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Review Article

# Plant-based Functional Foods from South Asia – Importance and Requirement for Better Healthcare: A review

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### ABSTRACT

Functional foods incorporating plant-derived bioactive compounds offer potential health benefits by providing nutrition in the form of polyphenols, dietary fiber, and vitamins. South Asia is rich in biodiversity and ethnobotanical heritage, and has the potential to provide a wide range of plants with high nutritional value. The existing knowledge and utilization of plants from South Asia that have been incorporated into functional food formulations, with specific emphasis on Nepal, is very limited. Cereals, millets, fruits, and medicinal plants have long been used in households to treat various health conditions, but their rich phytochemical and dietary fiber content remains incompletely understood. Plants such as Moringa, Ginger, and Amla have been successfully incorporated into bakery products, gummies, beverages, and dairy products. Additionally, several underutilized plants in Nepal and the region show potential for future use in functional food development. This review highlights the potential of plants in South Asia and functional food formulations based on these plants.

**Keywords:** Functional food; Healthcare; Medicinal plant; Nutraceuticals; Phytochemicals

## Introduction

Functional foods offer vital nutrients and health advantages that we might not get from our regular diet. Chronic conditions including diabetes, heart disease, and obesity are becoming more common worldwide, and are particularly pronounced in South Asia. As a result, there is greater interest in functional foods, which incorporate bioactive ingredients that confer health benefits beyond their basic nutritional value (Sahidi,

2009; Granato, 2010). Young children's consumption of unhealthy foods has also increased dramatically, and awareness of the importance of eating nutritious snacks has been gradually limited (Pries et al., 2019). Rich sources of bioactive compounds including flavonoids, phenolic acids, carotenoids, alkaloids and dietary fibers, have attracted particular attention to plant-based functional foods because they help prevent disease and promote health (Sahidi & Ambigaipalan, 2015). These substances have antibacterial, anti-inflammatory,

antidiabetic and antioxidant properties that are crucial for lowering the risk of chronic illnesses (Pandey & Rizvi, 2009).

Plants have long been used for food and medicinal purposes in South Asia. Many medicinal herbs that offer practical advantages are incorporated into traditional dietary systems, including Ayurvedic and indigenous food practices (Baliga et al., 2011). Nowadays, a large number of these plants are being studied scientifically and used in contemporary functional food products. The development of functional foods using traditional plants such as amla, moringa, turmeric and millets has attracted greater attention. Because of their rich nutritional and phytochemical content, these plants have been used in cereal-based foods, beverages and baked goods (Leone et al., 2015; Barbhai et al., 2021).

Despite these advances, many plants from Nepal and the Himalayan region remain underutilized and unknown for use in functional food development due to a lack of scientific research and validation of available compounds. Many medicinal plants are traditionally used as vegetables and have high pharmacological activity (Sharma et al., 2023), whereas some of the plants are being used by the community people in their daily life for a variety of sicknesses (Shrestha et al., 2021). Also, the proper amalgam of traditional knowledge of utilizing the medicinal herbs (Lamichhane et al., 2014) with added knowledge of the secondary metabolites can assure the benefits of using plants in functional foods. The separation and extraction of existing secondary metabolites in plants can be used

to produce health beneficial functional foods that can impact the personal health with specificity. This review examines the use of South Asian and some specific Nepali plants in functional food formulation and identifies future opportunities for research and development.

## Methods

This review was conducted following PRISMA guidelines to ensure a systematic and transparent selection of relevant studies (Page et al., 2021). Literature searches were conducted using Google Scholar, PubMed, and Science Direct databases. Keywords used included functional food, medicinal plants, South Asia, food formulation, and phytochemicals. Studies published between 2000 and 2025 were included. Studies were selected based on relevance to plant-based functional food formulation in South Asia. Data extracted included plant species, bioactive compounds, and functional food applications.

## Results and Discussion

### Global functional food, functional components and their health benefits

It highlights the diversity of commercially available functional foods developed by incorporating bioactive compounds shows the options to enhance nutritional value and promote targeted health benefits (Table 1).

**Table 1:** Global functional foods and their key bioactive compounds (Arshad et al., 2025).

Product/Functional food	Type	Key bioactive compounds	Company brand	Regional availability	Reported health benefits
Special K Fortified cereal	Cereals	Added vitamins and minerals (Iron, B vitamins)	Kelloggs	Global	General micronutrient fortification
GT's synergy Kombucha	Kombucha	Live cultures, Tea polyphenols	GT's Living Foods	USA, EU, APAC	Gut health, antioxidants
Quest protein bars	Snack Bar	(Whey/Milk isolates), Fiber	Quest Nutrition	USA, EU	Muscle maintenance, Satiety
Oatly (fortified oat milk)	Plant-based milk	Added calcium, vitamin D, and B12	Oatly	Global	Dietary alternative with fortification
Alpro (Fortified Plant Drink)	Plant-based beverage	Vitamins and minerals (Ca, B12, D)	Alpro (Danone)	EU, UK, APAC	Dietary alternative with micronutrients
Optimum Nutrition Gold Standard Whey Protein	Sports nutrition	Whey protein isolate/concentrate	Optimum nutrition (Glanbia)	Global	Muscle recovery and performance
Olly (multi-vitamin gummies)	Dietary Supplements/ Gummies	Vitamins (Multi-blends)	Olly	USA, online global	General wellness, Sleep/beauty formulation
Beyond Burger (plant-based patty)	Plant-based meat	P/Rice proteins; Fortified iron	Beyond meat	Globally	Protein alternative with lower saturated fat

Most functional food products are found in the United States and European markets. Giant multinational companies and brands such as Nestlé, Kellogg, and Cadbury appear to have advanced in functional food production.

Many of these products rely on micronutrient fortification, such as iron, calcium, and vitamins B12 and D, to address dietary deficiencies and support nutritional adequacy, particularly among populations adopting plant-based diets. Fermented beverages like kombucha provide live microbial cultures and tea-derived polyphenols that may contribute to gut health and antioxidant activity. At the same time, high-protein

functional foods, including protein bars and whey-based supplements, are formulated to support muscle maintenance, recovery, and safety (Arshad et al., 2025). Nutricosmetic ingredients such as resveratrol,  $\beta$ -sitosterol, and hyaluronic acid support skin health. Cardiovascular functional foods are positioned as a distinct category. A notable innovation depicted is the use of a jelly formulation for sleep support, incorporating bioactive compounds such as melatonin, theanine, and  $\gamma$ -aminobutyric acid to promote relaxation and sleep quality. Table 2 represents how different food matrices can be tailored to deliver specific functional ingredients for targeted physiological outcomes (Yuan et al., 2024).

**Table 2:** Key bioactive compounds and health benefits (Yuan et al., 2024).

Functional food category	Health function / Target	Key bioactive compounds
Nutricosmetics	Skin and beauty health	Resveratrol, $\beta$ -sitosterol, Hyaluronic acid
Cardiovascular Health	Heart health and cholesterol regulation	Lycopene, $\beta$ -carotene, Astaxanthin
Cognitive Health	Brain function and memory support	Phytoerythrin, Selenium
Immunity	Immune system enhancement	$\beta$ -glucan, phycocyanin, Human milk oligosaccharides
Intestinal Health	Gut microbiota balance and digestion	Inulin, Polysaccharides, Probiotics
Sleep Support	Sleep quality and relaxation	Melatonin, Theanine, $\gamma$ -aminobutyrate
Weight Management	Fat metabolism and body weight control	Cellulose, Capsaicin, Curcumin
Oral Care	Dental and oral health	Peptides, Enzymes, Sugar alcohol
Energy	Energy metabolism and alertness	Taurine, Caffeine, Vitamin B3
Physical Performance	Athletic performance and endurance	Menaquinone-7, Selenoproteins, Ginsenosides

**Table 3:** Fruits and their major bioactive compounds.

Fruit	Common Name	Major bioactive compound
<i>Phyllanthus emblica</i>	Amla	Vitamin C, gallic acid, ellagic acid, flavonoids
<i>Syzygium cumini</i>	Jamun	Anthocyanins, ellagic acid, jamboline
<i>Punica granatum</i>	Pomogranate	Punicalagin, ellagic acid, anthocyanins
<i>Psidium guajava</i>	Guava	Vitamin C, carotenoids, polyphenols
<i>Mangifera indica</i>	Mango	Mangiferin, carotenoids, vitamin C
<i>Carica papaya</i>	Papaya	Carotenoids, papain, flavonoids
<i>Morus alba</i>	Mulberry	Anthocyanins, resveratrol
<i>Ziziphus mauritiana</i>	Indian jujube	Phenolics, flavonoids, vitamin C
<i>Aegle marmelos</i>	Bael	Marmelosin, tannins, flavonoids
<i>Vitis vinifera</i>	Grape	Resveratrol, anthocyanins
<i>Litchi chinensis</i>	Litchi	Polyphenols, vitamin C

## Functional food formulation using South Asian plants

### Fruits-based functional foods

Due to their high antioxidant content and market appeal, fruit-based functional foods are among the most extensively produced items. Because of its potent antioxidant properties and remarkably high vitamin C content, amla (*Phyllanthus amlica*) is one of the most significant functional food plants in South Asia (Baliga & Dsouza, 2011). Although amla has previously been used as a refreshing beverage, its nutritional value is even greater. Amla has been shown to confer significant health benefits in nutraceutical products, confectionery, and functional beverages.

The anti-diabetic effects of jamun (*Syzygium cumini*) have also been well investigated. It has been demonstrated that its bioactive substances, such as ellagic acid and anthocyanins, enhance glucose metabolism (Ayyanar & Babu, 2012). Because of its antioxidant and cardioprotective qualities, pomegranate (*Punica granatum*) has been added to functional beverages (Martos et al., 2010). Because of its high phenolic and vitamin C content, guava (*Psidium guajava*) is another significant functional fruit (Thaipong et al., 2006). We have already found the market filled with fruit-based drinks that claim to provide additional nutritional value. Table 3 and Table 4 show fruits and their potential use in the formulation of functional food.

**Table 4:** Functional food properties and functional food products of the fruits.

Fruits	Reported functional properties	Functional food products/Formulation	References
<i>Phyllanthus emblica</i>	Antioxidant, antimicrobial, immunomodulatory	Functional beverages, fortified juices, gummies, nutraceutical powders	(Baliga & Dsouza, 2011); (Nile et al., 2018)
<i>Syzygium cumini</i>	Antidiabetic, antioxidant, anti-inflammatory	Functional juices, jams, fermented beverages, powders	(Ayyanar & Babu, 2012); (Rizvi et al., 2022)
<i>Punica granatum</i>	Cardioprotective, antioxidant, anti-inflammatory	Functional beverages, fortified juices, nutraceutical drinks	(Martos et al., 2010); (Gullon et al., 2020)
<i>Psidium guajava</i>	Antioxidant, immune-supportive	Functional juices, fruit blends, fortified beverages	(Thaipong et al., 2006); (Joseph & Priya, 2011)
<i>Mangifera indica</i>	Antioxidant, anti-inflammatory	Functional juices, dried fruit snacks, fortified dairy products	(Masibo & He, 2009)
<i>Carica papaya</i>	Digestive aid, antioxidant	Functional juices, fermented beverages, fruit powders	(G et al., 2013) (Rivera-Pastrana et al., 2010)
<i>Morus alba</i>	Antidiabetic, antioxidant	Functional teas, juices, powders	(Katsube et al., 2006); (Chen et al., 2021)
<i>Ziziphus mauritiana</i>	Antioxidant, anti-inflammatory	Functional beverages, dried functional snacks	(Akassh et al., 2020)
<i>Aegle marmelos</i>	Digestive aid, antimicrobial	Functional beverages, herbal drinks	(Gupta et al., 2026); (Khanal et al., 2023)
<i>Vitis vinifera</i>	Cardioprotective, antioxidant	Functional juices, nutraceutical drinks, fermented beverages	(Martin et al., 2020); (Jiridi et al., 2019); (Majeed et al., 2023)
<i>Litchi chinensis</i>	Antioxidant, anti-inflammatory	Functional beverages, dried nutraceutical fruits	(Prasad et al., 2009); (Emanuele et al., 2017)

### Cereals, millets and medicinal plants-based functional foods

Because of their high fiber and phytochemical content, traditional grains and millets have drawn interest as functional dietary ingredients. Due to its high calcium, phenolic, and dietary fiber content, finger millet (*Eleusine coracana*) is a good candidate for the creation of functional foods (Chandrasekara & Shahidi, 2010). Rutin, found in buckwheat (*Fagopyrum esculentum*), has cardio-protective and antioxidant qualities (Sofi et al., 2022). Beta-glucan, which is found in barley, lowers

cholesterol and enhances cardiovascular health (Raj et al., 2023).

According to Baraniak & Dobrowolska (2010), amaranth's high protein and antioxidant content have also led to its application in functional foods. Medicinal plants, including ginger, turmeric, and moringa, have been used extensively in functional food items. Fortified beverages and baked goods have been made with *Moringa olifera*, which is high in vitamins, minerals, and antioxidants (Leone et al., 2015). Curcumin, which has anti-inflammatory and antioxidant qualities, is

found in turmeric (Hewlings & Kalman, 2017). Ginger's digestive and antioxidant qualities have led to its use in functional beverages (Shaukat et al., 2023). The antidiabetic properties of fenugreek have led to its usage in functional foods (Sarker et al., 2024). Turmeric and ginger are being consumed along with milk and water to relieve a sore throat and during colds. Meanwhile, holy basil is already consumed as a plant that can boost

immunity. Ashwagandha, on the other hand, is used in the form of powder or paste for cognitive support, inflammation, and immunity boost. Cold extraction of Chirayata with laung (*Clove*) and dalchini (*Cinnamon*) is used to stimulate digestive fire, and it improves digestion. Other combinations of Chirayata with honey and other herbs have proved to cure fever and liver disorders (Chauhan & Chauhan, 2019).

**Table 5:** Millet, cereals, and medicinal plants and their major bioactive compounds.

Plant	Common name	Category	Major bioactive compounds
<i>Eleusine coracana</i>	Finger millet (Ragi)	Millet	Polyphenols, dietary fibre, and calcium
<i>Panicum miliaceum</i>	Proso millet	Millet	Phenolics, flavonoids
<i>Setaria italica</i>	Foxtail millet	Millet	Phenolic acids, flavonoids
<i>Pennisetum glaucum</i>	Pearl millet (Bajra)	Millet	Polyphenols, dietary fiber, and iron
<i>Fagopyrum esculentum</i>	Buckwheat	Pseudocereal	Rutin, flavonoids
<i>Avena sativa</i>	Oats	Cereal	Beta-glucan, phenolics
<i>Oryza sativa (brown rice)</i>	Brown rice	Cereal	Gamma-oryzanol, phenolics
<i>Hordeum vulgare</i>	Barley	Cereal	Beta-glucan, tocopherols
<i>Triticum aestivum</i>	Whole wheat	Cereal	Phenolic acids, fibre
<i>Moringa oleifera</i>	Moringa	Medicinal plant	Flavonoids, phenolics, vitamins
<i>Tinospora cordifolia</i>	Guduchi	Medicinal plant	Alkaloids, glycosides
<i>Withania somnifera</i>	Ashwagandha	Medicinal plant	Withanolides
<i>Ocimum tenuiflorum</i>	Holy basil (Tulsi)	Medicinal plant	Eugenol, flavonoids
<i>Curcuma longa</i>	Turmeric	Medicinal plant	Curcumin
<i>Zingiber officinale</i>	Ginger	Medicinal plant	Gingerols, shogaols
<i>Swertia chirayita</i>	Chirayita	Medicinal plant	Xanthones, flavonoids

## Conclusion

The formulation of functional foods incorporating medicinal plants and traditional plants from South Asia represents an expanding area of research that bridges traditional ethnobotanical knowledge with modern food science and innovation. This review demonstrates that a wide range of plants, such as *Curcuma longa*, *Withania somnifera*, *Ocimum tenuiflorum*, *Tinospora cordifolia*, *Emblica officinalis* and *Moringa oleifera*, have been successfully incorporated into various functional food matrices, including beverages, dairy products, bakery products, confectioneries and nutraceutical formulations. Among fruit-based functional foods, *Phyllanthus emblica* (amla) exhibits the most extensive product diversification, appearing in functional beverages, fortified juices, gummies and nutraceutical powders, and is reported to have antioxidant, immunomodulatory and antimicrobial activities. *Syzygium cumini* (jamun) has shown particular promise for antidiabetic applications, with anthocyanins and

ellagic acid contributing to improvements in glucose metabolism in functional juices, jams and fermented beverages. In the cereals and millets category, *Eleusine coracana* (finger millet) has been formulated into functional porridge, malt beverages and bakery products, leveraging its polyphenol and dietary fiber content for antidiabetic and antioxidant applications. *Avena sativa* (oats) and *Hordeum vulgare* (barley) have been incorporated into functional breakfast cereals and beverages, with beta-glucan content providing clinically validated cholesterol-lowering and prebiotic effects. Among medicinal plants, *Moringa oleifera* has been widely incorporated into fortified biscuits, beverages and powders, with its flavonoid and phenolic content supporting antioxidant and anti-inflammatory properties. *Curcuma longa* (turmeric) and *Zingiber officinale* (ginger) have been incorporated into functional drinks and fortified foods, with curcumin and gingerols providing anti-inflammatory and digestive health benefits. *Withania somnifera* (ashwagandha) and *Ocimum tenuiflorum* (tulsi) have been utilized in

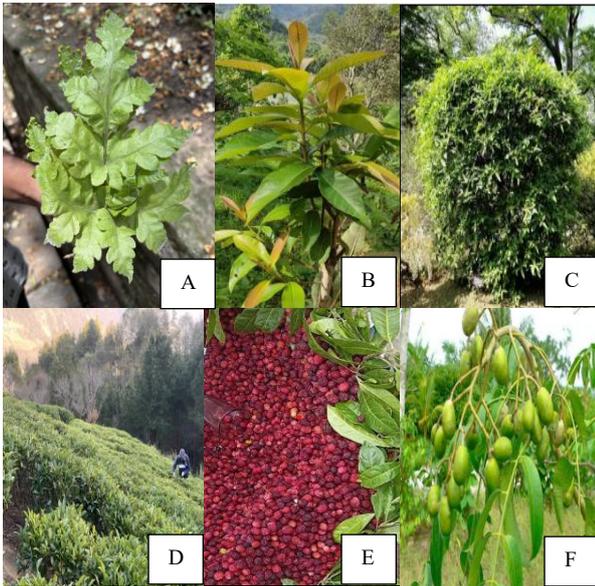
functional beverages and nutraceutical formulations for adaptogenic and antimicrobial properties, respectively. South Asia has a long history of traditional medicinal use and remarkable biodiversity, particularly in countries such as Bangladesh, Sri Lanka, Nepal, and India. Only a small percentage of the bioactive plant species have been investigated for the production of functional foods, despite their availability. While many native plants have not yet been investigated for use in functional food applications, most current formulations focus on well-known herbs such as turmeric, ginger, amla, and moringa.

Future studies should concentrate on the systematic investigation of underutilized plants for their use in functional foods, especially in Nepal and other

Himalayan regions. In addition to the extraction, integration, and improvement of phytochemical stability, clinical studies should be conducted. Overall, South Asia is a highly promising region for the development of plant-based functional foods owing to its rich biodiversity, robust traditional knowledge systems, and growing consumer demand for natural, health-promoting food products. Incorporating scientifically validated traditional medicinal plants into functional food formulations has the potential to improve public health and to support sustainable agriculture, economic growth, and the global functional food market. Unlocking the full potential of South Asian medicinal herbs as excellent functional food components may require ongoing research and innovation.

**Table 6:** Millet, cereals, and medicinal plants and their functional properties.

Plant	Reported functional properties	Functional food products/formulations	References
<i>Eleusine coracana</i>	Antidiabetic, antioxidant, hypoglycemic	Functional porridge, malt beverages, bakery products	(Devi et al., 2011); (kaur et al., 2024)
<i>Panicum miliaceum</i>	Antioxidant, cardioprotective	Functional porridge, ready-to-eat snacks	(Saleh et al., 2013);
<i>Setaria italica</i>	Antidiabetic, antioxidant	Functional noodles, bakery products	(Chandrasekara & Sahidi, 2011)
<i>Pennisetum glaucum</i>	Antioxidant, anti-anemia	Functional breads, fermented foods	(Taylor et al., 2006)
<i>Fagopyrum esculentum</i>	Antioxidant, cardioprotective	Functional noodles, bakery products	(Paul et al., 2021); (Gimenez-Bastida & Zielinski, 2015)
<i>Avena sativa</i>	Cholesterol-lowering, prebiotic	Functional breakfast cereals, beverages	(Rasane et al., 2013)
<i>Oryza sativa</i>	Antioxidant, antidiabetic	Functional rice products, nutraceutical foods	(Goufo & Trindade, 2014)
<i>Hordeum vulgare</i>	Hypocholesterolemic, prebiotic	Functional beverages, bakery products	(baik & Ullrich, 2008)
<i>Triticum aestivum</i>	Antioxidant, digestive health	Functional breads, cereals	(Fardet, 2010)
<i>Moringa oleifera</i>	Antioxidant, anti-inflammatory	Fortified biscuits, beverages, powders	(Leone et al., 2015); (Pareek et al., 2023)
<i>Tinospora cordifolia</i>	Immunomodulatory, antidiabetic	Herbal beverages, nutraceutical drinks	(Jabiullah et al., 2018)
<i>Withania somnifera</i>	Adaptogenic, anti-stress	Functional beverages, capsules	(Singirala et al., 2025)
<i>Ocimum tenuiflorum</i>	Antioxidant, antimicrobial	Functional herbal teas, beverages	(Kumari et al., 2024)
<i>Curcuma longa</i>	Anti-inflammatory, antioxidant	Functional drinks, fortified foods	(Hewlings & Kalman, 2017)
<i>Zingiber officinale</i>	Anti-inflammatory, digestive aid	Bakery and functional beverages	(Mao et al., 2019); (Shaukat et al., 2023)
<i>Swertia chirayita</i>	Anti-inflammatory, digestive aid	Herbal functional beverages	(Dey et al., 2020); (Joshi & Dhawan, n.d.)



**Figure 1:** A: *Dryoathyrium boryanum* (Kalo neuro); B: *Diploknema butyracea* (Chiuri) (Dahal et al., 2021); C: *Zanthoxylum armatum* (Timur) (Dahiya et al., 2025); D: *Camellia sinensis* (Tea); E: *Myrica esculenta* (Kafal) (Bhatt et al., 2023); F: *Choerospondias axillaris* (Lapsi) (Labh & Shakya, 2016).

## Research gap and future opportunities

Although many South Asian plants have been demonstrated to have strong bioactive properties, only a limited number have been used in functional food formulations. Tea (*Camellia sinensis*) can be a potent functional food ingredient because of the high content of catechins. Dark chocolates contain several health-promoting bioactive components; therefore, the addition of tea to food such as chocolate can enhance the nutritional value. Many plants, such as *Myrica esculenta*, *Diploknema butyracea*, and *Ficus auriculata*, remain underexplored for food applications despite their nutraceutical potential. Fruits such as Aiselu (*Rubus ellipticus*), Lapsi (*Choerospondias axillaris*) are already being consumed by most of the populations in Nepal. Hence, the addition of these fruits not only fulfil the quality of taste but also the nutritional value of the functional food products. Medicinal plants such as *Dryoathyrium boryanum* is considered important plants in the context of the formulation of functional food because of their high flavonoid content and also because they have already been consumed as a staple vegetable around communities in Nepal. Since ancient times, people have used the edible *Zanthoxylum armatum* (Timur) plant for cough, cholera, fever, itching, piles, leucoderma, rheumatism, tonic, indigestion, and toothache (Kumar & Gupta, 2020). Future research should focus on developing functional foods using underutilized plants from Nepal and the Himalayan

region. See Table 7 for more underutilized plants that can add nutritional value to the plant.

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