
Nutritional Potential and Health Benefits of Wild Edible Plants as Natural Nutraceuticals

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Abstract:

Wild edible plants are a very valuable resource of natural nutraceuticals that exist underutilized, with a wide range of essential nutrients and bioactive compounds that can play a significant role in human health. The native and rural populations traditionally use these plants, which are very suitable to the local agro-climatic environment and are in many cases of higher nutritional density as compared to the cultivated ones. The wild edible plants stand out as a major source of vitamins, minerals, dietary fibre, proteins and health-promoting phytochemicals, including phenolics, flavonoids, tannins, alkaloids and carotenoids. They are strongly antioxidant, antidiabetic, antimicrobial, anti-inflammatory and cardioprotective, which has been revealed in many studies, and are important in reducing the effects of oxidative stress and lifestyle diseases such as diabetes, cardiovascular diseases and some cancers. Besides their medicinal value, wild edible plants serve as food security and dietary diversification and sustainable nutrition, especially in ecologically vulnerable and resource-deficient zones. Although wild edible plants have a huge potential, they are yet to be scientifically validated, standardized and commercialized.

Keywords: Agro-climatic environment, Bioactive compounds, Food security, Medicinal value, Wild edible plants.

Introduction

Wild edible plants (WEPs) have been an integral component of the human diet since prehistoric times and continue to be a major source of nutrition in the food systems of indigenous and rural populations worldwide (Shirsat & Koche, 2024). These naturally grown plants have been a valuable investment in food, medicine, and livelihood, especially in isolated and ecologically productive areas. Wild edible plants also play a significant role in the food security of developing nations, nutritional diversity, and health, particularly when there is food shortage, drought or crop failure (Borelli et al., 2020). WEPs species are native plant species whose edible portions, including leaves, fruits, seeds, roots, tubers, flowers or stems, are eaten raw or cooked. These plants are found in forests, grasslands, wastelands and mountainous areas, unlike cultivated crops that require little or no agricultural inputs (Dhakal &

Kattel, 2019). The native people have extensive traditional knowledge on who they are, when they can be harvested, their harvesting methods, as well as on culinary and medicinal applications. This is the ethnobotanical information, which has been transferred across generations, and which has been crucial in sustaining rural populations and upholding dietary diversity (Dean, 2024). These plants play an important role in ensuring nutritional security since they are an important source of macro- and micronutrients that include carbohydrates, proteins, dietary fibre, vitamins, minerals, and bioactive substances as shown in Figure 1. These plants provide alternative or supplementary food, especially when there is a lack of food in most tribal and rural societies (Heywood, 2011). They tend to be higher in micronutrients like iron, calcium, zinc, and antioxidants than the vegetables grown in cultivated areas. Also, they are highly resilient to adverse climatic conditions, which would render them reliable as food resources during climate change and reduced agricultural productivity. Over the last few years, the global interest in nutraceuticals and functional foods has grown with the rise in the levels of knowledge on health, wellness, and preventive healthcare (Keservani et al., 2010). Nutraceuticals are products derived from foodstuffs that have a health advantage over the simple nutritional value, such as disease prevention and health promotion. Plants that are edible and wild have become popular sources of dietary nutraceuticals, including phenolics, flavonoids, alkaloids, vitamins, and antioxidants (Amsalu & Asfaw, 2020). These scientific studies have shown that a good number of wild plants have important antioxidant, antimicrobial, anti-inflammatory, antidiabetic and cardioprotective properties. These bioactive compounds aid in fighting the oxidative stress which is a significant cause of chronic diseases like cancer, diabetes, cardiovascular diseases, and neurodegenerative conditions. The consequence of this is that the WEPs are currently under research to be utilized in functional food, herbal preparations, and pharmaceutical sectors (Bacchetta et al., 2016). These plants can have a better nutritional and phytochemical composition in comparison with cultivated crops. Conversely, wild species are grown in natural stressful environments, and this enhances the production of secondary metabolites that enable them to have medicinal and antioxidant effects (Pant et al., 2021). Some of the studies have found that there are increased levels of phenolics, flavonoids, vitamins, and minerals in wild edible plants compared to the commonly consumed cultivated vegetables. In addition, wild plants tend to be chemical-free in terms of chemical fertilisers and pesticides and thus, they are a safer and sustainable source of food (Dhurve et al., 2024). They have not, however, been utilized well and neither documented systematically, limiting their application in mainstream diets and commercial food systems. The information on their nutritional content, bioactive constituents, and potential therapeutic nature is likely to be founded on the indigenous use rather than being experimentally validated (Latif & Nawaz, 2025). To authenticate traditional claims, guarantee the safety and efficacy of conventional products scientific assessment by nutritional analysis, phytochemical screening, antioxidant assays, and biological activity studies is necessary. Not only does conventional knowledge validation assist in the identification of potential nutraceutical resources, but it also has the role of conserving, sustainably utilizing, and adding value to the local plant resources (Heywood, 2011). In addition, the functional foods, dietary supplements

and herbal products can be developed based on scientific documentation and thus contribute to the improvement of the socio-economic status of the local populations.

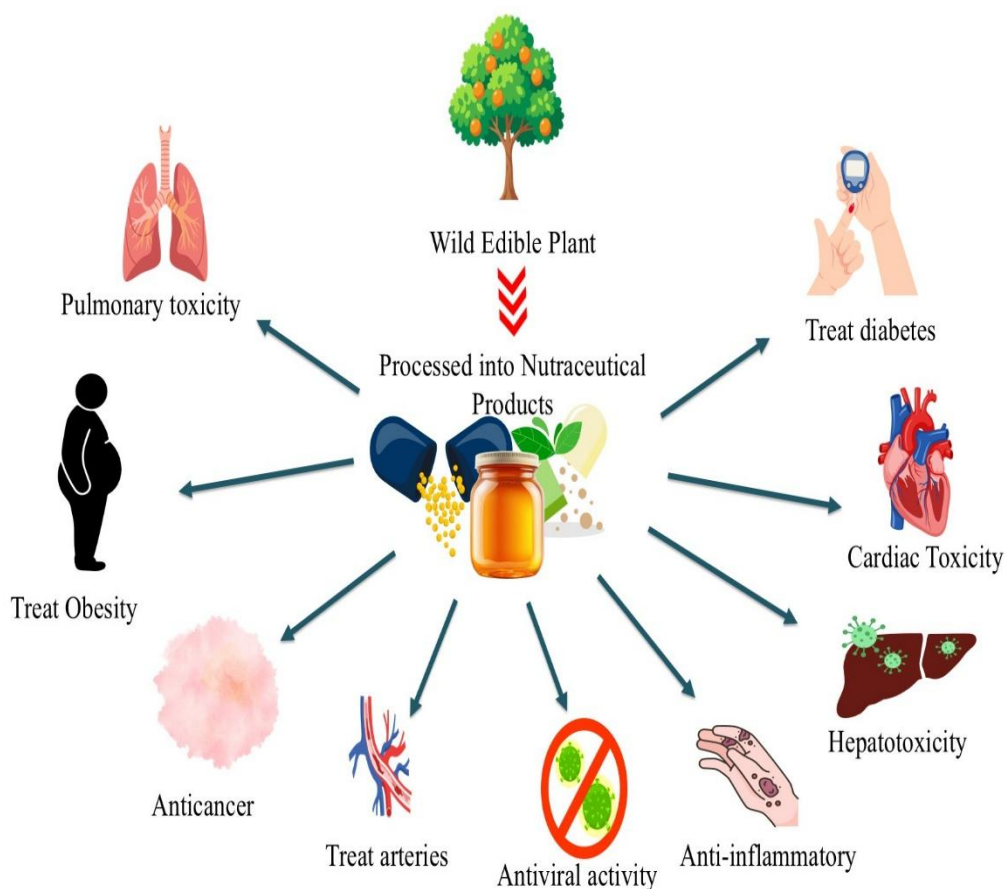


Figure 1: Potential health benefits of nutraceutical products processed from wild edible plants.

Nutritional Composition of Wild Edible Plants

Plants that are edible and wild are nowadays known to have a rich and diverse nutritional make-up that makes a significant contribution to human health as well as dietary sufficiency (Ray et al., 2020). The plants act as natural stores of important macro and micronutrients, and in many cases, are more nutritious than crops that have been cultivated. This is because their growth under natural and stress conditions in the environment enhances the production of high-value nutrients and bioactive compounds that help them to be nutritionally superior and ecologically sustainable food supplies. There are some antinutrients, too, which inhibit the absorption of nutritional compounds as shown in Figure 3.

Carbohydrates

The major source of energy in the human diet is carbohydrates, and most of the plants in the wild that are edible contain carbohydrates in their complex forms. Starches, sugars and polysaccharides in tubers, roots, seeds and fruits of wild species result in continuous energy release (Copeland, 2016). Wild carbohydrates that are found in plants are usually connected to dietary fibre, unlike refined carbohydrates, which regulate blood sugar and digestive well-being. They have a low glycaemic index; thus, they are specifically useful in the control of metabolic disorders like diabetes.

Proteins

Plant-based sources of protein are provided by wild edible plants, in particular, leafy vegetables and seeds and legumes. Plant sources of proteins may be deficient in some of the essential amino acids relative to animal foods, but, eaten as a mixed diet, wild plants can provide a balanced amino acid intake (Millward, 1999). These plants are a valuable alternative source of protein, both as a source of tissue repair, synthesis of enzymes and defense in resource-limited communities.

Dietary Fiber

One of the most useful nutritional constituents of wild edible plants is dietary fibre. Wild leafy vegetables, fruits, and seeds have been reported to have a high amount of fibre content (Achinewhu et al., 1995). Dietary fibre improves the state of the gastrointestinal tract, constipation, gut microbiota composition, and decreases the chance of chronic diseases, including cardiovascular diseases, obesity, and colorectal cancer. Soluble fibre is effective in controlling the level of cholesterol and blood glucose, and the insoluble fibre is effective in controlling bowel movement and the health of the intestines.

Lipids

Even though wild edible plants usually have low fat content, they are also the source of nutritionally significant lipids, such as essential fatty acids (Simopoulos, 2004). Wild species are especially found in seeds and nuts rich in unsaturated fatty acids, which are good for the heart. These lipids are imperative in the production of hormones, cell structure and absorption of fat-soluble vitamins. Wild plants contain low saturated fat, thus being heart-healthy foods (Gershuni, 2018).

Vitamins

Wild edible plants contain high fat as well as water-soluble vitamins. Wild leafy greens and fruits are an excellent source of vitamin A and its precursors (including β - carotene), which help maintain vision, the immune system, and the skin (Khan et al., 2017). Vitamin C, which is usually present in wild fruits and leaves, is an effective antioxidant

and increases the absorption of iron. Vitamin E helps prevent oxidative damage and maintain cardiovascular health. Wild edible plants contain B-complex vitamins that help in energy metabolism, the functioning of the nervous system and red blood cell formation.

Minerals

Macronutrients are important in the energy provision, growth and physiological functions. Wild plant foods make significant contributions to macronutrient consumption in conventional and rural diets in particular. In addition to micronutrients, they are essential in the body because they are needed in minor quantities but play an important role in keeping metabolic processes, immunity, and even health. Wild edible plants are good sources of essential vitamins and minerals.

Wild edible plants contain minerals in appreciable amounts, including calcium (Ca), iron (Fe), zinc (Zn), magnesium (Mg) and potassium (K). Bone, iron, zinc, magnesium, and potassium are important since they are vital to the immune response and enzyme activities, neuromuscular activity, and blood pressure and fluid balance, respectively. Some studies have found out that wild plants have higher concentrations of minerals than cultivated vegetables thus making it important in the fight against micronutrient deficiencies.

Energy Value

Wild edible plants contain certain energy depending on the part of the plant eaten, species, and the mode of preparation. Roots, tubers, seeds and fruits tend to be more caloric as a result of their carbohydrate and lipid structure, whereas the leafy vegetable has fewer calories but high nutrient density. The energy contribution of wild edible plants is balanced, which makes them applicable in both the energy supplementation diet and the weight management diet. Notably, wild edible plants have a vast role in the daily nutritional needs as they provide valuable nutrients with a relatively low-calorie consumption. Their intake assists in closing nutritional deficiencies, especially in populations at risk of malnutrition and micronutrient deficiencies. Wild edible plants, when used in normal diets, can supplement energy requirements and enhance nutritional health and well-being.

Bioactive Compounds and Nutraceutical Potential

Eating wild plants can be useful in the use of bioactive compounds with nutritional and therapeutic effects, as shown in Figure 2 (Anwar et al., 2024). Even though these secondary metabolites do not have a direct effect in the growth of the plants, these secondary metabolites are important in ensuring that the plants are resistant to environmental stress and when ingested, they have a massive effect on the health of humans. The existence of multiple phytochemicals in wild edible plants increases their nutraceutical values, and hence they are good targets of functional foods and natural health supplements (Dillard & German, 2000).

Phenolic Compounds

Phenolic compounds constitute one of the groups of bioactive constituents of the greatest importance in wild edible plants. They are commonly known to be very strong antioxidants in addition to being health-promoting.

Total Phenols

Total phenolic content is used as the cumulative sum of the concentration of phenolic compounds present in plant materials. Wild edible plants tend to have high concentrations of total phenols because they grow in natural and stressful conditions (Bautista et al., 2016). These compounds are powerful antioxidants as they give up their hydrogen atoms or electrons to counteract free radicals to prevent oxidative destruction of biomolecules, including lipids, proteins, and DNA. It has been seen that high levels of phenolics are linked to lower chances of chronic diseases, such as cardiovascular disease and diabetes, as well as some cancers.

Flavonoids

Flavonoids refer to a heterogeneous group of phenolic compounds that are abundant in wild fruits, leaves and flowers. They are potent antioxidants, anti-inflammatory, anti-microbial and cardioprotective agents (Houacine et al., 2021). Flavonoids promote antioxidant activity of reactive oxygen species (ROS), and regulate primary cellular signal transduction pathways that mediate oxidative stress and inflammation. Their normal diet intake is associated with better immune response and lower degenerative diseases.

Alkaloids

The alkaloids are nitrogenous substances that are heterogeneous in terms of pharmacological properties. They have antimicrobial, antidiabetic, analgesic and anticancer activity in wild edible plants. Alkaloids have a positive effect on human health at low doses; nevertheless, their existence is one more reason to indicate the need to implement appropriate methodology and dosage to guarantee safety.

Antioxidant Potential

Wild edible plants have a high potential of antioxidant which is largely attributed to high concentration of phenolic compounds and other bioactive compounds. Phenolics are important in the process of scavenging of free radicals, metal ion chelation, and lack of oxidative stress by inhibiting lipid oxidation. Oxidative stress has been a significant cause of chronic diseases such as cancer, diabetes, and neurodegenerative diseases. In vitro assays commonly used to determine the antioxidant capacity of wild edible plants include DPPH (2,2-diphenyl-1-picrylhydrazyl), FRAP (Ferric Reducing Antioxidant Power) and ABTS (2,2'-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid)). These assays are

reliable and comparative tests of the free radical scavenging activity as well as the reducing power of plant extracts. Such studies have always shown that wild edible plants have a high potential as antioxidants, and this supports their use as natural nutraceuticals as well as functional food ingredients.

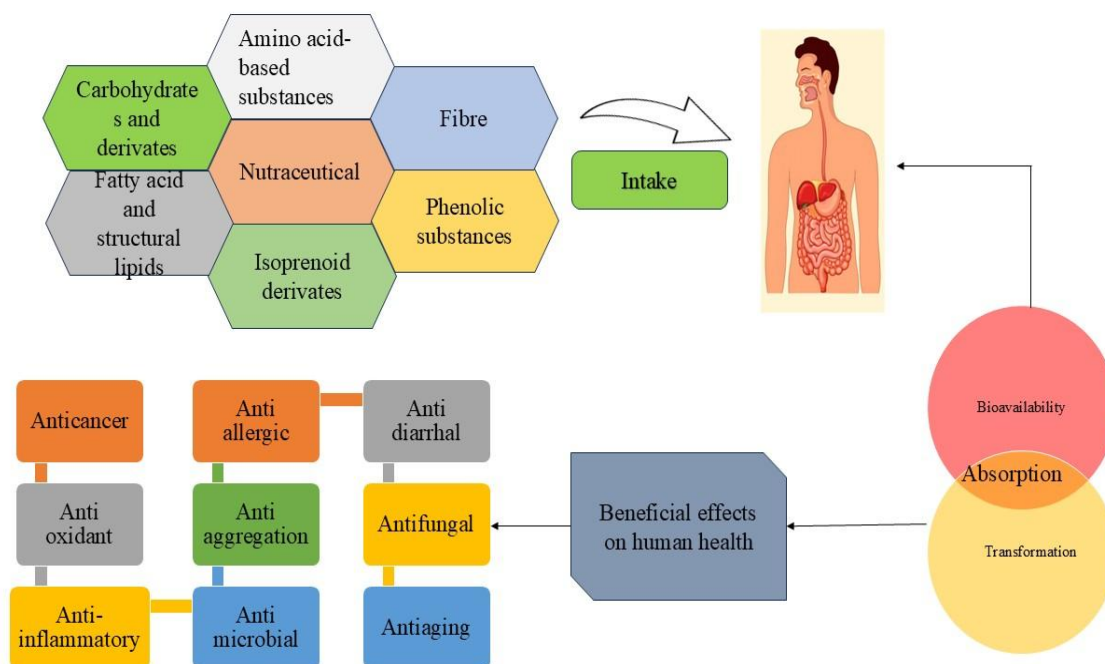


Figure 2: Overview of nutraceutical components, their intake, bioavailability, and health benefits in humans.

Anti-nutrients:

Tannins

Tannins are polyphenolic compounds that are known to possess astringent properties and protective biological processes. The tannins have antioxidant, antimicrobial and antidiarrheal properties in wild edible plants. Even though a tannin overdose can disrupt nutrient absorption, a moderate tannin consumption in traditional diets is associated with health-promoting characteristics, including better intestinal health and defence against microbial infections.

Saponins

The saponins are glycosidic compounds that possess foaming properties and biological properties. They have cholesterol-reducing, immunomodulatory, antioxidant and anticancer properties. Saponins also promote the

absorption of nutrients and help to prevent cardiovascular diseases. Saponins are commonly found in many edible wild plants that are eaten as vegetables or as herbs.

Terpenoids

Terpenoids are a big group of plant secondary metabolites having significant antioxidant, anti-inflammatory and antimicrobial properties. Such substances add to the aroma, taste and medicinal value of wild edible plants. It has been reported that terpenoids possess protective properties against oxidative stress and persistent inflammation.

Glycosides

Glycosides are a group of chemicals that consist of both sugar and non-sugar molecules and are significant in plant defense and in human health. Some glycosoid has cardiogenic, antimicrobial and antioxidant effects. This aspect of controlled intake of the traditional diets contributes to the nutraceutical value of wild edible plants.

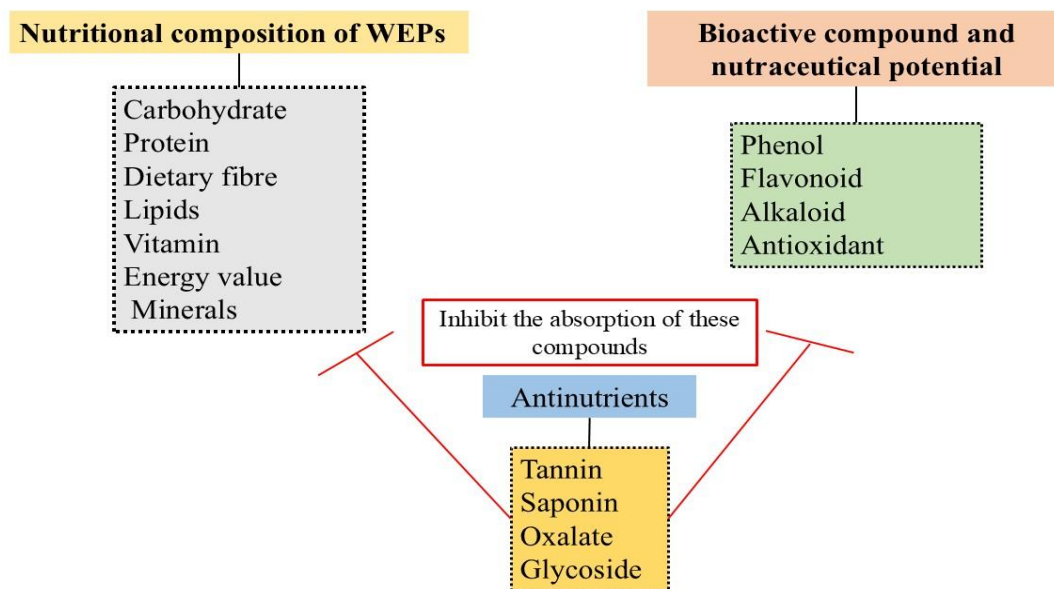


Figure 3: Illustration of Nutritional composition and Bioactive compound of WEPs.

Health Advantages of Edible Wild Plants

Because of their rich nutritional profile and abundance of bioactive compounds, wild edible plants are becoming more and more recognized for their many health-promoting qualities. Frequent ingestion of these plants as part of customary diets has been linked to better physiological processes, increased general well-being, and the prevention of disease. They are promising natural resources for the development of functional foods and nutraceuticals because of their many health benefits.

Antioxidants Activity

Antioxidant activity is one of the most researched health benefits of edible wild plants. These plants are abundant in vitamins, flavonoids, phenolic compounds, and other bioactive components that aid in the neutralisation of reactive oxygen species (ROS). One of the main causes of oxidative stress is the overproduction of free radicals, which is a major contributor to cellular damage, ageing, and the development of chronic diseases. Antioxidants found in wild edible plants prevent oxidative damage to cellular components like DNA, proteins, and membranes by scavenging free radicals and preventing lipid peroxidation. This protective effect is essential for preserving cellular integrity and lowering the risk of disorders linked to oxidative stress.

Antidiabetic Potential

Recent research confirms the antidiabetic potential of wild edible plants, which have long been used to treat diabetes. Through a variety of processes, such as improving insulin sensitivity and inhibiting the enzymes that break down carbohydrates, these plants aid in controlling blood glucose levels. Rapid postprandial glucose spikes are avoided by slowing down the digestion and absorption of carbohydrates through the inhibition of important enzymes like α -amylase and α -glucosidase. Furthermore, dietary fibre and polyphenols help to improve glycaemic control and glucose metabolism. Because of these qualities, wild edible plants are important dietary components for managing and preventing type 2 diabetes.

Antimicrobial activity

Significant antimicrobial activity is demonstrated by wild edible plants against a variety of harmful microorganisms, such as fungi and bacteria. Phytochemicals like phenolics, flavonoids, alkaloids, tannins, and terpenoids are mainly responsible for this activity. These substances interfere with microbial metabolism, damage microbial cell membranes, and suppress enzyme activity. Wild plant extracts have been shown in numerous studies to be effective against pathogenic fungi and both Gram-positive and Gram-negative bacteria. The traditional use of wild edible plants to treat infections is supported by their antimicrobial potential, which also emphasizes their potential use as natural preservatives and substitutes for synthetic antimicrobial agents.

Immunomodulatory and Anti-Inflammatory Properties

Numerous illnesses, such as cancer, diabetes, arthritis, and cardiovascular conditions, are strongly linked to the development of chronic inflammation. Bioactive substances found in wild edible plants have anti-inflammatory

qualities by modifying inflammatory mediators and signalling pathways. These plants contain flavonoids, phenolic acids, and terpenoids that reduce inflammation by inhibiting pro-inflammatory cytokines and enzymes. Additionally, edible wild plants have immunomodulatory properties that strengthen the body's defences and boost immunity. This dual function in reducing inflammation and enhancing immunity greatly aids in maintaining general health.

Role in Prevention of Lifestyle Diseases

Due to bad eating patterns and lack of movement, medical issues related to lifestyle are becoming more and more common. Virtually all lifestyle-associated disorders are preventable by regularly eating wild edible plants.

Cardiovascular diseases:

While consuming wild edible plants, one can significantly diminish the risk of contracting heart-related diseases. They can help diminish cholesterol, promote and regulate the levels of pressure in the blood, and stop blood vessel damage. Wild edible plants also actively support the heart because of the high fibre levels and the enhancement of lipid metabolism.

Cancer:

A wild edible plant's bioactive compounds are chemically neutral and help clean tissue away from dead or damaged cells. They promote the body's own complex cellular repair functions. Wild edible plants assist in defensively warding off the formation of new cells or tissues that begin cancer development. They also defend the body's own natural cancer-fighting systems as shown in Figure 4.

Digestive health:

The beneficial compounds in wild edible plants assist in the improvement of the digestion process and overall health of the individual. They promote the good microbiota and help in the movement and the healthy function of beneficial systems and the structures that comprise the intestines. Their traditional use in treating digestive ailments further supports their role in maintaining gastrointestinal well-being.

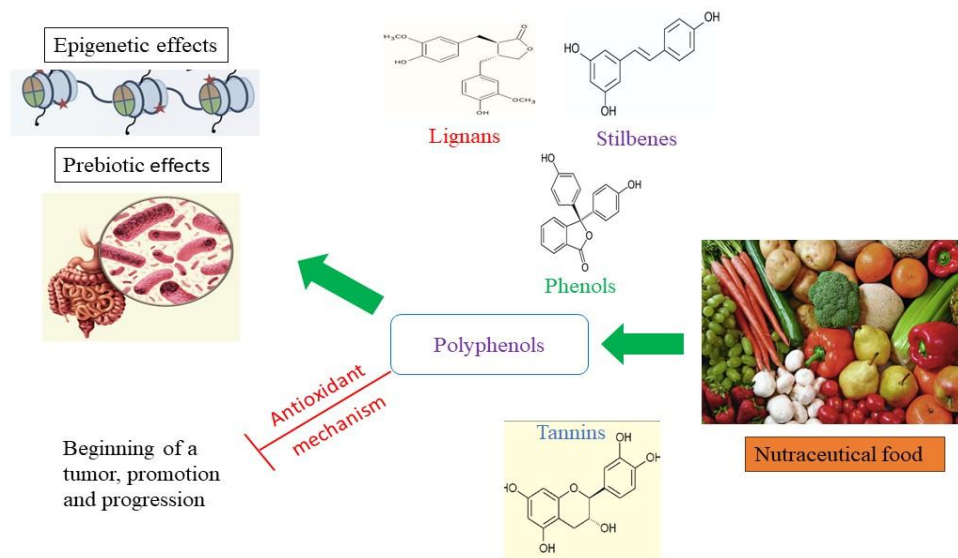


Figure 4: The impact of nutraceutical foods on tumour dynamics.

Ethnobotanical Importance and Traditional Uses

Wild edible plants are of great ethnobotanical potential, especially for indigenous, rural, and tribal people, for whom these plants are integral to their traditional food and health systems (Gebre et al., 2025). The knowledge of these plants and systems for their identification, collection, processing, and use has been built up in the course of a long history of community and environment interaction, and this knowledge is, for the most part, passed down through generations in an unrecorded manner. Such knowledge is essential for the community to survive, sustain its cultural identity, and to ensure a responsible and wise use of the available natural plant resources (Singh et al., 2010). It is well documented that the use of wild edible plants has in every part of the world been a normative practice. However, this use is most often a practice that is the result of traditional and cultural practices. The use of wild edible plants and their part, such as leaves, fruits, roots, tubers, seeds, and flowers, is done in a variety of ways (Khan et al., 2017). They are consumed in raw, cooked, dried, or fermented forms. In many rural areas, wild leafy vegetables are used in daily meals as food supplements rich in nutrients, and fruit and seeds are used in meals when they are available. These plants often serve as emergency food resources in the unfortunate periods of food lack, drought, or crop failure (Guinand & Lemessa, 2001).

Wild edible plants also serve in the traditional medicine systems as sources of medicinal use and prevention of various ailments, besides serving as food. The wild plants are used to prepare decoctions, infusions, pastes and powders which are traditionally used to treat digestive disorders, infections, inflammation, diabetes and other health conditions (Guinand & Lemessa, 2001). The fact that these plants are used as food and medicine is an indication of as

food-as-medicine concept, which has a strong root in the traditional healing process. Wild edibles are especially useful in rural and tribal societies where the availability of modern health care and commercial food resources might be scarce (Bharucha & Pretty, 2010). They are essential elements of local livelihoods since they are available, affordable, and useful in therapy. In addition, the utilization of wild edible vegetation helps conserve biodiversity and management of the sustainable resource, since the traditional harvesting practices are usually in agreement with the ecological balance. It is thus imperative to conserve and scientifically authenticate the ethnobotanical knowledge in order to facilitate sustainable development, nutritional security and modernisation of traditional wisdom into nutraceutical and functional food studies (Kumar et al., 2021).

Challenges and Future Prospects

Although there has been great nutritional, medicinal, and ethnobotanical importance of wild edible plants, their use and assimilation into mainstream food systems have various challenges. Among the largest drawbacks is the fact that traditional knowledge is not thoroughly scientifically proven. In spite of the fact that numerous edibles and medicinally valuable plants growing in the wild are commonly consumed and used by local people, only a few systematic investigations have been carried out to determine their nutritional content, bioactivity, safety and effectiveness. This lack of understanding limits their adoption in the modern healthcare and food sectors. The problem of overexploitation of these plants caused by the growing demand, as well as due to unsustainable harvesting activities, is a significant danger to biodiversity. Nevertheless, the wild edible plants also present enormous opportunities for future use in the nutraceutical and functional food sectors despite the challenges. Due to their high levels of bioactive substances, e.g. phenolics, flavonoids, antioxidants, etc., they are good candidates in the development of natural health products, dietary supplements, and functional foods. Their market potential can be improved by adding value to them by processing, standardization and formulation, as well as providing local communities with livelihood opportunities. The future studies need to be focused on specific nutritional profiling, phytochemical characterization, and assessment of the biological activities by using sophisticated analytical methods. There should also be toxicological investigations and clinical approvals to boost safety and effectiveness. Moreover, the interdisciplinary studies combining ethnobotany, food science, biotechnology, and pharmacology will help to make the use of wild edible plants sustainable and commercial. Investing more efforts in policy reinforcement and creating awareness on the potential of wild edible plants in contributing to nutritional security and sustainable development will be important.

Conclusion

The problem of wild edible plants is a potential but unproductively utilized part of human diets, which can have a considerable health and nutritional impact. High in the necessary amounts of macronutrients, micronutrients and

various bioactive compounds, these plants may add a positive contribution to the nutritional value and offer protection against oxidative stress, metabolic disorders, infections and lifestyle-related diseases. They possess strong antioxidant, antidiabetic, antimicrobial, anti-inflammatory and immunomodulatory properties, which highlight their excellent potential as natural nutraceutical resources. In addition to their nutritional and therapeutic properties, these plants are important in ensuring sustainability in nutrition and food security, especially in rural and indigenous populations. They are environmentally sustainable and have adaptability to climatic variability because they grow naturally without much agricultural input. Nevertheless, many of these plants have not been studied scientifically due to their long and traditional use. It is urgently demanded that the nutritional profiling, phytochemical characterization and safety evaluation, as well as the clinical validation of their health effects, be thoroughly studied. Moreover, standardized processing methods and value-added products should be developed to be successfully commercialized. Increasing the cooperation between researchers, policymakers, and local communities will also support the sustainable use of wild edible plants, which can be efficiently used in nutraceutical and functional food industries, which can provide health and nutrition security in the long term.

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