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Rhubarb: An underexplored source of bioactive compounds and functional food applications

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ABSTRACT

Himalayan rhubarb or Indian rhubarb is wild plant species belongs to the Polygonaceae family, grown in the temperate and subtropical regions of Asia continent. In India, it is found in Himachal Pradesh, Jammu and Kashmir, Himachal Pradesh, Uttarakhand and *trans*-Himalayan Ladakh region. It is locally known as 'Lachhu' or 'Chu-rtsa' in Ladakh and is an underexplored nutrient rich plant. Rhubarb plants are rich in bioactive compounds which contribute to a broad spectrum of their biological activities which includes anthraquinones, anthrones, stilbenes, tannins, polysaccharides, antioxidant, polyphenol etc. It provides health benefits such as such as, antiseptic, antidiabetic, antiviral, antimicrobial, antitumor, *anti*-inflammatory, liver stimulant, nephroprotective, purgative, stomachic, *anti*-cancerous, and tonic. Rhubarb has wide application in cosmetics, pharmaceutical and food industry. It is eaten freshly, as a vegetable and use in a variety of cakes, sauces, jellies, bread, juices, wines, ice cream, yogurt and other value-added products. Rhubarb has immense potential in the sustainable socio-economic development and nutritional security. Novel processing, eco-friendly technologies, value addition and awareness about nutritional value have an opportunity to enhance the livelihood of the locals, can improve the marketability of products and boost the economy.

Introduction

Rhubarb a wild plant species belonging to the *Polygonaceae* family, grown in mountainous regions at a high altitude and found in the temperate and subtropical regions of Asia continent. The species belonging to the genus *Rheum* are known as Rhubarb. Indian or Himalayan Rhubarb includes *Rheum australe*, *R. webbianum*, *R. moorcroftianum*, and *R. spiciforme*. These species are found at altitudes that range from 3,000 to 5,200 m above sea level (asl) (Al-Khatib *et al.*, 2022; Thakur, 2024)^[1, 2]. *Rheum webbianum* Royle, commonly known as Himalayan rhubarb or Indian rhubarb, is one of the high-value medicinal and nutraceutical herbs found in *trans*-Himalayan region. It is native to Asia-Temperate to Asia-Tropical, from China to India, Nepal and Pakistan. In India, it is found in Himachal Pradesh, Jammu and Kashmir, Ladakh, Himachal Pradesh, Uttarakhand and is mainly confined to alpine regions ranging between the elevations of 2,400–4,300 m.a.s.l. Commonly found species in cold arid zones of India are *Rheum webbianum*, *R. Speciformae*, *R. tibetana* and *R. morcroftianum* while the Sikkim Rhubarb (*R. nobile*) is limited to the Eastern Himalayas. It is locally known as 'Lachhu' or 'Chu-rtsa' in Ladakh and is underexplored nutrient rich plant found in the high mountains and hills (Wani *et al.*, 2021; Tayade *et al.*, 2012)^[3, 4]. Rhubarb exhibits a wide range of bioactive compounds in different parts of the plant. Phytochemicals or bioactive compounds are naturally occurring compounds in plants that are not classified as essential nutrients but have been recognized for their potential health-promoting properties (Chaurasia *et al.*, 2025)^[5]. *Rheum* species have long been used in traditional medicine because of their various properties such as tonic, astringent, antidiabetic, antiviral, antimicrobial, antiseptic, antitumor, cytotoxic, diuretic, *anti*-inflammatory, liver stimulant, nephroprotective, purgative, stomachic and *anti*-cancerous. They have also been traditionally used to manage wounds, boils, bone fractures, joint discomfort, rheumatic pain and back pain (Thakur, 2024)^[2]. In recent years, the global situation on food and nutrition consumption has changed to healthier and convenience foods. Consumers are becoming more health conscious of the foods they consume and there is a growing demand for plant-based health products, food supplements, cosmetics, pharmaceuticals etc. in the national and international markets. Rhubarb being a rich source of bioactive compound, conservation and sustainable use of these underexplored nutritionally rich plant are issues on which immediate focus is required in the context of conserving biodiversity and promoting and maintaining the health of local communities, besides generating productive employment for the poor with the objective of poverty alleviation in tribal and rural areas. Novel processing, eco-friendly technologies and value addition have an opportunity to enhance the livelihood of the locals, can improve the marketability of products and boost the economy.

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Figure 1. Rhubarb

Bioactive compounds

Rhubarb contains a wide range of nutrient composition between different parts of the plant. The stalks of rhubarb, which are the edible and commonly consumed portion, boast higher concentrations of minerals which contribute to the nutritional profile of the stalks, providing essential elements that can be beneficial for human health. On the other hand, the roots of the rhubarb plant exhibit high-valued bioactive phytochemicals. These phytochemicals are naturally occurring compounds in plants that have been recognized for their potential health-promoting properties. These bioactive compounds in the roots of rhubarb may offer numerous health benefits because of their antioxidant or other physiological effects (Chaurasia *et al.*, 2025)^[5].

The main bioactive compositions of rhubarb include anthraquinones, tannins, anthrones, stilbenes, and polysaccharides (Cao *et al.*, 2017)^[6]. Anthraquinones exhibits antitumor activity by inhibiting the growth of certain cancer cells (Wang *et al.*, 2014)^[7]. Besides, rhubarb also possess bioactive components like hydroxyanthraquinone, emodin, aloe-emodin, rhein and rhaponticin, (Bhat, 2021)^[8]. These compositions possess extensive therapeutic properties including regulating gastrointestinal, anticancer, antimicrobial, hepatoprotective, *anti-inflammatory*, protecting cardiovascular, cerebrovascular and so on. Rhubarb plants are rich in bioactive phytochemicals, belonging to diverse classes of specialized plant metabolites, which contribute to a broad spectrum of their biological activities, including the alleviation of inflammation of various etiologies. rhubarb demonstrates promising antioxidant and *anti-inflammatory* properties, which may contribute to therapeutic strategies targeting obesity, cardiovascular diseases, and other inflammation-associated disorders (Kolodziejczyk-Czepas *et al.*, 2025)^[9, 10]. It exerts a broad spectrum of pharmacological effects, such as anticancer, hepatoprotective, renoprotective, pulmoprotective, antidiabetic, *anti-colitis*, and antibacterial activities (Miao *et al.*, 2025, He *et al.*, 2019)^[10, 11]. It also contains high dietary fiber and organic acids, such as citric, fumaric malic acid and oxalic acids (Kalisz *et al.*, 2020)^[12]. Rhubarb is consumed freshly or cooked after peeling (Şat *et al.*, 2023)^[13] and is rich in minerals including calcium, iron, potassium, zinc, magnesium, sodium, phosphorus (Takeoka *et al.*, 2013; Ozcan *et al.*, 2007)^[14, 15], and vitamin C. Moreover, it has a high content of phenols and antioxidant (Dogan *et al.*, 2016)^[16]. Alkaya *et al.* (2019)^[17] revealed that the polyphenols extracted from the rhubarb stems and roots possess high antioxidant activity. However, rhubarb leaves can be poisonous, as they contain a high concentration of oxalates, unlike roots and petioles (Clementi *et al.*, 2010)^[18] as calcium oxalate is an *anti-nutritional* factor, which can also cause diarrhea and can become hepatotoxic (Mehmood *et al.*, 2019)^[19]. Rhubarb is an important source of biologically active ingredients for the treatment and prevention of lifestyle-related diseases because of its diuretic, laxative, *anti-inflammatory*, anticancer and antibacterial properties (Jintao *et al.*, 2018)^[20].

Health benefits

Rhubarb possesses a wide range of therapeutic properties and is the source of one of the most important crude drugs. It has been used in traditional medicine due to their various properties such as cytotoxic, astringent, antidiabetic, antiseptic, antiviral, antimicrobial, antitumor, *anti-inflammatory*, diuretic, tonic, liver stimulant, purgative, stomachic, *anti-cancerous*, and nephroprotective. Rhubarb is also used for the treatment of wounds, boils, bone fractures, backache, rheumatic and joint pains (Thakur, 2024)^[2]. *Rheum* species are pharmaceutically important plants because of the presence of anthracene derivatives present in the subterranean parts of the plant. *Rheum* (*Polygonaceae*). Rhubarb roots are used as oriental laxative medicine, young shoots and petioles are used against diarrhea, stomachic and antiemetic while juice of some parts of the plant is used against cholagogue, measles, smallpox as well as hemorrhoids. Its fresh stems and petioles are consumed as vegetable and the stems are also eaten fresh, which are used as digestive and appetizer. The roots are used to treat ulcer, diabetes, obesity, hypertension, diarrhea, expectorant and as antihelminthic. The decoction extract from the root of *Rheum ribes* shows significant blood sugar lowering activity (Andic *et al.*, 2009)^[21]. The leaf-stalks roots, leaves and stems are purgative and are used against abdominal diseases, indigestion, flatulence, astringent, purgative, boils, and wounds. The roots are laxative, diuretic, febrifuge, purgative, beneficial in treating indigestion, wounds and gastritis (Tayade *et al.*, 2012)^[4]. Regnier *et al.* (2020)^[22] studied the effects of rhubarb extract on microbiota and diet and found that the addition of rhubarb to the diet could prevent health problems such as weight gain, increased blood glucose levels, and visceral fat accumulation caused by high-fat and high-sucrose diet (HFHS).

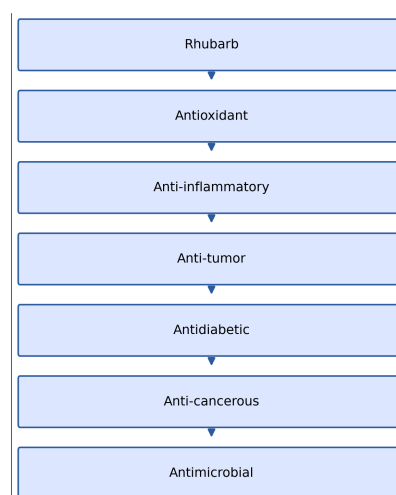


Figure 2. Health benefits of Rhubarb

Application

Rhubarb has a wide range of application from cosmetics, pharmaceutical and food industry. Rhubarb is eaten as raw, vegetable and is use in a variety of cakes, sauces, jellies, compotes, juices, ice cream, wines and yogurt. It seems that the inclusion of fruit and vegetable pomace in jelly, jam-like rhubarb products have potential health-promoting properties without compromising their quality (e.g., texture or color) and also expand the range of products that are interesting for the consumer (Korus *et al.*, 2024)^[23].

Will *et al.* (2013)^[24] develop processing method for rhubarb stalks including washing, comminution in a perforated disk mill followed by immediate dejuicing of the mash is presented. Rhubarb is an easy to process vegetable which does not necessarily need a special mash treatment like enzymation or heating to get high juice yields. Rhubarb juice contains a high amount of minerals, esp. potassium (up to 4000 mg/l), and magnesium (average 100 mg/l), whereas calcium is not present due to precipitation with oxalic acid.

Dogan and Meral, (2016)^[16] formulated biscuit by adding *Rheum ribes* at three different levels (0.5, 1, 2%) to the biscuits and found that *Rheum ribes* added to biscuit formulations has increased the amount of total phenolics and increased the functionality of biscuits by inhibiting free radicals.

Radu *et al.* (2019)^[25] studied on the quality of fruit juices innovated by adding rhubarb extract juice extracted from four types of fruits: grapes, plums, nectarines and peaches and used for the innovated fruit jellies which used rhubarb extracts with acidifying effect and inverting sucrose. Rhubarb extracts was added in fruit juices in different concentrations of: 3% (samples 1, 2, 3, 4 - grapes, plums, nectarines, peaches), 5% (samples 5, 6, 7, 8 - grapes, plums, nectarines, peaches), 10% (samples 9, 10, 11, 12- grapes, plums, nectarines, peaches), 15% (samples-13, 14, 15, 16 - grapes, plums, nectarines, peaches) and 20% (samples - 17, 18, 19, 20 - grapes, plums, nectarines, peaches).It recommend fruit jellies, which used 3% and 5% rhubarb extract, being the most balanced in taste.

Goksu *et al.* (2024)^[26] developed enriched wheat bread using rhubarb powder in the ratios of 0%, 4%, 8%, and 12% and found that as the rhubarb powder ratio increased, the fiber, ash, fat content, antioxidant activity and total phenolic contents of bread samples increased significantly ($p < 0.05$). The breads containing 12% rhubarb powder had the highest ash content (4.34 ± 0.13) and the samples containing 4% rhubarb powder took the highest sensory scores from the sensory panel in terms of overall impression and could be used to produce acceptable breads in terms of sensory properties with improved nutritional quality.

Defence Institute of High-Altitude Research (DIHAR), Leh has carried out a mass scale cultivation of *R. webbianum* in experimental fields. DIHAR used the root powder in development of various herbal products like Herbal Appetizer, Herbal Antioxidant Supplement etc. Leaf stalks contain 70-90% fresh juice which has 2% of oxalic acid content and to neutralize oxalic acid concentration calcium carbonate treatment was carried out which reduced the original oxalic acid to 95% and can be utilized for development of herbal beverages and other products (Tayade *et al.*, 2012)^[4].

Conclusion and future strategies

Rhubarb plants being rich in bioactive phytochemicals has immense potential in the sustainable, socio-economic development and nutritional security. Rhubarb contains wide range of bioactive compounds like anthraquinones, stilbenes, phenols, antioxidant and so on. It demonstrates promising antioxidant, anticancer, antimicrobial, anti-inflammatory, antidiabetic, anti-colitis, and antibacterial and other therapeutic properties. However, the local people are still unaware of the multitudinal benefits of this plant and it is underutilized. Preservation of high altitudinal underutilized plant species of Ladakh and their traditional knowledge system are the most important aspect and need to be promoted on a large scale and religiously by the local

and Governments. Further, preservation, scientific research, development of value-added products and awareness about the nutritional composition of underexplored plants will bring immense benefit to society, can improve the marketability of products and boost the economy.

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