# Wild edible plants of Northeast India: A tripartite review of nutritional, pharmacological and market value

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## Review

## Abstract

*Background*: Global food and nutritional insecurity, excavated by reliance on a narrow range of staple crops, has intensified micronutrient deficiencies worldwide. Wild edible plants (WEPs), embedded in indigenous knowledge systems, represent underutilized resources with nutritional, pharmacological, and economic potential. The North-Eastern Region (NER) of India, situated within two global biodiversity hotspots, harbors rich floral diversity and traditional WEP usage, yet their scientific validation and commercial exploration remain limited.

*Methods*: A systematic review of peer-reviewed literature published between 2000 and 2025 was conducted using Google Scholar, ScienceDirect, PubMed, and related databases. Studies were screened using predefined keywords focusing on nutritional composition, pharmacological activities, bioactive compound isolation, commercial utilization, and value addition.

*Results*: Among the initially retrieved records, 24 studies addressed nutritional aspects, 15 studies focused on commercial utilisation and 88 studies investigated medicinal uses. After applying the predefined eligibility criteria, 13 nutritional studies, 8 commercial utilisation studies and 63 medicinal utilisation studies were retained for qualitative synthesis, resulting in a total of 84 studies included in the final review. The findings indicate that many WEPs exhibit high protein, dietary fibre, essential micronutrient content, and diverse phytochemicals with antioxidant, anti-inflammatory, antimicrobial, and antidiabetic properties. Despite demonstrated bioactivity, large-scale commercialization and standardization remain limited.

*Conclusions*: Among the initially retrieved records, 24 studies addressed nutritional aspects, 15 studies focused on commercial utilisation and 88 studies investigated medicinal uses. After applying the predefined eligibility criteria, 13 nutritional studies, 8 commercial utilisation studies and 63 medicinal utilisation studies were retained for qualitative synthesis, resulting in a total of 84 studies included in the final review. The findings indicate that many WEPs exhibit high protein, dietary fibre, essential micronutrient content, and diverse phytochemicals with antioxidant, anti-inflammatory, antimicrobial, and antidiabetic properties. Despite demonstrated bioactivity, large-scale commercialization and standardization remain limited.

*Keywords*: Northeast India, Wild edible plants, Nutraceuticals, Bioactive compounds, Value addition

## Background

The growing concern over global food and nutritional insecurity has drawn attention to the limitations of modern agricultural systems, which rely heavily on a narrow range of staple crops (FAO 2021). This narrow dietary base has not only heightened vulnerability to food crises but also aggravated micronutrient deficiencies, commonly referred to as "hidden hunger", affecting nearly two billion people globally (Duguma 2020). Micronutrient deficiencies have become a serious global problem, especially in areas where the diet lacks variety (Flyman & Afolayan 2006). Although over 7,000 plant species are edible worldwide, only 417 are cultivated as food crops, and a mere 15 species contribute to 90% of global caloric intake, with rice, maize and wheat feeding more than four billion people (Casas *et al*. 2023, Asma *et al*. 2023). One of the greatest challenges facing humanity today is the widening disparity between the rapid growth of the global population and the availability of sufficient food resources. To mitigate this issue, researchers have shown increasing interest in identifying novel plant-based food sources that can enrich the human diet with both protein and non-protein energy components (Saikia & Deka 2015). Evidence suggests that dietary diversification through sustainable agriculture and the utilisation of wild plant resources as food can enhance nutritional security and resilience (Flyman & Afolayan 2006). Recent research also highlights that the extensive use of chemical agents such as fertilisers, herbicides and growth regulators in modern agriculture has diminished the natural taste, texture, and nutritional value of many cultivated crops (Sekeroglu *et al*. 2016). In addition, most foods consumed today undergo refined or modified processing techniques such as cooking, milling, leaching and husking that often lead to the depletion of essential nutrients (Legwaila *et al*. 2011). As a result, increasing scientific and nutritional interest has turned toward wild edible plants (WEPs), which grow naturally without cultivation and are utilized based on traditional ecological knowledge (Kidane & Kejela 2021). These plants are well adapted to their local environment and serve as vital sources of nutrients, including proteins, fats, fibres, vitamins and minerals, along with providing valuable by-products like medicines, dyes, fodder and fibres (Gogoi *et al*. 2024, Angami *et al*. 2006). Although indigenous leafy vegetables offer superior nutritional potential, they remain largely underexplored commercially (Barooah *et al*. 2023). With only about 5% of global plant species used for human consumption (Asfaw & Tadesse 2001), WEPs play a crucial role in improving food security and nutrition for over a billion people worldwide (Chen *et al*. 2022, Fongnzossie *et al*. 2020). The consumption of WEPs is deeply rooted in the traditional knowledge of indigenous communities, reflecting a harmonious balance between humans and nature. With growing global interest in natural products, sustainable diets and biodiversity conservation, WEPs have gained renewed attention as potential contributors to food, nutritional and health security.

Wild edible plants also play a crucial role in enhancing rural household income and ensuring livelihood security in developing regions. Despite the expansion of modern agriculture and industrial production, wild resources continue to support the economic stability of marginalised communities (Chowdhury *et al*. 2021). Local trading of these plants not only supplements income but also provides rural populations with access to the cash economy where wage opportunities are scarce (Meinhold & Darr 2021). Furthermore, the advancement of globalisation and digital commerce presents new possibilities for integrating WFPs into broader markets, unlocking their potential for sustainable international trade and economic growth. However, comprehensive economic assessments of WFPs remain limited. Most available studies are based on small-scale or localised data, which often fail to capture their true financial impact. As many of these plants are exchanged or consumed within communities rather than formally marketed, their economic value is frequently underestimated. Consequently, the broader significance of WFPs in rural and global economies remains inadequately explored and poorly documented.

Apart from their nutritional significance and increasing market demand wild edible plants demonstrate exceptional pharmacological potential due to their abundant and diverse phytochemical constituents. These species are rich in secondary metabolites such as flavonoids, alkaloids, terpenoids, saponins and phenolic compounds that exhibit potent antioxidant, antimicrobial, anti-inflammatory and anticancer activities (Chowdhury *et al*. 2021, Arya *et al*. 2024). Owing to their bioactive potential, plants continue to be a vital source of novel therapeutic agents. Several strategies have been developed to identify and isolate biologically active constituents from higher plants for drug discovery. According to the World Health Organisation (WHO), over 80% of the global population depends primarily on medicinal plants for healthcare needs (Sasidharan *et al*. 2011, Shanmugavel *et al*. 2018, Chowdhury *et al*. 2021). Remarkably, out of nearly 500,000 higher plant species identified globally, fewer than 15% have been subjected to pharmacological investigation, even though over 20,000 are acknowledged for their therapeutic importance (Basak *et al*. 2016). The fusion of traditional medicinal wisdom with modern scientific methodologies presents vast opportunities for discovering new bioactive compounds with potential pharmaceutical applications. Ethnobotanical insights, supported by advanced screening and analytical techniques, can accelerate the development of effective plant-derived drugs. Such integrative approaches not only enhance the understanding of medicinal flora but also contribute substantially to innovation in contemporary healthcare systems (Khalid *et al*. 2025).

The North-Eastern Region (NER)of India, comprising the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim, extends between 21°50′-29°34′N latitudes and 85°34′-97°50′E longitudes (Talang *et al*. 2023). Geographically positioned between two globally recognized biodiversity hotspots, the Eastern Himalayas and the Indo-Burma region. It represents one of the most biologically and culturally diverse landscapes worldwide (Mittermeier *et al*., 2011). The region is characterized by exceptional floristic and faunal richness alongside remarkable cultural heterogeneity, comprising more than 200 ethnic groups. Of the 450 tribal communities recorded in India, approximately 225 inhabit the NER, constituting nearly one-fourth of its population (Sajem & Gosai 2006). India is estimated to harbour nearly 800 species of wild edible plants (WEPs), of which approximately 300 species are utilized by tribal communities in the North-Eastern Hill (NEH) region for food, traditional medicine, and livelihood support (Bhatt *et al*. 2009; Konsam *et al*. 2016).

This review highlights traditionally consumed wild edible plants (WEPs) used by ethnic communities of Northeast India and systematically documents their nutritional composition and pharmacological relevance. It also aims to underscore the largely unexplored potential of WEPs as sustainable biological resources capable of strengthening food and nutritional security, supporting traditional healthcare systems, and improving rural livelihoods. An additional effort has been made to elucidate the market potential and value-addition prospects of these species. The findings presented in this article are expected to support future research aimed at detailed phytochemical investigation, therapeutic validation, and sustainable commercialization of wild edible plants.

## Materials and Methods

A systematic literature review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure a transparent and reproducible in the study selection process. A comprehensive literature search was performed using Google Scholar, Scopus and ScienceDirect to identify relevant studies on the nutritional, commercial and medicinal utilisation of WEPs in Northeast India. The search was conducted using combinations of the following keywords and Boolean operators: "wild edible plants" OR "WEPs", "Northeast India" OR "North East India"), ("nutrition" OR "nutritional composition" OR "food value" OR "medicinal use" OR "ethnomedicine" OR "commercial utilisation" OR "economic potential" OR "value addition". Only peer-reviewed articles published in English were considered for inclusion. Studies were considered if the articles (i) focused on wild edible plants occurring in Northeast India, (ii) reported information related to their nutritional composition, medicinal applications, or commercial utilisation, and (iii) provided sufficient methodological and experimental details. Studies were excluded if they were duplicate records, conference abstracts, editorials, book chapters, dissertations, review articles lacking primary data, or publications unrelated to the objectives of this review.

The database search identified 127 records. Following the removal of duplicate and irrelevant records, the remaining studies were screened based on their titles and abstracts. Full-text articles meeting the eligibility criteria were subsequently assessed in detail. The selected studies were then categorised into three thematic groups, namely nutritional studies, commercial utilisation of WEPs and medicinal utilisation of WEPs. Among the initially retrieved records, 24 studies addressed nutritional aspects, 15 studies focused on commercial utilisation and 88 studies investigated medicinal uses. After applying the predefined eligibility criteria, 13 nutritional studies, 8 commercial utilisation studies and 63 medicinal utilisation studies were retained for qualitative synthesis, resulting in a total of 84 studies included in the final review. For each eligible study, relevant information, including plant species, study location, nutritional composition, medicinal applications, commercial potential and key findings, was systematically extracted and synthesised. As the primary objective of this review was to compile and map the existing evidence on WEPs in Northeast India, no formal methodological quality assessment or risk-of-bias analysis was performed, which is consistent with evidence-mapping approaches (Fig. 1, Table 1).

## Results

### Nutritional Value of WEPs

Although wild plants play a minor role in daily diets, they hold immense cultural and nutritional importance for indigenous communities. Studies indicate that many wild edibles possess nutrient levels comparable to or even higher than those of cultivated crops (Nayak & Basak 2015). Researchers are increasingly exploring wild species as valuable providers of both protein and energy. Malnutrition remains a significant concern in many developing regions. Thus, encouraging the consumption of wild vegetables represents an economical and eco-friendly approach to reducing nutrient deficiencies while improving food security. Studies from the North Eastern Region (NER) of India consistently demonstrate the significant potential of wild edible plants as sustainable food resources to improve dietary diversity and reduce malnutrition among indigenous populations (Talang *et al*. 2023, Lalmuanpuii *et al*. 2024). The available literature highlights the remarkable nutritional diversity of wild edible plants from Northeast India, with considerable variation in moisture, crude protein, crude fat, crude fibre, ash, and carbohydrate contents (Table 1). These differences reflect the combined influence of species characteristics, edible plant parts, geographical origin, maturity stage, environmental conditions, analytical methodologies, and the reporting basis (fresh weight or dry weight) adopted in the original studies. These studies collectively reveal that many WEP species are nutritionally superior to common cultivated vegetables, affirming their vital supplementary role in regional food security. Several wild edible plants have been reported as valuable dietary protein sources, highlighting their potential contribution to enhancing nutritional security among indigenous and rural communities.

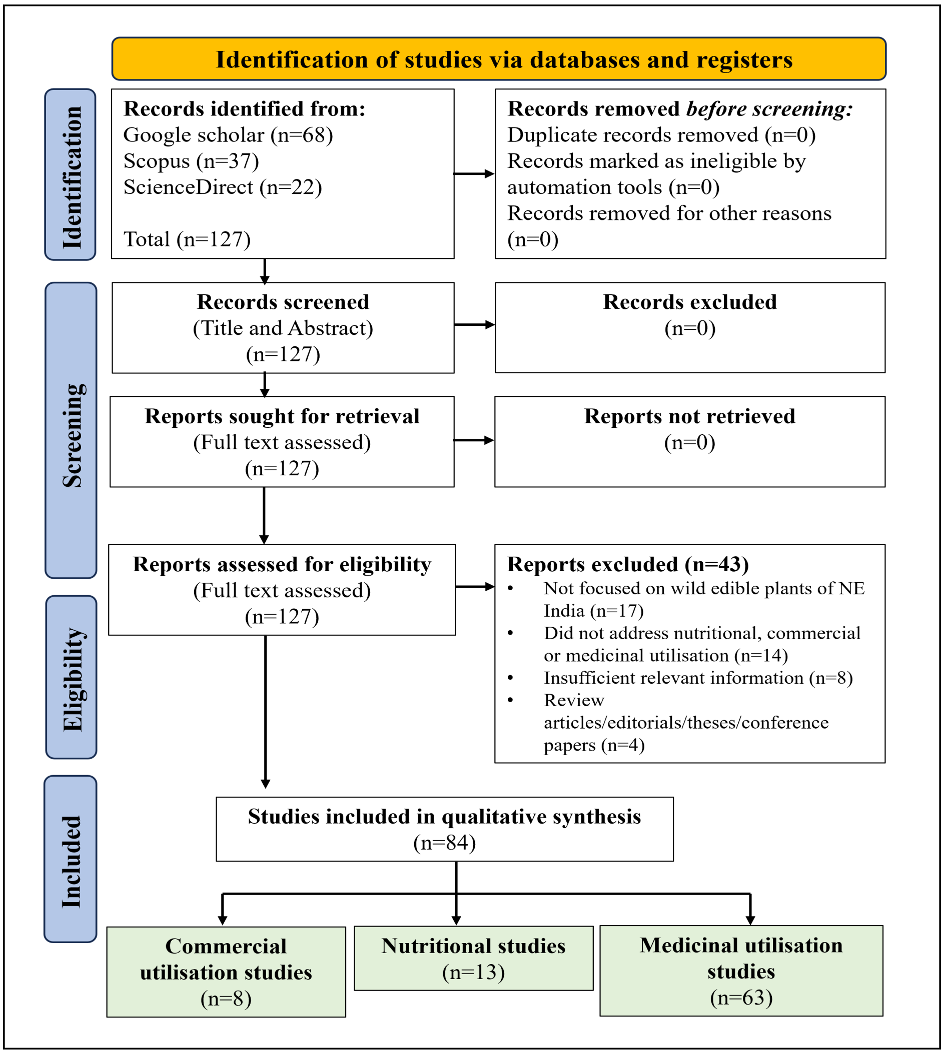


Figure 1. Schematic flow chart on screening and selection of articles based on nutritional, commercial and medicinal utilization of WEPs.

In studies reporting proximate composition on a dry weight (DW) basis, species such as *Phytolacca acinosa, Chenopodium album*, *Bacopa monnieri*, *Eclipta alba*, *Paederia foetida,* etc were identified as protein-rich edible plants (Choudhury *et al*. 2017, Chandra *et al*. 2016, Seal *et al*. 2017). Likewise, studies reporting nutritional composition on a fresh weight (FW) basis identified species such as *Herpetospermum operculatum*, *Lippia javanica*, *Natsiatum herpeticum*, and *Solanum nigrum* as notable sources of dietary protein (Narzary *et al.* 2015, Basumatry & Narzary 2017, Talang *et al*. 2023). On a dry weight basis, some species exhibit protein levels comparable to or exceeding those reported for commonly consumed leafy vegetables such as *Spinacia oleracea* (22.75%) (Ibrahim *et al*. 2025).The inclusion of these protein-rich WEPs in local diets may improve overall dietary quality by providing an additional source of plant-derived protein, thereby supporting balanced nutrition and helping address protein inadequacy, particularly among indigenous and rural populations that rely on locally available food resources. Several wild edible plants have also been identified as important sources of dietary fibre, emphasizing their potential role in promoting digestive health and improving overall dietary quality. Among studies reporting proximate composition on a dry weight (DW) basis, *Phlogacanthus thyrsiformis*, *Zanthoxylum oxyphyllum* (seeds), *Clerodendrum infortunatum*, *Houttuynia cordata*, *Amomum dealbatum*, *Leucas longifolia*, and *Polygonum chinense* were reported to possess appreciable fibre contents (Choudhury *et al*. 2017; Chandra *et al*. 2016; Gogoi *et al*. 2024). Similarly, fresh weight

(FW)-based studies identified *Litsea cubeba*, *Zanthoxylum rhetsa*, and *Trichodesma khasianum* as notable dietary fibre sources (Talang *et al*. 2023). High fibre intake is associated with improved digestive health, better regulation of blood glucose levels and reduced risk of metabolic disorders, thereby enhancing the nutritional value of these plants and supporting their role in promoting balanced diets and overall health (Barber *et al*. 2020). Although most wild edible plants contain low to moderate amounts of fat, several species were reported to possess relatively higher lipid contents. In DW-based studies, *Leucas plukenetii*, *Malva sylvestris*, *Houttuynia cordata*, *Oxalis acetosella*, and *Paederia foetida* exhibited comparatively higher crude fat contents (Choudhury *et al*. 2017; Chandra *et al*. 2016; Gogoi *et al*. 2024). Among FW-based studies, *Basella rubra*, *Brassica nigra*, *Bauhinia variegata*, and *Amaranthus viridis* were reported as relatively richer lipid sources (Verma *et al*. 2012; Jayanetti *et al*. 2024). These plants may contribute dietary lipids required for energy metabolism and the absorption of fat-soluble vitamins. Carbohydrates represent the principal source of dietary energy, and several WEPs have been reported to contain substantial carbohydrate levels. DW-based studies identified *Phytolacca acinosa*, *Piper pedicellatum*, *Pouzolzia hirta*, *Polygonum chinense*, *Chenopodium album*, and *Talinum triangulare* as carbohydrate-rich species (Choudhury *et al*. 2017; Chandra *et al*. 2016; Seal *et al*. 2017), whereas FW-based studies reported notable carbohydrate contents in *Bauhinia variegata*, *Lasia spinosa*, *Camellia sinensis*, *Polygonum perfoliatum*, and *Typhonium trilobatum* (Verma *et al*. 2012; Narzary *et al*. 2015). Collectively, these findings underscore the potential of WEPs to diversify diets and contribute to household food and nutritional security. Several wild edible plants are also valuable sources of dietary fibre. In studies reporting proximate composition on a dry weight (DW) basis, species such as *Phlogacanthus thyrsiformis*, *Zanthoxylum oxyphyllum* (seeds), *Clerodendrum infortunatum*, *Houttuynia cordata*, *Amomum dealbatum*, *Leucas longifolia*, *Polygonum chinense*, etc were identified as fibre-rich edible plants (Choudhury *et al*. 2017; Chandra *et al*. 2016; Gogoi *et al*. 2024). Likewise, studies reporting nutritional composition on a fresh weight (FW) basis identified species such as *Litsea cubeba*, *Zanthoxylum rhetsa*, *Trichodesma khasianum,* etc., asnotable dietary fibre sources (Talang *et al*. 2023). High fibre intake is associated with improved digestive health, better regulation of blood glucose levels and reduced risk of metabolic disorders, thereby enhancing the nutritional value of these plants and supporting their role in promoting balanced diets and overall health (Barber *et al*. 2020).Although wild edible plants are generally characterized by low to moderate fat contents, several species have been reported to contain appreciable amounts of lipids that may contribute to dietary energy and facilitate the absorption of fat-soluble vitamins(A, D, E and K), providing a concentrated source of energy. Among studies reporting proximate composition on a dry weight (DW) basis, relatively higher crude fat contents were observed in *Amomum dealbatum*, *Leucas plukenetii*, *Malva sylvestris*, *Houttuynia cordata*, *Oxalis acetosella*, and *Paederia foetida* (Choudhury *et al*. 2017; Chandra *et al*. 2016; Gogoi *et al*. 2024). Similarly, studies reporting nutritional composition on a fresh weight (FW) basis identified *Basella rubra*, *Brassica nigra*, *Phytolacca acinosa*, *Bauhinia variegata* and *Amaranthus viridis* as species with comparatively higher fat contents within their respective investigations (Verma *et al*. 2012; Jayanetti *et al*. 2024). Despite these differences, the generally low lipid content of most WEPs supports their inclusion as nutritious components of balanced diets. Carbohydrates represent the principal source of dietary energy, and several WEPs have been reported to contain substantial carbohydrate levels. DW-based studies identified *Phytolacca acinosa*, *Piper pedicellatum*, *Pouzolzia hirta*, *Polygonum chinense*, *Chenopodium album*, and *Talinum triangulare* as carbohydrate-rich species (Choudhury *et al*. 2017; Chandra *et al*. 2016; Seal *et al*. 2017), whereas FW-based studies reported notable carbohydrate contents in *Bauhinia variegata*, *Lasia spinosa*, *Camellia sinensis*, *Polygonum perfoliatum*, and *Typhonium trilobatum* (Verma *et al*. 2012; Narzary *et al*. 2015).High moisture content is a typical feature of fresh green leafy vegetables and is essential for improving palatability, digestibility and overall shelf-life. Most wild edible plants (WEPs) exhibit significantly high moisture levels. For instance, *Moringa oleifera* (98.20%) and *Brassica juncea* (92.22%) have been reported to have notably high moisture content, as documented by Saha et al. (2015). Crude ash content, which reflects the total mineral composition of plants, was also considerable in many WEPs. High ash values were recorded in species like *Basella rubra* (20.76%), *Brassica juncea* (26.01%), *Talinum triangulare* (24.58%) and *Chenopodium album* (21.42%), suggesting that these plants are rich sources of essential minerals (Saha *et al*. 2015, Chandra *et al*. 2016). Overall, the nutritional composition of wild edible plants from Northeast India highlights their potential as alternative nutrient resources. Their balanced proportions of moisture, fibre, lipids, proteins and carbohydrates make them suitable for inclusion in local diets to enhance food and nutritional security. Considering their nutrient richness, low cost and widespread availability, particularly in tribal and rural communities, greater promotion and scientific validation of these underutilized plants could play a significant role in sustainable dietary diversification.

Table 1. Proximate nutritional compositions of selected edible plant species of North East India

| **Species name** | **Part used** | **Basis** | **Moisture (%)** | **Crude ash (%)** | **Crude fat (%)** | **Crude fibre (%)** | **Crude protein (%)** | **Crude carbohydrate (%)** | **References** |
|---|---|---|---|---|---|---|---|---|---|
| *Alocasia odora (*G.Lodd.) Spach | Stem | FW | 90.8 | 2.13 | 0.12 | 1.52 | 2.21 | 4.13 | Saikia & Deka 2015 |
| *Alternanthera philoxeroides (*Mart.) Griseb | Leaves | FW | 85.7 | 2.61 | 0.13 | - | 2.74 | 7.14 | Saikia & Deka 2015 |
| *Alternanthera sessilis* (L.) R.Br. ex DC*.* | Tender parts | DW | 83.46 | 13.8 | 2.13 | 16.10 | 16.64 | - | Choudhury *et al*. 2017 |
| *Amaranthus spinosus* L. | Leaves | | 83.30 | 5.18 | 0.47 | 10.20 | 5.40 | 29.23 | Pereira *et al*. 2023 |
| *Amomum dealbatum* Roxb. | Flower buds | DW | 90.33 | 17.64 | 6.46 | 18.72 | 11.41 | - | Gogoi *et al*. 2024 |
| *Antidesma acidum* Retz. | Tender shoot | FW | 87.57 | 1.32 | 0.70 | - | 1.47 | 8.92 | Narzary *et al*. 2015 |
| *Bacopa monnieri (*L.*)* Pennell | Tender parts | DW | 83.59 | 8.70 | 3.10 | 9.13 | 24.67 | - | Choudhury *et al*. 2017 |
| *Basella alba* L. | Leaves | DW | 88.46 | 8.23 | 0.66 | 2.34 | 4.72 | 11.16 | Saha *et al*. 2015 |
| *Basella rubra* L. | Leaves | DW | 88.44 | 20.76 | 0.61 | 8.61 | 10.31 | 7.84 | Saha *et al*. 2015 |
| *Bauhinia variegata* L. | Flower bud | | 73.95 | 6.53 | 2.42 | - | 4.49 | 86.56 | Verma *et al*. 2012 |
| *Blumea lanceolaria* Roxb. | Leaves | FW | 88.87 | 1.96 | 0.31 | - | 1.84 | 7.00 | Narzary *et al*. 2015 |
| *Brassica juncea* (L.) Czern | Leaves | DW | 92.22 | 26.01 | 2.99 | 1.35 | 3.86 | 7.39 | Saha *et al*. 2015 |
| *Brassica nigra* L. Al-Shehbaz | Leaves | DW | 89.95 | 18.41 | 4.19 | 1.34 | 4.03 | 5.56 | Saha *et al*. 2015 |
| *Camellia sinensis* (L.) Kuntze | Tender shoot | FW | 81.96 | 1.97 | 0.64 | - | 2.92 | 12.48 | Narzary *et al*. 2015 |
| *Cardamine hirsute* L. | Whole plant | FW | 92.89 | 1.78 | 0.24 | 1.64 | 3.99 | 1.70 | Basumatry & Narzary 2017 |
| *Centella asiatica* (L.) Urban | - | FW | 91.21 | 1.35 | 0.29 | 5.44 | 2.28 | - | Talang *et al*. 2023 |
| *Chenopodium album* L. | Leaves | DW | 77.57 | 21.42 | 3.20 | 9.06 | 28.03 | 5.35 | Chandra *et al*. 2016 |
| *Clerodendrum glandulosum* Lindl. | - | FW | 87.17 | 1.57 | 0.37 | 9.01 | 3.75 | - | Talang *et al*. 2023 |
| *Clerodendrum infortunatum* L. | Tender Leaves | DW | 73.44 | 2.06 | 2.05 | 21.58 | 12.37 | - | Gogoi *et al*. 2024 |
| *Diplazium esculentum* (Retz.) Sw. | Leaves | DW | 71.74 | 14.42 | 0.34 | 4.45 | 18.32 | 5.45 | Saha *et al*. 2015 |
| *Drymaria cordata (*L.) Willd. ex Schult | Whole plant | FW | 89.23 | 2.71 | 0.16 | - | 2.58 | 5.29 | Narzary *et al*. 2015 |
| *Eclipta abla (*L.) L. | Tender parts | DW | 91.09 | 13.8 | 2.13 | 16.10 | 23.64 | - | Choudhury *et al*. 2017 |

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|---|---|---|---|---|---|---|---|---|---|
| *Enhydra fluctuans* Lour. | Leaves and stem | FW | 89.28 | 1.51 | 0.51 | - | 1.39 | 7.29 | Narzary *et al*. 2015 |
| *Eryngium foetidum* L. | Leaves | FW | 87.24 | 1.44 | 0.33 | - | 2.09 | 8.87 | Narzary *et al*. 2015 |
| *Garcinia cowa* Roxb. ex DC. | - | FW | 90.64 | 0.99 | 0.41 | 5.55 | 2.75 | | Talang *et al*. 2023 |
| *Glinus oppositifolius* (L.) Aug.DC | Tender shoot | FW | 90.53 | 2.17 | 0.20 | - | 1.58 | 5.50 | Narzary *et al*. 2015 |
| *Herpetospermum operculatum* | - | FW | 80.0 | 3.43 | 0.35 | 6.98 | 6.66 | - | Talang *et al*. 2023 |
| *Houttuynia cordata* Thunb. | Tender parts | DW | 88.25 | 12.67 | 4.80 | 17.60 | 17.6 | - | Choudhury *et al*. 2017 |
| *Lasia spinosa* (L.) Thwaites | Whole plant | DW | 83 | 3.4 | 1.16 | - | 17.6 | 35.74 | Brahma *et al*. 2014 |
| *Leucas longifolia* Benth. | Tender parts | DW | 84.6 | 12.5 | 2.80 | 13.10 | 24.67 | - | Choudhury *et al*. 2017 |
| *Leucas plukenetii (*Willd.) Link | Leaves | DW | 73.72 | 11.58 | 6.16 | 12.10 | 21.21 | 18.80 | Chandra *et al*. 2016 |
| *Lippia javanica (*Burm. f.) Spreng. | Young leaves | FW | 84.53 | 3.15 | 0.27 | - | 4.38 | 7.65 | Narzary *et al*. 2015 |
| *Litsea Cubeba* (Lour.) | - | FW | 72.3 | 1.16 | 1.18 | 16.0 | 3.47 | - | Talang *et al*. 2023 |
| *Malva sylvestris* L. | Tender parts | DW | 88.46 | 11.10 | 6.20 | 11.10 | 31.60 | - | Choudhury *et al*. 2017 |
| *Melothriaperpusilla*(Blume) Cogn. | Whole plant | FW | 82.83 | 0.66 | 0.21 | 3.03 | 2.64 | 13.64 | Basumatry & Narzary 2017 |
| *Moringa oleifera* Lam. | leaves | DW | 98.20 | 8.93 | 3.01 | 0.25 | 4.72 | 8.58 | Saha *et al*. 2015 |
| *Natsiatum herpeticum* Buch. -Ham. ex Arn | Whole plant | FW | 83.72 | 3.42 | 0.67 | 1.99 | 5.37 | 6.80 | Basumatry & Narzary 2017 |
| *Oenanthe javanica* (Blume) DC. | Leaves | FW | 90.44 | 1.60 | 0.16 | - | 1.22 | 6.55 | Narzary *et al*. 2015 |
| *Oxalis acetosella* L. | Tender parts | DW | 89.08 | 13.50 | 4.33 | 10.50 | 31.54 | - | Choudhury *et al*. 2017 |
| *Paederia foetida* L. | leaves | DW | 76.93 | 12.40 | 4.16 | 14.08 | 23.42 | 8.12 | Chandra *et al*. 2016 |
| *Persicaria chinensis* (L.) H.Gross. | Whole plant | FW | 92.35 | 1.58 | 0.33 | 2.57 | 3.66 | 2.07 | Basumatry & Narzary 2017 |
| *Phlogacanthus thrysiformis* (Roxb. ex Hardw.) Mabb | Tender Leaves | DW | 79.77 | 3.46 | 2.21 | 41.36 | 20.92 | - | Gogoi *et al*. 2024 |
| *Phytolacca acinosa* Roxb. | Leaves | DW | 72.37 | 18.65 | 1.32 | 1.54 | 21.90 | 56.57 | Seal *et al*. 2017 |
| *Piper pedicellatum* C. DC. | Leaves | DW | 89.44 | 13.12 | 0.60 | 1.99 | 21.22 | 63.06 | Seal *et al*. 2017 |
| *Plukenetia corniculata* Sm. | - | FW | 72.7 | 4.57 | 1.36 | 11.13 | 5.27 | - | Talang *et al*. 2023 |
| *Polygonum Chinese* L. | Tender parts | DW | 91.14 | 9.77 | 3.20 | 12.20 | 34.15 | - | Choudhury *et al*. 2017 |
| *Polygonum perfoliatum* (L.) L. | Young leaves | FW | 85.23 | 1.37 | 0.76 | - | 3.38 | 9.23 | Narzary *et al*. 2015 |

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|---|---|---|---|---|---|---|---|---|---|
| *Pouzolzia hirta*(Blume ex Hassk.) Miq. | Leaves | DW | 77.35 | 17.99 | 1.31 | 1.01 | 19.19 | 60.47 | Seal *et al*. 2017 |
| *Pteridium aquilinum (*L.) Kuhn | Tender parts | DW | 87.14 | 11.27 | 2.30 | 9.10 | 39.38 | - | Choudhury *et al*. 2017 |
| *Solanum nigrum* L. | Leaves | FW | 86.3 | 2.55 | 0.07 | 2.52 | 3.34 | 6.46 | Saikia & Deka 2015 |
| *Sphaeranthus peguensis* Kurz ex C.B.Clarke. | Whole plant | FW | 90.89 | 2.35 | 0.25 | 1.92 | 3.18 | 3.32 | Basumatry & Narzary 2017 |
| *Sphenoclea zeylanica* Gaertn. | Whole plant | FW | 92.81 | 1.49 | 0.12 | 1.25 | 3.08 | 2.55 | Basumatry & Narzary 2017 |
| *Stellaria media* (L.) Vill. | Whole plant | FW | 90.84 | 2.09 | 0.24 | - | 1.83 | 4.97 | Narzary *et al*. 2015 |
| *Talinum triangulare* (Jacq.) Willd. | Leaves | DW | 89.60 | 24.58 | 3.70 | 9.06 | 27.80 | 6.35 | Chandra *et al*. 2016 |
| *Trichodesma khasianum* C.B.Clarke | - | FW | 72.2 | 3.96 | 0.35 | 14.58 | 5.89 | - | Talang *et al*. 2023 |
| *Trifolium angstifolium* L. | Young leaves | FW | 87.46 | 1.15 | 0.52 | - | 1.86 | 8.99 | Narzary *et al*. 2015 |
| *Typhonium trilobatum* (L.) Schott. | Leaves | FW | 87.2 | 2.64 | 0.10 | 2.72 | 2.13 | 6.30 | Saikia & Deka 2015 |
| *Zanthoxylum oxyphyllum* Edgew | Seeds | DW | 23.0 | 1.0 | 4.42 | 29.2 | 6.11 | - | Gogoi *et al*. 2024 |
| *Zanthoxylum oxyphyllum* Edgew | Tender Leaves | DW | 80.44 | 2.0 | 1.75 | 24.46 | 27.86 | - | Gogoi *et al*. 2024 |
| *Zanthoxylum rhetsa* (Roxb.) DC. | - | FW | 88.14 | 1.82 | 0.50 | 11.15 | 3.64 | - | Talang *et al.* 2023 |

“-” indicates no data available

**Commercial value of WEPs in Northeast India**

Wild edible plants have evolved from their traditional role as simple food sources to become a vital livelihood resource for marginalized groups nationwide. Available in both unprocessed and processed forms, they offer income opportunities and are commonly traded in local markets (Mihu *et al*. 2025). These plants form a crucial part of the sustenance and local economies of indigenous communities across Northeast India. Recent studies highlight the significant commercial value of these bioresources, which are increasingly moving from local consumption to bustling markets, thus providing a vital income source for many households. The trade in WEPs varies across states like Sikkim, Assam, Manipur, Arunachal Pradesh, Tripura, Nagaland and Mizoram, demonstrating a deep-rooted traditional knowledge which is now intersecting with modern market dynamics. Throughout the region, the trade of wild bioresources is a key element of the rural economy. Markets in Northeast India are lively centres for a diverse range of WEPs. A study in Assam documented about 158 species of wild plants in local markets, and the selling of wild resources contributes around 75% to the total income of many rural households. This income is essential for communities with limited access to wage labour, offering a pathway into the cash economy (Chaudhury *et al*. 2021). Similarly, in the Sikkim Himalaya, wild edible plants are a vital income source for plant dwellers and serve as a subsistence option for farming families. The total trade of wild edible plants in Sikkim is estimated at around 140 tons annually, generating roughly Rs 15 lakhs each year (Sundriyal & Sundriyal 2004). while a survey at Mizoram's largest local market, Bara Bazar, recorded 47 different WEVs being sold (Lalmuanpuii *et al*. 2024). Mizoram's markets also display a broad price range, from 0.1 to 2.4 USD, depending on the species and season. For example, tender shoots of bamboo species like *Dendrocalamus hamiltonii* and cane shoots from *Calamus* species are highly sought after and fetch good prices, significantly boosting household incomes (Lalmuanpuii *et al*. 2024). In a survey from Tripura, (Reang *et al*. 2024) studied the markets in Jirania, Champaknagar, Garjee and BC Manu, recording 17 wild edible vegetable species, including leafy, floral, fruit and tender shoot types. These markets trade about 500 kg of wild edibles daily, generating around Rs. 7,000-10,000 in revenue. Popular species of wild edibles commonly traded in these markets include *Amorphophallus bulbifer*, *Melocanna baccifera*, *Dioscorea hamiltonii* and *Hibiscus sabdariffa*. In Nagaland, indigenous wild edible fruits play a vital role in ensuring food security, traditional healthcare, and livelihood support. 47 wild fruit species belonging to 29 families were sold in local markets across Kohima, Phek and Tuensang (Khruomo & Deb 2018). Highly traded species such as *Rhus semialata*, *Terminalia chebula*, *Spondias pinnata* and *Emblica officinalis* generated market prices of INR 10 to 100 per packet, contributing substantially to rural incomes, with seasonal earnings ranging from INR 1 to 2.5 lakhs. A report from Meghalaya underscored the significance of non-timber forest products in rural livelihoods, revealing that nearly 40% of these resources are consumed as wild edible plants. This highlights the vital role of forest-derived foods in supporting nutrition, food security and traditional diets (Lynser & Tiwari 2016). In some parts of the northeast, value addition in WEPs is done to maximise profit from wild edible plants. Particularly, all of these value-added processes were carried out manually using minimal processing. The processing methods used involved simple techniques such as drying, chopping, pickling, boiling, fermentation, filtration and packaging. A study in Manipur revealed that WEPs are primarily collected from community forests and marketed in suburban areas, often directly by the collectors without intermediaries. Commonly traded species include *Eurya acuminata*, *Oenanthe javanica* and wild mushrooms such as *Schizophyllum commune*. Prices vary with species, freshness, and season. Although processing and value addition remain minimal, the sale of WEPs contributes notably to household income and food security, underscoring their growing commercial and economic importance in Manipur's markets (Ningthoujam *et al*. 2022). In Arunachal Pradesh, commercialization of WEPs has expanded beyond raw product to include value-added food products prepared using traditional knowledge. A year-long market assessment was conducted from June 2022 to June 2023 across nine districts of Arunachal Pradesh, documenting 323 vendors engaged in the sale of value-added products derived from wild edible plants in daily, weekly and roadside markets (Mihu *et al*. 2025). These vendors functioned as both collectors and traders, sourcing WEPs from forest areas as well as private and community lands. The survey recorded 14 wild edible plant species belonging to nine families, marketed in both fresh and processed forms. In total, 19.7 metric tonnes of raw WEPs and 119.6 metric tonnes of value-added products were traded, generating revenues of ₹5,478,640 and ₹27,962,700, respectively, with value addition increasing returns by approximately 2-10 times per kilogram (Figure 2). Sundriyal and Sundriyal (2004) conducted comprehensive studies on the marketing and value addition of wild edible plants in the Sikkim Himalaya, focusing on three major markets of Sikkim: Gangtok, Namchi and Singtam. Across these markets, a total of 44 wild edible species were recorded, with several available throughout the year. Peak species diversity occurred during April-May in Gangtok, January-March in Namchi and February and July-August in Singtam. *Spondias axillaris* was the most traded species, sold in the highest quantity (4995 kg at Rs. 10-12/kg), followed by *Machilus edulis* and *Diplazium esculentum*. The study also noted the use of certain wild edibles for preparing pickles, chutneys, jams, jellies, and squashes, enhancing their market value and economic returns.

Although the commercialization of wild edible plants (WEPs) has expanded across Northeast India, several bottlenecks continue to restrict their economic potential. Limited value addition, inadequate post-harvest infrastructure, poor transportation and market access, insufficient technical expertise, and dependence on seasonal wild harvesting reduce profitability and market stability. Weak institutional support, limited producer organizations, and inadequate policy frameworks further constrain value-chain development (Meinhold & Darr 2021, Bora & Mahanta 2024). Comparative analysis across the region indicates that economic returns depend not only on species diversity but also on the efficiency of value chains. States such as Arunachal Pradesh and Sikkim, which emphasize processing, product diversification, and organized marketing, generate substantially higher returns than those relying primarily on fresh produce. Strengthening value addition, post-harvest management, market infrastructure, producer cooperatives, branding, certification and supportive policies will improve market competitiveness while enhancing rural livelihoods and promoting the sustainable utilization and conservation of WEP resources (Fig. 2).


Figure 2. Conceptual framework of stakeholder interactions, value addition and economic flow in the wild edible plant (WEP) value chain.

**WEPs as traditional medicines**

Wild edible plants (WEPs), in addition to serving as important sources of staple foods, functional foods and nutritional supplements, also play a significant role in traditional medicine across many regions of the world. They are rich in plant-derived secondary metabolites that act as lead compounds and have been widely investigated for novel drug discovery (Sivakumar & Sunmathi 2016). In fact, a large proportion of modern pharmaceuticals are of natural origin. According to the World Health Organization (WHO), nearly 80% of the global population depends on herbal products for primary healthcare needs (Chowdhury *et al*. 2021). This widespread reliance is attributed to their affordability, minimal side effects, and potent pharmacological efficacy. Numerous species belonging to families such as Amaranthaceae, Asteraceae, Fabaceae, Lamiaceae, Brassicaceae and others have been documented for diverse bioactivities, underscoring their therapeutic potential in both traditional and modern medicine. These plants exhibit antioxidant, antimicrobial, anti-inflammatory, antidiabetic, anticancer and cytotoxic properties, making them valuable in mitigating oxidative stress and managing various chronic disorders. Globally, cancer and diabetes remain the leading and most serious health challenges, emphasizing the need for novel and effective therapeutic options. Certain wild edible species have shown cytotoxic potential, indicating their usefulness in developing cancer treatments. Notably, plants like *Antidesma acidum*, *Brassica juncea*, and *Phlogacanthus thyrsiformis* have been documented for their significant roles in combating cancer (Kiem *et al*. 2016, Rahmatullah *et al*. 2010, Poeaim *et al*. 2016, Pintatum & Laphookhieo 2022). While *Amaranthus spinosus* and *Amaranthus viridis* (Amaranthaceae) possess anti-inflammatory, antitumor and antioxidant properties (Zeashan *et al*. 2009, Kumar *et al*. 2011). At present, infectious diseases are increasing globally, raising serious concern due to the growing resistance of microorganisms to commonly used modern antibiotics. Plants, long valued in traditional medicine, offer promising potential for developing novel and effective antimicrobial agents through systematic exploration and scientific evaluation. WEPs such as, *Bacopa monnieri* and *Basella alba* exhibit a broad spectrum of antimicrobial and antioxidant effects (Mathur *et al*. 2010, Adegoke *et al*. 2017). Several Asteraceae members, including *Blumea lanceolaria*, *Eclipta alba* and *Enhydra fluctuans*, have also demonstrated strong antimicrobial and antioxidant activities (Mishra *et al*. 2015, Pandey *et al*. 2011). Moreover, lesser-known taxa like *Drymaria cordata*, *Lasia spinosa* and *Phytolacca acinosa* show antidiabetic, thrombolytic and cytotoxic effects, broadening the pharmacological scope of traditionally used plants (Arya *et al*. 2024, Chowdhury *et al*. 2021, Khalid *et al*. 2025). *Clerodendrum infortunatum*, one of the recently studied species, exhibits potent antioxidant and anti-inflammatory activity, supporting its ethnomedicinal use in inflammatory disorders (Verma *et al*. 2025). The compiled body of evidence establishes a strong scientific rationale for conducting advanced phytochemical and pharmacological investigations aimed at isolating and characterizing bioactive constituents with potential therapeutic applications in drug discovery and disease management (Fig. 3). An overview of previously documented studies describing the bioactive potential of various wild edible plants commonly consumed as vegetables is presented separately in Table 2.

The pharmacological significance of WEPs is closely linked to their rich diversity of bioactive compounds. Various studies have identified and characterised compounds responsible for these biological activities, as summarised in Table 3 and illustrated in Figure 4. For instance, *Houttuynia cordata*, a widely consumed wild plant in Northeast India, is recognised for its remarkable medicinal potential. Several bioactive constituents, including Quercitrin, quercetin-3-O-β-D-glucopyranoside, norcepharadione B, Cepharadione B, houttuynoside A and houttuynamide A, were identified in its methanolic extract. These compounds exhibited significant antiviral, antioxidant and anti-tyrosinase activities (Chou *et al*. 2009). Similarly, *Malva sylvestris* has demonstrated significant antioxidant, anti-inflammatory, and anti-osteoclastogenic properties in both in vitro and in vivo studies. Phytochemical analysis identified rutin as the predominant bioactive constituent of the aqueous fraction (Benso *et al*. 2016). Several wild edible plants from Northeast India have been reported to exhibit antidiabetic properties. For instance, *Antidesma acidum*, a wild edible leafy vegetable of the region, has been found to contain Kaempferol 3-O-rutinoside, a compound isolated by Kashyap *et al*. (2023), which has been documented for its notable antidiabetic activity by enhancing glucose utilisation through SIRT1 activation, thereby improving insulin sensitivity. Similarly, *Amaranthus viridis*, a well-known wild edible plant of Northeast India, was reported by Helen *et al*. (2023) to contain Decane 1,1-Diethoxy and Epibromohydrine exhibiting antidiabetic and antiurolithiatic activities. Likewise, flowers of Amomum dealbatum yielded quercetin-3-O-galactoside, myricetin, and gallic acid, with quercetin-3-O-galactoside showing strong α-glucosidase inhibitory activity. The bioactive ethyl acetate fraction also markedly reduced blood glucose levels in diabetic rats, highlighting its antidiabetic potential (Chelleng 2023). Several wild edible plants, including *Solanum nigrum*, *Chenopodium album* and *Lasia spinosa*, have been reported to exhibit potent cytotoxic properties attributed to their bioactive constituents. Alam *et al*. (2011) isolated Meridinol from the rhizome of *Lasia spinosa*, which demonstrated significant cytotoxic activity in the brine shrimp lethality bioassay. Likewise, Nawaz *et al*. (2024) identified two bioactive compounds, Quercetin and Chlorogenic acid, from *Solanum nigrum*, both of which exhibited pronounced anticancer activity against HepG2 and HeLa cell lines, respectively. Furthermore, Javed *et al*. (2022) isolated Lectin from the seeds of *Chenopodium album*, which displayed notable antibacterial activity against *Staphylococcus aureus* and strong anticancer potential by suppressing AFP and GPC3 expression by nearly 90% in HepG2 cells, thereby suggesting its apoptosis-inducing therapeutic potential. Despite these promising findings, most pharmacological evidence is derived from in vitro assays and in silico analyses, whereas only a limited number of wild edible plants have been validated through in vivo animal studies. Therefore, further well-designed in vivo investigations and clinical studies are essential to validate their therapeutic efficacy and facilitate their translation into potential medicinal applications. In addition, comprehensive toxicological evaluations, including acute and chronic toxicity studies, are necessary to establish their long-term safety.

Table 2. Bioactivity of some wild edible plants of NorthEast India consumed as vegetables

| Plant | Family | Part use | Pharmacological activity | Mode of Study | References |
|---|---|---|---|---|---|
| *Alternanthera philoxeroides* | *Amaranthaceae* | Leaves | Antimicrobial | *In vitro* | Sivakumar & Sunmathi 2016 |
| *Alternanthera sessilis* | *Amaranthaceae* | Tender parts | Antioxidant, antimicrobial, anticataract | *In vitro* | Kota *et al*. 2017 |
| *Amaranthus Spinosus* | *Amaranthaceae* | Leaves | Anti-inflammatory, Antibacterial, analgesic | *In vitro; In Vivo* | Zeashan *et al*. 2009, Maiyo *et al*. 2010 |
| *Amaranthus viridis* | *Amaranthaceae* | - | Antioxidant, anti-inflammatory | *In vivo* | Kumar *et al*. 2011 |
| *Amomum dealbatum* | *Zingiberaceae* | Flowers | Antidiabetic | *In vitro* | Pintatum & Laphookhieo 2022 |
| *Antidesma acidum* | *Euphorbiaceae* | Leaves | Anticancer | *In vitro* | V Kiem *et al*. 2016 |
| *Bacopa monnieri* | *Plantaginaceae* | Whole plant | Antibacterial, cytotoxic, analgesic, antioxidant, antimicrobial, anti-inflammatory | *In vitro* | Mathur *et al*. 2010, Basak *et al*. 2016 |
| *Basella alba* | *Basellaceae* | Leaf, stem, fruits | Antioxidant, antimicrobial | *In vitro* | Adegoke *et al*. 2017 |
| *Basella rubra* | *Basellaceae* | Leaf, stem, fruits | Antioxidant, antimicrobial | *In vitro* | Adegoke *et al*. 2017 |
| *Bauhinia variegata* | *Fabaceae* | Flower Bud | Antioxidant, antitumor | *In vitro; In vivo* | Pandey *et al*. 2017, Johnson *et al*. 2018 |
| *Blumea lanceolaria* | *Asteraceae* | Leaves | Antimicrobial, antioxidant | *In vitro* | Mishra *et al*. 2015 |
| *Brassica juncea* | *Brassicaceae* | Leaves | Anticancer, antinociceptive, antihyperglycemic | *In vitro; In vivo* | Rahmatullah *et al*. 2010, Kwak *et al*. 2016 |
| *Brassica nigra* | *Brassicaceae* | Leaves | Antioxidant, anti-inflammatory, Nephroprotective, hepatoprotective | *In vitro; In vivo* | Rajamurugan *et al*. 2012, Alam *et al*. 2011 |
| *Camellia* sinensis | *Theaceae* | Shoot | Antioxidant | *In vitro* | Chan *et al*. 2007 |
| *Chenopodium album* | *Amaranthaceae* | Leaves | Anthelmintic, antimicrobial, antioxidant | *In vitro; In vivo* | Lone *et al*. 2017 |
| *Clerodendrum infortunatum* | *Lamiaceae* | Tender leaves | Antioxidant, anti-inflammatory | *In vitro; In vivo* | Verma *et al*. 2025 |
| *Diplazium esculentum* | *Athyriaceae* | Leaves | Antibacterial | *In vitro* | Saragih*et al*. 2025 |
| *Drymaria cordata* | *Caryophyllaceae* | Whole plant | Oxidative stress, bacterial infections, antidiabetic | *In vitro* | Arya *et al*. 2024 |
| *Eclipta abla* | *Asteraceae* | Aerial part | Antibacterial | *In vitro* | Pandey *et al*. 2011 |
| *Enhydra fluctuans* | *Asteraceae* | Leaves and stem | Antioxidant, anthelmintic, thrombolytic | *In vitro* | Kuri *et al*. 2014 |
| *Houttuynia cordata* | *Saururaceae* | Leaves | Antibacterial, anti-inflammatory | *In vitro* | Sekita *et al*. 2016 |
| *Lasia spinosa* | *Araceae* | Whole plant | Thrombolytic, analgesic, anti-inflammatory, | *In vitro; In vivo* | Goshwami *et al*. 2012, Chowdhury *et al*. 2021 |

| | | | | | |
|---|---|---|---|---|---|
| | | | antioxidant, cytotoxicity, antimicrobial | | |
| *Leucas longifolia* | *Lamiaceae* | Whole plant | Antioxidant, antiglycation | *In vitro* | Pratima *et al*. 2024 |
| *Lippia javanica* | *Verbenaceae* | Leaves | Antioxidant, anti-inflammatory, antimicrobial | *In vitro* | Asowata-Ayodele *et al*. 2016 |
| *Malva sylvestris* | *Malvaceae* | Whole plant | Antioxidant, anti-inflammatory, anticancer, wound-healing, hepatoprotective, antinociceptive, antimicrobial | *In vitro; In vivo* | Mousavi 2021 |
| *Moringa oleifera* | *Moringaceae* | Leaves | Anti-inflammatory, antioxidant | *In vitro; In vivo* | Lin *et al*. 2018 |
| *Phlogacanthus thrysiformis* | *Acanthaceae* | Leaves | Antioxidant, cytotoxic | *In vitro* | Poeaim *et al*. 2016 |
| *Phytolacca acinosa* | *Phytolaccaceae* | Leaves | Antioxidant, cytotoxic, antitumour | *In vitro* | Khalid *et al*. 2025 |
| *Polygonum Chinese* | *Polygonaceae* | Leaves | Antidiarrheal | *In vitro; In vivo* | Xiao *et al*. 2013 |
| *Piper pedicellatum* | *Piperaceae* | Leaves | Antifungal, antioxidant | *In vitro* | Tamuly *et al*. 2013 |
| *Pteridium aquilinum* | *Dennstaedtiaceae* | Tender parts | Antimicrobial | *In vitro* | Awe & Amobi 2015 |
| *Sesamum indicum* L. | *Pedaliaceae* | Seeds | Anti-inflammatory, anticancer | - | Watanabe *et al*. 2017<br>Zhang *et al*. 2016 |
| *Sesbania grandiflora* | *Fabaceae* | Flower | Antimicrobial | *In vitro*; *In situ* | China *et al*. 2012 |
| *Solanum nigrum* | *Solanaceae* | Leaves | Antioxidant, antibacterial | *In vitro* | Campisi *et al*. 2019, Hayat *et al*. 2025 |
| *Stellaria media* | *Caryophyllaceae* | Whole plant | Antioxidant, antimicrobial | *In vitro* | Šircelj *et al*. 2010, Miere *et al*. 2023 |
| *Talinum triangulare* | *Portulacaceae* | Leaves | Antioxidant, anticancer, antimicrobial | *In vitro* | Adefegha & Oboh 2011, Sebastin *et al*. 2018 |
| *Trifolium angustifolium* | *Fabaceae* | Leaves | Antioxidant, Anticholinesterase, Antimicrobial | *In vitro* | Ertaş *et al*. 2015 |
| *Zanthoxylum oxyphyllum* | *Rutaceae* | Leaves | Anti-oxidant | *In vitro* | Chelleng *et al*. 2021 |

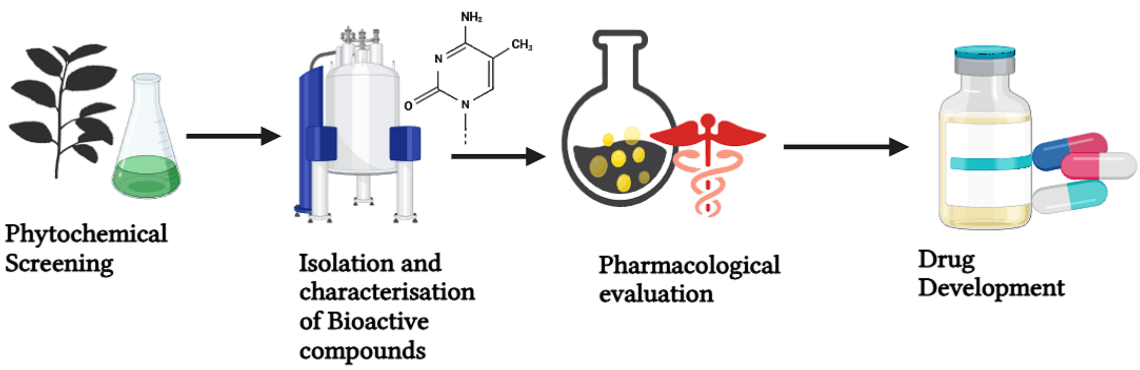


Figure 3. Generalized pathway of transition of WEPs from ethnomedicinal use to contemporary drug discovery

Table 3. Bioactive compounds with their reported bioactivity of some wild edible plant

| Plant | Bioactive compound | Mode of study | Bioactivity | References |
|---|---|---|---|---|
| *Alternanthera philoxeroides* | Kaempferol, ferulic acid, salicylic acid, syringic acid and chlorogenic acid | In vitro | Antioxidant, antimicrobial & antidiabetic | Bhattacherjee *et al*. 2014 |
| *Amaranthus viridis* | Decane 1,1-Diethoxy & Epibromohydrine | In vitro | Antidiabetic & Antiurolithiatic | Helen&Bency 2023 |
| *Amomum dealbatum* | Quercetin-3-O-galactoside, myricetin, and gallic acid | In silico & In vivo | Antidiabetic | Chelleng 2023 |
| *Antidesma acidum* | Kaempferol 3-O-rutinoside | In vitro | Antidiabetic | Kashyap *et al*. 2023 |
| *Basella alba* | Globosin & malabarin | In vitro | Anti-inflammatory | Sutor-Swiezy *et al*. 2024 |
| *Basella rubra* | Isovitexin | In vitro | Cytotoxicity | Kilari *et al*. 2018 |
| *Chenopodium album* | Lectin | In vitro and Ex vivo | Antimicrobial & anti-cancer | Javed *et al*. 2022 |
| *Drymaria cordata* | Drymaritin E | In vitro and Ex vivo | Antioxidant | Nono *et al*. 2016 |
| *Eclipta abla* | p-Coumaric acid and luteolin | In vitro | Antioxidant | Samson *et al*. 2012 |
| *Houttuynia cordata* | Quercitrin, quercetin-3-O-β-D-glucopyranoside, norcepharadione B, Cepharadione B, houttuynoside A and houttuynamide A | In vitro | Anti-viral, Antioxidant and Anti-tyrosinase | Chou *et al*. 2009 |
| *Lasia spinosa* | Meridinol | In vitro | Cytotoxic | Alam *et al*. 2011 |
| *Malva sylvestris* | Rutin | In vitro & In vivo | Anti-inflammatory, Anti-osteoclastogenic and Antioxidant | Benso *et al*. 2016 |
| *Moringa oleifera* | kaempferol, Quercetin, multiflorin-B and apigenin | In vitro | Antioxidant | Karthivashan *et al*. 2013 |
| *Phytolacca acinosa* | Esculentoside B, Jaligonic acid, Esculentoside H, and Jaligonic acid B | In vitro | Anti-inflammatory & Cytotoxic | Ma *et al*. 2019 |
| *Pteridium aquilinum* | Emodin | - | - | Khan *et al*. 2021 |
| *Solanum nigrum* | Quercetin and Chlorogenic acid | In silico | Anti-cancer | Nawaz *et al*. 2024 |
| *Stellaria media* | Sinapinic acid, Chrysin and Syringic acid | In vitro | Anti-inflammatory | Chak *et al*. 2024 |

"-" indicates not reported

**Critical perspectives on sustainability and limitations of value addition in WEPs**

Despite the growing recognition of wild edible plants (WEPs) as nutritionally and economically valuable resources, their long-term sustainability and value-addition potential remain constrained by several ecological and socio-economic limitations. One of the primary concerns is the unsustainable harvesting of wild populations, as most WEPs are collected directly from forests without regulated management practices (Belcher *et al*. 2005). Increasing market demand, particularly for commercially popular species, may lead to overexploitation, habitat degradation and loss of biodiversity, thereby threatening the ecological balance of fragile ecosystems in Northeast India (Saikia 2014; Choudhary 2016). Climate change poses an additional challenge by altering species distribution, regeneration and habitat suitability. Although many WEPs exhibit greater tolerance to environmental stress than cultivated crops, they remain vulnerable to rising temperatures, changing precipitation patterns and extreme weather events, particularly in tropical regions (Borelli *et al.* 2020). The absence of domestication strategies and cultivation protocols continues to increase dependence on wild populations, limiting both sustainable utilization and commercial scalability (Bajgai *et al.* 2023).Developing effective propagation protocols and promoting the cultivation of priority WEP species through agroforestry systems and community-based farming, in partnership with indigenous and local communities, can substantially reduce harvesting pressure, ensure a sustainable supply of raw materials, and enhance the long-term conservation and sustainable management of these valuable genetic resources (Shirsat & Koche 2024). Complementary *in situ* and *ex situ* conservation is essential to safeguard the genetic diversity of WEPs in

Northeast India. A global assessment of 1,587 wild food plant taxa revealed that only 3.3% are adequately conserved *ex situ*, while 89.1% require urgent off-site conservation measures. Sustainable community-based management and habitat protection have contributed to *in situ* conservation of many species; however, expanding seed banks, field gene banks and living collections will be crucial for conserving threatened and economically important WEPs under increasing anthropogenic and climatic pressures (Khoury *et al*. 2019). Although value addition has demonstrated the potential to increase returns, current efforts remain largely small-scale, informal and technologically limited. Most processing techniques, such as drying, fermentation, and pickling, are carried out using traditional methods with minimal standardization (Ahmada *et al*. 2026). This results in inconsistent product quality, poor shelf life, and a lack of compliance with food safety regulations, which restricts access to larger national and international markets. In addition, inadequate infrastructure, limited cold storage facilities and poor transportation networks further hinder the development of efficient value chains.

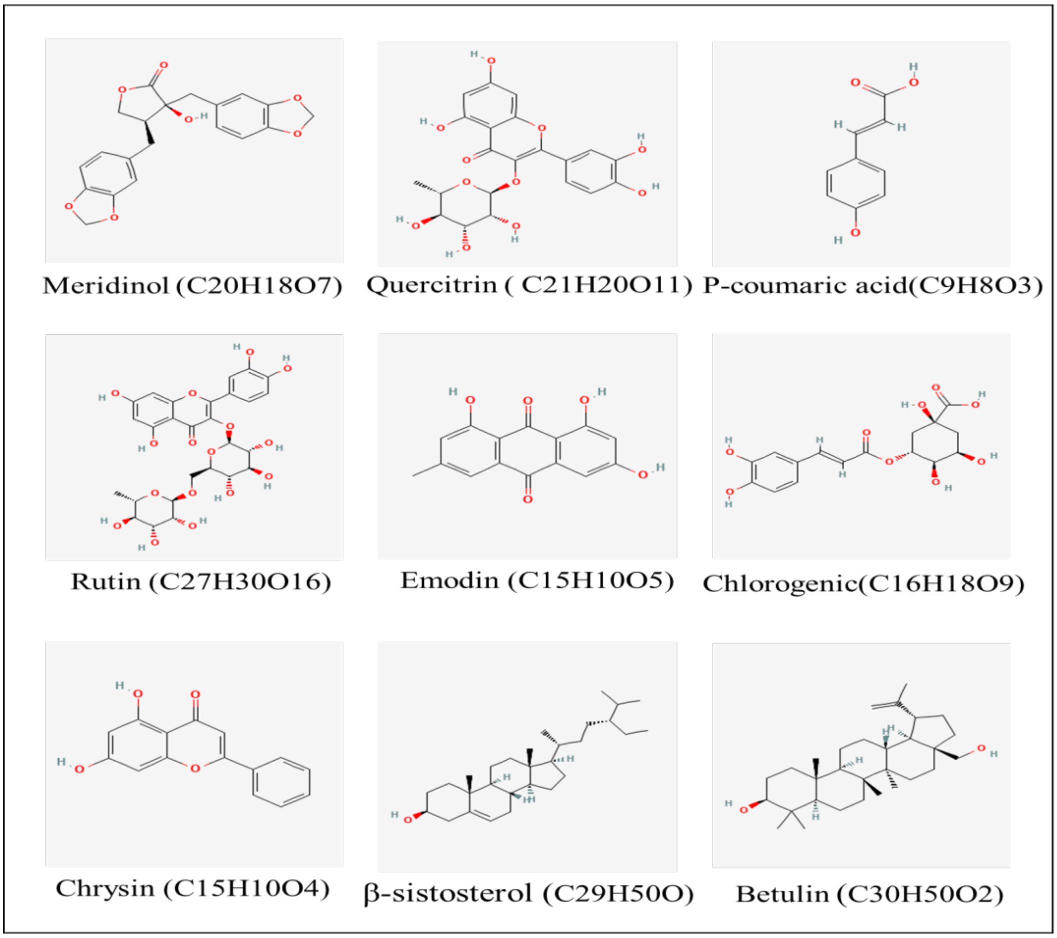


Figure 4. Representative chemical structures of major bioactive compounds reported from wild edible plants

Another major limitation is the lack of scientific validation and standardization of value-added products (Trigo *et al*. 2020). Although wild edible plants (WEPs) are widely recognized for their nutritional and pharmacological potential, evidence regarding their dosage, toxicity, bioavailability, and long-term health effects remains limited. Furthermore, the presence of anti-nutritional factors such as oxalates and phytates in certain species necessitates proper processing techniques, which are often not optimized or widely disseminated among local communities (Ram *et al*. 2020; Zayed *et al*. 2025). Socio-economically, the benefits of WEP commercialization are often unevenly distributed. Local collectors and indigenous communities frequently receive low economic returns due to the absence of organized market structures and intermediaries capturing higher profits. Additionally, the erosion of traditional knowledge among younger generations poses a significant challenge to the continued use and conservation of these resources. To address these limitations, a multi-dimensional and sustainable approach is essential. This includes the development of cultivation practices for high-demand species, implementation of community-based resource management systems and promotion of agroforestry models integrating WEPs. Strengthening value chains through improved processing technologies, standardization and quality control can enhance marketability. Moreover, integrating traditional knowledge with modern scientific validation will be crucial for ensuring both sustainability and wider acceptance. Without such interventions, the current trajectory of WEP utilization risks remaining economically marginal and ecologically unsustainable.

**Research gaps and future research priorities**

Over the past couple of decades, substantial progress has been made in documenting the nutritional composition, pharmacological properties, and commercialization of wild edible plants (WEPs) from Northeast India. Nevertheless, several important research gaps still remain and needs to be address. Existing studies have largely focused on a limited number of commonly consumed species, while many locally significant WEPs remain scientifically underexplored. Furthermore, given the exceptional ethnic diversity of Northeast India, which counts over 200 diverse tribes inhabiting in remote and inaccessible regions, a considerable number of traditionally used WEPs have yet to be documented (Bora & Mahanta 2024). Besides, rigorous toxicological evaluation is essential before recommending any wild species for regular consumption. Food safety is an important public health concern because WEPs may accumulate toxic substances from their natural habitats (Guil 2014). Depending on the species and environmental conditions, they can contain harmful levels of heavy metals such as lead (Pb), cadmium (Cd), arsenic (As) and mercury (Hg), as well as pesticide residues and other environmental contaminants. Due to their persistence and bioaccumulative nature, chronic exposure to these contaminants may increase the risk of neurological, renal, hepatic, and developmental disorders (Seal *et al*. 2023). The safety of WEPs cannot be determined solely by their nutritional composition or beneficial phytochemicals, as many species naturally contain toxic secondary metabolites and antinutritional compounds, including alkaloids, cyanogenic glycosides, oxalates, saponins, tannins and phytates, whose concentrations vary with genotype, plant part, developmental stage, season and environmental conditions (Satter *et al*. 2016). Therefore, reporting only their nutritional or functional benefits without evaluating potential toxic constituents may create a false perception of safety and therefore boost inappropriate consumption. Another important gap remains within the WEPs research is that, most pharmacological investigations related with these plants are limited to in vitro studies. In vivo studies, mechanistic investigations, pharmacokinetic analyses, toxicological assessments and well-designed clinical trials remain scarce. Consequently, the therapeutic efficacy and safety of many reported bioactive compounds have not yet been adequately validated. Addressing these knowledge gaps through multidisciplinary research integrating botany, phytochemistry, pharmacology, food science, economics, conservation biology and public health will facilitate the sustainable development of WEPs as future functional foods, nutraceuticals, and bioresource-based enterprises.

**Challenges and future directions of Wild Edible Plants (WEPs) of Northeast India**

The future integration of Wild Edible Plants (WEPs) from Northeast India into mainstream food and health systems faces critical challenges and offers promising directions. A major obstacle is the under exploitation and documentation deficit, as many nutritionally superior species remain commercially underutilized despite their vital role in local diets and medicine. Furthermore, while often manageable, the presence of anti-nutritional factors likes oxalate and phytic acid in some species necessitates further scientific study and processing guidance. Economically, the current reliance on trading WEPs in a raw or minimally processed state, utilizing simple techniques like drying and boiling, significantly limits the potential for higher income, although early value-addition efforts have shown a capacity to increase revenue by 2-10 times per kilogram. Moving forward, the focus must be on developing robust value chains and scaling up the production of value-added food products (WEP-VAFP) to maximize economic returns and rural welfare. The sustainable utilization and commercialization of wild edible plants should be supported by ethical frameworks that acknowledge the contributions of indigenous knowledge systems to their identification, utilization and conservation. The implementation of prior informed consent, equitable access and benefit-sharing (ABS) and appropriate recognition of community knowledge is essential to promote responsible research, biodiversity conservation, and the fair distribution of benefits arising from the use of these biological resources. Furthermore, integrating wild edible species into agricultural systems can enhance food availability, strengthen rural economies, and contribute to biodiversity conservation. For this purpose, identifying locally preferred edible species is essential. Scientifically, the documented antioxidants, anticancer and antidiabetic activities, attributed to bioactive compounds such as kaempferol 3-O-rutinoside and quercetin, provide a strong rationale for comprehensive phytochemical and pharmacological investigations aimed at identifying novel therapeutic agents. Ultimately, leveraging the rich biodiversity of Northeast India through sustainable harvesting, cultivation, advanced processing technologies and dietary diversification strategies will be critical for improving food and nutritional security while supporting sustainable rural development.

## Conclusion

Wild edible plants (WEPs) of Northeast India represent an invaluable biological resource with immense nutritional, pharmacological, socio-economic and cultural significance. The evidence compiled in this review demonstrates that many WEPs are rich sources of essential nutrients and diverse bioactive compounds that can be utilized for novel drug discovery to support the healthcare system. Despite their considerable potential, the transition of WEPs from traditional food resources to commercially viable nutraceuticals and functional foods remain constrained by several challenges. Although these plants have been consumed traditionally for generations, systematic investigations into their long-term safety, anti-nutritional factors, possible toxic constituents, herb-drug interactions, and dosage standardization remain insufficient. Addressing these knowledge gaps is essential to ensure their safe and sustainable utilization. Parallel efforts should focus on sustainable harvesting practices, conservation of wild genetic resources, value addition, market development and supportive policy frameworks that actively involve indigenous communities.

## Declarations

**List of abbreviations:** DW - Dry weight; FW - Fresh weight**;** NEH - North-Eastern Hill**;** NER - North-Eastern Region; PRISMA - Preferred Reporting Items for Systematic Reviews and Meta-Analyses**;** WEP - Wild edible plants**;** WHO - World Health Organization

**Ethics approval and consent of participate**: Not applicable

**Consent for publication**: Not applicable

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