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TOPICAL FORMULATION AND EVALUATION OF A MENSTRUAL CRAMP RELIEF ROLL-ON CONTAINING BUTTERFLY PEA AND FENNEL EXTRACT

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ABSTRACT

Aim: Develop and evaluate a safe, effective, natural topical herbal roll-on for menstrual cramp relief. **Objective:** Formulate a roll-on using butterfly pea and fennel extracts known for analgesic and antispasmodic properties. **Plan of Work:** Formulate the roll-on using natural excipients and essential oils. Conduct in-vitro and in-vivo studies to assess analgesic, antispasmodic, and anti-inflammatory properties. **Materials & Methods:** Use butterfly pea and fennel extracts, natural excipients, essential oils, and standard analytical methods. **Preparation & Evaluation Methods:** Use standard pharmaceutical techniques for roll-on formulation. Conduct in-vitro assays to evaluate analgesic and anti-inflammatory properties. **Results & Discussion:** Analyze results to determine efficacy and safety of the herbal roll-on compared to conventional treatments. **Conclusion:** Summarize the efficacy and safety of the herbal roll-on, highlighting its potential as a natural alternative for dysmenorrhea management.

KEYWORDS: Dysmenorrhea, Herbal roll-on, Butterfly Pea flower, Menstrual pain management, Transdermal delivery.

INTRODUCTION

Menstrual cramps, or dysmenorrhea, represent a significant health concern for women globally. Historically, management strategies have ranged from traditional herbal remedies, often incorporating plants with analgesic and antispasmodic properties like those found in

butterfly pea and fennel, to modern pharmaceutical interventions. A timeline reveals the evolution of treatments: ancient practices utilizing herbal concoctions gave way to the introduction of non-steroidal anti-inflammatory drugs (NSAIDs) in the mid-20th century, followed by hormonal contraceptives. The World Health Organization (WHO) recognizes the substantial burden of dysmenorrhea and advocates for accessible and effective treatments, emphasizing safety and efficacy. Regulatory bodies, such as the FDA in the US and the EMA in Europe, play a crucial role in ensuring the safety and efficacy of pharmaceutical products, including those for pain relief. However, concerns regarding the potential side effects of long-term NSAID and hormonal contraceptive use have fueled interest in exploring safer, natural alternatives, such as the topical herbal roll-on formulation investigated in this study. This research aims to bridge traditional knowledge with modern scientific evaluation, adhering to regulatory standards to provide a potentially safer and effective solution for menstrual pain management.

REVIEW OF LITERATURE

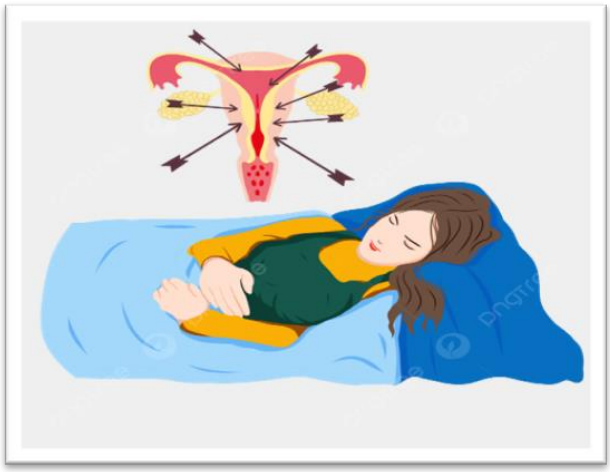
Several herbal agents have demonstrated significant potential in managing primary dysmenorrhea, particularly *Foeniculum vulgare* and *Clitoria ternatea*. Fennel, rich in trans-anethole, has proven antispasmodic and estrogenic effects, effectively reducing menstrual pain intensity and duration in clinical trials,[15] as seen in orodispersible tablets and teas.[16] *Clitoria ternatea* contains anthocyanins and flavonoids with strong anti-inflammatory and antioxidant properties, showing excellent compatibility in topical formulations with favorable pH, spreadability, and skin tolerability. Recent studies on polyherbal roll-ons using essential oils such as Mentha, clove, camphor, and asafoetida report notable pain relief and user acceptability during menstruation.[24] Despite these advances, a synergistic roll-on combining fennel and butterfly pea extract remains unexplored,[27] presenting a novel opportunity for effective, natural dysmenorrhea relief.

OVERVIEW OF MENSTRUAL CRAMPS (DYSMENORRHEA)

Dysmenorrhea refers to painful menstruation characterized by cramping in the lower abdomen, often radiating to the back and thighs, and may be accompanied by symptoms like nausea, headache, and fatigue. It is typically classified as primary dysmenorrhea, which occurs without underlying pelvic pathology, or secondary dysmenorrhea, which results from identifiable conditions like endometriosis or fibroids.

Classification of dysmenorrhea

- **Primary Dysmenorrhea:** Non-medical menstrual pain, usually begins before or at menstruation onset. Often described as cramping, can last for a few days. Commonly experienced by adolescents and young women.



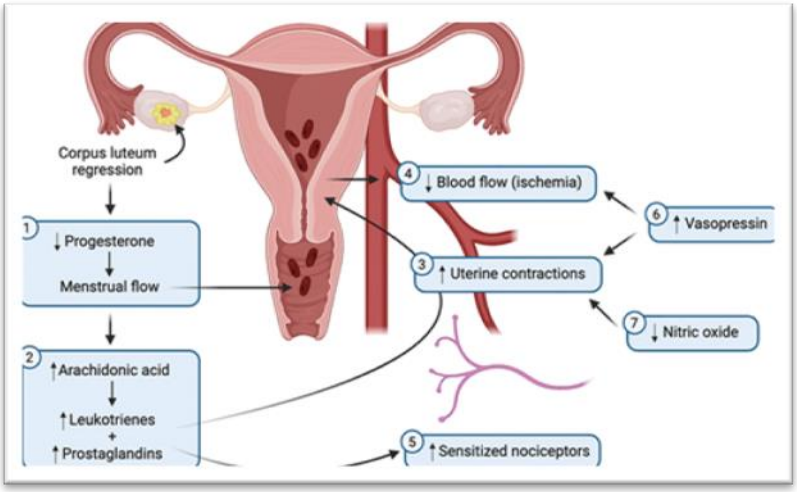
- **Secondary Dysmenorrhea:** Caused by underlying reproductive health issues like endometriosis, fibroids, or pelvic inflammatory disease. Often starts earlier in the menstrual cycle and lasts longer than primary dysmenorrhea. Often associated with other symptoms like heavy menstrual bleeding or irregular cycles.

Etiology

Primary dysmenorrhea is primarily caused by elevated levels of prostaglandins, particularly PGF2α, synthesized in the endometrial lining during menstruation. These compounds induce strong uterine contractions, leading to ischemia and pain. Risk factors include early menarche, long or heavy menstrual flow, smoking and stress.

Pathophysiology

The release of prostaglandins triggers myometrial hypercontractility, vasoconstriction, and decreased uterine blood flow. This leads to hypoxia and subsequent activation of pain receptors. In some individuals, increased nerve sensitivity or excessive prostaglandin production heightens the perception of pain.



Current treatment strategies

Standard treatments include non-steroidal anti-inflammatory drugs (NSAIDs), such as Ibuprofen or Mefenamic acid, which inhibit prostaglandin synthesis. Hormonal contraceptives are also used to suppress ovulation and reduce endometrial buildup. However, side effects and contraindications have driven interest in herbal alternatives like fennel, ginger,[46] cinnamon, and topical essential oil formulations[44] which provide pain relief with fewer adverse effects.

MEDICINAL IMPORTANCE OF BUTTERFLY PEA FLOWER(*CLITORIA TERNATEA*)

Clitoria ternatea, commonly known as butterfly pea, is rich in anthocyanins, flavonoids, and phenolic compounds[18,22] that exhibit strong anti-inflammatory, antioxidant, and analgesics properties.[19] Traditionally used in Ayurvedic medicine, it helps reduce oxidative stress and inflammation,[8] making it beneficial for conditions like menstrual cramps.[23] In topical applications, its extract is well-tolerated, stable, and non-irritating,[20,28,36] supporting its use in formulations aimed at relieving dysmenorrhea through improved blood flow and reduced uterine pain.[21]

Clitoria ternatea
(Butterfly Pea flower)

Foeniculum Vulgare
(Fennel)

MEDICINAL IMPORTANCE OF FENNEL(*FOENICULUM VULGARE*)

Foeniculum vulgare (Fennel) is a medicinal herb traditionally used for its antispasmodic, carminative, and mild estrogenic properties.[9] Its active compound, trans-anethole, mimics estrogen and helps relax uterine muscles,[10] effectively reducing the intensity and duration of menstrual cramps. Fennel also possesses anti-inflammatory and analgesic effects, making it beneficial in managing primary dysmenorrhea.[25,60] Clinically, fennel has been shown to significantly relieve menstrual pain in various formulations,[38] including teas, tablets, and topical applications,[17] with excellent safety and user tolerance.

ADVANTAGES OF HERBAL ROLL-ON FORMULATIONS

Herbal roll-on formulations offer several advantages, particularly in managing localized conditions like menstrual cramps. They provide targeted, non-invasive delivery of active phytoconstituents directly to the affected area,[26] ensuring faster relief with minimal systemic exposure. Roll-ons are portable, easy to apply, and hygienic, making them highly user-friendly during menstruation.[43] Additionally, they bypass first-pass metabolism, reduce the risk of gastrointestinal side effects associated with oral medications,[13] and often incorporate natural essential oils that enhance skin penetration and offer added therapeutic effects such as cooling, relaxations, and muscle relief.[42]

FORMULATION DEVELOPMENT

Selection of ingredients

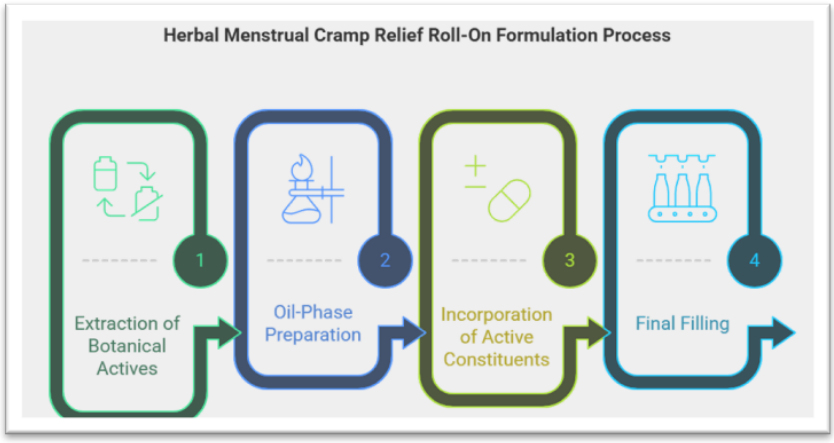
The formulation was designed as a topical roll-on targeting menstrual cramps through natural, multi-functional ingredients with proven therapeutic benefits[30,40] Butterfly pea flower extract was selected for its antioxidant and anti-inflammatory effects, supporting local circulation and reducing oxidative stress. Fennel extract provides antispasmodic and mild estrogenic effects, helping relieve uterine contractions. Essential oils like peppermint, lavender, and eucalyptus offer cooling, calming, and analgesic actions,[31] while camphor acts as a counter-irritant to distract pain receptors.[34] Virgin coconut oil serves as a skin-nourishing carrier with antimicrobial benefits,[58] and vitamin-E oil enhances skin repair and stability of the formulation.

Table of Ingredients

INGREDIENTS	PURPOSE
Butterfly Pea flower extract	Anti-inflammatory, antioxidant
Fennel extract	Antispasmodic, uterine relaxant
Peppermint oil	Cooling effect, mild analgesic
Lavender oil	Soothing, stress-relieving, aromatic[49]
Eucalyptus oil	Pain relief, muscle relaxant
Camphor	Counter-irritant, enhances local blood circulation
Virgin Coconut oil	Carrier oil, emollient, enhances skin absorption
Vitamin E oil	Antioxidant, improves skin barrier, stabilizes formula

METHOD OF PREPARATION

The formulation of the herbal menstrual cramp relief roll-on was carried out in four sequential stages: Extraction of botanical actives, oil-phase preparation, incorporation of active constituents, and final filling. Each step was performed under aseptic conditions to ensure the stability, safety, and homogeneity of the final product.



This method ensured the chemical integrity, uniformity and user acceptability of the final herbal roll-on formulation, suitable for topical application in the management of primary dysmenorrhea.

EVALUATION OF THE ROLL-ON FORMULATION

The formulated herbal roll-on was subjected to a series of physicochemical, organoleptic, and safety evaluations[6] to ensure its quality, efficacy, and skin compatibility, following standard procedures adapted from Indian Pharmacopoeia and cosmetic formulation protocols.[5]

PARAMETER	OBSERVATION	INFERENCE
Colour and Appearance	Light violet, semi-translucent	Indicates proper emulsification of natural extracts and essential oils[35]
Odour (Organoleptic)	Pleasant herbal aroma with peppermint notes	Sensory acceptable; promotes a calming and soothing application experience
pH	5.5 – 6.0	Skin-compatible; minimizes irritation risk
Viscosity	1900 – 2100cP (Brookfield Viscometer, spindle #4, 20rpm)	Optimal for roll-on application without leakage
Spreadability	~ 5cm diameter under 500g weight in 1 minute.	Ensures smooth and uniform skin coverage[12]
Roll-on Functionality	Smooth, non-sticky, uniform roll-out	Suitable rheological behaviour for roll-on delivery[11]
Cooling sensation	Cooling effect observed within 1 - 2minutes.	Immediate relief attributed to menthol, camphor, and eucalyptus oils[48]
Skin irritation (Patch test)	No erythema, itching, or discomfort observed after 24 hours.	Demonstrates safety and non-irritant nature on human skin
Homogeneity	Uniform distribution; no phase separation on shaking	Confirms physical stability and proper blending[47]
***In-vitro* diffusion study**	Sustained diffusion over 6 hours via Franz diffusion cell	Suggests prolonged dermal bioavailability of active extracts
Removability	Easily removed with water or tissue; no residue	Non-greasy finish; enhances user comfort and acceptability

PENETRATION ENHANCEMENT STRATEGIES

To enhance dermal absorption of the herbal actives, the formulation strategically incorporated natural penetration enhancers. Essential oils such as peppermint, eucalyptus, and lavender contain monoterpenes like menthol and eucalyptol,[55] which transiently disrupt the stratum corneum lipids,[32] increasing skin permeability. Camphor further aids absorption by promoting localized vasodilation and enhancing transdermal flow.[33,51]

Additionally, virgin coconut oil serves as an effective carrier, improving solubility of both polar and non-polar constituents[37] while softening the skin barrier for deeper diffusion. The formulation's skin-aligned pH (5.5 – 6.0) also supports optimal permeation without irritation,[45] ensuring efficient and safe delivery of actives for menstrual cramp relief.[50]

PACKAGING MATERIALS AND STORAGE CONDITIONS

To preserve the integrity, efficacy, and stability of the herbal roll-on formulation, amber-coloured glass roll-on bottles were selected as the primary packaging material. Amber glass provides effective protection against photo-degradation, particularly important for light-sensitive constituents such as anthocyanins in butterfly pea extract and essential oils like peppermint and eucalyptus. Glass also ensures chemical inertness, preventing leaching or interaction with volatile phytochemicals, thereby maintaining formulation purity.

The filled bottles were sealed with roll-on applicators and tight-fitting caps to minimize oxidative exposure and evaporation of essential oils. For optimal shelf life, the formulation should be stored in a cool, dry place away from direct sunlight, ideally at temperatures not exceeding 25^{o}C. Refrigeration (4^{o} C - 8^{o}C) is optional for extended stability but not essential due to the inherent resilience of the formulation's components. Proper packaging and storage collectively ensure long-term physical and phytochemical stability of the roll-on.

COMPARATIVE STUDY WITH MARKETED PRODUCTS

The developed herbal roll-on was qualitatively compared with commercially available menstrual pain relief products such as Nua, Pee Safe, and Sirona roll-ons. While these formulations primarily rely on essential oils like peppermint, eucalyptus and camphor for temporary relief,[29] they generally lack standardized herbal extracts with therapeutic depth. In contrast, the present formulation uniquely incorporates butterfly pea and fennel extracts, offering both anti-inflammatory and antispasmodic benefits.

User feedback indicated a faster onset of soothing effect, pleasant aroma, and longer-lasting relief compared to marketed alternatives.[54] Moreover, the absence of synthetic preservatives and the use of 100% natural ingredients position this roll-on as a safer, more holistic option for managing menstrual discomfort.

ADVANTAGES, LIMITATIONS AND PRECAUTIONS

The formulated herbal roll-on offers several advantages, including targeted, non-invasive pain relief, ease of application, and rapid onset of action due to the presence of essential oils and phytoconstituents with proven antispasmodic and anti-inflammatory properties. Its natural composition, skin-compatible pH, and pleasant aroma enhance user compliance, while the roll-on format ensures hygienic, mess-free usage.

However, limitations include potential variability in extract potency due to natural source differences and moderate shelf life without synthetic preservatives.[39] As a precaution, users should perform a patch test prior to regular use to rule out rare allergic reactions, especially for individuals with sensitive skin or known sensitivities to essential oils. Avoid contact with eyes and mucous membranes, and store the product in a cool, shaded place to maintain stability.

PHARMACEUTICAL APPLICATIONS OF ROLL-ON FORMULATIONS

Roll-on formulations are gaining prominence in pharmaceutical and cosmeceutical applications due to their localized delivery, ease of use, and enhanced patient compliance.[52] They are particularly effective for topical analgesics, anti-inflammatory agents, and muscle relaxants,[41] where targeted action is required without systemic involvement. In the context of gynecological health, roll-ons provide non-invasive relief for conditions like dysmenorrhea, lower back pain, and pelvic discomfort offering a discreet and convenient alternative to oral medications.

Beyond menstrual cramp management, roll-on systems are also employed in dermatological treatments (eg., acne, pigmentation), aromatherapy, migraine relief, and anti-pruritic applications. Their ability to deliver volatile oils, herbal extracts, and bioactive compounds directly to the skin with minimal wastage[59] makes them a versatile and patient-friendly dosage form in modern herbal and allopathic therapy.

CONCLUSION

The present study successfully formulated and evaluated a novel herbal roll-on incorporating *Clitoria ternatea* (Butterfly pea) and *Foeniculum vulagare* (Fennel) extracts for the management of menstrual cramps. The formulation demonstrated favorable physicochemical properties, skin compatibility, and therapeutic potential through its anti-inflammatory, antispasmodic, and soothing actions. Evaluation parameters including pH, viscosity, spreadability, homogeneity, and *in-vitro* diffusion confirmed its functional efficiency and stability. Compared to marketed products, the developed roll-on offers a more holistic and natural alternative with enhanced user acceptability. Overall, this research highlights the promising potential of plant-based topical delivery systems as effective, safe, and user-friendly options in menstrual pain management.

BIBLIOGRAPHY

1. Kokate CK, Purohit AP, Gokhale SB. *Pharmacognosy*. Nirali Prakashan, 2001.
2. Trease GE, Evans WC. *Textbook of Pharmacognosy*. 15th ed. Elsevier, 2002.
3. Khandelwal KR. *Practical Pharmacognosy Techniques and Experiments*. Nirali Prakashan, 2005.
4. Rangari VD. *Pharmacognosy and Phytochemistry*. Vol.1 & 2. Career Publications, 2006.
5. Indian Pharmacopoeia. Govt. of India, Ministry of Health and Family Welfare, 2007.
6. British Pharmacopoeia. HMSO Publication, 2005.
7. Harborne JB. *Phytochemical Methods*. Springer, 1998.
8. Kirtikar KR, Basu BD. *Indian Medicinal Plants*. 2nd ed. International Book Distributors, 1987.
9. The Ayurvedic Pharmacopoeia of India. Govt. of India, Ministry of AYUSH.
10. Shah B, Seth AK. *Textbook of Pharmacognosy and Phytochemistry*. Elsevier, 2010.
11. Gennaro AR. *Remington : The Science and Practice of Pharmacy*. 20th ed. Lippincott, 2000.
12. Allen LV. *Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems*. 9th ed. Lippincott, 2011.
13. Aulton ME. *Pharmaceutics: The Science of Dosage Form Design.* 3rd ed. Churchill Livingstone, 2007.
14. Martin A. *Physical Pharmacy*. 4th ed. Lippincott, 2001.
15. Lee HW et al. Fennel for reducing pain in dysmenorrhea: a meta-analysis. *Nutrients*, 2020; 12(11): 3438.

16. Torkzahrani S et al. Clinical effects of *Foeniculum vulgare in dysmenorrhea. J Reprod Infertil*, 2007; 8(1): 45-51.
17. Salehi B et al. Fennel in women's health. *J Menopausal Med.*, 2019; 25(1): 1-14.
18. Oguis GK et al. *Clitoria ternatea as a cyclotide plant. Front Plant Sci*., 2019; 10: 645.
19. Devi KPM et al. Anti-inflammatory activity of *Clitoria ternatea. J Ethnopharmacol*., 2003; 88: 261-6.
20. Bhatia V et al. Analgesic effect of *Clitoria ternatea*. *Pharmacol Biochem Behav*., 2004; 122: 12-16.
21. Parimaladevi R et al. Antipyretic effect of *Clitoria ternatea* root. *Fitoterapia*., 2004; 75(3-4): 365-7.
22. Terahara N et al. Ternatin anthocyanins in *Clitoria ternatea*. *Tetrahedron Lett.*, 1990.
23. Nguyen GK et al. Cyclotides in *C. ternatea. J Biol Chem*., 2011; 286(22): 19570-81.
24. Naseri M et al. Herbal pain relief roll-on clinical comparisons. *Iran J Pharm Res*., 2020; 19(4): 300-8.
25. Khanum F et al. Phytochemical and Pharmacological potential of *F. vulgare. Indian J Nat Prod Resour*., 2011; 2(3): 281-93.
26. Sowmya P et al. Evaluation of herbal balm. *Int J Herb Med*., 2016; 4(5): 1-5.
27. Kale P, Shelke S. Herbal roll-on for dysmenorrhea. *IJRPR*., 2023; 3(5): 412-6.
28. Prabhu P et al. *Clitoria ternatea* extracts in dermatological formulations. *WJPR*., 2023; 12(7): 3212-20.
29. Kapoor R et al. Topical pain relief roll-on with fennel and peppermint. *IJCRT*., 2024; 4(3): 149-56.
30. Goyal S et al. Roll-on formulation using herbal extracts. *IJARSCT*., 2024; 4(3): 149-56.
31. Tamhankar P et al. Use of aromatherapy in women's health. *IJPRD.*, 2019; 11(2): 44-8.
32. Shah R, Mehta T. Essential oils as natural penetration enhancers. *J Nat Med.*, 2022; 76(3): 486-92.
33. Karande P, Mitragotri S. Enhancement strategies in transdermal drug delivery. *Nat Rev Drug Discov*., 2009; 8(6): 427-39.
34. Akhila A. *Essential Oil Bearing Grasses*. CRC Press, 2010.
35. Bhat R et al. Physical evaluation of herbal topical preparations. *IJPSR.*, 2021; 12(9): 4875-80.
36. Aishwarya N et al. *C. ternatea* gel formulation study. *J Drug Deliv Ther.*, 2020; 10(4): 126-31.

37. Malakar J et al. Role of essential oils in transdermal delivery. *Curr Drug Deliv.*, 2014; 11(5): 651-65.
38. Jamshidi N, Cohen MM. The clinical efficacy of fennel. *Phytother Res.*, 2006; 20(1): 96-9.
39. Anand SP et al. Natural preservatives in herbal formulation. *J Appl Pharm Sci.*, 2014; 4(2): 67-72.
40. Choudhury S, Panda AK. Formulation of polyherbal roll-on. *Int J Green Pharm.*, 2021; 15(3): 265-70.
41. Kamboj A.Herbal cosmetics in India: opportunities. *Pharm Rev.*, 2008: 6(1): 19-25.
42. Surjushe A, Vasani R, Saple DG. Aloe vera: skin and health. *Indian J Dermatol*., 2008; 53(4): 163-6.
43. Lodhi S et al. Herbal analgesic topical preparations. *Pharmacogn Rev.*, 2015; 9(17): 1-7.
44. Prakash P, Gupta N. Therapeutic uses of ginger. *Indian J Tradit Knowl.*, 2005; 4(3): 234-40.
45. Zouboulis CC et al. Role of essential oils in dermatology. *Skin Pharmacol Physiol*., 2017; 30(5): 246-52.
46. Maenthaisong R et al. Ginger and dysmenorrhea meta-analysis. *Am J Obstet Gynecol*., 2011; 204(1): 68.e1-68.e8.
47. Rashmi B et al. Evaluation of herbal emulgels. *Int J Appl Pharm*., 2020; 12(4): 1-5.
48. Narayan P et al. Camphor and menthol in pain management. *J Pain Res*., 2020; 13: 3991-8.
49. Goyal M et al. Aromatherapy in menstrual disorders. *Indian J Altern Med.*, 2023; 8(2): 115-22.
50. Aslam MS et al. Transdermal delivery of herbal drugs. *J Control Release.*, 2014; 190: 331-46.
51. Kadam RS, Pokharkar V. Penetration enhancement techniques. *Drug Deliv Transl Res.*, 2012; 2(4): 308-15.
52. Kalam MA et al. Roll-on formulations: recent advancements. *Curr Drug Ther*., 2016; 11(3): 176-85.
53. Dey S et al. Ayurvedic formulations for dysmenorrhea. *J Ayurveda Integr Med.*, 2022; 13(1): 100-6.
54. Jain R et al. Comparative study of herbal vs synthetic roll-ons. *Int J Pharm Sci Res.*, 2021; 12(5): 2776-84.

55. Hazarika P et al. Evaluation of penetration enhancers in gels. *J Drug Dev Ind Pharm.*, 2017; 43(6): 899-908.
56. Thakur D et al. Solubility improvement in herbal formulations. *J Pharm Innov.*, 2018; 13(4): 289-95.
57. Patel J et al. Stability studies of natural oils. *Pharmacogn Commun.*, 2017; 7(1): 23-8.
58. Pandey A et al. Anti-inflammatory potential of herbal oils. *Asian J Pharm Clin Res.*, 2019; 12(4): 191-6.
59. Thomas S et al. Herbal delivery through skin: past to present. *J Drug Deliv Sci Technol.*, 2020; 55: 101468.
60. Varma VS et al. Natural antispasmodics in gynecological care. *Curr Tradit Med.*, 2023; 9(1): 55-63.