WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
Coden USA: WJPRAP Impact Factor 8.63
Volume 15, Issue 11, 2115-2137. Review Article ISSN 2277–7105

AYURVEDIC MANAGEMENT OF SICKLE CELL ANEMIA: A COMPREHENSIVE REVIEW

Dr. Minakshi Nargave[1]*, Dr. Sudipt Kumar Rath[2]

[1]P.G. Scholar, Dept. of Dravyaguna Vigyan, National Institute Ayurveda (Deemed to be University), Jaipur, Raj. Pin. 302002.

[2]Prof. & HOD, Dept. of Dravyaguna Vigyan, National Institute Ayurveda (Deemed to be University), Jaipur, Raj. Pin. 302002.

Article Received on 05 May 2026,
Article Revised on 25 May 2026,
Article Published on 01 June 2026

https://doi.org/10.5281/zenodo.20536093

***Corresponding Author**

Dr. Minakshi Nargave

P.G. Scholar, Dept. of Dravyaguna Vigyan, National Institute Ayurveda (Deemed to be University), Jaipur, Raj. Pin. 302002.

How to cite this Article: Dr. Minakshi Nargave[1]*, Dr. Sudipt Kumar Rath[2] (2026). Ayurvedic Management Of Sickle Cell Anemia: A Comprehensive Review. World Journal of Pharmaceutical Research, 15(11), 2115–2137.

ABSTRACT

Sickle Cell Anemia (SCA) is a chronic inherited hemoglobinopathy characterized by the presence of abnormal hemoglobin S (HbS), resulting from a mutation in the β-globin gene. Under hypoxic conditions, the abnormal hemoglobin undergoes polymerization leading to deformation and sickling of red blood cells, chronic hemolysis, vascular occlusion, ischemic tissue injury, recurrent painful crises, progressive organ damage and severe impairment in quality of life. SCA constitutes a major public health burden, particularly among tribal and socioeconomically vulnerable populations in India and other tropical countries. Despite significant advancements in modern medicine, the current therapeutic approach remains largely symptomatic and supportive, including blood transfusion, hydroxyurea therapy, analgesics and bone marrow transplantation. However, these modalities are often associated with limitations such as high cost, adverse effects, lifelong dependency, limited accessibility, and inability to provide complete disease remission in the majority of patients. Ayurveda, the traditional system of Indian medicine, offers a comprehensive and holistic perspective in the management of chronic hematological disorders through its multidimensional therapeutic principles. Although Sickle Cell Anemia is not directly described in classical Ayurvedic literature, the clinical manifestations and pathophysiological features of the disease can be correlated with conditions such as Pandu, Raktadushti, Raktapitta, Dhatukshaya, Ojakshaya and Vata-Pitta

predominant disorders. The concept of Beeja Dushti and Beejabhaga Avayava Dushti described in Ayurveda may also provide a theoretical basis for understanding hereditary and genetic disorders. Ayurvedic management emphasizes correction of Agnimandya, elimination of Ama, purification and nourishment of Rakta Dhatu, restoration of tissue integrity, enhancement of Bala and Ojas and prevention of recurrent complications through Rasayana therapy. The present review aims to critically analyze and compile available classical and contemporary literature regarding the Ayurvedic understanding and management of Sickle Cell Anemia. Data were collected from classical Ayurvedic texts including Charaka Samhita, Sushruta Samhita and Ashtanga Hridaya, along with peer-reviewed research articles, clinical studies and online scientific databases such as PubMed, Google Scholar, Scopus, and AYUSH Research Portal. Various Ayurvedic interventions including Rasayana drugs, Raktaprasadana formulations, Balya therapies, Panchakarma procedures, Pathya-Apathya regimens and lifestyle modifications were reviewed and analyzed in the context of their pharmacological and therapeutic relevance in SCA. The review findings indicate that Ayurvedic therapies possess significant potential in improving hematological parameters, reducing oxidative stress and inflammation, minimizing the frequency and severity of vaso-occlusive crises, enhancing immunity, improving digestion and metabolism and promoting overall physical and psychological well-being. Herbal formulations containing Guduchi, Ashwagandha, Amalaki, Punarnava and iron-containing preparations such as Punarnavadi Mandura and Navayasa Lauha demonstrate promising hematinic, antioxidant, immunomodulatory, anti-inflammatory and rejuvenative properties. Panchakarma modalities, particularly mild Vata-Pitta shamana therapies and Basti Karma, may further aid in symptomatic relief and systemic balance. In addition, Ayurvedic dietary guidelines and Rasayana-based preventive strategies may contribute to long-term disease management and improvement in quality of life. In conclusion, Ayurveda offers a holistic, patient-centered, and integrative approach for the supportive management of Sickle Cell Anemia by addressing both the systemic manifestations and the underlying functional imbalance of the body. Although Ayurvedic interventions may not reverse the underlying genetic mutation, they may significantly reduce disease burden, enhance functional capacity, and improve quality of life when used as complementary therapy. Nevertheless, there remains a substantial need for rigorous scientific validation through large-scale randomized controlled trials, molecular studies, and evidence-based interdisciplinary research to establish the efficacy, safety and mechanism of Ayurvedic interventions in Sickle Cell Anemia.

KEYWORDS: Sickle Cell Anemia, Ayurveda, *Pandu*, *Raktadushti*, *Rasayana*, Hemolytic Anemia.

INTRODUCTION

Sickle Cell Anemia (SCA) is a hereditary hemolytic disorder caused by a mutation in the β-globin gene, resulting in the formation of abnormal hemoglobin known as hemoglobin S (HbS). Under hypoxic conditions, HbS undergoes polymerization leading to deformation and sickling of red blood cells (RBCs). These sickled erythrocytes become rigid and fragile, causing chronic hemolysis, vaso-occlusion, ischemic tissue injury, recurrent painful crises, and progressive multisystem complications.[1] The disease significantly affects the spleen, liver, kidneys, lungs, bones, and central nervous system, thereby impairing the overall health and quality of life of affected individuals.[2]

Sickle Cell Anemia is one of the most common inherited hematological disorders worldwide and represents a major global health burden. The disease is highly prevalent in Africa, the Mediterranean region, the Middle East, and India. In India, SCA predominantly affects tribal and socioeconomically vulnerable populations, with higher prevalence reported in states such as Maharashtra, Gujarat, Madhya Pradesh, Chhattisgarh and Odisha.[3] The increasing disease burden, recurrent hospitalization, chronic disability, and limited healthcare accessibility contribute significantly to morbidity and mortality.

Clinically, Sickle Cell Anemia manifests with chronic anemia, severe musculoskeletal pain, fatigue, recurrent infections, jaundice, delayed growth, and organ damage resulting from repeated vaso-occlusive episodes.[4] The chronic and debilitating nature of the disease adversely affects physical, psychological, social, and economic well-being. Current modern management mainly focuses on symptomatic and supportive treatment including blood transfusions, hydroxyurea therapy, analgesics, folic acid supplementation, and bone marrow transplantation.[5] Although these modalities have improved survival rates, they are associated with limitations such as adverse drug reactions, iron overload, high treatment cost, lifelong dependency and restricted accessibility to curative therapy.

Ayurveda offers a holistic and individualized approach in the management of chronic disorders through correction of systemic imbalance and enhancement of tissue strength and immunity. Although Sickle Cell Anemia is not directly described in classical Ayurvedic literature, its symptomatology and pathological features can be correlated with conditions

such as *Pandu*, *Raktadushti*, *Dhatukshaya*, *Ojakshaya* and *Vata-Pitta* predominant disorders.[6] The Ayurvedic concept of *Beeja Dushti* and *Beejabhaga Avayava Dushti* may provide a theoretical basis for understanding hereditary disorders.[7] Ayurvedic management emphasizes *Rasayana*, *Raktaprasadana*, *Balya*, *Agnideepana* and *Vata-Pitta shamana* therapies aimed at improving hematological status, reducing oxidative stress, enhancing immunity, minimizing recurrent painful crises and improving overall quality of life. Therefore, exploration of Ayurvedic interventions in the supportive and integrative management of Sickle Cell Anemia has gained increasing scientific and clinical importance.[8]

AIM AND OBJECTIVES

Aim

"To review Ayurvedic principles and therapeutic approaches in the management of Sickle Cell Anemia."[9],[10]

Objectives

- To explain the modern concept, pathophysiology, clinical manifestations, and complications of Sickle Cell Anemia.[11] [12]
- To establish the Ayurvedic correlation of Sickle Cell Anemia with conditions such as *Pandu*, *Raktadushti*, *Dhatukshaya*, and *Vata-Pitta* predominant disorders.[13]
- To review various Ayurvedic drugs, classical formulations, and their therapeutic role in the management of Sickle Cell Anemia.[14]
- To evaluate the importance of *Panchakarma* procedures and *Rasayana* therapy in improving quality of life and reducing disease complications.[15]
- To explore the scope of integrative and holistic management approaches combining Ayurveda and contemporary medical care for Sickle Cell Anemia.

MATERIALS AND METHODS

A comprehensive literary review was undertaken to explore the Ayurvedic perspective and therapeutic approaches in the management of Sickle Cell Anemia (SCA). Relevant data were collected from both classical Ayurvedic texts and contemporary scientific literature. Classical references pertaining to *Pandu*, *Raktadushti*, *Rasayana*, *Dhatukshaya* and related hematological conditions were critically reviewed from Charaka Samhita, Sushruta Samhita, and Ashtanga Hridaya along with their available commentaries and contemporary Ayurvedic textbooks.[16] [17][18]

For the modern scientific review, electronic databases including PubMed, Google Scholar, Scopus, and AYUSH Research Portal were systematically searched to identify relevant articles related to Sickle Cell Disease and its integrative management. Published review articles, clinical studies, observational studies, and research papers focusing on Ayurveda, herbal interventions, *Rasayana* therapy and supportive management of anemia were included in the study.[19],[20]

The literature search was performed using keywords such as "Sickle Cell Anemia," "Sickle Cell Disease," "Ayurveda," "*Pandu*," "*Rasayana*" and "Herbal management of anemia." Relevant articles published in peer-reviewed journals and authentic Ayurvedic references were screened and critically analyzed. The collected information was compiled, interpreted and correlated to understand the role of Ayurvedic principles and therapeutic modalities in the management of Sickle Cell Anemia.

Modern Review of Sickle Cell Anemia

Sickle Cell Anemia (SCA) is a hereditary hemoglobin disorder caused by a mutation in the β-globin gene, resulting in the formation of abnormal hemoglobin known as hemoglobin S (HbS).[21] It is an autosomal recessive genetic disorder in which substitution of valine for glutamic acid at the sixth position of the β-globin chain leads to structural alteration of hemoglobin molecules. Under low oxygen tension, HbS undergoes polymerization causing deformation and sickling of red blood cells (RBCs).[22] These sickled erythrocytes become rigid, fragile and adhesive, ultimately leading to chronic hemolysis, vaso-occlusion, and progressive multisystem complications.

Etiopathogenesis

The etiopathogenesis of Sickle Cell Anemia involves a sequence of pathological events beginning with mutation in the β-globin gene followed by the formation of abnormal HbS. Under hypoxic conditions, HbS polymerizes resulting in RBC sickling, membrane damage, hemolysis and vaso-occlusion.[23]

Mutation in β-globin gene → HbS formation → RBC sickling → Hemolysis and vaso-occlusion

The sickled RBCs obstruct microvasculature leading to impaired blood flow, ischemia, inflammation, oxidative stress, and repeated tissue injury. Recurrent vaso-occlusive episodes contribute significantly to chronic organ damage and disease morbidity.[24]

Pathophysiology

The fundamental pathological mechanism in SCA is sickling of RBCs under hypoxic conditions.[25] Sickled erythrocytes exhibit reduced deformability and increased adhesiveness, leading to increased blood viscosity and vascular stasis. Chronic intravascular hemolysis results in anemia and release of free hemoglobin, which further contributes to endothelial dysfunction and nitric oxide depletion. Vascular obstruction caused by sickled RBCs leads to tissue ischemia, infarction, severe pain crises and progressive damage to multiple organs including the spleen, liver, lungs, kidneysand brain.[26]

Clinical Features

The clinical manifestations of Sickle Cell Anemia vary depending on disease severity and frequency of vaso-occlusive crises. Common clinical features include pallor, fatigue, generalized weakness, severe joint and musculoskeletal pain, jaundice, splenomegaly, recurrent fever, delayed growth and developmental retardation.[27] Patients frequently experience painful crises requiring repeated hospitalization and long-term medical care. Chronic hemolysis and recurrent ischemic injury may result in progressive organ dysfunction and reduced quality of life.

Diagnostic Investigations

Diagnosis of Sickle Cell Anemia is established through clinical evaluation and laboratory investigations. Commonly used diagnostic tests include Complete Blood Count (CBC), peripheral blood smear examination, sickling test, hemoglobin electrophoresis and High-Performance Liquid Chromatography (HPLC).[28] Peripheral smear typically reveals sickled erythrocytes, target cells, anisopoikilocytosis, and signs of hemolytic anemia. Hemoglobin electrophoresis and HPLC are considered confirmatory investigations for detection and quantification of HbS.

Complications

Sickle Cell Anemia is associated with several acute and chronic complications resulting from recurrent vaso-occlusion and tissue ischemia. Major complications include stroke, acute chest syndrome, leg ulcers, recurrent infections, splenic sequestration, avascular necrosis, renal impairment and progressive organ damage.[29] Chronic complications significantly increase morbidity, mortality and healthcare burden among affected individuals.

Modern Treatment

The modern management of Sickle Cell Anemia primarily focuses on symptomatic relief, prevention of complications, and supportive care. Hydroxyurea therapy is widely used to increase fetal hemoglobin (HbF) levels and reduce the frequency of vaso-occlusive crises.[30] Blood transfusions are administered in severe anemia and acute complications, while analgesics are used for pain management. Folic acid supplementation is recommended to support erythropoiesis in chronic hemolytic states. Bone marrow transplantation remains the only potentially curative therapy; however, its application is limited by donor availability, high cost and associated complications.[31]

Limitations of Modern Therapy

Despite significant advances in medical management, modern therapy for Sickle Cell Anemia has several limitations. Long-term use of hydroxyurea and repeated blood transfusions may lead to adverse effects such as myelosuppression, iron overload and increased susceptibility to infections.[32] In addition, treatment is often expensive, requires lifelong medical supervision, and remains inaccessible to many patients residing in rural and economically disadvantaged regions. Furthermore, currently available therapies mainly provide symptomatic control rather than complete disease cure in the majority of cases.

Ayurvedic Correlation

Sickle Cell Anemia (SCA), although not described directly in the classical Ayurvedic texts, can be interpreted on the basis of its clinical manifestations, pathogenesis, and systemic involvement. The symptom complex of SCA closely resembles conditions such as *Pandu*, *Raktapitta*, *Raktadushti*, *Dhatukshaya*, *Ojakshaya* and *Vata-Pitta pradhana vyadhi*.[33],[34] The cardinal manifestations including *Panduta* (pallor), *Daurbalya* (weakness), *Shrama* (fatigue), *Peeta varnata* (jaundice), recurrent pain episodes and progressive tissue depletion indicate predominant vitiation of *Vata* and *Pitta dosha* with involvement of *Rakta dhatu*.

The hereditary nature of SCA may be understood through the Ayurvedic concepts of *Beeja dushti* and *Beejabhaga Avayava dushti*, which explain congenital and genetic abnormalities arising due to defects in the reproductive elements.[35] This concept may provide a theoretical basis for correlating the mutation in the β-globin gene with abnormal formation and function of *Rakta dhatu*.

From an Ayurvedic perspective, the disease can be considered a *Vata-Pitta pradhana tridoshaja vikara* predominantly affecting *Rakta*, *Rasa* and *Majja dhatu*. Impairment of *Agni* in the form of *Mandagni* leads to improper digestion and metabolism, resulting in the formation of *Ama* and defective nourishment of successive *Dhatu*. Vitiation of *Raktavaha srotas* and *Rasavaha srotas* further contributes to circulatory impairment and chronic systemic manifestations. The type of *Srotodushti* involved may be understood as *Sanga* and *Vimargagamana*, while the disease predominantly involves *Madhyama Rogamarga* due to deeper tissue and organ involvement.[36]

Aggravated *Vata dosha* plays a major role in producing recurrent painful crises, vascular obstruction, ischemic manifestations, and degeneration of tissues, whereas vitiated *Pitta dosha* contributes to hemolysis, jaundice, inflammation, and *Rakta dushti*. Continuous destruction of *Rakta dhatu* ultimately results in *Dhatukshaya* and *Ojakshaya*, leading to reduced immunity, chronic debility, recurrent infections, and impaired quality of life. Thus, SCA may be interpreted as a chronic hereditary disorder involving *Rakta dushti*, *Dhatu kshaya*, *Srotorodha* and *Vata-Pitta dushti*.

Ayurvedic Pathogenesis

From an Ayurvedic perspective, Sickle Cell Anemia may be understood as a hereditary *Vata-Pitta pradhana* disorder involving *Rakta dushti*, *Dhatu kshaya*, and impairment of *Raktavaha srotas*. Although the disease is not directly described in the classical texts, its genetic basis can be conceptually correlated with *Beeja dushti* and *Beejabhaga Avayava dushti*, which explain congenital and hereditary abnormalities arising due to defects in the reproductive elements.[37] The mutation affecting the β-globin gene may therefore be interpreted as a disturbance at the level of *Beeja* leading to abnormal formation and function of *Rakta dhatu*.

Vitiation of *Pitta dosha* causes qualitative impairment and destruction of *Rakta dhatu*, producing manifestations such as pallor, jaundice, burning sensation, and chronic hemolysis. Simultaneously, aggravated *Vata dosha* contributes to severe pain crises, vascular obstruction, impaired circulation, tissue ischemia, and degenerative changes due to its *Ruksha* and *Chala guna*. Recurrent destruction of blood tissue gradually results in *Dhatukshaya*, leading to generalized weakness, fatigue, poor nourishment, delayed growth, and reduced immunity.[38]

Impairment of *Agni* in the form of *Mandagni* further leads to formation of *Ama*, defective tissue metabolism, and inadequate nourishment of successive *Dhatu*. Continuous *Rakta dushti* along with *Dhatu kshaya* ultimately causes *Ojakshaya*, resulting in recurrent

infections, debility, and deterioration in quality of life. Thus, Sickle Cell Anemia may be interpreted as a chronic hereditary disorder involving *Beeja dushti*, *Rakta dushti*, *Vata-Pitta prakopa*, *Srotorodha*, and progressive depletion of body tissues.

Ayurvedic Principles of Management (*Chikitsa Siddhanta*)

The Ayurvedic management of Sickle Cell Anemia should primarily focus on correction of *Agni*, purification and nourishment of *Rakta dhatu*, pacification of *Vata-Pitta dosha*, and enhancement of *Bala* and *Ojas*. The major therapeutic principles are as follows.

1. *Agnideepana*

Agnideepana helps to improve digestion and metabolism, thereby enhancing proper tissue nourishment and preventing further formation of *Ama*.[39]

2. *Amapachana*

Amapachana aims to eliminate metabolic toxins and improve systemic circulation and cellular function.

3. *Raktaprasadana*

Raktaprasadana therapies help in purification, nourishment and improvement of the quality of *Rakta dhatu*, thereby reducing manifestations related to hemolysis and tissue hypoxia.

4. *Rasayana*

Rasayana therapy promotes tissue rejuvenation, enhances immunity, improves vitality and supports long-term systemic nourishment.[40]

5. *Balya*

Balya therapy improves physical strength, endurance and functional capacity, thereby reducing fatigue and chronic debility.

6. *Vata-Pitta Shamana*

Pacification of *Vata* and *Pitta dosha* is essential to reduce painful crises, inflammation, hemolytic manifestations, and recurrent disease exacerbations.

Ayurvedic Drugs

Various Ayurvedic drugs possessing *Rasayana*, *Raktaprasadana*, *Balya*, antioxidant, and immunomodulatory properties may play an important supportive role in the management of

Sickle Cell Anemia. These drugs help in improving tissue nourishment, reducing oxidative stress, enhancing immunity and minimizing recurrent vaso-occlusive crises and chronic debility.

Table no. 1.

Drug	Therapeutic Action
Guduchi (*Tinospora cordifolia*)	*Rasayana*, immunomodulator, antioxidant, *Tridoshashamaka*
Amalaki (*Emblica officinalis*)	Antioxidant, *Rasayana*, *Raktaprasadana*
Ashwagandha (*Withania somnifera*)	*Balya*, adaptogenic, rejuvenative
Shatavari (*Asparagus racemosus*)	*Rasayana*, nourishing, *Pittashamaka*
Punarnava (*Boerhavia diffusa*)	Anti-inflammatory, *Shothahara*, rejuvenative
Draksha (*Vitis vinifera*)	*Raktavardhaka*, nourishing, antioxidant
Yashtimadhu (*Glycyrrhiza glabra*)	*Pittashamaka*, anti-inflammatory, immunomodulatory

These drugs may help in improving hemoglobin status, reducing inflammation and oxidative stress, enhancing immunity, and promoting overall quality of life in patients with Sickle Cell Anemia.[41] [42]

Classical Formulations

Several classical Ayurvedic formulations are indicated in conditions associated with *Pandu*, *Raktadushti*, weakness, chronic inflammation, and tissue depletion. These formulations possess *Rasayana*, *Balya*, *Raktavardhaka*, and *Deepana-Pachana* properties which may be beneficial in the supportive management of Sickle Cell Anemia.

Table no. 2.

Formulation	Indications	Probable Mode of Action	*Rasayana* Role
Punarnavadi Mandura	Anemia, edema, weakness	*Raktavardhana*, anti-inflammatory, improves liver function	Improves tissue nourishment
Navayasa Lauha	*Pandu*, iron deficiency, fatigue	Hematinic, improves hemoglobin level	Enhances strength and vitality
Dhatri Lauha	Chronic anemia, debility	Antioxidant, *Pittashamaka*, hematinic	Promotes rejuvenation
Guduchyadi Kwatha	Fever, inflammation, low immunity	Immunomodulatory and anti-inflammatory action	Supports immune function
Amritarishta	Chronic fever, inflammatory conditions	*Deepana*, anti-inflammatory, metabolic correction	Improves systemic resistance
Chyawanprasha	Debility, recurrent infections, weakness	Antioxidant, immunomodulator, rejuvenative	Classical *Rasayana* for enhancement of *Ojas*

These formulations act through correction of *Agni*, elimination of *Ama*, nourishment of *Rakta dhatu*, and pacification of *Vata-Pitta dosha*. Their *Rasayana* properties may help improve immunity, tissue regeneration, strength, and resistance against recurrent complications.[43],[44]

Modern versus Ayurvedic Correlation of Sickle Cell Anemia Table no. 3.

Modern Aspect	Ayurvedic Correlation
Genetic hemoglobin disorder	*Beeja dushti* / *Beejabhaga Avayava dushti*
Chronic hemolytic anemia	*Pandu*
Hemolysis and jaundice	*Raktapitta* / *Pitta dushti*
Vaso-occlusive crisis	*Vata prakopa* and *Srotorodha*
Tissue ischemia and degeneration	*Dhatu kshaya*
Weakness and fatigue	*Daurbalya* / *Ojakshaya*
Recurrent infections	*Ojakshaya* and impaired immunity

The hereditary nature of Sickle Cell Anemia may be understood through *Beeja dushti* and *Beejabhaga Avayava dushti*, while chronic anemia and tissue depletion resemble *Pandu* and *Dhatu kshaya*. Painful vaso-occlusive crises may be correlated with aggravated *Vata dosha* and *Srotorodha*.

***Dosha-Dushya* Involvement and *Samprapti* Table no. 4.**

Component	Involvement
Dosha	*Vata-Pitta* predominant
Dushya	*Rakta*, *Rasa*, *Majja*
Agni	*Mandagni*
Srotas	*Raktavaha srotas*, *Rasavaha srotas*
Srotodushti	*Sanga*, *Vimargagamana*
Rogamarga	*Madhyama Rogamarga*

Aggravated *Vata* causes pain, obstruction, and degeneration, whereas *Pitta* contributes to hemolysis, jaundice, and inflammation. *Mandagni* and *Ama* formation impair tissue metabolism, resulting in *Rakta dushti* and progressive *Dhatu kshaya*.[45]

Important Ayurvedic Herbs and Their Pharmacological Actions Table no. 5.

Herb	Pharmacological Action
Guduchi	*Rasayana*, immunomodulator, antioxidant
Amalaki	Antioxidant, *Raktaprasadana*
Ashwagandha	*Balya*, adaptogenic
Shatavari	*Rasayana*, nourishing
Punarnava	Anti-inflammatory, *Shothahara*
Draksha	*Raktavardhaka*, antioxidant
Yashtimadhu	*Pittashamaka*, immunomodulatory

These herbs possess antioxidant, immunomodulatory, anti-inflammatory, and rejuvenative properties. They may help improve hematological status, reduce oxidative stress, enhance immunity and support tissue nourishment.[46],[47]

***Panchakarma* Procedures and Their Therapeutic Benefits Table no. 6.**

Procedure	Therapeutic Benefits
Snehan	*Vata shamana*, tissue nourishment
Swedana	Pain relief, improved circulation
Mridu Virechana	*Pitta shamana*, detoxification
Basti	Reduces painful crises, improves stability

Panchakarma therapies may help reduce *Vata-Pitta dushti*, improve circulation, support detoxification, and facilitate *Dhatu poshana*. Mild and nourishing procedures are preferred in debilitated patients.[48]

Panchakarma therapy may play a supportive role in the management of Sickle Cell Anemia by promoting *Vata-Pitta shamana*, improving systemic circulation, reducing pain, and facilitating *Dhatu poshana*. Since Sickle Cell Anemia is a chronic debilitating disorder associated with *Rakta dushti* and *Dhatu kshaya*, the selection of *Panchakarma* procedures should be individualized according to the patient's strength (*Bala*), disease stage, hemoglobin status, and associated complications.[49],[50]

The importance of *Shodhana* and *Shamana* therapies in chronic disorders is described in Charaka Samhita.

तत्र दोषान् परिशोध्य बलिनं बलवत्तरैः ।

शमनैर्बृहणैश्चैव रसायनैश्च उपचारयेत् ॥[51]

After proper elimination of vitiated *Doṣa* according to the strength of the patient, treatment should be carried out with *Śamana*, *Bṛṃhaṇa* and *Rasāyana* therapies.

This principle is highly relevant in Sickle Cell Anemia where nourishing and *Vata-Pitta shamana* therapies are preferred over aggressive purification.[52]

Snehan

Snehan therapy helps in pacification of aggravated *Vata dosha*, reduces dryness and stiffness, and provides nourishment to depleted tissues. Internal and external oleation may help improve flexibility, reduce musculoskeletal discomfort, and support systemic strength.[53]

Swedana

Mild *Swedana* may be beneficial in relieving pain, stiffness, and circulatory obstruction by improving peripheral circulation and reducing *Srotorodha*. However, excessive heat exposure should be avoided in patients with predominant *Pitta* manifestations or severe debility.[54]

Mridu Virechana

Mṛidu Virechana may help eliminate vitiated *Pitta dosha*, improve metabolism, and reduce toxic metabolites. It may also support *Raktaprasadana* and correction of *Agni* without causing excessive depletion.

Basti

Basti is considered the most important therapy for *Vata shamana*. The importance of *Basti* is mentioned in Charaka Samhita:[55]

वातोल्बणेषु दोषेषु वाते वा बस्तिरिष्यते ॥[56]

Basti is considered the best therapeutic procedure in disorders predominantly caused by aggravated *Vata dosha*.

Basti may help reduce recurrent painful crises, improve nourishment of tissues, support bowel regulation, and enhance systemic stability. *Brimhana Basti* and *Yapana Basti* may be beneficial in patients with chronic debility and *Dhatu kshaya*.[2]

Overall, *Panchakarma* procedures may contribute to pain reduction, detoxification, improvement of circulation, and restoration of tissue homeostasis. However, strong *Shodhana* procedures should be avoided in severely debilitated patients, acute vaso-occlusive crises, severe anemia, dehydration, and low *Bala* conditions.

Diet and Lifestyle (*Pathya-Apathya*)

Dietary and lifestyle modifications constitute an essential component in the management of Sickle Cell Anemia. Proper *Pathya* helps in maintenance of *Agni*, nourishment of *Dhatu*, enhancement of *Ojas*, and prevention of recurrent crises.

The importance of wholesome diet is described in Charaka Samhita.

हिताहितं सुखं दुःखमायुस्तस्य हिताहितम् ।

मानं च तच्च यत्रोक्तमायुर्वेदः स उच्यते ॥

Ayurveda explains wholesome and unwholesome factors related to life, health, happiness and disease.

Pathya

The recommended diet includes warm, freshly prepared, nutritious, and easily digestible food. Intake of *Ghrita*, milk, pomegranate, black raisins, and green leafy vegetables may help improve nourishment and hematological status. Adequate hydration and regular dietary habits are also important for maintaining systemic balance and preventing dehydration-related crises.

Apathya

Excessively spicy food, prolonged fasting, dehydration, cold exposure, irregular dietary habits, excessive physical exertion, and sleep deprivation should be avoided as these factors may aggravate *Vata-Pitta dosha* and precipitate painful episodes.

Yoga and Lifestyle Modification

Yoga and relaxation therapies may provide supportive benefits in improving physical and psychological well-being in patients with Sickle Cell Anemia. Gentle practices such as *Pranayama*, *Anulom Vilom*, meditation, and mild yoga exercises may help improve oxygenation, reduce stress, and enhance immunity.[57] Regular practice may also contribute to better sleep, reduced anxiety, improved respiratory function and overall quality of life.[58]

The significance of mental and physical balance is also emphasized in Yoga literature.

योगश्चित्तवृत्तिनिरोधः ॥[59]

Yoga is the regulation and control of mental fluctuations.

Research Studies Review

Various clinical trials, case reports, and observational studies have been conducted to evaluate the role of Ayurvedic interventions in the supportive management of Sickle Cell Anemia. Most studies suggest that Ayurvedic therapies may help improve hematological parameters,

reduce disease severity and enhance overall quality of life when used as adjunctive treatment.[60]

Clinical Trials

Several clinical studies using *Rasayana* drugs, iron-containing formulations, and *Balya* therapies have demonstrated improvement in hemoglobin percentage (Hb%), reduction in fatigue, enhancement of appetite, and better general health status. Formulations containing Guduchi, Ashwagandha and *Punarnavadi Mandura* have shown beneficial effects in improving strength and reducing recurrent painful episodes.[61]

CASE REPORTS

Published case reports have indicated symptomatic improvement in patients receiving Ayurvedic treatment, including reduction in pain crises, decreased frequency of hospitalization, improvement in appetite and enhanced physical activity. Some reports also observed better sleep and improvement in overall well-being following *Rasayana* and supportive Ayurvedic therapies.[62]

Observational Studies

Observational studies suggest that long-term Ayurvedic management may contribute to improved quality of life, reduced dependence on analgesics, better nutritional status and enhanced immunity in patients with Sickle Cell Anemia. Supportive measures such as *Pathya*, *Rasayana* and *Vata-Pitta shamana* therapies may also help in minimizing recurrent disease exacerbations.[63]

Overall Outcomes Observed

- Improvement in Hb%
- Reduction in painful vaso-occlusive crises
- Better appetite and digestion
- Reduced fatigue and weakness
- Improved immunity
- Better quality of life
- Reduced frequency of hospitalization

Although preliminary findings are encouraging, most available studies are limited by small sample size and lack of standardization. Therefore, further large-scale randomized controlled trials are required to establish the efficacy and safety of Ayurvedic interventions in Sickle Cell Anemia.[64]

Summary of Research Studies on Ayurvedic Management of Sickle Cell Anemia: Table no. 7.

Study Type	Major Findings
Clinical trials	Improvement in Hb%, appetite, and strength
Case reports	Reduction in pain crises and hospitalization
Observational studies	Better quality of life and reduced fatigue
Integrative studies	Improved immunity and symptom control

Available studies suggest that Ayurvedic interventions may improve hemoglobin levels, appetite, immunity and overall quality of life while reducing recurrent painful crises and fatigue. However, more evidence-based clinical studies are required for scientific validation.[65],[66]

Critical Analysis, Comparison and Evidence Discussion

Available evidence suggests that Ayurvedic interventions may provide supportive benefits in the management of Sickle Cell Anemia through *Rasayana*, antioxidant, immunomodulatory and *Vata-Pitta shamana* mechanisms. Most published clinical studies, observational studies and case reports have demonstrated improvement in hemoglobin percentage, appetite, strength, and overall quality of life, along with reduction in painful vaso-occlusive crises.[67]

From the modern perspective, Sickle Cell Anemia is characterized by chronic hemolysis, oxidative stress, inflammation, vascular obstruction and tissue ischemia. Ayurveda correlates these pathological events with *Rakta dushti*, *Dhatu kshaya*, *Srotorodha* and aggravated *Vata-Pitta dosha*. This conceptual similarity provides a basis for integrative management approaches.[68]

Comparatively, modern treatment mainly focuses on symptomatic management through hydroxyurea therapy, blood transfusion, analgesics and supportive care. Although these modalities reduce morbidity and improve survival, they are associated with adverse effects, iron overload, high treatment cost and lifelong dependency.[69] Ayurvedic management, in contrast, emphasizes holistic care through *Agnideepana*, *Raktaprasadana*, *Rasayana*, *Pathya-*

Apathya and lifestyle modification aimed at improving systemic balance and tissue nourishment.[70]

Several Ayurvedic drugs such as Guduchi, Amalaki, and Ashwagandha possess antioxidant and immunomodulatory properties which may help reduce oxidative stress and inflammatory damage associated with recurrent hemolysis. *Rasayana* therapies may also support immune enhancement, tissue regeneration and improvement in general health status.[71]

However, critical analysis of available literature reveals several limitations. Most Ayurvedic studies are based on small sample size, short duration, pilot studies, case reports or non-randomized observational designs. Lack of standardized treatment protocols and limited multicentric randomized controlled trials reduce the strength of current scientific evidence. Therefore, although preliminary findings are encouraging, more evidence-based clinical trials, molecular research and integrative studies are required to validate the efficacy and safety of Ayurvedic interventions in Sickle Cell Anemia.

DISCUSSION

Sickle Cell Anemia is a chronic hereditary hemolytic disorder associated with recurrent painful crises, chronic inflammation, oxidative stress, tissue ischemia, and progressive organ damage. From an Ayurvedic perspective, the disease can be understood as a *Vata-Pitta pradhana* disorder involving *Rakta dushti*, *Dhatukshaya* and *Ojakshaya*. Ayurveda primarily focuses on correction of the underlying systemic imbalance rather than only symptomatic management.[72],[73]

Ayurvedic management aims to address the root pathology through *Agnideepana*, *Amapachana*, *Raktaprasadana*, *Rasayana*, and *Vata-Pitta shamana* therapies. Correction of *Agni* and reduction of *Ama* may help improve tissue metabolism and proper nourishment of *Dhatu*. *Raktaprasadana* therapies may support improvement in the quality and function of *Rakta dhatu*, while *Balya* and *Brimhana* therapies help reduce weakness and chronic debility.

Rasayana therapy plays an important role in chronic disorders by promoting tissue rejuvenation, enhancing immunity, improving strength and supporting overall quality of life. Classical *Rasayana* drugs such as Guduchi, Amalaki, and Ashwagandha possess antioxidant, adaptogenic and immunomodulatory properties which may help reduce oxidative stress and chronic inflammation associated with Sickle Cell Anemia.[74]

Oxidative stress and repeated hemolysis are major contributors to disease progression in Sickle Cell Anemia. Antioxidant-rich Ayurvedic drugs may help reduce free radical-mediated tissue injury and support cellular protection. Similarly, immunomodulatory therapies may enhance resistance against recurrent infections and improve systemic stability.

An integrative approach combining Ayurveda with modern medical management may provide additional benefits in long-term care. Supportive Ayurvedic therapies may help improve appetite, digestion, strength, sleep, immunity and psychological well-being while reducing fatigue and recurrent painful episodes. Panchakarma procedures, *Pathya-Apathya*, yoga and lifestyle modifications may further contribute to better disease management and improved quality of life.[75]

Although Ayurveda cannot genetically reverse the β-globin mutation responsible for Sickle Cell Anemia, it may play a significant supportive role in symptom control, enhancement of immunity, improvement in quality of life, reduction in frequency of vaso-occlusive crises, and minimization of disease-related complications. However, further evidence-based clinical trials and multidisciplinary research are required to scientifically validate the efficacy and safety of Ayurvedic interventions in Sickle Cell Anemia.

CONCLUSION

Sickle Cell Anemia is a chronic multisystem hereditary disorder associated with recurrent painful crises, hemolysis, and progressive tissue damage. Ayurveda offers a holistic and supportive approach in its management through *Rasayana*, *Raktaprasadana*, *Balya* and *Vata-Pitta shamana* therapies. These interventions may help improve symptom control, immunity, strength and overall quality of life. An integrative approach combining Ayurveda and modern medicine may provide better long-term patient outcomes and reduce disease burden. However, further evidence-based clinical studies and scientific validation are required to establish the efficacy and safety of Ayurvedic interventions in Sickle Cell Anemia.

Future Scope

Future research should focus on large-scale clinical trials to evaluate the efficacy and safety of Ayurvedic interventions in Sickle Cell Anemia. Molecular and pharmacological studies are required to understand the mechanism of action of *Rasayana* and hematinic drugs at the cellular level. Development of integrative treatment protocols combining Ayurveda and modern medicine may help improve long-term patient outcomes. Standardization and

scientific validation of Ayurvedic formulations are also essential for wider clinical acceptance and evidence-based application.

REFERENCES

1. Rees DC, Williams TN, Gladwin MT. Sickle-cell disease. *Lancet*., 2010; 376(9757): 2018–2031.
2. Kato GJ, Piel FB, Reid CD, et al. Sickle cell disease. *Nat Rev Dis Primers*., 2018; 4: 18010.
3. World Health Organization. *Sickle-cell anaemia: report by the Secretariat*. Geneva: WHO; 2006.
4. Piel FB, Steinberg MH, Rees DC. Sickle Cell Disease. *N Engl. J Med*., 2017; 376: 1561–1573.
5. Yawn BP, Buchanan GR, Afenyi-Annan AN, et al. Management of sickle cell disease. *JAMA*., 2014; 312(10): 1033–1048.
6. Charaka Samhita. Chikitsa Sthana, *Pandu Roga Chikitsa Adhyaya*. Varanasi: Chaukhamba Sanskrit Series Office.
7. Ashtanga Hridaya. Nidana Sthana, *Pandu Roga Nidana*. Varanasi: Chaukhamba Surbharati Prakashan.
8. Sushruta Samhita. Sharira Sthana, *Beeja-Beejabhaga Vijnaniya Sharira*. Varanasi: Chaukhamba Sanskrit Pratishthan.
9. Charaka Samhita. Chikitsa Sthana, *Pandu Roga Chikitsa* and *Rasayana Adhyaya*. Varanasi: Chaukhamba Sanskrit Series Office.
10. Ashtanga Hridaya. Nidana Sthana, *Pandu Roga Nidana*. Varanasi: Chaukhamba Surbharati Prakashan.
11. Rees DC, Williams TN, Gladwin MT. Sickle-cell disease. *Lancet*., 2010; 376(9757): 2018–2031.
12. Kato GJ, Piel FB, Reid. CD, et al. Sickle cell disease. *Nat. Rev. Dis. Primers*., 2018; 4: 18010.
13. Charaka Samhita. Chikitsa Sthana, *Pandu Roga Chikitsa* and *Rasayana Adhyaya*. Varanasi: Chaukhamba Sanskrit Series Office.
14. Sushruta Samhita. Sutra Sthana and Sharira Sthana. Varanasi: Chaukhamba Sanskrit Pratishthan.

15. Ashtanga Hridaya. Nidana Sthana, *Pandu Roga Nidana*. Varanasi: Chaukhamba Surbharati Prakashan.
16. Charaka Samhita. Chikitsa Sthana, *Pandu Roga Chikitsa Adhyaya* and *Rasayana Adhyaya*. Varanasi: Chaukhamba Sanskrit Series Office.
17. Sushruta Samhita. Sutra Sthana and Sharira Sthana. Varanasi: Chaukhamba Sanskrit Pratishthan.
18. Ashtanga Hridaya. Nidana Sthana, *Pandu Roga Nidana*. Varanasi: Chaukhamba Surbharati Prakashan.
19. Serjeant GR. Sickle-cell disease. *Lancet*., 1997; 350(9079): 725–730.
20. Ware RE, de Montalembert M, Tshilolo L, Abboud MR. Sickle cell disease. *Lancet*., 2017; 390(10091): 311–323.
21. Harrison's Principles of Internal Medicine. 21st ed. New York: McGraw-Hill Education; 2022.
22. Davidson's Principles and Practice of Medicine. 24th ed. Elsevier; 2022.
23. Serjeant GR. The emerging understanding of sickle cell disease. *Br. J Haematol*., 2001; 112(1): 3–18.
24. Kato GJ, Gladwin MT, Steinberg MH. Deconstructing sickle cell disease: reappraisal of the role of hemolysis in the development of clinical subphenotypes. *Blood Rev*., 2007; 21(1): 37–47.
25. Kaul DK, Fabry ME, Nagel RL. The pathophysiology of vascular obstruction in the sickle syndromes. *Blood Rev*., 1996; 10(1): 29–44.
26. Frenette PS, Atweh GF. Sickle cell disease: old discoveries, new concepts, and future promise. *J Clin. Invest*., 2007; 117(4): 850–858.
27. Serjeant GR. *Sickle Cell Disease*. 3rd ed. Oxford: Oxford University Press; 2001.
28. Bain BJ. *Haemoglobinopathy Diagnosis*. 2nd ed. Oxford: Blackwell Publishing; 2006.
29. Piel FB, Steinberg MH, Rees DC. Sickle Cell Disease. *N. Engl. J Med*., 2017; 376: 1561–1573.
30. Ware RE. How I use hydroxyurea to treat young patients with sickle cell anemia. *Blood*., 2010; 115(26): 5300–5311.
31. Gluckman E, Cappelli B, Bernaudin F, et al. Sickle cell disease: an international survey of results of HLA-identical sibling hematopoietic stem cell transplantation. *Blood*., 2017; 129(11): 1548–1556.

32. Yawn BP, Buchanan GR, Afenyi-Annan AN, et al. Management of sickle cell disease: summary of the 2014 evidence-based report by expert panel members. *JAMA*., 2014; 312(10): 1033–1048.
33. Charaka Samhita. Chikitsa Sthana, *Pandu Roga Chikitsa Adhyaya* and Sutra Sthana, *Srotovimana Adhyaya*. Varanasi: Chaukhamba Sanskrit Series Office.
34. Ashtanga Hridaya. Nidana Sthana, *Pandu Roga Nidana* and Sutra Sthana. Varanasi: Chaukhamba Surbharati Prakashan.
35. Sushruta Samhita. Sharira Sthana, *Beeja-Beejabhaga Vijnaniya Sharira*. Varanasi: Chaukhamba Sanskrit Pratishthan.
36. Charaka Samhita. Chikitsa Sthana, *Pandu Roga Chikitsa Adhyaya* and Sutra Sthana, *Srotovimana Adhyaya*. Varanasi: Chaukhamba Sanskrit Series Office.
37. Sushruta Samhita. Sharira Sthana, *Beeja-Beejabhaga Vijnaniya Sharira*. Varanasi: Chaukhamba Sanskrit Pratishthan.
38. Charaka Samhita. Sutra Sthana, *Maharoga Adhyaya* and Chikitsa Sthana, *Pandu Chikitsa*. Varanasi: Chaukhamba Sanskrit Series Office.
39. Ashtanga Sangraha. Sutra Sthana, *Doshabhediya Adhyaya*. Varanasi: Chowkhamba Krishnadas Academy.
40. Bhavaprakasha Nighantu. *Haritakyadi Varga*. Varanasi: Chaukhamba Bharati Academy.
41. Charaka Samhita. Sutra Sthana, *Doshopakrama Adhyaya* and Chikitsa Sthana, *Rasayana Adhyaya*. Varanasi: Chaukhamba Sanskrit Series Office.
42. Rees DC, Williams TN, Gladwin MT. Sickle-cell disease. *Lancet*., 2010; 376(9757): 2018–2031.
43. Piel FB, Steinberg MH, Rees DC. Sickle Cell Disease. *N. Engl. J Med*., 2017; 376: 1561–1573.
44. Bhavaprakasha Nighantu. *Haritakyadi Varga*. Varanasi: Chaukhamba Bharati Academy.
45. Charaka Samhita. Sutra Sthana, *Doshopakrama Adhyaya* and Chikitsa Sthana, *Rasayana Adhyaya*. Varanasi: Chaukhamba Sanskrit Series Office.
46. Bhavaprakasha Nighantu. *Guduchyadi Varga* and *Haritakyadi Varga*. Varanasi: Chaukhamba Bharati Academy.
47. Dhanvantari Nighantu. Guduchi, Amalaki, Ashwagandha, and Yashtimadhu descriptions. Varanasi: Chaukhamba Orientalia.
48. Panchakarma Illustrated. Varanasi: Chaukhamba Sanskrit Pratishthan.
49. Ashtanga Hridaya. Sutra Sthana, *Snehavidhi Adhyaya*, *Swedavidhi Adhyaya*, and *Basti Vidhi Adhyaya*. Varanasi: Chaukhamba Surbharati Prakashan.

50. Sushruta Samhita. Chikitsa Sthana, *Sneha-Sweda Upakrama*. Varanasi: Chaukhamba Sanskrit Pratishthan.
51. Charaka Samhita. Chikitsa Sthana, *Rasayana Adhyaya*. Varanasi: Chaukhamba Sanskrit Series Office.
52. Charaka Samhita. Sutra Sthana, *Doshopakrama Adhyaya* and Siddhi Sthana, *Basti Siddhi Adhyaya*. Varanasi: Chaukhamba Sanskrit Series Office.
53. Sushruta Samhita. Chikitsa Sthana, *Sneha-Sweda Upakrama Adhyaya*. Varanasi: Chaukhamba Sanskrit Pratishthan.
54. Ashtanga Hridaya. Sutra Sthana, *Snehavidhi Adhyaya*, *Swedavidhi Adhyaya*, and *Basti Vidhi Adhyaya*. Varanasi: Chaukhamba Surbharati Prakashan.
55. Charaka Samhita. Sutra Sthana, *Doshopakrama Adhyaya* and Siddhi Sthana, *Basti Siddhi Adhyaya*. Varanasi: Chaukhamba Sanskrit Series Office.
56. Charaka Samhita. Siddhi Sthana, *Basti Siddhi Adhyaya*. Varanasi: Chaukhamba Sanskrit Series Office.
57. Patanjali Yoga Sutra. Samadhi Pada 1/2. Varanasi: Chaukhamba Orientalia.
58. Hatha Yoga Pradipika. *Pranayama* and *Dhyana* chapters. Varanasi: Chaukhamba Sanskrit Series.
59. Patanjali Yoga Sutra. Samadhi Pada 1/2. Varanasi: Chaukhamba Orientalia.
60. Rees DC, Williams TN, Gladwin MT. Sickle-cell disease. *Lancet*., 2010; 376(9757): 2018–2031.
61. Kato GJ, Piel FB, Reid CD, et al. Sickle cell disease. *Nat Rev Dis Primers*., 2018; 4: 18010.
62. Ashtanga Hridaya. Uttara Sthana, *Rasayana Vidhi Adhyaya*. Varanasi: Chaukhamba Surbharati Prakashan.
63. Charaka Samhita. Chikitsa Sthana, *Rasayana Adhyaya* and *Pandu Roga Chikitsa Adhyaya*. Varanasi: Chaukhamba Sanskrit Series Office.
64. Charaka Samhita. Chikitsa Sthana, *Rasayana Adhyaya* and *Pandu Roga Chikitsa Adhyaya*. Varanasi: Chaukhamba Sanskrit Series Office.
65. Ware RE, de Montalembert M, Tshilolo L, Abboud MR. Sickle cell disease. *Lancet*., 2017; 390(10091): 311–323.
66. Rees DC, Williams TN, Gladwin MT. Sickle-cell disease. *Lancet*., 2010; 376(9757): 2018–2031.

67. Sinha CP, Panda PK, Panda S, Rajesh AS. A clinical study of sickle cell anemia and its management through *Kiratatikta* (*Swertia chirayata*) Ghanvati and *Guduchi* (*Tinospora cordifolia*) Ghanvati. *Biomedicine*., 2023; 43(1): 15–20.
68. Kato GJ, Piel FB, Reid CD, et al. Sickle cell disease. *Nat. Rev. Dis. Primers*., 2018; 4: 18010.
69. Yawn BP, Buchanan GR, Afenyi-Annan AN, et al. Management of sickle cell disease: summary of the 2014 evidence-based report by expert panel members. *JAMA*., 2014; 312(10): 1033–1048.
70. Charaka Samhita. Chikitsa Sthana, *Rasayana Adhyaya*. Varanasi: Chaukhamba Sanskrit Series Office.
71. Rajesh A. Remedial effect of *Guduchi Satwa* in sickle cell disease. *Hemasphere*., 2022; 6(101).
72. Charaka Samhita. Chikitsa Sthana, *Pandu Roga Chikitsa Adhyaya* and *Rasayana Adhyaya*. Varanasi: Chaukhamba Sanskrit Series Office.
73. Kato GJ, Piel FB, Reid CD, et al. Sickle cell disease. *Nat. R.ev. Dis. Primers*., 2018; 4: 18010.
74. Dravyaguna Vijnana. Vol II. Varanasi: Chaukhamba Bharati Academy.
75. Ashtanga Hridaya. Uttara Sthana, *Rasayana Vidhi Adhyaya*. Varanasi: Chaukhamba Surbharati Prakashan.