NUTRITIONAL AND MEDICINAL FACTS OF BASELLA (INDIAN SPINACH): A REVIEW

Abstract

Basella rubra L. belongs to the Basellaceae family with stems, leaves as well as petioles that are red in colour. The presence of vitamins, phytochemicals and minerals in this plant makes it an important source of nutrition and health benefits. Various curative properties of *Basella rubra* have been demonstrated including anti-inflammatory, antibiotic, antidiabetic and wound healing activities. Antioxidant potential, as well as immune stimulation properties, are some other qualities displayed by this plant that elevate its therapeutical potentials still higher. Ayurveda has given an important place for *Basella rubra* in treating diseases like anemia, diarrhea, skin infections, etc. Moreover, the paper stresses that *Basella rubra* market value could be increased if further research is undertaken regarding its complete pharmacological potential as well as the development of value-added products. This review reveals that basella is an underrated crop when it comes to medicinal and nutritional values and mainly focuses on the medicinal, botanical and nutritional attributes of basella which is also called Indian spinach or poi.

Keywords: *Basella rubra,* medicinal importance, nutritional value, Indian spinach

Introduction

Traditional healthcare practices, which rely on plants, animals, and minerals for healing, are often the only option for many in rural areas. This widespread use highlights the potential of medicinal plants like *Basella rubra* for new drugs. Despite modern medicine, natural products remain a valuable source for pharmaceutical research (Sharma and Behera, 2022).Many nutritious leafy greens are neglected in our diets because we lack awareness of their nutritional value, and a growing disinterest in vegetables is prevalent among younger people. These under-appreciated plants offer local benefits and have been used for various purposes like medicine or fiber, but haven't gained mainstream popularity (Zhang*et al*., 2024).It is fleshy in nature and herbaceous with trade leaf, thriving in hot climates and even poor soil, Malabar spinach (*Basella alba* and *Basella rubra*) is a nutritional powerhouse. Its leaves are packed with essential minerals (calcium, iron, magnesium, etc.), beneficial plant compounds (flavonoids), and protein building blocks (amino acids) (Talucder*et al*., 2024;

Singh*et al*., 2018).Red Basella (*B. rubra*) has reddish stems and leaves, while Green Basella (*B. alba*) is all green.

These two species are widely grown in West Bengal, the Southern part of India, and the Northern East i.e., Assam. The green species are cultivated mostly in the Northern region of UP and Punjab.Traditionally used in both Chinese and ancient Indian medicine, Basella species possess medicinal properties for constipation, diuresis and inflammation (Kumar *et al*., 2020). In India, farmers traditionally grow poi (Basella) by saving seeds from the best plants or using tip cuttings from existing vines. Unlike some crops, there's no formal breeding program for it. The plants can climb poles, trellises, or grow on the ground (Bose *et al*., 2003).

Botanical Description

Indian spinach *Basella rubra* L. also goes by the name "poi" and is also called Malabar spinach which is grown as annual leafy green vegetables in the Caryophyllales order i.e., Basellaceae family (Fadhila *et al*., 2024). Despite being a perennial vine, Basella thrives in hot climates and exhibits rapid growth. This adaptation allows it to be cultivated as a cool-season vegetable (Chaurasiya *et al*., 2021). Basella plant has various forms, including *Basella alba* with dark green, round or oval leavesand*Basella rubra* with vibrant red leaves and stems. Other species include *B. cannifolia, B. cordifolia, B. nigra* and*B. saponica*(Deshmukh and Gaikwad, 2014).Basella is known for its long, fleshy stem which can reach up to 8-10 meters in length, succulent, thin, smooth, and shiny(Chaurasiya *et al*., 2021). It is a prolific grower, producing numerous secondary shoots often exceeding 100 shoots. Its root system is fibrous and spreads laterally.Leaves remain spiral at the stem. Leaves are oblong in shape; the length of the leaves is more (Sharma and Behera, 2022), the breadth is less, the leaves' stalk is small and side branches are also found. The flower color is white, reddish and pinkish (Singh *et al*., 2016). Fruits are smaller in size and have both red and black in colour. Seeds are blackish brown having a rough texture.

Table 1: Distinguishing morphological characters of *Basella alba* (green) and *Basella rubra* (red) given by Chaurasiya *et al*. (2021); Almeida (2003)

Sl.no.	Morphological characters	*Basella alba* (green)	*Basella rubra* (red)
1.	Leaves	Dark green in color, acute ovate shape	Sharp leaf point, acute ovate and thick, heart-shaped i.e., cordate base.
2.	Stem	Thick strong fleshy base, narrow branches	Narrow, long, tender, smooth and glossy and have more no. of branches
3.	Flower	White or pinkish-red, short stalk	Either red or white flower, weak growing stalk
4.	Bracts	Typically, small and have scales, short bracteoles	Short sharp leaf points i.e., apiculate, large bracteoles
5.	Fruit	Generally, Black or purple colored covered within the calyx	Generally Black or red-colored, smaller in size.
6.	Seed	Globular black in colour	Black in colour

Table 2: some varieties list of Malabar spinach

S.NO.	Category	Variety	characteristics	Source	reference
1.	*Basella rubra* (red)	a) VI047671-A1	Healthy growth habit, high agricultural output, broad greenish leaflet, pale radish veins, length of the internode is small, purple stems and delayed anthesis line.	World Vegetable Center	Chaurasiya *et al.*,(2021)
		b) L5	Color is due to the Anthocyanin	V.R.D.S. Buzau, Romaniav	Tănase*et al.* (2020)

			pigment, mostly near the stem and rear side of the leaves.		
		c)Pulahan	Stem is reddish disc-shaped green leaves.	IPB-UPLB, Phillippines Los Banos	Singh *et al.* (2016)
2.	*Basella alba* (green)	a) Lutian	Green color stem, leaves are elliptical in shape.	IPB-UPLB, Phillippines Los Banos	Singh *etal*. (2016)
		b) kalyani (hybrid)	Green color leaves and stems	Kishan seed farm	
		c)Pooin Deshi Basella	Green color	Bankinmprosadghosh& co.	

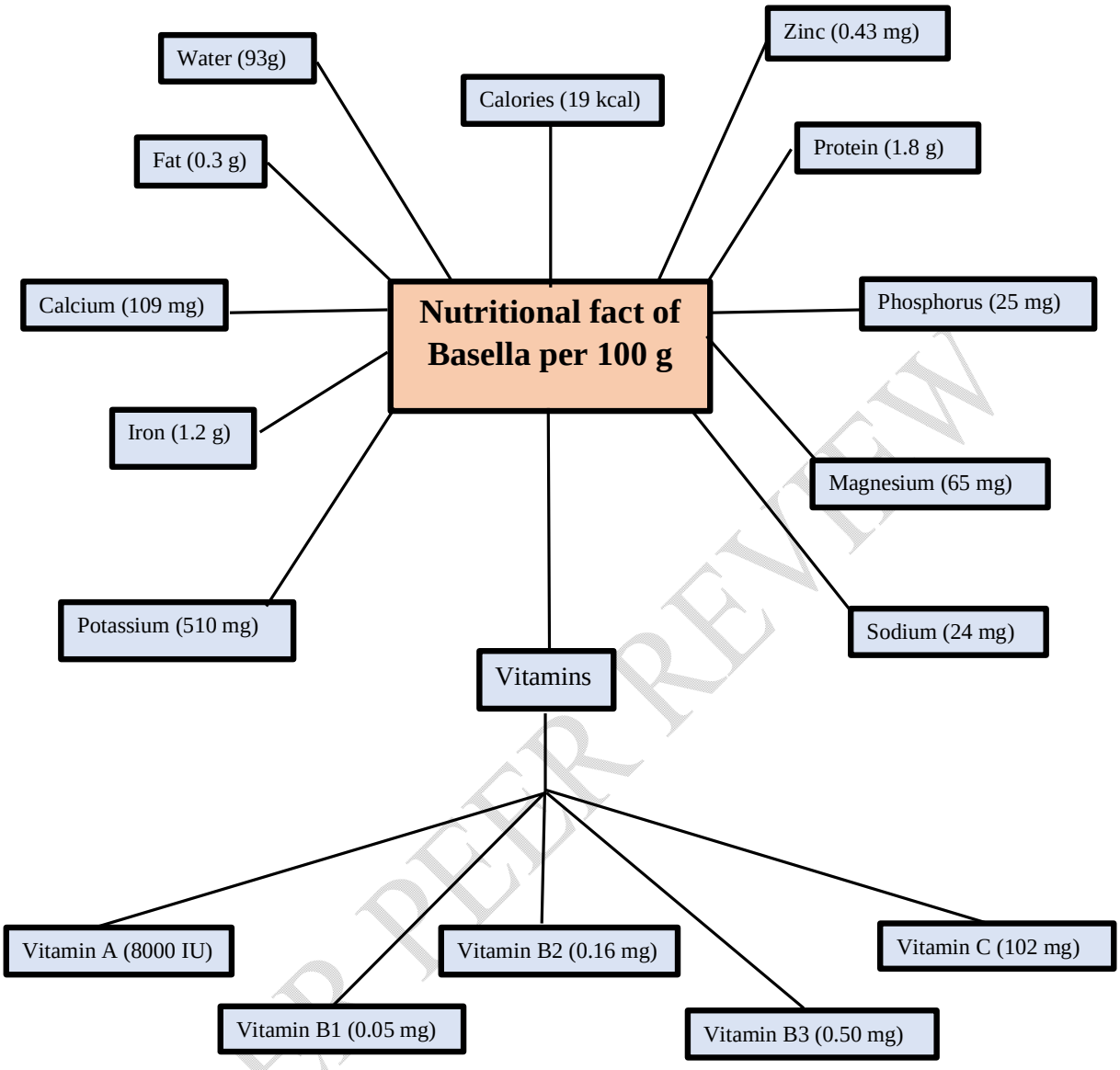
Pigmentation of *Basella spp*.

Several studies and reviews have explored the encapsulation of betalains from both quinoa and *B. rubra* to improve their stability (Kumar*et al*., 2020;Aguilar-Tuesta*et al*., 2018).Basella leaves and fruits contain β – cyanin and phytochemicals. *Basella alba* when extracted in dye form shows red pigment due to gomphrenin-I which belongs to the family betalain(Chaurasiya *et al*., 2021).Despite being water-soluble, these betalain pigments from *B. rubra*, boast three times the coloring power (tinctorial strength) and better stability in acidic environments compared to anthocyanins from other sources. Additionally, the color profile (chroma) of *B. rubra* fruits offers a distinct alternative to commercially used beetroot, The betalains found in are a valuable source of health-promoting compounds. These pigments have been linked to positive effects on blood pressure and cardiovascular health (Kumar*et al*., 2020; Kaur*et al*., 2018; Kumar*et al*., 2015).

Nutrition benefits

Green leafy vegetables are a nutritional powerhouse, providing essential vitamins and minerals that contribute to overall well-being,packed with pigments, polyphenols, and flavonoids, they act as antioxidants, helping the body fight free radicals (Alam*et al*., 2023). Typically, a 100-gram serving of leafy vegetables offers essential nutrients, including carbohydrates (2-3%), protein (3-5%), healthy fats (0.5-1.5%), dietary fiber (4-7%), and a significant amount of vitamin C (up to 60%) along with various minerals (5-35%) (Alam*et al*., 2023; Kumar *et al*., 2015).Red basella is rich in Ca, Fe and vitamin A, Basella rubra leaves contain carotenoids, primarily beta-carotene, with smaller amounts of alpha-carotene and traces of other types.(Saranya*et al*., 2023).Basella consumption might increase testosterone levels in men, leading to a possible boost in libido.In some traditions, crimson Basella roots paste mixed with rice washing water is consumed for 30 days on an empty stomach in the morning to regulate irregular menstrual cycles (Jhankar and Mohapatra*et al*., 2022).Basella oil is a good substitute for vegetable oil Adedotun (2017). Basella leaf powder hasa moisture content (12.06%), crude fiber content (10.36%), ash content (16.17%), crude protein content (40.03%) and carbohydrate (40.03%)(Singh and Sonkar, 2024). Basella fruit contains specific types of beta-cyanins present: gomphrenin I, II and III, along with trace amounts of isogomphrenin I and II (Ali*et al*., 2024).

Fig.1 Nutritional fact of Basella per 100 g(Chaurasiya *et al*., 2021)



Medicinal potential of basella

Red Basella (*B. rubra*) fruits are packed with health-promoting compounds like phenolics and flavonoids. Studies show extracts from these fruits have antioxidant and anti-cancer properties against human cervical cancer cells and offer benefits against worms, high cholesterol, artery hardening, skin issues, diarrhea and dysentery, it also acts as a laxative, anti-viral, anti-cancer, anti-viral, hypoglycemic and wound healing (Nur *et* al., 2023; Chaurasiya *et al.*, 2021). Plant's potential health benefits stem from its rich composition of antioxidants (betacyanin, carotenoids), antiproliferative agents (bioflavonoids) and anti-inflammatory compounds (β-sitosterol and lupeol) (Sansawat*et al.*, 2023; Moutusi*et al.*, 2019). The high levels of betalains, particularly betacyanins, suggest the potential of *B. rubra* as a nutraceutical with anti-cancer benefits (Kumar *et al.*, 2023; Kumar *et al.*, 2015). Basella

seeds also contain oil for their potential uses in food coloring, cosmetics, and even health research for nutraceuticals and pharmaceuticals (Nur *et* al., 2023; Sharma and Behera, 2022; Diemeleou*et al*., 2014). Kumar *et al.* (2018) identified the presence of specific compounds like hydroxybenzoic acids, hydroxyl cinnamic acids and flavones in the plant extract. These compounds are believed to have disinfectant properties and antioxidant benefits.

Medicinal properties and physiological action

Wound healing properties

Basella species are rich in plant chemicals which may offer antioxidant properties. These antioxidants can help combat free radicals produced by the body (Adenegan-Alakinde and Ojo, 2019). While free radicals can damage cells, they also play a role in wound healing (Comino-Sanz*et al*., 2021).Safe and effective antioxidants applied directly to wounds are a promising approach for faster healing. Basella's rich phytochemical content suggests it may play a role in regulating various stages of wound healing by managing excessive free radicals (ROS) (Swastini*et al.*, 2023;*Comino*-Sanz*et al*., 2021).*B. alba* leaf extract significantly sped up wound healing in rats. Treatment for 20 days led to complete healing, whereas control groups took 35-39 days (Reddy*et al*., 2023; Haneefa*et al*., 2012).

Anti-microbial properties

The phytocomponents discovered through GC-MS analysis of different *Basella alba* leaf extracts and their corresponding biological effects *viz.*, cyclotetracosane (hydrocarbon)(Mongalo*et al.*, 2019) andl-Heptatriacotanol(Kalaimagal, 2019)have been documented (Reddy*et al*., 2023).Nguyen *et al*. (2022) found that a substance extracted from *B. alba* has antiadhesive properties against *Helicobacter pylori*. The extract inhibited the adhesion of the bacteria to human stomach cells (AGS cells) in a dose-dependent way, with the strongest effect (67% inhibition) observed at a concentration of 2mg/ml. An ethanol extract of *B. alba* stem showed most effective at 100mg/ml concentration, inhibiting *Staphylococcus aureus* (15.65mm) and *Escherichia coli* (17.67mm) more than standard drug gentamycin, *Candida albicans* (20.2mm) and *Trichophyton rubrum* (15.25mm) more effectively than fluconazole at the same concentration (Reddy*et al*., 2023;Dash and Dash, 2017).

Anti-viral properties

Basella rubra having acidic structured polysaccharides and its results on HSV type-2 (Herpes Simplex Virus) were studied by Reddy*et al*. 2023; Dong *et al*.(2012).A glycoprotein with antiviral properties, specifically targeting potato virus, has been detected in *Basella alba* leaves (Chaurasiya *et al.*, 2021).Four neutral polysaccharides (BRN-1, BRN-2, BRN-3, and BRN-4) were isolated from *Basella rubra*, BRN-3, a polysaccharide isolated has antiviral activity against HSV-2. BRN-3 works by preventing the virus from attaching to host cells(Sharma and Behera, 2022; Dong *et al*., 2012).

Anti-diabetic or anti-hypoglycemic properties

Consuming *Basella rubra* includes reducing oxidative stress (protecting cells from damage), acting as antioxidants, aiding in DNA repair, potentially helping with cognitive decline and diabetes, and offering radioprotective (protecting against radiation), anti-cancer (anti-proliferative), and anti-spasm effects(Kumar *et al*., 2020;Kaur *et al*., 2018).*Basella rubra* leaves could lower blood sugar in rats. After one month, rats given Basella extract showed a significant decrease in blood sugar levels, suggesting it has anti-diabetic properties (Sharma and Behera, 2022; Nirmala*et al.*, 2009).

Anti-inflammatory properties

The anti-inflammatory effects of Basella plants come from various compounds they contain, including betacyanin, carotenoids, bioflavonoids, β-sitosterol, and lupeol (Alam*et al*., 2022; Moutusi*et al.*, 2019). Methanol extract from *B. rubra* leaves significantly reduced inflammation in rats with colitis caused by oxazolone. This suggests the extract has strong anti-inflammatory properties(Sansawat*et al*., 2023; Bhanu Priya*et al*., 2014). Basella rubra consists of various phytochemicals *viz*., coumaric acid, myricetin, quercetin and apigenin (Ahmad*et al*., 2023).

Anti-ulcer properties

Basella rubra leaves in treating stomach ulcers,rats were first given ethanol and pylorus ligation to induce ulcers. Then, they were treated with varying doses (10mg/kg and 20mg/kg) of an aqueous extract from *Basella rubra* leaves. The results showed a significant and dose-dependent reduction in ulcer formation, suggesting the extract has anti-ulcer properties that become stronger at higher doses. Studies show that extracts made from Basella rubra leaves have a strong and dose-dependent effect in reducing stomach ulcers (anti-ulcer) and protecting the stomach lining (cytoprotective). This effect is so strong that even chewing the

raw leaves can bring relief from mouth ulcers (aphthae) (Saranya*et al*., 2023;Sharma and Behera, 2022).

Central Nervous System (CNS) depressant properties

Aerial parts or upper portion of *Basella alba* extracts when conducted on Swiss albino mice of both male and female sex, showed that the presence of methanol extract in *Basella alba* resulted in CNS depressant properties because of terpenoids which are present in the plant (Reddy*et al*., 2023;Anandarajagopal*et al*., 2011).

Role of Basella on kidney and liver

A study investigated if Basella leaf extract harms the kidneys or livers of rats. Rats were given the extract at various doses for two weeks. Examination of their organs showed no damage, suggesting the extract is safe for these organs at these doses (Sharma and Behera, 2022; Adekilekun*et al*., 2012).

Anti-oxidant properties

Despite being discarded as waste, the red-purple fruit of *B. rubra* holds value. It contains betalain pigments and phenolics, which offer antioxidant, anti-cancer and antimicrobial benefits (Nitteranonand Sansawat, 2023; Pawar*et al*., 2018; Kumar *et al*., 2015).An extract made with ethyl acetate (EtOAc) from the leaves showed the strongest antioxidant activity compared to similar extracts from the fruit and stem (Sansawat*et al*., 2023;Adegoke and Ojo, 2017).Gomphrenin I, the main red pigment in *B. rubra* fruits, gets more abundant as the fruit ripens. Ripe fruits contain the highest amount, with a yield of 36.1 mg per 100 g of fresh weight (Sharma and Behera, 2022).The methanol extract showed significant free radical scavenging activity in various assays, with DPPH being the most effectively neutralized (up to 94.8%) (Sheik*et al*., 2023). Omowumi*et al*. (2022) investigated *Basella alba* extract could protect rats from acrylamide, a toxin found in processed foods. They found that the ethanol extract significantly reduced markers of kidney and liver damage in rats exposed to acrylamide.

Conclusion

This review gives insight and focuses mainly on the medicinal and nutritional facts of the Basella plant. It concluded many medicinal effects of *Basella rubra* L. which is used for

treating many diseases. The activities conducted using the plant showed immense potential and significance in human life.All the activities conducted have huge prospects in the medical field and the data are performed at the molecular level.Lastly, it is concluded that Basella has huge medicinal and nutritional value even being an underrated crop. The chemical constitute of Basella can be studied and other value-added products can be investigated by increasing the market value.

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