestor TC. 2001. Markets: Anthropological Aspects. In: Smelser NJ, Baltes PB (eds.). *International encyclopedia of the social & behavioral sciences*. Elsevier, Amsterdam, New York, Pp. 9227-9231.
- Brown C. 2003. Consumers' preferences for locally produced food: a study in Southeast Missouri. *American Journal Alternative Agriculture* 18:213-224.
- Brummitt NA, Bachman SP, Griffiths-Lee J, Lutz M, Moat JF, Farjon A, Donaldson JS, Hilton-Taylor C, et al. 2015. Green plants in the red: A baseline global assessment for the IUCN sampled Red List Index for plants. *PLoS One* 10: e0135152.
- Bussmann RW, Zambrana NYP, Romero C, Hart RE. 2018. No consensus in "traditional" medicine - medicinal plants and their uses in the markets of Bogotá (Colombia), La Paz/El alto (Bolivia) and Trujillo/Chiclayo (Perú). *Indian Journal of Traditional Knowledge* 17:494-498.
- Bye RA. 1986. Medicinal plants of the Sierra Madre: comparative study of Tarahumara and Mexican market plants. *Economic Botany* 40(1):103-124.
- CBD. 2012. *The global strategy for plant conservation: 2011-2020*. Botanic Gardens Conservation International, Richmond, U.K.
- CBD. 2018. *Aichi biodiversity targets*. Montreal, Quebec, Canada.
- CBD. 2020. *Zero draft of the post-2020 global biodiversity framework*. Open-ended working group on the post-2020 Global Biodiversity Framework, Kunming, China.
- Champion HG, Seth SK. 1968. *A revised survey of the forest types of India*. Manager of Publications, New Delhi, India.
- Corlett RT. 2016. Plant diversity in a changing world: Status, trends, and conservation needs. *Plant Diversity* 38: 10-16.
- Cunningham AB. 2001. *Applied ethnobotany: People, wild plant use and conservation*. Earthscan Publishing Ltd., London, UK.
- Datta S, Sinha BK, Bhattacharjee S, Seal T. 2019. Nutritional composition, mineral content, antioxidant activity and quantitative estimation of water-soluble vitamins and phenolics by RP-HPLC in some lesser used wild edible plants. *Heliyon* 5: e01431
- Diaz S, Settele J, Brondizio ES, Ngo HT, Agard J, Arneth A, Zayas CN. 2019. Pervasive human-driven decline of life on Earth points to the need for transformative change. *Science* 366(6471): eaax3100.
- Díazgranados M, Anderson G, Bambrick H, Blackman R, Bruce J, Sutherland W et al. 2020a. Food and agriculture: the future of sustainability. In *The future of sustainability*. Palgrave Macmillan, Cham, London, U.K.
- Díazgranados M, Allkin B, Black N, Camara-Leret R. 2020b. *World checklist of useful plant species*. Royal Botanic Gardens, Kew, U.K.
- Delang CO. 2006. The role of wild food plants in poverty alleviation and biodiversity conservation in tropical countries. *Progress in Development Studies* 6(4): 275-286.
- Devi M, Ghatani K. 2022. The use of coconut in rituals and food preparations in India: a review. *Journal of Ethnic Foods* 9: 37.
- Dixit RD. 1974. Fern – A much neglected group of medicinal plants. *Journal of Research in Indian Medicine* 9: 74-90.

- Dogan Y, Ugulu I, Durkan N. 2013. Wild edible plants sold in the local markets of Izmir, Turkey. *Pakistan Journal of Botany* 45(S1):177–184.
- Dogan Y, Nedelcheva A. 2015. Wild plants from open markets on both sides of the Bulgarian-Turkish border. *Indian Journal of Traditional Knowledge* 14(3):351–358.
- Ertug F. 2004. Wild edible plants of the Bodrum Area (Mugla, Turkey). *Turkish Journal of Botany* 28:161–174.
- FAO. 2018. Future smart food – Rediscovering hidden treasures of neglected and underutilized species for Zero Hunger in Asia. Li X, Siddique KHM (eds.). Food and Agriculture Organization of the United Nations, Rome, Italy.
- FAO. 2019. The state of the world’s biodiversity for food and agriculture. Belanger J, Pilling D. (eds.). FAO Commission on Genetic Resources for Food and Agriculture Assessments, Rome, Italy.
- FAO, IFAD, UNICEF, WFP, & WHO. 2019. The state of food security and nutrition in the world 2019. Safeguarding against economic slowdowns and downturns. Food and Agriculture Organization of the United Nations, Rome, Italy.
- Frank SM, Webster J, McKenzie B, Geldsetzer P, Manne-Goehler J, Andall- Brereton G, Jaacks LM. 2019. Consumption of fruits and vegetables among individuals 15 years and older in 28 low- and middle-income countries. *The Journal of Nutrition* 149: 1252–1259.
- Franco FM, Chaw LL, Bakar N, Abas SNH. 2020. Socialising over fruits and vegetables: the biocultural importance of an open-air market in Bandar Seri Begawan, Brunei Darussalam. *Journal of Ethnobiology and Ethnomedicine* 16:6.
- Fu H, Xie B, Ma S, Zhu X, Fan G, Pan S. 2011. Evaluation of antioxidant activities of principal carotenoids available in water spinach (*Ipomoea aquatica*). *Journal of Food Composition Analysis* 24:288–297.
- Gee E, Borelli T, de Oliveira Beltrame DM, Neves Soares Oliveira C, Coradin L, Wasike V, Manjella A, Samarasinghe G, Güner B, Tan A, et al. 2020. The ABC of mainstreaming biodiversity for food and nutrition: concepts, theory and practice. In: Hunter D, Borelli T, Gee E. (eds.) *Biodiversity, food and nutrition: A new agenda for sustainable food systems. Issues in Agricultural Biodiversity*, Routledge, London, UK, Pp. 85–186.
- Ghane SG, Lokhande VH, Ahire ML, Nikam TD. 2010. *Indigofera glandulosa* Wendl. (Barbada) a potential source of nutritious food: underutilized and neglected legume in India. *Genetic Resources and Crop Evolution* 57:147–153.
- Ghorbani A, Langenberger G, Sauerborn J. 2012. A comparison of the wild food plant use knowledge of ethnic minorities in Naban River Watershed National Nature Reserve, Yunnan, SW China. *Journal of Ethnobiology and Ethnomedicine* 8: 17-10.
- Gupta SC, Prasad S, Tyagi AK, Kunnumakkara AB, Aggarwal BB. 2017. Neem (*Azadirachta indica*): An Indian traditional panacea with modern molecular basis. *Phytomedicine* 34: 14–20.
- Gupta A, Ansari S, Gupta S, Narwani M, Gupta M, Singh M. 2019. Therapeutics role of neem and its bioactive constituents in disease prevention and treatment. *Journal of Pharmacognosy and Phytochemistry* 8:680–691.
- Hamayun M, Khan MA, Begum S. 2003. Marketing of medicinal plants of Utror- Gabral Valleys, Swat, Pakistan. *Ethnobotany Leaflets* (1):13.
- Hanlidou E, Karousou R, Kleftoyanni V, Kokkini S. 2004. The herbal market of Thessaloniki (N Greece) and its relation to the ethnobotanical tradition. *Journal of Ethnopharmacology* 91:281–299.
- Haq SM, Khoja AA, Lone FA, Waheed M, Bussmann RW, Casini R, Mahmoud EA, Elansary HO. 2023. Keeping healthy in your skin—plants and fungi used by indigenous Himalayan communities to treat dermatological ailments. *Plants* 12: 1575.
- Haq SM, Waheed M, Khoja AA, Amjad MS, Bussmann RW, Ali K. 2023a. A cross-cultural study of high-altitude botanical resources among diverse ethnic groups in Kashmir Himalaya, India. *Journal of Ethnobiology and Ethnomedicine* 19:12.
- Helmstadter A. 2008. *Syzygium cumini* (L.) Skeels (Myrtaceae) against diabetes: 125 Years of Research. *Die Pharmazie* 63(2):91-101.
- Hufford M, Berny Mier Y Teran JC, Gepts P. 2019. Crop biodiversity: An unfinished magnum opus of nature. *Annual Reviews of Plant Biology* 70:727–51.

- Huntington HP. 2000. Using traditional ecological knowledge in science: Methods and applications. *Ecological Applications* 10:1270–1274.
- Jacobsen SE, Sørensen M, Pedersen SM, Weiner J. 2013. Feeding the world: Genetically modified crops versus agricultural biodiversity. *Agronomy for Sustainable Development* 33(4): 651–662.
- Jagtap SD, Deokule SS, Bhosle SV. 2006. Some unique ethnomedicinal uses of plants used by the Korku tribe of Amravati district of Maharashtra, India. *Journal of Ethnopharmacology* 107: 463–469.
- Jong W, Kusters K, de Koning J. 2007. From forest to farmer: managing forest resources for human needs. *Journal of Rural Studies* 23(1): 76-87.
- Kar A, Borthakur SK. 2007. Wild vegetables sold in the markets of Karbi Anglong, Assam. *Indian Journal of Traditional Knowledge* 6(1):169-172.
- Karousou R, Deirmentzoglou S. 2011. The herbal market of Cyprus: traditional links and cultural exchanges. *Journal of Ethnopharmacology* 133:191–203.
- Kasper-Pakosz R, Pietras M, Łuczaj L. 2016. Wild and native plants and mushrooms sold in the open-air markets of South-Eastern Poland. *Journal of Ethnobiology and Ethnomedicine* 12:45.
- Kennedy D. 2011. 21st century greens: Leaf vegetables in nutrition and sustainable agriculture. Leaf for Life, Berea, USA.
- Khoja AA, Andrabi SAH, Mir RA. 2022a. Traditional medicine in the treatment of gastrointestinal diseases in northern part of Kashmir Himalayas. *Ethnobotany Research and Applications* 23:1-17.
- Khoja AA, Andrabi SAH, Mir RA, Bussmann R.W. 2022b. Ethnobiological uses of plant species among three ethnic communities in the administrative (Kupwara) of Jammu and Kashmir-India: A cross cultural Analysis. *Ethnobotany Research and Applications* 24:1-22.
- Khoury CK, Amariles D, Soto JS, Diaz MV, Sotelo S, Sosa CC, Ramírez-Villegas J, Achicanoy HA, et al. 2019. Comprehensiveness of conservation of useful wild plants: An operational indicator for biodiversity and sustainable development targets. *Ecological Indicators* 98: 420–429.
- Kikuchi A, Ryan C. 2007. Street markets as tourist attractions – Victoria market, Auckland, New Zealand. *International Journal of Tourism Research* 9 (4):297-300.
- Klemperer, P. 2018. *Markets: a brief history*. Oxford University Press, Oxford, UK.
- Konsam S, Thongam B, Handique AK. 2016. Assessment of wild leafy vegetables traditionally consumed by the ethnic communities of Manipur, northeast India. *Journal of Ethnobiology and Ethnomedicine* 12:1.
- Kumar VS, Navaratnam V. 2013. Neem (*Azadirachta indica*): prehistory to contemporary medicinal uses to humankind. *Asian Pacific Journal of Tropical Biomedicine* 3:505–514.
- Kumari S, Kumar S. 2018. Ethnomedicinal importance of plants used by the tribals of Sahebganj district of Jharkhand. *Ethnobotany* 30: 22-34.
- Kusel R, Ras PJ. 2010. Gender buying behaviour: German tourists–informal craft markets. *African Journal of Economic and Management Studies* 1(2):211-21.
- Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H, Ezzati M, et al. 2012. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: A systematic analysis for the Global Burden of Disease Study 2010. *The Lancet* 380(9859): 2224–2260.
- Liu Z, Liu Q, Zhao P, Tang J, Gong Z. 2022. Investigating access to periodic markets in rural China. *Transportation Research Part D: Transport and Environment* 103: 103162,
- Łuczaj L, Zovko-Koncic M, Milicevic T, Dolina K, Pandza M. 2013. Wild vegetable mixes sold in the markets of Dalmatia (southern Croatia). *Journal of Ethnobiology and Ethnomedicine* 9:2.
- Łuczaj L, Lamxay V, Tongchan K, Xayphakatsa K, Phimmakong K, Radavanh S, Kanyasone V, Pietras M, Karbarz M. 2021. Wild food plants and fungi sold in the markets of Luang Prabang, Lao PDR. *Journal of Ethnobiology and Ethnomedicine* 17:6.

- Luo B, Liu Y, Liu B, Liu S, Zhang B, Zhang L, Lin C, Liu Y, Kennelly EJ, Guo Z, Long C. 2018. Yao herbal medicinal market during the dragon boat festival in Jianghua County, China. *Journal of Ethnobiology and Ethnomedicine* 14:61.
- Maestri G. 2014. The political economy of food markets: ethnographic insights on power, culture, and agency. *Anthropology of Food* (S8):1-15.
- Marrelli M, Statti G, Conforti F. 2020 A review of biologically active natural products from Mediterranean wild edible plants: Benefits in the treatment of obesity and its related disorders. *Molecules* 25: 649.
- Martin GJ. 1995 *Ethnobotany: A methods manual*. Chapman and Hall, London, U.K.
- Mati E, de Boer H. 2011. Ethnobotany and trade of medicinal plants in the Qaysari Market, Kurdish Autonomous Region, Iraq. *Journal of Ethnopharmacology* 133(2):490–510.
- Massy C. 2017. *Call of the reed warbler: a new agriculture—a new earth*. University of Queensland Press, Brisbane, QLD, Australia
- Mateos-Maces L, Chavez-Servia JL, Vera-Guzmán AM, Aquino-Bolanos EN, Alba-Jiménez JE, Villagómez-Gonzalez BB. 2020. Edible leafy plants from Mexico as sources of antioxidant compounds, and their nutritional, nutraceutical and antimicrobial potential: A review. *Antioxidants* 9: 541.
- Medhi P, Borthakur SK. 2012. Phytoresources from North Cachar Hills of Assam-III: Edible plants sold at Haflong market. *Indian Journal of Natural Products and Resources* 3(1): 84 – 109.
- Metz JJ, Scherer SM. 2022. The rise and decline of farmers markets in Greater Cincinnati. *Agriculture Human Values* 39(1):95-117.
- Meyer RS, Duval AE, Jensen HR. 2012. Patterns and processes in crop domestication: An historical review and quantitative analysis of 203 global food crops. *New Phytologist* 196(1): 29–48.
- Minocha S, Thomas T, Kurpad AV. 2018. Are “fruits and vegetables” intake really what they seem in India? *European Journal of Clinical Nutrition* 72 (4): 603–608.
- Monteiro JM, de Lima E, Cavalcanti- Amorin EL, Albuquerque UP. 2010. Local markets and medicinal plant commerce: A review with emphasis on Brazil. *Economic Botany* 64:352–366.
- Morales A, Balkin S, Persky J. 1995. The value of benefits of a public street market: the case of Maxwell Street. *Economic Development Quarterly* 9:304–320.
- Muftiadi RA, Maulina MA. 2016. The business dynamic of traditional market place: demand preference approach. *Jurnal Adbispreneur* 1 (2): 113-126.
- Muthayya S, Rah J, Sugimoto J, Roos F, Kraemer K, Black R. 2013. The global hidden hunger indices and maps: An advocacy tool for action. *PLoS One* 8(6): e67860.
- Nedelcheva A, Dogan Y. 2015. An ethnobotanical study on wild medicinal plants sold in the local markets at both sides of the Bulgarian–Turkish border. *Planta Medica*. 81(16):PW\_13
- Nguyen ML, Doherty KT, Wieting J. 2008. Market survey research: a model for ethnobotanical education. *Ethnobotany Research and Applications* 17(6):87–92.
- Nguyen TS, Xia NH, Van Chu T, Van Sam H. 2019. Ethnobotanical study on medicinal plants in traditional markets of Son La province, Vietnam. *Forest Society* 3(2):171–92.
- Nic Lughadha E, Bachman SP, Leao TCC, Forest F, Halley JM, Moat J, Acedo C, Bacon KL, et al. 2020. Extinction risk and threats to plants and fungi. *Plants, People, Planet* 2: 389–408.
- Okop KJ, Ndayi K, Tsolekile L, Sanders D, Puoaneet T. 2019. Low intake of commonly available fruits and vegetables in socio-economically disadvantaged communities of South Africa: influence of affordability and sugary drinks intake. *BMC Public Health* 19: 940.
- Osella F, Osella C. 2003. Ayyappan saranam: 1 masculinity and the Sabarimala pilgrimage in Kerala. *Journal of Royal Anthropology Institute* 9(4):729–754.



- Pem D, Jeewon R. 2015. Fruit and vegetable intake: benefits and progress of nutrition education interventions- Narrative review article. *Iranian Journal of Public Health* 44(10): 1309–1321.
- Pemberton RW, Lee NS. 1996. Wild food plants in South Korea; market presence, new crops, and exports to the United States. *Economic Botany* 50(1):57–70.
- Pereira C, Barros L, Carvalho AM, Ferreira ICFR. 2011. Nutritional composition and bioactive properties of commonly consumed wild greens: Potential sources for new trends in modern diets. *Food Research International* 44: 2634–2640.
- Perry LM. 1980. Medicinal plants of east and southeast Asia: Attributed properties and uses. The MIT Press, Cambridge, MA, USA.
- Pieroni A, Nebel S, Santoro RF, Heinrich M. 2005. Food for two seasons: culinary uses of non-cultivated local vegetables and mushrooms in a south Italian village. *International Journal of Food Science and Nutrition* 56:245–272.
- Pingali U, Ali MA, Gundagani S, Nutalapati C. 2020. Evaluation of the effect of an aqueous extract of *Azadirachta indica* (Neem) leaves and twigs on glycemic control, endothelial dysfunction and systemic inflammation in subjects with type 2 diabetes mellitus – A randomized, double-blind, placebo-controlled clinical study. *Diabetes Metabolic Syndrome and Obesity* 13:4401-4412.
- Pongajarn C, van der Duim R, Peters K. 2018. Floating markets in Thailand: same, same, but different. *Journal of Tourism and Cultural Change* 18(2):109–122.
- Rakotoarivelo N, Randrianarivony T, Rakotoarivony F, Randrianasolo A. 2019. Mangidy: Malagasy folk beverages sold in Madagascar's market places. *Ethnobotany Research and Applications* 18:29.
- Ramaseshan ST, Pitchaiah P, Bharti V, Ramakrishna KK, Venkateswarlu G, Tewari D, Rath C, Anupam M, Madan MP, Singh DK. 2016. Pharmacognostical, Phytochemical and Nutritional Evaluation of *Glinus oppositifolius* (L.) Aug. DC. *Pharmacognosy Journal* 8(1): 31-35.
- Randrianarivony T, Raktoarivony F, Randrianasolo A, Bussmann RW. 2015. Medicinal plants sold in the markets of Antananarivo, Madagascar. *Journal of Ethnobiology and Ethnomedicine* 11:60.
- Rao TV, Tuhina V. 2002. Iron, calcium,  $\beta$ -carotene, ascorbic acid and oxalic acid contents of some less common leafy vegetables consumed by the tribals of Purnia district of Bihar. *Journal of Food Science and Technology* 39:560-562.
- Ray A, Ray R, Reevidya EA. 2020. How many wild edible plants do we eat-their diversity, use, and implications for sustainable food system: An exploratory analysis in India. *Frontiers in Sustainable Food Systems* 4: 56.
- Rozelle S, Benzinger V, Huang J. 2002. Continuity and change in China's rural periodic markets. Working Papers 02-009, Department of Agricultural and Resource Economics, University of California, Davis, USA.
- Reeves TG, Thomas G, Ramsay G. 2016. Save and grow in practice: Maize, rice, wheat—a guide to sustainable cereal production. UN Food and Agriculture Organization, Rome, Italy.
- Sadigov R. 2022. Rapid growth of the world population and its socioeconomic results. *The Scientific World Journal*. 2022: 8110229.
- Sathyavathi R, Janardhan K. 2011. Wild edible fruits used by Badagas of Nilgiri District, Western Ghats, Tamil Nadu, India. *Journal of Medicinal Plants Research* 8(2): 128-132.
- Saxena HO, Brahmam M. 1996. The Flora of Orissa. Vol. I-IV. Orissa Forest Development Corporation, Bhubaneswar, Odisha.
- Schmetzer K, Gilg HA, Schüssler U, Panjikar J, Calligaro T, Perin P. 2017. The Linkage between garnets found in India at the Arikamedu archaeological site and their source at the garibpet deposit. *The Journal of Gemmology*, 35(7):598–627.
- Sekharan R, Jagadeesan M. 1997. An ethnobotanical survey of Javvadhu hills, Tamil Nadu. *Ancient Science of Life* 16: 206-214.
- Sen S, Chakraborty R, De B, Devanna N. 2011. An ethnobotanical survey of medicinal plants used by ethnic people in West and South district of Tripura, India. *Journal of Forestry Research* 22: 417–26.
- Shankar B, Poole N, Bird FA. 2019. Agricultural inputs and nutrition in South Asia. *Food Policy* 82: 28–38.

- Sharma JK, Kumar S. 2012. Rural-urban dichotomy in Indian economy: Myth or reality?. *Indian Journal of Marketing* 42(9): 5-14.
- Sekhar CSC, Roy D, Bhatt Y. 2017. Food inflation and food price volatility in India: Trends and Determinants. *International Food Policy Research Institute, Washington, D.C., USA.*
- Sheu SY, Yao CH, Lei YC, Kuo TF. 2014. Recent progress in *Glinus oppositifolius* research. *Pharmaceutical Biology* 52: 1079–1084.
- Shirai Y, Rambo AT. 2014. Urban demand for wild foods in northeast Thailand: a survey of edible wild species sold in the Khon Kaen municipal market. *Ethnobotany Research and Applications* 12:113–129.
- Singh AK, Singh S, Saroj PL, Krishna H, Singh RS, Singh RK. 2019. Research status of bael (*Aegle marmelos*) in India: A review. *Indian Journal of Agricultural Sciences* 89 (10): 1563–1571.
- Singh V, Roy M, Garg N, Kumar A, Arora S, Malik DS. 2021 An insight into the dermatological applications of neem: A review on traditional and modern aspect. *Recent Advances in Anti-infective Drug Discovery* 16(2):94-121.
- Skinner GW. 1964. Marketing and social structure in rural China, part one. *Journal of Asian Studies* 24:3-42.
- Spencer JE. 1940. The Szechuan village fair. *Economic Geography* 16 (1):48-58.
- Sundriyal M, Sundriyal RC. 2004. Wild edible plants of the Sikkim Himalaya: Marketing, value addition and implications for management. *Economic Botany* 58(2): 300-315.
- Susanti H. 2015. Ethnobotanical study for swamp indigenous vegetables at Martapura market of South Kalimantan. *Ziraaah* 40 (2): 140-144.
- Tak M, Shankar B, Kadiyala S. 2019. Dietary transition in India: temporal and regional trends, 1993 to 2012. *Food Nutrition Bulletin* 40 (2): 254–270.
- Termote C, Van Damme P, Dhed'a Djailo B. 2011. Eating from the wild: Turumbu, Mbole and Bali traditional knowledge on non-cultivated edible plants, District Tshopo, DR Congo. *Genetic Resources and Crop Evolution* 58:585–618.
- The National Health Service. 2018. Why 5 A Day? U.K. Available at <https://www.nhs.uk/live-well/eat-well/why-5-a-day>
- Upreti K, Jalal JS, Tewari LM, Joshi GC, Pangtey YP, Tewari G. 2009. Ethnomedicinal uses of pteridophytes of Kumaun Himalaya, Uttarakhand, India. *Journal of American Science* 5:167–70.
- Wallace TC, Bailey RL, Blumberg JB, Freeman BB, Chen C-y O, Crowe-White KM et al. 2020. Fruits, vegetables, and health: A comprehensive narrative, umbrella review of the science and recommendations for enhanced public policy to improve intake. *Critical Reviews in Food Science and Nutrition* 60 (13): 2174-2211.
- Wang DD, Li Y, Bhupathiraju SN, Rosner BA, Sun Q, Giovannucci EL, Rimm EB, Manson JE, Willett WC, Stampfer MJ, Hu FB. 2021. Fruit and vegetable intake and mortality: results from 2 prospective cohort studies of US men and women and a meta-analysis of 26 cohort studies. *Circulation* 143(17):1642-1654.
- Webb P. Eiselen, H. 2009. *Fiat Panis: For a world without hunger*. Balance Publications, Hampp Media, Stuttgart, Germany.
- Wengrow D. 2008. Prehistories of commodity branding. *Current Anthropology* 49 (1):7-34.
- Widiandra OD, Sasana H. 2013. Analysis of the impact of modern market presence on the profitability of traditional traders (Case study in Traditional Market of Banyumanik Sub-district, Semarang City. *Diponegoro Journal of Economics* 2 (1):1-6.
- World Health Organization (WHO). 2019. Nutritional rickets: A review of disease burden, causes, diagnosis, prevention and treatment. World Health Organization, Geneva, Switzerland.
- World Health Organization (WHO). 2019a. Increasing fruit and vegetable consumption to reduce the risk of noncommunicable diseases. World Health Organization, Geneva, Switzerland.
- World Cancer Research Fund/American Institute for Cancer Research. 2018. Diet, Nutrition, Physical Activity and Cancer: a Global Perspective. U.K. Available at <https://www.wcrf.org/dietandcancer/resources-and-toolkit>.

Vakshasya S, Dixit G. 2018. Usage of flowers as ethnomedicine by ethnic people of Ind—Nepal sub-Himalayan border region of Pilibhit Tiger Reserve (PTR), India. *Ethnobotany* 30:49-52.

Van Andel T, Myren B, Van Onselen S. 2012. Ghana's herbal market. *Journal of Ethnopharmacology* 140(2):368–378.

Vazquez-Garcia V. 2008. Gender, ethnicity, and economic status in plant management: Uncultivated edible plants among the Nahuas and Popolucas of Veracruz, Mexico. *Agriculture Human Values* 25:65–77.

Verenkar NG, Sellappan K. 2018. Some potential natural dye yielding plants from the State of Goa, India. *Indian Journal of Natural Products and Resources* 8(4):306–315.

von Grebmer K, Bernstein J, Nabarro D, et al. 2016 *Global Hunger Index: Getting to zero hunger*. International Food Policy Research Institute, Washington, DC, USA.

Xu YK, Tao GD, Liu HM, Yan KL, Dao XS. 2004. Wild vegetable resources and market survey in Xishuangbanna ~ southwest China. *Economic Botany* 58(4):647–667.