CODEN [USA]: IAJPBB ISSN : 2349-7750

INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES
SJIF Impact Factor: 7.187

Available online at: http://www.iajps.com Research Article

FORMULATION AND CHARACTERISATION OF GLYCYRRHIZA GLABRA EXTRACT ENRICHED HYDROGEL UNDER EYE PATCH

Ms. Smitha John[1], Aleena Joseph K J[2], S Lekshmi[2], Chaithanya Sajeev[2], Alriza Parikochu[2]

[1]Associate Professor, Department of Pharmaceutics, Department of Pharmaceutical Sciences, Cheruvandoor Campus, CPAS, Ettumanoor P.O, Kottayam, India.

[2]B. Pharm students, Department of Pharmaceutical Sciences Cheruvandoor, Centre for Professional and Advanced Studies Cheruvandoor Campus Ettumanoor P.O, Kottayam, Kerala, India.

Abstract:

The purpose of this study was to create and describe a hydrogel eye patch enhanced with Glycyrrhiza glabra extract for the treatment of under-eye issues such puffiness, wrinkles, and dark circles. Due to its intricate and delicate structure, the under-eye area is more susceptible to ageing, environmental stress, and other conditions that can result in wrinkles, puffiness, and dark circles. Liquorice extract is a perfect active ingredient for treating under eye issues since it contains triterpenoid saponins and flavonoids, which have anti-oxidant, anti-inflammatory, and anti-hyperpigmentation qualities. The Glycyrrhiza glabra extract was prepared by maceration process and the hydrogel eye patches were developed by incorporating the liquorice extract into a gelatin matrix, along with key ingredients like hyaluronic acid for hydration, vitamin E for antioxidant protection, and phenoxyethanol as a preservative to extend shelf life. The extract was evaluated by determining organoleptic properties, phytochemical analysis, TLC, FT-IR and antioxidant assessment by DPPH assay. Three formulations of eyepatch were prepared and optimized for its physiochemical properties and F3 was selected as better formulation. Additionally, its efficacy was evaluated by determining pH, viscosity, compatibility and solubility. The physicochemical features of the prepared patches, which include viscosity, swelling ratio, and drug release characteristics, were assessed. Its continuous release profile, as demonstrated by in-vitro drug release tests, supports its possible effectiveness in reducing puffiness and enhancing skin texture. The extract's DPPH study revealed 93.114% antioxidant activity, making it a perfect ingredient for treating puffiness, wrinkles, and dark circles. The hydrogel eye patch is stable, effective, and a viable therapeutic option for under eye issues, according to the results.

KEY WORDS: Glycyrrhiza glabra, Hydrogel eye patch, Under eye concerns, Antioxidant, DPPH Assay

Corresponding author:

Ms. Smitha John- smitha.john83@gmail.com

Coauthors:

Aleena Joseph K J- aleenatheresa987@gmail.com

S Lekshmi- lekshmis413@gmail.com

Chaithanya Sajeev- chaithanyasajeev01@gmail.com

Alriza Parikochu- alrizaparikochu@gmail.com

QR CODE

Please cite this article in press ***Smitha John et al., Formulation And Characterisation Of Glycyrrhiza Glabra Extract Enriched Hydrogel Under Eye Patch****, Indo Am. J. P. Sci, 2025; 12(12).*

INTRODUCTION:

Glycyrrhiza glabra (Liquorice) is a member of the fabaceae family and a well know medicinal plant having naturally occurring anti-inflammatory, anti-oxidant, depigmenting and soothing effects. Its bioagents, including glycyrrhizin, flavonoids and liquiritin, are proven to decrease hyperpigmentation, preventing skin from oxidative stress, and relieving skin irritation, thereby offering potential in treating under-eye skin.

The tender under-eye skin is susceptible to problems like dark circles, puffiness, dryness, and fine lines from stress, aging, and environment as well. Hydrogel eye patches represent an exciting new take on targeting skin care at this delicate area. Hydrogels have a three-dimensional hydrophilic polymeric network that can hold a significant amount of water to give a cooling and hydrating sensation and to achieve the prolonged release of an active substance. Hydrogels are good in skin adhesion, flexibility, and transparency which make them user friendly and cosmetically superior.

This study was aimed to prepare and characterize hydrogel eye patches containing *Glycyrrhiza glabra* extract at high concentrations suitable for the development of a functional herbal cosmetic. The prepared patches were subjected to extensive characterization studies such as physicochemical examination, swelling index, moisture absorption, surface morphology, in vitro dissolution, and skin irritation studies to ascertain the effectiveness, safety, and performance.

The aim of the study was to evaluate the therapeutic potential of *Glycyrrhiza glabra* in a hydrogel-based delivery system and to develop a natural, efficacious and consumer friendly eye patch formulation for tackling common under-eye disorders. [1]

MATERIALS AND METHODS:

Collection of plant



Fig.1 Dried *Glycyrrhiza glabra* root



Fig.2 Powdered *Glycyrrhiza glabra* root

The dried roots of *Glycyrrhiza glabra* was purchased from the Kottakkal ayurvedic shop near Ettumanoor, Kottayam.

Extraction Method

Dried roots of *Glycyrrhiza glabra* were powdered and its extraction was done by maceration method. Weighed 2g of dried *Glycyrrhiza glabra* powder and 50mL ethanol water mixture in the ratio 30:70 was added to it. The container was sealed and shaken gently to mix the solvent system and powdered liquorice. The mixture was allowed to sit at room temperature for 72 hrs, while shaking it once or twice a day to ensure even extraction. After the extraction period, the mixture was strained through a filter paper to separate the liquid extract from the solid plant material. Transfered the filtered hydroalcoholic extract into a clean storage container and stored in a cool, dry place. [2]



Fig.4 Day 1



Fig.5 Day 2



Fig.6 Day 3

PREFORMULATION STUDIES

I.Organoleptic evaluation

Colour, odour, texture and taste of the extract were evaluated

II.Phytochemical analysis

- Test for Alkaloids

1. Dragendroff's Test: Added Dragendroff's reagent to the extract. A reddish-brown precipitate indicated the presence of alkaloids
2. Mayer's Test: Added Mayer's reagent to the extract. A cream coloured precipitate indicated the presence of alkaloids.

- Test for Saponins

Foam Test: Mixed the plant extract with water in a test tube. Shaken the mixture vigorously and observed for the formation of a stable foam. A persistent foam indicated the presence of saponins.

- Test for Carbohydrates

Molisch's Test: Added 3mL of aqueous extract to 2mL of Molisch's reagent and resultant mixture was shaken properly. Then concentrated sulphuric acid was poured carefully along the sides of the test tube. A purple ring indicated the presence of carbohydrates.

- Test for Flavonoids

1. Alkaline reagent test: Added 2-3 drops of sodium hydroxide to 2mL extract. A yellow colour that disappeared on adding dilute acid indicated the presence of flavonoids.
2. Shinoda test: Added ferric chloride solution to the extract. Formation of pink colour indicated the presence of flavanoids.
3. Lead acetate test: Added lead acetate solution to the extract. Formation of blackish red colour indicated the presence of flavanoids.

- Test for Glycosides

Baljet test: To the extract picric acid solution was added. To this sodium hydroxide solution was added, the formation of orange red color indicated the presence of glycosides.

- Test for Triterpenoids

Legal test: To the extract added few drops of pyridine and sodium nitroprusside, formation of deep red colour indicated the presence of triterpinoids. [3]

III.Thin layer chromatographic (TLC) profiling of *Glycyrrrhiza glabra* extract

Thin layer chromatographic studies were conducted on the ethanolic extract of *Glycyrrrhiza glabra* using different mobile phases.

Preparation of stationary phase

The stationary phase was silica gel slurry prepared by mixing 30 g of silica gel G in 100 ml of water.The mixture was stirred well and slurry was poured on to the well cleaned grease free glass slide. It was then allowed to set at room temperature and then activated by keeping it in the oven at 110°C for 20 minutes. These activated plates were then used for the studies. The different mobile phases employed includes;

Table 1: Preparation of mobile phase

Mobile phase	Ingredients	Development
A	Chloroform:Glacial acetic acid:Water:Ammonia	30:16:6:4
B	Ethylacetic acid:Ethanol:Water:Ammonia	65:25:9:1
C	Chloroform:Ethanol:Water	64:50:10

Preparation and application of extract

The extracts were taken in capillary tubes separately and spotted on the precoated three TLC plates at a distance of 2 cm above from the base of the plates.It was then allowed to dry at room temperature.

Preparation of visualizing agent (Anisaldehyde-sulphuric acid reagent)

0.5 ml Anisaldehyde was mixed with 10ml of glacial acetic acid in the beaker, followed by 85 ml ethanol and 5 ml of concentrated sulphuric acid.

Development of chromatogram

The spotted TLC plates were placed in the saturated mobile phase chambers for the development of a chromatogram which is marked as A, B, C. When the mobile phase reached 3/4th of the plates, plates were removed, dried in air. Then after drying the visualising agent was sprayed with the help of a sprayer. Then allowed it to air dry at room temperature for 5 minutes. Then these plates were placed in an oven at a temperature of 110°C for 5 to 10 minutes and examined for the presence of spots. The RF values were calculated and tabulated in table. [4]

IV.Fourier Transform Infrared (FTIR) Spectroscopy

FT-IR (Fourier Transform Infrared) spectroscopy is a powerful analytical technique used to study the molecular structure and properties of materials. In FTIR study, the sample was exposed to a range of infrared frequencies, and the absorption or transmittance of these frequencies were measured. [5]

V.Antioxidant Activity Assessment using DPPH Assay

Sample preparation

Due to colour interference, the plant ethanolic extract was diluted 2 times and then used as sample stock. Then, the sample was taken in varying amounts for the test.

The free radical scavenging activity of the sample was evaluated by assessing its ability to scavenge DPPH radicals. A DPPH reagent solution was prepared by mixing 100 µl of DPPH (1 mM) with

100 µl of methanol (98%). Test solutions were prepared by adding varying volumes of the sample (T1 = 20µl T2 = 40µl, T3 = 60µl T4=80 µl T5 = 100µl) to the DPPH reagent solution, adjusting the final volume to 300µl. A control sample was prepared using methanol alone, and ascorbic acid served as the standard. After 30 minutes of incubation in the dark at room temperature, the absorbance was recorded at 515 nm. Antioxidant activity was indicated by a colour change from purple to yellow or colourless, depending on the level of radical scavenging. The IC50 value was determined from the dose response curve. [6]

$$\text{Radical scavenging activity \%} = \left(\frac{ControlOD - TestOD}{ControlOD}\right) \times 100$$

VI. Determination of maximum wavelength and calibration curve for *Glycyrrhiza glabra* extract using UV- Visible Spectrophotometry

Method:

UV Spectrophotometric method was used to determine the maximum wavelength of the liquorice extract.

1. Stock solution preparation: The stock solution of liquorice extract was made with a concentration of 1mg/ml in the phosphate buffer saline solution at a pH of 5.5.
2. Using this stock solution, different concentrations of extract (100, 200, 300, 400, 500 µg/ml) were made in the PBS solution using dilution method.
3. The absorption spectrum was then read by spectrophotometer in the range of 200-600nm for all dilution and determined the λmax of liquorice extract.
4. At this maximum wavelength the calibration curve of Glycyrrhiza glabra extract was drawn and linear equation of the extract in PBS was calculated in the obtained diagram. [7]

FORMULATION OF HYDROGEL EYE PATCH

1. Method of preparation

To prepare the hydrogel eye patch, the required amount of gelatin, distilled water, and glycerin were weighed and mixed in a beaker. The mixture was then heated in a water bath at 60-70°C for 15 minutes until a uniform consistency was obtained. In a separate beaker, weighed quantity of hyaluronic acid and extract solution was added and thoroughly mixed to prevent lump formation. The two solutions from the previous steps were then combined in another beaker, followed by the addition of phenoxyethanol, with gentle stirring. The prepared hydrogel solution (20 mL) was poured into a clean mold and allowed to set for four days. After the setting period, the hydrogel eye patch was carefully removed from the mold and stored in a cool and dry place.

2. Preparation of soaking solution

Table.2- Preparation of soaking solution

Ingredients	Percentage
Distilled water	70-80%
Glycyrrhiza glabra	1-5%
Glycerine	3-5%
Sodium hyaluronate	0.1-1%
Phenoxyethanol	0.5%
Citric acid	A small amount to adjust pH (typically between 4.5-5.5 for eye area compatibility)

Procedure

In a clean, sterilized container, *Glycyrrhiza glabra* extract and sodium hyaluronate were dissolved in distilled water. Mixed until fully dissolved. Then added glycerine to the mixture, stirring gently to ensure uniformity. Using citric acid, the pH of the solution was adjusted to a range of 4.5-5.5 for optimal compatibility with the skin around the eyes. Then the preservative was added to protect the solution from bacterial or fungal contamination. Once the soaking solution was prepared, the hydrogel patches were immersed and allowed to absorb the solution evenly. [8]

OPTIMIZATION STUDY OF HYDROGEL EYE PATCH

Table.3-Formulation chart

Ingredients	F1	F2	F3
Gelatin	4g	8g	16g
Glycerin	2ml	2ml	2ml
Vitamin E	400mg	400mg	400mg
Hyaluronic acid	0.1g	0.1g	0.1g
Liquorice extract	5ml	5ml	5ml
Water	40ml	40ml	40ml
Essential oil	1ml	1ml	1ml
Phenoxyethanol	0.05ml	0.05ml	0.05ml

The optimisation study was conducted using three different concentration of the hydrogel eye patch base. The formulations were prepared and evaluated for setting time, appearance, ease of removal of eye patch from the mold and folding endurance. The eye patch formulation that exhibited the most desirable characteristics in these parameters was selected for further studies.

EVALUATION OF OPTIMISED HYDROGEL EYE PATCH

a. Determination of pH

pH is the measure of the acidity or alkalinity of a solution. It quantifies the concentration of hydrogen (H+) present in a solution. The pH was measured using a pH meter [9]

b. Determination of viscosity.

Viscosity is the measure of resistance of the fluid to flow. It describes how thick or thin a fluid is, which influences the how easily it moves. Atago viscometer was used to measure the viscosity.[10]

c. Compatibility.

The compatibility study was carried out using FTIR Spectroscopy by comparing the the spectrum of the liquorice extract with the spectrum of the hydrogel eye patch base containing the extract. Any significant shifts, disappearance, or appearance of new peaks were analysed to determine potential interactions between the extract and the hydrogel components. The absence of major spectral changes would indicate good compatibility, ensuring the stability of the formulation.

d. SEM Analysis

Scanning Electron Microscopy (SEM) analysis was used to study the surface structure, morphology, and composition of material at a high resolution. [11]

e. Swelling ratio (SR)

The term swelling ratio (SR) refers to the ratio between the weight of solvent absorbed by the hydrogel and the dry weight of the gel. It indicates the increase in the size of the dry hydrogel when fully hydrated. To calculate the SR a hydrogel discs of 1 cm in diameter were cut from fully hydrated hydrogel film and weighed. The discs were then fully dried by placing them in a petridish until they reached a constant weight (Wd). To measure the SR dry disc was placed in 5mL of water and 5mL glycerin. The SR was measured. The discs were left in the solvents for 24 hours to ensure complete hydration. After 24 hours the discs were removed from the solvents; the surfaces of the discs were wiped carefully to remove extra solvents and weighed at equilibrium (We). [12]

$$SR = \left(\frac{We - Wd}{Wd}\right)$$

f. Thickness

The thickness is an important factor as it affects the patch's ability to adhere to the skin, release active ingredients, and provide comfort during wear. A thinner patch is often more flexible and comfortable, while thicker patch may offer better hydration and extended ingredients release. In order to accurately determine the thickness of hydrogel under-eye patches, a screw gauge was used.

g. Folding Endurance

Folding endurance of hydrogel under-eye patches refers to the ability of the hydrogel material used in the eye patch to withstand repeated folding and manipulation without compromising its structural integrity, causing cracks or losing its functional properties (e.g.; adhesion or elasticity). It is an important quality attribute, as the eye patch may be folded during storage or application, and a higher folding endurance ensures that the patch remains effective and durable throughout its use.

Procedure

i. The hydrogel under-eye patch was cut into consistent, defined shape and size for uniformity across all tests.
ii. Taken the prepared hydrogel patch sample and folded manually
iii. The sample should be folded along the same axis for each fold.
iv. The number of folds the hydrogel under-eye patch can undergo before it shows any damage or failure in terms of cracking or breaking was counted.
v. This was generally done visually with the aid of magnification to detect any micro-cracking.
vi. The value of folding endurance was determined by the number of times the films can be folded at the same location without breaking. [13]

h. *In-vitro* drug release study

The in-vitro drug release study was done using an egg membrane and a diffusion tube for evaluating the release of active pharmaceutical ingredients (APIs) from formulation. The egg membrane acts as a semi-permeable barrier, mimicking biological membranes.

Procedure for *In-vitro* drug release study:

Step 1: The Diffusion Apparatus

i. A beaker (200 mL) was filled with PBS (pH 5.5) and placed on a magnetic stirrer at 37°C (to simulate body temperature).
ii. A diffusion tube (e.g., an open-ended glass tube) was used, and one end was tightly covered with the egg membrane, securing it with a rubber band or thread.
iii. The diffusion tube was placed vertically, with the membrane-covered end immersed in the PBS receptor medium inside the beaker.

Step 2: Sample Loading

i. A known quantity of the hydrogel eye patch was placed inside the diffusion tube (donor compartment).
ii. It was ensured that the egg membrane was the only barrier between the formulation and the PBS receptor medium.

Step 3: Drug Release Measurement

i. Stirring was maintained at 50–100 rpm to ensure uniform distribution of the drug in the receptor medium.
ii. At predetermined time intervals (e.g., 0, 5, 10, 15, 30, 45, 60 minutes), 10 mL of the receptor medium was withdrawn using a syringe.
iii. The withdrawn sample was replaced with fresh PBS to maintain sink conditions.

iv. The collected samples were analysed using a UV-Vis spectrophotometer at the specific wavelength of the drug. [14]

i. Stability Study

The stability study of the hydrogel eye patch was conducted by the cyclic test method. The test was performed by storing the formulated hydrogel eye patch at 4 ˚C for 24 hrs in refrigerator, followed by placing it at 40° C for 24 hrs. This cycle was repeated for 6 times. [15]

RESULT AND DISCUSSION:

Preformulation studies

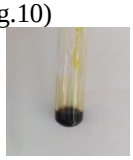
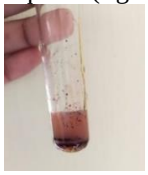
The Glycyrrhiza glabra extract underwent systematic preformulation assesments to elucidate its physicochemical profile and establish its compatibility with formulation components.

1. Organoleptic evaluation

- Colour -Reddish brown
- Texture -Liquid
- Taste - Sweet
- Odour -Distinctive, mild and pleasantly sweet aroma

2. Phytochemical Test

Table.4: Result of phytochemical analysis

Test for:	Test	Observation	Inference
Alkaloids	a) Mayers Test b) Dragendroff's Test	Formation of creamy white precipitate. (fig7.) Formation reddish brown precipitate. (fig.8)   Fig.7 Fig.8	Indicates the presence of alkaloid in extract.
Flavonoids	a) Shinoda Test b) Alkalative Test c)Ferric chloride Test	Formation of deep pink colour. (fig.9) Formation of blackish red colour. (fig.10)   Fig.9 Fig.10	Suggest the presence of flavonoids.
Saponins	Foam Test	Formation of persistent foam. (fig.11)  Fig.11	Indicates the presence of saponin.
Carbohydrate	Molisch Test	A purple-coloured ring at the junction of two liquids. (fig.12)  Fig.12	Indicates the presence of carbohydrate

3. Determination of λmax and calibration curve for hydroalcoholic extract of glycyrrhiza glabra using UV-Visible spectrophotometry

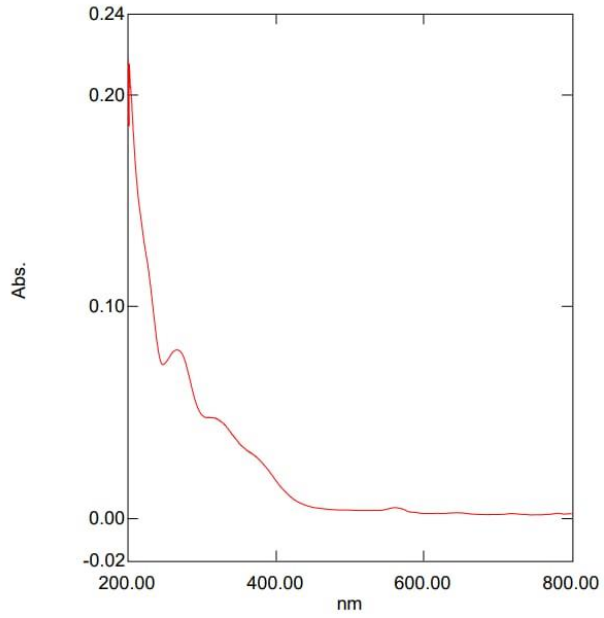


Fig.13 UV spectral analysis of *Glycyrrhiza glabra*

The UV spectroscopic analysis of Glycyrrhiza glabra extract showed a maximum absorbtion peak at 267nm.
Caliberation curve of *Glycyrrhiza glabra* extract

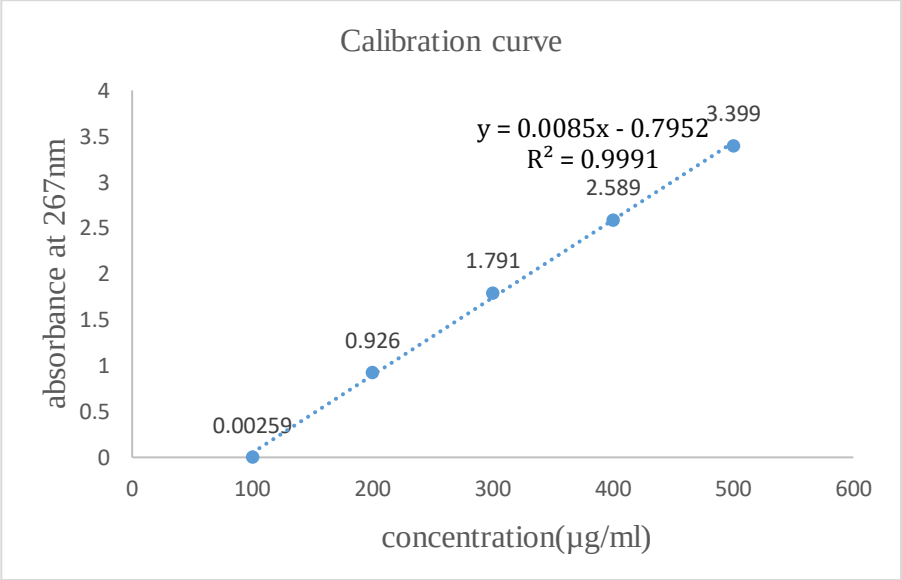


Fig.14: Calibration curve of *Glycyrrhiza glabra* extract

Conclusion

UV-Spectrophotometric analysis of glycyrrhiza glabra extract exhibited a characteristic maximum absorbance (λmax) at 267nm. Calibration studies performed using serial dilutions of the glycyrrhiza glabra extract in PBS solution demonstrated a strong linear relationship between concentrated and absorbance. The linear equation was found to be y = 0.009x – 0.77 and R^2 value was 0.993.

4. DPPH free radical scavenging assay

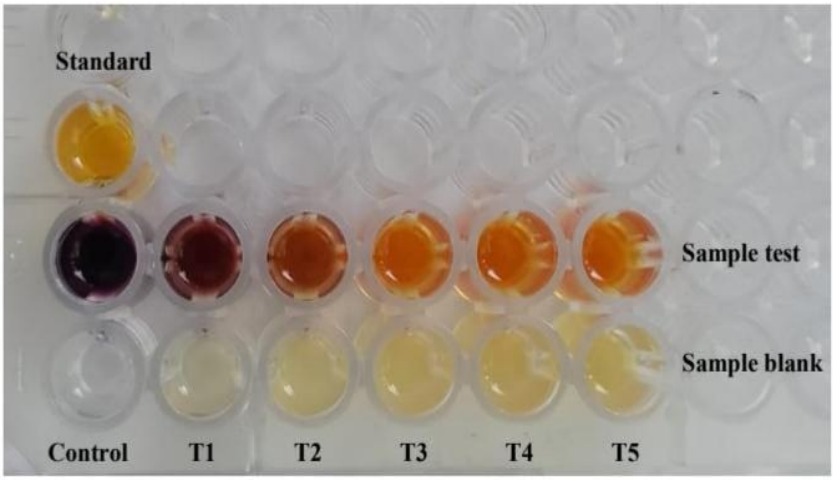


Fig.15: DPPH radical scavenging assay of sample

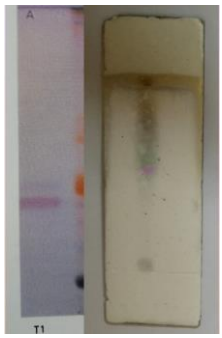
Table 5: Percentage scavenging activity of DPPH by sample

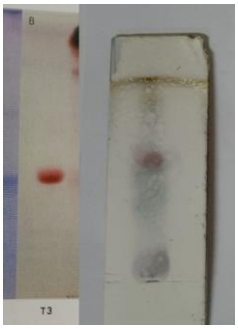
Sample name	Sample dose (µL)	Absorbance	Sample blank	Corrected OD	Radicle scavenging activity %
T1	20	0.834	0.124	0.710	54.309
T2	40	0.670	0.163	0.507	67.372
T3	60	0.448	0.174	0.274	82.367
T4	80	0.325	0.191	0.134	91.377
T5	100	0.308	0.201	0.107	93.114
Control		1.643	0.089	1.554	
Standard = 100µl 100mM ascorbic acid		0.085			94.530

The ethanolic extract of *Glycyrrhiza glabra* (LIQ10) exhibited strong DPPH radical scavenging activity, with the percentage of radical inhibition exceeding 50% at all tested concentrations. The highest scavenging activity observed was 93.114% at 100 µL, indicating potent antioxidant potential comparable to the standard ascorbic acid. The IC50 value could not be determined as the activity remained consistently high across the tested dose.

5.Thin layer chromatography

Table.6 : TLC of *Glycyrrhiza glabra* extract

Mobile phase	**Spot**	**Solvent front length**	**Distance travelled by solute**	**Rf value**	**Compound detected**
A	 Fig.16: TLC plate of glcyrrhizin	5.5	2.1	0.38	Presence of glycyrrhizin

B	 Fig.17: TLC plate of glycyrrhetic acid	5	2.5	0.44	Presence of glycyrrhetic acid
C	 Fig. 18: TLC plate of liquiritin	5.5	4.2	7.6	Presence of liquiritin

Conclusion

The study demonstrated that the hydroalcoholic liquorice extract may contain significant bioactive compounds such as glycyrrhizin, glycyrrhitenic acid, liquiritin as identified through thin layer chromatography based on matching Rf value with standard references. The presence of these compounds contributes to the antioxidant, anti-inflammatory and hydrating properties of hydrogel eye patch.

6.FTIR

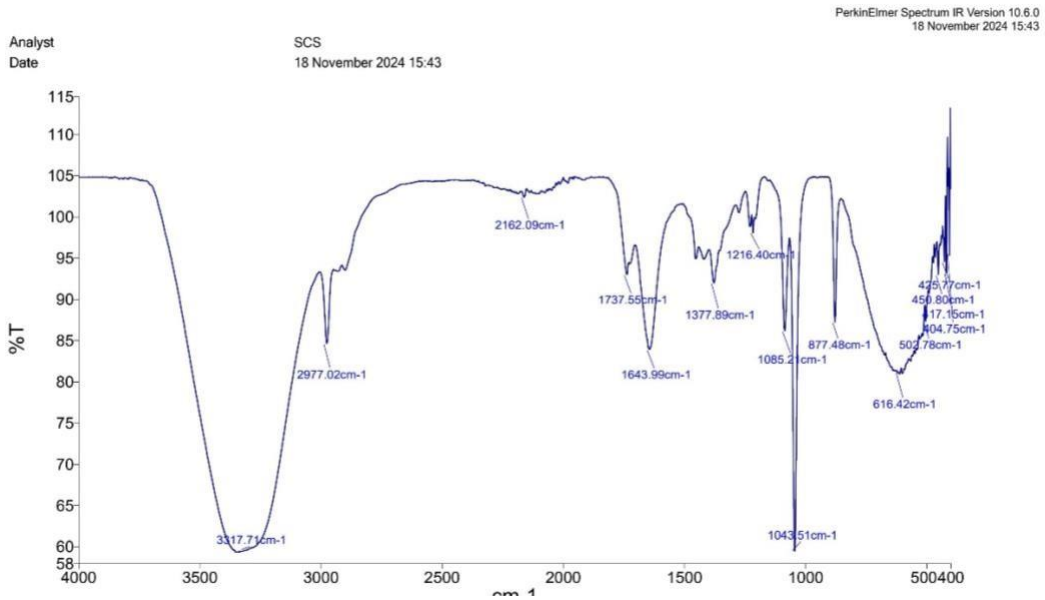


Fig.19 : FT-IR Spectra of *Glycyrrhiza glabra* extract

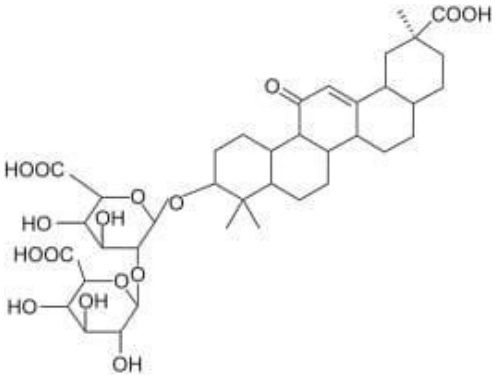


Fig.20: Structure of glycyrrhizin

Table.7: Interpretation data of FTIR spectrum of *Glycyrrhiza glabra* extract

SI No	Functional group	Frequency range	Observed frequency	Inference
1	-OH (Hydroxyl)	3000-3500	3317	Presence Cl alcoholic or phenolic -OH group
2	-C=O(Carbonyl)	1600-1650	1643	Indicate the presence carbonyl functional group
3	=C-O	1000-1200	1043	It indicate the presence of ether or ester linkage
4	-COOH (Carboxylic acid)	1200-1320	1216	Indicate the presence of carboxylic acid

Conclusion

The FTIR spectral profile of the hydroalcoholic extract of Glycyrrhiza glabra suggesting the presence of glycyrrhizin as a major constituent in extract.

OPTIMIZATION STUDY OF HYDROGEL EYE PATCH

F1 F2 F3

Table.8: Observation chart of F1 F2 F3

Test	F1	F2	F3
Colour	Pale yellow	Straw colour	Straw colour
Odour	Characteristic smell	Characteristic smell	Characteristic smell
State	Liquid	Thick liquid	Semisolid
Consistency after 3days	Sticky, difficult to remove from mould	Sticky, less difficult to remove from mould than F1	Perfect consistency for eye patch
Ease of removal from the mold	Difficult to remove	Difficult to remove	Easy to remove
Folding endurance	0	0	70



Fig.21: Day 1



Fig.22: Day 3

Based on the evaluation of setting time, appearance, ease of removal of eye patch from mould and folding endurance, the F3 formulation was found to exhibit the most desirable characteristics. Therefore, F3 was selected in the optimised hydrogel eye patch formulation for the further studies.

EVALUATION OF OPTIMIZED HYDROGEL EYE PATCH

1. Determination of pH



Fig. 23: pH meter

Data obtained from pH meter was found to be 5.7.

The formulation F3was found to be compatible with the pH of skin. Hence it selected for further process for the preparation of eye patch.

2. Determination of Viscosity



Fig.24: Atago Viscometer

Viscosity of the eye patch base was determined using Atago Viscometer.

Table.9: Data obtained from Atago Viscometer

SI no	Amount of base	Mean Viscosity
1	100mL	62,114cP

Conclusion

Viscosity of the F_3 base at room temperature was found to be 62114CP

3. FTIR-based compatibility study of Glycyrrhiza glabra extract and hydrogel excipients**.**

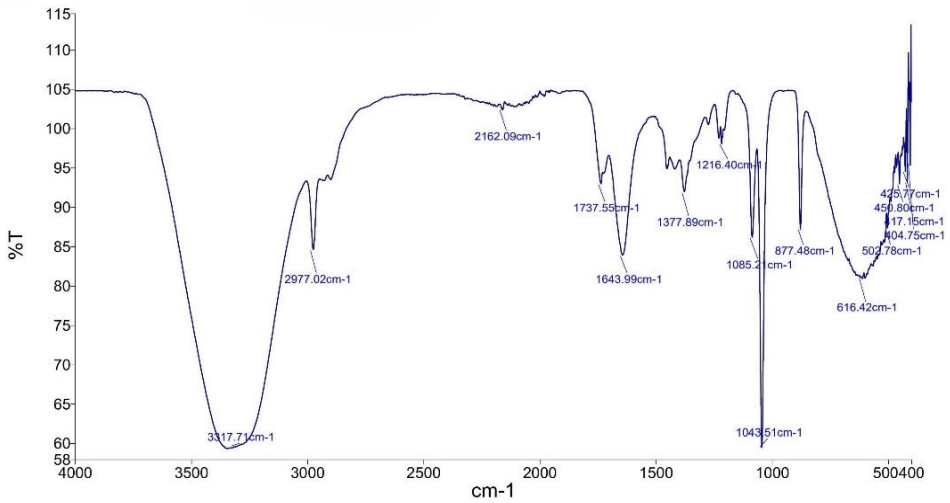


Fig. 25 FT-IR Spectra of *Glycyrrhiza glabra* extract

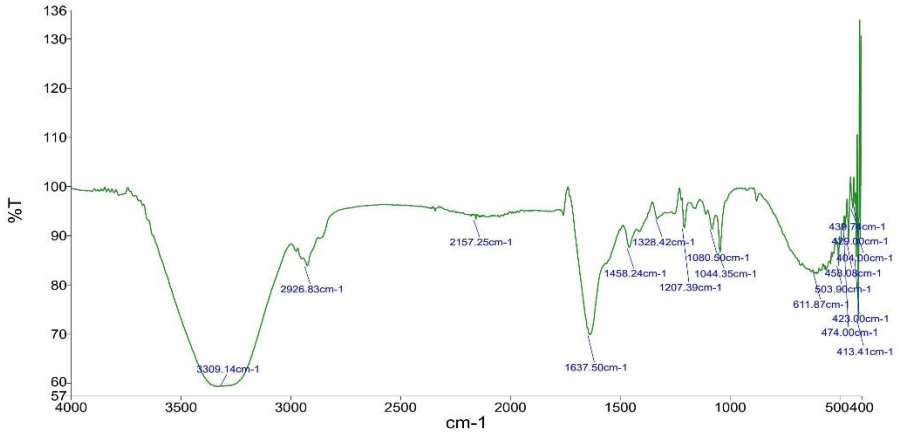


Fig.26: FT-IR Spectra of compatibility of *Glycyrrhiza glabra* extract and hydrogel excipients

Table.10: Interpretation data of FT-IR spectrum of compatibility of *Glycyrrhiza glabra* extract and hydrogel excipients

SI No	Functional group	Frequency range	Observed frequency of liquorice extract	Observed frequency range of extract loaded hydrogel eyepatch
1	-OH	3000-3500	3317	3309.14
2	-C=O	1600-1650	1643	1637
3	-C-O	1000-1200	1043	1044
4	-COOH	1200-1320	1216	1207

The FTIR based compatibility study of *Glycyrrhiza glabra* extract enriched hydrogel eyepatch revealed no significant shift or alterations in the characteristic functional group peaks of the extract. The presence of hydroxyl (-OH), ketone (-C=O), carboxylic acid (COOH) and single bonded C-O groups in both pure extract and formulated hydrogel indicates that no major chemical interactions or incompatibility occurred between the extract and excipients. These findings confirm the chemical stability and compatibility of *Glycyrrhiza glabra* extract within the hydrogel matrix ensuring that the bioactive compounds retain its structural integrity.

4. SEM Analysis

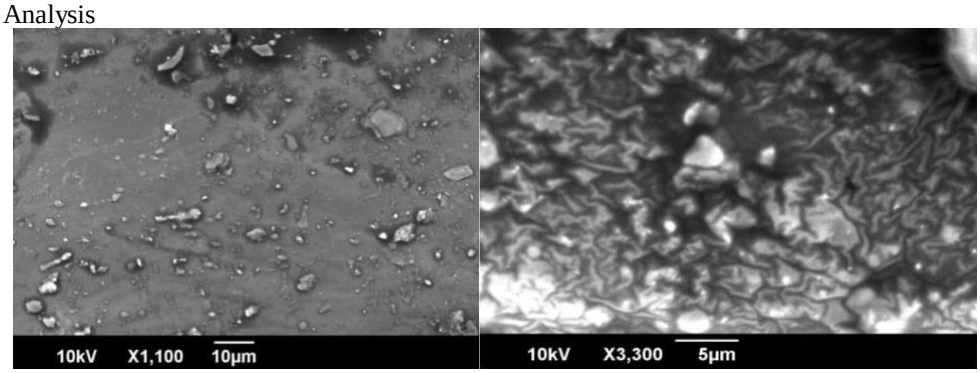


Fig.27. SEM surface morphology structure

The hydrogel eye patch exhibited a uniform surface, which suggests film forming ability and homogeneity in polymer distribution…….

5. Determination of swelling ratio

Swelling ratio (SR) = $\frac{Ws-Wd}{Wd}$

- W_s = weight of the swollen material (after absorbing fluid)
- W_d = weight of the dry material (before absorbing fluid)

$SR=\frac{1.542-0.23}{0.23}$

= 5.70

The swelling ratio was found to be 5.7

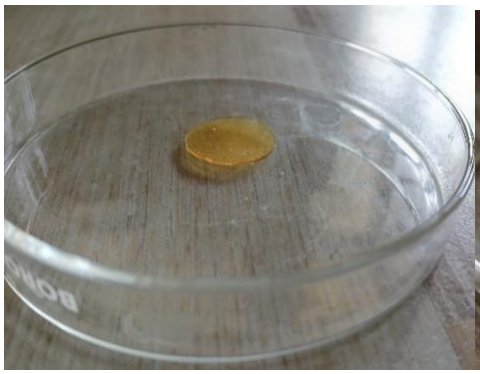


Fig.28: Before swelling



Fig.29: After swelling (24hrs)

6. Determination of Thickness

Pitch of the screw= Distance moved by the pitch scale after one complete rotation of the head scale

Least count (LC) = $\frac{pitch}{numberofdivisionsontheheadscale}$

$=\frac{1}{100}$

= 0.01

Zero error = 0

Zero correction = 0

Table 11: Thickness of hydrogel eye patch

Trial no.	PSR (Pitch scale reading)	HSR (Head scale reading)	Corrected HSR	Total reading= PSR+ (corrected HSR×LC)	Mean thickness(mm)
1	0	11	11	0.11	0.708
2	0	9	9	0.09	
3	1	10	10	1.1	
4	1	13	13	1.13	
5	1	11	11	1.11	

CONCLUSION:

The mean thickness of the hydrogel under-eye patch was found to be 0.708mm, which is within the ideal range of 0.2mm-1mm.

7. *In-vitro* Drug Release Study

In-vitro drug release studies of hydrogel under-eye patch were performed and following data were obtained.

Table 12: % Cumulative drug release

Time	Absorbance	Concentration(µg/ml)	Amount of drug per 10ml of the median (mg)	Amount of drug present in 200ml of the median (mg)	Cumulative amount of drug in 200ml	%CDR
5	0.0177	88.25	0.8625	17.65	17.65	25.34
10	0.0314	89.77	0.8977	17.954	18.8365	48.58
15	0.0412	90.86	0.9036	18.172	19.9525	60.35
20	0.0439	91.166	0.9116	18.233	20.922	69.74
30	0.0548	92.37	0.9237	18.474	22.0744	73.58
40	0.0564	92.55	0.9255	18.41	23.0323	76.774
60	0.0691	93.96	0.9396	18.792	24.2393	80.799

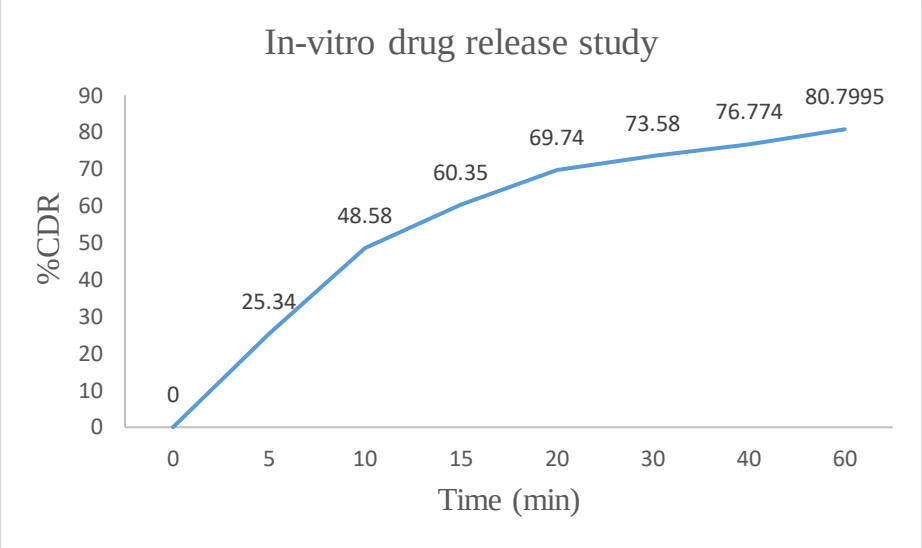


Fig.30: % Cumulative Drug Release



Fig.31: *In-vitro* drug release through egg membrane

Conclusion

The in-vitro drug release study shows a biphasic pattern, with a rapid increase up to 20minutes followed by sustained release up to 60minutes. This suggests an initial burst release of surface bound drug, followed by a controlled diffusion, making the hydrogel under-eye patch prolonged ocular drug delivery.

8. Stability Study

The stability study results showed that the hydrogel eye patch stored at 4°C , 40°C and at room temperature remained physically stable with no significant change in colour, texture or phase separation and no microbial contamination was observed.



Fig.32: Stability study at 4°C



Fig.33: stability study at 40°C

SUMMARY AND CONCLUSION:

The study successfully formulated and evaluated a hydrogel eye patch enriched with *Glycyrrhiza glabra* extract for the management of under-eye problems such as puffiness, wrinkles and dark circles. The formulation was prepared using a gelatin based hydrogel system by incorporating safe and skin compatible ingredients such as gelatin, hyaluronic acid, vitamin E and phenoxy ethanol. The evaluation studies confirmed the

presence of important phytoconstituents such as glycyrrhizin and flavonoids in the extract, which are responsible for its antioxidant and anti-inflammatory activities. The optimized patch (F3) showed desirable physicochemical properties, a compatible pH (5.7), good viscosity, uniform morphology, and a mean thickness within the ideal range. The drug release profile exhibited an initial burst followed by sustained release, ensuring both immediate and prolonged therapeutic action. Stability studies confirmed that the formulation retained its physical and functional integrity under varying storage conditions.

The results suggest that the *Glycyrrhiza glabra* hydrogel under-eye patch is an effective, natural, and safe alternative to synthetic cosmetic products for under-eye care. By avoiding harsh chemical additives, the formulation enhances consumer safety while providing therapeutic efficacy.
Future research can be directed towards refining the formulation, conducting in-vivo studies, and exploring opportunities for commercialization after confirming long-term skin and occular safety.

REFERENCE:

1) Cerulli A, Masullo M, Montoro P, Piacente S. Licorice (Glycyrrhiza glabra, G. uralensis, and G. inflata) and their constituents as active cosmeceutical ingredients. Cosmetics. 2022 Jan 5;9(1):7.
2) Tian M, Yan H, Row KH. Extraction of glycyrrhizic acid and glabridin from licorice. International journal of molecular sciences. 2008 Apr 16;9(4):571-7.
3) Meena AK, Singh A, Sharma K, Kumari S, Rao MM. Physicochemical and preliminary phytochemical studies on the rhizomes of Glycyrrhiza glabra Linn. International Journal of Pharmacy and Pharmaceutical Sciences. 2010 Jan 19;2(Suppl 2):48-50.
4) Kinghorn AD. Plant Drug Analysis. A Thin Layer Chromatography Atlas. By H. Wagner and S. Bladt (Universität München). Photographs by V. Rickl. Springer-Verlag, Brooklyn, New York. 1996. xv+ 384 pp. 19.5× 24 cm. $198.00. ISBN 3-540-58676-8.
5) Kumari A, Kumar J. Phyto-Chemical Screening of Root Extracts of Glycyrrhiza Glabra by Spectroscopic Methods (UV-VIS Spectrophotometer, FTIR & HPLC). Kumari, A., and J. Kumar.'Phyto-Chemical Screening of Root Extracts of Glycyrrhiza Glabra by Spectroscopic Methods (UV-VIS Spectrophotometer, FTIR & HPLC)'. International Journal of Pharmaceutical Sciences and Drug Research. 2019 Nov;11(6):376-81.
6) Nazzal RQ, Addai ZR. Antioxidants and antibacterial activity of Glycyrrhiza glabra extract. 2023;8(1):8-13.
7) Patil SK, Salunkhe VR, Mohite SK. Development and validation of UV spectrophotometric method for estimation of glycyrrhetinic acid in hydro-alcoholic extract of glycyrrhiza glabra. Int J Pharm Chem Biol Sci. 2012;2(4):617-21.
8) Maikovych O, Nosova N, Bukartyk N, Fihurka N, Ostapiv D, Samaryk V, Pasetto P, Varvarenko S. Gelatin-based hydrogel with antiseptic properties: Synthesis and properties. Applied Nanoscience. 2023 Dec;13(12):7611-23.
9) Riya ZS, Nair D, Abhirami JR, Abhirami JP, Ramesh NK. FORMULATION AND EVALUATION OF HERBAL HYDROGEL UNDER EYE PATCH.
10) Peter M, Jose J, Mahesh A. FORMULATION AND EVALUATION OF POLYHERBAL EYE PATCH.
11) Arshad J, Barkat K, Ashraf MU, Badshah SF, Ahmad Z, Anjum I, Shabbir M, Mehmood Y, Khalid I, Malik NS, Bin Jardan YA. Preparation and characterization of polymeric cross-linked hydrogel patch for topical delivery of gentamicin. e-Polymers. 2023 Aug 26;23(1):20230045.
12) Dewi BS, Surini S. Study on hydrogel eye mask with Centella asiatica L and Aloe vera L extract. Journal of Advanced Pharmacy Education & Research| Apr–Jun. 2024;14(2).
13) Irappanavar S, Mudalagi S, Meti B, Bhumika D, Kapali D, Yalaburgi K, Masuti S, Vijapur LS. Development and Evaluation of α-Arbutin Based Periorbital Depigmentation Hydrogel Patches for Cosmetic Application. Journal of Pharmaceutical Research International. 2025 Dec 2;37(12):101-14.
14) Akhlaghi M, Eftekharivash L, Taebpour M, Afereydoon S, Ebrahimpour M, Zarezadeh MM, Zarezadeh MM, Haghirosadat BF. Improving the therapeutic performance of glycyrrhiza glabra hydroalcoholic extract using liposomal nano-carriers and their characterization.
15) Arshad J, Barkat K, Ashraf MU, Badshah SF, Ahmad Z, Anjum I, et al. Preparation and characterization of polymeric cross-linked hydrogel patch for topical delivery of gentamicin. E-Polymers. 2023;23(1).