



Review Article

NUTRITIONAL AND THERAPEUTIC POTENTIAL OF *SHIGRU* (*Moringa Oleifera*) IN *RASAVAHA* AND *RAKTAVAHA SROTODUSHTI*: A SCOPING REVIEW OF IRON AND HAEMATOLOGICAL OUTCOMES

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Article info

Article History:

Received: 20-07-2026

Accepted: 16-08-2026

Published: 10-09-2026

KEYWORDS:

Shigru, *Moringa oleifera*, *Rasavaha Srotodushti*, *Raktavaha Srotodushti*, Serum iron, Ferritin, Iron deficiency anaemia.

ABSTRACT

Rasavaha and *Raktavaha Srotodushti* are important pathological entities in Ayurveda associated with impaired tissue nourishment, reduced *Rakta* formation, fatigue, pallor, and diminished vitality. Iron deficiency and depleted ferritin stores are among the leading causes of anaemia worldwide. *Moringa oleifera* (*Shigru*) is rich in micronutrients, antioxidants, polyphenols, vitamins, and minerals that may improve haematological parameters. Although most published studies evaluate moringa leaves, Ayurvedic texts also describe medicinal properties of *Shigru*. **Aim & Objective:** To review the available literature regarding the role of *Shigru* (*Moringa oleifera*) in amending *Rasavaha* and *Raktavaha Srotodushti* with special prominence on haematological parameters along with serum iron and ferritin. **Methods:** A systematic search of PubMed, Scopus, ScienceDirect, the Cochrane Library, Google Scholar and the AYUSH Research Portal was undertaken in accordance with PRISMA guidance. Studies involving human participants were considered eligible when they examined the effect of moringa supplementation on haematological outcomes. Eligible publications included randomised controlled trials, non-randomised clinical trials, quasi-experimental investigations and relevant systematic reviews. **Results:** Actual evidence demonstrates improvement in haemoglobin concentrations following moringa supplementation, particularly among women, adolescents, and children with iron deficiency. Evidence for improvement in serum ferritin is promising but remains limited due to heterogeneity in study designs, dosages, preparations, and durations. Most available evidence concerns leaf preparations rather than fruits. **Conclusion:** *Shigru* may support *Rasa-Rakta Dhatu Poshana* and haematological health. However, the current evidence primarily concerns moringa leaf preparations. Well-designed trials using standardised *Shigru Churna* are needed to assess serum iron, ferritin and relevant Ayurvedic outcomes.

INTRODUCTION

Iron deficiency remains the most widespread micronutrient deficiency globally. It poses a substantial public-health burden, with women of reproductive age, pregnant and breastfeeding women, adolescents, and children being especially vulnerable.

The World Health Organization recognizes iron deficiency as a major factor contributing to anaemia worldwide. Iron deficiency anaemia can adversely affect maternal health, physical work capacity, cognitive development and immune function. During pregnancy, it may also be associated with an increased risk of unfavourable maternal and fetal outcomes.

The depletion of body iron stores initially manifests as reduced serum ferritin levels, followed by decreased serum iron concentration, reduced transferrin saturation, and ultimately diminished haemoglobin synthesis, resulting in anaemia. Therefore, serum ferritin has emerged as one of the

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<https://doi.org/10.47070/ayushdhara.v13i4.2916>

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most sensitive biomarkers for the early detection of iron deficiency before the onset of overt anaemia.^[1]

Despite the availability of conventional iron supplementation, long-term therapy is frequently associated with gastrointestinal adverse effects such as nausea, constipation, abdominal discomfort, metallic taste, vomiting, and poor patient compliance. Furthermore, inflammation, oxidative stress, malabsorption syndromes, and chronic diseases may reduce the effectiveness of oral iron therapy by interfering with iron absorption and utilisation. Consequently, there is growing interest in identifying safe, affordable, plant-based interventions that improve iron metabolism, reduce oxidative stress, and enhance nutritional status.^[2]

In Ayurveda, health depends upon the orderly nourishment of the seven *Dhatus*. This process begins with *Rasa Dhatu*, which supports the subsequent formation and nourishment of *Rakta Dhatu*. When *Agni* becomes impaired, food may not be adequately digested or metabolically transformed. The resulting *Ama* can disturb the movement of nutrients through the *Srotas* and interfere with normal *Dhatu Poshana*.

Continued disruption of this process may involve the *Rasavaha* and *Raktavaha* Srotas. The clinical presentation can include *Panduta*, *Daurbalya*, *Shrama*, *Aruchi*, *Bhrama*, *Hridspandana* and diminished *Ojas*. Several of these manifestations-particularly pallor, weakness, fatigue, reduced appetite, dizziness and palpitations- overlap with symptoms reported in iron deficiency anaemia. This similarity may support an integrative clinical interpretation, although Ayurvedic conditions should not be treated as exact biomedical equivalents of iron-deficiency anaemia.^[3]

Pandu Roga is described in Ayurvedic literature as a *Pitta*-predominant disorder in which *Vata* and *Kapha* may also participate. Its development is associated with disturbances of *Agni* and inadequate nourishment of *Rakta Dhatu*. Factors such as improper dietary habits, prolonged illness, blood loss, and progressive *Dhatu Kshaya* may contribute to its manifestation.

From a biomedical perspective, iron deficiency can arise through several pathways. Insufficient dietary intake and reduced intestinal absorption limit the amount of iron available to the body, whereas chronic blood loss gradually depletes existing stores. Iron requirements also rise during periods of increased physiological demand, particularly pregnancy. Parasitic infection and inflammatory disease may further affect iron availability or utilisation. Although the two systems explain disease through different conceptual frameworks, both recognise the importance of nutrition, digestion or

absorption, blood loss and chronic illness in the development of anaemia-related manifestations.^[4]

Among medicinal plants described in Ayurveda, *Shigru* (*Moringa oleifera* Lam.), belonging to the family Moringaceae, has attracted considerable scientific interest due to its exceptional nutritional and pharmacological profile. Every part of the plant-including leaves, fruits (pods), seeds, flowers, bark, and roots- is traditionally utilised for therapeutic purposes. According to Ayurvedic classics, *Shigru* possesses *Katu-Tikta Rasa*, *Laghu-Tikshna Guna*, *Ushna Virya*, and *Katu Vipaka*, making it particularly effective in *Kapha-Vata* disorders, *Ama Pachana*, *Deepana*, *Pachana*, and *Srotoshodhana*. These pharmacodynamic properties suggest its potential role in restoring digestive function and improving nutrient assimilation.^[5]

Modern phytochemical investigations have identified numerous bioactive constituents in *Moringa*, including iron, calcium, potassium, zinc, magnesium, vitamin C, β -carotene, folates, vitamin E, essential amino acids, flavonoids (quercetin and kaempferol), chlorogenic acid, glucosinolates, isothiocyanates, and various phenolic compounds. These bioactive constituents may contribute to the antioxidant, anti-inflammatory, hepatoprotective, immunomodulatory, antimicrobial, and haematopoietic properties of *Moringa oleifera*. Its vitamin C content may improve the absorption of non-haem iron, while antioxidant components may protect erythrocytes from oxidative damage and provide a favourable environment for normal erythropoiesis. Experimental studies have further demonstrated that *Moringa* supplementation may improve haemoglobin concentration, red blood cell indices, serum iron, ferritin levels, and overall nutritional status.^[6]

Available research on *Moringa oleifera* largely focuses on leaf-based preparations, whereas the use of *Shigru Phala* is also recognised in Ayurvedic literature. Evidence specifically examining *Shigru Churna* in relation to serum iron and ferritin is still scarce. This limited evidence highlights the need to review the existing literature and identify areas requiring further clinical investigation.

AIM AND OBJECTIVES

Aim

To review the available evidence on *Shigru* (*Moringa oleifera*) in *Rasavaha* and *Raktavaha Srotodushti*, with special reference to iron status and haematological parameters.

Objectives

1. To assess the available evidence on the effect of *Shigru* on serum iron, ferritin, haemoglobin, and other haematological parameters.

2. To explore its Ayurvedic basis in *Rasa-Rakta Dhatu Poshana* and its nutritional and phytochemical relevance.
3. To understand its possible mechanisms related to iron absorption and erythropoiesis.
4. To identify existing research gaps and scope for further clinical studies.

MATERIALS AND METHODS

This systematic review followed PRISMA guidelines.

Data Sources

Different classical texts of Ayurveda, viz. *Charaka Samhita*, *Sushruta Samhita*, *Ashtanga Hrudaya*, and *Ashtanga Sangraha*; relevant *Nighantus* and commentaries; as well as Modern literature sources, viz. Indexed journals related to nutrition, haematology, and integrative medicine, review articles and clinical studies on anaemia and nutritional deficiencies, WHO reports, and standard nutrition textbooks, databases such as PubMed, Scopus, and

Ayurvedic Concept [7,8,9]

Rasavaha Srotodushti

Etiological factors

Google Scholar, etc., were critically reviewed, compared and analysed.

Inclusion Criteria: Studies involving human participants who received *Moringa oleifera* in any suitable form and reported changes in iron status or haematological parameters, particularly haemoglobin, serum iron, ferritin, and RBC indices, were considered. Relevant Ayurvedic literature describing *Shigru*, *Rasa-Rakta Dhatu Poshana*, *Rasavaha* and *Raktavaha Srotas*, and *Pandu* was also reviewed to provide the classical perspective.

Exclusion Criteria: Studies without relevant information on *Moringa oleifera* or iron and haematological outcomes, duplicate publications, case reports, editorials, and articles with inadequate data were excluded. Animal and in vitro studies were not considered part of the primary clinical evidence but were referred to, where necessary, to understand possible mechanisms of action.

Table 1: Etiological Factors of *Rasavaha Srotodushti*

Stage	Contributing factor or process	Ayurvedic interpretation
1. <i>Nidana Sevana</i>	Frequent consumption of <i>Guru Ahara</i> and <i>Viruddha Ahara</i>	Improper dietary practices place an excessive burden on digestion.
2. <i>Agni</i> impairment	Development of <i>Agnimandya</i> or <i>Mandagni</i>	Digestive and metabolic capacity becomes weakened.
3. Incomplete digestion	Inadequate transformation of consumed food	Food is not properly converted into nutritionally adequate <i>Ahara Rasa</i> .
4. <i>Ama</i> formation	Persistence of incompletely digested material	<i>Ama</i> is generated due to impaired digestion and metabolism.
5. Impaired <i>Rasa</i> formation	Reduced quality of the primary nutritive product	The normal formation and nourishment of <i>Rasa Dhatu</i> become compromised.
6. <i>Srotas</i> dysfunction	<i>Ama</i> interferes with the transport and circulation of <i>Rasa Dhatu</i>	Obstruction or functional disturbance develops within <i>Rasavaha Srotas</i> .
7. Disease development	Continued impairment of <i>Rasa Dhatu</i> nourishment and circulation.	<i>Rasavaha Srotodushti</i> becomes clinically established.

The accumulation of *Ama* can interfere with the normal nourishment and circulation of *Rasa Dhatu*, thereby contributing to the development of *Rasavaha Srotodushti*.

Clinical manifestations

The disturbance of *Rasavaha Srotas* may be reflected through symptoms such as *Alasya*, *Gaurava*, *Aruchi*, *Hrillasa*, and *Daurbalya*. Impaired digestion and inadequate nourishment can disrupt the body's nutrient supply, gradually contributing to nutritional deficiencies and reduced physical strength.

Raktavaha Srotodushti

According to Ayurvedic principles, abnormalities involving the *Raktavaha Srotas* can present with several clinical features. These are shown in the table given below.

Table 2: Clinical manifestation of *Raktavaha Srotodushti*

Clinical manifestation	Ayurvedic correlation
<i>Pandu</i>	Indicates impairment of the normal <i>Varna</i> attributed to healthy <i>Rakta Dhatu</i> .
<i>Twak Vaivarnya</i>	Reflects disturbed <i>Rakta Dhatu Poshana</i> , resulting in alteration of the normal skin complexion.
<i>Daha</i>	May arise from the involvement of <i>Pitta</i> and the <i>Ushna</i> quality associated with <i>Rakta Dhatu</i> .
<i>Bhrama</i>	May occur when vitiated or inadequately nourished <i>Rakta</i> fails to support normal physiological functioning.
<i>Murchha</i>	Represents a more pronounced disturbance of <i>Rakta Dhatu</i> that may affect <i>Chetana</i> .
<i>Klama</i>	Suggests inadequate <i>Dhatu Poshana</i> and reduction in <i>Bala</i> resulting from disturbed <i>Rakta</i> function.

Such manifestations may reflect disturbance in the normal maintenance and functioning of *Rakta Dhatu*. These conditions closely resemble anaemia with reduced oxygen-carrying capacity.

Rationale for Serum Ferritin

Serum ferritin is an important indicator of stored iron and is widely used to assess iron status. Low ferritin levels generally suggest reduced iron reserves and can appear before a noticeable fall in haemoglobin. Hence, ferritin offers additional information about iron stores that may not be evident from haemoglobin assessment alone. In this review, serum ferritin was included as a relevant biochemical parameter for understanding changes in iron status reported across the selected studies. Its values should be interpreted with caution because inflammation can increase ferritin levels independently of iron stores.^[8,9]

Pharmacological Properties of *Shigru*

Table 3 Major Phytoconstituents and Pharmacological Properties of *Shigru* ^[10,11]

Major phytoconstituent	Reported pharmacological/biological relevance
Iron	Contributes to iron availability and supports haemoglobin synthesis and erythropoiesis
Vitamin C	Enhances the intestinal absorption and bioavailability of non-haem iron and provides antioxidant activity.
β -Carotene	Acts as a precursor of vitamin A and contributes to antioxidant defence.
Folates	Support DNA synthesis and normal erythropoiesis.
Polyphenols	Exhibit antioxidant and anti-inflammatory activities.
Flavonoids	Possess antioxidant, anti-inflammatory, and immunomodulatory properties.
Quercetin	Contributes to antioxidant and anti-inflammatory activity and protects cells against oxidative stress
Kaempferol	Exhibits antioxidant and anti-inflammatory effects
Chlorogenic acid	Demonstrates antioxidant and anti-inflammatory potential
Essential amino acids	Provide nutritional support for protein synthesis and erythropoiesis.

Overall pharmacological relevance: The combined presence of these phytoconstituents may contribute to *Shigru's* antioxidant, anti-inflammatory, hematinic, and immunomodulatory potential. Vitamin C may additionally enhance non-haem iron absorption, while antioxidant constituents may help protect erythrocytes from oxidative stress.

Proposed Mechanism ^[12]

***Shigru Churna* in *Rasavaha* and *Raktavaha Srotodushti*: Its Proposed Influence on Iron and Ferritin Status**

The therapeutic efficacy of *Shigru* (*Moringa oleifera*) can be understood through an integrative approach combining Ayurvedic principles with contemporary biomedical evidence. According to Ayurveda, the proper formation of *Rasa Dhatu* is the

foundation for the nourishment of all subsequent *Dhatus*, particularly *Rakta Dhatu*. Impairment of *Jatharagni* and *Dhatvagni* leads to the formation of *Ama*, obstruction of *Rasavaha* and *Raktavaha Srotas*, and defective tissue metabolism, ultimately resulting in *Pandu Roga*, fatigue, pallor, weakness, and reduced vitality. *Shigru* possesses *Deepana* (appetizer), *Pachana* (digestive), *Ama-Pachana* (detoxifying), and *Srotoshodhana* (channel-cleansing) properties that help restore physiological metabolism and improve nutrient assimilation.^[13]

Enhancement of *Agni* and Correction of *Ama*

According to Ayurvedic pharmacology, *Shigru* exhibits *Katu-Tikta Rasa*, *Laghu-Tikshna Guna*, *Ushna Virya*, and *Katu Vipaka*, which stimulate digestive and metabolic activities. These properties enhance *Jatharagni*, promote efficient digestion, and reduce the accumulation of *Ama*, thereby preventing obstruction of microchannels (*Srotorodha*). Improved digestive function facilitates optimal absorption of dietary nutrients, including iron, folate, and other micronutrients essential for hematopoiesis.^[14]

Ahara-Induced *Agnimandya* and *Dhatu Khsaya*

The central pathological event in *Pandu Roga* is *Agnimandya*. Improper diet- either quantitatively

insufficient, qualitatively deficient, or incompatible- leads to diminished digestive and metabolic efficiency. As *Agni* becomes impaired, food is inadequately digested, producing nutritionally poor or toxic metabolites (*Ama*). This results in:^[15]

1. Inadequate formation of *Ahara Rasa*
2. Deficient nourishment of *Rasa Dhatu*
3. Secondary depletion of *Rakta Dhatu*
4. Progressive systemic weakness and pallor

From a modern nutritional standpoint, this sequence closely parallels malnutrition-associated anaemia, in which impaired digestion, malabsorption, or chronic poor dietary intake leads to deficiencies in iron, folate, vitamin B12, and protein.^[16]

Restoration of *Rasavaha Srotas* Function

Rasa Dhatu serves as the primary nutritive tissue responsible for transporting nutrients throughout the body. In *Rasavaha Srotodushti*, impaired nutrient circulation leads to tissue malnourishment and decreased vitality. By improving digestion and promoting *Srotoshodhana*, *Shigru* enhances the formation and circulation of healthy *Rasa Dhatu*, ensuring adequate delivery of nutrients required for subsequent *Rakta Dhatu* synthesis.^[17]

Table 4: Promotion of *Rakta Dhatu* formation

Sequential stage	Ayurvedic interpretation	Nutritional or biomedical correlation
Formation of <i>Rakta Dhatu</i>	Properly nourished <i>Rasa Dhatu</i> undergoes further transformation through the action of <i>Ranjaka Pitta</i> , supporting <i>Rakta Dhatu</i> formation.	Adequate nutritional status provides the physiological foundation required for normal blood-cell formation.
Nutritional support from <i>Shigru</i>	<i>Shigru</i> may contribute to <i>Rasa-Rakta Dhatu Poshana</i> by providing relevant nourishing constituents.	Iron, folate, B-complex vitamins, vitamin A precursors, copper and essential amino acids may provide substrates and cofactors involved in erythropoiesis.
Support for haemoglobin formation	Improved <i>Rakta Dhatu Poshana</i> may help maintain its normal functional qualities.	Iron supports haem synthesis, while amino acids provide substrates for globin-chain formation.
Erythrocyte development	The orderly transformation and nourishment of <i>Rakta Dhatu</i> may support its normal formation.	Folate and certain B vitamins participate in DNA synthesis and erythrocyte maturation.
Maintenance of red-cell characteristics	Properly nourished <i>Rakta Dhatu</i> may help preserve normal <i>Varna</i> and physiological function.	Adequate micronutrient availability supports red blood cell development and morphology.
Possible clinical outcome	Improved <i>Rakta Dhatu</i> status may reduce manifestations associated with <i>Pandu</i> .	Support for haemoglobin formation and erythropoiesis may contribute to improvement in pallor, weakness, fatigue and giddiness.
Symptoms potentially alleviated	<i>Panduta</i> , <i>Daurbalya</i> , <i>Shrama</i> and <i>Bhrama</i>	Pallor, weakness, fatigue and giddiness, respectively.

Improvement of Iron Absorption

One of the most significant nutritional advantages of Moringa is its vitamin C content, which markedly enhances the intestinal absorption of non-heme iron. Vitamin C reduces ferric iron (Fe^{3+}) to the more absorbable ferrous form (Fe^{2+}), increasing its uptake in the duodenum. Simultaneously, organic acids and other phytochemicals present in Moringa may improve iron bioavailability, thereby increasing serum iron concentration and replenishing iron stores.^[19]

Replenishment of Iron Stores and Increase in Serum Ferritin

Ferritin functions as the principal intracellular iron storage protein and reflects total body iron reserves. Adequate dietary iron intake, combined with improved intestinal absorption, facilitates replenishment of depleted iron stores, leading to a gradual elevation in serum ferritin levels. Restoration of ferritin reserves is particularly important because it precedes normalisation of haemoglobin and provides sustained iron availability for future erythropoiesis.^[20]

Stimulation of Erythropoiesis

Shigru supplies essential nutrients required for erythroid cell proliferation and differentiation within the bone marrow. Iron is incorporated into heme synthesis, while amino acids contribute to globin chain formation. Folate supports DNA synthesis during erythroblast maturation, and trace elements such as copper assist iron metabolism. Together, these nutrients stimulate effective erythropoiesis, resulting in increased red blood cell count, improved haemoglobin concentration, and enhanced oxygen-carrying capacity.^[21]

Antioxidant Protection of Erythrocytes

Oxidative stress contributes significantly to erythrocyte membrane damage and shortened red blood cell lifespan. *Moringa oleifera* contains abundant antioxidants, including quercetin, kaempferol, chlorogenic acid, vitamin C, β -carotene, tocopherols, and various polyphenols, which neutralise reactive

oxygen species and reduce lipid peroxidation. Protection of erythrocyte membranes enhances red blood cell survival and contributes to sustained improvement in haematological parameters.^[22]

Anti-inflammatory Modulation of Iron Metabolism

Chronic inflammation increases hepatic hepcidin production, a regulatory peptide that inhibits intestinal iron absorption and prevents iron release from macrophages. Bioactive compounds in Moringa exhibit anti-inflammatory properties by suppressing pro-inflammatory cytokines, including interleukin-6 (IL-6) and tumour necrosis factor-alpha (TNF- α). Reduced inflammatory activity may decrease hepcidin expression, thereby improving iron absorption, mobilisation of stored iron, and overall iron homeostasis.^[23]

Immunomodulatory and Hepatoprotective Effects

The liver plays a central role in ferritin synthesis, iron storage, and regulation of systemic iron metabolism. Moringa demonstrates hepatoprotective activity by reducing oxidative stress, improving hepatic antioxidant defences, and preserving liver function. Additionally, its immunomodulatory properties may improve overall health and reduce chronic inflammatory conditions that interfere with erythropoiesis and nutrient utilisation.^[24]

Improvement in Clinical Outcomes

Through the combined effects of improved digestion, enhanced nutrient absorption, replenishment of iron stores, stimulation of erythropoiesis, antioxidant protection, and anti-inflammatory activity, *Shigru* may lead to measurable improvements in both laboratory and clinical parameters. These include increased serum iron, elevated serum ferritin, higher haemoglobin concentration, improved red blood cell indices, reduced fatigue, enhanced physical endurance, better appetite, improved complexion, and restoration of overall strength and quality of life.^[25]

Shigru Churna

Proposed multi-domain action in *Pandu*

↓	↓	↓
Ayurvedic Action <i>Deepana - Pachana</i> <i>Agni</i> support and <i>Ama Pachana</i> <i>Srotoshodhana</i> Improved <i>Rasa Dhatu</i> formation	Nutritional / Haematological Action Potential supply of iron, vitamin C, folate and amino acids May support nutrient availability, iron absorption and utilization	Antioxidant / Phytochemical Action Bioactive phytochemical constituents, may help limit oxidative stress, may support cellular protection and a favourable milieu for erythropoiesis
↓	↓	↓

Rakta Dhatu Poshana Supports nourishment of <i>Rakta Dhatu</i> and correction of <i>Raktavaha Srotodushti</i>	Hematopoietic Substrate Availability Improved availability/utilization may contribute to effective erythropoiesis	Reduced Oxidative Burden May support RBC integrity and the hematopoietic microenvironment
✓	✓	✓
Enhanced / More Effective Erythropoiesis Integrated effect may contribute to improved RBC production and haemoglobin status.		
↓		
Clinical And Ayurvedic Outcomes ➤ Reduced <i>Panduta</i> ➤ Reduced <i>Daurbalya</i> ➤ Reduced <i>Shrama</i> ➤ Improved <i>Bala</i> and <i>Ojas</i>		

This integrative mechanism provides a scientific rationale for the potential role of *Shigru Churna* as an adjunctive intervention in disorders characterised by *Rasavaha* and *Raktavaha Srotodushti*, particularly iron deficiency and nutritional anaemia. However, dedicated clinical trials specifically evaluating *Shigru Churna* and its effects on serum iron and ferritin are still needed to confirm these proposed mechanisms.^[26]

DISCUSSION

Principal Findings of the Systematic Review

Favourable changes in haematological parameters were reported following *Moringa oleifera* supplementation. Improvements in haemoglobin were among the most frequently observed findings, particularly in participants with iron deficiency or anaemia associated with inadequate nutrition. Overall, the evidence indicates a possible supportive role for *Moringa*, although the response was not consistent across all studies, erythrocyte count, red-cell indices, and serum iron. A smaller number of studies also reported favourable changes in serum ferritin. These results were not uniform, however, as the extent and statistical significance of improvement differed among the included studies.

The observed effects are unlikely to be attributable exclusively to the iron content of *moringa*. The plant provides several nutrients and bioactive constituents relevant to blood formation, including vitamin C, folate, amino acids, trace elements and antioxidant compounds. Their combined activity may promote the absorption and utilisation of dietary iron, provide substrates required for haemoglobin synthesis and erythroid maturation, and help protect circulating erythrocytes against oxidative injury. *Moringa* may therefore serve as a broad-based nutritional and phytotherapeutic support rather than a simple source of supplemental iron.

These findings must nevertheless be interpreted with caution regarding *Shigru Churna*. Most of the available clinical evidence was generated using *moringa* leaves administered as powders, capsules, extracts or components of fortified foods. Direct investigation of *Shigru* fruit and its *Churna* preparation remains limited. Differences among plant parts, processing techniques, and dosage forms may influence nutrient composition, phytochemical profile, and bioavailability. Consequently, evidence derived from leaf preparations can support the scientific rationale for studying *Shigru*. Still, it cannot independently confirm the clinical effectiveness of *Shigru Churna* in the management of *Pandu*.^[27]

Ayurvedic Interpretation of *Shigru* in *Rasa-Rakta Dhatu Poshana*

In Ayurveda, impairment of *Rasavaha Srotas* can affect the normal process of tissue nourishment. When *Agni* becomes weak, digestion and the transformation of food remain incomplete, leading to the formation of *Ama* and poor-quality *Ahara Rasa*. Since *Rasa Dhatu* provides the basis for further nourishment of *Rakta Dhatu*, disturbed formation and circulation of *Rasa* may subsequently affect proper *Rakta Dhatu Poshana*. This relationship is reflected clinically through features such as *Panduta*, *Daurbalya*, *Aruchi*, *Shrama*, *Klama* and reduced *Bala*. Although *Pandu* and iron deficiency anaemia arise from different conceptual systems and should not be regarded as identical conditions, several of their clinical manifestations show meaningful similarities.

Shigru is traditionally described as possessing *Deepana* and *Pachana* actions. These properties may support *Agni*, assist in the digestion of *Ama*, and promote more effective nutrient assimilation. Improved formation of *Ahara Rasa* may subsequently facilitate the orderly nourishment of *Rasa*, *Rakta* and the succeeding *Dhatu*s. In this manner, restoration of

Rasavaha Srotas function could indirectly support *Rakta Dhatu Poshana* and contribute to improved physiological functions associated with oxygen transport.^[28]

Role of Shigru in the Correction of Rasavaha Srotodushti

The possible haematological effects of moringa *oleifera* may be related to its combination of nutrients involved in erythrocyte formation and haemoglobin synthesis. In addition to iron, the plant contains vitamin C, folate, provitamin A compounds, amino acids and trace elements such as copper and zinc. The concentrations and biological availability of these constituents may vary according to the plant part, cultivation conditions, processing method and administered preparation.

Vitamin C can enhance the absorption of non-heme iron by reducing ferric iron to the more soluble ferrous form and by maintaining iron in a condition favourable for uptake within the intestine. Amino acids provide the structural components needed for globin-chain synthesis, whereas folate contributes to DNA synthesis and the maturation of erythroid precursor cells. Copper and zinc also participate in processes associated with iron metabolism, cellular proliferation and hematopoiesis.

The haematological response to moringa supplementation may therefore result from the complementary activity of several nutrients rather than from its iron content in isolation. Such interactions provide a plausible explanation for improvements in haemoglobin and related erythrocyte parameters reported in some studies. Nevertheless, these effects depend on the composition and bioavailability of the preparation, the participant's nutritional status and the presence of other causes of anaemia.^[29]

Oxidative imbalance may contribute to the development and persistence of anaemia, particularly in the presence of chronic inflammation. Excessive generation of reactive oxygen species can promote lipid peroxidation within erythrocyte membranes, impair membrane stability and accelerate the removal of damaged red blood cells from circulation. Oxidative and inflammatory processes may also interfere with erythroid-cell development and the normal regulation of iron metabolism.

Moringa oleifera contains several phytochemical groups with reported antioxidant activity, including flavonoids, phenolic acids, quercetin, kaempferol, chlorogenic acid and glucosinolate-derived compounds. These constituents may assist endogenous antioxidant defences by limiting oxidative reactions and reducing damage to membrane lipids.

Such activity could help maintain erythrocyte integrity and potentially support the normal lifespan of circulating red blood cells.

The antioxidant constituents of moringa may complement its nutritional effects by helping protect erythrocytes from oxidative damage. This could contribute to some of the haematological improvements observed in participants with inflammatory conditions. Nevertheless, laboratory evidence of antioxidant activity cannot by itself demonstrate protection against anaemia in clinical practice. This proposed mechanism should be examined in controlled human trials using standardised moringa preparations and suitable measures of inflammation, oxidative stress and red blood cell survival.^[30]

Serum ferritin provides clinically useful information about stored iron and is therefore different from serum iron, which is influenced by the amount of iron circulating at the time of measurement. Ferritin commonly declines as iron stores become depleted, often before marked changes in other haematological parameters become apparent. It is consequently useful for identifying iron deficiency and monitoring the restoration of iron stores during treatment.

Ferritin outcomes varied across the studies included in this review following Moringa supplementation. Although favourable changes were observed in some investigations, statistically significant increases were not consistently reported. Differences in treatment duration, administered dose, type of moringa preparation, baseline iron status, dietary intake, participant characteristics and laboratory assessment may have contributed to the variation. Shorter interventions may improve the availability of iron for haemoglobin synthesis without being long enough to substantially replenish iron stores.

Ferritin must also be interpreted in relation to the participant's inflammatory status, as it is an acute-phase protein. Infection or inflammation can increase its concentration even when usable iron is limited, or tissue iron reserves are inadequate. An apparently normal or elevated ferritin value may therefore obscure an underlying deficiency. Where possible, ferritin should be assessed together with transferrin saturation, serum iron, total iron-binding capacity and an inflammatory marker such as C-reactive protein. These considerations may account for part of the inconsistency in ferritin outcomes reported across the included studies.^[31]

Methodological Heterogeneity and Evidence Gaps

Interpretation of the current evidence is limited by substantial methodological and clinical diversity among the included studies. The investigations differed in their research designs, the number and characteristics of participants, treatment duration, administered doses, comparator interventions, and the selection of haematological outcomes. Additional variation arose from the use of different plant parts and dosage forms, including leaf powder, capsules, extracts and Moringa-fortified foods.

This variability makes direct comparison difficult because preparations derived from different parts of *Moringa oleifera* may not contain equivalent concentrations of nutrients or phytochemicals. Processing and administration methods may further influence stability, absorption, and bioavailability. Differences in the participants' baseline iron status, dietary patterns and underlying causes of anaemia could also contribute to variation in treatment response.

A further concern is the limited direct evidence concerning *Shigru Churna*. Most of the available clinical findings were generated using leaf-based preparations and should not be applied to the fruit preparation without verification. Although the edible parts of moringa may share certain nutritional and phytochemical constituents, their composition and therapeutic activity cannot be assumed to be identical. The existing evidence therefore supports the biological rationale for investigating *Shigru*, but preparation-specific clinical studies are required before conclusions regarding its effectiveness can be established.^[32]

Integration of Ayurvedic Outcomes with Biomedical Assessment

The present review indicates that future investigations of *Shigru* in *Pandu* should adopt a framework that evaluates both biomedical changes and Ayurvedic clinical responses. Haematological tests can show changes in blood parameters, but they may not fully capture the broader clinical improvement described in the Ayurvedic understanding of *Pandu*.

Biomedical assessment should include haemoglobin concentration, complete blood count, red blood cell count and indices, serum iron, ferritin, transferrin saturation and total iron-binding capacity. Reticulocyte count may help assess the bone-marrow response. Because ferritin can increase during inflammation, measurement of C-reactive protein or another inflammatory marker would improve its interpretation. Dietary intake, treatment adherence, and supplement use should also be documented, as these factors may influence haematological outcomes.

Laboratory findings should be evaluated alongside clearly defined Ayurvedic manifestations. *Panduta* may be assessed through standardised examination of pallor and complexion. *Agni* and *Aruchi* can be assessed using structured questions about appetite, digestive capacity, and postprandial comfort. *Daurbalya*, *Shrama*, *Klama* and *Bala* may be documented using symptom-grading scales, fatigue measures and functional assessments. A validated quality-of-life instrument could further determine whether a meaningful change in daily functioning and well-being accompanies laboratory improvement.

Ayurvedic outcomes should be defined before commencing the study. Investigators must use uniform assessment procedures, provide adequate training to evaluators and select validated or appropriately tested instruments whenever available. Blinding outcome assessors to treatment allocation, where feasible, would help reduce observer bias.

A combined assessment would allow researchers to examine whether improvements in haematological parameters correspond to changes in Ayurvedic manifestations. For example, changes in haemoglobin could be analysed alongside *Panduta*, *Shrama* and *Bala*, while changes in appetite and *Agni* could be evaluated in relation to nutritional intake and clinical recovery. This approach may clarify whether symptomatic improvement occurs together with, before or independently of laboratory changes.

Integration should not involve treating Ayurvedic concepts as exact equivalents of biomedical variables. Instead, both sets of outcomes should be investigated using clearly defined, reproducible methods while preserving their distinct theoretical foundations. A rigorous integrative framework could strengthen the clinical interpretation of *Shigru*, improve comparability across studies, and support a more scientifically informed evaluation of its potential role in *Pandu*.^[33]

CONCLUSION

The present systematic review suggests that *Shigru* (*Moringa oleifera*) represents a promising Ayurvedic medicinal and nutritional intervention for disorders involving *Rasavaha* and *Raktavaha Srotodushti*, particularly those associated with impaired iron metabolism and nutritional anaemia. Available evidence demonstrates consistent improvements in haemoglobin concentration and favourable effects on erythropoiesis, while preliminary findings also indicate potential improvements in serum iron and ferritin status. These beneficial effects are likely mediated through multiple complementary mechanisms, including improved gastrointestinal iron absorption, correction of nutritional deficiencies,

antioxidant protection of erythrocytes, reduced inflammation, and enhanced tissue metabolism. From an Ayurvedic perspective, the *Deepana*, *Pachana*, *Ama-Pachana*, and *Srotoshodhana* properties of *Shigru* support the restoration of *Agni*, the normalisation of *Rasa Dhatu* formation, and the subsequent improvement of *Rakta Dhatu*. This integrative mechanism provides a logical correlation between classical Ayurvedic principles and contemporary understanding of iron homeostasis and erythropoiesis. Nevertheless, the current body of evidence is limited by methodological heterogeneity, relatively small sample sizes, short study durations, and the predominance of investigations utilising moringa leaves rather than *Shigru Churna*. Consequently, although the available findings are encouraging, they do not yet support definitive clinical recommendations for *Shigru* to improve serum ferritin and iron stores.

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Cite this article as:

Pawar Yash H, Jain Sumeeta S, Wasnik Vidya. Nutritional and Therapeutic Potential of Shigru (Moringa Oleifera) in Rasavaha and Raktavaha Srotodushti: A Scoping Review of Iron and Haematological Outcomes. AYUSHDHARA, 2026;13(4):518-528.

<https://doi.org/10.47070/ayushdhara.v13i4.2916>

Source of support: Nil, Conflict of interest: None Declared

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