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Formulation and Evaluation of Aloe Vera Mediated Topical Photo Protective Cream

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ABSTRACT

This study develops and evaluates a topical photoprotective cream containing Aloe vera extract because of its established soothing and moisturizing properties along with antioxidant effects. The developers chose appropriate excipients to create a cream that offered excellent spreadability alongside stability and skin compatibility features and selected Aloe vera as the main bioactive element because of its protective potential against ultraviolet (UV) radiation. The first step in formulation involved preparing an oil-in-water emulsion base which later received Aloe vera gel addition. A series of physicochemical tests evaluated the final cream product through assessments of organoleptic properties together with pH measurements and spreadability tests and viscosity measurements and stability tests conducted under different storage conditions. The spectrophotometric method measured in vitro sun protection factor to determine the photoprotective ability of the formulation. The cream met the requirements for desirable physical characteristics and provided moderate to good UV protection according to traditional skin care practices that use Aloe vera. This study suggests that Aloe vera-based topical formulations can serve as effective, natural photoprotective agents and provide a promising alternative to synthetic sunscreens.

Keywords: *Aloe vera, photoprotective cream, topical formulation, sun protection factor (SPF), natural sunscreen, UV protection, herbal cosmetics, antioxidant, skin care, emulsion*

1. INTRODUCTION

An emulsion refers to a system where one fluid spreads through another non-mixing fluid. Surfactants enable the maintenance of phase immiscibility at the macroscopic level. The oil-in-water emulsion consists of dispersed oil droplets that float within an aqueous medium. [1] A water-in-oil, or W/O, emulsion is a system made up of water droplets scattered throughout an oil phase. [2] The food, paint, and cosmetics industries, as well as the pharmaceutical, agricultural, and petroleum industries, all make extensive use of emulsions. [3] Since the emulsion has been shown to have a number of beneficial properties that often increase the medicinal substance's bioavailability, there has been a revived interest in using it to deliver medications to the body. The components' medicinal qualities and capacity to disseminate are enhanced in an emulsion. [4] Waterin-oil emulsions are used more frequently for emollient and dry skin treatments. [5] By adding active substances with particular cosmetic benefits, these compositions can gain even more value. The inclusion of antioxidants as active components results in particularly beneficial cosmetic emulsion formulations. [6]

Traditional remedies and cosmetics together with health foods rely on aloe vera as one of their main ingredients. The medicinal properties of aloe extract compounds display various functions including anti-inflammatory activities and antioxidant properties together with anti-aging effects and anti-cancer abilities and immunomodulatory effects which work through ROS levels. Research for stable and active antioxidants extracted from natural origins has increased substantially because of rising safety concerns about synthetic commercial antioxidants. Research has explored the antioxidant effects of aloe vera leaves because of their traditional medicinal use. Previous laboratory research by our team established that prolonging the extraction procedure of A. vera leaves through ethanol affected both product concentration and antioxidant properties. The literature from [8] demonstrates that Aloe effectively addresses stomach ulcers and wounds and burns. Studies have shown that Aloe vera demonstrates its ability to block cancer cells while helping diabetes patients and inhibiting the enzyme tyrosinase. Aloe gel's ability to hydrate skin remains a widely recognized fact. Scientific studies demonstrate that the main ingredient in filet gel is aloe vera polysaccharides especially acetylated mannans together with small amounts of multiple additional components. Arbutin acts as a competitive inhibitor but aloesin employs noncompetitive inhibition to

reduce human tyrosinase activity. The healing process benefits from zinc and amino acids vitamin E and vitamin C (ascorbic acid) which naturally exist in aloe vera. [9] The suppression of cross-linkage promotes normal wound recovery while lysosomal enzymes need stabilization to synthesize collagen. [10]. Vitamin E which is fat-soluble exists as an antioxidant in Aloe vera products. Normal wound healing benefits from blocked cross-linkage while lysosomal enzymes need enzyme stabilization to synthesize collagen. The research team at their laboratory proved that adding zinc to wounds increased their tensile strength which led to better healing outcomes. [11] The purpose of this study was to create a W/O cream containing aloe vera extract and assess its impact on skin hydration.

1.2 Benefits of *Aloe vera*

- Ayur herbals cream with aloe vera's high concentration of natural lubricants slows the pace at which water leaves the skin by forming a thick film of moisture on the epidermis. Natural moisturizing elements found in aloe vera aid in hydrating and calming the skin.
- The antioxidants in aloe vera protect skin from free radical damage while benefiting its health. The soothing properties of aloe vera help minimize skin irritation and reduce redness.

Figure 1: Freshly cut Aloe vera leaf with exudate

2. MATERIAL AND METHODS

2.1 Preformulation study

The pre-formulation phase of drug development involves assessing the drug's physical attributes and content before production. This evaluation helps identify the appropriate dosage and administration method, as well as the chemical and physical characteristics of the medication. Analytical techniques like infrared, UV, and melting point spectroscopy were used to identify the drug sample. The study also examined the solubility, partition coefficient, and drug-excipients interaction using FT-IR spectra, identifying any physical differences or incompatibilities [12].

2.2 Preparation of Emulgel

The research team prepared multiple formulations through the use of gelling agents at different concentrations. The emulsion preparation steps remained identical across all formulations. The gel phase of the formulations emerged through continuous stirring at 100 RPM and 37 C of Carbopol 934 solution in purified water. The emulsion's aqueous phase included dissolved Tween 20 in purified water while span 80 created the oil phase by dissolving it in light liquid paraffin. A mixture of propylene glycol and water was used to create solutions containing methyl and propyl parabens and extract. The aqueous phase received both solutions after combination. The single phases of oil and water underwent independent heating at 70–80 degrees Celsius prior to slowly combining the oil phase into the water phase while continuous stirring occurred until the mixture reached room temperature. The emulgel production process involved mixing the emulsion with gel while maintaining a slow stirring motion. Table 1 discusses the makeup of several formulations [13].

Table 1: Preparation of Emulgel

Ingredient	F1	F2	F3	F4	F5	F6	F7	F8
Extract (mg)	100	100	100	100	100	100	100	100
Carbopol 934 (mg)	100	150	200	250	100	150	200	250
Light Liquid paraffin (mg)	500	550	600	750	800	850	900	950
Tween 20 (mg)	50	50	50	50	-	-	-	-
Span 80 (mg)	100	100	100	100	100	100	100	100
Tween 80 (mg)	-	-	-	-	50	50	50	50
Propylene glycol (mg)	500	500	500	500	500	500	500	500
Methyl parabene (mg)	30	30	30	30	30	30	30	30
Propyl parabene (mg)	10	10	10	10	10	10	10	10
Water (ml)	20	20	20	20	20	20	20	20

2.3.2 Extractive Value

The extractive value determination required 10 grams of Aloe barbadensis powder which was added to a Soxhlet apparatus with 400 milliliters of Petroleum Ether solvent for two hours of settling time. The extraction process included drying the wet sample at 65°C within a hot air oven. It was then treated with 400ml of n-hexane, 400ml of methanol, and 400ml water to determine its extractive value, which was computed, based on the sample's weight gain and represented by the following equation.

$$Extractive\ value = \frac{Final\ weight\ obtained}{Initial\ weight\ of\ Solvent} \times 100$$

2.4 Evaluation of Plant Extracts

2.4.1 Percentage Yield

The calculation of percent yield involves comparing the obtained product amount to its theoretical maximum yield. It is calculated using the following formula, where the actual yield is divided by the theoretical yield:

$$Percentage\ yield = \frac{Final\ weight}{Initial\ weight} \times 100$$

2.5 Screening of Phytochemical Components for the plant Extract

Following standard procedures, a preliminary phytochemical analysis was performed on the methanolic extract.

2.5.1 Detection of Alkaloids

- **Mayer's test:** Analysis using Mayer's reagent detected alkaloids through the formation of yellow cream precipitates.
- **Wagner's test:** The extract demonstrated positive results for alkaloids when combined with Wagner's reagent because it generated brown or reddish-brown precipitates.

2.5.2 Detection of Flavonoids

- **The test of alkaline reagents**. The process involved adding two to three drops of sodium hydroxide solution to two milliliters of extract during this step. Flavonoid compounds in the test solutions caused the yellow color to fade after HCL solution was added to sodium hydroxide solutions.
- **H2SO4 test:** A limited drop of H2SO4 solution served for extracts analysis. An orange solution coloration reveals the presence of flavonoids in the test material.

2.5.3 Detection of Steroids

A mix of two milliliters acetic anhydride and five milliliters extract solution required two milliliters H2SO4 solution per two milliliters solution. Steroids show their presence through blue or green coloration when added to the mixture.

2.5.4 Detection of Terpenoids

To detect terpenoids mix 5 ml of plant extract with 2 ml of chloroform followed by gradual addition of 3 ml of concentrated H2SO4 to form reddish-brown layers.

2.5.5 Detection of Anthraquinones or glucosides

The Borntrager Glycoside test requires dissolving 0.5 milligrams of plant extract in one milliliter of water followed by adding an aqueous NaOH solution. Glycoside presence becomes visible when a yellow tint appears.

2.5.6 Detection of Phenols

- **Litmus Test:** The basicity or acidity of the provided solution was determined by testing with litmus paper. Base solution application results in both the preservation of blue color for blue litmus paper and the transformation of red litmus paper into blue. The exposure of phenols to blue litmus paper leads it to turn crimson. Through this test Phenol demonstrates its acidic nature.
- **Ellagic acid test:** Plant extract samples required one milliliter and were combined with 5% glacial acetic acid before adding a few drops of 5% NaNO2 solution. A muddy brown color formed in the test samples confirmed their content of phenols.

2.5.7 Detection of Saponins

- **Foam Test:** The extraction procedure combined 0.5 ml of extract solution with 5 ml of distilled water. When extract samples generate creamy bubble formations or foaming effects it indicates the presence of saponins.

2.5.8 Detection of Tannins

- **Alkaline reagent test:** Plants samples received two milliliters of 1N NaOH solution followed by two milliliters of plant extract. The tannins could be identified when they turned the solution into yellow or red colors.

2.5.9 Detection of Carbohydrates

Before filtering each 0.5 ml extract received 5 ml of distilled water as dilution. A test checked for the carbohydrate presence in the plant extract filtrate.

- **Molish Test:** A test tube was used to mix equivalent amounts of test solution with Molisch's reagent. Boiling the mixture under a boiling water bath lasted for five minutes. The detection of diminished sugar concentration became visible through the formation of violet or purple color rings.

- **Fehlings Test:** One milliliter of Fehling solution A and B was mixed before boiling the mixture for one minute. The aforesaid combination was now mixed with an equal volume of test solution. For five to ten minutes, the solution was boiled in a boiling water bath. A yellow precipitate was seen first, followed by a brick-red one.

2.5.10 Detection of Protein & Amino acids Biuret test

The experimental procedure included combining 0.5 milliliters of extract with equal amounts of 40% NaOH solution and two drops of 1% copper sulphate solution. The appearance of violet color indicates the presence of protein in the solution.

- **Ninhydrin test:** The extract received two drops of 0.2% Ninhydrin solution that had just been prepared while the mixture reached boiling temperature. A pink or purple color indicates that proteins, peptides, or amino acids are present in the solutio.

2.3 Evaluation of Emulgel of *Aloe Vera*

2.3.1 Physical appearance [14]

The researchers visually inspected new gels while observing the physical properties including color and homogeneity of the generated formulas.

2.3.2 pH

A single gram of gel was distributed evenly across the 100ml water compartment. A digital pH meter served to assess the pH level of the dispersed solution.

2.3.3 Viscosity

The main instrument for rheological behavior evaluation conducted a Viscosity Viscometer assessment. The L-4 spindle rotated at five revolutions per minute to determine dial readings after the sample reached equilibrium while soaking in the beaker for five minutes. The experiment recorded the viscometer's dial reading that matched this velocity. The research team noted down the dial readings at every step of reducing spindle speed.[15]

2.3.4 Spreadability

The following method was used to assess the gel's spreadability: The 0.5 g gel was covered with a second glass plate positioned according to a pre-identified circle with 1 cm diameter. The top glass plate received a 500 g weight as it rested for five minutes. The gels showed expansion resulting in an increased diameter.

$$S = m\,l / t \ldots\ldots\ldots\ldots\ldots\ldots Eq\ (1)$$

The spreadability variable S gets calculated from the formula S = m l / t using weights m and glass slide length l over time t [16].

2.3.5 Drug content

The drug content determination method required dissolving 1gm precise gel weights containing 5mg drug concentration using a 100 ml volumetric flask with solvent. A HPLC instrument enabled researchers to determine the medication content [17].

$$\text{Drug Content} = \text{Drug concentration/theoretical value of drug} * 100$$

2.3.6 FTIR Study

An optimised formulation underwent FTIR spectral analysis using FTIR spectroscopy.

2.3.7 In-Vitro Drug Release Study [18]

Franz diffusion cells ran tests at 37º C ± 5º C while dialysis membranes soaked in 40% ethanol solution throughout an overnight period. The experimental setup featured 5mg of extract weight equivalent to 1g of sample for drug release evaluation by using membranes within cells containing phosphate buffer at pH 7.4 in the donor and receptor chambers. The magnetic stirrer operated at 37°C to provide agitation for the receptor medium while maintaining its temperature constant. A sampling device collected 2 ml of receptor solution from predefined time points including 0.08 through 0.25, 0.5, 1, 2, 3, 4, 6, 8,10, 12 and 24 hours. Fresh receptor solution then replaced the used aliquots. The periodic sampling intervals collected solutions which underwent HPLC analysis. Multiple testing rounds were performed.

2.3.8 Drug release kinetic studies

The pharmacogenetic assessment included microscopic evaluation and organoleptic assessment and preliminary phytochemical screening. Drug release prediction utilized Korsmeyer-Peppas equation together with Higuchi's model accompanied by First-order equation and Zero-order equation. The zero-order prediction required the equation $At = A0 – K0t$ and the first-order estimation needed $Log\ C = Log\ C0 – Kt/2.303$. The classical diffusion equation $Q = [D\varepsilon/\tau\ (2A – \varepsilon Cs)]\ Cst1/2$ explains matrix device diffusion according to Higuchi's model. The Korsmeyer-Peppas model serves to analyze controlled release polymeric matrix kinetics by evaluating $Q = K1tn$. The slope for Fickian release matches 0.45 while anomalous transport ranges from 0.45 to 0.89 and zero-order release maintains a slope of 0.89.

3. RESULTS AND DISCUSSION

3.1 Pharmacogenetic Activity

Scientists at Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan verified the plant powder obtained from Hamirpur district. The pharmacogenetic examination of the plant involved both microscopic examination and organoleptic testing and initial phytochemical screening. The powder's characteristics included a brown coarse powder, slightly pungent flavour, and bitter taste.

3.1.1 Microscopic study of Plant extracts

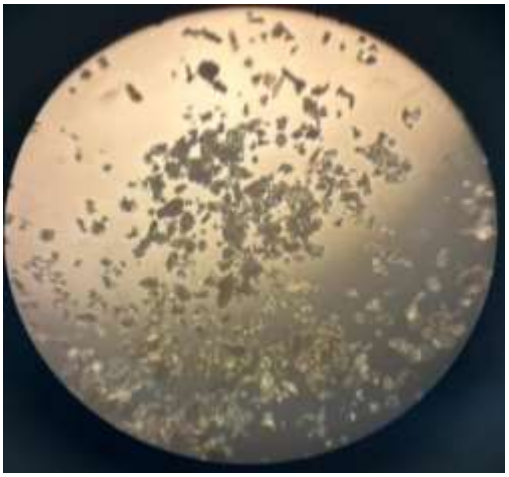

Figure 2: Powder microscopy of *Aloe barbadensis*

Discussion: A microscopic analysis determined the state of plant extract particles after grinding. Under microscopic study the sample exhibited small vesicle-like structures that showed evidence of glycosides along with granulated particles which indicated the presence of flavonoids. The detected compound belongs to the pyranopyridine group that contains fused structures of pyran rings bonded to pyridine rings. The powder presented crystalline calcium oxalate clusters along with primarily simple starch granules but showed occasional compound forms. A microscopic analysis revealed the presence of trichomes that existed as single cells or multicellular structures with a single row.

3.2 Extraction and Analysis

3.2.1 Extraction of plant extract will be done by continuous Soxhlet method

Figure 3: Soxhlet apparatus

3.2.2 Percentage Yield and Extractive Value of the extracts

Table 2: Percentage Yield and Extractive Value of the extracts

Sr. No.	Name of Extract	Petroleum Ether (%)	n- Hexane (%)	Water (%)	Methanol (%)
01	*Aloe barbadensis*	**Extractive Value**	**Extractive Value**	**Extractive Value**	**Extractive Value**

		0.035 ± 0.004	0.015 ± 0.008	0.378 ± 0.018	0.470 ± 0.011
		Percentage Yield	**Percentage Yield**	**Percentage Yield**	**Percentage Yield**
		1.425 ± 0.147	0.403 ± 0.020	15.436 ± 0.401	20.647 ± 0.611

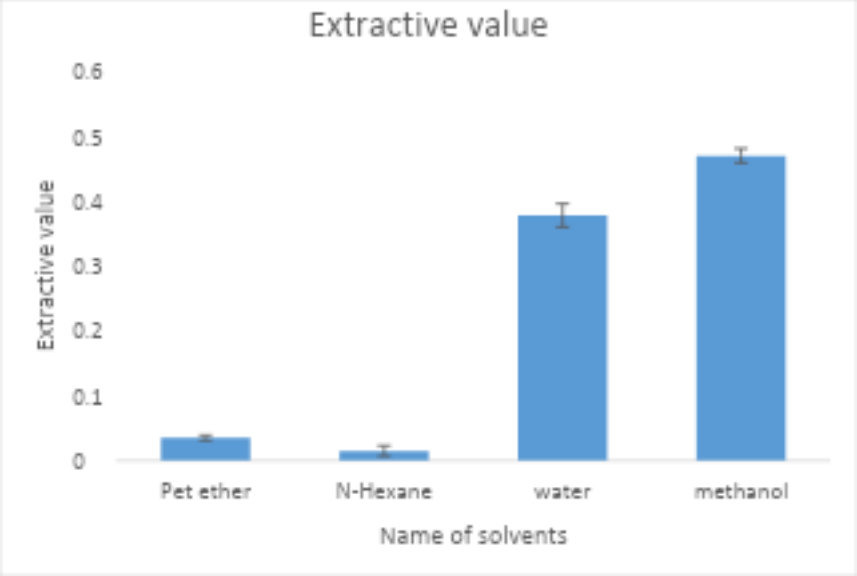

Figure 4: Extractive value of Aloe barbadensis in different solvents

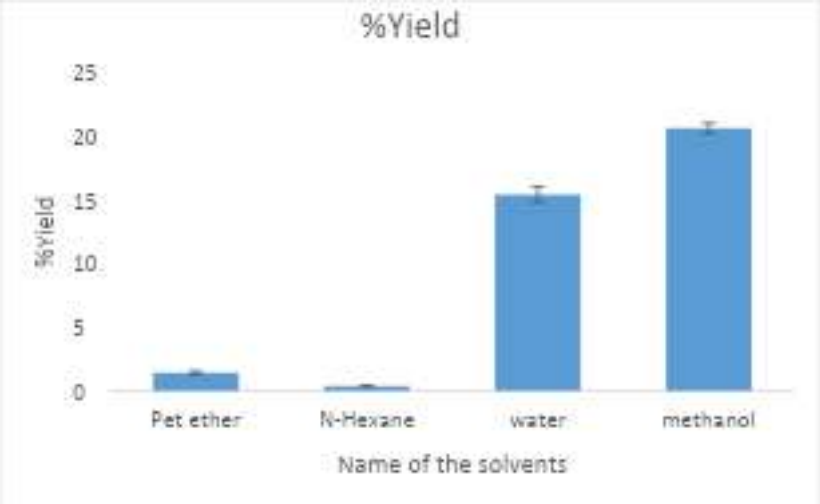

Figure 5: Percentage yield of Aloe barbadensis in different solvents in different solvents

Discussion: The extractive value and percentage yield of *Aloe barbadensis* varied significantly with solvent polarity. Methanol showed the highest extractive value (0.470 ± 0.011%) and yield (20.647 ± 0.611%), followed by water, indicating that most phytoconstituents are polar. In contrast, petroleum ether and n-hexane, being non-polar, showed much lower values. The extraction data indicates that methanol represents the best solvent for retrieving active metabolites from Aloe barbadensis.

3.2.3 Screening of Phytochemical Components of the methanolic Extract of Aloe barbadensis

Table 3: Screening of Phytochemical Components of the methanolic Extract of Aloe barbadensis

S.NO.	Phytochemicals Test	Test Name	Methanolic Extract of Aloe barbadensis
1	Alkaloids	Mayer's test	+++
		Wagner's test	++
2	Flavonoids	Alkaline reagent test	+++
		H_2SO_4 test	++
3	Steroids	Steroids	_ _
4	Terpenoids	Salkowski's Test	++
5	Glycosides-Anthraquinones	Borntrager's Test	_ _
6	Phenols	Litmus test	++
		Ellagic acid test	++
7	Saponins	Foam Test	+++
8	Tannis	Alkaline reagent test	_ _
9	Carbohydrates	Molish Test	++
		Fehlings Test	++
10	Amino Acid	Ninhydrin Test	+++

3.3 HPLC

3.3.1 Determination of chromatogram of Blank & Standard Quercetin

According to the provided approach, the HPLC analysis of the standard solution of quercetin at 1000µg/ml was optimized. The HPLC analysis of the chromatograms of a blank and a standard is shown in Figures 3.5 and 3.6.

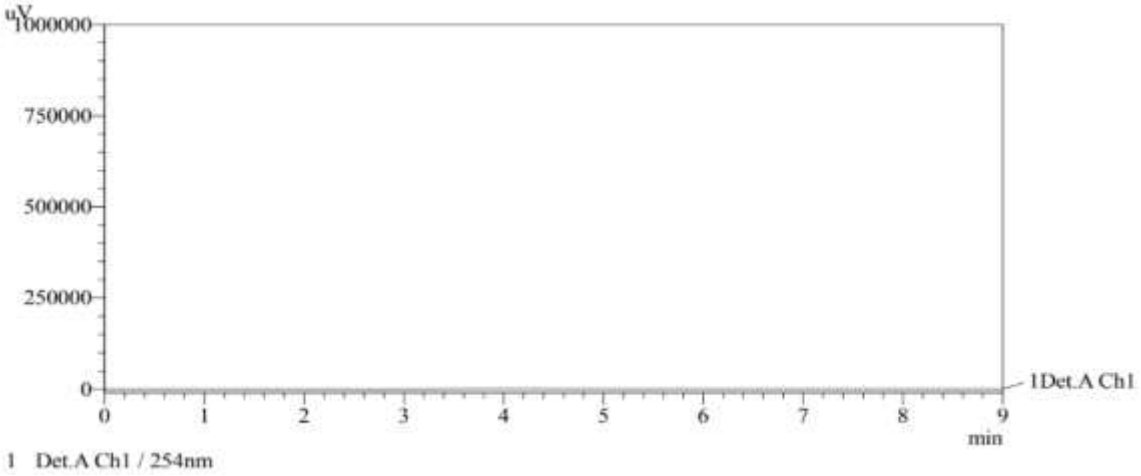

Figure 6: Chromatogram of Blank

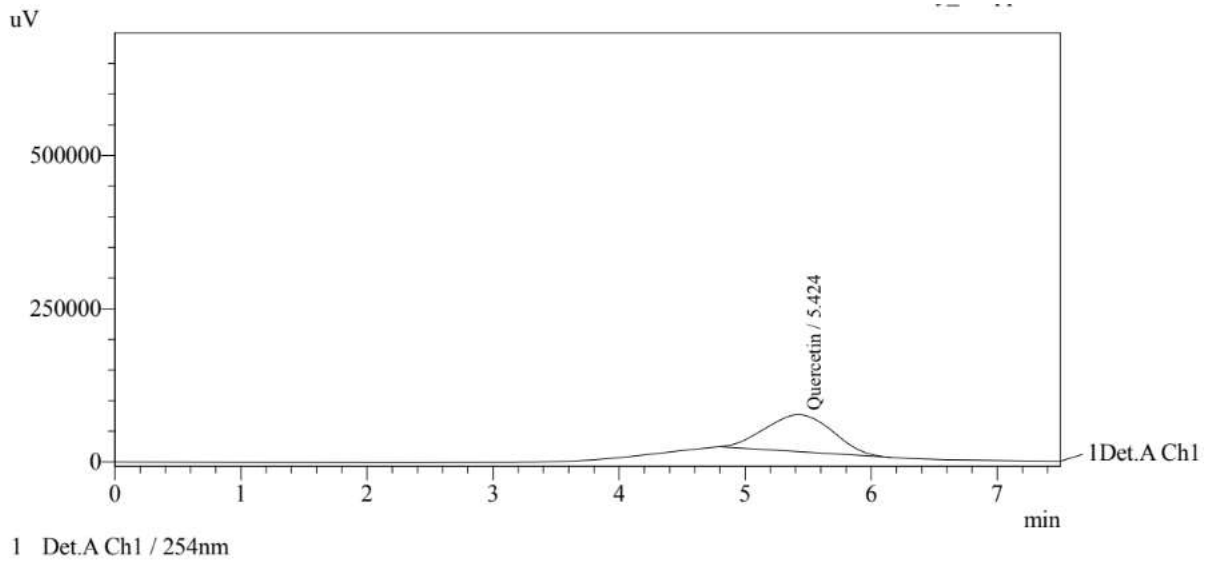

Figure 7: Chromatogram of quercetin

3.3.2 Preparation of standard curve of Quercetin

Table 4: Calibration curve of Quercetin (λ_{max}= 254nm)

Sr.no.	Concentration (µg/ml)	Area
1	20	442699±4299.22
2	40	872142±4264.82
3	60	1344940±5537.38
4	80	1875982±2499.58

5	100	2345674±8417.83
6	120	2802622±3459.48

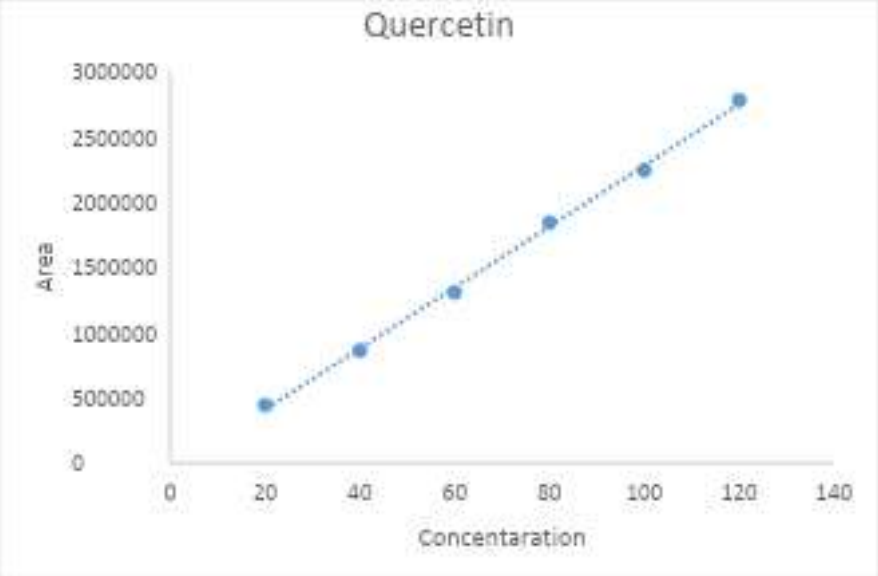

Figure 8: Graph of standard calibration curve of Quercetin

Table 5: Result of regression analysis for estimation of Quercetin

Statistical parameters	Results
λ max	254nm
Regression equation: y=mx+ C	Y = 23374x - 57201
Slope (m)	23374
Intercept (C)	57201
Correlation coefficient (r^2)	0.9984

Discussion: - Researchers created a calibration curve of Quercetin at concentrations ranging from 20 to 120 µg/ml. The curve produced displayed an excellent linear pattern using the regression model Y = 15550x + 683341 while maintaining a correlation coefficient (R^2) of 0.9976 as shown in Figure 3.7.

3.4 FTIR of methanolic extract of Aloe barbadensis

3.4.1 FTIR of methanolic extract of Aloe barbadensis

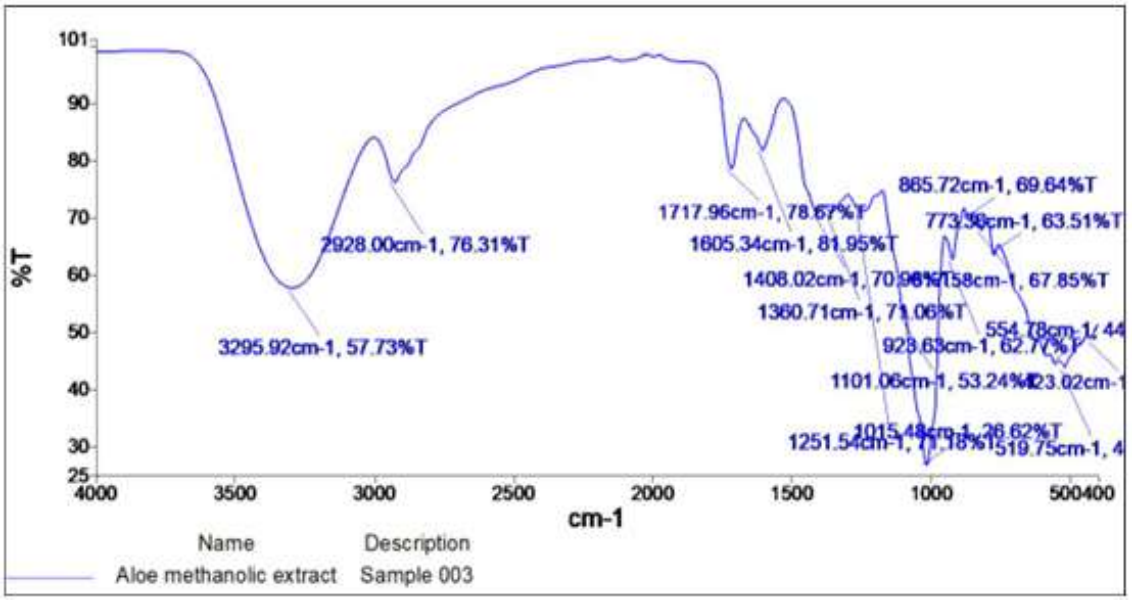

Figure 9: FTIR spectrum of methanolic extract of Aloe barbadensis

Table 6: Interpretation of FTIR spectrum of methanolic extract of Aloe barbadensis

Reported peak (cm^{-1})	Observed peak (cm^{-1})	Functional group
3265	3295.92	–OH stretching
2922	2928.00	-CH^2 stretching
1602	1605.34	C=O stretching vibration
1401	1408.02	COO groups vibrations

Discussion: The FTIR spectra for the methanolic extract of Aloe barbadensis can be found in figure 3.8 along with table 3.8. The principal IR absorption peaks of methanolic extract of *Aloe barbadensis* were observed at 3295.92cm^{-1} (–OH stretching), 2928cm^{-1} (- CH^2 stretching), 1605.34cm^{-1} (C=O stretching vibration) and 1408.02cm^{-1} (COO groups vibrations) were all observed.

3.5 Evaluation of Emulgel

3.5.1 Physical Appearance

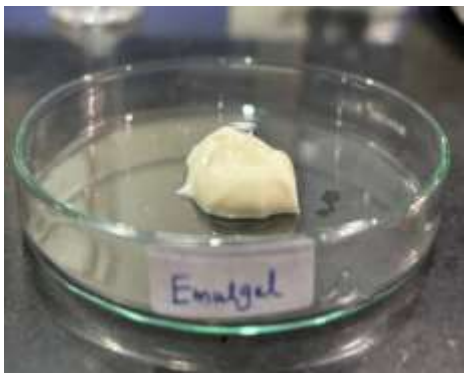

Figure 10: Visual Appearance of Emulgel

Discussion: The prepared gel displayed a well-ordered texture that was uniform throughout its structure. The formulations in F1 through F8 demonstrated uniform distribution without any noticeable clumps or irregularities throughout. Analysis proceeded with the batches that displayed this consistent appearance.

3.5.2 pH, Viscosity, Spreadability and Drug content

Table 7: pH, Viscosity, Spreadability and Drug content of Formulations F1 to F8

Sr. No	Formulation Code	pH	Viscosity(cPs)	Spread ability	%Drug Content
1	F1	5.91±0.03	2012±0.781	16.190±0.585	85.62±0.06
2	F2	5.93±0.01	2671±0.947	8.289±0.572	88.20±0.63
3	F3	5.90±0.02	2923±0.115	11.457±0.564	96.91±0.650
4	F4	6.15±0.05	3483±0.502	9.419±0.572	87.57±0.996
5	F5	6.06±0.05	2198±0.345	4.310±0.427	84.94±0.917
6	F6	6.07±0.06	2782±0.387	10.511 ±0.564	82.63±0.914
7	F7	5.87±0.07	3235±0.123	6.144±0.594	80.26±0.165
8	F8	5.65±0.04	3673±0.429	10.511±0.563	77.45±0.594

Discussion: The evaluation of emulgel formulations (F1–F8) showed that all formulations had pH values ranging from 5.65 to 6.15, suitable for topical application without skin irritation. Viscosity increased with higher polymer concentration, with F8 showing the highest viscosity (3673 cPs). Spreadability was inversely related to viscosity; formulations with lower viscosity like F1 and F5 showed higher spreadability, while F4 and F8 had the lowest. Drug content varied from 77.45% (F8) to 96.91% (F3), indicating formulation F3 had optimal drug retention with acceptable viscosity and pH, making it the most promising among the tested batches.

3.5.3 FTIR

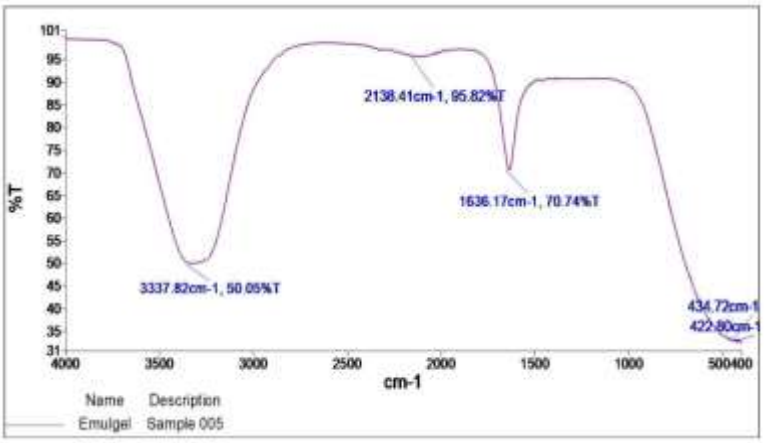

Figure 11: FTIR of Formulation F3

Discussion: The Emulgel formulation contains functional groups consistent with expected components, such as gelling agents, emulsifiers, and solvents. The presence of hydroxyl and carbonyl groups suggests hydrogen bonding and polar interactions, contributing to the stability and performance of the emulgel.

3.5.4 In vitro drug release studies

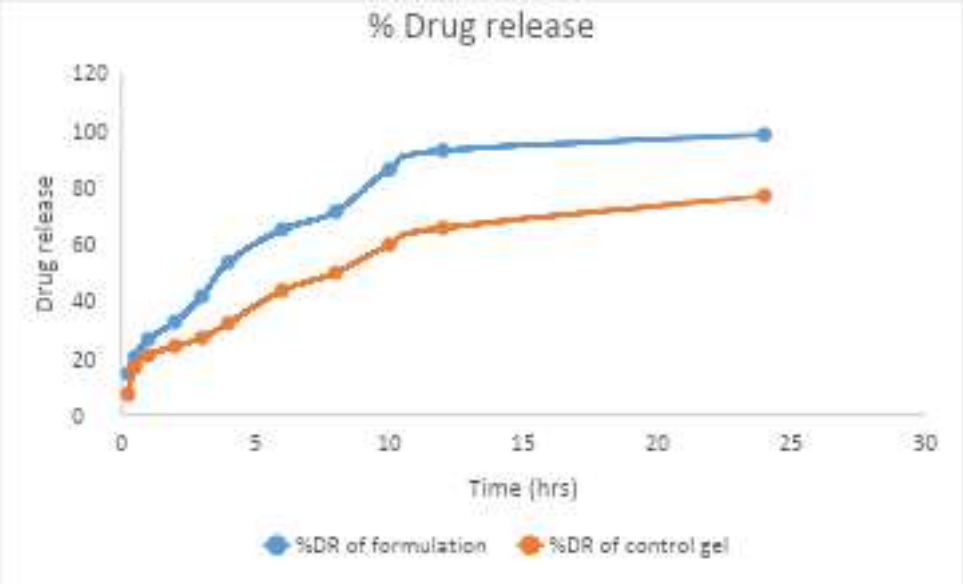

Figure 12: Percentage Drug Release of Emulgel and Control Gel (Quercetin) Formulations

Result: The drug release profiles of both the Emulgel formulation along with its control gel containing quercetin are shown in Table 3.17 together with Figure 3.19. During a 24-hour period the control gel released 76.82 ± 0.12% of the quercetin content. The P4 gel demonstrated a higher extraction level through its 98.22 ± 0.12% release of extract content during 24 hours in phosphate buffer at pH 7.4.

3.5.5 Drug Release kinetics

Table 8: Kinetic equation parameter of formulation F3

Formulation Code	Zero order		First order		Higuchi		K. Peppas	
	K_0	R^2	K_0	R^2	K_0	R^2	K_0	R^2
F3	4.0964	0.7643	-0.0524	0.3072	22.43	0.9507	0.4576	0.9821

Several mathematical models helped forecast medication release patterns. For the optimized formulation, graphs were generated based on four kinetic models: (1) Zero-order, plotting the percentage of drug released versus time; A drug release study employed four mathematical models including (1) Zero-order, with percentage drug release against time and (2) First-order using drug remaining percentage in logarithmic form, (3) Higuchi model based on percentage release and square root of time, (4) Korsmeyer-Peppas model using percentage release and logarithmic time.

The graph's R2 value was determined for each instance and is shown in Table 8. The Korsmeyer and Peppas Model

(R2=0.9821) was determined to best match the release data when the determination coefficients were considered. The findings suggested that a sustained process was responsible for the herbal extract's release from Emulgel.

4. CONCLUSION

Research work created and tested a topical photoprotective cream that included Aloe barbadensis extract which has antioxidant and skin-relaxing capabilities because of its phytoconstituents such as flavonoids vitamins and polysaccharides. The research team used an O/W emulsion base to formulate a cream which received Carbopol 934 as stabilizing gelling agent that improved spreadability while increasing patient adherence to treatment. The obtained extract used Soxhlet extraction to yield a product containing quercetin as confirmed by phytochemical screening and HPLC analysis of the extract which demonstrated both UV-protective and antioxidant functionalities. FTIR tests verified that the extract blended well with all formulation components. The cream formulation testing revealed satisfactory results for organoleptic characteristics while the pH testing alongside spreadability tests and measurements of viscosity and drug content demonstrated suitable physical characteristics with extended drug release properties. Studies show that Aloe vera-based topical creams appear to function successfully as natural and secure photoprotective agents. Overall, the study supports the use of herbal ingredients in dermatological preparations and provides a foundation for further investigation and optimization for commercial application

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