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Research Article

Optimization and Evaluation of Bakuchi Oil-Loaded Hydrogel for the Management of Psoriasis

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ABSTRACT

Novel drug delivery systems offer several advantages as compared to conventional systems. Drugs can be effectively delivered topically by being incorporated into gel, which will prevent first-pass metabolism and increase local action for skin conditions. Hydrogels are 3D polymeric system structures of hydrophilic polymers. The main goals of hydrogels are to improve patient compatibility and release medication at a controlled rate with maximum therapeutic effects. Bakuchi oil is obtained from the seeds of *Psoralea corylifolia* (family: Leguminosae), which has anti-inflammatory qualities. The research was conducted to investigate how to enhance anti-psoriatic activity by using herbal bakuchi oil in the form of hydrogel. Carbopol 940 (carbomer) polymer, Transcutol-P as a permeation enhancer, and triethanolamine for pH adjustment were used to prepare hydrogel. The impact of formulation variables, such as concentration of polymer and permeation enhancer, on the formulation responses was assessed. Optimized formulation F8 demonstrated a maximum drug release of 85.36 ± 0.33% in 1-hour. Viscosity and spreadability of formulation F8 were found to be 5089 ± 0.70 cps and 11.45 ± 1.47 gm.cm/sec, respectively. The findings suggested that a successful herbal formulation containing Bakuchi oil can be developed with improved rheological properties and good permeation profile.

Introduction

Topical medication delivery is essential for treating mild to moderate cases of psoriasis and can be a helpful adjunct to systemic therapy for more severe cases. Nonetheless, a significant worry with topical therapy for psoriasis is its potency.[1] The chronic autoimmune type-1 disorder known as psoriasis is typically seen in adults and teens. This disease affects 2.7% of the population. Rashes, wounds, Infections, and individuals with pre-existing autoimmune conditions like rheumatoid arthritis can exacerbate psoriasis.[2] Rapid cell accumulation on the skin, resulting in erythematous plaques and (red) papules with silver scales, is a sign of psoriasis. The skin is covered in red, scaly plaques that can occasionally itch and hurt. Psoriasis lesions can appear on any area of the skin, including the scalp, neck, feet, hands and face. They usually start on joints like the elbows and knees.[3] Psoriasis is closely associated with diabetes and cardiovascular disorders, primarily caused by aberrant epidermal hyperproliferation and keratinocyte differentiation. It advances by inducing an immune response in the host, which may be brought on by the proliferation of keratin-mediating cells and their appearance on the skin's surface.[4]Some histopathological conditions linked to psoriasis include excess Th-17 and Th-1 abnormal keratinocyte differentiation epidermal hyperproliferation angiogenesis with blood vessel dilatation.[5]

As secondary metabolites found in aromatic plants, essential oils are complex substances that have two or more bioactive in comparatively higher concentrations (20–70%).[6] Among these essential oils is Bakuchi

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oil, which offers a less harsh alternative to synthetic medications prescribed for psoriasis treatment. The *Psoralea corylifolia* plant's seeds are used to make bakuchi oil. Because of its antioxidant, antimicrobial, and anti-inflammatory qualities, Bakuchi oil has been recommended for the treatment of skin situations in Ayurveda and traditional Chinese medicine. This essential oil, which is obtained from the seeds of *P. corylifolia* (a member of the Leguminosae family), is a phytotherapeutic agent whose main constituents are furocoumarins, which inhibit DNA synthesis and slow down cell proliferation, thus having an anti-psoriatic effect.[7] The major composition of Bakuchi essential oil is psoralen, isopsoralen and bakuchiol, which have anti-inflammatory and antimicrobial effects. [8] One of the bioactive moiety from *P. corylifolia* psoralen is tricyclic furanocoumarin. It has major application in the treatment of psoriasis.[9]

Applications for hydrogels in pharmacy and medicine are growing because of their favorable physicochemical properties, intended interaction with living environments, and advantageous biocompatibility. [10] Three-dimensional, hydrophilic polymeric networks known as hydrogels are proficient at retaining large quantities of biological fluids or water.[11] They are able to detect changes in temperature, pH, or metabolite concentration and release their load in response.[12]

Available literature data provides that Bakuchi oil can be effectively used for the treatment of psoriasis. Marwaha TK. *et al*. created emulgel, a biphasic drug delivery system using bakuchi oil, an herbal remedy for psoriasis. Dr. A. Abdul Hasan Sathali *et al*. developed bakuchi oil loaded transethosome to enhance anti-fungal and anti-psoriatic properties through the formulation, development, and characterization.[15]

The goal of the present learning was to study bakuchi oil's anti-inflammatory properties in the hydrogel formulation with good spreadability, excellent permeation capability, suitable pH and viscosity. On the other hand, applying a pure essential oil at the application site can be challenging. Therefore, hydrogels were created to increase the amount of time that active substances and skin come into contact.

Materials And Methods

Materials

Bakuchi oil was procured from Janani organics, Dharvad (India). Carbopol 940, glycerol, Transcutol-P, potassium dihydrogen phosphate, albumin were supplied by Analab fine chemicals, Mumbai. Disodium hydrogen phosphate (Loba chemie pvt ltd), was used throughout this research.

Methods

Preformulation study of drug

Sample was subjected to the following preformulation studies

Organoleptic properties

Bakuchi oil was manually analyzed for the organoleptic properties including color, odor and appearance.

Solubility profile

Solubility of Bakuchi oil was checked visually in methanol, distilled water, petroleum ether, ethanol, acetone, DMSO, chloroform and KH_2PO_4 (pH 5.4). Accurately weighed, 1-mL of oil was transferred in a test tube. Above mentioned solvents were individually added and shaken vigorously and the solubility of oil was estimated visually in each solvent. [13]

Phytochemical screening

Bakuchi oil was dissolved in ethanol and evaluated for presence of different phytochemical constituent including alkaloids, glycosides, carbohydrates, tannins, steroids, phenols, saponin, flavonoids and coumarin. [14]

UV-Visible Spectrophotometry

Estimation of lambda max for bakuchi oil in KH_2PO_4 (pH 5.4)

A precisely measured 100 mg portion of bakuchi oil was placed in a volumetric flask of capacity 100 mL and allowed to dissolve with a small amount of ethanol. KH_2PO_4 (pH 5.4) was then added to the flask to bring the volume up to the desired level, yielding a stock solution with a conc. of 1000 µg/mL. The given solution was examined in a UV spectrophotometer between 200 and 400 nm.

Calibration of Bakuchi oil in KH_2PO_4 (pH 5.4)

Serial dilutions from stock solution having conc. of (1000 µg/mL) with KH_2PO_4 (pH 5.4) was prepared within a 2 to 10 µg/mL range. Absorption readings of above solutions were measured at determined λmax (255 nm) taking KH_2PO_4 (pH 5.4) as blank and the calibration plot was prepared.[15]

Drug-excipients Compatibility Studies

Fourier transfer infrared spectrophotometer spectroscopy

The functional groups present in Bakuchi oil were determined by FTIR-ATR (BRUCKER, TENSOR-27) spectrophotometry; selected formulation was also examined by FTIR-ATR spectrophotometry. The samples were added on sample holder and scanned between IR range of 4000 to 400 cm^{-1}.

Formulation Studies

Preliminary screening of penetration enhancer

The solubility of bakuchi oil was investigated in permeation enhancers including tween 80, clove oil, turpentine oil, peppermint oil, almond oil, cinnamon oil, oleic acid, and eucalyptus oil. The selection of penetration enhancers for further research was based on their ability to effectively

Table 1: Independent variable and their level in the design of Box–Behnken.

Independent variable	*Low level*	*High level*
A= Concentration of polymer (Carbopol 940 % w/v)	0.5 %	1 %
B= concentration of permeation enhancer (Transcutol-P % w/v)	3 %	5 %
C= Stirring speed (RPM)	700	1000

solubilize drugs. Excess of oil was added in 1-mL of each penetration enhancer which was then vortexed for 30 seconds. After that, centrifugation of sample were carried out for 10 minutes at 1000 rpm to extract the clear supernatant liquid. Oil solubility was measured at 255 nm using UV spectroscopy.

Optimization Study

Experimental design and statistical analysis can assess and determine the most crucial parameters and their interactions by reducing the amount of experimentation.[16] The polymer concentration and the permeation enhancer concentration were found to be the most critical factors influencing the pH, viscosity, and drug diffusion of the hydrogel based on preliminary research and the literature that was available. [17,18] Design-Expert® version 13, a commercial software program, was used to apply Box-Behnken design to statistical evaluation the impact of formulation variables on the responses.

Table 1 shows the independent variable and their level used in the investigation.

Formulation of Hydrogel

Each component was gathered using the formula shown in Table 2. Dispersion of Carbopol 940 was carried out in distilled water until formation of homogenized solution. Then, bakuchi oil was dissolved in glycerol and this solution was added to the Carbopol-940 mixture. Transcutol- P (selected enhancer) was added in different concentration to formulas. Finally, to achieve the necessary skin pH of 6.8 to 7.2, 0.3 mL of triethanolamine was added dropwise to the formulation. [19,20] Composition of bakuchi oil hydrogel is given in Table 2.

Evaluation of Topical Bakuchi Oil Hydrogel

pH

Digital pH meter (BioEra) was used for the determination of pH of hydrogel. For determination of pH, 1% solution of hydrogel formulation was prepared in distilled and pH was determined.

Viscosity

Viscosity is a crucial characteristic that determine the resistance of flow of hydrogel formulation so that it can easily spread on the skin after application. A Brookfield viscometer (Labman) with Spindle 4 was used to measure the hydrogel preparations' viscosity at a speed of 50 revolutions per minute. For every preparation, the process was done 3 times, and the mean viscosity was measured in centipoise units.[21]

Spreadability

Spreadability was measured with the help of apparatus containing a wooden block having lifter at one end (Fig. 1). This process measured spreadability based on the basis of drag and slipe characteristic of hydrogel. On the bottom slide, an excess of the hydrogel under investigation (roughly 20 gm) was placed. After that, the hydrogel was positioned with the hook in between glass slide and other one that had the same measurement as a fixed bottom slide. For 5 minutes, a 1000 g weight was kept on top of each of the 2 slides to eliminate air and produce a consistent layer of hydrogel between them. The extra hydrogel was removed by scraping off the edges. The upper plate was subsequently pulled with a 5 g weight. The entire time and distance travelled by upper slide were examined. A shorter time for spreading showed well spreadability. [21] Spreadability was determined by formula given below:

$$S = (M \times L)/T$$

Where,
S; Spreadability
M; Weight placed the pan
L; Length travelled by upper glass slide
T; Time (in sec.) taken to travel upper slide.

Extrudability

The quantity of hydrogel that squeeze out from the tube after application of pressure was used to determine the extrudability of hydrogels. The prepared hydrogel was poured into a spotless, collapsible aluminum tube with a 5 g capacity and a 5 mm orifice. A 500 g weight was added to the end that had been crimped. The quantity of hydrogel that was squeeze out (in percentage) through

Fig. 1: Spreadability apparatus

Table 2: Composition of Bakuchi oil Hydrogel

Formulation code	*Carbomer 940 (% w/v)*	*Bakuchi oil (% v/v)*	*Transcutol-P (% v/v)*	*Glycerol (mL)*	*Triethanolamine (mL)*	*Distilled water q.s upto (mL)*
F1	0.75	4	5	5	0.3	100
F2	1	4	4	5	0.3	100
F3	1	4	3	5	0.3	100
F4	0.75	4	4	5	0.3	100
F5	0.75	4	5	5	0.3	100
F6	1	4	5	5	0.3	100
F7	0.5	4	3	5	0.3	100
F8	0.5	4	4	5	0.3	100
F9	0.5	4	5	5	0.3	100
F10	0.75	4	3	5	0.3	100
F11	1	4	4	5	0.3	100

the orifice following the application of pressure was used to determine the extrudability. Three duplicates of the experiment were carried out.[22]

In-vitro drug diffusion

In-vitro drug diffusion assay was conducted with the Franz diffusion compartment. Dialysis membranes were made of cellophane. As a donor compartment, 1 g of gel was applied to a cellophane membrane. The dissolution medium in the receiver compartment was KH_2PO_4 (pH 5.4).[23] The whole diffusion cell system was positioned on a magnetic stirrer that had a thermostat set at 37°C. At regular intervals, samples were gathered.[24] Sink conditions were preserved by substituting a fresh buffer solution. The samples were collected and subjected to UV spectrophotometer analysis at 255 nm.

In-vitro anti-inflammatory activity

When an external stressor or complex, such as organic solvent, strong base or strong acid or heat is applied to proteins, they lose their secondary and tertiary structures. This process is known as denaturation, and most biological proteins become functionally denatured as a result. Inflammation is known to be caused by protein denaturation. The ability of the extract to prevent denaturation of protein was studied as part of the anti-inflammatory action. Well-known cause of inflammation is albumin denaturation. Diclofenac sodium, in the concentration series of 200 to 1000 µg per mL, was used as a reference drug. [25]

Inhibition of albumin denaturation

The % of protein denaturation inhibition was assessed by using the below procedure. [26]

- *Control solution*

KH_2PO_4 (pH 5.4) (14 mL), egg albumin (2 mL), and 20 mL distilled water.

- *Reference drug*

28 mL of (pH 5.4) phosphate buffer, egg albumin (2 mL), and 10 mL different concentration of reference drug (Diclofenac sodium) conc. range of 200, 400, 600, 800 and 1000 µg/mL.

- *Test solution*

KH_2PO_4 (pH 5.4) (28 mL), 2 mL of egg albumin, and 10 mL various concentration of gel solution [1000, 800, 600, 400, and 200 µg/mL]. The samples were heated to 70°C for five minutes after being incubated at 37°C for 15 minutes. Following cooling, the turbidity absorbance was measured in a UV-vis spectrophotometry at 660 nm. Using the formula below, the % of inhibition of denaturation of protein in the above solutions was determined.

$$\text{Percent inhibition} = \frac{(\text{Absorbance of control solution} - \text{Absorbance of test solution})}{(\text{Absorbance of control solution})}$$

Results And Discussion

Organoleptic Properties of Bakuchi Oil

Organoleptic properties of bakuchi oil are shown in Table 3.

Solubility Profile of Bakuchi Oil

Solubility profile of bakuchi oil in various solvent is given in Table 4.

Phytochemical Analysis of Bakuchi Oil

Phytochemical analysis of bakuchi oil is shown in Table 5.

UV-visible Spectrophotometry

Estimation of λmax for bakuchi oil in KH2PO4 (pH 5.4)

λmax of bakuchi oil in KH2PO4 (pH 5.4) was found to be 255 nm

Table 3: Organoleptic properties of bakuchi oil

Color	Brownish yellow color
Odor	Pungent (nutty like aroma)

Table 4: Solubility profile of bakuchi oil

S. No	*Solvent*	*Solubility*
1	Distilled water	Insoluble
2	Ethanol	Soluble
3	Methanol	Insoluble
4	Chloroform	Sparingly soluble
5	Acetone	Completely soluble
6	DMSO	Soluble
7	KH_2PO_4 (pH 5.4)	Partially soluble
8	Petroleum ether	Soluble

Table 5: Phytochemical constituents of bakuchi oil

S. No	*Test*	*Result*
1	Alkaloids	+
2	Glycoside	+
3	Carbohydrates	-
4	Tannins	+
5	Steroids	+
6	Phenol	-
7	Saponin	+
8	Flavonoids	+
9	Coumarin	+

(+) Presence of phytoconstituent. (-) Absence of phytoconstituent.

Calibration of bakuchi oil in KH2PO4 (pH 5.4)

With KH2PO4 pH 5.4, the bakuchi oil standard calibration plot was created. It was discovered that the correlation coefficient was 0.998. Beer-Lambert's law is followed by bakuchi oil in the conc. series of 2 to 10 µg/mL. Table 6 displays the calibration plot of bakuchi oil in KH2PO4 at pH 5.4. Calibartion curve of bakuchi oil is given in Fig. 2.[27]

Drug-excipients Compatibility Studies

Fourier transfer infrared spectrophotometer (FTIR) spectroscopy

A 1724 cm^{-1} (C=O carbonyl group), 1449 cm^{-1} (Aromatic ring), 1285, 1023, 1125 (C-O-C ether group) are some characteristic peaks from psoralen.[27] The main functional group responsible for psoralen's anti-inflammatory properties has been found to be the furanocoumarin moiety, which is made up of a furan ring fused to a coumarin ring.[28] This characteristic functional groups are also present in IR spectra of bakuchi oil and hydrogel. Wide absorption band in bakuchi oil at 2925 cm^{-1} and

Table 6: Estimation of Bakuchi oil measured at 255 nm in UV spectrometry

Concentration (µg/mL)	*Absorbance (255 nm)*
2	0.136 ± 0.05
4	0.176 ± 0.07
6	0.217 ± 0.08
8	0.255 ± 0.10
10	0.294 ± 0.11

n = 3, ± SD

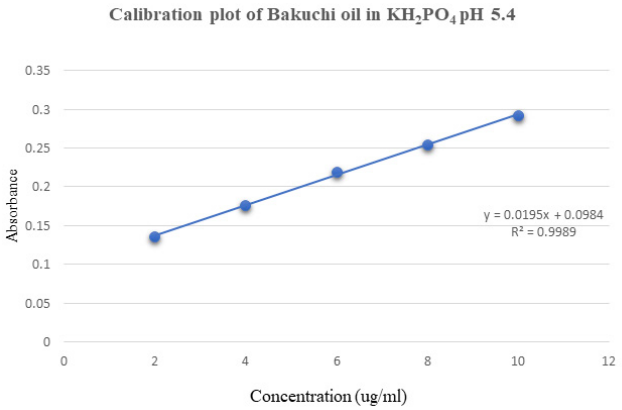

Fig. 2: Calibration curve of bakuchi oil

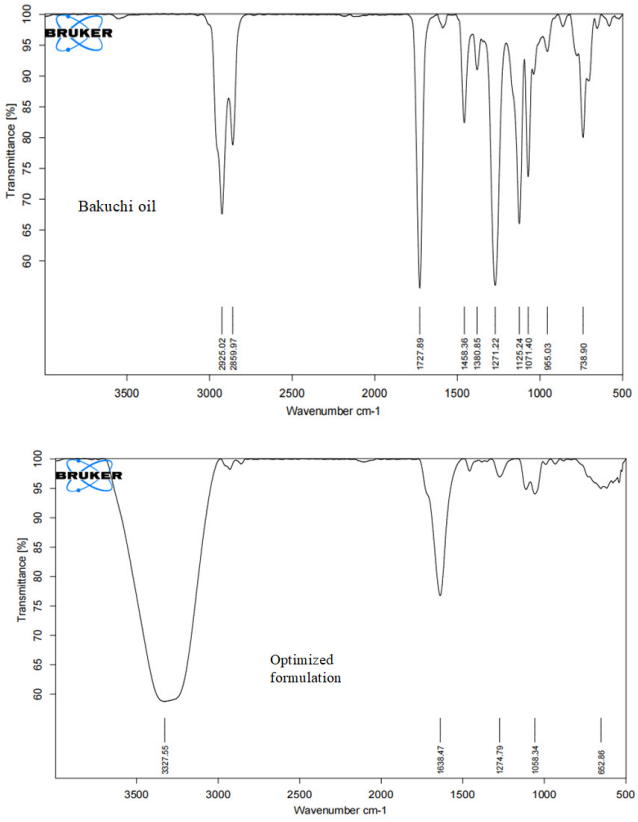

Fig. 3: FTIR spectroscopy of pure Bakuchi oil and optimized batch

Table 7: Evaluation parameters for formulation batches

Formulation code	*pH*	*Viscosity (cps)*	*Spreadability (gm.cm/sec)*	*Extrudability (%)*
F1	6.71 ± 0.21	6002 ± 1.41	3.2 ± 0.14	57.66 ± 1.69
F2	6.36 ± 0.04	10000 ± 0.40	3.1 ± 0.42	61.66 ± 2.5
F3	6.16 ± 0.03	12347 ± 1.22	3.5 ± 0.14	72.00 ± 2.1
F4	6.22 ± 0.03	7056 ± 0.40	3.4 ± 0.24	62.66 ± 1.69
F5	6.42 ± 0.05	6900 ± 0.40	4.5 ± 0.56	62.33 ± 1.69
F6	6.00 ± 0.09	9823 ± 0.40	4.77 ± 0.58	62.33 ± 2.05
F7	7.00 ± 0.04	5904 ± 1.00	9.1 ± 2.3	82.00 ± 1.41
F8	6.98 ± 0.02	5089 ± 0.70	11.45 ± 1.47	91.66 ± 0.47
F9	7.10 ± 0.04	5000 ± 0.40	11.44 ± 1.47	90.33 ± 1.63
F10	6.40 ± 0.04	7900 ± 1.21	8.74 ± 0.88	81.33 ± 1.24
F11	6.20 ± 0.12	10092 ± 1.22	6.63 ± 0.61	81.00 ± 0.47

(n=3) ± SD

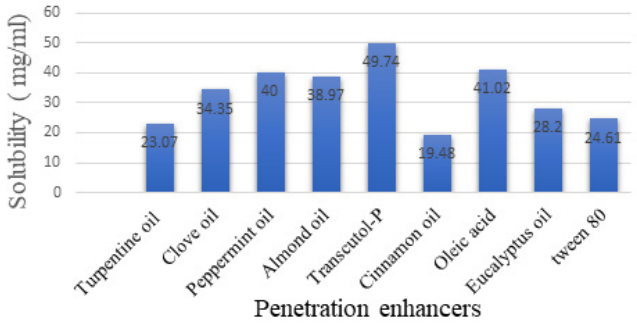

Fig. 4: Preliminary screening of penetration enhancers

2859 cm^{-1} describes (C-H) stretching vibration. After incorporation of bakuchi oil in hydrogel, intensity of absorption band at 2925 and 2859 cm^{-1} reported from IR spectra of bakuchi oil was found to be decreased in the spectra of bakuchi oil loaded hydrogel due to some steric impediments and hydrogen bonding.[29] Other peaks at 1071 and 738 cm^{-1} (ether group) reported from IR spectra of bakuchi oil were signified at slight lesser frequency of 1058 and 652 cm^{-1} in Bakuchi oil loaded hydrogel.[30]

Preliminary Selection of Penetration Enhancer

Fig. 3 shows that the solubilty of Bakuchi oil was significantly higher in Transcutol -P (49.74 mg/mL) as compared to other penetration enhancer. Transcutol® P's ability to solubilize hydrophilic and lipophilic APIs is one of its primary characteristics. Increasing the vehicle's drug solubility and, consequently, its thermodynamic driving force Transcutol-P gives higher drug release and better permeation of skin.[41] Thus, Transcutol-P was selected as a permeation enhancer for further formulation studies. Fig. 4 shows preliminary screening of penetration enhancers.

Evaluation Parameters of Hydrogel

Prepared hydrogel was examined for pH value, viscosity, spreadability and extrudability at room temperature. The pH value of the hydrogel which is convenient when used is 6.2 to 7.2 and will not irritate the skin when used. [31] The pH of all hydrogel batches was found to be in range of 6 to 7 and which was near to the physiological pH of the skin. Viscosity is a property of preparations that affects the hydrogel preparation's spreadability, consistency, and drug release at the time of application. The hydrogels had viscosities ranging from 5000 to 11000 cPs. For gel preparations, a viscosity of 5000 to 150,000 cPs is the ideal range.[31]

The gel preparations' capacity to disperse and spread when applied to skin was assessed by the spreadability test. The measurements of viscosity and the spreadability test results were inversely correlated. [32] Every formulation had spreadability between 3-12 gm.cm/second. An essential factor in the hydrogel's application on skin and

Table 8: *In-vitro* drug diffusion of formulation batches

Formulation code	*%Drug release after 1 hour*
F1	82.03 ± 0.04
F2	58.08 ± 0.04
F3	57.21 ± 0.15
F4	68.18 ± 0.12
F5	69.13 ± 0.07
F6	57.24 ± 0.21
F7	80.20 ± 0.16
F8	85.36 ± 0.33
F9	83.18 ± 0.22
F10	68.12 ± 0.95
F11	57.96 ± 0.66

(n=3) ± SD

Table 9: Formulation of optimized batch, F8 of hydrogel

Formulation code	*Bakuchi Oil (%v/v)*	*Carbopol 940 (% w/v)*	*Transcutol-P (%v/v)*	*Glycerol (ml)*	*Triethanolamine (ml)*	*Distilled Water (ml)*
F8	4	0.5	4	5	0.3	Upto 100

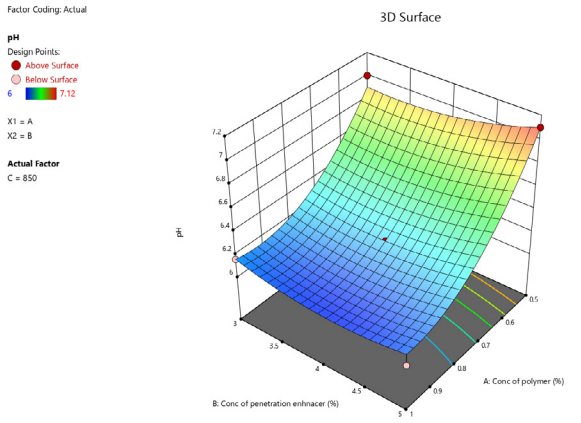

Fig. 5: 3-Dimensional response surface plot showing influence of formulation variable on pH

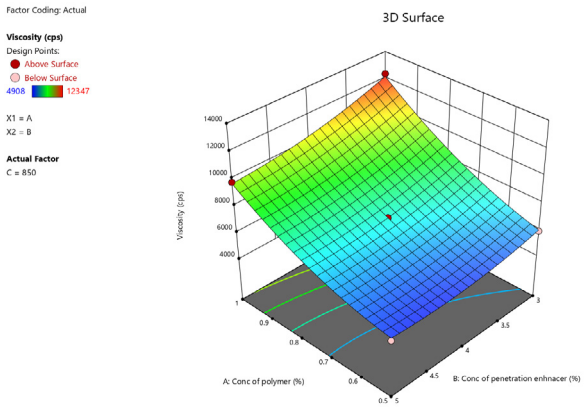

Fig. 6: 3-Dimensional response surface plot showing effect of formulation variable on viscosity

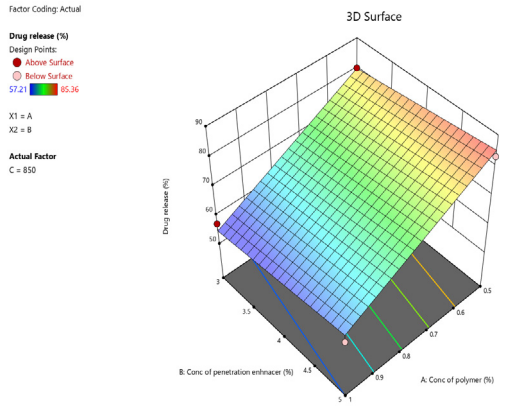

Fig. 7: 3-Dimensional response surface plot showing effect of formulation variable on %drug release

Table 10: Evaluation parameters for optimized batch for hydrogel where (n = 3) ± SD

Parameter	*Result*
pH	6.98 ± 0.02
Viscosity	5089 ± 0.70
Spreadability	11.45 ± 1.47
Extrudability	91.66 ± 0.47
Drug release	85.36 ± 0.33%

patient acceptance is how well it extrudes from the tube.[33] All of the formulations showed good extrudability between 60 and 90%.

Table 7 shows evaluation parameters for formulation batches.

In-vitro Drug Diffusion Profile

In-vitro drug release was studied by use of Franz diffusion setup for 1-hour.[25] Formulation F8 was chosen as the optimized batch because it demonstrated good drug release when compared to the other formulation batches. Maximum release of bakuchi oil from hydrogel was obtained with 0.5% Carbopol 940 and 4% Transcutol-P. Drug release of all formulation is given in Table 8.

Optimization of Batch

After examination of all hydrogel batches for their evaluations including viscosity, spreadability, pH**,** and extrudability, it was found that formulation F8 has good results and suitable for topical use. Formulation F8 showed highest drug release as compared to other formulation. Based on physicochemical property and *in-vitro* drug diffusion profile formulation F8 was selected as optimized batch which was further used for *in-vitro* anti-inflammatory study.

Table 9 shows formulation of optimized batch, F8 of hydrogel.

Table 10 shows evaluation parameters for optimized batch for hydrogel.

Effect of Formulation Variable on pH, Viscosity and Drug Release

Fig. 5 exhibits the 3D response surface plot, which shows influence of formulation variable on pH. pH of all hydrogel batches ranged between 6 to 7. From pH values of all hydrogel batches, it was found that high level of concentration of polymer showed decrease in pH of formulation. The conc. of Carbopol-940 has -ve effect on

Table 11: *In-vitro* anti-inflammatory activity of formulation, where (n = 3) ± SD

Concentration (µg/mL)	*Absorbance at 660 nm*	*Percent inhibition (%)*
Control	0.75	-
200	0.120	84.00 ± 0.12
400	0.119	84.13 ± 0.15
600	0.109	85.46 ± 0.34
800	0.109	85.46 ± 0.34
1000	0.109	85.46 ± 0.34

Table 12: *In-vitro* anti-inflammatory activity of diclofenac sodium, where (n = 3) ± SD

Concentration (ug/mL)	*Absorbance at 660 nm*	*Percent inhibition (%)*
Control	0.75	-
200	0.125	85.33 ± 0.16
400	0.071	90.53 ± 0.33
600	0.062	91.73 ± 0.22
800	0.060	92.00 ± 0.25
1000	0.058	92.26 ± 0.96

pH readings.[34] As concentration of penetration enhancer increases there is decrease in pH of formulation. [35]

Fig. 6 exhibits the response surface plot, which shows influence of formulation variable on viscosity. Increase in concentration of polymer results into increase in viscosity of formulation. The viscosity of hydrogel is found to be positively impacted by polymer concentration because of a larger grade of interspecific cross-linking between the drug & polymer.[36] Concentration of Carbopol shows direct relationship with a viscosity. [37] High viscosity was observed when Carbomer concentration was improved up to 1% perhaps due to swelling behaviour of Carbomer. [38] Hydrogel batch with (0.5% w/v) Carbopol 940 resulted in lower viscosity. Decrease in concentration of Transcutol-P resulted into increase in viscosity. Viscosity of hydrogel was hardly influenced by stirring condition. Increase in preparative stirring speed resulted into decrease in viscosity of hydrogel. [39]

Fig. 7 exhibits the response surface plot, indicating effect of formulation variable on drug diffusion. Rise in amount of polymer decreases permeation of drug due to swelling.[36] A decrease in the drug release rate was correlated with an increase in the content of carbopol 940. This might be the result of the polymer swelling extensively.[40] Minimum levels of polymer concentration (0.5) resulted into increase in %DR of the formulation to the maximum 85.36%. Concentration of penetration enhancer (Transcutol-P) has slight significant effect on drug release. Transcutol-P is colorless liquid soluble in both oil and water. Higher the % of Transcutol, higher the flux and gathering of drug into skin.[41] Transcutol -P can grip water from skin, and improves skin penetration by increasing thermodynamic action because of variation in solubility.[42]

In-vitro Anti-inflammatory Assay with the Help of Albumin Denaturation Test

In-vitro anti-inflammatory action of optimized formulation was analysed by use of diclofenac sodium as a standard. These experimental results explained a concentration-dependent, significant inhibition of egg albumin denaturation. Table 11 shows *in- vitro* anti-inflammatory activity of formulation.

Table 12 shows *In-vitro* anti-inflammatory activity of diclofenac sodium.

Conclusion

For skin disorders, the topical drug transport system is regarded as a crucial therapeutic approach. Comparatively speaking to oral therapy, it has a quicker onset of action and reduces the possibility of systemic toxicity. Systemic research was conducted to develop topical hydrogel for effective delivery of bakuchi oil. Hydrogel preparations containing bakuchi oil were developed to increase the penetration of drugs into skin and operative way to increase the effectiveness of topical formulations for psoriasis treatment. Appropriate selection of polymer is prerequisite for design and development of topical drug delivery system. Hydrogel batches [F1- F11] containing bakuchi oil were developed with variation in amount of Carbopol 940 and Transcutol- P. The concentration of Carbopol-940 was found to have a crucial influence on drug release and rheological properties of hydrogel. The physicochemical properties of formulation F8, which contains 4% Transcutol-P and 0.5% carbopol 940, were found to be superior to those of the other formulations. As a result, it was determined that prepared formulation might offer psoriasis patients a promising topical substitute. By using topical hydrogels, one can prevent the side effects linked to conventional therapy.

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