



FORMULATION AND EVALUATION OF HERBAL HAND SANITIZER

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ABSTRACT The main objective of this study is to formulate and evaluate a herbal hand sanitizer. Hand sanitizers are essential topical preparations used in daily life to maintain personal hygiene and prevent the transmission of pathogens. However, synthetic, alcohol-heavy commercial sanitizers have sometimes been the cause of adverse effects among consumers, such as severe skin dryness, irritation, and disruption of the skin's natural barrier. A more radical approach in reducing these harsh synthetic ingredients is by incorporating natural, plant-derived ingredients whose antimicrobial and moisturizing functionalities are comparable to, or better than, their synthetic counterparts. The ingredients used in the formulation of the Herbal Hand Sanitizer include Aloe barbadensis (Aloe Vera) gel, Azadirachta indica (Neem) extract, and Ocimum sanctum (Tulsi) extract, combined with a base of Ethanol, Glycerin, and Carbopol 940 as a gelling agent. These were prepared by mixing with each other and evaluated for their organoleptic and physico-chemical characteristics. Performance tests in terms of pH, viscosity, spread ability, drying time, and in vitro antimicrobial activity were performed. The combination of several such ingredients of herbal origin has made it possible to secure a highly effective, skin-friendly sanitizing gel. The formulation at the laboratory scale was done and evaluated for a number of parameters to ensure its safety and efficacy. The formulated Herbal Hand Sanitizer was clear, translucent, and aesthetically appealing. It demonstrated excellent spread ability, rapid drying time, ideal pH compatibility with the skin, and significant antimicrobial efficacy against common pathogens. The physicochemical evaluation of the formulated sanitizer showed ideal results. However, to further improve its quality, product performance, and long-term stability, further development and clinical testing may be required.

KEYWORDS : Herbal, Azadirachta Indica (Neem), Ocimum Sanctum (Tulsi), Aloe Barbadensis (Aloe Vera) etc.

INTRODUCTION

Hand Sanitizer

Sanitizers are most probably used as topical hygiene preparations. It is a hand care product that is used for cleaning hands and reducing microorganisms in our daily life. Sanitizers are most likely utilized as public health agents and a viscous solution or gel containing suitable additives, preservatives, and active antimicrobial ingredients. It is usually applied on wet or dry hands, rubbed together thoroughly, and cleansed by allowing it to dry with water or air. The purpose of using a sanitizer is to remove or kill transient pathogens that are built up on the hands. Many synthetic sanitizers are present in the current market both medicated and non-medicated however, herbal sanitizer popularized due to natural origin which is safer and free from side effects which is increasing consumer demand. In synthetic sanitizers, high concentrations of alcohol and harsh chemicals are added mainly for their rapid antimicrobial property, but the continuous use of these chemicals leads to serious effects such as skin irritation, severe dryness, cracking, and disruption of the skin barrier.

Beyond mere aesthetic enhancement, cosmetics and topical preparations serve a vital role in skin health and personal hygiene. While often perceived through the lens of creative self-expression, their utility spans across diverse global cultures as a fundamental pillar of public health. In modern markets, the term "cosmetics" is frequently—and narrowly—misinterpreted as referring only to makeup. However, the US FDA provides a broader classification: products intended for cleansing, beautifying, or altering appearance without affecting the body's physical structure. Hand hygiene products fall squarely into this essential category. The global industry is currently witnessing a significant shift; following recent global health crises, a market once dominated by purely clinical, chemical-heavy sanitizers is now a highly competitive landscape where consumers actively demand safer, skin-friendly alternatives.^(1,2)



Fig 1. Herbal Hand Sanitizer: The Natural Alternative

Herbal hand sanitizers are designed to cleanse and protect the skin using plant-based ingredients rather than the harsh synthetic chemicals and excessively high alcohol concentrations found in traditional products. While formulating a 100% natural cosmetic is technically difficult, the use of medicinal plant extracts—in purified or gel forms—provides numerous benefits. The primary advantage lies in the mitigation of synthetic side effects. Regular exposure to high-alcohol synthetic sanitizers and harsh chemical preservatives is linked to contact dermatitis, severe skin dryness, cracking, and the disruption of the skin's natural acid mantle. Consequently, the public is increasingly gravitating toward herbal cosmetics. They offer a stable, inexpensive, and side-effect-free experience that maintains the skin's natural integrity and moisture barrier without the long-term damage associated with synthetic sanitizing agents.^(3,4)



Figure 2. Herbal Hand Sanitizer: Hygiene Hand Care

Vedic History

(Azadirachta indica) commonly known as Neem is one of the most revered and versatile trees in Indian history, often referred to as "Sarva Roga Nivardini" (curer of all ailments) in ancient Sanskrit texts. It holds immense mythological, religious, and medicinal importance in Indian culture, dating back over 4,000 years to the Vedic period and the Indus Valley Civilization. Every part of the tree—roots, bark, leaves, flowers, seeds, and fruit—has been used in traditional Ayurvedic medicine, and it is often considered the original "sanitizer" of ancient India due to its potent antimicrobial properties.^(5,6)

Taxonomy/ Botanical Classification

Table 1 Classification of Azadirachta Indica

Domain:	Eukaryota
Kingdom:	Plantae

Phylum:	Tracheophyta
Class:	Magnoliopsida
Order:	Sapindales
Family:	Meliaceae
Genus:	Azadirachta
Species:	A. indica

Nomenclature

'Azadirachta' is derived from the Persian word 'Azad', meaning 'free' or 'noble', and 'dirakht' meaning 'tree', thus translating to 'the free or noble tree'. 'Indica' denotes its origin and abundance in the Indian subcontinent. In ancient Indian languages and Ayurvedic texts (such as the Charaka Samhita and Sushruta Samhita), Neem is known by numerous Sanskrit names, each highlighting its profound healing properties:

Nimba' is derived from the Sanskrit root Nimbati swastyam tanoteyati, meaning "to give good health" or "to preserve health". 'Arishta' means "relief from sickness" or "that which prevents disease". 'Kali' refers to its dark, potent nature, while 'Picumarda' translates to "the tree that crushes or destroys diseases".

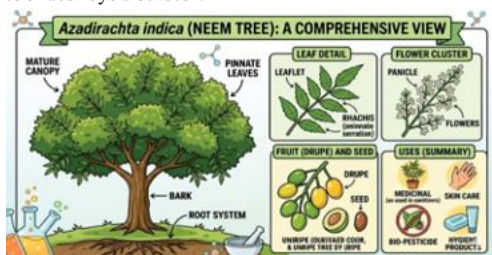


Figure 3. A Comprehensive View of Neem Tree

Historically, Neem twigs were used as toothbrushes (Datan) for oral hygiene, and its leaves were traditionally hung in homes, maternity wards, and hospitals to purify the air and prevent the spread of infectious diseases. Its natural ability to eliminate pathogens on surfaces and skin makes it the most scientifically validated botanical ingredient for modern hand sanitizers.⁽⁷⁾

Types of Hand Sanitizers

Hand sanitizers are of following types given below

- Liquid sanitizers
- Gel sanitizers
- Foam sanitizers
- Spray sanitizers
- Sanitizer wipes
- Medicated herbal sanitizers
- Moisturizing sanitizers



Figure 4. Types of Hand Sanitizers

Benefits of Herbal Hand Sanitizer

- Kills germs and bacteria effectively
- Prevents cross-contamination and infections
- Moisturizes and prevents skin dryness
- No harsh chemical residue
- Soothes skin irritation and cracking
- Maintains natural skin pH (acid mantle)
- Safe for frequent and daily use
- Pleasant natural fragrance
- Won't irritate sensitive skin



Figure 5. Benefits of Herbal Hand Sanitizer

Function of Herbal Hand Sanitizer

- Antimicrobial action
- Miniaturization (Humectant property)
- Skin soothing and healing
- Barrier protection
- Rapid cleansing without water



Figure 6: Functions of Herbal Hand Sanitizer

History of Hand Sanitizer –



Fig 7. Historical Context and Traditional Use

Historically, the concept of hand antisepsis and hygiene originated in the Indian subcontinent. Early Indian practitioners used a variety of herbs and their extracts as natural cleansers and antiseptics. Ancient Ayurvedic texts, such as the Charaka Samhita and Sushruta Samhita, document the use of *Azadirachta indica* (Neem), *Ocimum sanctum* (Tulsi), and *Curcuma longa* (Turmeric) for their potent antimicrobial, wound-healing, and purifying properties. When early surgical and ritualistic practices required strict hand hygiene, practitioners relied on the decoctions of these medicinal plants to eliminate pathogens, which eventually laid the foundation for modern topical antiseptics and hand rubs.⁽⁸⁾

Scientific Comparison: Herbal vs. Synthetic Sanitizers

Current literature focuses heavily on the dermatological impact of synthetic antimicrobial agents.

• **Synthetic Sanitizers:** Most commercial hand sanitizers utilize high concentrations (60-80%) of Ethanol or Isopropanol, sometimes combined with synthetic biocides like triclosan. While highly effective at rapid microbial kill, research indicates that long-term, continuous use can strip the skin of its natural sebum, leading to severe dryness, contact dermatitis, and disruption of the skin's protective barrier.

• **Herbal Sanitizers (Botanical Antimicrobials):** Research into medicinal plants has highlighted phytoconstituents like nimbidin (in Neem) and eugenol (in Tulsi). Unlike harsh synthetic alcohols, these plant extracts sanitize the skin without disrupting the skin's natural acid mantle (pH approx. 5.5). Studies show that herbal formulations provide effective, broad-spectrum antimicrobial action while simultaneously maintaining skin hydration and preventing irritation.

Key Medicinal Plants and their Phytochemical Roles⁽⁹⁾

A survey of recent pharmacological studies identifies several primary herbs used in modern herbal hand sanitizers:

- **Aloe Barbadensis (Aloe Vera):** Rich in polysaccharides (acemannan) and vitamins; acts as a natural humectant that repairs the skin barrier, soothes inflammation, and prevents the severe drying effects typically caused by the alcohol base.
- **Azadirachta Indica (Neem):** Extensively researched for its broad-spectrum antibacterial and antifungal properties, particularly highly effective against common transient pathogens like *Staphylococcus aureus* and *Escherichia coli*.
- **Ocimum Sanctum (Tulsi):** Contains eugenol and ursolic acid, providing strong antiviral and antibacterial properties that boost the overall sanitizing efficacy of the formulation.
- **Melaleuca Alternifolia (Tea Tree):** An essential oil rich in terpinen-4-ol, widely documented in clinical trials for its ability to disrupt the cell membranes of bacteria and fungi, while also providing a natural, pleasant fragrance.

Evaluation Parameters⁽¹⁰⁾

Literature regarding the evaluation of herbal hand sanitizers emphasizes several key physicochemical and microbiological tests to ensure quality:

- **pH Stability:** Ensuring the product stays within the 5.0–6.5 range to match the skin's natural acid mantle and prevent irritation.
- **Viscosity and Spreadability:** Measuring the gel's flow properties using a Brookfield viscometer to ensure it spreads easily and uniformly across the hands without dripping or feeling overly sticky.
- **Drying Time:** A critical parameter for consumer acceptability; the formulation must evaporate quickly (ideally under 30–45 seconds) without leaving a tacky residue.
- **In Vitro Antimicrobial Activity:** Using the agar well diffusion method to measure the Zone of Inhibition (ZOI) against standard pathogenic bacterial and fungal strains to prove sanitizing efficacy.

Herbal Ingredients - Selection of Drug^(11,12)

1. Criteria for Selection

The herbs and excipients were selected based on the following pharmaceutical and dermatological requirements:

- **Antimicrobial Efficacy:** To provide broad-spectrum protection against transient bacteria, fungi, and viruses on the skin.
- **Phytochemical Synergy:** To combine antioxidants, soothing agents, and natural antimicrobial agents for comprehensive skin care and barrier protection.
- **pH Compatibility:** Ingredients that help maintain the skin's natural acidic mantle (pH 4.5–5.5) to prevent irritation.
- **Safety Profile:** High biocompatibility to ensure the product is non-irritant, non-sensitizing, and safe for frequent topical application.

Table 2. Profile of Selected Herbal Drugs

Common Name	Botanical Name	Family	Part Used	Primary Function
Aloe Vera	<i>Aloe barbadensis</i>	Asphodelaceae	Leaf Gel	Moisturizing, soothing and healing
Neem	<i>Azadirachta indica</i>	Meliaceae	Leaves	Antimicrobial; antifungal
Tulsi	<i>Ocimum sanctum</i>	Lamiaceae	Leaves	Antibacterial; antiviral
Tea Tree	<i>Melaleuca alternifolia</i>	Myrtaceae	Essential Oil	Antiseptic; natural fragrance
Glycerin	Propane-1,2,3-triol	N/A	Liquid	Humectant; prevents dryness
Carbopol 940	Polyacrylic acid	N/A	Polymer	Gelling; thickening agent

Justification for Selection⁽¹³⁻¹⁵⁾

A. Primary Antimicrobial Agents (Ethanol, Neem & Tulsi)

The primary challenge in formulating a hand sanitizer is ensuring rapid

and effective microbial kill. Ethanol (70% v/v) was selected as the primary base because it rapidly denatures microbial proteins. However, to reduce the reliance on excessively high alcohol concentrations and to provide residual antimicrobial action, Neem and Tulsi were selected. Neem contains Nimbidin, and Tulsi contains Eugenol; both phytochemicals exhibit potent, broad-spectrum antibacterial properties that synergize with the alcohol base to eliminate pathogens like *Staphylococcus aureus* and *Escherichia coli*.

B. Skin Protectants and Moisturizers (Aloe Vera & Glycerin)

Continuous use of alcohol-based sanitizers strips the skin of natural sebum, leading to severe dryness and cracking.

- Aloe Vera is selected for its rich Mucopolysaccharides and polysaccharides (like acemannan), which bind moisture to the skin, promote tissue healing, and soothe irritation. It acts as a natural biological buffer to stabilize the formulation.
- Glycerin is included as a primary humectant. It draws moisture from the environment into the stratum corneum, effectively counteracting the desiccating effects of the alcohol and maintaining the skin's suppleness.

C. Formulation Base and Stabilizers (Carbopol 940 & Tea Tree Oil)

- Carbopol 940 is selected as the gelling agent because it forms a clear, elegant, and non-sticky gel when neutralized. It ensures the sanitizer has the perfect viscosity to spread evenly across the hands without dripping.
- Tea Tree Oil is added in trace amounts not only for its natural, pleasant fragrance but also for its high terpinen-4-ol content, which disrupts the cell membranes of fungi and bacteria, providing an extra layer of antimicrobial synergy.

2. Collection and Authentication

The selected herbal drugs (Neem leaves, Tulsi leaves, and Aloe Vera) were procured from a local medicinal market and authenticated. The raw plant materials were washed and processed using shade-drying techniques to preserve the thermolabile (heat-sensitive) active constituents like essential oils, eugenol, and polysaccharides. They were then subjected to extraction and filtration processes to obtain concentrated, pure extracts and gels suitable for incorporation into the final formulation.

MATERIALS AND METHODS

Ingredients that are used in the preparation of herbal hand sanitizer are -:

1. Neem (*Azadirachta Indica*)

Neem is a fast-growing, evergreen tree commonly found in the Indian subcontinent. It is an herb commonly used as traditional medicine for about fifty types of skin disorders and infections. The leaves of *A. indica* are reported phytoconstituents of nimbidin, azadirachtin, flavonoids, triterpenoids, and quercetin. These bioactive compounds are highly effective against a wide range of bacteria and fungi.

Application:- Broad-spectrum antimicrobial, Antibacterial.

2. Tulsi (*Ocimum Sanctum*)

Tulsi is an aromatic medicinal plant in the family Lamiaceae, widely revered in India. It has been used in traditional medicine for centuries to treat various infections and boost immunity. Tulsi leaves are rich in essential oils like eugenol, ursolic acid, and rosmarinic acid, which possess strong antiviral and antiseptic properties.

Application:- Antiseptic, Antiviral.

3. Aloe Vera (*Aloe Barbadensis*)

Aloe vera is a succulent plant species of the genus *Aloe*. It is widely distributed and considered a miracle plant for skin care. Aloe vera has many active ingredients and minerals that can help heal and protect the skin. It has fatty acids and amino acids and is rich in vitamins A, B12, C, and E. These play a part in healthy skin cells and controls dryness.

Application:- Moisturizer, Skin soothing and healing.

Other Ingredients:-

1. Ethanol (Ethyl Alcohol)

Ethanol is a volatile, flammable, colorless liquid. In hand sanitizers, it acts as the primary active antimicrobial agent. It works by denaturing the proteins and dissolving the lipid membranes of most bacteria and viruses, providing rapid sanitization.

Application:- Primary antimicrobial agent, Solvent.

2. Glycerin

Glycerin (or glycerol) is a simple polyol compound. It is a colorless, odorless, viscous liquid that is sweet-tasting and non-toxic. In topical

formulations, it acts as a powerful humectant, drawing moisture from the air into the outer layer of the skin to prevent severe dryness caused by alcohol.

Application-: Humectant, Prevents skin dryness.

3. Carbopol 940

Carbopol 940 is a high molecular weight, cross-linked polyacrylic acid polymer. It is sold under a variety of trade names and is used as a thickener, dispersing agent, and gelling agent in various cosmetic and pharmaceutical products. It is occasionally added to liquid soaps and sanitizers to generate their characteristic clear, thick gel consistency.

Application-: Gelling agent, Thickener.

4. Triethanolamine (TEA)

Triethanolamine (TEA) is an organic compound that is both a tertiary amine and a triol. It is a clear, colorless to pale yellow viscous liquid. In gel formulations containing Carbopol, TEA is strictly required as a neutralizing agent to convert the acidic polymer dispersion into a clear, highly viscous gel.

Application-: Neutralizing agent, pH balancer.

5. Tea Tree Oil (*Melaleuca Alternifolia*)

Tea tree oil is an essential oil derived from the leaves of the Australian tea tree. It is generally considered safe when diluted and reports of skin irritation are very rare when used in trace amounts. Tea Tree Oil is renowned for its skin-friendly, natural antiseptic, and produce fragrance properties. It contains terpinen-4-ol which boosts the sanitizing effect.

Application-: Natural fragrance, Additional antiseptic boost.

6. Distilled Water

Distilled water is water that has been boiled into vapor and condensed back into liquid in a separate container. It is free from impurities, minerals, and microorganisms.

Application-: Vehicle, Solvent.

METHODS

Preparation of Herbal Hand Sanitizer

Step 1 - Preparation of Neem Extract:-

Step 2 - Preparation of Tulsi Extract:-

Step 3 - Preparation of Aloe vera gel:-

Step 4 - Preparation of Carbopol 940 Dispersion:-

Table 3 - Ingredients Use in Herbal Hand Sanitizer

S.No.	Ingredients	Quantity	Uses
1.	Ethanol (95%)	70ml	Primary antimicrobial agent
2.	Aloe vera gel	10ml	Moisturizer, skin soothing
3.	Neem extract	5ml	Antimicrobial, antifunga
4.	Tulsi extract	5ml	Antibacterial, antiviral
5.	Glycerin	2ml	Humectant
6.	Carbopol 940	Q.S. (appx. 1gm)	Gelling / Thickening agent
7.	Triethanolamine (TEA)	1ml	Neutralizing agent
8.	Tea tree oil	0.5ml	Fragrance, antiseptic boost
9.	Distilled water	Q.S.(100ml)	Vehicle

Formulation of the Herbal Hand Sanitizer was done as per the formula given in above Table:

1. Firstly, we weighed all the ingredients according to the formula.
2. Swollen Carbopol 940 dispersion was prepared in one part of distilled water.
3. Ethanol and Glycerin were mixed in another separate beaker.
4. Neem extract, Tulsi extract, and Aloe vera gel were added to the ethanol-glycerin mixture and stirred continuously.
5. Mix both the mixture with each other (herbal-ethanol mix into carbopol dispersion) and stir it continuously.
6. Pour all ingredients into a mortar pestle or magnetic stirrer to make a uniform mixture.
7. After that add Triethanolamine (TEA) dropwise as a neutralizing agent to form a clear gel.
8. At last, Tea tree oil was added to it for Fragrance and additional antiseptic property.
9. Make up the volume using Distilled water.

10. The product was prepared and transferred to the container.
11. Labelled the container properly and stored it in a cool and dry place.



Figure 8 Formulated Herbal Hand Sanitizer

Evaluation of Herbal Hand Sanitizer

To evaluate the prepared formulations, quality control tests including visual assessment and physicochemical controls such as pH, viscosity, spreadability, and antimicrobial activity were performed.

1. Organoleptic Properties:-

We have done the visual inspection of product and observed that it was of:-

- Colour – Light greenish-translucent
- Odour – Aromatic (Herbal/Tea tree)
- State- Gel
- Consistency – Smooth, non-sticky

2. Determination of PH:-

The pH of formulated hand sanitizer was 6.0. A formulated hand sanitizer is acid balanced which is near to the skin pH. The pH of hand sanitizer is important for improving and enhancing the qualities of skin, minimizing irritation to the skin and stabilizing the pH balance of the acid mantle. Mild acidity prevents skin dryness and promotes the tightening of the stratum corneum, thereby inducing softness and preventing cracking.

3. Viscosity:-

The viscosity of the formulated herbal hand sanitizer was determined using a Brookfield Viscometer at 25°C. The formulation showed a viscosity of 4500 cps. Viscosity is an important parameter for a gel-based sanitizer as it ensures the product stays on the hands during application without dripping, while still being easily spreadable.



Fig 9 Viscosity Determination by Brookfield Viscometer

4. Spreadability:-

Spreadability was measured by placing 1 gm of gel between two glass slides and applying a standard weight. The time taken for the upper slide to separate was noted. The formulation showed excellent spreadability (2.5 seconds). Good spreadability ensures uniform coverage of the antimicrobial agents across the entire surface of the hands.

5. Drying Time:-

About 1 gm of the formulated gel was applied to the back of the hand, and the time required for it to dry completely was recorded. The drying time was found to be 25 seconds. A rapid drying time is one of the most important needs of a hand sanitizer from a consumer point of view, ensuring convenience and leaving no tacky residue.

6. Antimicrobial Activity:-

The antimicrobial efficacy of the herbal hand sanitizer was evaluated using the agar well diffusion method against common pathogens like *Staphylococcus aureus* and *Escherichia coli*. The formulation showed a clear Zone of Inhibition (ZOI), proving its effectiveness in killing transient microorganisms on the skin.

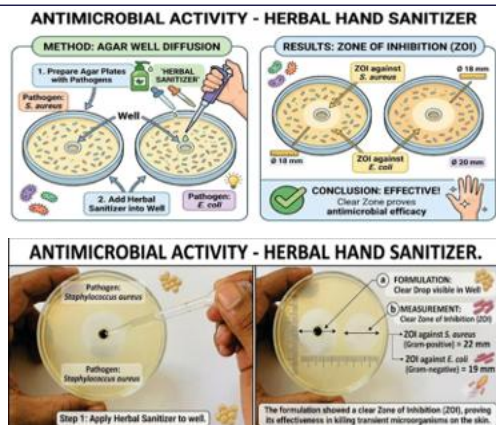


Fig 10 Antimicrobial Activity Determination

Stability Testing: Evaluate physical and chemical stability under various conditions (temperature, light)

7. Human Trials:-

- Sensory Evaluation:** Assess user experience (e.g., feel on skin, stickiness, fragrance).
- Skin Tolerance:** Evaluate irritation, redness, or allergic reactions (Patch test).
- Efficacy Studies:** Measure effects on skin hydration and barrier protection.

RESULTS AND DISCUSSION

Test results of Herbal Hand Sanitizer

Table 4

S.NO.	Parameters	Result
1.	Colour	Light greenish translucent
2.	Odour	Aromatic (Herbal)
3.	pH	Mild acidic (6.0)
4.	Viscosity	4500 cps
5.	Spreadability	Excellent (2.5 sec)
6.	Drying Time	25 seconds
7.	Texture	Smooth, non-sticky

The Formulated hand sanitizer was clear and good appealing. It demonstrated good stability, rapid drying time, excellent spreadability, and executed good moisturizing property. The herbal hand sanitizers are the preparations which are used for the cleansing and sanitizing of hands and to provide nourishment.

The herbal hand sanitizers are widely used due to their no or less side effects as compared to conventional synthetic sanitizers, because it contains pure natural or herbal ingredients rather than harsh synthetic chemicals. Herbal hand sanitizer does not require animal testing and it is skin friendly. Herbal hand sanitizer was formulated by mixing different Ingredients in specific proportions. Selected plant materials are rich in phytochemical compounds such as nimbidin, eugenol, polysaccharides and terpenoids. They have found to exhibit Antibacterial, Anti-viral, moisturising and soothing properties. Physicochemical properties of the herbal hand sanitizer were statistically evaluated.

The effectiveness of herbal hand sanitizer containing Aloe vera, Neem, Tulsi and Tea tree oil can vary depending on several factors, including individual skin type and condition. While these ingredients are commonly used in ayurvedic and herbal skin care remedies, there is growing scientific research specifically on the combination of these ingredients in sanitizer gel form.

CONCLUSION

The formulated hand sanitizer is not only safer than the chemical sanitizing agents but also greatly reduces the skin dryness as well as strengthens the skin barrier. The pH of the sanitizer was adjusted to 6.0 to retain the acidic nature of skin. Synthetic preservatives and high alcohol concentrations have sometimes been the cause of adverse effects among consumers. We have used the physicochemical approach to preservation and by formulating a self-preserving herbal gel and avoided the risk posed by harsh chemical additives. However, the aesthetic attributes, such as extreme clarity, of the laboratory sanitizer are not comparable with the marketed synthetic sanitizers.

The gel consistency is on a par although the retail products do not fare so well in the tests conducted by us and they enjoy market popularity, especially if they contain strong artificial fragrances.

This is mainly due to the false information among consumers that 'a sanitizer that smells strongly of alcohol works well', and no real effort was taken on the part of manufacturers to counter this fallacy. In the present scenario, it seems improbable that herbal sanitizers are better in performance and safer than the synthetic ones which are popular in consumers. A more radical approach in popularizing herbal hand sanitizer would be to change the consumer expectations from a synthetic sanitizer with emphasis on safety and efficacy. Formulators must play an active role in educating the consumers about the potential harmful effects of synthetic detergents and other chemical additives present in sanitizers. There is a strong need to change the consumer perception of a good sanitizer and the harmful sanitizer. All the ingredients used to formulate the sanitizer are safer than generic commercial sanitizers and the physicochemical evaluation showed ideal results.

The main purpose behind this investigation was to develop a stable and functionally effective hand sanitizer. The present study was carried out with the aim of preparing the herbal hand sanitizer that provides smooth and moisturizing effect to hands, safer than the chemical sanitizing agents. Herbal hand sanitizer was formulated with the extracts of medicinal plants that are commonly used for cleansing and protecting skin traditionally.

REFERENCES

- Mainkar, A. R., & Jolly, C. I. (2001). Formulation of natural sanitizers and topical gels. *International Journal of Cosmetic Science*, 23(1), 59–62.
- U.S. Food and Drug Administration (FDA). (2022). *FDA Updates on Hand Sanitizers for Consumers*. (Provides regulatory guidelines on the safe limits of alcohol, methanol warnings, and labeling requirements for over-the-counter hand sanitizers). Retrieved from <https://www.fda.gov/drugs/hand-sanitizers-and-covid-19>
- World Health Organization (WHO). (2009). *WHO Guidelines on Hand Hygiene in Health Care and Formulations for Handrub*. (Provides the standard global parameters for hand rub efficacy, alcohol concentrations, and hygiene protocols). Retrieved from <https://www.who.int/publications/i/item/9789241597937>
- Barel, A. O., Paye, M., & Maibach, H. I. (2014). *Handbook of cosmetic science and technology* (4th ed.). CRC Press.
- Chaudhary, S., et al. (2018). Phytochemical and pharmacological profile of *Azadirachta indica* and *Ocimum sanctum*: A review. *The Pharma Innovation Journal*, 7(3), 11–15.
- National Center for Biotechnology Information (NCBI) / PubChem. (2024). Compound Summaries for Azadirachtin (Neem) and Eugenol (Tulsi). (Used for verifying the chemical structures, molecular weights, and pharmacological profiles of the active phytoconstituents). Retrieved from <https://pubchem.ncbi.nlm.nih.gov/>
- Centers for Disease Control and Prevention (CDC). (2023). *Hand Hygiene in Healthcare Settings*. (Outlines the clinical efficacy of alcohol-based hand rubs versus soap and water, and proper application techniques). Retrieved from <https://www.cdc.gov/handhygiene/>
- Ministry of Ayush, Government of India. (2020). *Standard Operating Procedures and Guidelines for Herbal Cosmetics*. (Provides the Indian regulatory framework and safety standards for formulating Ayurvedic and herbal topical products). Retrieved from <https://ayush.gov.in/>
- Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2008). *Pharmacognosy* (42nd ed.). Nirali Prakashan.
- Sharma, R. M., Shah, K., & Patel, J. (2011). Evaluation of prepared herbal antimicrobial formulations. *International Journal of Pharmacy and Pharmaceutical Sciences*, 3(4), 120–126.
- Kothari, V., et al. (2011). Preparation and evaluation of polyherbal topical antimicrobial gel. *International Journal of Pharma and Bio Sciences*, 2(1), 159–165.
- Shweta S. Dhamankar, Ankush R. Dudhe, Pranita I. Rathod, Preparation of Herbal Hand Sanitizer, *International Journal of Pharmaceutical Research and Applications* Volume 7, Issue 4 July-Aug 2022, 386-392
- Indian Pharmacopoeia Commission (IPC). (2022). *Monographs on Herbal Drugs and Cosmetics*. (Provides the official Indian standards for the extraction, identification, and quality control of herbal ingredients like Aloe barbadensis). Retrieved from <https://ipc.gov.in/>
- Nawaz, H., Iqbal, Z., & Khan, A. (2021). Evaluation of antibacterial properties of herbal hand sanitizer prepared from Neem and Aloe vera extracts, *International Journal of Biological and Pharmaceutical Research*, 12(4), 89
- Khan, S., & Ahmad, I. (2021). Herbal hand sanitizer: An eco-friendly alternative for hygiene. *Journal of Pharmacognosy and Phytochemistry*, 10(2), 1234–1239