DEVELOPMENT AND ASSESSMENT OF HERBAL NAIL POLISH UTILIZING CLOVE OIL AS ANTIMICROBIAL AGENT

Meenakshi V*, Nandhini Devi M[2], Manikandan V[1], Balaji R[1]

[1]Department of Pharmaceutics, Karpagam College of Pharmacy, Coimbatore, Tamilnadu, India.
[2]Department of Pharmacology, Karpagam College of Pharmacy, Coimbatore, Tamilnadu, India.

Corresponding author: meena.venkat3099@gmail.com

ABSTRACT

The present study involves the formulation and evaluation of a novel herbal nail polish utilizing clove oil as a natural antimicrobial agent. With growing concerns over the side effects and toxicity of conventional cosmetic products, the formulation was designed to offer a safer and eco-friendly alternative. The nail polish was prepared using ethyl cellulose and polyvinyl pyrrolidone as film formers, with ethyl acetate and ethanol as solvents. Clove oil was incorporated for its broad-spectrum antimicrobial properties, while salicylic acid, propylene glycol, and glycerine were added to enhance nail softness, flexibility, and moisture retention. The formulation underwent comprehensive physical evaluations—such as drying time, consistency, gloss, and water resistance—and was also tested for antimicrobial activity against *Staphylococcus aureus* and *Escherichia coli* using the agar well diffusion method. The formulation showed acceptable physical properties and demonstrated a zone of inhibition of 14 mm against *S. aureus* and 25 mm against *E. coli*, indicating moderate antimicrobial efficacy. The findings support the potential of clove oil-enriched herbal nail polish as a multifunctional cosmetic product with both beautifying and therapeutic benefits.

KEYWORDS: Herbal formulation, Nail polish, Clove oil, Antimicrobial activity, *Staphylococcus aureus*, *Escherichia coli*, Transungual drug delivery, Natural cosmetics.

INTRODUCTION

Cosmetics have become an integral part of personal care and grooming, with nail polish being widely used to enhance the appearance and protect the surface of fingernails and toenails. Traditional nail polishes, though effective in beautification, often contain hazardous chemicals such as formaldehyde**,** toluene, and dibutyl phthalate**,** which are associated with skin irritation**,** allergic reactions**,** and environmental toxicity**.** In response to these concerns, the demand for herbal and natural cosmetics has significantly increased, prompting the development of safer and more biocompatible alternatives. Herbal nail polish formulations incorporate plant-derived ingredients that offer both cosmetic appeal and therapeutic benefits**.**

Among these, clove oil (*Syzygium aromaticum*) is a promising natural agent known for its strong antimicrobial**,** antifungal**,** and analgesic properties, largely attributed to its active component, eugenol**.** Its inclusion in topical formulations has been studied for treating microbial infections and promoting healing. The concept of transungual drug delivery**—** transport of active agents through the nail plate—has emerged as an innovative approach for managing localized nail disorders such as onychomycosis**,** paronychia**,** and nail psoriasis. Nail polish-based drug delivery systems offer the dual advantage of providing a cosmetic finish while ensuring controlled and localized release of therapeutic agents.This study aims to develop a herbal nail polish formulation containing clove oil as an antimicrobial agent**,** assess its physicochemical properties**,** and evaluate its antimicrobial efficacy against common pathogens such as *Staphylococcus aureus* and *Escherichia coli*. The overall objective is to establish a safe, effective, and eco-friendly nail care product that combines aesthetic value with therapeutic functionality.[1-4]

REQUIREMENT:

Ethyl cellulose, Ethanol, Ethyl acetate, Propylene glycol, Salicylic acid, Poly vinyl pyrrolidone (PVP), Glycerine, Clove oil, Saffranine.

Nail polish for Transungual drug delivery:

Transungual drug delivery is defined as the system which is related to drug transport across the nail to gain targeted drug delivery in treatment of nail diseases. In the term Transungual, “Trans” denote “through” and “unguis” denote “nails”.

Transungual delivery systems, including drug-containing Nail polish, are an innovative way to administer medications through the nail. These formulations consist of an organic solution containing a film-forming polymer and the active drug, designed to penetrate the nail and deliver the medication effectively to the underlying tissues. This delivery method is particularly advantageous for treating conditions such as on chomycosis, paronychia, nail psoriasis, and other localized nail disorders.

Nail polish can be defined as viscous or semi-liquid preparations that are applied to human fingernails or toenails to decorate and/or protect the nail plate. Conventional nail polish have been used as cosmetics since a long time for beautification and protection of nails. It protects the nail plate, but more importantly it enhances their beauty, imparting color and luster.

Herbal nail polish is a natural alternative to conventional nail polish, formulated without harmful chemicals like formaldehyde, toluene, and phthalates. Instead, it uses plant-based ingredients, such as botanical extracts and essential oils, which not only provide color and shine but also nourish and protect the nails.[5-7]

Characteristics of Nail polish:

➢Should be safe for the skin and nails and should not lead to any harmful effects.

➢ Should form a uniform and satisfactory film on the nails.

➢Should have good wetting and flow properties and should be viscous in nature in order to form an appropriate film.

➢ The distribution of colour should be uniform.

➢ Should possess sufficient adhesive property so that it may uniformly adhere to the nail without slipping.

➢Should possess the required flexibility so that it may not become brittle and crack upon application.

➢Should have reasonable drying time (1-2 minutes).

➢ Should be able to preserve all the properties at least for a week after its application.

Benefits of Herbal Nail Polish Over Synthetic Nail polish:

➢ The natural ingredients often include nourishing oils and botanical extracts that promote stronger, healthier nails, reducing brittleness and breakage.

➢ Herbal formulations typically offer hydration, helping to prevent dryness and keep nails moisturized.

➢ With fewer synthetic chemicals, herbal nail polish is less likely to cause allergic reactions or irritate sensitive skin.

➢ Many herbal formulas are designed to be chip-resistant, providing a longer-lasting manicure without the harsh chemicals.

Drawbacks of synthetic nail polish:

➢ Thins natural nails and makes them weaker.

➢ Chemicals irritate the skin around the nails and are absorbed into the skin and blood stream.

➢ Readily dries on skin and makes it dehydrated.

➢ Often causes allergic reactions.

➢ Chemicals like toluene, formaldehyde, dibutyl phthalate are toxic to the environment.

Constituents of Nail polish:

Film forming agent: when Nail polish is applied, the solvent evaporates, leaving the polymer to form a film on the nail.

Example: Nitrocellulose, Ethyl cellulose, vinyl polymers and various polymers of methacrylate.

Plasticizers: They impart flexibility and adhesiveness to the film and also effects viscosity, volatility and rate of drying and also makes the nail polish last longer.

Example: Dibutyl phthalate, camphor, triphenyl phosphate, castor oil.

Resins: Enhances the glossy nature of the nail polish and also impart adhesive property. To make sure that the nitrocellulose stick to the nail plate's surface.

Example: shellac, benzoin, formaldehyde resins.

Dyes and pigments: The dyes and pigment are imparted in colour.

Example-Chromium oxide greens, ferric ferrocyanide, titanium dioxide.

Thickening agents: The thickening agent used to maintain the sparkling particles in suspension while in the bottle.

Example: Stearalkonium hectorite

Ultraviolet stabilizers: Ultraviolet stabilizer is used to resist colour changes when the dry film is exposed to sunlight.

Example: Benzophenone-1

FORMULATION OF NAIL POLISH:

➢Film forming material (Ethyl acetate) was triturated into mortar pestle and make free flowing powder.

➢Ethyl cellulose and resin were dissolved into ethyl acetate and stirred for 20 min (solutionA).

➢API (Clove oil) was suspended into plasticizer (Propylene glycol) and mixed well in separate beaker was added to solution A.

➢ Further, add desired amount of salicylic acid and glycerine.

➢ Pigment was added to the solution and stirred for 20 min.

➢Transfer all content in to suitable container.[7-8]

INGREDIENTS	PURPOSE	QUANTITY
Ethyl cellulose	Film former	1gm
Ethyl acetate	Solvent	2ml
Ethanol	Solvent	1ml
Glycerine	Humectant	0.5ml
Propylene glycol	Plasticizer	0.5ml
Salicylic acid	Softness	0.01gm
Poly vinyl pyrrolidone	Film former	1gm
Clove oil	Anti-microbial agent	1ml
Safranine	Colouring agent	0.001gm

Table 1: Formulation of nail polish

Fig1: Final product

EVALUATION OF NAIL POLISH:

Physical evaluation:

The physical appearance of the formulation was checked visually.

➢ **Colour**: The colour of the formulation was checked out against white background.

➢ **Odour:** The odour of the nail polish was checked by manually.

➢ **Consistency:** The consistency was checked by applying on nail.

➢ **Grittiness:** The product was checked for the presence of any gritty particles by applying it on the nail.

Determination of Drying Time:

Apply material on the nail of the thumb with the help of a nail polish brush in a usual manner. Start stopwatch. Touch the film with the finger at a frequent time interval. When the film becomes dry on touch stop the watch and note the time. The time recorded is taken as drying time. The test shall be conducted away from direct air.

Smoothness to flow:

The sample was spread on the glass slide. The glass slide was then raised vertically.

Gloss:

The sample covered the nail in an even layer. The gloss and the marketed cosmetic nail polish were visually compared.

Water resistance test:

It was carried out to evaluate the water-permeability resistance. On a glass slide, a continuous film was applied, allowed to dry, and then the film was submerged in water. Before and after immersion, the weight of the glass slide was measured, and the weight gain was determined. It was calculated by using formulae,

Water resistance = Loss of the weight of lacquer /Actual weight × 100

ANTIMICROBIAL EVALUATION[9-11]

The minimum inhibition concentration determines the lowest concentration of an antimicrobial agent that prevents the visible growth of microorganism. Formulation was tested for antimicrobial activity against test organisum *staphylococcus aureus* and *Escherichia coli* using agar well plate method. Both Gram-positive and Gram –negative strains were cultured using nutrient broth.

Medium: Muller-Hinton agar

Standard: Ciprofloxacin.

Procedure:

Agar well diffusion method[12-15]

1. The bacteria *S.aureus* and *E.coli* was inoculated by swabbing on the surface of Muller-Hinton agar media plate.

2. Wells of 6-8 mm in diameter was performed in the MHA media and each well filed with 100 microliter of extract, formulation, standard respectively.

3. The plates were kept in laminar air flow for 30 minutes for proper diffusion of gel and thereafter incubated for 24 hours. The radius for the zone of inhibition was measured and compared against standard (ciprofloxacin) and recorded

RESULTS AND DISCUSSIONS:

Evaluation of formulations:

Results of physical evaluation:

PARAMETER	OBSERVATION
Colour	Pink
Odour	Distinct
Consistency	Viscous
Grittiness	Nil
Drying time	72 seconds
Smoothness of film	Free of foreign particles
Water resistance	0.68

Results of physical evaluation:

Fig3: Colour – Pink

Fig4: Smoothness of film

Fig4: Drying time

Fig5: Water resistance

Results of antimicrobial evaluation:

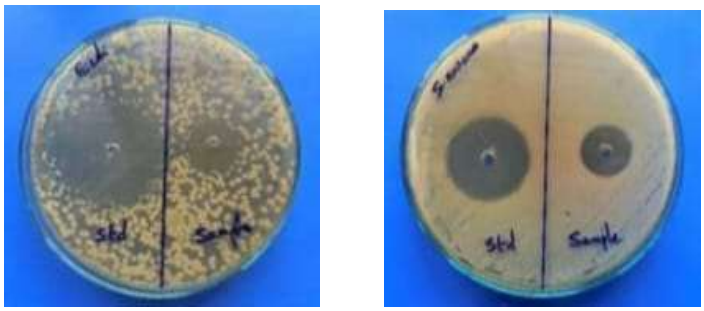

Fig7: Antibacterial activity of clove oil against *E.coli* and *S.aureus*

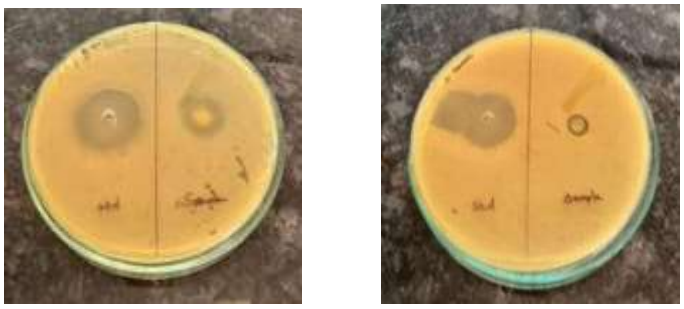

Fig8: Antibacterial activity of formulation against *E.coli* and *S.aureus*

Antimicrobial evaluation:

Results of antimicrobial evaluation:

SAMPLES	ZONE OF INHIBITION (mm)	
	S.aureus	***E.coli***
Ciprofloxacin	42	53
Clove oil	26	28
Formulation	14	25

CONCLUSION:

The study reveals that the developed nail polish with herbal active ingredient Clove oil as anti-microbial agent, medicated nail polish is formulated to provide the requisite sustained medication release, better drug permeation, and desirable anti-microbial effectiveness.

Based on physical evaluation of formulated nail polish, showed good appearance, consistency, drying time and smoothness. Clove, being a natural product, can offer more safety to people and environment, and is considered to be less of risk for resistance development by pathogenic microorganism. Formulation of nail polish with herbal active ingredient make it more effective over synthetic products.

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