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Edible Plants as Promising Candidates for Various Hematological Disorders: A Comprehensive Review

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Abstract

Since ancient times, plants have been used for the treatment of various ailments, including blood-related disorders. The most common problem which people face today is mainly anemia; however, many other conditions, including thalassemia, myeloid leukemia, lymphoblastic leukemia etc., are also of major concern. Plants are primarily used as dietary supplements for the prevention of anemia to a significant extent. However, the lack of a detailed explanation of the exact mechanism for the preventive action shown by the plants makes it difficult to understand the ancient concept of plant-based preventive care. Many of the plants mentioned have also been used for centuries in the Indian traditional medicinal system, Ayurveda and other traditional medicinal systems. However, the scientific investigation of the mechanism behind their preventive role is still a matter of investigation. This review aims to highlight the importance of edible plants that are useful for treating anemia and other blood disorders. The scientific explanation of the preventive role exhibited by these plants is still unclear, but they are still used for edible purposes, making them valuable to prevent anemia-like conditions.

Keywords: Edible plants, Phytochemicals, Ayurveda, Anemia

Introduction

The ancient medicinal system of Ayurveda highlights the role of diet in remaining healthy and disease-free. Plants form the essential diet in Indian households, and much emphasis is laid on eating proper food at the right time interval. In recent research conducted it was found that many of the plant species widely used as vegetables in Indian cuisines are also used medicinally for the treatment of various diseases. The phytochemicals present in plants are mainly responsible for the beneficial and curative actions [1]. Globally, among the blood-related disorders most commonly encountered is anemia, i.e., a reduction in blood cells due to various reasons. It can also be indicative of any other underlying disease in a person, which seems to be diagnosed with great difficulty. It usually occurs due to chronic blood loss, malignancy, infection, increased hemolysis, endocrine disorders, bone marrow disorders and some other diseases [2]. The classification of anemia is shown in **Figure 1**.

Sometimes the use of some adverse drugs can also result in anemia as they cause toxic effects on blood cells, erythropoietic organs and hemoglobin production. However, in the majority of cases, it occurs due to inadequate dietary intake of some substances such as folic acid, iron, and vitamin B12, necessary for the production of blood cells in the body [3]. The clinical symptoms of anemia include fatigue, paleness, weakness, loss of appetite, difficulty in swallowing, however the definition, prevalence of anemia generally varies according to the demography and general health status of the region, but still WHO defines anemia if the concentration of hemoglobin under 13 g/dL in men and 12 g/dL in women who are not pregnant over the age of 15 and 11 g/dL during pregnancy [4]. The treatment of anemia is usually initiated after detecting the exact cause. The commonly encountered anemia is considered to be nutritional deficiency anemia resulting from a poor and unhealthy diet. If it occurs due to nutritional factors, the deficiency of folic acid, iron, and vitamin B12 can be overcome by oral and injection forms. This concept of oral

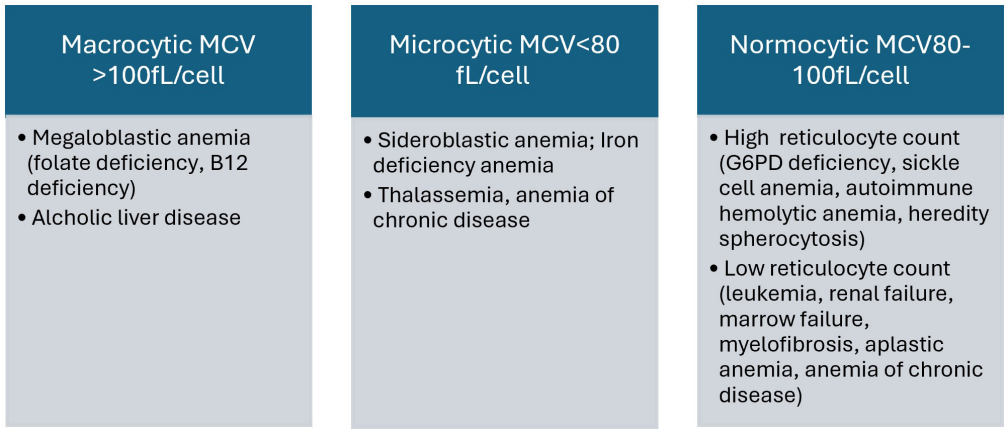

Figure 1. Classification of anemia.

form and injection has changed in today's scenario, as much emphasis is laid on improving dietary habits so as to avoid this nutrition-deficient anemia to a great extent. This paper is an attempt to highlight the importance of edible plants widely consumed in India and used for the treatment of various other blood-related disorders. These plants are also known for their blood purifying effects and are also found useful in sickle cell anemia and β-thalassemia. However, the detailed scientific investigation of the mechanism behind their preventive action is not known to any great extent. An attempt has been made through this review to highlight the importance of edible plants in daily life, as they play a protective and preventive role in hematological problems as revealed through many scientific sources. This study will be helpful to bring research investigations in this area, especially for disorders other than anemia.

Methodology

An extensive search of the various ancient and modern texts (more than 500) on Indian cuisines was carried out in the library of the University of Patanjali and Patanjali Research Foundation, Haridwar, India. This resulted in the identification of 869 plant species widely used in Indian kitchens for the preparation of various cuisines, including sweets, pickles, salad, vegetables, and many others. The expert team of botanists identified the scientific names of these plants. The common English names as well as local Hindi names, were also identified using "World Herbal Encyclopedia". Then the plant species were screened for their medicinal uses through various scientific engines such as PubMed, Google Scholar, Some Useful Tropical Plants etc. Most of the plant species were medicinally acclaimed in traditional medicinal systems

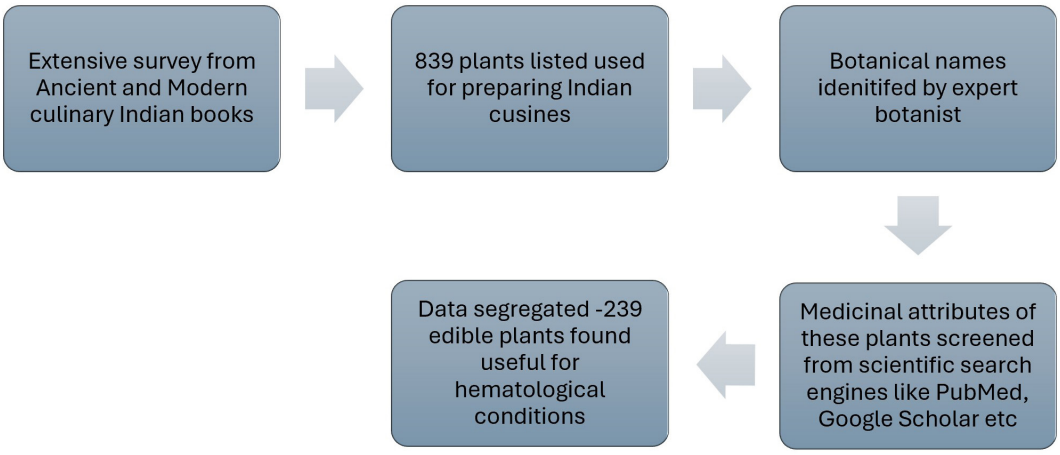

Figure 2. Literature search.

in India for the treatment of fever, ear disease, gastrointestinal problems, blood-related disorders, cancer, and many other conditions. The plant species were segregated for their medicinal usage against hematological problems including anemia, thalassemia, and sickle cell anemia.

Results and Discussion

Although there is much scientific research on medicinal plants usage in the treatment of anemia and other blood-related disorders, very little information is available on the use of edible plants and their medicinal usage for blood-related disorders. Nowadays, much emphasis is laid on medicinal usage of edible plants as their daily intake through various food recipes can ultimately bring health benefits without producing any side effects. The daily intake of such useful plants can always be beneficial in the prevention and cure of many diseases. However, the studies conducted on edible plants used for medicinal and therapeutic purposes are very scarce. This paper is an attempt to highlight the importance of edible plants for the treatment of various blood-related disorders, including anemia [5].

This paper presents a glimpse of such information so that an extensive survey and research can be carried out to look forward in this aspect. The extensive literature survey of ancient and modern culinary books helped to identify 839 plant species used in Indian kitchens for various cuisines. However, only 229 plant species (**Table 1**) were found to be used medicinally for various hematological problems not only in India but many other countries in their traditional medicinal systems. The detailed scientific investigation about the phytochemicals present in these plants producing such beneficial effects is absolutely required.

These plant species belonged to 60 families with a minimum of one plant species in one family, extending to 25 species from Fabaceae family. The plant species from the families Amaranthaceae, Fabaceae, Convovulaceae, Cucurbitaceae, and many others possess significant amounts of iron, vitamins, and minerals, which help elevate hemoglobin percentage in the blood [27].

The data analyzed reveals that 169 plant species are commonly used for the treatment of anemia, 43 species are used as blood purifiers, and 26 species are used for improving blood flow or disorders. Eleven plant species are used as a preventive cure in thalassemia, and 13 species are reported to serve as an anti-sickling agent. Some of the plant species are exclusively used for specific treatments such as *Eclipta prostrata* L., is used to control bleeding, *Hippophae rhamnoides* L., is used to improve cardiovascular functions, *Terminalia catappa* L., is used for sickle cell anemia. Some of the species are used for two or more specific uses. Species like *Allium cepa* L., *Berberis aristata* DC., *Berberis vulgaris* L., are commonly used for anemia as well in improving blood flow. The use of *Allium* species is also mentioned as an anti-sickling agent, along with improving blood flow. The species like *Anacardium occidentale* L., is used as anti-sickling agent as well as for anemia.

Figure 3 clearly represents the various types of preparations commonly consumed for the treatment of different blood-related disorders. The most common method of using various plant parts is in the form of decoction (93 plant species). The plants are also used in the form of vegetables (8), juice (27), infusion (14) chewed (8) or simply eaten (31), used as syrup (10), and even as a beverage (31). *Allium cepa L., Allium sativum L., Capsicum annum L., Curcuma longa* L., are also commonly used as spices in Indian kitchens for seasoning food products.

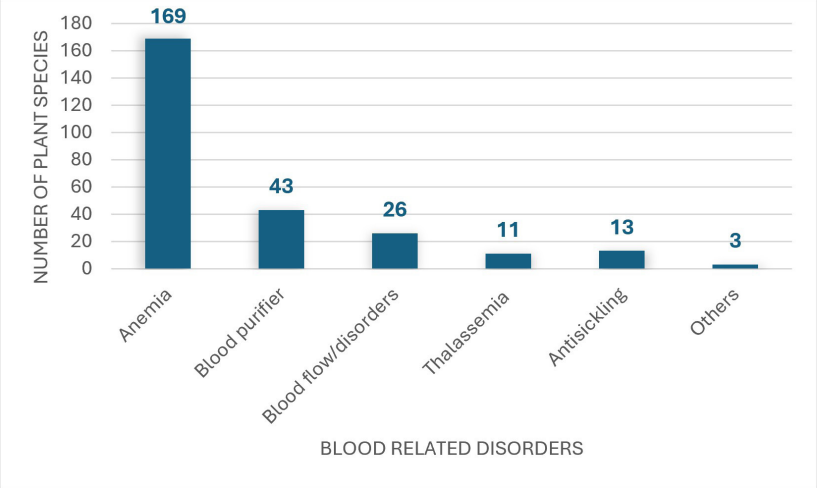

Figure 3. Number of plant species utilized for the treatment of various blood related disorders.

Table 1. List of plants commonly used for the treatment of various blood-related disorders.

Scientific Name	Family	Common /local names	Blood related disorders	Medicinal part	Mode of usage
Abelia chinensis R.Br.	Caprifoliaceae	Gunal	Blood purifier	Whole plant	Decoction [6]
Abroma augustum (L.) L.f.	Malvaceae	Devils cotton	Blood purifier	Petiole	Decoction [6]
Achillea millefolium L.	Asteraceae	Common yarrow	Anemia	Leaf	Decoction [7]
Achyranthes aspera	Amaranthaceae	Apamarg, Apam	Blood purifier	Flower	Chewed [6]
Adansonia digitata L.	Bombacaceae	Baobab	Anemia	Stem bark	Decoction, beverage [6]
Adenanthera pavonina L.	Fabaceae	Rakt Chandon	Blood purifier	Stem bark	Decoction, powder [6]
Aegle marmelos (L.) Correa	Rutaceae	Bilva, Bael	β-Thalassemia	Fruit	Pulp [6]
Alcea striata subsp. *rufescens* (Boiss.) Cullen subsp. *rufescens* (boiss.)	Malvaceae	Desert hollyhock	Anemia	Flower	Decoction with milk [7]
Alocasia macrorrhizos (L.) G.Don	Araceae	Giant taro	Blood purifier	Whole plant, leaf	Plant decoction, leaf as vegetable [6]
Aloe vera (L.) Burm.f.	Asphodelaceae	Kumari,	Thalassemia	Pulp	Pulp juice [9] (ingredient of Kumara-Kalyana Rasa) [10]
Alpinia galanga (L.) Willd.	Zingiberaceae	Greater galangal	Blood purifier	Rhizome	Juice [6]
Alternanthera sessilis (L.) DC.	Amaranthaceae	Sissoo, spinach	Anemia	Plant, leaf	Leaf as vegetable or juice [11]
Allium cepa L.	Amaryllidaceae	Onion/ Piyaz	Blood flow/ anemia	Bulb	Salad/ spice [12,14]
A. sativum L.	Amaryllidaceae	Garlic, Lassun	Blood flow/ anemia, anti-sickling	Bulb, clove	Spice, pickle [12–14]
Amaranthus spinosus L.	Amaranthaceae	Prickly amaranth, Tanduliya	Anemia	Leaf	Decoction, beverage [15]
A. tricolor L.	Amaranthaceae	Chaulai, Datha Saag	Blood purifier	Leaf and shoot top	Leaf as vegetable [6]
Anacardium occidenaale L.	Anacardiaceae	Cashew	Anti-sickling, anemia	Leaf	Decoction [16]
Anacyclus radiatus Loisel.	Asteraceae	Yellow anacyclus	Anemia	Shoot	Cooked in steam [16]
Angelica acutiloba (Siebold & Zucc.) Kitag.	Apiaceae	Shengxuesu	Anemia	Shoot	Extract [17]
Anogeissus leiocarpus (DC.) Guill. & Perr.	Combretaceae	African-birch	Anemia	Stem bark	Decoction [15]
Arachis hypogaea L.	Fabaceae	Groundnut	Anemia	Seed	Decoction [14]
Arbutus unedo L.	Ericaceae	Strawberry tree	Anemia	Root, fruit	Decoction, infusion or eaten [7]
Ardisia solanacea Roxb.	Primulaceae	Tita Jam	Blood purifier	Fruit	Eaten [6]
Armeria mauritanica Wallr.	Plumbaginaceae	Sea pink	Anemia	Root	Decoction [14]
Artemisia absinthium L.	Asteraceae	Common wormwood	Anemia	Shoot	Decoction [7]
A. annua L.	Asteraceae	Sweet wormwood	Anemia	Whole plant	Decoction [7]
Artocarpus lacucha Buch.-Ham.	Moraceae	Dawa, Lacooch	Blood purifier	Fruit	Eaten [6]

Scientific Name	Family	Common /local names	Blood related disorders	Medicinal part	Mode of usage
Asparagus racemosus Willd.	Asparagaceae	Shatavari	Blood purifier	Whole plant	Plant juice [6]
Asphodelus ramosus L.	Asphodelaceae	Branched asphodel	Anemia	Rhizome	Infusion [14]
Asplenium scolopendrium L.	Aspleniaceae	Harts tongue fern	Anemia	Shoot	Decoction [7]
Azadirachta indica A.Juss.	Meliaceae	Neem, Nimb	Blood purifier	Stem bark	Decoction [6]
Bacopa monnieri (L.) Wettst.	Plantaginaceae	Brahmi	Blood purifier	Leaf	Chewed [6]
Barleria prionitis L.	Acanthaceae	Jhingti	Blood purifier	Leaf	Decoction [6]
Bauhinia racemosa Lam.	Fabaceae	Konchan	Blood purifier	Root	Decoction [6]
B. variegata L.	Fabaceae	Kanchanar, Rakt Konchan,	Blood purifier	Bark	Decoction [6]
Berberis aristata DC.	Berberidaceae	Indian barberry	Blood flow/ anemia	Fruit	Pulp/juice as desert [12,18]
B. vulgaris L.	Berberidaceae	European barberry	Blood flow/ anemia	Fruit	Pulp, juice [12,18]
Beta maritima L.	Amaranthaceae	Sea beet	Anemia	Spontaneous Leafy stem	Cooked in steam [14]
B. vulgaris L.	Amaranthaceae	Beet root	Blood disorder/ anemia	Root	Fresh, vegetable [7,19]
Boerhavia diffusa L.	Nyctaginaceae	Punarnava	Blood purifier	Leaf	Decoction [6]
Borago officinalis L.	Boraginaceae	Borage	Thalassemia	Leaf	Decoction, beverage [19]
Brassica oleracea L.	Brassicaceae	Broccoli	Anemia	Thalamus	Vegetable [13]
Bridelia ferruginea Benth.	Euphorbiaceae	Blackbird tree	Anemia	Leaf	Decoction, beverage [15]
Caltha palustris L.	Ranunculaceae	Nergisi	Anemia	Leaf	Poultice, tincture, decoction [7]
Camellia sinensis (L.) Kuntze	Theaceae	Green tea	Thalassemia	Leaf	Beverage [19]
Caesalpinia sappan L.	Fabaceae	Sappan Wood	Anemia	Leaf	Decoction [20]
Cajanus cajan (L.) Millsp.	Fabaceae	Pigeon pea	Anemia, anti-sickling	Leaf, stem, seed	Decoction [6,15–17]
Capsicum annuum L.	Solanaceae	Cayenne pepper	Blood flow, anemia	Fruit	Eaten fresh and as spice [12]
Carica papaya L.	Caricaceae	Papaya	Sickle cell anemia	Leaf extract, unripe fruit extract	Fruit eaten fresh [16]
Carissa carandas L.	Apocynaceae	Bengal currant	Blood purifier	Fruit	Eaten fresh [6]
Corrigiola telephiifolia Pourr.	Caryophyllaceae	Mediterranean strapwort	Anemia	Root	Infusion, decoction [14]
Centaurea calcitrapa L.	Asteraceae	Red star thistle	Anemia	Leafy shoot	Cooked in steam [14]
Centaurium erythraea Rafn	Gentianaceae	European centaury	Anemia	Shoot	Decoction [14]
Centella asiatica (L.) Urb.	Apiaceae	Indian pennywort	Blood purifier	Leaf	Chutney [14]
Ceratonia siliqua L.	Fabaceae	Carob tree	Anemia	Fruit	Infusion, molasses [7]
Chenopodium album L.	Chenopodiaceae	Goose foot	Anemia	Leaf, shoot	Infusion [7,14]
C. quinoa Willd.	Chenopodiaceae	Quinoa	Anemia	Seed	Cooked in steam [7]

Scientific Name	Family	Common /local names	Blood related disorders	Medicinal part	Mode of usage
Cicer arietinum L.	Fabaceae	Chickpea, gram	Blood disorder/ anemia	Seed	Pulse [21]
Cichorium intybus L.	Asteraceae	Chicory	Thalassemia	Whole plant	Decoction [19,7]
Cinnamomum verum	Lauraceae	Dalchini	Thalassemia	Bark	Powder [19]
Cissus populnea Guill. & Perr.	Vitaceae	African treebine	Anti-sickling, anemia	Root, stem bark	Decoction [161]
Cistus laurifolius L.	Cistaceae	Laurel leaved rock rose	Anemia	Leaf	Cooked in steam [14]
Cladanthus arabicus (L.) Cass.	Asteraceae	Arabian cladanthus	Anemia	Flower	Decoction [14]
Citrus aurantium L.	Rutaceae	Orange	Anemia, anti-sickling	Fruit	Eaten [14,16]
Citrus × *limon* (L.) Osbeck	Rutaceae	Lemon, Nimbu	Blood disorders/ anemia	Fruit juice	Fresh juice [21]
C. maxima (Burm.) Merr.	Rutaceae	Chakotara, Jambura,	Blood purifier	Fruit	Eaten with mustard oil [6]
Clerodendrum infortunatum L.	Lamiaceae	Bharangi, Vite	Blood purifier	Leaf	Juice [6]
Coccinia grandis (L.) Voigt	Cucurbitaceae	Kundru,Telakucha	Blood purifier	Whole plant	Juice [6]
Codiaeum variegatum (L.) Rumph. ex A.Juss.	Euphorbiaceae	Patu Bahar	Blood purifier	Stem bark	Decoction [6]
Colocasia esculenta (L.) Schott	Araceae	Garden croton	Blood purifier	Stem	Juice [6]
Combretum pilosum Roxb. ex G. Don	Combretaceae	Hairy combret	Blood purifier	Whole plant	Juice [6]
Coriandrum sativum L.	Apiaceae	Coariander, Dhaniya	Anemia	Dried fruit	Decoction [14]
Corylus avellana L.	Corylaceae	Common hazel	Anemia	Seed	Eaten [7]
C. avellana var. *pontica* (C. Koch) Winkler	Corylaceae	Common hazel	Anemia	Seed	Eaten [7]
Crataegus azarolus var. aronia L.	Rosaceae	Mediterranean medlar	Anemia	Fruit	Eaten [7]
Cryptolepis nigrescens (Wennberg) L. Joubert & Bruyns	Apocynaceae	African parquetina	Anti-sickling, anemia	Lead	Decoction [16,17]
Cucurbita moschata Duchesne	Cucurbitaceae	Cucumber	Anemia	Seed	Eaten [7]
C. pepo L.	Cucurbitaceae	Pumpkin seeds	Blood purifier	Seed	Dry fruit [17]
Cuminum cyminum L.	Apiaceae	Cumin	Anemia	Dried fruit	Decoction [14]
Curcuma amada Roxb.	Zingiberaceae	Aama haldi	Blood purifier	Rhizome	Chutney [24]
C. longa L.	Zingiberaceae	Turmeric, Haldi,	Blood flow/ anemia	Rhizome	Spice, infusion [12,14]
Cymbidium aloifolium (L.) Sw.	Orchidaceae	Aloe leafed cymbidium	Blood purifier	Leaf, root	Juice [6]
Cynodon dactylon (L.) Pers.	Poaceae	Durba	Blood purifier	Leaf	Chewed [6]
Detarium microcarpum Guill. & Perr.	Fabaceae	Sweet detar	Anemia	Leaf	Decoction, beverage [15]

Scientific Name	Family	Common /local names	Blood related disorders	Medicinal part	Mode of usage
D. senegalense J. F. Gmel.	Fabaceae	Tallow tree	Anemia	Leaf	Decoction, beverage [15]
Dioscorea communis (L.) Caddick & Wilki	Dioscoreaceae	Black bryony	Anemia	Flowering branch, root	Raw or ınfusion [7]
D. glabra Roxb.	Dioscoreaceae	Glabrous yam	Blood purifier	Root	Chewed [6]
Diosypros kaki L.	Ebenaceae	Japanese persimmon	Anemia	Fruit	Eaten [7]
D. peregrina (Gaertn.) Gürke	Ebenaceae	Gab Ripe	Blood purifier	Fruit	Eaten [6]
Ecballium elaterium (L.) A. Rich.	Cucurbitaceae	Squirting cucumber	Anemia	Fruit	Eaten [7]
Eclipta prostrata (L.) L.	Asteraceae	Bhringraj	Anemia, bleeding	Plant, leaf	Plant extract taken orally [13]
Emex spinosa (L.) Campd.	Polygonaceae	Devils thorn	Anemia	Leafy shoot	Cooked in steam [14]
Enydra fluctuans Lour.	Asteraceae	Marsh herb	Blood purifier	Leaf	Chewed [6]
Eragrostis viscosa (Retz.) Trin.	Poaceae	Sticky lovegrass	Blood purifier	Whole plant	Juice [6]
Eruca sativa Miller.	Brassicaceae	Arugula	Anemia	Leafy shoot	Cooked in steam [14]
Faidherbia albida (Delile) A. Chev.	Fabaceae	Apple-ring acacia	Anemia	Leaf	Decoction, beverage [15]
Ficus carica L.	Moraceae	Common fig	Anemia	Fruit	Eaten [7]
F. hispida L.f.	Moraceae	Devils fig	Blood purifier	Leaf	Juice [6]
F.platypphylla Del.	Moraceae	Broad leaved fig	Anemia	Stem bark, root	Decoction, beverage [15]
F. simplicissima Lour.	Moraceae	Hairy fig	Blood purifier	Fruit	Fruit paste taken with honey [6]
Foeniculum vulgare Miller	Apiaceae	Fennel	Anemia	Fruit	Eaten [7]
Fragaria vesca L.	Rosaceae	Wild strawberry	Anemia	Fruit	Eaten [7]
Glebionis coronaria (L.) Cass. ex Spach	Asteraceae	Crown daisy	Anemia	Leafy stem	Cooked in steam [14]
Glycine max (L.) Merr.	Fabaceae	Soyabean	Anemia	Seed	Vegetable [13]
Glycyrrhiza glabra L.	Fabaceae	Licorice	Anemia	Root	Powder, decoction [7]
Gmelina arborea Roxb.	Lamiaceae	Kashmir tree	Anemia	Bark	Decoction [6]
Harungana madagascariensis Lam. ex Poir.	Hypericaceae	Dragon's blood tree	Anemia	Stem bark	Decoction, beverage [15]
Helianthus annuus L.	Asteraceae	Sunflower/ Surajmukhi	Blood disorders/ anemia	Seed	Dry fruit [21]
Hellenia speciosa (J.Koenig) S.R.Dutta	Costaceae	Crepe ginger	Blood purifier	Stem, root	Paste taken orally [6]
Hemidesmus indicus (L.) R. Br	Apocynaceae	Indian sarsaparilla	Anemia	Root	Chewed [6]
Hibiscus acetosella Welw. ex Ficalh	Malvaceae	Rose Mallow	Anemia	Leaf	Decoction [22]
H. sabdariffa L.	Malvaceae	Cranberry hibiscus	Anemia	Dried flower, seed	Infusion [14]

Scientific Name	Family	Common /local names	Blood related disorders	Medicinal part	Mode of usage
Hippophae rhamnoides L.	Elaeagnaceae	Sea buckthorn Seaberry	Blood flow and cardiovascular function	Fruit	Pulp, juice [23]
Holarrhena pubescens Wall. ex G. Don	*Apocynaceae*	Ivory tree	Blood purifier	Leaf	Chewed [6]
Hoslundia opposita Vahl.	Lamiaceae	Orange bird-berry	Anemia	Stem, leaf	Decoction, beverage [15]
Hoya diversifolia Blume	Apocynaceae	Shyam plant	Blood purifier	Whole plant	Juice [6]
Hygrophila auriculata (Schumach.) Heine	Acanthaceae	Marsh barbel	Anemia	Shoot	Decoction [17]
Imperata cylindrica var. *africana* (Anderss.) C.E. Hubbard.	Poaceae	Cogon grass	Anemia	Whole plant	Decoction, beverage [15]
Ipomoea aquatica Forssk.	Convolvulaceae	Kolmi shak	Blood purifier	Whole plant	Juice [6]
I. batatas (L.) Lam.	Convolvulaceae	Shakarkand	Anemia	Root tuber	Cooked [24]
I. mauritiana Jacq.	Convolvulaceae	Bhui kumra	Blood purifier	Root	Decoction [6]
Juglans regia L.	Juglandaceae	English walnut	Anemia	Leaf, kernel	Eaten [7]
Juniperus drupacea Labill.	Cupressaceae	Syrian juniper	Anemia	Fruit	Molasses intake [7,14]
Justicia secunda Vahl	Acanthaceae	Vasaka	Anemia	Stem, leaf	Decoction, beverage [15]
Khaya senegalensis (Desv.) A. Juss.	Meliaceae	Senegal Khaya	Anemia	Stem bark	Decoction, beverage [15]
Lagerstroemia speciosa (L.) Pers	Lathyraceae	Rose of India	Anemia	Stem	Decoction [25]
Lannea acida A. Rich	Anacardiaceae	African walnut	Anemia	Stem bark, root	Decoction, beverage [15]
L. barteri (Oliv.) Engl.	Anacardiaceae	Butter oil tree	Anemia	Stem bark	Decoction, beverage [15]
Lavandula stoechas L.	Lamiaceae	Spanish lavander	Anemia	Shoot	Decoction [7]
Lepidium sativum L.	Brassicaceae	Garden cress	Anemia	Leaf	Decoction [7]
L. vesicarium L. leaf	Brassicaceae	Pepper weed	Anemia	Leaf	Decoction [7]
Lophira lanceolata van Tiegh. ex Keay	Ochnaceae	Dwarf red ironwood	Anemia	Stem bark	Decoction, beverage [15]
Malus domestica Borkh.	Rosaceae	Apple	Anemia	Fruit	Syrup [7]
Malva nicaeensis All.	Malvaceae	Dwarf mallow	Anemia	Leaf	Eaten [7]
M. sylvestris L.	Malvaceae	Common mallow	Anemia	Leafy stem	Cooked in steam [14]
Medicago sativa L.	Fabaceae	Alfalfa	Anemia	Seed	Decoction [14]
Melilotus officinalis (L.) Lam.	Fabaceae	Yellow sweet clover	Anemia	Young leaf	Eaten, cooked [7]
Melissa officinalis L.	Lamiaceae	Lemon balm	Anemia	Flowering and leafy branch	Decoction [7]
Mercurialis annua L.	Euphorbiaceae	Annual mercury	Anemia	Leafy shoot	Cooked in steam [14]

Scientific Name	Family	Common /local names	Blood related disorders	Medicinal part	Mode of usage
Milicia excelsa L.	Moraceae	African teak	Anemia	Stem bark	Decoction, beverage [15]
Momordica charantia L.	Cucurbitaceae	Karela	Anemia	Fruit	Vegetable [26]
Moringa oleifera Lam.	Moringaceae	Sahjan, Sigru	Anemia	Leaf, flower, fruit	Vegetable, chutney, juice [26,13]
Morus alba L.	Moraceae	White mulberry	Anemia	Fruit	Syrup [7,14]
M. nigra L.	Moraceae	Black mulberry	Anemia	Fruit	Syrup, jam, syrup, juice [7]
Nasturtium officinale W.T.Aiton	Brassicaceae	Watercress	Anemia	Leafy shoot	Cooked in steam [14]
Nigella arvensis L.	Ranunculaceae	Black cumin	Anemia	Seed	Intake with honey [7,14]
Olax subscorpioidea Oliv.	Olacaceae	Stink Ant Forest	Anemia, antisickling	Root, stem bark	Decoction, beverage [15,16]
Opuntia ficus-indica (L.) Miller	Cactaceae	Prickly pear	Anemia	Fruit	Eaten [7]
Paliurus spina-christi Miller	Rhamnaceaea	Christ's thorn	Anemia	Seed	Decoction [7]
Papaver rhoeas L.	Papaveraceae	Common poppy	Anemia	Flower	Syrup, or cooked with leaf of *Spinacia oleraceae* and *Malva nicaeensis* and eaten [7,14]
Peganum harmala L.	Nitrariaceae	Wild rue	Anemia	Seed	Syrup made in honey [14]
Persea americana Mill.	Lauraceae	Avakado	Anti-sickling, anemia	Leaf	Decoction [16]
Petroselinum crispum (Mill .) Fuss	Apiaceae	Parsley	Anemia	Leaf	Decoction [7]
Phaseolus vulgaris L.	Fabaceae	Bean, black bean	Blood disorders, anemia	Fruit/ seeds	Vegetable [6]
Phoenix dactylifera L.	Arecaceae	Date	Anemia	Fruit	Eaten [14]
Phyllanthus amarus Schum. & Thonn.	Phyllanthaceae	Bhuamlaki	Anemia	Whole plant	Decoction, beverage [15]
P. emblica L.	Phyllanthaceae	Amlaki, gooseberry	Blood flow/ anemia	Fruit	Pulp, juice [12]
Pimenta pseudocaryophyllus (Gomes) Landrum	Myrtaceae	Clove	Anti-sickling, anemia	Seed	Spice [12]
Pimpinella anisum L.	Apiaceae	Aniseed	Anemia	Seed	Paste made in honey [14]
Piper guineense Schumach. & Thonn.	Piperaceae	West African black pepper	Anemia	Fruit	Decoction [16]
Polygonum arenastrum Boreau.	Polygonaceae	Common knotweed	Anemia	Shoot	Decoction [7]
P. aviculare L.	Polygonaceae	Prostrate knotgrass	Anemia	Shoot	Infusion [7]
P. cognatum Meisn.	Polygonaceae	Indian knotgrass	Anemia	Shoot	Infusion [7]
Portulaca oleraceae L.	Portulacaceae	Purslane	Anemia	Shoot	Infusion [7,14]
Prunus amygdalus Batsch	Rosaceae	Almond, Badam	Blood disorder/ anemia	Seed	Dried and eaten, syrup [14,21]
P. armeniaca L.	Rosaceae	Apricot	Anemia	Seed	Syrup in honey [14]
P. spinosa L.	Rosaceae	Blackthorn	Anemia	Fruit	Juice, infusion, eaten fresh [7]

Scientific Name	Family	Common /local names	Blood related disorders	Medicinal part	Mode of usage
Psidium guajava L.	Myrtaceae	Guava	Anti-sickling, anemia	Leaf	Decoction [16]
Pterocarpus erinaceus Poir	Fabaceae	African kino tree	Anemia	Stem bark	Decoction, beverage [15]
P. osun Craib	Fabaceae	African rosewood	Anti-sickling, anemia	Leaf	Decoction [16]
Punica granatum L.	Lythraceae	Pomegranate	Blood flow, disorder/ anemia	Fruit	Juice [12]
Pyrus elaeagnifolia Steud.	Rosaceae	Silver leaf pear	Anemia	Fruit	Eaten [7]
Ridolfia segetum (Guss) Moris	Apiaceae	False fennel	Anemia	Leafy stem, fruit	Cooked, decoction [14]
Ribes × *nidigrolaria* Rud.Bauer & A.Bauer	Grossulariaceae	Jostaberries	Blood flow, disorder/ anemia	Fruit pulp	Eaten, juice [12]
Ricinus communis L.	Euphorbiaceae	Castor bean, Erand	Anemia	Stem, leaf	Decoction, beverage [15]
Rosa canina L. Fruit	Rosaceae	Rose	Anemia	Flower, fruit	Decoction [7,14]
R. indica L.	Rosaceae	Rose, gulab	Thalassemia	Petals	Decoction (ingredient of Praval Pishti, Keharva Pishti) [9]
Rubia peregrina L.	Rubiaceae	Wild madder	Anemia	Root	Decoction, syrup [14]
Rubus canescens DC.	Rosaceae	Woolly blackberry	Anemia	Fruit, root, young leaf and flower	Eaten [7]
R. discolor Weihe et nees	Rosaceae	Himalayan blackberry	Anemia	Fruit	Eaten [7]
R. ellipticus Sm.	Rosaceae	Raspberry	Blood flow/ anemia	Fruit	Pulp/juice [12]
R. molluccanus L.	Rosaceae	Raspberry	Blood flow/ anemia	Fruit	Pulp/juice [12]
R. sanctus Schreber	Rosaceaea	Blackberry	Anemia	Fruit	Eaten or infusion [7]
R. saxatilis L.	Rosaceae	Stoneberry		Fruit, root	Decoction [7]
Rumex acetosella L.	Polygonaceae	Sheep sorrel	Anemia	Shoot, fruit pulp	Eaten [7]
R. conglomeratus Muray	Polygonaceae	Clustered dock	Anemia	Leaf	Intake in any form [7]
R. crispus L.	Polygonaceae	Yellow dock	Anemia	Leaf	Intake in any form [7]
Salvia rosmarinus Spenn.	Lamiaceae	Rosemary	Anemia	Shoot	Intake in any form [7]
Securidaca longepedunculata Fres.	Polygalaceae	Violet tree	Anemia	Stem, root	Decoction, beverage [15]
Senna occidentalis (L.) Link	Fabaceae	Coffee senna	Blood purifier	Leaf	Eaten with Mishri (candid sugar) [6]
S. sophera (L.) Roxb.	Fabaceae	Kasunda	Blood purifier	Leaf	Juice taken orally, empty stomach [6]
Senegalia catechu (L.f.) P.J.H. Hurter & Mabb.	Fabaceae	Khoyar, Khadir	Blood purifier	Wood extract	Used with *Piper betel* and lime [6]
Sesamum indicum L.	Pedaliaceae	Til	Blood purifier	Seed	Infusion in milk [14]
Solanum lycopersicum L.	Solanaceae	Tomato	Blood flow/ anemia	Fruit	Pulp, sauce [12]

Scientific Name	Family	Common /local names	Blood related disorders	Medicinal part	Mode of usage
S. melongena L.	Solanaceae	Eggplant	Anemia	Fruit	Eaten [7]
Sorghum bicolor (L.) Moench	Poaceae	Great millet, Jowar	Anemia, Anti-sickling	Dried stem, seed	Decoction, beverage, powder [15,16]
Spinacia oleracea L.	Amaranthaceae	Spinach, Palak	Blood flow/ anemia	Leaf	Vegetable [12,14]
Stylosanthes erecta P. Beauv.	Fabaceae	Pencil flower	Anemia	Whole plant, leaf, stem	Decoction, beverage [13,15]
Syzygium cumini (L.) Skeels	Myrtaceae	Black berries	Blood flow/ anemia	Fruit	Pulp [12]
Tapinanthus dodoneifolius (DC.) Danser	Loranthaceae	African mistletoe, Kauchhi	Anemia	Leaf	Decoction, beverage [15]
Tectona grandis L. f.	Verbenaceae	Teak, Shagaun	Anemia	Leaf, stem, bark	Decoction, beverage [15]
Terminalia catappa L.	Combretaceae	Tropical almond, Indian almond	β-Thalassemia, sickle cell anemia	Leaf	Extract [8,16]
Tetrapleura tetraptera (Schumach. & Thonn.) Taub.	Fabaceae	Adian tree	Antisickling	Fruit, seed	Decoction [16]
Teucrium chamaedrys sub sp. *chamaedrys* L.	Lamiaceae	Wall germander	Anemia	Flowering and leafy branch, whole plant	Infusion [7]
T. polium L.	Lamiaceae	Felty germander	Anemia	Shoot	Decoction [7]
Thalia geniculata L.	Marantaceae	Arrowroot, fire-flag	Anemia, hemorrhage	Leaf, stem	Decoction, beverage [15]
Thymus vulgaris L.	Lamiaceae	Thyme	β-Thalassemia	Leaf	Decoction [19]
Tilia rubra DC	Tiliaceae	Red twigged lime	Anemia	Flower, leaf	Decoction [7]
Tinospora cordifolia (Willd.) Hook.f. & Thomson	Menispermaceae	Giloy, Guduchi	β-Thalassemia	Stem	Juice, decoction [7]
Trichosanthes kirilowii Maxim	Cucurbitaceae	Chinese cucumber	β-Thalassemia	Fruit	Extract [8]
Trigonella foenum graecum L.	Fabaceae	Fenugreek	Anemia	Seed	Decoction [14]
Triticum aestivum L.	Poaceae	Wheat	Anemia	Seed	Crushed and consumed [7]
T. turgidum subsp. *durum* (Desf.) Husn.	Poaceae	Macaroni wheat	Anemia	Fruit	Crushed and consumed [7,14]
T. vulgare L.	Poaceae	Common wheat	Anemia	Seed	Crushed and consumed [7]
Urtica dioica L.	Urticaceae	Common nettle	Anemia	Leaf, shoot	Decoction or cooked, or infusion [7]
U. pilulifera L.	Urticaceae	Roman nettle	Anemia	Seed, leaf, flower	Dried, and consumed or decoction [7]
U. urens L.	Urticaceae	Dwarf nettle	Anemia	Shoot, Fruit	Decoction [7]
Vicia lens (L.) Coss. & Germ.	Fabaceae	Lentil, Masoor	Blood disorders/ anemia	Seed	Pulse, paste with boiled egg [14,21]

Scientific Name	Family	Common /local names	Blood related disorders	Medicinal part	Mode of usage
Vaccinium ovatum Pursh	Ericaceae	Huckleberry	Blood flow/ anemia	Fruit	Pulp/ juice [12]
Vachellia farnesiana (L.) Wight & Arn.	Fabaceae	Babula	Blood purifier	Stem bark	Chewed [6]
Vitellaria paradoxum C. F. Gaertn	Sapotaceae	Shea tree	Anemia, intestinal worm	Root	Decoction, beverage [15]
Vitis sylvestris L.	Vitaceae	Wild grape	Anemia	Fruit	Syrup [7]
V. vinifera L.	Vitaceae	Common grapevine	Anemia	Fruit.	Syrup [14]
Waltheria indica L.	Sterculiaceae	Sleep morning	Anemia	Leaf, stem	Decoction, beverage [15]
Zea mays L.	Poaceae	Corn	Anemia	Stylus and corn cob	Decoction [7]
Zingiber officinale Roscoe	Zingiberaceae	Ginger, Shunthi	Blood flow/ anemia	Rhizome	Decoction, powder [12,13]

Allium cepa and Allium sativum are used to maintain blood flow in the body. These two species are widely consumed in Indian kitchens for the preparation of green leafy vegetables, as well as used in seasoning in various dishes. These are also used in salads and eaten raw as well as also consumed in pickle form. The use of *Centella asiatica* (L.) Urb., and *Curcuma amada* Roxb., is widely accepted in the form of paste with other ingredients commonly known as Chutney in Indian cuisines. *Caltha palustris* L., is used in the form of a poultice and tincture, *Citrus maxima* (Burm.) Merr., is eaten with mustard oil, seeds of *Cucurbita pepo* L., are consumed in the form of dry fruits, added in various preparations or even consumed raw. The fruit paste of *Ficus simplicissima* Lour., is consumed with honey in the treatment of anemia. The flower decoction of *Aegle marmelos* (L.) Correa is taken orally with milk to treat anemia; however, its pulp is used to treat thalassemia. *Abelia chinensis* R.Br., *Abroma augustum* (L.) L.f., *Achyranthes aspera, Alocasia macrorrhizos* (L.) G. Don are widely used as a blood purifier. The leaf decoction of *Brago officinalis* L., is used as a common beverage and is considered beneficial in thalassemia. Decoction of the whole plant of *Cichorium intybus* L., and bark powder of *Cinnamomum verum* are also found useful in thalassemia. The leaf extract as well as the unripe fruit extract of *Carica papaya* is found useful in sickle cell anemia, although its ripe fruits are mainly consumed. This information is based on the folklore knowledge of the traditional healers, and it needs immediate attention to find a scientific explanation for the same. Probably the answer lies in the detailed scientific investigation on the phytochemistry of the various plant parts utilized for their beneficial effects.

In **Figure 4** the various plant parts used in the treatment of blood-related disorders are shown. In most of cases the leaves (75 plant species) and fruits (70 plant species) are used for medicinal purposes. Although the other plant parts such as roots (24 species) stem (31 species) seeds (29 species), shoots (23 species), whole plant (22 species), flowers (13 species), along with rhizome (5 species) bulb (2 species) are also found to be useful in the treatment of anemia and other blood related disorders. In some cases, very specific plant part is used such as - wood extract of *Senegalia catechu* (L.f.) P.J.H. Hurter & Mabb., is used with Piper betel and lime as blood purifier, petals of *Rosa indica* L., are used in the form of a decoction as a main ingredient of Indian Ayurvedic preparations Praval pishti and Keharva pishti for thalassemia. The spontaneous leafy stem of *Beta maritima* L., is cooked in steam and used as a vegetable for anemia. The flowering and leaf branches of *Melissa officinalis* L., and *Teucrium chamaedrys* sub sp. *chamaedrys* L., flowering branch of *Dioscorea communis* (L.) Caddick & Wilki are used in anemia. The stylus and corn cob of *Zea mays* L., are used in the form of a decoction for curing anemia. The consumption of such beneficial edible plants in the form of various preparations will help in speedy recovery from nutritional deficiency anemia, especially besides other ailments. The administration through oral modes easily passes through the digestive system and facilitates its assimilation [28]. However, few plant species are also used in addition to the main diet as they are consumed in lesser amounts like species of *Allium*. In a study conducted in Turkey, it was found that 77 taxa of plants are used in traditional treatment against anemia in one form or another i.e., decoction, infusion, or eaten raw. The plant parts were the leaf, flower, aerial parts, fruit, stem, roots, seeds, and flowering branches. The seeds of *Cucurbita moschata* Duchesne are consumed with yoghurt, and the fruits of *Ceratonia siliqua* L., are used in the form of infusion, and even as molasses [29]. Very little information is available on the edible plants used in various forms as traditional herbal remedies for the treatment of blood-related

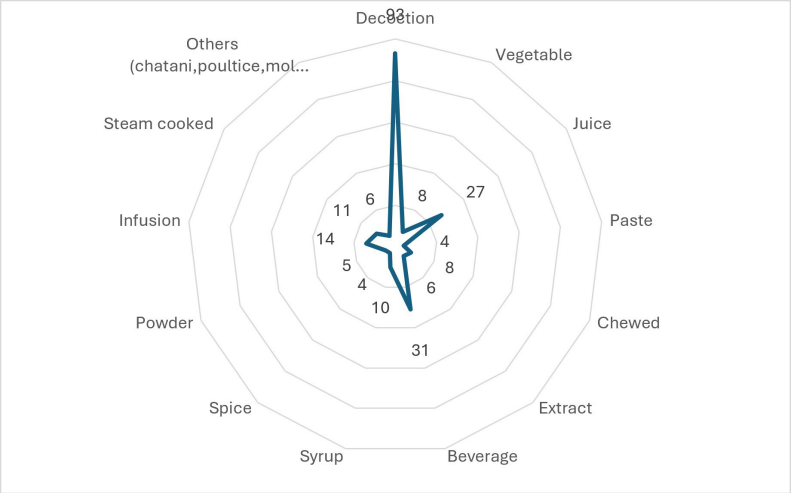

Figure 4. Usage of plant parts for the treatment of blood-related disorders.

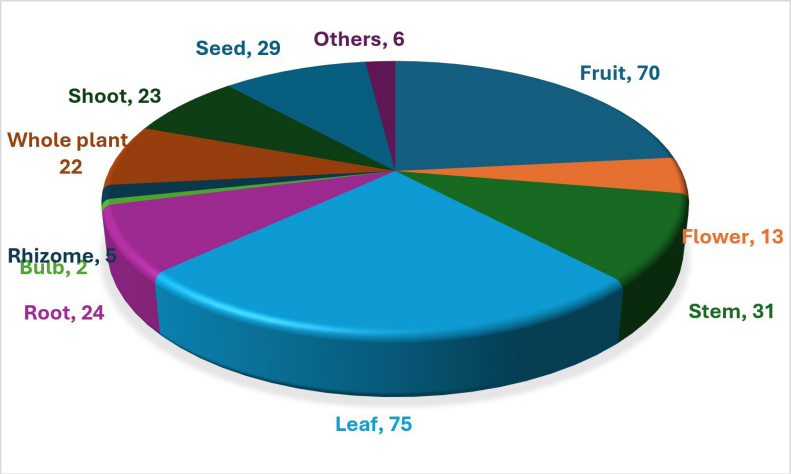

Figure 5. Various plant parts used for the treatment of blood-related disorders.

disorders. Hence, this study was conducted to identify various plants from Indian cuisines which can be useful for these disorders, especially anemia. All across the globe, there is an increase in the number of clinical trials for herbal therapeutics used in various diseases, including anemia, to confirm their therapeutic value, so that they can be marketed through various channels. In much of the research conducted so far, emphasis is laid on the pharmacological effects of the bioactive compounds from various plant species, especially used in iron deficiency anemia. In research conducted so far, it has been shown that the phytochemicals present in various plant parts act directly to induce resolution of anemia, while few others act pleiotropically through their antioxidant activity, thereby increasing resistance to oxidative stress or trigger specific cellular mechanisms, such as autophagy [30].The commonly present phytochemicals in almost all these plant species are flavonoids, anthocyanins, minerals, sugars, and vitamins. In various studies, it has been found that flavonoids encourage the formation of red blood cells (erythropoiesis). The plants rich in iron are useful in iron deficiency anemia [31]. The anti-anemic activity of *Ipoema batatas* (L.) Lam., was evaluated through hematological indices, namely Hb (hemoglobin), hematocrit, RBC (red blood corpuscles), MCHC (mean corpuscular hemoglobin concentration) MCV (mean corpuscular volume) and MCH (mean corpuscular hemoglobin), in an experimental study performed on albino

rats. The results reveal that n-hexane leaf extract triggered regeneration of RBC, Hb, hematocrit, MCH and MCV [32]. Similarly, in a clinical study in Indonesia involving pregnant women, it was found that the leaf decoction of *Ipoema batatas* increased the hemoglobin levels [33]. In another study, it was found that the iron content in the *Moringa* leaves acts as the primary nutrient in hematopoiesis in the spinal cord. The amino acid and protein content in *Moringa* leaves acts as hematopoietic growth factors, vital in managing blood cell differentiation and proliferation. The ascorbic acid content present in its leaves also helps to increase iron absorption in the body [34]. In a study, it was found that dietary iron from *Moringa* leaves was more effective in overcoming iron deficiency in male Wistar rats than ferric citrate, suggesting its possible effects on the expression of liver hepcidin mRNA [35]. These are only a few examples to quote; therefore, confirmatory experimental studies should be conducted on these edible plants to express their curative power. This type of study will encourage people to be focused on consuming a healthy, plant-based based natural diet.

Conclusion

India is a land of diversity in its flora, and generally, people here use plants for their edible and medicinal requirements. The present paper aims to highlight the edible plants commonly used for the treatment of blood-related disorders. In an extensive survey of Indian culinary delicacies from various ancient and modern cookery books, the names of plants used were screened out. These plants were further investigated for their medicinal usage against blood-related disorders. It was found that almost all parts of the plants, i.e., flower, roots, shoots, stems, fruit, leaf, aerial parts, wood, are used in various forms as decoction, infusion, paste, vegetable, syrup, molasses, chewed, and even eaten raw for improving blood-related disorders, especially anemia to a great extent. Two hundred twenty-nine plant species from sixty different families were found useful in these blood-related disorders, from anemia to thalassemia. It would therefore be more interesting to validate the effectiveness of these plants mentioned in this study by appropriate experimental studies, so that their use is more scientifically considered. The study will help to seek and isolate new active principles that could have curative and preventive properties against these disorders. Therefore, the detailed scientific investigation on these plants and their specific part used is the need of the hour. This study is a preliminary concept about the use of edible plants in India, which can be a natural source of herbal medicines for the treatment of various blood-related disorders.

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