Formulation and Evaluation of Herbal Anti-Inflammatory Gel from *Butea Monospermal* Flower Extract

Adnan Siddiqui[1], Wilfred Dsilva[2], Komal Waykos[3], Payal Mudhe[4], Kedar Mane[5], Sandhya Kamble[6]
[1]*Department of Pharmaceutics, Mahadevrao Wandre Institute of Technology, Turkewadi.*
[2,3,4,5,6]*Mahadevrao Wandre Institute of Technology, Turkewadi.*

***Abstract*—The present study focuses on the formulation and evaluation of an herbal anti-inflammatory gel using *Butea Monosperma* flower extract. The ethanolic extract was prepared by the Soxhlet extraction method and was found to contain flavonoids, alkaloids, tannins, saponins, terpenoids, phenolic compounds and glycosides. The gel was formulated using Carbopol-940 and evaluated for various organoleptic and physicochemical parameters. Among the formulations, F3 showed satisfactory characteristics, including good homogeneity, smooth texture, acceptable pH, suitable viscosity and excellent spreadability. The formulation was safe for topical application and exhibited significant concentration-dependent inhibition of protein denaturation, indicating anti-inflammatory activity. The study concludes that *Butea Monosperma* flower extract can be successfully incorporated into a topical gel and may serve as a promising herbal alternative for the management of inflammatory conditions.**

***Index Terms*—*Butea Monosperma*, Herbal Anti-inflammatory Gel, Soxhlet Extraction, Phytochemical Screening, Carbopol-940, Protein Denaturation, Topical Drug Delivery System, Inflammation, Flavonoids, Herbal Formulation.**

I. INTRODUCTION

Topical drug delivery systems are widely used for both local and systemic effects. In recent years, the use of non-steroidal anti-inflammatory drugs (NSAIDs) through topical formulations has increased. Topical gels are non-greasy, easy to apply and help avoid gastrointestinal side effects and first-pass metabolism. Gels are formed by natural or synthetic polymers that create a three-dimensional matrix in a hydrophilic medium. After application, the liquid evaporates, leaving a thin film of the gel matrix on the skin.

Inflammation is a complex biological response characterized by increased vascular permeability, protein denaturation and membrane alterations. Common symptoms include redness, pain, heat, swelling and loss of function. It is commonly caused by infections, burns, trauma and immune responses.

Butea Monosperma (Palash or Flame of the Forest) is a medicinal tree widely distributed in India. Its flowers possess analgesic, anti-inflammatory, antioxidant and antimicrobial properties. Phytochemical studies have reported the presence of flavonoids, chalcones, phenolic compounds, glycosides and terpenoids, which contribute to its therapeutic and anti-inflammatory effects.

Topical anti-inflammatory gels provide targeted action with reduced systemic side effects. Due to their ease of application, rapid skin absorption and better patient compliance, gels are preferred dosage forms. Therefore, formulating an anti-inflammatory gel containing Butea monosperma flower extract offers a safe, effective and convenient approach for managing inflammation.

INTRODUCTION OF DRUG

Butea Monosperma L., commonly known as Palash or Flame of the Forest, is a medicinal plant belonging to the Fabaceae family. Its flowers are rich in flavonoids, tannins, phenolic compounds, glycosides and triterpenoids, which possess anti-inflammatory, antioxidant and antimicrobial properties. Traditionally, the flowers have been used in Ayurveda for the treatment of inflammation, wounds and skin disorders. Due to its proven pharmacological activities, Butea monosperma flower extract was selected for the formulation of an herbal anti-inflammatory gel for effective and safe topical treatment.

INTRODUCTION OF GEL

A gel is a semisolid dosage form in which a liquid phase is entrapped within a three-dimensional network of natural or synthetic polymers. Gels are widely used in topical drug delivery because they are non-greasy, easy to apply and provide better patient compliance. They allow localized drug action, improve drug penetration through the skin and minimize systemic side effects. Due to their cooling effect, smooth texture and ease of removal, gels are commonly used for the treatment of inflammatory and dermatological conditions.

NEED OF RESEARCH

- Inflammation is a common condition associated with pain, redness, swelling and tissue damage.
- Long-term use of synthetic anti-inflammatory drugs may cause adverse effects such as gastric irritation, ulcers and kidney disorders.
- There is a growing demand for safer and more effective herbal alternatives with minimal side effects.
- Butea monosperma flowers contain bioactive compounds such as flavonoids, tannins, glycosides and phenolic compounds with proven anti-inflammatory activity.
- Limited research has been conducted on topical gel formulations containing Butea monosperma flower extract.
- Therefore, the development of an herbal anti-inflammatory gel may provide a safe, effective and patient-friendly treatment option.

.

AIM:

To formulate and evaluate an herbal anti-inflammatory gel using *Butea Monosperma.L* flower extract.

OBJECTIVES

PREFORMULATION STUDIES

- To collect and authenticate *Butea Monosperma* flowers.
- To prepare ethanolic extract using the Soxhlet extraction method.
- To perform phytochemical screening of the extract.

POST-FORMULATION STUDIES

- To formulate herbal anti-inflammatory gel containing *Butea Monosperma* flower extract.
- To evaluate the gel for organoleptic properties such as colour, odour, appearance and texture.
- To determine physicochemical parameters including pH, viscosity, spreadability and homogeneity.
- To perform skin irritation and washability studies.
- To evaluate the anti-inflammatory activity of the formulated gel.

II. MATERIAL AND METHODOLOGY

Materials

The drug and equipment used in the project research given in the following table. All materials utilized in the study were of analytical grade quality

Table No 01. Instrument/Equipment

Sr. No.	Equipment/Instrument name	Model/ Company
1.	Soxhlet apparatus	IC-122 / Borosilicate glass
2.	Hot air oven	LSC-358 Labline
3.	Water bath	ASI instrument for scientific water bath active scientific industries. Dombivali-421202.
4.	Stirrer	Elektrocraft PVT. LTD. Mumbai
5.	Round bottom flask	Borosilicate glass
6.	Auto digital pH meter	LT-111 Labline

Table No 02. List of Drug / Materials

Sr. No.	Materials	Manufacturer
1.	*Butea Monosperma.L*	Local field of Chandgad, Maharashtra
2.	Carbopol-940	MWIT Turkewadi
3.	Glycerin	MWIT Turkewadi
4.	Popylene glycol	MWIT Turkewadi
5.	Triethanolamine	MWIT Turkewadi
6.	Methyl paraben	MWIT Turkewadi
7.	Propyl paraben	MWIT Turkewadi
8.	Distilled Water	MWIT Turkewadi

Collection of *Butea Monosperma.L*:

The *Butea Monosperma* plants powder was collected from local field of Chandgad Maharashtra, India.

Fig No 1 *Butea Monosperma.L*

PREPARATION OF PLANT EXTRACT AND PHYTOCHEMICAL SCREENING

Dried flowers of *Butea Monosperma* were powdered, and 25 g of the powder was extracted with ethanol using a Soxhlet apparatus. The extraction was continued for 3 hours until the solvent in the siphon tube became colorless, indicating complete extraction. The extract was then filtered, concentrated under reduced pressure and dried to obtain a thick semisolid ethanolic extract, which was stored in an airtight container for further studies.

PHYTOCHEMICAL SCREENING

The ethanolic extract was subjected to preliminary phytochemical screening to identify the presence of bioactive constituents. The analysis confirmed the presence of amino acids, carbohydrates, alkaloids, steroids, cardiac glycosides, tannins, saponins, flavonoids, glycosides, phenolic compounds, terpenoids, coumarins and emodins. Standard qualitative tests were performed for each phytoconstituents, and the observed color changes or precipitate formation confirmed their presence. These phytochemicals are known to contribute to the anti-inflammatory and antioxidant activities of *Butea Monosperma* flower extract.

FORMULATION AND EVALUATION OF ANTI-INFLAMMATORY GEL

The anti-inflammatory gel was prepared by dispersing Carbopol 934 in distilled water and allowing it to swell for 30 minutes. *Butea Monosperma* flower extract (1, 2 and 3 mL) was mixed with glycerin, propylene glycol, methyl paraben and propyl paraben. This mixture was gradually added to the Carbopol gel base with continuous stirring. Triethanolamine was added to adjust the pH to 6–7 and obtain the desired gel consistency. The final volume was adjusted with distilled water, sonicated to remove air bubbles and stored in an airtight container. Three formulations (F1, F2 and F3) were prepared using different concentrations of the extract.

EVALUATION PARAMETERS

1. Color: The color of the gel was visually observed under natural light to assess uniformity and physical stability.
2. Odor**:** The odor of the gel was examined to detect its characteristic smell and identify any signs of degradation or contamination.
3. Texture**:** The texture was evaluated by gently rubbing the gel between the fingers to determine its smoothness, consistency and homogeneity.
4. pH Determination**:** The pH of the gel was measured using a digital pH meter after dispersing the gel in distilled water. This test ensures compatibility with the skin.
5. Spreadability: Spreadability was determined by the glass slide method to evaluate the ease with which the gel spreads on the skin surface.

6. Homogeneity: The gel was visually inspected for uniformity and the absence of lumps, aggregates or coarse particles.
7. Skin Irritation Test: The gel was applied to a small area of skin and observed for signs of irritation, erythema or edema to assess its safety for topical use.
8. Washability Test: The ease of removal of the gel from the skin using water was evaluated to determine its washability.
9. Viscosity: The viscosity of the gel was measured using a Brookfield digital viscometer to determine its consistency and flow characteristics.
10. In-vitro Anti-inflammatory Activity: The anti-inflammatory activity of the gel was evaluated by the protein denaturation method using BSA. The percentage inhibition of protein denaturation was calculated to assess the anti-inflammatory potential of the formulation.

Calculations:

$$\% \text{ inhibition} = \frac{\text{absorbance of control} - \text{absorbance of test}}{\text{absorbance of control}} \times 100$$

III. RESULT AND DISCUSSION

1. FORMULATION OF GEL: The gel was prepared using *Butea Monosperma* flower extract (3% w/w) with Carbopol-940 as the gelling agent. Carbopol was dispersed in distilled water and stirred using a magnetic stirrer, then allowed to swell. Glycerin was added as a humectant, while Methylparaben and Propyl paraben were used as preservatives. The extract was incorporated with continuous stirring. Triethanolamine was added to adjust pH and form the gel. The final gel was smooth and homogeneous.

2. FORMULATION TESTS FOR GEL: The formulated anti-inflammatory gel was evaluated using a series of physiological and physicochemical tests. These assessments provide essential information regarding the quality, stability, efficacy and safety of the formulation, ensuring that it meets the desired standards for topical application.

3. PHYTOCHEMICAL SCREENING: Phytochemicals are naturally occurring chemical compounds in plants that contribute to their color, flavour and organoleptic properties. Several classes of phytochemicals, such as phenols, tannins, flavonoids, saponins and alkaloids are recognized for their therapeutic and physiological effects. In the present study, various secondary metabolites including alkaloids, glycosides, flavonoids, terpenoids, steroids, saponins, tannins, quinones and carotenoids were screened in the plant extract to evaluate their presence and potential bioactivity. The results of the same are mentioned in table no.08

Fig No 12 Phytochemical Screening of *Butea Monosperma.L*

Table No.12 Phytochemical Investigation of *Butea Monosperma.L*

SR.NO.	PHYTOCHEMICALS TEST	INFERENCE
1.	Amino acids	+
2.	Carbohydrates	+
3.	Alkaloids	+
4.	Steroids	+
5.	Cardiac Glycosides	+
6.	Flavonoids	+

7.	Saponins	+
8.	Tannins	+
9.	Terpenoids	+
10.	Phenols	+
11.	Coumarins	-
12.	Emodins	-

(+) indicates presence whereas (-) indicates absence of the phytochemical

A.ORGANOLEPTIC PROPERITES:

1. PHYSICAL APPEARANCE:

1. Color and Odour:

The prepared formulation is examined by visually and we get following results mention table no. 09

Fig No 13 Herbal Gel of *Butea Monosperma.L*

Table No.13 Physical Appearance

Sr. No.	Evaluation Parameter	Observation
1	Color	Yellowish-green colour
2	Odour	Mild characteristics herbal odour
3	Texture	Smooth

Discussion: The prepared *Butea Monosperma* herbal gel showed a yellowish-green color, which indicates the presence of plant constituents in the formulation. The gel exhibited a mild characteristic herbal odour, suggesting the absence of any strong or unpleasant smell, making it suitable for topical application. The smooth texture of the gel reflects proper formulation and uniform dispersion of ingredients, contributing to good patient acceptability. Overall, the physical appearance parameters confirm that the gel possesses desirable aesthetic and application properties.

B. PHYSICOCHEMICAL ANALYSIS

1. Determination of pH:

The prepared formulation is examined by digital pH meter and we get following results mention table no. 14

Fig No 14 Digital pH Meter Evaluation of Herbal Gel Formulation

Table No.14 Determination of pH

Sr. No.	Sample Name	pH
1	F1	4.18±0.05
2	F2	6. 18±0.04
3	F3	6.29±0.03

±SD (n=3)

Discussion: The pH of the prepared herbal gel formulations was determined using a digital pH meter, and the results are presented in Table No. 14. The observed pH values for formulations F1, F2 and F3 were found to be 4.18±0.05, 6.18±0.04, and 6.29±0.03, respectively (n=3). The low standard deviation values indicate good precision and reproducibility of the measurements. Among the formulations, F1 exhibited a slightly acidic pH, which may be less suitable for topical application as it can cause mild skin irritation. In contrast, F2 and F3 showed pH values closer to the normal skin pH (around 5.5–7), indicating better compatibility with the skin. Therefore, formulations F2 and F3 can be considered more suitable for topical use, with F3 showing the most optimal pH among all the tested formulations.

2. Spreadability: The prepared formulation is examined by glass plate method and we get following results mention table no. 15

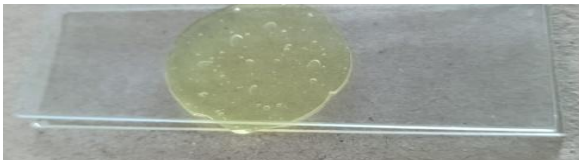


Fig No 15 Spreadability Evaluation of Herbal Gel Formulation

Formula:

Spreadability it can be calculated by using formula:

$$\text{Spreadability (S)} = \frac{\text{ML}}{\text{T}}$$

Table No.15 Determination of Spredability

Sr.No.	Sample Name	Spreadability
1	F1	21.15±0.41 g.cm/sec
2	F2	24.47±1.09 g.cm/sec
3	F3	25.59±0.60g.cm/sec

±SD (n=3)

Discussion: The spreadability of formulations F1, F2 and F3 was evaluated using the glass plate method. The values obtained were 21.15±0.41, 24.47±1.09, and 25.59±0.60 g·cm/sec (n=3), respectively. Among them, F3 showed the highest spreadability, indicating better ease of application and uniform spreading. Hence, F3 was found to be the most suitable formulation for topical use.

3. Viscosity: The prepared formulation is examined by Brookfield Viscometer and we get following results mention table no. 16

Fig No 16 Viscosity Evaluation of Herbal Gel Formulation

Table No.16 Determination of Viscosity

Sr.No.	Sample Name	Viscosity
1	F3	545±0.05cP

±SD (n=3)

Discussion: The Prepared Herbal gel showed suitable consistency and good spreadability of the gel for topical application.

5. Washability: F1 and F2 were found to be non-washable, while F3 showed good washability and was easily removed with water.

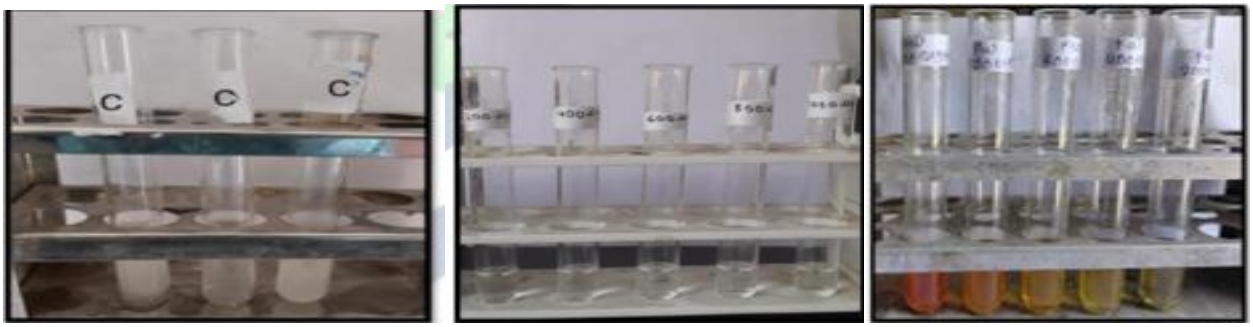
Fig No 17 Washability Evaluation of Herbal Gel Formulation

6. Skin Irritation Test**:** F1, F2, and F3 formulation did not show any redness, itching or irritation on the skin after application. Hence, all formulations were found to be safe for topical use.

Fig No 18 Skin Irritation Evaluation of Herbal Gel Formulation

7. Homogeneity: F1 showed poor homogeneity with slight lumps or uneven mixing, while F2 and F3 showed good homogeneity with smooth and uniform appearance.

8. Anti-inflammatory Testing: The prepared formulation is examined by Protein denaturation method and we get following results mention table no. 17



Control Standard Diclofenac Sodium Sample

Fig No 19 Anti-inflammatory activity

Table No.17 *In-Vitro* Anti-Inflammatory Activity by Protein Denaturation Method

Sr.no	Sample	Concentration µg/ml	O.D			Mean	%inhibition
1	Control		0.82	0.89	0.87	0.86	
2	andard Diclofenac Sodium	200 µg/ml	0.25	0.24	0.21	0.23	72.87
		400µg/ml	0.19	0.18	0.19	0.19	78.29
		600µg/ml	0.15	0.17	0.16	0.16	81.40
		800µg/ml	0.13	0.14	0.12	0.13	84.88
		1000µg/ml	0.11	0.18	0.09	0.13	85.27
3	Sample-KW	200 µg/ml	0.67	0.66	0.66	0.66	22.87
		400µg/ml	0.63	0.62	0.63	0.63	27.13
		600µg/ml	0.57	0.58	0.59	0.58	32.56
		800µg/ml	0.47	0.46	0.48	0.47	45.35
		1000µg/ml	0.32	0.31	0.35	0.33	62.02

IV. DISCUSSION

The in vitro anti-inflammatory activity of Sample–KW was evaluated using the protein denaturation method, which is a widely accepted model for assessing the ability of compounds to inhibit protein denaturation, a key mechanism involved in inflammation. The results indicate that the standard drug, Diclofenac sodium, exhibited strong anti-inflammatory activity with percent inhibition ranging from 72.87% to 85.27% across concentrations of 200–1000 µg/ml. In comparison, Sample–KW showed a concentration-dependent increase in inhibition of protein denaturation. At lower concentrations (200 µg/ml), the sample exhibited mild activity (22.87%), which gradually increased to 62.02% at 1000 µg/ml. Although the activity of Sample–KW was lower than that of the standard drug, the steady increase in inhibition with concentration suggests the presence of bioactive compounds capable of stabilizing proteins and preventing denaturation.

V. CONCLUSION

The present study successfully formulated and evaluated an herbal anti-inflammatory gel using *Butea Monosperma* flower extract. The extract was prepared by Soxhlet extraction using ethanol and showed the presence of various phytoconstituents such as flavonoids, alkaloids, tannins, saponins, terpenoids and phenolic compounds, which are responsible for anti-inflammatory activity. The gel formulations were prepared using Carbopol-940 as a gelling agent and evaluated for various organoleptic and physicochemical parameters.

Among all formulations, F3 showed the most satisfactory results with good appearance, smooth texture, acceptable pH, better spreadability, suitable viscosity, good washability and excellent homogeneity. The skin irritation test confirmed that the formulation was safe for topical application and did not produce any irritation or redness. The in-vitro anti-inflammatory activity performed by the protein

denaturation method demonstrated that the formulated gel possessed significant anti-inflammatory potential, with increased activity at higher concentrations.

Therefore, the study concludes that *Butea Monosperma* flower extract can be effectively incorporated into a topical gel formulation and may serve as a safe, effective and promising herbal alternative for the management of inflammatory conditions.

BIBLIOGRAPHY

[1] Patil BR, Akarte AM, Chaudhari PM, Wagh KS, Patil PH. Development and characteristics of topical gel containing nimesulide: A review. GSC Biol. Pharm. Sci. 2021; 15:295-301.

[2] Yerragunta V, Saba A, Sadia A, Begam A, Fatima SK, Nausheen H, Reddy ES. Evaluation of In-vitro Anti-Inflammatory activity of Petroleum Ether Extract of Butea Monosperma Flowers. Research Journal of Pharmacy and Technology. 2016 Jun 1;9(6):755.

[3] Patil PB, Datir SK, Saudagar RB. A review on topical gels as drug delivery system. Journal of Drug Delivery & Therapeutics. 2019 May 2; 9.

[4] Sailaja AK, Supraja R. An overall review on topical preparation-gel. Innovat International Journal of Medical & Pharmaceutical Sciences. 2016 Nov; 1(1):17-23.

[5] Rathod HJ, Mehta DP. A review on pharmaceutical gel. International Journal of Pharmaceutical Sciences. 2015 Oct 1; 1(1):33-47.

[6] Pal K, Banerjee I, editors. Polymeric gels: characterization, properties and biomedical applications. Woodhead Publishing; 2018 Jun 15.

[7] Fernández-Barbero A, Suárez IJ, Sierra-Martín B, Fernández-Nieves A, de Las Nieves FJ, Marquez M, Rubio-Retama J, López-Cabarcos E. Gels and microgels for nanotechnological applications. Advances in colloid and interface science. 2009 Mar 1; 147:88-108.

[8] Montagna W. The structure and function of skin. Elsevier; 2012 Dec 2.

[9] Langton AK, Graham HK, Griffiths CE, Watson RE. Ageing significantly impacts the biomechanical function and structural composition of skin. Experimental Dermatology. 2019 Aug; 28(8):981-4.

[10] Kushagra N, Mukesh KS, Dhansay D, Verma VK, Tripathi DK., Anti- inflammatory activity and chemo profile of plants used in traditional medicine: A review. J. Chem. Pharm, 2010, 5vol, 2nd ed. p.122-130

[11] Indian Materia Medica. Bombay: Popular Prakashan 2002, vol 1 p.223

[12] Kasture VS, Chopade CT, Deshmukh YK. Anticonvulsive activity of Albizria lebbeck, Hibiscus Rosa and Butea Monosperma in experimental animals. Journal of Ethanopharmacology. 2000 p.71:65- 75.

[13] Mr. Deepesh Sharma, Dr. B. K. Kumawat., Formulation and evaluation of different parts of Butea Monosperma: A IJTSRD., 9vol, ed. P.2456-6470

[14] Dinesh Shakya, Namrata Singh., Formulation, Development and Characterization of gels of extracts of Butea Monosperma and Acacia arabina Linn and evaluation of wound healing activity, 14vol, Issue 32s (2025).

[15] Chavan RS, Shrirao AV, Kochar NI, Chandewar AV. Formulation and Evaluation of Butea Monosperma (Lam.) Ointment. Asian Journal of Pharmacy and Technology. 2023 Jul; 13(3):175-7.

[16] Bagul VR, Mahale BN, Palwe SD, Gajbhiye AV. Monospema (Lam.) Taub." 2021. International Journal of Curren. 13.

[17] Hait M, Behera SK, Chaturwedi AK, Vaishnav MM. Exploration of phytochemical potential on flower of Butea monosperma. Journal of Pharmacognosy and Phytochemistry. 2019;8(3):2083-5.

[18] Yerragunta V, Saba A, Sadia A, Begam A, Fatima SK, Nausheen H, Reddy ES. Evaluation of In-vitro Anti-Inflammatory activity of Petroleum Ether Extract of Butea Monosperma Flowers. Research Journal of Pharmacy and Technology. 2016 Jun 1; 9(6):755.

[19] Pandey P, Garg A, Shukla A. Preliminary phytochemical and physicochemical Investigation and thin layer chromatography of Butea Monosperma flower extract. Journal of Medical Pharmaceutical and Allied Sciences. 2016:1-0.

[20] Rana F, Avijit M. Anti-inflammatory activity of flower extract of Butea monosperma. Int J Pharmacogn. 2015; 2(5):266-8.

[21] Mishra MK. Preliminary phytochemical screening and pharmacological evaluation of the leaves of Butea monosperma. International Journal of Pharmaceutical Sciences and Research. 2016 Feb 1; 7(2):714.

[22] More BH, Sakharwade SN, Tembhurne SV, Sakarkar DM. Antioxidant and anti-inflammatory mediated mechanism in thermal wound healing by gel containing flower extract of Butea Monosperma. Proceedings of the National Academy of Sciences, India Section B: Biological Sciences. 2015 Jun; 85(2):591-600.

[23] Sawale JA, Panchal CV, Poul BN, Patel JR. Physico-chemical Properties and Anti-inflammatory Activity of Butea Monosperma (lam.) gum. JONRPT. 2014;1(1):11-6.

[24] Sapkale Anita P, Thorat Mangesh S, Dighe Deepak A, Munot Neha M, Singh Meera C., Investigation of Anti-Inflammatory Activity of whole flower extract of Butea Monosperma by Ex-Vivo and In-Vitro Techniques and their Correlation.

[25] Brijesh KS, Madhusudan NS. A comprehensive review on pharmacological Profile of Butea Monosperma (Lam.) Taub. J Appl Pharm Sci, 5(09), 2015, 159-66.

[26] Somayaji A, Hegde K. A review on pharmacological profile of Butea Monosperma. International Journal of Phytopharmacology. 2016;7(4):237-49.

[27] Hamdi NA, Azmi NA, Sabari NH, Harun AF, Haris MS. An insight into the use and advantages of Carbopol in topical mucoadhesive drug delivery system: A systematic review. Journal of Pharmacy. 2023 Jan 31; 3(1):53-65.

[28] Fiume MM, Bergfeld WF, Belsito DV, Hill RA, Klaassen CD, Liebler D, Marks Jr JG, Shank RC, Slaga TJ, Snyder PW, Andersen FA. Safety assessment of propylene glycol, tripropylene glycol, and PPGs as used in cosmetics. International journal of toxicology. 2012 Sep; 31(5_suppl):245S-60S.

[29] Gregory SR. Physical properties of glycerine. InGlycerine 2018 May 2 (pp. 113-156). CRC Press.

[30] Fiume MM, Heldreth B, Bergfeld WF, Belsito DV, Hill RA, Klaassen CD, Liebler D, Marks Jr JG, Shank RC, Slaga TJ, Snyder PW. Safety assessment of triethanolamine and triethanolamine-containing ingredients as used in cosmetics. International journal of toxicology. 2013 May; 32(3_suppl):59S-83S.

[31] Methylparaben E, Propylparaben I, Butylparaben I. and Benzylparaben as used in Cosmetic Products. International Journal of Toxicology. 2008; 27(4):1-82.

[32] Soni MG, Burdock GA, Taylor SL, Greenberg NA. Safety assessment of propyl paraben: a review of the published literature. Food and Chemical Toxicology. 2001 Jun 1; 39(6):513-32.

[33] Giri MA, Bhalke RD. Formulation and evaluation of topical anti-inflammatory herbal gel. Asian J Pharm Clin Res. 2019; 12(7):252-5.

[34] Metta S, Amir KM, Lakshmi MS, Devi P, Shruthi KA. A review: Pharmaceutical gels and its types with prominence role of its drug delivery systems. Int. J. Res. Adn Anal. Rev. 2023; 10:686-701.

[35] Goyal S, Sharma P, Ramchandani V, Shrivastava SK, Dubey PK. Novel anti-inflammatory topical herbal gels containing Withania somnifera and Boswellia serrata. Int J Pharm Biol Sci Arch 2011; 2:1087-94.

[36] Mizushima Y, Kobayashi M. Interaction of anti-inflammatory drugs with serum proteins, J. Pharm. Pharmacol., 1968; 20: 169–173.

[37] Sakat SS et al., In vitro anti-inflammatory activity of some medicinal plants, Int J Pharm Pharm Sci, 2010; 2(4): 146–155.