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Research Article

Development and Characterization of Salicylic Acid Film Forming Gel for the Treatment of Hyperkeratotic and Scaling Disorders

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ABSTRACT

Skin problems known as hyperkeratotic diseases are characterized by red, dry, cracked, and scaling skin, and they can be treated by using salicylic acid through topical application. The purpose of this study is to create and characterize a salicylic acid film-forming of hydrophilic polymers for the treatment of hyperkeratotic and scaling disorders that have wipe-off resistance, longer retention at the treatment site and is simple to spread and apply to the skin in to overcome the disadvantages of conventional topical formulation. The film-forming gel is prepared with HPMC E15, Carbopol 934, propylene glycol, water, ethanol, and the drug. It is then optimized using 2^2 factorial designs and is characterized by its physical characteristics, pH level, spreadability, drug content, rheological study, in vitro drug release, drying time, mechanical properties of the film, and other factors. Salicylic acid film-forming gel stability, skin irritancy, *ex-vivo* permeation, and skin retention were also investigated. For certain tests, every formulation produces the expected results. The optimization analysis found that viscosity increases and drug release decrease when HPMC E15 and Carbopol 934 concentrations rise. The improved formulation had a viscosity of 47.6 ± 1.23 cp and a 90.23 ± 2.01% drug release. It is concluded that salicylic acid film-forming gel is efficiently produced with hydrophilic polymers and creates thin, protective, emollient, and water-soluble film to treat hyperkeratotic and scaling diseases.

Introduction

The beta hydroxy acid salicylic acid was first separated from salicin in the middle of the 18th century. By exfoliating the skin and preserving wide pores, it is recognized for minimizing acne. There are two potential mechanisms by which topical salicylic acid acts, both of which result in the desquamation of corneocytes. By dissolving the intercellular cement material, salicylic acid decreases the horny cells' intercellular cohesion. Additionally, it helps to facilitate desquamation by solubilizing the intercellular cement material in the stratum corneum. Salicylic acid is used topically to treat hyperkeratotic and scaling skin diseases such as dandruff and seborrheic dermatitis, ichthyosis, psoriasis, and acne because of its keratolytic effects. It also possesses anti-inflammatory and anti-pruritic properties.[1-3]

The need to rub, poor adherence to the skin, poor permeability, easily wiped off due to sweat, clothing, movements, and getting easily washed away on contact with water, and not keep the drug on your skin for a too long period, are some issues with a conventional topical formulation like ointment, cream, and gel that have limited the effectiveness or require oral therapy as a supplement. This is why film forming gel (FFG), a semisolid dosage form, was developed, which is a semisolid dosage form that forms a film on body surface and may allow for less frequent administration by keeping close touch with the skin for an extended length of time to increase patient compliance.[4,5]

In order to overcome the drawbacks of conventional topical formulation, the goal of this work is to develop and characterize a salicylic acid film-forming gel for the

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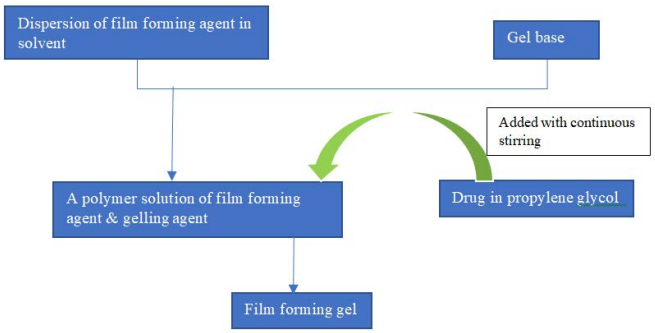

Fig. 1: Method of Preparation for FFG

treatment of hyperkeratotic and scaling disorders that have wipe-off resistance, longer retention at the treatment site, is easy to spread, and forms a thin, protective, emollient, and water-soluble film on skin when applied.

MATERIALS AND METHODS

Materials

Loba Chemie, Mumbai, supplied salicylic acid, HPMC E15 (hydroxypropyl methylcellulose), and propylene glycol. From Akhil Healthcare (P) Ltd. in Vadodara, Gujarat came a gift of carbopol 934. The Mumbai Research Lab is where ethanol was acquired.

Methods

Preparation of Film-Forming Gel

HPMC E15 was sprinkled into a beaker with a solvent combination containing ethanol and water and served as a film-forming agent. In another beaker, water was given a sprinkle of carbopol 934 as a gelling agent. To prevent evaporation and to prevent the production of air bubbles, both beakers were covered with aluminum foil and left to swell overnight. Then, using a mechanical stirrer, the two mentioned solutions were thoroughly combined to create a homogenous polymeric solution of film-forming and gelling agents. Propylene glycol and drug were added to another beaker and sonicated for 15 minutes. Propylene glycol was added to the polymeric solution after sonication while continuously stirred to create a film-forming gel forming films as shown in Fig. 1.[4]

Formulation of Film Forming Gel using 22 Full Factorial Designs

The preliminary studies' chosen polymers were placed in a two-factor, two-level factorial design with Design-Expert® software version 13 in order to study the impact of independent variables (i) concentrations of HPMC E15 (X1) and (ii) Carbopol 934 (X2) on dependent variables i.e. viscosity (Y1) and percent cumulative drug release (Y2). On the basis of preliminary research, HPMC E15 concentrations of 12.5 and 14.5% (w/w) and Carbopol 934 concentrations of 0.1 and 0.5% (w/w) were chosen for the film-forming gel. The composition is shown in Table 1 as FFG1 through FFG4.

Table 1: Composition of different formulation batches as per 2^2 factorial design

Ingredient (%w/w)	*FFG1*	*FFG2*	*FFG3*	*FFG4*
Drug	2	2	2	2
HPMC E15	12.5	12.5	14.5	14.5
Carbopol 934	0.5	0.1	0.5	0.1
Propylene glycol	6.5	6.5	6.5	6.5
Ethanol	8	8	8	8
Water	q.s	q.s	q.s	q.s

Characterization of Salicylic Acid Film Forming Gel

Physical Examination

Evaluation of the color, texture, homogeneity, and consistency of prepared FFGs. A pH metre was used to calculate the pH value.

Drying Time

By applying a little quantity of preparation on the inner sides of a volunteer's forearm, the drying time of prepared FFGs was measured. After a certain amount of time, the drying was assessed using a glass slide maintained loosely attached to the film. Only after seeing that there is no liquid visible on the glass slide was the film considered to be dry.[6]

Spreadability

In 2 g of FFG was placed between the two slides of the apparatus. A consistent film was created and the air between the slides was released by letting a weight of 1000 g sit on the slide for 5 minutes. The top slide was pulled by an 80 g weight while the bottom slide was secured. The duration of seconds needed to entirely separate the slides was recorded.[7]

Rheological Study

Viscosity of the developed film-forming gels was determined by using an R/S-CPS rheometer (7030107) with measuring system C75-2.

Drug Content

To achieve perfect solubility of the medication, an amount of the gel equal to 10 mg of salicylic acid was dissolved in 100 mL of PBS 7.4 and shaken for two hours. Then, using PBS 7.4 as a blank, it was filtered, appropriately diluted, and spectrophotometrically measured at 296 nm.

In-vitro Drug Release Study

A modified vertical Franz diffusion cell with a receptor compartment capacity of 12 mL and an effective diffusion area of 1.44 cm^2 was used for the *in-vitro* drug release. Phosphate buffer solution, pH 7.4, was placed

in the receptor compartment of the diffusion cell at a temperature of 37°C. With the tip of a pipet, FFG (0.5 g) was applied to the cellulose acetate membrane and evenly distributed. The samples were taken out at various intervals from receptor compartment, and their drug content was analyzed spectrophotometrically at a wavelength of 296 nm.

In-vitro Skin Permeation and Retention Studies

- *In-vitro Skin Permeation Study*

The Wistar albino rats skin was used in the *in-vitro* skin permeation investigation. The Appasaheb Birnale College of Pharmacy's CPCSEA Committee, which oversees Institutional Animal Ethics, gave its approval for the use of the animals. Its authorization number is IAEC/ABCP/09/2018-19. The effective permeation area was 1.44 cm^2, and 12 mL of PBS 7.4 solution were placed in the receptor compartment. Using a circulating water bath, the temperature of the receiver chamber holding 12 mL of receptor medium was maintained at 37°C. A donor chamber was filled with the optimized formulation (0.5 g), which had been gently applied to skin. A 0.5 mL sample portion was taken out of the receptor compartment at various intervals and promptly refilled with an equivalent volume of receptor fluid. The salicylic acid concentration of receptor fluid was analyzed using a UV spectrophotometer.[8]

- *Skin Retention Study*

The skin was cut into small pieces and subjected to a 30 minute ultrasonic treatment to estimate the amount of drug retention in the skin. Following centrifugation, the sample was filtered, and the supernatant was obtained for UV-visible spectrophotometer analysis at 296 nm.

Skin Irritation Test

The hair on the dorsal side of wistar albino rats was removed 24 hours before the experiment. The rats were divided into 3 groups (n = 3). Group I served as the control, group II placebo film-forming gel, and group III as test. On a square centimeter of rat skin, the test and placebo of optimized preparation were applied. The test sites were checked for dermal responses such as erythema and edema after 24, 48, and 72 hours.[9,10]

Surface Response Study

The effect of variables on response variables was evaluated statistically using Design-Expert® software version 13.[11]

Characterization of Gel Films

Appearance

The appearance of prepared gel films was evaluated.

Outward stickiness

It is determined by lightly pressing cotton wool against a dry film, and the amount of cotton fibers that are retained by the film is reported as high, medium, or low.[4]

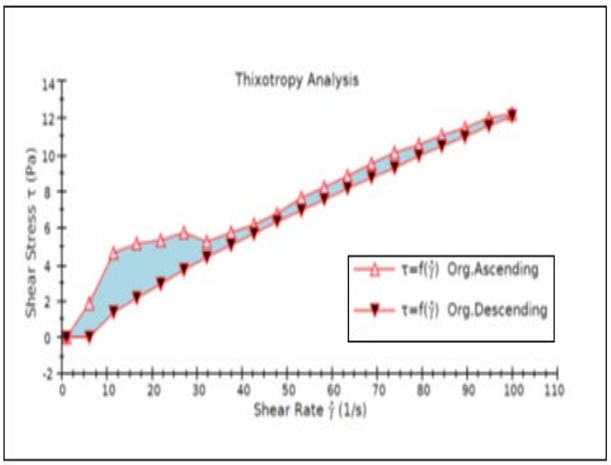

Fig. 2: Thixotropy analysis of FFG 2

Film Thickness

After drying, the film was peeled off, measured at five different points using a vernier calliper, and then cut into a 10 x 40 mm size.

Folding Endurance

The value of folding endurance was determined by how many times the film could be folded in the same position without breaking or cracking.

Tensile Strength and Percentage Elongation

An apparatus assembled in the lab was used to measure the tensile strength and percent elongation of films.[12]

Stability Study of Checkpoint Batch of Film Forming Gel

The optimized sample was examined for physical alterations, pH, drug content as a percentage, and viscosity throughout a typical period of t = 0, 3, and 6 months at 40°C 20°C/75% RH 5%.[13]

RESULTS

Evaluation of Salicylic Acid Film Forming Gel Formulation

Physical Examination

All of the salicylic acid FFG formulations had an off-white color and a pourable gel-like consistency that were smooth and clear. According to table 2, the pH of the entire FFG formulation ranged from 6.01 ± 0.11 to 6.26 ± 0.08.

Drying Time

Table 2 indicates that all formulations' total drying time was between 6.16 ± 0.12 to 8.12 ±0.35 minutes.

Spreadability

The spreadability of gels that form films ranges from 10.81 ± 0.29 to 22.21 ± 0.17 g.cm/sec, as evidenced in Table 2.

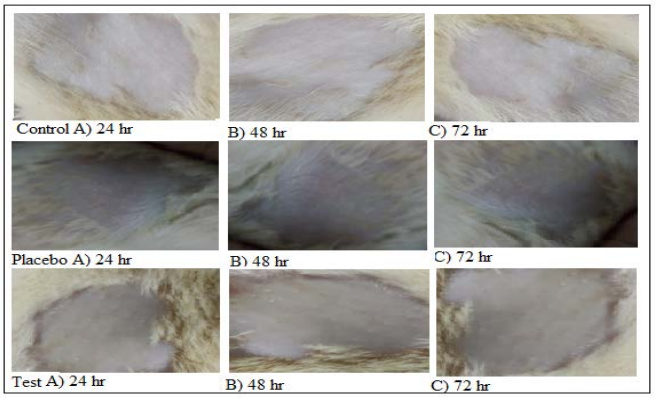

Fig. 3: Skin irritation test showing results of control, placebo, test after 24, 48 and 72 hours

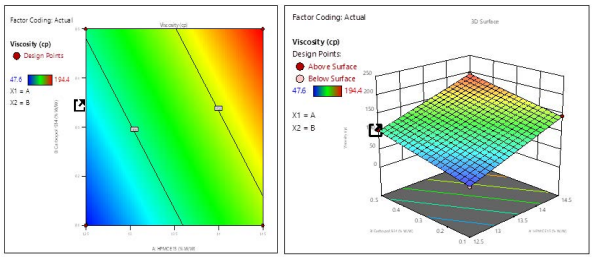

Fig. 4: 2D- Contour plots and surface response showing the effect of HPMC E15 and Carbopol 934 on viscosity

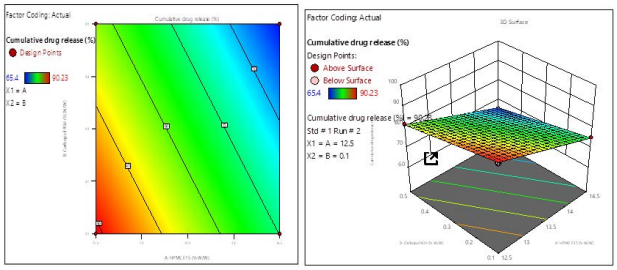

Fig. 5: 2D- Contour plots and surface response showing the effect of HPMC E15 and Carbopol 934 on Cumulative drug release

Rheological Study

The gels' viscosity was suitable, falling between 47.6 ±1.23 to 194.4 ± 1.47 cp sign in Table 2. Thixotropic analysis of optimized formulation FFG2 reveals little thixotropic plastic and pseudoplastic flow shown in Fig. 2

Drug Content

According to Table 2, the percentage of FFGs' drug content was more than 95%.

In-vitro Release Study

The following is a list of the sequence in which the active pharmaceutical ingredients release from FFG's formulation; F2>F1>F4>F3 where the medication was released after 12 hours were 90.23913 ± 0.61%, 81.81304 ± 0.69%, 75.36957 ± 0.54% and 65.4087 ± 0.42% respectively given in Table 3.

In-vitro Skin Permeation and Retention Studies

The results showed that cumulative drug permeated from the commercialized gel after calculating the percent cumulative amount of drug permeated for 12 hours was 23.19565 ± 0.6155% lower than film-forming gel (24.53623 ± 0.4167%) indicated in Table 4. Both preparations' studies on skin retention were conducted. Salicylic acid was shown to be deposited in the skin at greater rates when using film-forming gel (51.55 ± 0.31 %%) than marketed gel (50.42 ± 0.40%) denoted in Table 5.

Skin Irritation Test

The results in Fig. 3 showed no erythema (redness) or edema (swelling) indications of irritation at 24, 48, or 72 hours.

Surface Response Study

Viscosity (Y1) and percent cumulative medication release (Y2) were chosen as the dependent variables (Y2). According to a factorial design, a total of four formulations for salicylic acid film-forming gel were created. Table 6 displays the observed responses for viscosity and cumulative drug release.

Using Design-Expert® software, the acquired responses were fitted into a variety of mathematical models, including linear, two-factor interactions (2FI), and quadratic models. For viscosity (Y1) and cumulative drug release (Y2), the 2FI model was shown to be the best fit model as shown in Table 7. The correlation coefficient for viscosity (Y1) was found to be 0.9995, indicating a good fit. The "Pred R squared" of 0.9920 is in reasonable

Table 2: pH, drying time, spreadability, viscosity and drug content of film forming gels

Formulation code	*pH*	*Drying time (Min)*	*Spreadability (g.cm/sec)*	*Viscosity (cp)*	*Drug content (%)*
FFG1	6.20 ± 0.09	7.18 ± 0.21	18.79 ± 0.33	103.7 ± 0.96	96.33 ± 0.29
FFG2	6.01 ± 0.11	6.16 ± 0.12	22.21 ± 0.17	47.6 ± 1.23	97.10 ± 0.20
FFG3	6.26 ± 0.08	8.12 ± 0.35	10.81 ± 0.29	194.4 ± 1.47	96.28 ± 0.15
FFG4	6.13 ± 0.10	7.62 ± 0.20	13.76 ± 0.25	143.1± 1.63	97.28 ± 0.35

Table 3: *In-vitro* drug release data of FFGS factorial batches (F1-F4)

Time (hr)	*% Cumulative Drug Release**			
	F1	F2	F3	F4
1	7.82 ± 0.43	9.91 ± 0.61	3.13 ± 0.69	5.53 ± 0.69
1.5	14.62 ± 0.54	17.73 ± 0.73	5.97 ± 0.54	9.830 ± 0.75
2	22.10 ± 0.87	25.86 ± 0.68	9.03 ± 0.85	14.92 ± 0.54
2.5	26.53 ± 0.67	33.67 ± 0.81	11.9 ± 0.42	19.69 ± 0.85
3	32.46 ± 0.30	40.62 ± 0.56	13.30 ± 0.53	23.7 ± 0.42
3.5	38.19 ± 0.71	45.51 ± 0.50	15.58 ± 0.85	26.79 ± 0.54
4	43.99 ± 0.69	52.31 ± 0.73	17.1 ± 0.69	31.13 ± 0.69
4.5	48.10 ± 0.42	57.34 ± 0.61	19.49 ± 0.42	35.91 ± 0.42
5	53.98 ± 0.53	62.19 ± 0.81	21.64 ± 0.53	39.91 ± 0.53
5.5	59.10 ± 0.85	67.99 ± 0.73	25.42 ± 0.54	44.86 ± 0.69
6	66.02 ± 0.67	73.10 ± 0.81	34.75 ± 0.53	53.09 ± 0.85
12	81.81 ± 0.69	90.23 ± 0.61	65.40 ± 0.42	75.36 ± 0.54

*Average of three determinations (n=3)

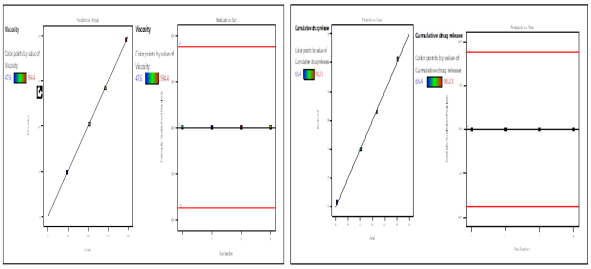

Fig. 6: Linear correlation graphs for the viscosity and cumulative drug release salicylic acid film forming gel between actual and predicted values, together with the accompanying residual plots

Table 4: *In-vitro* skin permeation studies of film forming gel and marketed gel of salicylic acid

Time (hr)	*(%) Cumulative drug permeated From film forming gel*	*(%) Cumulative drug permeated from marketed gel*
0	0.00	0.00
1	2.817391±0.3130	2.852174±0.3187
2	4.430435±0.2755	5.134783±0.3225
3	6.871014±0.2326	7.673913±0.2485
4	8.536232±0.3664	9.57971±0.4700
5	10.12029±0.3627	12.1087±0.4578
6	12.48696±0.4252	14.37971±0.5366
12	24.53623±0.4167	23.19565±0.6155

*Average of determinants (n = 3)

Table 5: Percentage of salicylic acid retention in skin after 12 hours

Salicylic acid FFG	*Salicylic acid marketed gel*
51.55 ± 0.31%	50.42 ± 0.40%

*Average of determinants (n = 3)

agreement with the "Adj R Squared" of 0.9985, and the correlation coefficient for cumulative drug release was found to be 0.9983, and the "Pred R squared" of 0.9734 is in reasonable agreement with the "Adj R Squared" of 0.9950. These findings show that the variables used for the investigation significantly impact both viscosity and cumulative drug diffusion.

Regression Equation

Viscosity (Y1) = +122.20+46.55 X1+26.85 X2 (a)

Cumulative drug release (Y2) = +78.19-7.84 X1-4.58 X2 (b)

Where X1 and X2 are concentration of HPMC E15 and carbopol 934, respectively. Equations (a) and (b)represent that, increased viscosity and reduced cumulative drug release are due to higher HPMC E15 and carbopol 934 concentrations.

- *Effect of Independent Variables on Viscosity (Y1)*

By using 2D-contour plots and surface response as in Fig. 4, the impact of independent factors on viscosity was further shown that viscosity significantly increased when HPMC E15 concentration climbed from 12.5 to 14.5%. (w/w) and Carbopol 934 from 0.1 to 0.5 % (w/w) due to HPMC E15 and carbopol 934 both are viscosity increasing agent.

Table 6: Salicylic acid film-forming gel factorial design layout

Run	Factor 1 HPMC E15		Factor 2 Carbopol 934		Response 1 Viscosity (cp)	Response 2 (%) Cumulative drug release
	Coded	Actual	Coded	Actual		
FFG1	-1	12.5	+1	0.5	103.7 ± 0.96	81.81± 1.55
FFG2	-1	12.5	-1	0.1	47.6 ± 1.23	90.23 ± 2.01
FFG3	+1	14.5	+1	0.5	194.4 ± 1.47	65.4 ± 1.65
FFG4	+1	14.5	-1	0.1	143.1 ± 1.63	75.3 ± 1.75

*Average of determinants (n = 3)

Table 7: Summary of regression analysis for responses Y1 AND Y2

Responses	Model	R^2	Adjusted R^2	Predicted R^2
Viscosity(Y1)	2FI	0.9995	0.9985	0.9920
Cumulative drug release(Y2)	2FI	0.9983	0.9950	0.9734

- *Effect of Independent Variables on Cumulative Drug Release (Y2)*

The lesser cumulative drug release was observed for film forming gel formulations FFG 3 (65.4 ± 1.65%) while the maximum cumulative drug release was obtained in FFG 2 (90.23 ± 2.01%). It is clear from the graphs and plots in Fig. 5 the 2D-contour plot and surface response that cumulative medication release significantly decreased as HPMC E15 concentration increased from 12.5 to 14.5% w/w and Carbopol 934 from 0.1 to 0.5% w/w due to drug release is inversely proportional to viscosity. Following a careful analysis, it was determined that FFG2 (HPMC E15 12.5 w/w and Carbopol 934 0.1 w/w) met the criteria for an ideal formulation. The improved salicylic acid FFG2 formulation had a viscosity of 47.6 ± 1.23 cp and a drug release of 90.23 ± 2.01 cp.

- *Data Evaluation*

Tables 8 and 9 provided details of the analysis of variance study.

As for the case viscosity and cumulative drug release, the model's F-values of 1002.72 and 300.82, respectively show that the model is significant ($p<0.0223$ and, $p<0.0407$, respectively). Both instances show that model terms are significant as the *p-value* (significance probability value) is less than 0.05.

- *Validation of the Created Model*

The correlation graphs between actual (observed) and predicted (theoretical) values provided evidence for the validity of the polynomial 2FI model. Fig. 6 quantitatively compared the experimental values obtained for the various reactions with those of the expected values. The predicted and observed response values have a respectably good agreement as revealed in Table 10. These outcomes verified the created model's applicability.

Evaluation of Film

Appearance

All FFG have a flexible and tacky appearance.

Outward Stickiness

The outward stickiness of the formulations FFG1 and FFG2 was low, whereas that of FFG3 and FFG4 was medium.

Film Thickness

The film thickness of the developed FFGs ranged from 0.19 ± 0.09 to 0.27 ± 0.15 mm.

Folding Endurance

The folding endurance values were discovered in folds ranging from 322 ± 0.19 and 140 ± 0.21.

Table 8: Analysis of variance for response Y1 (viscosity)

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	11551.30	2	5775.65	1002.72	0.0223	Significant
A-HPMC E15	8667.61	1	8667.61	1504.79	0.0164	
B-carbopol 934	2883.69	1	2883.69	500.64	0.0284	
Residual	5.76	1	5.76	---	---	
Cor Total	11557.06	3	---	---	---	

Table 9: Analysis of variance for response y2(cumulative drug release)

Source	*Sum of Squares*	*df*	*Mean Square*	*F-value*	*p-value*	
Model	329.45	2	164.73	300.82	0.0407	Significant
A-HPMC E15	245.55	1	245.55	448.41	0.0300	
B-carbopol 934	83.91	1	83.91	153.22	0.0513	
Residual	0.5476	1	0.5476	---	---	
Cor Total	330.00	3	---	---	---	

Table 10: Actual and predicted values of viscosity

Run order	*1*	*2*	*3*	*4*
Actual value for viscosity	103.70	47.60	194.40	143.10
Predicted value for viscosity	102.50	48.80	195.60	141.90
Actual value for CDR	81.81	90.23	65.40	75.30
Predicted value for CDR	81.44	90.60	65.77	74.93

Tensile Strength and Percentage Elongation

Tensile strength ranged from 2.03 ± 0.10 to 3.81 ± 0.12 N/m^2 and percentage elongation ranged from 6.25 ± 0.09 to 8.21 ± 0.14%, respectively.

Stability of The FFG

After subjecting the formulations to stability stress for 6 months, there was no considerable change in the formulations' appearance, pH, viscosity, or drug content.

Discussion

Carbopol's hydrophilic nature, bioadhesive capability, good stabilising agent, increased potency, lack of irritancy, and capacity to absorb and hold water helped make it the ideal ingredient for the formulation of salicylic acid film-forming gel. This quality keeps skin soft and smooth. The most effective film forming, hydrophilic by nature, well-resistant to microbial attack, non-irritating, aiding in regulated medication release, creating cooling effect, and without clogging skin pores is HPMC E15.[14] Propylene glycol has humectant, emollient, and plasticizing properties that help to hydrate the skin and treat dryness and dullness. Salicylic acid's keratolytic activity causes it to soften keratin, decrease swelling and redness, increase moisture, exfoliate dead skin cells, remove dry, scaly, or thicker skin, stop the growth of extra skin cells, and facilitate desquamation. All of these characteristics of ingredients and drugs can be helpful for scaling and hyperkeratotic conditions. All of FFG's formulations had a uniform, pourable gel-like consistency, and their pH values indicated that they were all acceptable for skin application. One of the crucial factors for the film-forming gel is drying time since it affects the patient's waiting period (between applications and full drying). It was discovered that low-viscosity formulations dried more quickly than higher ones. Different formulations' spreadabilities revealed that spreadability decreased when HPMC E15 and carbopol 934 concentrations increased. Due to the low concentration of HPMC E15 and Carbopol 934, which can be effortlessly laid out on the skin and will retain contact with the skin for longer, the lowest and best viscosity was discovered in FFG2 among all formulations, resulting in the maximum therapeutic benefit. The most crucial aspect in the composition of FFGs is the drug content, and the outcomes are satisfactory. FFG's formulations have slow, controlled drug release. Batch FFG2 contains a lower concentration of HPMC E15 (X1) and Carbopol 934 (X2) exerts highest drug release 90.23 ± 0.61% at 12 hours and proved to be a promising formulation. It was clear from the diffusion profile of several factorial batches that drug release reduced as both polymer concentrations increased. According to *in-vitro* skin permeation and retention experiments, the enhanced FFG formulation is superior to and equal to commercially available conventional salicylic acid gel. Skin irritation research showed that neither the test nor placebo gels showed any noticeable irritation or inflammation at or around the application site. According to the polynomial equation, Carbopol 934 and HPMC E15 have a negative impact on cumulative drug release but a good impact on viscosity. After careful consideration, the FFG2 formulation was determined to be the most optimal one based on the criteria of lowest viscosity 47.6 cp and greatest cumulative drug release 90.23%. Both met the requirements of an ideal formulation.[15,16]

All of the films were homogeneous, undetectable, hardly perceptible, and free of gritty and air bubbles. A flexible and tacky film was formed by all formulations. A film must have good integrity, flexibility, and tackiness in order to be kept on a hyperkeratotic skin surface. Low external stickiness prevents the produced film from unwanted clinging to patient clothing and dressings. The maximum film thickness and medium outward stickiness found in FFG3 and FFG4 may be caused by high polymer content. The low quantity of polymer may be the cause

of the thin film and low outward stickiness observed FFG1 and FFG2. A thin film which would please users after application. The values for folding endurance were deemed satisfactory. FFG2's tensile strength is more than FFG1's, while FFG4's is greater than FFG3's. These findings showed that carbopol enhanced the softness, elasticity, and flexibility of both HPMC E15 films while usually reducing their strength. In the meantime, %elongation increases as carbopol 934 concentration rises. This demonstrated how flexible and simple it was to peel off prepared films. The improved FFG2 batch held constant for six months.

Conclusion

It may be inferred from the current work that RSM can be used to build and improve the FFG of salicylic acid. In comparison to other models, the 2FI model was determined to best suit both replies ($p < 0.05$). Carbopol 934 and HPMC E15 have a negative impact on cumulative drug release but a positive effect on viscosity, according to the polynomial equation. It was discovered that the ideal mixture had 12.5% HPMC E15 and 0.1% Carbopol 934. Viscosity of the said composition was 47.6 ± 1.23 cp, and drug release was 90.23 ± 2.01%. The modified batch demonstrates advantageous physical properties, spreadability, pH, viscosity, thixotropy, drug content, and the controlled release of salicylic acid from the formulation matrix. Data from an *ex-vivo* permeation and retention investigation revealed that drug accumulated in skin layers which is necessary for a topical therapeutic effect to be seen. Additionally, the optimised batch demonstrated high stability and no skin sensitivity. The above-said results indicated that salicylic acid film-forming gel, successfully developed with hydrophilic polymers, can potentially treat hyperkeratotic and scaling disorders. It has wipe-off resistant, retains longer at the treatment site, is simple to spread, and forms a thin, transparent, protective, emollient, and water-soluble film after application.

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