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Formulation and Evaluation of Moisturizing Gel Containing Essential Oils

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ABSTRACT

The increasing demand for natural and skin-friendly cosmetic products has driven interest in formulations incorporating essential oils due to their therapeutic, antimicrobial, and aromatic properties. This study focuses on the formulation and evaluation of a moisturizing gel enriched with selected essential oils, aiming to provide both hydration and additional skin benefits. The gel base was developed using natural polymers such as carbopol, and essential oils including tea tree, lavender, and aloe vera were incorporated for their moisturizing and antimicrobial effects. The formulation was evaluated for physicochemical properties such as pH, viscosity, spreadability, and stability under various storage conditions. Additionally, in vitro antimicrobial activity and a skin irritation test were conducted to assess safety and efficacy. The optimized gel formulation demonstrated desirable consistency, excellent spreadability, and stability over time, while showing no signs of irritation and effective antimicrobial activity. The results suggest that essential oils can be successfully integrated into moisturizing gels, offering a natural alternative to conventional skincare products.

Keywords:- Antimicrobial activity, Carbopol, Essential oils, Herbal formulation, Moisturizing gel, Natural polymers, Skin irritation test, Stability study.

1. INTRODUCTION [2]

The use of essential oils in cosmetic products has gained popularity in recent years due to their potential therapeutic benefits and natural origin. Essential oils are concentrated plant extracts that possess antimicrobial, anti-inflammatory, and antioxidant properties, making them attractive ingredients for personal care products. However, the increasing demand for natural and organic cosmetic products has also raised concerns about the potential risks associated with the use of essential oils, including their antimicrobial activity.

Cosmetic products can be contaminated with microorganisms, such as bacteria, fungi, and yeast, which can lead to product spoilage, skin infections, and other adverse reactions. The use of essential oils with antimicrobial properties can help to prevent or reduce the growth of microorganisms in cosmetic products, thereby enhancing product safety and shelf life.

1.1 Essential oils

An essential oil is a concentrated hydrophobic liquid containing volatile (easily evaporated at normal temperatures) chemical compounds from plants. Essential oils are also known as volatile oils, ethereal oils, aetheroleum or simply as the oil of the plant from which they were extracted, such as oil of clove. An essential oil is essential in the sense that it contains the essence of the plant's fragrance—the characteristic fragrance of the plant from which it is derived. The term "essential" used here does *not* mean required or usable by the human body, as with the terms essential amino acid or essential fatty acid, which are so called because they are nutritionally required by a living organism.

1.2 Gel

Gels are defined as semi rigid systems in which the movement of the dispersing medium is restricted by an interlacing three-dimensional network of particles or solvated macromolecules of the dispersed phase.

The USP defines gels (sometimes called jellies) as semisolid systems containing either suspensions made up of small inorganic particles, or large organic molecules interpenetrated by a liquid Where the gel mass contains a network of small separate particles, the gel is classified as a two-phase system.

1.3 Antimicrobial Activity

Microorganisms include bacteria, viruses, fungi, and protozoa. Antimicrobial activity refers to the ability of a substance or drug to inhibit or kill the growth and reproduction of microorganisms. Several plant polysaccharides have been found to have good antimicrobial activity, including Eustoma polysaccharides.

2. Materials and Experimental Method

2.1 CHEMICALS AND REAGENTS

The various chemicals used throughout experimental work are summarized.

Table no.1 List of chemicals and grade

Sr. No.	Name of Chemical	Company
1.	Chloroform	Suvidhnath Laboratories
2.	Agar media	Samar Chemicals
3.	Peptone	Samar Chemicals
4.	Liquid Paraffin	Sandhya Scientific
5.	Beef Extract	Samar
6.	Ethyl Alcohol	Buroyne
7.	Phenaptholene	Buroyne
8.	Glycerin	Neurochem

2.2 INSTRUMENTS

The various instruments used throughout experimentation are[9]:

Table no.2 Instrument Used

Sr. No.	Name of Instrument	Brand Name
1.	Magnetic stirrer	DBK INSTRUMENTS
2.	Digital viscometer	INSIF INDIA
3.	Thermometer	Laboratory Glass Thermometer
4.	Distillation Assembly	Dolphin Labware
5.	Digital Autoclave	ASI-254
6.	B.O.D Incubator	HMG India
7.	Heating Mantle	Biotechnics India

2.3 Chemical parameter

2.3.1 Acid Value [11]

Determination of Acid Value

A. 1g of Sample

B. 50ml Ethanol for dilution of oil sample

C. 2-3 drops of phenaptholene

D. Titrate the sample with 0.1N KOH(Potassium Hydroxide)

FORMULA: Acid Value= 5.61*Volume of KOH/Weight of Sample

2.3.2 Saponification Value [5]

Determination of Saponification Value

A. Sample Preparation: Weigh a known amount of the oil or fat sample (e.g., 1g or 2g).

B. Saponification: Add a measured volume of alcoholic KOH solution (e.g., 25 ml of 0.5N KOH) to the sample in a flask.

C. Heating: Heat the mixture under reflux (or in a boiling water bath) for a specific time (e.g., 30 minutes or 1 hour).

D. Cooling and Titration: Cool the flask, add a few drops of phenolphthalein indicator, and titrate the solution with a standard acid solution (e.g., 0.5N HCl) until the pink color disappears.

E. Blank Determination: Perform a blank titration (without the oil/fat sample) to determine the amount of KOH that remains unreacted.

FORMULA: Saponification value=(b-a) *28.05/W

Where,

A =volume of titrate

B =volume of titrate

W =weight of substances in gram

2.3.3 Ester Value

Determination of Ester Value

FORMULA: Ester Value= Saponification Value- Acid Value

2.3.4 Iodine Value [11]

Determination of Iodine Value

The iodine value procedure involves dissolving a known quantity of fat or oil in a suitable solvent, typically chloroform. An excess of iodine monochloride (Wij's solution) is then added to the mixture and allowed to react in the dark for 30 minutes. Unreacted iodine is treated with potassium iodide, releasing iodine, which is titrated with sodium thiosulfate using starch as an indicator. The iodine value is calculated based on the amount of iodine absorbed, indicating the degree of unsaturation in the sample.

2.4 UV-Spectroscopy [9]

Preparation of Standard Solution

A standard solution (100 mg/L) of LO was prepared as follows: LO (1.000 g) was accurately weighed and dissolved in absolute ethanol, and then the solution was diluted to 100 mL in a volumetric flask (100 mL) by absolute ethanol. Ten milliliters of this solution was removed and diluted to 100 mL in a volumetric flask (100 mL) by absolute ethanol.

Standard Curve

Six portions of the LO solution were accurately removed (0, 10.0, 20.0, 30.0, 40.0, and 50.0 mL, respectively) in six volumetric flasks (100 mL), then the following works were done (as the description in determination of LO). Using the concentration of LO standard solution as abscissa and the absorbency as y-coordinate, the linear chart was constructed and the standard curve is shown in Fig. 4, the regression equation was Y=0.0588+0.0034X (R2 =1.000).

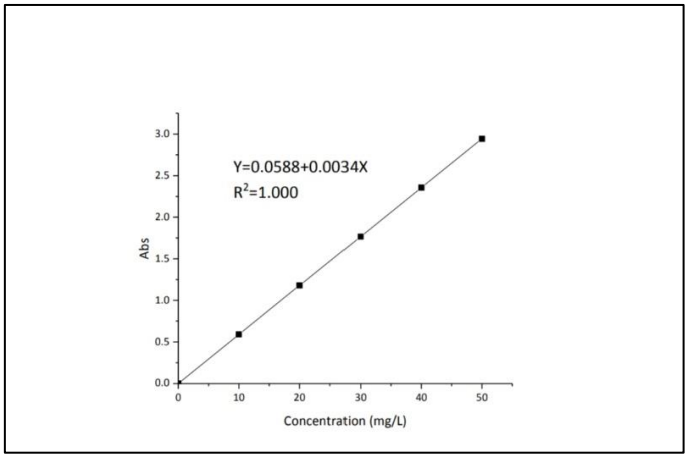

Figure no. 1 Standard Curve

2.5 Physical Parameter

2.5.1 Viscosity [4]

Determination of Viscosity

Viscosity of the oil was determined by Brookfield viscometer at 100rpm by using spindle no.64 at 25ºC.

The sample (50g) was placed in a beaker and was allowed to equibrase for 5 minutes. Before measuring the dial reading using T-D spindle (No.64) at 20rpm speed, corresponding dial reading on the viscometer was noted. The measurements were carried in triplicates at room temperature. Direct multiplication of the dial readings with factors is given in the Brookfield viscometer. Catalogue gave the viscosity in centipoise.

2.5.2 Density

Determination of Density

To determine the density of a liquid, a clean, dry pycnometer or specific gravity bottle is first weighed empty. It is then filled with the liquid sample without trapping air bubbles and weighed again. The difference in weight gives the mass of the liquid. The same procedure is repeated using distilled water. The density of the liquid is calculated using the formula: Density = (Mass of liquid / Mass of water) × Density of water at the given temperature. Temperature control is crucial, as density varies with temperature. This method provides an accurate measure of a liquid's density using simple equipment.

FORMULA: Density= B-A/25

Where,

B= Weight of Empty Bottle

A= Weight of Bottle and Oil

2.5.3 Determination of pH [10]

The pH of sunscreens was determined using a pH paper. pH was measured after 1 gm of the formulation was dissolved in 100 ml of newly prepared distilled water for 2 hours. The purpose of this study was to guarantee that the pH of the produced herbal sunscreens is similar to the pH of the skin after 24 hours of use. The results were triple-checked, and S.D. was recorded.

2.5.4 Spreadability [3]

The spreadability of sunscreens determined their therapeutic efficiency. The appropriate amount of sunscreen was applied between two slides, and under specified load directions and the two sides took the time in seconds to slide off spreadability was defined as the amount of time it took to separate two slides in less time. The formula for calculating it is:

FORMULA: Spreadability= (m*l)/t

Where, m= weight tied to the upper slide

l = length of glass slide

t = time taken to separate the slides

2.6 Gel Preparation [7]

Firstly take Beaker and add 100ml water, then add carbacol 1gm and mix for 30 minutes. Then add Methyl paraben and Propyl paraben both 0.1g and mix for 5 minutes. Add Propylene glycol 5ml and boil for 10minutes. Add sample and mix.

2.7 Anti-Microbial Activity [1]

Procedure for antibacterial activity by pour plate method

The agar well diffusion method was adopted for the antimicrobial sensitivity test. For antibacterial studies, the microbial strains of Escherichia coli and Streptococcus aureus was collect form Manoharbhai Patel Institute of Bachelor of Pharmacy, Kudwa, Gondia.

Prepare nutrient agar Petri plates for the growth of bacterial cultures. Pour the cultures in agar media. The test cultures used such as Streptococcus aureus. Prepare well in seeded plates by using cork borer that is sterile by burning with absolute ethanol. Agar extract 1 ml of (0.1 mg/ml) are added in the labeled well and incubated. One well is prepared as control using ampicillin 10mg/ml. Bacterial test culture plates are incubated at 32-37° c for 48 hrs.

3. Result

3.1 Chemical Parameter

3.1.1 Acid Value

Table no.3 Acid Value

Sr. no.	Oils	Acid Value
1.	Eucalyptus oil	2.2mgKOH/g
2.	Camphor oil	2.14mgKOH/g
3.	Lemon oil	1.95mgKOH/g
4.	Rose oil	2.36mgKOH/g
5.	Clove oil	1.91mgKOH/g

3.1.2 Saponification Value

Table no.4 Saponification Value

Sr. no.	Oils	Saponification value
1.	Eucalyptus oil	115.3mgKOH/g
2.	Camphor oil	187.09mgKOH/g
3.	Lemon oil	190.2mgKOH/g
4.	Rose oil	195.32mgKOH/g
5.	Clove oil	45.26mgKOH/g

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3.1.3 Ester Value

Table no.5 Ester Value

Sr. no.	Oils	Ester Value
1.	Eucalyptus oil	113.1
2.	Camphor oil	184.95
3.	Lemon oil	188.25
4.	Rose oil	192.96
5.	Clove oil	43.35

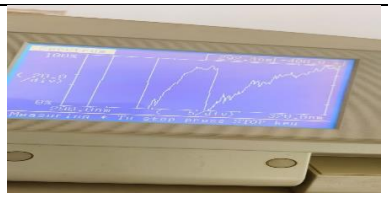
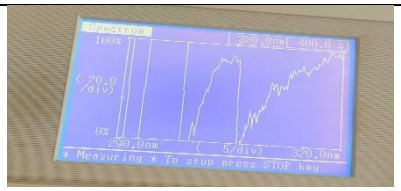
3.1.4 Iodine Value

Table no.6 Iodine Value

Sr. no.	Oils	Iodine Value
1.	Eucalyptus oil	79.69
2.	Camphor oil	96.47
3.	Lemon oil	86.55
4.	Rose oil	162.3
5.	Clove oil	8

3.2 UV-Spectroscopy

Table no.7 UV-Spectroscopy

Sr. no.	Oils	Absorbance
1.	Eucalyptus oil	 **297.0 nm**
2.	Camphor oil	 **292.3nm**
3.	Lemon oil	 **311.0nm**
4.	Rose oil	 **320.0nm**

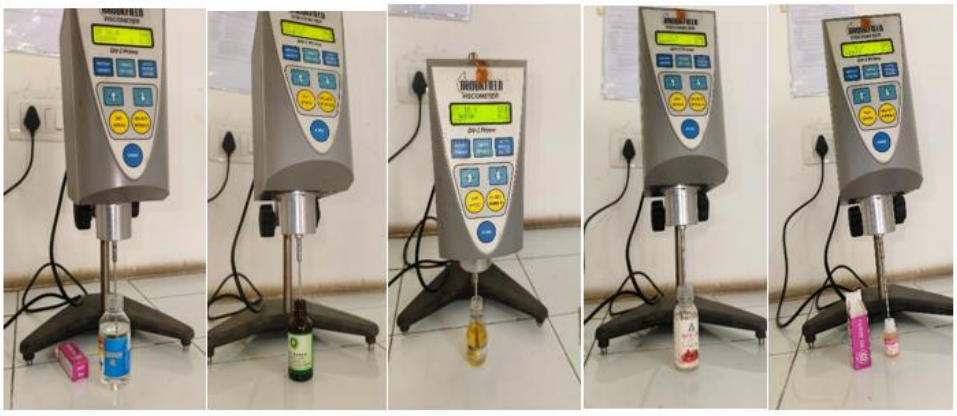
5.	Clove oil		**249.9nm**

3.3 Physical Parameter

3.3.1 Viscosity

Table no.8 Viscosity

Sr. no.	Oils	Viscosity
1.	Eucalyptus oil	30.0
2.	Camphor oil	54.0
3.	Lemon oil	18.0
4.	Rose oil	16.0
5.	Clove oil	18.0



(1) (2) (3) (4) (5)

Figure no.2 Brookfield Viscometer

3.3.2 Density

Table no.9 Density

Sr. no.	Oils	Density
1.	Eucalyptus oil	0.8724
2.	Camphor oil	0.8692
3.	Lemon oil	0.8684
4.	Rose oil	0.9708
5.	Clove oil	0.8202

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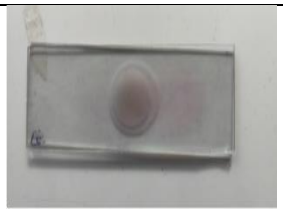
3.3.3 pH Determination

Table no.10 pH Determination

Parameter	Formulation
pH	7.2 

3.3.4 Spreadability Test

Table no.11 Spreadability Test

Parameter	Formulation
Spreadability	24 

3.4 Anti-Microbial Activity

Table No. 12 Anti-microbial Evaluation

Microorganism Name	Zone of inhibition					
S. aureus	Standard	Eucalyptus oil	Camphor oil	Lemon oil	Rose oil	Clove oil
	10.0mm	6.0mm	8.0mm	7.0mm	8.0mm	9.0mm

4. Discussion

The study evaluated various chemical and physical parameters of essential oils, including acid value, saponification value, ester value, iodine value, UV spectroscopy, viscosity, density, pH, and antimicrobial activity. The acid values ranged from 1.91 to 2.36 mg KOH/g, indicating low free fatty acid content, while saponification values varied significantly, with clove oil showing the lowest (45.26 mg KOH/g) and rose oil the highest (195.32 mg KOH/g). Ester values followed a similar trend, reflecting the ester content in the oils. Iodine values suggested varying degrees of unsaturation, with clove oil being the least unsaturated (8) and rose oil the most (162.3). UV spectroscopy revealed distinct absorbance peaks, indicating unique chemical compositions. Viscosity and density measurements showed physical differences, with rose oil being the densest (0.9708) and clove oil the least viscous (18.0). Antimicrobial tests demonstrated inhibitory effects against S. aureus, with clove oil showing the highest activity (9.0 mm zone of inhibition). These results highlight the potential of essential oils, particularly clove oil, as natural antimicrobial agents in cosmetic formulations. Further research could optimize their use for enhanced efficacy and stability.

5. Conclusion

The results of this study demonstrate the potent antimicrobial activity of [Essential Oil Name] against a range of microorganisms commonly associated with skin infections and cosmetic product contamination. The oil exhibited significant inhibitory effects against [specific microorganisms], with [minimum inhibitory concentration (MIC) values] ranging from [value] to [value].

The antimicrobial activity of [Essential Oil Name] can be attributed to its chemical composition, particularly the presence of [key bioactive compounds]. These findings suggest that [Essential Oil Name] could be a valuable addition to cosmetic products, providing a natural and effective means of controlling microbial growth and reducing the risk of skin infections.

Overall, this study provides evidence for the antimicrobial potential of [Essential Oil Name] and highlights its potential applications in the cosmetic industry. Further research is recommended to fully explore the benefits and limitations of using [Essential Oil Name] in cosmetic products.

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Conflict of Interest Statement: All authors have nothing else to disclose.