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Optimization and Evaluation of Topical Gel from *Euphorbia hirta* L extract Towards Skin Infections

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ABSTRACT: Skin disease is the most common disease caused to humans, according to World Health Organization (WHO) around 900 million experience skin diseases. Skin diseases are caused due to allergies, irritants, genetic makeup, certain diseases, and immune system problems. Microbes like *Candida albicans, Propionibacterium, Staphylococcus, and Escherichia coli* are important reasons for cause of skin disease. To overcome this issue, there is a need of medication that cures skin infections like acne, cellulitis, cutaneous candidiasis, boils and furuncles in one solution. In this research article, we developed a novel plant-based topical gel from *Euphorbia hirta* L. The extract of *E. hirta* and silver nanoparticles loaded in the gel showed good activity against *E. coli, Propionibacterium, Staphylococcus, and Candida albicans.* Thereby, the formulated gel would be promising skin care product that cures acne, cellulitis, cutaneous candidiasis, boils and furuncles.

Keywords: Skin disease, *E. hirta* L, topical gel, optimization, antibacterial, antifungal.

INTRODUCTION

Euphorbia hirta L. is classified under the kingdom Plantae, order malpighiales, family Euphorbiaceace, genus Euphorbia, species *E. hirta. Euphorbia hirta* L. also known as Asthma weed, Amampatchaiarisi in Tamil. This annual herb is widespread, fruiting, and blooming throughout virtually the entire year. In Asia, this plant has long been used to treat laryngeal spasms and bronchial asthma (Basyal *et al.*, 2021). Athletes' feet can also be treated with this plant. Dysentery, enteritis, conjunctivitis, and worm skin conditions and infestation can also be treated with *Euphorbia hirta* L. The rubber latex of Warts and cuts can be treated with plants. This plant is aphrodisiac, depurative, carminative, antipruritic purgative, diuretic, febrifuge, galactogogue, and being a vermifuge. You may consume its leaves as veggie while feminine. Many phytochemicals have been discovered in this plant that belongs to several sterols, alkaloids, tannins, glycosides, and both alkenes and triterpenoids. Phytochemical Among the characteristics of this plant are camphol, rhamnose, quercitin, quercitol, leucocyanidol, eophorbon, chlorophenolic acid, taraxerol, taraxerone and gallic acid (Das *et al.*, 2022; Charles and Bonareri 2021).

Skin disease is the most common disease that most people suffer from. According to World Health Organization (WHO), Nearly 900 million individuals worldwide experience skin disorders at any given moment, making them one of the most prevalent conditions affecting human health. Numerous skin disease conditions can result in permanent deformity, incapacity, and stigma (Mahanani and Idris 2021). Several reasons cause skin diseases like allergies, irritants, genetic makeup, certain diseases, and immune system problems. Skin disease can be caused either because of internal factors or external factors (Luz *et al.*, 2009). Skin disease due to the Microbial effect is the most common one. Bacteria like *Staphylococcus, Corynebacterium, Propionibacterium, Streptococcus,* and *Pseudomonas* are responsible for skin disease (Mazur *et al.*, 2021). Bacteria can affect the follicles, the endodermis of the skin, or the epidermis. Bacterial skin diseases could propagate throughout the body if they are not properly treated (Moriello and Coyner 2021). The most common skin disease that people suffer from is rashes that are caused by fungus. Fungal skin infections may cause itching, swelling, redness, blisters, and irritation. Anywhere throughout the body fungus may cause infection. The most prevalent fungal skin disease includes yeast infections, jock itch, athlete's foot, and ringworm (Richard *et al.*, 2022).

Natural medicines made from plants are becoming more and more popular due to their many benefits, including the fact that they frequently have fewer side effects, are more patient-friendly, are relatively less expensive, and are accepted because of their long history of use. Additionally, herbal remedies offer practical ways to treat a variety of illnesses that are difficult to treat and uncurable using conventional medical practices. For these reasons, various plants have been researched as potential treatments for skin conditions ranging from itchiness to skin cancer (Moriello and Coyner 2021). Many plant species are used as a natural medication for skin diseases like the herb *Achyranthes aspera* is used to treat skin conditions such as boils, scabies, and skin eruptions. *A. aspera* acted effectively against the Epstein-Barr virus (Sharma *et al.*, 2021). Other plants like Aloe vera against wrinkles and stretch marks (Kumara *et al.*, 2021),

Azadirachta indica in healing blisters (Gaikwad *et al.*, 2022), *Cannabis sativus* in dressing wounds (Antezana *et al.*, 2021), *Curcuma longa* in reducing tumor cells (Poompavai and Gowri, 2022), *Lawsonia inermis* against impetigo (Tahri *et al*., 2021) are used.

In recent, most people started using organic medications for several diseases. Some of the organic plant-based medications are as follows:

Polonini *et al.* (2021) developed ready to use cream from *Cleome gynandra* L for acne treatments. This cream has reduced the production of sebum by around 30% within 7 days. Guntupally *et al.* (2019) developed emulgel from *Coccinia grandis* against skin pathogenic bacteria. This emugel is efficient and showed good antibacterial activity against skin disease-causing bacteria. Mounika *et al*. (2019) developed emulgel from Guggulu and Babchi oil against Psoriasis. In-vitro characterization showed better results against Psoriasis. Shadab and Shamsi (2020) developed an ayurvedic gel from Unani formulated Safoof-e-baris against vitiligo. In-vitro studies showed better drug release profiles and stability. Kaur *et al.* (2021) developed nanosponges loaded with Cinnamon oil extracted from *Cinnamomum zeylanicum* that showed increased antimicrobial activity and also reduced skin irritation. Nelson *et al.* (2020) developed a botanical gel as an alternative todocosanol that treats cold sores causores by Herpes simplex virus 1 (HSV-1). This gel is made up of *Hypericum perforatum, Lavandula officinalis, Glycyrrhiza glabra, Melissa officinalis, Eleutherococcus senticosus, Sarracenia.* This gel showed a better healing effect by reducing the healing time by 70%, the cold sore is healed within 2 to 3 days.

MATERIALS AND METHODS

Materials: Carbopol, Sodium benzoate, tomato peel powder, sodium hydroxide (NaOH), ferric chloride ($FeCl_3$), Sodium Carbonate (Na_2CO_3), silver nitrate, trisodium citrate, silica gel, agar-agar, Muller Hinton agar, Polyethylene glycol, Vitamin E oil, Sandalwood oil, ethanol (C_2H_5OH), acetone, chloroform ($CHCl_3$), sulphuric acid (H_2SO_4), Hydrochloric acid (HCl), Mayer's reagent, folicciocalteu reagent, Ampicillin, Streptomycin, Amikacin, distilled water.

Extraction: Fresh plant samples of *Euphorbia hirta* L are collected and washed cleanly in distilled water and dried. The dried leaves are ground into a fine powder using a mechanical grinder and stored in a container. Ethanolic extract is done using the Soxhlet apparatus, 24g of the powdered sample for 200ml of ethanol was taken. The extraction process is let until the completion of 5 cycles in the Soxhlet apparatus. Finally, solvent is removed from extract using rotary evaporator drum.

Preparation of silver nanoparticles: In 95 ml of distilled water, 0.016g of silver nitrate is dissolved and in 5 ml of distilled water 0.185g of trisodium citrate is dissolved, both the solutions are mixed and heated for 10 to 20 mins. The color of solution will change into orange that indicates the synthesized silver nanoparticles (AgNPs), further, a wavelength scan was done using a UV spectrometer with a wavelength ranging between 200 to 700 nm.

Phytochemical evaluation: Terpenoid: In 5ml of the plant extract, 2ml of chloroform ($CHCl_3$) and 2ml of sulphuric acid (H_2SO_4) are added.

Coumarin: In 1ml of the plant extract, 1ml of 10% sodium hydroxide (NaOH) is added.

Tannin: In 2ml of the plant extract, a few drops of 10% ferric chloride ($FeCl_3$) is added.

Flavonoids: In 2ml of plant extract, a few drops of 10% sodium hydroxide (NaOH) is added then a few drops of concentrated Hydrochloric acid (HCl) is added.

Volatile oil: In 2m of plant extract, 0.5ml of sodium hydroxide (NaOH) and a few drops of diluted Hydrochloric acid (HCl) are added.

Foam: 0.5g of powdered sample is added with 2ml of distilled water is added and shaken well for 10 to 15 mins.

Phenols: In 2ml of the plant extract, 2 to 3 drops of chloride ($FeCl_3$) are added.

Quinones: In 1ml of the plant extract, 2 drops of concentrated Hydrochloric acid (HCl) are added.

Carbohydrate: In 2 ml of extract, 2 drops of alcoholic α naphthol are added and a few drops of concentrated sulphuric acid (H_2SO_4) are added through the walls.

Glycosides: In 5 ml of extract, 5 ml of distilled water is added and shaken well.

Phytosterols: In 2ml of extract, 2ml of chloroform ($CHCl_3$) and 2ml of sulphuric acid (H_2SO_4) are added.

Alkaloids: In 2ml of extract 2ml of Mayer's reagent is added.

Thin layer chromatography (TLC): Silica gel is mixed in distilled water to form slurry mixture, then it was spread over a TLC plate. The TLC plate is allowed to dry in the hot air oven at 60◦C. The samples are loaded on the spotting line of the TLC plate and kept in the TLC chamber that is filled with Solvent (ethanol). The mobile phase is not allowed to reach the end of the TLC plate. Then the plate is viewed under the UV transilluminator. The distance covered by the sample loaded from the origin is calculated as well as the distance covered by the solvent is also calculated, using these data the R_f value is determined.

$$R_f = \frac{\text{Distance covered by sample from origin}}{\text{Distance covered by solvent from origin}}$$

Preparation of gel: For 100 ml formulation, 1% Carbopol, 2% tomato peel powder, 1% polyethylene glycol, 10% glycerol, 0.1% sodium benzoate (preservative), 2 drops vitamin E oil, 2 drops sandalwood oil were added and stirred for 2hrs using a magnetic stirrer. Later this, 4% of *E. hirta* extract, and 4% of silver nanoparticles (AgNPs) were added and stirred until they homogenize. Finally, the resulting formulation was filtered using a filter and the pH of the gel is adjusted using triethanolamine (TEA).

Optimization of gel: Using a central composite design with Design Expert (Version 12), the tests are optimized. Carbopol (Factor A) and TEA (Factor B) at two levels low and high were chosen as the independent variables. Viscosity (P), and spreadability (g cm s^{-1}) are the dependent or response variables (Table 1). Regarding several statistical metrics, including probability (P value), regression coefficient (R^2 value),

model Fischer's value (F value), and lack of fit model, the design was optimized. The experimental portion was carried out based on the outcome of the design. Table 2 contains the final formulation.

Table 1: Independent and dependent variables of the herbal gel formulation.

Factors	Designation	Units	Low level	High level
A	Carbopol	%	0.5	1
B	TEA	µl	400	600

Response	Designation	Units
R1	Viscosity	P
R2	Spread ability	g cm/s

Table 2: Final formulation of the given input.

	Factor 1	Factor 2
Run	Carbopol (%)	TEA (µl)
	%	µl
1	0.5	600
2	0.75	358.57
3	0.5	400
4	1	600
5	1.10	500
6	1	400
7	0.75	500
8	0.75	500
9	0.75	500
10	0.75	641.42
11	0.75	500
12	0.75	500
13	0.39	500

Physiochemical studies for gel:

1. **pH:** pH meter is calibrated using pH 7 buffer solution and 0.5 g of the gel was weighed and dissolved in 50 ml of distilled water and the pH of the solution is measured.
2. **Viscosity:** The viscosity of the gel is measured using a viscometer at 100 rpm.
3. **Spreadability test:** 0.5 g of gel is taken and compressed using two plates which are pressured by 500g of weight, this process is allowed for 5 mins and the length of spread gel is measured.
4. **Centrifugal test:** 10 g of the gel is taken and centrifuged at 3000 rpm for 30 mins at room temperature.
5. **Stability test:** Gel was maintained at different temperatures (25°C, 45°C, 4°C) for 1 month and the test for pH, viscosity, spreadability, and centrifugal were performed at equal intervals of time.

Antimicrobial activity: The plates are prepared with Muller Hinton agar (MHA-3.8%) and the needed materials are sterilized. The MHA agar is poured into the plates and allowed to d solidify, later, the Microbial culture is spread over the plate using a cotton swab, and the well is punched using a good puncher finally the samples (Extract, silver, and gel) are loaded into the well and incubated at 37°C for 24h. The next day, the Zone of inhibition is measured for the control and samples.

RESULTS AND DISCUSSIONS

We successfully extracted and isolated the *Euphorbia hirta* L. using the soxhlet apparatus and rotary vacuum evaporator, respectively. The synthesized silver nanoparticles also showed a peak nearly at 430 nm in the wavelength scan using a UV spectrometer that ensured the presence of AgNPs. The gel incorporated with *E. hirta* extract and AgNPs was formulated and stored.

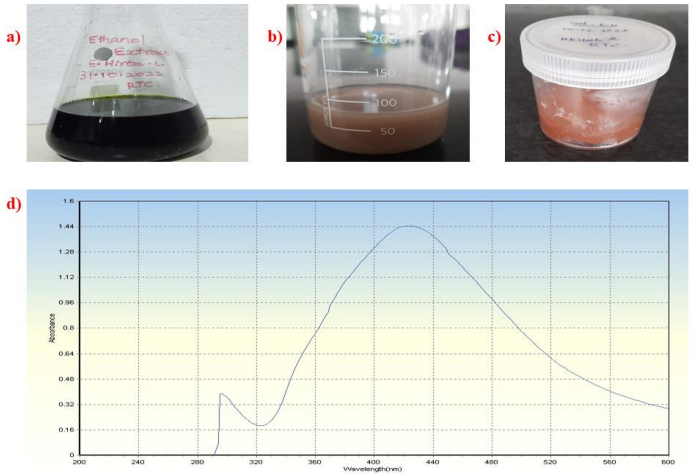

Fig. 1. This figure shows the outcome of the a) *E. hirta* L extract, formulated b) AgNPs and c) gel, and d) shows the peak of synthesized AgNPs during the wavelength scan using UV spectrometry.

Phytochemical studies: At the end of the phytochemical evaluation, we got some positive results that showed the presence of terpenoids, coumarin, tannin, phenols, flavonoids, alkaloids, glycosides, phytosterols, and volatile oils. Also, we got some negative results that showed the absence of carbohydrates, and quinones (Table 3).

Table 3: Presence of phytochemical constituents in the ethanolic extract of *Euphorbia hirta* L.

Phytochemical Constituents	Ethanol Extract	Determination
Terpenoid	+	Formation of reddish browncolor
Coumarin	+	Formation of yellow color
Tannin	+	Formation of bluish-blackcolor
Phenols	+	Formation of bluish-blackcolor
Flavonoids	+	Formation of intense yellow
Foam	+	Formation of foam
Carbohydrate	-	Formation of violet color in the junction
Alkaloids	+	Formation of yellow precipitate
Glycosides	+	Formation of foam
Phytosterols	+	Formation of golden yellow
Quinones	-	Formation of red color
Volatile oil	+	Formation of white precipitate

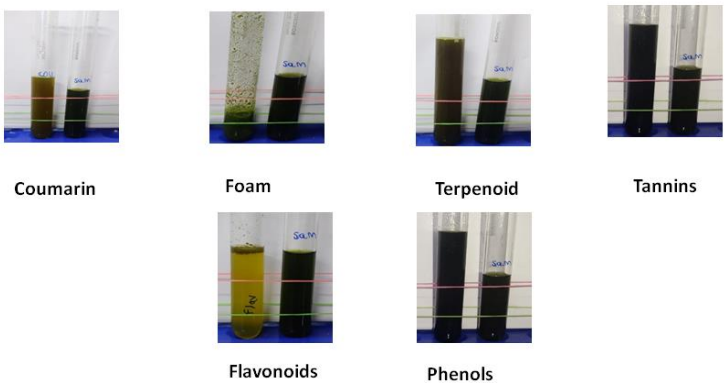

Fig. 2. Presence of some phytochemical constituents in the ethanolic extract of *Euphorbia hirta*.

Anthroquinones, coumarin, glycoside, saponin, terpenoids, alkaloids, steroids, tannins, proteins, lipids, oils, mucilages, chlorophyll, and carotenoids were all found in the leaf extract of *E. hirta* after a phytochemical examination. *Euphorbia hirta* contains flavonoids such as quercetin, quercitrin, and quercetin as well as its derivatives such rhamnose, quercetin rhamnoside, chlorophenolic acid, rutin, leucocyanidin, myricitrin, cyaniding 3,5-diglucoside, camphol, flavonol, inositol, tetraxerol, - Gallic acid, protocatechuic acid, afzelin, euphorbin-A, euphorbin-B, euphorbin-C, and euphorbin-D were also extracted from the plant aerial portions (Cayona and Creencia 2022; Gautam *et al.*, 2022; Alsaffar *et al.*, 2022; Tripathi *et al.*, 2021; Ali *et al*., 2023).

Thin layer chromatography: The distance covered by the mobile phase = 5.5±0.2 cm

The distance covered by extract = 2.3±0.1 cm.

On average, the retention factor (R_f) of ethanolic extract of *E. hirta* = 0.418

Optimization of gel: 13 trial formulations have been obtained from CCD design and are put in Table 2. Table 4 gives the result of all 13 trials formulation for response factor viscosity (P) and spreadability (g cm/s).

Table 4: Results of 13 trial formulations.

	Factor 1	Factor 2	Response 1	Response 2
Run	Carbopol (%)	TEA (µl)	Viscosity (P)	Spreadability (g cm/s)
	%	µl	Poise	g cm/s
1	0.5	600	70.01	9.3
2	0.75	358.57	66.03	9.45
3	0.5	400	68	9.27
4	1	600	78.4	10.66
5	1.10	500	76	9.88
6	1	400	74.12	9.5
7	0.75	500	70.45	9.46
8	0.75	500	68	9.45
9	0.75	500	70.12	9.62
10	0.75	641.42	72.8	9.36
11	0.75	500	68.1	9.23
12	0.75	500	68.1	9.65
13	0.39	500	66.4	9.15

Viscosity. The response was constructed based on a polynomial equation in which independent factors are coded. The coded equation is as follows:

Viscosity = 70.50 + 3.51 *A + 1.98 *B

In this polynomial equation, Carbopol is coded as A, and TEA is coded as B.

ANOVA table (Table 5) shows the significance of the model. The model is significant given its Model F-value of 15.42. An F-value this great might be caused by noise with a mere 0.09% probability. Significant model terms are those with P-values less than 0.0500, here, the model terms A and B are significant. Indicators of the model terms' significance are values larger than 0.1000. According to the Lack of Fit (F-value) of 4.05, the lack of fit is not significant in comparison to pure error. A significant Lack of Fit F-value has a 9.86% likelihood of being the result of noise. We want the model to fit, thus a negligible lack of fit is ideal.

Table 5: ANNOVA for the response viscosity.

Source	Sum of Squares	Degree of Freedom	Mean Square	F-value	p-value	
Model	130.07	2	65.03	15.42	0.0009	significant
A-Carbopol	98.61	1	98.61	23.37	0.0007	
B-TEA	31.46	1	31.46	7.46	0.0212	
Residual	42.19	10	4.22			
Lack of Fit	36.22	6	6.04	4.05	0.0986	not significant
Pure Error	5.97	4	1.49			
Cor Total	172.25	12				

Fit statistics (Table 6) showed a correlation coefficient (R^2) value of 0.7551, and a coefficient of variance % of 2.91 for response factor Viscosity (P). The predicted R^2 for viscosity is 0.5671, the adjusted R^2 for viscosity is 0.7061 and their difference is <0.2. The desirable adeq precision should be >4 and the obtained adeq precision is 11.136 which indicates an adequate signal.

Table 6: Fit statistics for response factor viscosity.

Std. Dev.	2.05	**R^2**	0.7551
Mean	70.50	**Adjusted R^2**	0.7061
C.V. %	2.91	**Predicted R^2**	0.5671
		Adeq Precision	11.136

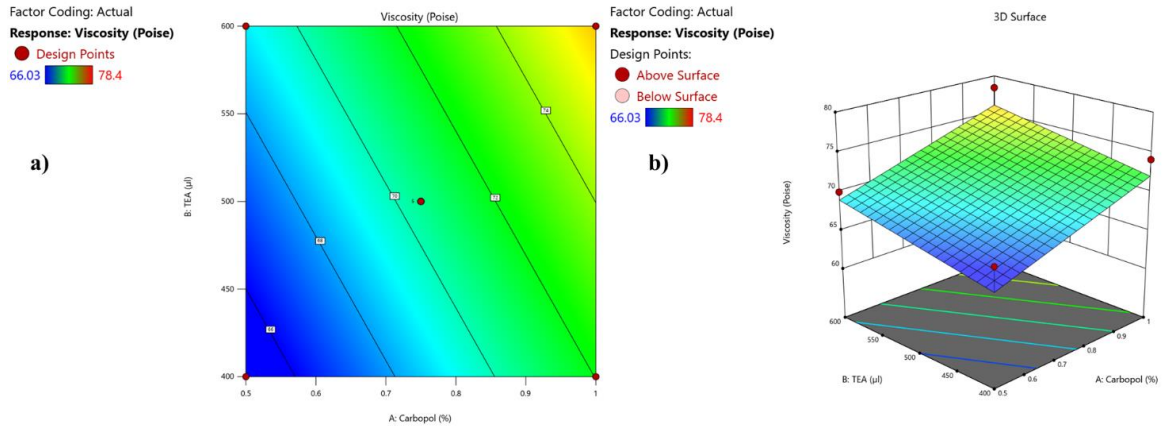

Fig. 3: a) Contour plot and b) 3D surface plot for the response factor viscosity.

Spreadability. The response was constructed based on a polynomial equation in which independent factors are coded. The coded equation is as follows:

Spreadability = 9.54 + 0.3278 *A + 0.1328 *B + 0.2825 *AB

In this polynomial equation Carbopol is coded as A and TEA is coded as B.

ANOVA table (table 7) shows the significance of the model. The model is significant given its Model F-value of 7.86. An F-value this great might be caused by noise with a mere 0.70% probability. Significant model terms are those with P-values less than 0.0500, here, the model terms A and B are significant. Indicators of the model terms' significance are values larger than 0.1000. According to the Lack of Fit (F-value) of 2.79, the lack of fit is not significant in comparison to the pure error. A significant Lack of Fit F-value has a 17.10% likelihood of being the result of noise. We want the model to fit, thus a negligible lack of fit is ideal.

Fit statistics (Table 8) showed a correlation coefficient (R^2) value of 0.7238, and a coefficient of variance % of 2.48 for response factor Spreadability (g cm/s). The predicted R^2 for spreadability is 0.685, the adjusted R^2 for spreadability is 0.6318 and their difference is <0.2. The desirable adeq precision should be >4 and the obtained adeq precision is 9.3016 which indicates an adequate signal.

Table 7: ANNOVA for the response spreadability.

Source	Sum of Squares	Degree of Freedom	Mean Square	F-value	p-value	
Model	1.32	3	0.4400	7.86	0.0070	significant
A-Carbopol	0.8596	1	0.8596	15.36	0.0035	
B-TEA	0.1412	1	0.1412	2.52	0.1467	
AB	0.3192	1	0.3192	5.70	0.0407	
Residual	0.5037	9	0.0560			
Lack of Fit	0.3914	5	0.0783	2.79	0.1710	not significant
Pure Error	0.1123	4	0.0281			
Cor Total	1.82	12				

Table 8: Fit statistics for response factor spreadability.

Std. Dev.	0.2366	**R^2**	0.7238
Mean	9.54	**Adjusted R^2**	0.6318
C.V. %	2.48	**Predicted R^2**	0.685
		Adeq Precision	9.3016

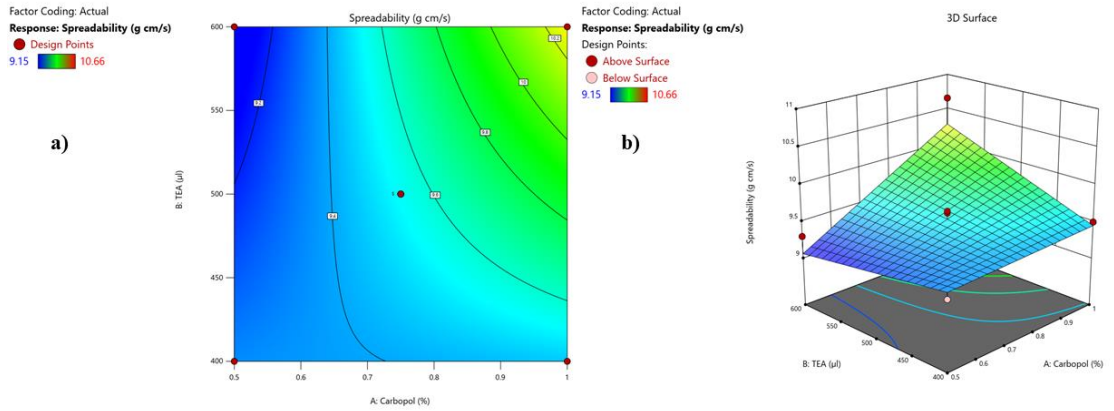

Fig. 4. a) Contour plot and b) 3D surface plot for the response factor spreadability.

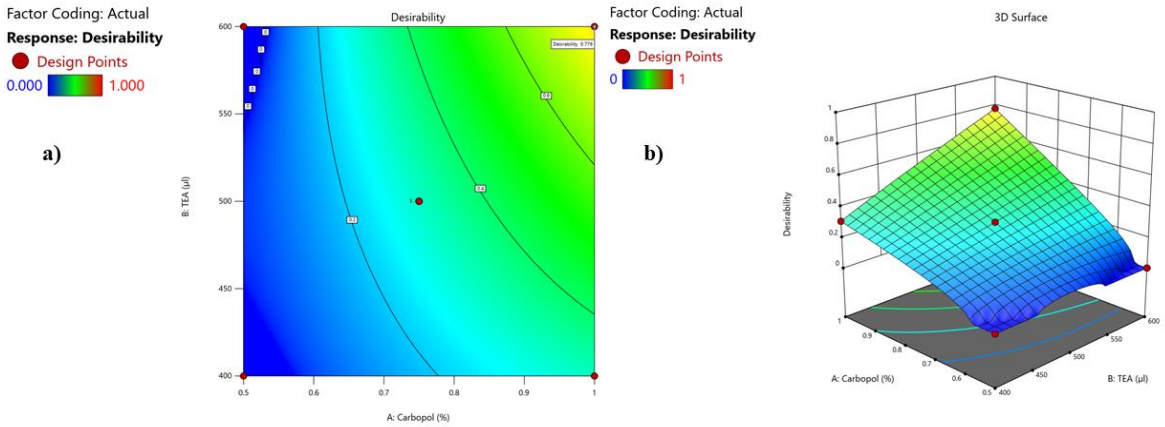

Fig. 5. a) Contour plot and b) 3D surface plot for desirability.

Physiochemical evaluation:

1. pH: The pH of the solution came to be 6.28 while the actual pH of the gel is 6.5.

2. Spreadability: The formula used to find the spreadability (S) is as follows, S = ML/T

Where, M is the mass of the object used to compress the gel, L is the distance extended by the gel in diameter, and T is the time taken.

M = 500g, L = 6.4cm, T = 300 s, S = 10.66 g cm/s. The spreadability of the gel is 10.66 g cm/s

3. Centrifugal: No noticeable instability in the formulation. The Consistency and the texture of the gel remained the same.

4. Viscosity: The viscosity of the gel is found to be 78.4 Poise

5. Stability test: Gel is exposed to different temperatures (25ºC, 45ºC, 4ºC) for 1 month and the test for pH, spreadability, and viscosity are taken. There were no comparable changes found in the gel which indicates the resulting gel is stable.

Antimicrobial activity. The formulated gel, AgNPs, and the *E.hirta* L extract showed good antimicrobial activity against *E. coli, S. aureus, P. acne, and C. albicans* (Table 9). For *P. acne and C. albicans*, there was no zone of inhibition formed by the control whilst there is a huge noticeable zone of inhibition formed by the samples (gel, extract, AgNPs).

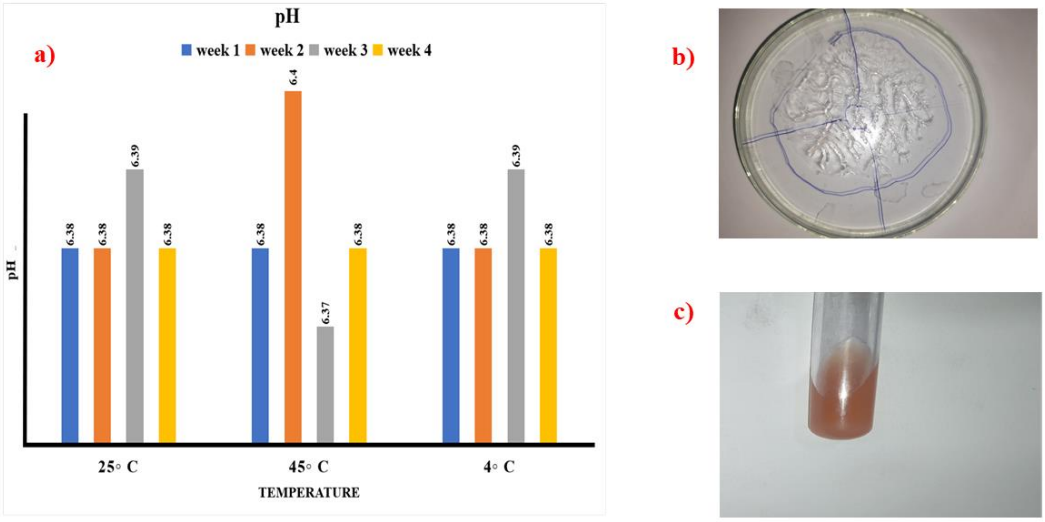

Fig. 6. Physiochemical and stability test for the formulated gel, a) pH test @ stability test, b) spreadability test, and c) centrifugal test.

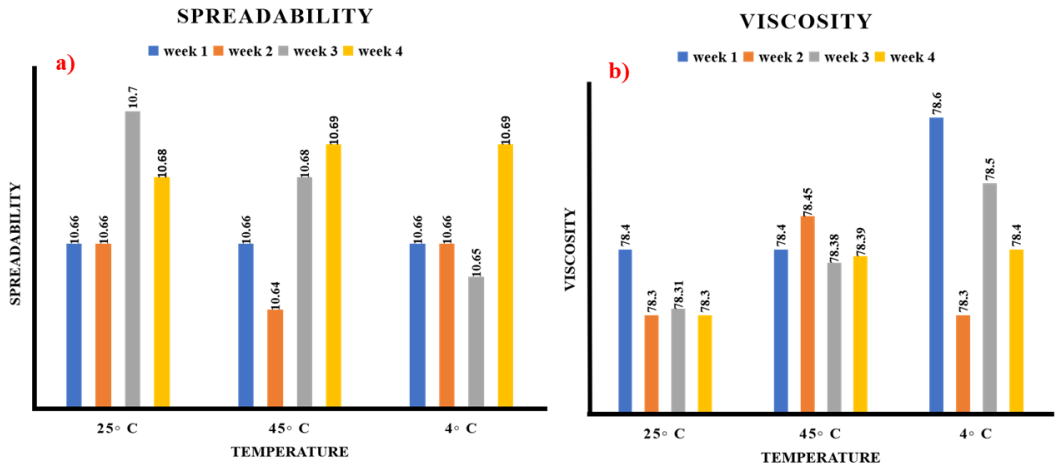

Fig. 7. This image shows the stability test for the formulated gel a) spreadability test and b) viscosity.

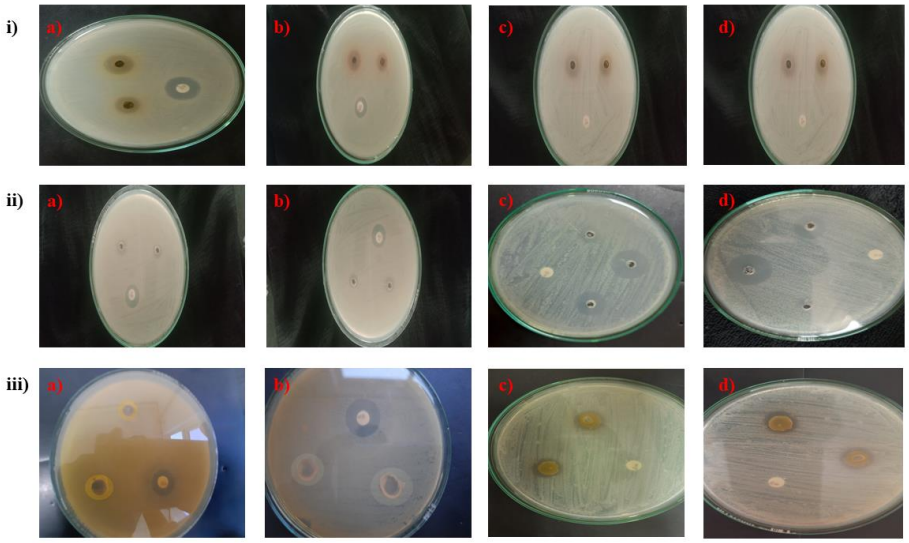

Fig. 8. Antimicrobial activity against a) *E. coli*, b) *S. aureus*, c) *C. albicans, and* d) *P. acne* for i) ethanolic extract of *Euphorbia hirta* L, ii) AgNPs, and iii) formulated gel

Table 9: Antimicrobial activity of *Euphorbia hirta* L extract, Silver nanoparticles (AgNPs), and the formulated gel.

Microorganism	Extract of *E. hirta*			AgNPs			Gel		
	Concentration (µl)	Zone of inhibition (mm)		Concentration (µl)	Zone of inhibition (mm)		Concentration (g)	Zone of inhibition (mm)	
		Extract	Control		AgNPs	Control		Gel	Control
E. coli	35	9.0±1.2	12.6±0.1	35	7.4±0.2	12.4±0.1	0.25	10.2±0.5	10.8±1.3
	50	12.3±0.4		40	9.2±0.7		0.5	11.2±0.3	
	-	-		-	-		-	-	
S. aureus	35	6.0±0.1	8.7±0.2	35	6.9±0.3	8.2±0.1	0.25	8.4±1.0	9.8±0.6
	50	10.5±0.3		40	9.8±0.1		0.5	10.6±0.8	
				-	-		-	-	
P. acne	35	6.8±0.6	-	10	4.7±1.2	-	0.25	11±0.5	-
	50	8.1±1.4		20	13±0.6		0.5	14±1.1	
	-	-		40	20±0.1		-	-	
C. albicans	35	6.9±1.2	-	10	8±0.9	-	0.25	10.8±1.2	-
	50	7.8±0.7		20	16±0.7		0.5	14.2±0.4	
	-	-		40	19.5±0.3		-	-	

According to Tran *et al. (*2020) there was no zone of inhibition formed by *E. hirta* against *E. coli* and *Staphylococcus*. According to Ogbulie *et al.* (2007) the zone of inhibition formed against *E. coli* (50mg/ml) and *Staphylococcus* (50mg/ml) is 0 and 7.8mm respectively. According to Olaoluwa *et al.* (2018) the zone of inhibition formed against *E. coli* (50mg/ml) and *Staphylococcus* (50mg/ml) is 12mm and 18mm respectively, also *Candida albicans* showed zone of inhibition around 16mm. According to Simanjuntak and Rahmiati (2021) the zone of inhibition formed by *E. hirta* L against *C. albicans* was 11.22 mm.

CONCLUSIONS

The formulated gel showed good properties of topical-like stability and the optimization describes the effectiveness of the formulated topical gel. The ethanolic extract of *Euphorbia hirta* L showed good antimicrobial activity, also the formulated gel incorporated *E. hirta* extract and AgNPs showed better activity against bacteria and fungi like *E.coli, S. aureus, P. acne, C. albicans*, respectively. These bacteria and fungi causes acne, cellulitis, cutaneous candidiasis, boils and furuncles. Antimicrobial activity showed that the formulated gel would cure the disease caused by those microbes. Therefore, we conclude that the resulting topical gel would be effective in curing skin infections.

FUTURE SCOPE

In the future, the developed topical gel would examined under invitro like cell culture studies and *in vivo*. We hope that the formulated gel would be marketed in the future for skin infections.

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Conflict of Interest. None.

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