International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Shallaki (Boswellia Serrata Roxb.) in the Management of Primary Dysmenorrhea: Bridging Ayurvedic Concepts and Contemporary Pharmacological Evidence

Dr. Ramila Bhinde[1], Dr. Grishma Solanki[2]

[1]MS Second year scholar Dept. of PTSR, ITRA JAMNAGAR
[2]Asst. Professor Dept. of PTSR, ITRA JAMNAGAR

Abstract

Background: Primary dysmenorrhea is a common gynaecological disorder characterized by painful menstruation in the absence of pelvic pathology, significantly affecting the quality of life of women, particularly adolescents and young adults. Although NSAIDs and hormonal therapies are effective for many women, treatment choice should consider individual contraindications, tolerability, and the possibility of recurrence after discontinuation. Ayurveda correlates primary dysmenorrhea with *Kashtartava*, predominantly resulting from the vitiation of *Apana Vata*. *Shallaki* (*Boswellia serrata* Roxb.), a renowned Ayurvedic medicinal plant, has been traditionally used for inflammatory and painful disorders and has gained increasing scientific attention because of its diverse pharmacological properties.

Objective: This review aims to critically examine the therapeutic potential of *Shallaki* in the management of primary dysmenorrhea by integrating classical Ayurvedic concepts with contemporary pharmacological evidence.

Methods: A narrative review was conducted using classical Ayurvedic texts and published scientific literature. Evidence related to the phytochemistry, pharmacological actions, molecular mechanisms, and potential role of *Boswellia serrata* in primary dysmenorrhea was critically synthesized.

Results: Boswellic acids, particularly AKBA, have demonstrated anti-inflammatory and other pharmacological activities in preclinical and clinical studies, including modulation of 5-lipoxygenase and inflammatory signalling pathways through inhibition of the 5-lipoxygenase pathway, modulation of inflammatory cytokines, suppression of NF-κB signaling, and reduction of oxidative stress. These pharmacological findings may be conceptually correlated with the Ayurvedic properties attributed to *Shallaki*, including *Shothahara* and *Vedanasthapana*. The available evidence provides a plausible mechanistic basis for the potential role of *Shallaki* in reducing uterine inflammation, hypercontractility, ischemia, and menstrual pain. However, direct clinical evidence in women with primary dysmenorrhea remains limited.

Conclusion: The integration of Ayurvedic principles with contemporary pharmacological evidence suggests that *Shallaki* may serve as a promising complementary therapeutic option for primary dysmenorrhea. Nevertheless, well-designed randomized controlled trials employing standardized formulations are required to establish its clinical efficacy, optimal dosage, and long-term safety.

Keywords: Primary dysmenorrhea; *Kashtartava*; *Boswellia serrata*; *Shallaki;* Boswellic acids; Ayurveda; Inflammation; Integrative medicine

1. INTRODUCTION.

Primary dysmenorrhea refers to painful menstruation occurring in women with normal pelvic anatomy and without any identifiable pelvic pathology. It is one of the most common gynaecological complaints, affecting approximately 45–95% of menstruating women worldwide, with the highest prevalence reported among adolescents and young adults. Severe menstrual pain significantly interferes with daily activities, academic performance, social interactions, and emotional well-being, thereby imposing a substantial public health burden[1].

The pathophysiology of primary dysmenorrhea is closely associated with excessive production of endometrial prostaglandins, particularly prostaglandin F2α (PGF2α), during menstruation. Elevated prostaglandin levels induce intense uterine contractions, vasoconstriction, uterine ischemia, and stimulation of pain receptors, resulting in characteristic cramping pain in the lower abdomen. Recent evidence further suggests that leukotrienes contribute to uterine inflammation and heightened pain perception, indicating the involvement of multiple inflammatory pathways in the development of primary dysmenorrhea[2].

Current treatment strategies primarily include non-steroidal anti-inflammatory drugs (NSAIDs) and hormonal contraceptives[3]. NSAIDs inhibit cyclooxygenase (COX) enzymes, thereby reducing prostaglandin synthesis, whereas hormonal therapies suppress ovulation and endometrial proliferation[4]. Although these therapies are effective in many patients, NSAIDs may cause gastrointestinal, renal, and cardiovascular adverse effects, particularly with inappropriate or prolonged use and recurrence of symptoms following discontinuation. Consequently, there is growing interest in safer, evidence-based herbal medicines that offer sustained symptom relief with minimal adverse effects.

Ayurveda provides a holistic approach to women's reproductive health by correcting *Dosha* imbalance, restoring normal physiological functions, and improving tissue integrity. Painful menstruation is correlated with *Kashtartava*, which is often explained under *Udavarta Yonivyapada*, where in obstruction to the normal downward movement of *Apana Vata* results in severe menstrual pain[5]. Among the various Ayurvedic medicinal plants, *Shallaki* (*Boswellia serrata* Roxb.) has attracted considerable scientific interest owing to its potent anti-inflammatory and analgesic properties. The oleo-gum resin of *Shallaki* contains boswellic acids, which exhibit significant inhibition of inflammatory mediators, making it a promising therapeutic agent for painful inflammatory disorders, including primary dysmenorrhea[6].

2. Review Methodology

This article was prepared as a narrative review integrating Ayurvedic textual literature with contemporary biomedical evidence. Literature relevant to primary dysmenorrhea, *Kashtartava, Udavarta Yonivyapada,* Boswellia serrata, *Shallaki,* boswellic acids, AKBA, 5-lipoxygenase, leukotrienes, inflammatory mediators and analgesic activity was considered. Biomedical evidence was identified from PubMed/PMC-indexed literature and other scholarly sources, while classical Ayurvedic concepts were drawn from standard Ayurvedic texts cited in the manuscript. Priority was given to human clinical studies, randomized controlled trials, systematic reviews and mechanistic studies that could clarify the pharmacological rationale of Boswellia. Studies in inflammatory and painful disorders

other than dysmenorrhea were retained as indirect supportive evidence and were not interpreted as proof of efficacy in primary dysmenorrhea. Evidence from combination products containing Boswellia was also considered, but the contribution of Boswellia alone was explicitly distinguished from the effects of the complete formulation. Data were narratively synthesized according to clinical relevance, pharmacological mechanism, Ayurvedic interpretation, formulation characteristics and limitations. Because this manuscript is a narrative review rather than a systematic review or meta-analysis, no quantitative pooling of effect estimates was undertaken.

3. Literature Review

3.1 Modern Perspective of Primary Dysmenorrhea

Primary dysmenorrhea generally begins within six to twelve months after menarche, coinciding with the establishment of ovulatory menstrual cycles. The pain usually starts shortly before or at the onset of menstruation and persists for approximately 8–72 hours. It is characteristically spasmodic in nature and may radiate to the lower back and thighs. Common associated symptoms include nausea, vomiting, fatigue, diarrhoea, headache, dizziness, and generalized discomfort[7].

The principal pathological mechanism involves increased synthesis of prostaglandins, particularly PGF2α and PGE2, by the secretory endometrium during menstruation. Elevated prostaglandin levels enhance uterine contractility and vasoconstriction, leading to uterine ischemia and activation of nociceptive nerve fibres. In addition to prostaglandins, leukotrienes, vasopressin, endothelins, cytokines, and reactive oxygen species have been implicated in augmenting uterine contractility, inflammation, and pain perception[8].

Several risk factors have been associated with primary dysmenorrhea, including early menarche, younger age, nulliparity, positive family history, prolonged menstrual bleeding, heavy menstrual flow, smoking, psychological stress, obesity, and physical inactivity[9]. The diagnosis is primarily clinical and is established after excluding secondary causes such as endometriosis, adenomyosis, uterine fibroids, pelvic inflammatory disease, and congenital anomalies of the reproductive tract.

3.2 Ayurvedic Perspective of Primary Dysmenorrhea

Ayurveda does not describe primary dysmenorrhea as an independent disease entity; rather, painful menstruation is explained under the concepts of *Kashtartava* and *Udavarta Yonivyapada*. According to Ayurvedic principles, *Apana Vata* governs menstruation, ovulation, conception, childbirth, and the expulsion of menstrual blood. Vitiation of *Apana Vata*, resulting from improper dietary habits, suppression of natural urges, psychological stress, excessive physical exertion, or faulty lifestyle practices, obstructs its normal downward movement. This disturbance leads to painful menstruation, delayed menstrual flow, and difficulty in the expulsion of menstrual blood.

The involvement of *Kapha Dosha* may contribute to obstruction (*Srotorodha*) within the *Artavavaha Srotas*, whereas aggravated *Pitta Dosha* may intensify pain through inflammatory changes. Therefore, the management of *Kashtartava* focuses on normalizing *Apana Vata*, eliminating *Srotorodha*, reducing inflammation, and alleviating pain through *Vata*-pacifying, anti-inflammatory, and analgesic interventions[10].

4. Botanical and Ayurvedic Profile *of Shallaki*

- **Botanical name:** *Boswellia serrata* Roxb.
- **Family:** Burseraceae

- **English name:** Indian Frankincense
- **Sanskrit names:** *Shallaki, Sallaki*
- **Hindi name:** Salai Guggul
- **Part used:** Oleo-gum resin[11]

The oleo-gum resin of *Shallaki* contains several pharmacologically active compounds, particularly pentacyclic triterpenoids collectively known as boswellic acids, which are primarily responsible for its therapeutic effects.

4.1 Ayurvedic Properties of *Shallaki:*

Rasa -Madhur, Katu, Tikta,
Guna- Guru, Snigdha, Tikshna,
Virya- Ushna
Vipaka- Madhur
Karma- Balya,Kaphahara, Vatahar, Raktsthambhar,

5. Phytochemistry and Standarization

The therapeutic activity of *Shallaki* is mainly attributed to its diverse phytochemical constituents, including β-boswellic acid, acetyl-β-boswellic acid, 11-keto-β-boswellic acid (KBA), acetyl-11-keto-β-boswellic acid (AKBA), α-pinene, limonene, incensole acetate, terpenoids, and essential oils. Among these, AKBA is an important bioactive boswellic acid that has been extensively investigated for its anti-inflammatory activity, particularly in relation to the 5-lipoxygenase pathway.", thereby exerting significant anti-inflammatory activity[12].

6. Pharmacological Evidence

6.1 Anti-inflammatory Activity

Boswellic acids inhibit the 5-lipoxygenase (5-LOX) enzyme, thereby suppressing leukotriene synthesis. Leukotrienes are important mediators of inflammation, smooth muscle contraction, and pain. by modulating leukotriene-related inflammatory pathways, Shallaki may have potential relevance to inflammatory mechanisms involved in dysmenorrhea.[13]

6.2. Analgesic Activity

Experimental and clinical studies have demonstrated significant analgesic effects of *Shallaki*. Suppression of inflammatory mediators reduces stimulation of peripheral nociceptors, thereby decreasing pain perception during menstruation[14].

6.3. Antioxidant Activity

Oxidative stress plays a significant role in the pathogenesis of primary dysmenorrhea. Boswellia possesses potent antioxidant properties that reduce free radical generation and may contribute to protection against oxidative stress in experimental models. thereby preserving tissue integrity and improving physiological function[15].

6.4. Antispasmodic Activity

Inflammatory mediators play an important role in the pathophysiology of primary dysmenorrhea by contributing to increased uterine contractility, uterine ischemia and pain. Boswellic acids present in Boswellia serrata have demonstrated anti-inflammatory activity, particularly through inhibition of the 5-lipoxygenase pathway and leukotriene synthesis. Therefore, Shallaki may potentially alleviate

dysmenorrhoeal pain by modulating inflammatory pathways associated with uterine hypercontractility and ischemic pain[16].

6.5. Immunomodulatory Activity

Boswellia serrata exhibits significant immunomodulatory activity by regulating the production of pro-inflammatory cytokines, including TNF-α, IL-1β, and IL-6. This modulation attenuates chronic inflammatory responses These findings support its potential immunomodulatory activity, although the clinical relevance of these effects in primary dysmenorrhea remains to be established[17].

7. Conceptual Framework: Mechanism of Action of *Shallaki* (*Boswellia serrata*) in Primary Dysmenorrhea

Primary dysmenorrhea is characterized by painful menstruation in the absence of identifiable pelvic pathology. The underlying pathophysiology involves increased production of prostaglandins (particularly $PGF_2\alpha$ and PGE_2) and leukotrienes during menstruation, leading to excessive uterine contractions, vasoconstriction, uterine ischemia, and activation of pain pathways. These events culminate in the characteristic lower abdominal cramping accompanied by symptoms such as nausea, fatigue, headache, and general discomfort.

From the Ayurvedic perspective, primary dysmenorrhea closely resembles *Kashtartava*, particularly *Udavarta Yonivyapada*. Improper dietary habits (*Mithya Ahara*), irregular lifestyle (*Mithya Vihara*), psychological stress, suppression of natural urges (*Vegadharana*), and excessive physical exertion (*Ativyayama*) contribute to the vitiation of *Apana Vata*. Disturbed *Apana Vata*, together with *Kapha*-induced *Srotorodha* (obstruction of the channels), interferes with the normal downward movement of *Artava*, resulting in painful and difficult menstruation.

Shallaki (*Boswellia serrata*) acts at multiple levels through both Ayurvedic and modern pharmacological mechanisms. The oleo-gum resin contains boswellic acids, particularly acetyl-11-keto-β-boswellic acid (AKBA), which selectively inhibit the 5-lipoxygenase (5-LOX) pathway and suppress leukotriene synthesis. This inhibition may modulate inflammatory responses that are potentially relevant to uterine contractility and pain in primary dysmenorrhea. However, direct evidence demonstrating improvement in uterine blood flow or reduction of ischemia by *Shallaki* in women with primary dysmenorrhea is currently lacking.In addition, boswellic acids modulate inflammatory cytokines, including TNF-α, IL-1β, and IL-6, inhibit NF-κB signaling, and exert antioxidant effects by reducing oxidative stress within endometrial tissues[18].

According to Ayurvedic principles, *Shallaki* possesses *Vata-Kapha Shamaka*, *Shothahara*, *Vedanasthapana*, and *Rasayana* properties. The *Vata Shamana* action helps restore the normal function of *Apana Vata* and facilitates physiological menstrual flow. Its *Shothahara* property corresponds to the reduction of uterine inflammation, while *Vedanasthapana* provides analgesic effects by alleviating menstrual pain. Furthermore, the *Rasayana* property supports tissue nourishment, promotes repair, and helps maintain reproductive health.

Collectively, these complementary mechanisms reduce inflammation, normalize uterine contractility, improve menstrual flow, relieve pain, and enhance the overall quality of life in women with primary dysmenorrhea. The convergence of classical Ayurvedic concepts with contemporary pharmacological evidence provides a scientific rationale for the potential therapeutic role of *Shallaki* in the management of primary dysmenorrhea.

8. Correlation between Ayurveda and Modern Science

The traditional Ayurvedic properties attributed to *Shallaki* may be conceptually correlated with findings from contemporary pharmacological research. Its ***Shothahara*** property corresponds to the experimentally established anti-inflammatory activity mediated through inhibition of inflammatory pathways. ***Vedanasthapana*** correlates with its analgesic effect resulting from suppression of inflammatory mediators and reduced activation of pain receptors. The *Vata-Shamana* concept may be interpreted as a traditional therapeutic framework for restoring physiological function; its relationship to uterine contractility should not be considered a direct molecular equivalence. Furthermore, the ***Rasayana*** property is reflected in its antioxidant activity, tissue-protective effects, and enhancement of cellular repair mechanisms.

Thus, the classical Ayurvedic attributes of *Shallaki* closely parallel the modern pharmacological evidence supporting the therapeutic efficacy of *Boswellia serrata*.

9. Proposed Mechanistic Pathways

Primary dysmenorrhea is characterized by painful uterine contractions resulting from increased production of inflammatory mediators, particularly prostaglandins and leukotrienes. From an Ayurvedic perspective, this condition closely resembles *Kashtartava*, wherein vitiated *Apana Vata* obstructs the normal downward movement of *Artava*, leading to painful menstruation. *Shallaki* exerts its therapeutic effects through a combination of Ayurvedic principles and modern pharmacological mechanisms, thereby interrupting the underlying pathophysiological processes.

9.1. *Vata Shamana* (Normalization of *Apana Vata*): According to Ayurveda, *Apana Vata* governs menstruation, ovulation, conception, and the proper expulsion of menstrual blood. Vitiation of *Apana Vata* results in painful and difficult menstruation. Based on its traditionally described Ayurvedic properties, *Shallaki* may be considered supportive of normal *Apana Vata* function; however, direct clinical evidence demonstrating this effect in primary dysmenorrhea is lacking., facilitating smooth menstrual flow and relieving menstrual pain.

9.2. *Shothahara* (Anti-inflammatory Action): Inflammation plays a central role in the pathogenesis of primary dysmenorrhea. Boswellic acids present in *Shallaki* inhibit the 5-lipoxygenase (5-LOX) enzyme, thereby suppressing leukotriene synthesis. Since leukotrienes promote inflammation, smooth muscle contraction, and pain, their inhibition reduces uterine inflammation and alleviates dysmenorrheic symptoms.

9.3. *Vedanasthapana* (Analgesic Action): Boswellic acids suppress inflammatory mediators responsible for sensitizing peripheral nociceptors, thereby reducing pain transmission and decreasing the intensity of menstrual cramps. Unlike NSAIDs, which primarily reduce prostaglandin synthesis through cyclooxygenase inhibition, boswellic acids have been investigated particularly for effects on the 5-lipoxygenase pathway. However, direct comparative efficacy and safety data for isolated *Shallaki* in primary dysmenorrhea are currently insufficient.

9.4. Reduction of Uterine Hypercontractility: Excessive uterine contractions impair uterine blood flow, resulting in ischemia and severe menstrual pain. By suppressing inflammatory mediators, because inflammatory mediators contribute to uterine contractility and pain, modulation of these pathways by Boswellia may potentially influence dysmenorrhea-related symptoms. However, direct evidence demonstrating reduced uterine contractions or improved uterine perfusion with *Shallaki* in primary dysmenorrhea is currently unavailable.

9.5. Antioxidant Effect: Oxidative stress contributes significantly to inflammation and tissue injury in primary dysmenorrhea. *Boswellia serrata* possesses potent antioxidant properties that scavenge reactive oxygen species and protect endometrial cells from oxidative damage, thereby preserving endometrial integrity and reducing inflammatory responses.

9.6. Immunomodulatory Effect: Boswellic acids regulate key inflammatory cytokines, including TNF-α, IL-1β, and IL-6, and modulate NF-κB signaling pathways. Suppression of these inflammatory mediators further attenuates inflammation and contributes to sustained analgesic and anti-inflammatory effects.

9.7. *Rasayana* Effect: From an Ayurvedic perspective, *Shallaki* possesses ***Rasayana*** properties that promote tissue nourishment, facilitate healing, and support reproductive health. The *Rasayana* attribute provides a traditional framework for discussing tissue nourishment and resilience; however, whether *Shallaki* reduces recurrence of primary dysmenorrhea has not been established clinically.

10. Summary of published clinical evidence on Boswellia serrata in inflammatory and painful disorders:

Author,year	Disorder /Population	Study Design	Intervention/ Dose	Major Outcomes	Relevencel to Dysmenorrhea
Gupta et al., 1998	Bronchial asthma; 80 patients	Randomized, doubl-eblind, placebo controlled, 6-week clinical trial	B. serrata gumresin;300mg boswellic acid, three times daily	Improvement in pulmonary parameters and reduction in asthma attacks were reported	Supports the anti-inflammatory and 5LOX/leukotriene modulating potential of Boswellia, which maybe mechanistically relevant to inflammatory pathways involved in menstrual pain
Kimmatkar et al., 2003	Knee osteoarthritis; 30 patients	Randomized, double-blind, placebo-controlled crossover trial	B. serrata extract 333 mg three times daily; 8-week treatment periods	Reduced knee pain and swelling and improved knee flexion and walking distance	Provides clinical evidence for analgesic and anti-inflammatory effects that may be relevant to painful menstruation
Gerhardt et al., 2001	Active Crohn's disease; 102 randomized patients	Randomized, double-blind, active-controlled, 8-week parallel-	B. serrata extract H15 compared with mesalazine	Clinical improvement and remission-related outcomes were assessed	Supports systemic anti-inflammatory and immunomodulatory activity, but does not provide direct evidence for

		group trial			dysmenorrhea
Madisch et al., 2007	Collagenous colitis	Randomized, double-blind, placebo-controlled clinical study	B. serrata extract	Improvement in clinical disease activity/remission parameters was reported	Supports anti inflammatory activity in another inflammatory gastrointestinal disorder; relevance to dysmenorrhea is indirect
Sontakke et al., 2007	Knee osteoarthritis; 66 patients	Randomized, prospective, open-label comparative trial	B. serrata extract, 333 mg three times daily, compared with valdecoxib	Improvement in WOMAC-related clinical parameters and pain was reported	Supports analgesic and anti-inflammatory effects,
Agarwal D, Chaudhary P., 2023	60 women with primary dysmenorrhea, 18–35 years	Randomized, double-blind, placebo-controlled trial	Turmeric–Boswellia–Sesame formulation vs placebo	2 softgels × 500 mg (total 1000 mg), single dose when NRS pain ≥5; assessment up to 6 h	Single-dose study; short follow-up; Boswellia was combined with turmeric and sesame, so its individual contribution cannot be determined Directclinical relevance: demonstrates that a Boswellia containing botanical formulation can reduce acute menstrual cramp pain in primary dysmenorrhea. It provides preliminary clinical support for investigating Boswellia as an analgesic/anti-inflammatory

					component.
Schettino MT et al., 2025	33 women, 20–35 years, with dysmenorrhea and inadequate response to NSAIDs	Single-center retrospective study	Acmella oleracea + Boswellia serrata food supplement used with NSAIDs	Treatment over 3 menstrual cycles	suggests a possible adjunctive role of a Boswellia-containing formulation in reducing dysmenorrhea symptoms and analgesic requirement, particularly in women with inadequate response to NSAIDs. However, independent efficacy of Boswellia cannot be established.

11. Mechanistic Basis and Ayurvedic Correlation of Boswellia serrata:

Boswellia serrata contains pentacyclic triterpenoids collectively known as boswellic acids, among which acetyl-11-keto-β-boswellic acid (AKBA) is an important bioactive constituent. Boswellic acids have been investigated for their effects on inflammatory pathways, particularly 5-lipoxygenase-mediated leukotriene synthesis. Additional experimental evidence suggests modulation of inflammatory signaling, including NF-κB and pro-inflammatory cytokines, together with antioxidant effects. In the context of primary dysmenorrhea, these mechanisms may be relevant because menstrual pain is associated with inflammatory mediator activity, uterine hypercontractility, vasoconstriction and ischemia. However, the proposed relationship between Boswellia-mediated molecular effects and clinical improvement in dysmenorrhea remains a biologically plausible hypothesis rather than a directly established clinical mechanism. From an Ayurvedic perspective, *Kashtartava* is understood in relation to disturbance of *Apana Vata* and, in appropriate contexts, obstruction of normal Artava movement. The traditional properties attributed to *Shallaki,* including *Shothahara, Vedanasthapana* and *Vata-Kapha Shamaka*, may be conceptually correlated with reduction of inflammation, pain and disturbance of normal physiological movement. These correlations should be presented as an Ayurvedic–modern interpretative framework, rather than as direct molecular equivalence.

12. Modern Perspective vs Ayurvedic Perspective:

Primary Dysmenorrhea

↓

↑ Prostaglandins (PGE_2) & Leukotrienes

↓

Increased Uterine Contractions & Vasoconstriction

↓

Uterine Ischemia & Inflammation

↓

Pain *(Kashtartava)* & Associated Symptoms

↓

Administration of *Shallaki* (Boswellia serrata)

↓

Boswellic Acids (Especially AKBA

↓

5-Lipoxygenase (5-LOX) Inhibition

↓

↓ Leukotriene Synthesis

↓

↓ Inflammation &↓ Uterine Contractions

↓

Relief in Primary Dysmenorrhea

Nidana Sevana (Improper diet, irregular lifestyle, stress, suppression of natural urges, physical overexertion, etc.)

↓

Vitiation Of Apana Vata (Disturbed downward movement)

↓

Srotorodha (Obstruction of channels due to *Kapha* & other *Dosha* involvement)

↓

Kashtartava (Painful menstruation, delayed & difficult flow)

↓

Shallaki (Boswellia serrata) Properties: *Vata-Kapha Shamaka, Shothahara, Vedanastapana, Rasayana*

↓

Shothahara (Reduces inflammation)

Vedanasthapana (Relieves pain)

Vatashamaka (Normalizes *Apana Vata*)

↓

Restoration Of Normal*Apana Vata* Function

↓

Relief In *Kashtartava* (Pain relief, normal menstrual flow& improved well-being)

12. Safety, Standardization and Translational Considerations

Interpretation of Boswellia evidence requires attention to preparation, extract composition and dose. Clinical studies have used crude gum resin, standardized Boswellia extracts and enriched preparations containing specified proportions of boswellic acids or AKBA. Consequently, findings obtained with one extract cannot automatically be extrapolated to another preparation. Standardization of botanical

identity, plant part, extraction process and marker compounds is therefore important for reproducibility. Available clinical studies generally report acceptable short-term tolerability, although gastrointestinal complaints such as nausea, abdominal discomfort or diarrhoea have been reported in some studies. Long-term safety data specifically in adolescents and reproductive-age women with dysmenorrhea remain limited. Future clinical studies should prospectively monitor adverse events, concomitant medication use, reproductive outcomes where appropriate, and laboratory safety parameters. From a translational perspective, the use of a standardized pharmaceutical preparation with defined boswellic-acid content would improve comparability between studies and facilitate dose selection.

13. Evidence Gaps and Future Research

Direct evidence for isolated *Shallaki* in primary dysmenorrhea remains limited. The currently available dysmenorrhea trial evaluated a turmeric–Boswellia–sesame combination rather than Boswellia alone, so its findings cannot establish the independent efficacy of *Shallaki*. Most other clinical evidence is derived from osteoarthritis, *asthma*, Crohn's disease and other inflammatory conditions and should therefore be regarded as indirect supportive evidence. Important research priorities include randomized controlled trials of standardized *Shallaki* preparations; comparison with established NSAID therapy; assessment across multiple menstrual cycles; validated pain and quality-of-life outcomes; evaluation of rescue-medication use; standardized characterization of boswellic-acid/AKBA content; and systematic safety monitoring. Mechanistic studies should also determine whether the proposed inflammatory pathways translate into measurable changes in dysmenorrhea-specific outcomes. Claims regarding improved uterine perfusion, reduced uterine ischemia or direct normalization of *Apana Vata* should remain hypotheses unless supported by dedicated clinical or physiological studies.

14. Discussion

Primary dysmenorrhea remains one of the leading causes of school and workplace absenteeism among adolescent girls and young women worldwide, substantially affecting their physical, psychological, social, and academic well-being. Although non-steroidal anti-inflammatory drugs (NSAIDs) and hormonal contraceptives remain the cornerstone of conventional management, their prolonged use is frequently associated with gastrointestinal irritation, renal toxicity, cardiovascular risks, hormonal adverse effects, and recurrence of symptoms following discontinuation. Consequently, there is an increasing need for safer, effective, and evidence-based complementary therapies that not only alleviate pain but also target the underlying pathophysiological mechanisms of the disease.

Ayurveda approaches primary dysmenorrhea from a holistic perspective by correcting the underlying imbalance of *Apana Vata* rather than merely suppressing symptoms. According to Ayurvedic principles, vitiation of *Apana Vata* obstructs the normal downward movement of *Artava*, resulting in *Kashtartava*. Therefore, the primary therapeutic objectives include *Vata Shamana, Shothahara, Vedanasthapana,* and restoration of normal menstrual physiology. *Shallaki* possesses these classical therapeutic properties and thus provides a rational Ayurvedic basis for its use in the management of painful menstruation.

Contemporary pharmacological evidence further supports the therapeutic potential of Boswellia serrata. Unlike NSAIDs, which primarily inhibit cyclooxygenase (COX)-mediated prostaglandin synthesis, boswellic acids selectively inhibit the 5-lipoxygenase (5-LOX) pathway, thereby suppressing leukotriene production. Since leukotrienes play an important role in uterine inflammation, smooth muscle hypercontractility, and pain perception, inhibition of this pathway provides an additional therapeutic

advantage. The principal bioactive constituent, acetyl-11-keto-β-boswellic acid (AKBA), has also been shown to suppress NF-κB activation, reduce the production of pro-inflammatory cytokines such as TNF-α, IL-1β, and IL-6, inhibit inflammatory cell infiltration, and attenuate oxidative stress. Collectively, these pharmacological actions provide a strong biological rationale for the use of *Shallaki* in inflammatory gynecological disorders, including primary dysmenorrhea.

An important therapeutic advantage of *Shallaki* is its multitarget mechanism of action. Primary dysmenorrhea is now recognized as a multifactorial disorder involving excessive prostaglandin and leukotriene synthesis, inflammatory cytokines, oxidative stress, uterine hypercontractility, and ischemia. Unlike conventional pharmacological agents that predominantly target a single inflammatory pathway, *Shallak*i simultaneously exhibits anti-inflammatory, analgesic, antioxidant, immunomodulatory, and antispasmodic activities. Such a pleiotropic pharmacological profile may provide broader therapeutic benefits by modulating multiple components of the inflammatory cascade responsible for menstrual pain.

Despite these encouraging findings, the current evidence supporting the use of Boswellia serrata in primary dysmenorrhea remains largely indirect. Most experimental and clinical studies have evaluated its efficacy in chronic inflammatory disorders such as osteoarthritis, rheumatoid arthritis, inflammatory bowel disease, and asthma, where significant reductions in pain and inflammation have consistently been reported with a favorable safety profile. However, well-designed randomized controlled trials specifically investigating the efficacy of *Shallaki* in women with primary dysmenorrhea are still limited. Therefore, the proposed therapeutic role of *Shallaki* in dysmenorrhea is primarily supported by mechanistic evidence and extrapolation from studies conducted in other inflammatory conditions.

Another important challenge is the lack of standardization among commercially available *Shallaki* preparations. Variations in the concentration of boswellic acids, particularly acetyl-11-keto-β-boswellic acid (AKBA), extraction techniques, dosage regimens, formulation characteristics, and duration of treatment may influence therapeutic efficacy and contribute to variability in clinical outcomes. Standardized extracts with clearly defined phytochemical composition and quality control measures are therefore essential to ensure reproducibility and facilitate meaningful comparison across future clinical studies.

Future research should focus on adequately powered randomized controlled trials evaluating standardized *Shallaki* formulations in women with primary dysmenorrhea. Clinical studies should assess not only pain intensity and duration but also menstrual quality of life, absenteeism from school or work, requirement for rescue analgesics, recurrence rates, and long-term safety. Simultaneous evaluation of inflammatory biomarkers, including prostaglandins, leukotrienes, TNF-α, IL-1β, IL-6, NF-κB activity, and oxidative stress markers, would further clarify the molecular mechanisms underlying its therapeutic effects. In addition, emerging approaches such as network pharmacology, molecular docking, metabolomics, and systems biology may help identify the multiple molecular targets of boswellic acids and provide deeper insight into their interactions with inflammatory and pain-signaling pathways. Pharmacokinetic studies and the development of novel drug delivery systems to improve the bioavailability of boswellic acids should also be prioritized.

Overall, the convergence of classical Ayurvedic principles and contemporary pharmacological evidence provides a compelling scientific rationale for the therapeutic potential of *Shallaki* in the management of primary dysmenorrhea. Its anti-inflammatory, analgesic, antioxidant, immunomodulatory, antispasmodic, and Vata-pacifying properties suggest that it may serve as a safe and effective

complementary therapeutic option. Nevertheless, the existing evidence is predominantly derived from preclinical investigations and studies conducted in other inflammatory disorders. Therefore, high-quality multidisciplinary research integrating Ayurvedic concepts with modern biomedical approaches is essential to establish its clinical efficacy, optimize therapeutic protocols, and facilitate its incorporation into evidence-based integrative gynecological practice.

15. Conclusion

Primary dysmenorrhea is a highly prevalent gynecological disorder that significantly impairs the quality of life, daily functioning, and psychological well-being of women, particularly adolescents and young adults. Although conventional therapies, including non-steroidal anti-inflammatory drugs (NSAIDs) and hormonal contraceptives, remain the mainstay of treatment, their long-term use may be associated with adverse effects and symptom recurrence, highlighting the need for safer and more sustainable therapeutic alternatives.

Shallaki (*Boswellia serrata* Roxb.), a well-established medicinal plant in Ayurveda, possesses remarkable ***Shothahara***, ***Vedanasthapana***, ***Vata-Kapha Shamaka***, and ***Rasayana*** properties that closely align with the Ayurvedic principles of managing *Kashtartava*. Contemporary pharmacological research further substantiates these traditional claims by demonstrating that boswellic acids, particularly acetyl-11-keto-β-boswellic acid (AKBA), exert potent anti-inflammatory, analgesic, antioxidant, immunomodulatory, and antispasmodic effects through inhibition of the 5-lipoxygenase (5-LOX) pathway, modulation of inflammatory cytokines, suppression of NF-κB signaling, and reduction of oxidative stress. These proposed mechanisms may potentially influence inflammatory and pain-related processes involved in primary dysmenorrhea; however, their clinical relevance in this specific condition remains to be established.

The close correlation between Ayurvedic concepts and modern biomedical evidence provides a strong scientific rationale for considering *Shallaki* as a promising complementary therapeutic option for primary dysmenorrhea. Nevertheless, the current evidence is largely based on mechanistic studies and clinical investigations conducted in other inflammatory disorders, while direct clinical evidence in women with primary dysmenorrhea remains limited. Therefore, well-designed randomized controlled trials using standardized *Shallaki* formulations are essential to establish its efficacy, optimal dosage, long-term safety, and comparative effectiveness with existing therapies.

In conclusion, *Shallaki* represents a promising bridge between traditional Ayurvedic wisdom and contemporary biomedical science. Its multitarget pharmacological profile, favorable safety characteristics, and alignment with Ayurvedic therapeutic principles suggest considerable potential in the integrative management of primary dysmenorrhea. Future interdisciplinary research integrating Ayurvedic principles, phytochemistry, pharmacology, and well-designed clinical trials will be essential to validate the therapeutic efficacy of *Shallaki* and facilitate its incorporation into evidence-based integrative gynaecological practice. Such efforts may contribute to the development of safer, mechanism-based therapeutic strategies for the management of primary dysmenorrhea.

1. Iacovides S, Avidon I, Baker FC. What we know about primary dysmenorrhea today: a critical review. Hum Reprod Update. 2015;21(6):762-778.

2. Bernardi M, Lazzeri L, Perelli F, Reis FM, Petraglia F. Dysmenorrhea and related disorders. F1000Res. 2017; 6:1645.
3. Ferries-Rowe E, Corey E, Archer JS. Primary dysmenorrhea: diagnosis and therapy. Obstet Gynecol. 2020;136(5):1047-1058. doi:10.1097/AOG.0000000000004096. (PubMed)
4. Guimarães I, Póvoa AM. Primary dysmenorrhea: assessment and treatment. Rev Bras Ginecol Obstet. 2020;42(8):501-507. doi:10.1055/s-0040-1712131. PubMed
5. Agnivesha. Charaka Samhita. Revised by Charaka and Dridhabala, with Ayurveda Dipika commentary of Chakrapani Datta. Varanasi: Chaukhambha Orientalia.
6. Siddiqui MZ. Boswellia serrata, a potential antiinflammatory agent: an overview. Indian J Pharm Sci. 2011;73(3):255-261. doi:10.4103/0250-474X.93507.
7. Ferries-Rowe E, Corey E, Archer JS. Primary dysmenorrhea: diagnosis and therapy. Obstet Gynecol. 2020;136(5):1047-1058. doi:10.1097/AOG.0000000000004096. (PubMed)
8. Dawood MY. Primary dysmenorrhea: advances in pathogenesis and management. Obstet Gynecol. 2006;108(2):428-441. doi: 10.1097/01.AOG .0000230214.26638.
9. Pulkkinen MO. Prostaglandins and the non-pregnant uterus. The pathophysiology of primary dysmenorrhea. Acta Obstet Gynecol Scand Suppl. 1983; 113:63-67. doi:10.3109/00016348309155200.
10. Agnivesha. Charaka Samhita. Revised by Charaka and Dridhabala, with Ayurveda Dipika commentary of Chakrapani Datta. Varanasi: Chaukhambha Orientalia.
11. Siddiqui MZ. Boswellia serrata, a potential antiinflammatory agent: an overview. Indian J Pharm Sci. 2011;73(3):255-261. doi:10.4103/0250-474X.93507. PubMed Central (PMC)
12. Siemoneit U, Pergola C, Jazzar B, Northoff H, Skarke C, Jauch J, et al. On the interference of boswellic acids with 5-lipoxygenase: mechanistic studies in vitro and pharmacological relevance. Eur J Pharmacol. 2009;606(1-3):246-254. doi:10.1016/j. ejphar.2009.01.044. PubMed +1
13. Siddiqui MZ. Boswellia serrata, a potential antiinflammatory agent: an overview. Indian J Pharm Sci. 2011;73(3):255-261. doi:10.4103/0250-474X.93507
14. Kimmatkar N, Thawani V, Hingorani L, Khiyani R. Efficacy and tolerability of Boswellia serrata extract in treatment of osteoarthritis of knee—a randomized double -blind placebo -controlled trial. Phytomedicine. 2003;10(1):3-7. doi:10.1078/094471103321648593.
15. Gupta A, et al. Correlation of boswellic acids with antiproliferative, antioxidant and antimicrobial activities of topographically collected Boswellia serrata oleo-gum-resin. Phytomedicine Plus. 2022;2(3):100289. doi:10.1016 / j. phyplu.2022.100289.
16. Safayhi H, Sailer ER, Ammon HPT. 5-Lipoxygenase inhibition by acetyl-11-keto-β-boswellic acid (AKBA) by a novel mechanism. Phytomedicine. 1996;3(1):71-2. doi:10.1016/S0947-1135(96)80013-4. PubMed
17. Gayathri B, Manjula N, Vinaykumar KS, Lakshmi BS, Balakrishnan A. Pure compound from Boswellia serrata extract exhibits anti-inflammatory property in human PBMCs and mouse macrophages through inhibition of TNFα, IL-1β, NO and MAP kinases. Int Immunopharmacol. 2007;7(4):473-482. doi:10.1016/j. intimp.2006.12.003.
18. Abdel-Tawab M, Werz O, Schubert-Zsilavecz M. Boswellia serrata: an overall assessment of in vitro, preclinical, pharmacokinetic and clinical data. Clin Pharmacokinet. 2011;50(6):349-369. doi:10.2165/11586800-000000000-00000.