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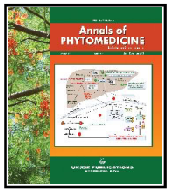

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Development and evaluation of polyherbal emulgel for antifungal activity

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Abstract

In the present study, the herbal combination comprising ginger, turmeric, clove oil, and neem has been incorporated into the emulgel for antifungal activity as these herbs are extensively well known for antifungal potentiality. The purpose of this research was to formulate topical emulgel, as emulgels have become a potentially effective method of delivering hydrophobic medications. The study's goal was to create an emulgel employing Carbapol 940 as a gelling agent made of ginger, turmeric, neem, and clove oil. In order to increase permeation, clove oil was employed. After being prepared, the emulsion was added to the gel base. The Rheological tests, spreading coefficient tests, and antifungal activity tests were performed on the formulations.

1. Introduction

Fungal skin infection ranks among the most prevalent dermatological issues worldwide. Fungal infections in people occur when an invasive fungus accumulates in a part of the body which is too big for the immune system to control. The most common fungal illnesses are dermatophytic infections and superficial candidiasis of the mouth, skin, or genital area (Kusum and Agarwal, 2019; Shoham and Levitz, 2005).

For many centuries, diagnosis of such infectious illness or chronic condition has primarily been achieved by delivering medication to patients *via* various pharmaceutical dosage forms such as tablets, capsules, cream, ointments, liquids, pills, suppositories, aerosols, and a variety of additional formulations as therapeutic applications (Gupte, 2015). Drug delivery through the skin is an efficient and specific treatment for local dermatological problems. Since it avoids the first-pass effects, gastrointestinal annoyances, and metabolic degradation that accompany oral medication, topical drug application has grown in favour (Kasar *et al*., 2018).

The dosage form that is applied directly to the surface of the skin or mucosal membranes is known as a topical drug delivery method. Topical drug administration methods come in a variety of forms, including solid, semisolid, and liquid. Patient compliance, ease of administration, optimized bioavailability of drugs, greater physiological and pharmacological response, reduced systemic toxicity and least exposure of drugs to non-infectious cells, easy closure of treatment, prevent unnecessary gastric compatibility issues, minimal fluctuation in plasma levels, and convenient for drugs with a narrow therapeutic window are all potential benefits of topical drug delivery (Sreevaidya, 2015; Jeurkar *et al*., 2022; Sah *et al*., 2017).

Several commonly used topical preparations, such as ointments, creams, lotions, and gels, have drawbacks such as instability issues, stickiness and poor spreading abilities, irritation, allergic responses, low permeability, and poor absorption. The majority of topical drug delivery methods have underperformed in the administration of hydrophobic drugs. To circumvent this limitation, an emulgel method was developed (Sah *et al*., 2017).

Emulgels are the dosage forms used when emulsions are combined with gel bases. Emulgels are emulsions, either of the water-in-oil or oil-in-water types, which are made gel-like by combining them with a gelling agent. Oil-in-water emulsions are best suited for general cosmetic application and serve as water washable medication bases, whereas water-in-oil emulsions are more frequently used for emollient activities and the healing of dry skin. Drugs that are hydrophobic can be made as emulgels because they have both an aqueous phase as well as an oil phase. Emulgels are now showing promise as a medication delivery mechanism in the field of dermatology (Kute and Saudagar, 2013).

2. Materials and Methods

2.1 Chemicals

Herbal extract powders of ginger, neem, curcuma, and clove oil were obtained from the local market, Nagpur depicted in Figure 1. Carbopol 940, span 80, Tween 20, methyl paraben, propyl paraben, propylene glycol, triethanolamine and distilled water were obtained from the laboratories of Kamla Nehru College of Pharmacy, Butibori. All the chemicals used were of analytical grade.

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2.2 Instruments

pH meter, brookfield viscometer, spreadability apparatus

2.3 Phytochemical analysis

The phytochemical analysis of the extracts of ginger, neem, and turmeric powders and clove oil was determined (Tura, 2019).

Figure 1: Ginger powder, Turmeric powder, Neem powder and Clove oil.

2.4 Formulation of emulgel

The oil phase and aqueous phase were combined for the formation of o/w or w/o emulsion. The emulsion was incorporated into the gel base and the emulgel was prepared (Khullar *et al*., 2012; Raju *et al*., 2019).

2.5 Preparation of emulsion

a) Aqueous phase

The liquid phase was created by combining Tween 80 with the powdered extracts of ginger, neem, and turmeric in adequate distilled water.

b) Oil phase

The oil phase has been prepared by combining clove oil and span 80. Methyl paraben and propyl paraben was dissolved in propylene glycol. Then both the solutions were mixed with prepared aqueous phase.

The water and oil phases has been incorporated and triturated until an emulsion is formed, which is indicated by a clicking sound.

2.6 Preparation of gel

The gel base was made by dispersing various carbopol concentrations in distilled water individually while stirring continuously at an even pace with a mechanical shaker and then storing for 24 h to allow adequate swelling.

2.7 Preparation of emulgel

To create the emulgel, the gel and emulsion was gently stirred together (Khullar *et al*., 2012; Raju *et al*., 2019).

Table 1: Composition of polyherbal emulgel

Ingredients	F1	F2	F3
Ginger extract (g)	0.5	0.8	01
Neem extract (g)	0.5	0.8	01
Turmeric extract (g)	0.5	0.8	01
Clove oil (ml)	0.5	01	1.5
Carbopol 940 (g)	01	1.5	02
Span 80 (ml)	1.25	1.25	1.25
Tween 80 (ml)	2.5	2.5	2.5
Methyl paraben (g)	0.15	0.15	0.15
Propyl paraben (g)	0.15	0.15	0.15
Propylene glycol (ml)	2.5	2.5	2.5
Triethanolamine (ml)	q.s	q.s	q.s
Water sufficient for 50g	q.s	q.s	q.s

Figure 2: Polyherbal emulgel (F1).

2.8 Phytochemical analysis of extracts (Tura, 2019)

The phytochemical tests were performed to check the presence and absence of carbohydrates, proteins, saponins, glycosides, steroids, tannins, terpenoids, flavonoids, anthraquinone and reducing sugars was tested.

2.9 Evaluations of emulgel

2.9.1 Physical appearance

Color, homogeneity, consistency, grittiness and phase separation of the produced emulgel are all assessed through visual inspection (Ambala and Vemula, 2015).

2.9.2 pH determination

The pH of the prepared emulgel was measured using a digital pH meter. 100 ml of distilled water and 1 g of an emulgel were combined, then let it sit for 2 h. The aforesaid solution was applied to a glass electrode, and the pH readings was recorded (Sultana *et al*., 2016).

2.9.3 Viscosity determination

Using spindle No. 7 of a brookfield viscometer, the viscosity of emulgel formulations was tested. In a beaker, the necessary amounts of the emulgels was added, and the viscosity was recorded at 100 rpm and 150 rpm (Khullar *et al*., 2012).

2.9.4 Spreadability test

The spreading coefficient was calculated using Mutimer's recommended equipment. It is made up of a solid block of wood with a pulley affixed to one end. The 'Slip' and 'Drag' properties of emulgels was used to calculate the spreading coefficient. The wooden block was mounted a ground glass slide. On this ground slide, more emulgel (approximately 1 g) from the research was applied. Then, a second glass slide with the same dimensions as the mounted ground slide was placed above this slide, and the emulgel mixture. The second glass slide has a hook attached to it. A certain amount of weight was added to the pan, which was hooked to the pulley. The top slide's time (in sec) needed to travel across a length of 15 cm was recorded. The spreading coefficient is better with a shorter interval (Kumar and Saxena, 2019).

It is determined by using the formula:

$$S = M.L/T$$

where,

S = Spreadability

M = Weight tied to upper slide

L = Length of glass slide

T = Time taken to separate the slide completely.

Figure 3: Spreadability apparatus depicting spreading ability of emulgel (F1).

2.9.5 Microbial examination of the emulgel

The formulated emulgel was inoculated into agar medium plates, and control was created by leaving out the cream. The plates was put in the incubator and kept at 37ºC for 24 h. Plates were removed from the incubation time and checked for microbial growth by comparing them to the control (Nair and Mathew, 2012).

2.9.6 Antifungal activity

The effectiveness of produced emulgel against fungi was tested using the agar-well diffusion technique. Commercial clotrimazole cream, an antifungal medication, was used as a standard and positive control. It is a topical antifungal cream with a broad spectrum of activity used to treat fungal skin diseases like ringworm, athlete's foot, diaper rash, sweat rash, and vaginal thrush (Deshmukh *et al*., 2022). The Kamla Nehru College in Nagpur provided the fungus strain of latent *Candida albicans.*

A gel borer was used to hole four wells on an agar plate. The fungal strain was uniformly distributed throughout the agar bed. Using a micropipette, we put emulgel samples into three of the wells above the agar bed and commercial clotrimazole cream into the fourth well. The different values of the inhibition zone have been recorded and assessed after 24 h of incubation at 37ºC (Manjunath *et al*., 2014).

3. Results

3.1 Phytochemical analysis

Table 2: Phytochemical analysis

Phytochemical tests	Ginger	Neem	Turmeric	Clove
Carbohydrates	++	++	––	++
Proteins	++	––	––	––
Glycosides	++	––	++	++
Steroids	++	++	––	++
Alkaloids	++	++	++	++
Flavonoids	––	++	++	––
Saponins	++	++	++	++
Anthraquinone	––	––	++	++
Tanins	––	++	++	++
Terpenoids	––	––	––	++
Reducing Sugar	++	––	++	++

++ Shows the presence of the phytochemicals, — Shows the absence of the phytochemicals

3.2 Physical appearance of emulgel

Table 3: Physical appearance

Formulations	Colour	Phase seperation	Grittiness	Homogenity	Consistency
F1	Yellow	None	––	++	++
F2	Yellow	None	––	++	++
F3	Yellow	None	––	++	++

3.3 pH determination of emulgel

Table 4: pH determination

Formulations	pH
F1	6.1
F2	5.7
F3	5.9

3.4 Viscosity determination

Table 5: Viscosity determination

Formulations	100 rpm	150 rpm
F1	1480	1440
F2	1456	1421
F3	1474	1433

3.5 Spreadability coefficient

Table 6: Spreadability test

Formulations	Spreadability coefficient (g.cm/sec)
F1	3.7
F2	2.5
F3	3.1

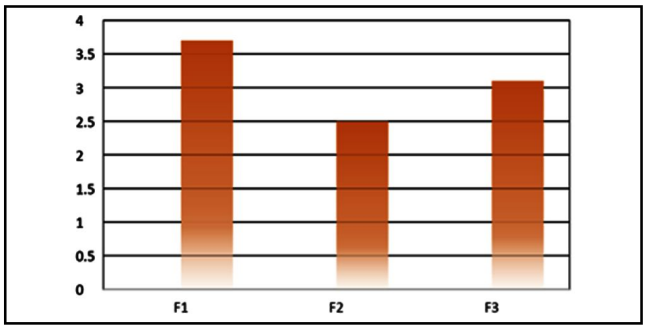

Figure 4: Graphical representation of spreadability coefficient.

3.6 Microbial examination

Figure 5: Microbial examination of the emulgel.

3.7 Antifungal activity

From the result, it was found that all formulations have satisfactory inhibition of fungal growth. It was observed that among all the samples, the inhibition rate of first sample F1 was greater.

Figure 6: Antifungal activity of emulgel formulations: Standard, F1, F2 and F3.

Table 7: Zone of inhibition

Formulations	Standard	F1	F2	F3
Zone of inhibition	26 mm	25 mm	22 mm	18 mm

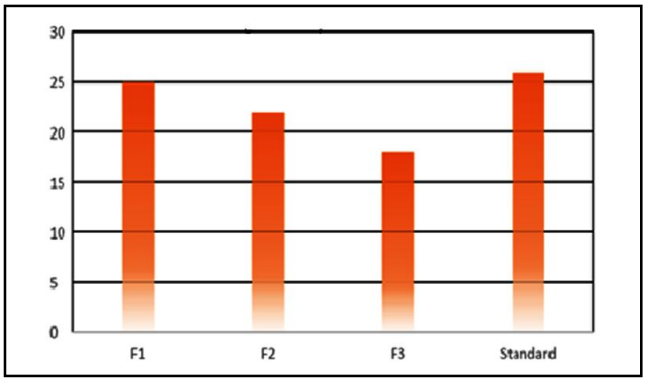

Figure 7: Graphical representation of antifungal activity.

4. Discussion

4.1 Phytochemical analysis

The phytochemical analysis of ginger extract showed the presence of carbohydrates, steroids, alkaloids, saponins and reducing sugar, while showed absence of flavonoids, anthraquinone, tannins and terpenoids. The neem extract showed the presence of carbohydrates, steroids, alkaloids, saponins, flavonoid and tannins, and absence of anthraquinone, tannins and reducing sugar. The turmeric extract showed the presence of alkaloids, saponins, flavonoids, anthraquinone, tannins and reducing sugar, and absence of carbohydrates, steroids and terpenoids. The clove extract showed the presence of carbohydrates, steroids, alkaloids, saponins, anthraquinone, tannins, terpenoids and reducing sugar, and absence of flavonoids as mentioned in table 2.

4.2 Physical appearance of emulgel

The physical appearance of the emulgel was shown in Table 3. The grittiness was absent and satisfactory homogeneity and consistency was present. The phase separation was not found in any of the formulations.

4.3 pH determination

The Formulations 1, 2 and 3 pH was noted using the pH meter. The pH of F1 was found to be 6.1 which was more as compared to other two formulations.

4.4 Viscosity determination

The viscosity of all the formulations was checked using the viscometer at 2 rpm, *i.e.,* 100 rpm and 150 rpm. The F1 viscosity was found to be more at 100 rpm as compared to the 150 rpm.

4.5 Spreadability test

The spreadability coefficient of the formulations was calculated with the help of formula. The coefficient noted in Table 6 indicates that F1 has more value as compared to F2 and F3.

4.6 Microbial examination

The absence of a zone of inhibition after being inoculated on agar proved that the formulation was devoid of microorganisms.

4.7 Antifungal activity

From the result, it was found that all formulations have satisfactory inhibition of fungal growth. It was observed that among all the samples the inhibition rate of the first sample F1 was greater.

5. Conclusion

The current study aimed to create and assess a polyherbal emulgel with antifungal characteristics. Several herbs, clove oil, neem powder, turmeric powder, and ginger powder were utilized to make emulgel. The wet gum technique is used to create the requisite emulsion for emulgel production. The physicochemical characteristics such as carbohydrates, proteins, glycosides, steroids, flavonoids, alkaloids, saponins, anthraquinone, tannins, terpenoids, and reducing sugar were assessed in the extracts of polyherbs. Physical appearance, pH, viscosity, and spreadability of emulgel were assessed. It was discovered that the optimized batch (F1) had a pH of 6.1, a viscosity of 1480 cp at 100 rpm, and a spreadability of 3.7 g cm/sec. The emulgel was subjected to a microbial investigation, and it was discovered that there were no bacteria present. When the antifungal activity of the optimized batch (F1) of emulgel was tested, it was discovered that the zone of inhibition for the optimized batch was substantially identical to that of the standard batch. Future plans for such research include animal tests for drug release and skin irritancy.

Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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