

Formulation and Evaluation of Essential Oil Based Anti Bacterial Hand Sanitizer Gel

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ABSTRACT: Hand sanitizers and antiseptics play a critical role in healthcare settings to prevent the transmission of harmful microorganisms through hand and skin contact. There's a growing interest in integrating essential oils into hand sanitizer formulas to mitigate potential adverse effects linked with conventional options. However, the widespread production of homemade hand sanitizers raises concerns about their quality. Therefore, this study aims to develop an optimal hand sanitizer formula. The increasing popularity of herbal-based antibacterial sanitizers is attributed to their fewer side effects compared to synthetic compounds. Amidst the COVID-19 pandemic, various disinfectants are extensively used to control viral spread, with essential oils emerging as potential antimicrobial agents. This research focuses on creating a pleasantly scented hand sanitizer by incorporating herbal oils like eucalyptus, tea tree, rose, and aloe vera gel, alongside other additives. The sanitizer formulation is prepared using the dispersion method, incorporating denatured alcohol, Carbopol 940, polysorbate 20, glycerine, triethanolamine, and preservatives.

The primary objective is to develop an alcohol-based herbal hand sanitizer for effective antimicrobial purposes. A controlled trial was conducted to explore the effects of a disinfectant containing eucalyptus oil, tea tree oil, and rose oil on hand disinfection and skin condition. The prepared formulations underwent comprehensive testing to assess their sensory attributes, physical and chemical properties, and stability. Moreover, the antimicrobial effectiveness of the formulated alcohol-based herbal hand sanitizer was evaluated against *Escherichia coli*, *Staphylococcus aureus*, and *Bacillus subtilis* using the agar well disk diffusion technique. The results indicate that formulation F7 demonstrated superior pH, viscosity, antimicrobial activity, and stability. This study highlights the potential of incorporating essential oils into hand sanitizer formulations to

develop products that not only effectively combat pathogens but also offer a pleasant fragrance and ensure optimal safety.

KEYWORDS: Hand sanitizers, Essential oils, Safety, anti-microbial, Preservatives.

I. INTRODUCTION

Hygiene is the act of maintaining cleanliness, particularly in relation to the skin, which helps prevent diseases and ensures overall well-being. (1) Hands transmission pathogenic mode is of microorganisms a primary opportunistic such as *Escherichia coli*, *Staphylococcus aureus*, and *Pseudomonas* spp. that primarily cause nosocomial infections. Generally, these organisms are known to cause infections in various organs, including the skin. (2)

The skin, being constantly exposed to daylight and environmental pollutants, is prone to various conditions such as eczema, warts, acne, psoriasis, rashes, and allergic reactions. Protecting the skin from harmful microorganisms and preventing the spread of skin infections is crucial. Hand hygiene, particularly hand cleaning, plays a vital role in this regard. Hand sanitizers are widely used hygiene products designed to prevent and eliminate germs, viruses, and bacteria, especially on the hands. They offer convenience and ease of use compared to other cleaning products. Hand sanitizers come in various forms, including gel, foam, and liquid solutions. Denatured alcohol (ethanol) typically serves as the active ingredient, with additional ingredients such as polyacrylic acid for gel thickening, glycerine for liquid rubs, polypropylene glycol, and plant essential oils. Compared to soap, alcohol-based hand sanitizers are more effective at killing a wide range of microorganisms and are less drying to the hands. The alcohol content in hand sanitizers typically ranges from 60% to 81%, with 62% being the most common concentration. They effectively destroy bacteria, fungi, and certain viruses.

Alcohol-based hand sanitizers have been shown to improve hand hygiene compliance and significantly reduce infection rates, particularly in healthcare settings. Numerous laboratory studies have demonstrated their effectiveness in reducing bacterial test organisms such as *Escherichia coli* and *Staphylococcus aureus* to a greater extent than soap and water. Field studies among various groups, including veterinary staff workers in Canada, livestock handlers in the US, and mothers visiting health clinics in Tanzania, have also confirmed the efficacy of alcohol-based hand sanitizers in reducing bacterial infections. (3-5)

This study assessed formulations comprised of natural ingredients, including glycerine and various essential oils (EOs), which are readily available on the market. Glycerine is known for its moisturizing properties, while EOs serve as the main active ingredient in the gel, offering a broad spectrum of antibacterial activity. The hydrophobic nature of EOs facilitates the distribution of active components in bacterial cell membranes and mitochondrial lipids, thereby disrupting cell membrane integrity and exhibiting antibacterial effects. (6-8)

Hand sanitizer in gel form offers several advantages over liquid (spray) or foam formulations. Gels form a protective layer on the application site and provide longer-lasting protection to the skin compared to other forms of hand sanitizers. They have a longer retention time, offer better moisturization, and adhere more effectively to the skin. (9)

EOs are aromatic oily liquids derived from plants, consisting of compounds such as terpenes and their oxygenated derivatives. Numerous studies have demonstrated the antiseptic, antibacterial, antiviral, antioxidant, anthelmintic, antifungal, and insecticidal properties of EOs. They exert antibacterial effects by disrupting bacterial cell walls and membranes, leading to cell lysis and release of intracellular components. Due to their flavour characteristics, EOs are widely used in the food and cosmetics industries. The study aimed to formulate and characterize hand sanitizers using camphor, tea tree, and lemongrass EOs and compare their effectiveness against commercial gels using various bacterial strains. (10-12). Research indicates that EOs possess significant antiseptic, antibacterial, antiviral, antioxidant, anti-parasitic, antifungal, and insecticidal properties. Their antimicrobial activity is attributed to their ability to disrupt bacterial cell walls and

membranes, leading to cell lysis and release of intracellular components.

One alternative to alcohol for its antibacterial properties is the *Eucalyptus* species. *Eucalyptus*, known for its production of essential oils, particularly in its leaves, is frequently cited for its antibacterial characteristics. Numerous studies have demonstrated the potent inhibition of bacterial growth by essential oils derived from *Eucalyptus* leaves, particularly against *Staphylococcus aureus* and *Escherichia coli*.

Tea tree oil, derived from the leaves of the *Melaleuca alternifolia* plant, is widely recognized as a natural component. Its inclusion in hand sanitizer formulations appeals to consumers seeking products with natural ingredients, particularly for personal care items like hand sanitizers. This preference for natural ingredients aligns with the growing demand for environmentally friendly options. In addition to its antimicrobial properties, tea tree oil offers aromatherapeutic benefits. Its distinctive and refreshing aroma enhances the sensory experience of using hand sanitizer, making it more enjoyable for users. This aromatic aspect adds to the overall appeal of hand sanitizer formulations containing tea tree oil, making them favoured choices among both consumers and healthcare practitioners. (14)

Rose oil possesses natural antimicrobial properties that can help eliminate harmful bacteria and viruses, contributing to the sanitizing efficacy of the product. It can aid in reducing microbial contamination on the hands, thus lowering the risk of infections and illnesses.

II. MATERIALS



The tools used are a set of distillation tools, analytical balance, autoclave, magnetic stirrer, pHmeter, micropipette, Brookfield viscometer, measuring flask, beaker, petri dish, dropper, spatula, Bunsen.

The materials used were *Eucalyptus* and Tea tree essential oil which is procured from

sanchomeeherbovedapvt. Ltd traded as mankarnikaushadhalya , Aloe vera gel from sanchomeeherbovedapvt. Ltd traded as mankarnikaushadhalya , Rose oil, triethanolamine (TEA), glycerine, Carbopol 940, methylparaben, aluminium foil, and Ethanol.

III. METHOD

The process of creating the alcohol-infused herbal hand sanitizer began by stirring Carbopol 940 into distilled water at 1000 rpm for 5 minutes using a magnetic stirrer until a uniform mixture was achieved. This mixture was then left undisturbed for 24 hours.

Denatured alcohol, polysorbate 20, glycerine, and all the herbal extracts were combined with the water-based solution at 500 rpm for 10 minutes to ensure thorough blending.

Triethanolamine was added with continuous stirring at 500 rpm to ensure uniformity, followed by the incorporation of methyl paraben preservative.

The final product was stored in tightly sealed containers. The developed hand sanitizer underwent initial physical assessment and was subsequently tested for its antimicrobial sensitivity. (18,19,20)

Table 1: Formulation Table

Sr no.	Ingredients	QUANTITIES									
		F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
1	Distilled water(ml)	10.06	9.54	8.94	8.34	7.74	7.14	7.74	8.34	7.99	9.54
2	Ethanol(ml)	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6
3	Eucalyptus oil(ml)	0.075	0.15	0.30	0.45	0.60	0.75	0.50	0.35	0.50	----
4	Tea tree oil(ml)	0.075	0.15	0.30	0.45	0.60	0.75	0.50	0.35	0.50	----
5	Rose oil(ml)	0.037	0.75	0.15	0.30	0.45	0.60	0.75	0.60	0.50	----
6	Aloe vera oil(gm)	0.075	0.15	0.30	0.45	0.60	0.75	0.50	0.35	0.50	0.45
7	Carbopol (gm)	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
8	Glycerine (ml)	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69

9	Tween 20(ml)	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
10	Triethanola mine(ml)	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
11	Methyl paraben(gm)	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
	Total:(gm)	30	30	30	30	30	30	30	30	30	30

IV. EVALUATION PARAMETER

1) Visual appearance:

The sanitizer was visually examined for clarity, colour, transparency, and the presence of any particles. The external appearance of the formulations was evaluated through the organoleptic test for hand sanitizer gel. Results from the visual inspection of the prepared hand sanitizer gels indicated that the tested formulations displayed the following favourable characteristics. Sanitizer smears were applied to glass slides and then examined under a microscope to detect any particles or grit. (21)

2) Physical Evaluation:

The study aimed to determine the effectiveness of different prepared formulations in achieving neutralization. An optimal pH range for topical dosage forms, ideally between 4.0 and 7.0, mirroring the skin's pH, is crucial to prevent skin irritation and inflammation. The pH of an alcohol-based herbal hand sanitizer formulation was assessed using a digital pH meter. One gram of gel was dispersed in 100 millilitres of distilled water, and the mixture was allowed to stand for two hours. (22)

3) Viscosity:

Viscosity, an essential characteristic in gel formulations, can be unpredictable and requires careful control. It governs the texture and spreadability of the gel during skin application, directly impacting its consistency and flow. The viscosity of an alcohol-based herbal hand sanitizer formulation was evaluated using a Brookfield viscometer. To measure viscosity, a Brookfield viscometer was employed. A 10ml beaker filled with 5gm of the solution was utilized, and the spindle was lowered vertically into the solution,

ensuring it remained clear of the beaker's bottom. (22)

4) Spreadability:

Spreadability plays a significant role in the application of hand sanitizers, influencing consumer satisfaction and the consistency of applied gels, which are critical aspects of topical preparation quality. The spreadability test was conducted on the gel formulation to gauge its ability to evenly distribute on the skin. Ideally, a high-quality gel formulation exhibits excellent spreadability, meaning it disperses quickly. The viscosity of the liquid is a crucial factor, impacting the spreadability of the gel formulation.(22)

5) Skin compatibility Test:

Skin compatibility refers to the extent to which a product or substance is well-tolerated by the skin without causing irritation, allergic reactions, or other adverse effects. In the context of sanitizer gel, skin compatibility testing ensures that the product can be safely used on human skin without provoking any negative reactions. Skin compatibility assessment involves conducting patch tests or other evaluations to ensure the sanitizer gel does not cause skin irritation or adverse reactions. (22)

7)Antimicrobial test:

The effectiveness of the formulated alcohol-based herbal hand sanitizer against *Escherichia coli*, *Staphylococcus aureus*, and *Bacillus subtilis* was evaluated using the agar well disk diffusion method under aseptic conditions. Wells were created in plates containing 15ml of Muller Hinton agar medium using a cork-borer (0.85cm), and 100µl of the sanitizer was added to each well. Streptomycin antibiotic disks served as

the standard reference. The plates were then incubated at 37°C overnight for 24 hours, and the efficacy of the sanitizer was determined by measuring the diameter of the inhibition zone. (23,24)

V. RESULT:

1) Visual appearance:

The visual examination results of the prepared hand sanitizer gels showed several favourable characteristics.

There was no evidence of syneresis, and all gels demonstrated consistent flow, homogeneity, and transparency, with a distinct EO scent. They were user-friendly and easy to apply. Moreover, when spread on a transparent glass surface, the hand sanitizer gels exhibited no coarse particles due to the uniformity of the developed formulations.

Colour: Colourless to light yellow

Odour: Aromatic characteristics

2)PH determination:

Table 2:PH

Sr no:	Formulation	PH values
1.	F1	7.31
2.	F2	7.18
3.	F3	6.81
4.	F4	6.84
5.	F5	6.64
6.	F6	6.55
7.	F7	6.42
8.	F8	6.88
9.	F9	6.84
10.	F10	6.64
11.	Blank	6.84

3)Viscosity determination:

Table 3: Viscosity

Sr no:	Formulations	Viscosity at 60 RPM (mPa.s)
1.	F1	392.2
2.	F2	393.3
3.	F3	414.7
4.	F4	476
5.	F5	489.5
6.	F6	754.5
7.	F7	458.3
8.	F8	460.4
9.	F9	392.2
10.	F10	447.8
11.	Blank	795.7

4) Spreadability:

The sanitizer from batch F5 and F6 was easily spreadable.

In the context of sanitizer gel, skin compatibility testing ensures that the product can be safely used on human skin without provoking any negative reactions and no irritation or allergic reaction is seen.

5) Compatibility test:



5) Anti-microbial test:

Sr No.	Sample	Zone Of Inhibition(mm)		
		E. coli	Bacillus Subtillis	Staphylococcus aureus
1.	Sample	2.4	2.1	2.6
2.	Marketed product	4.2	4.5	3.9



VI. CONCLUSION:

The primary objective of the study was to develop an innovative alcohol-based herbal hand sanitizer that prioritizes safety, efficacy, and a natural approach to disease prevention. This sanitizer utilizes a blend of eucalyptus oil, tea tree oil, rose oil, and aloe vera gel, all of which are renowned for their antibacterial, antifungal, and antiseptic properties. These ingredients not only contribute to the sanitizing efficacy of the product but also provide additional benefits such as skin hydration and a pleasant fragrance. The methodology involved the creation of ten different formulations, each labelled as F1 to F10. The variations in these formulations were achieved by adjusting the concentration levels of the essential

oils. This approach aimed to determine the most effective combination of ingredients for optimal sanitizing performance. Overall, the study's detailed methodology allowed for the identification of an optimal formulation (F7) that balances safety, efficacy, and user experience. This formulation can serve as a basis for the development of a high-quality herbal hand sanitizer that meets the growing demand for natural and effective hygiene products.

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