DESIGN AND EVALUATION OF NATURAL HAND SANITIZER USING NEEM

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1.ABSTRACT:

Hand hygiene plays a crucial role in preventing the transmission of infectious diseases. Alcohol-based hand sanitizers are widely used due to their rapid antimicrobial action. However, frequent use may lead to skin dryness and irritation. Herbal hand sanitizers incorporating natural ingredients such as neem (*Azadirachta indica*) offer antimicrobial benefits with improved skin compatibility.
The present study focuses on the formulation of a neem-based herbal hand sanitizer and its evaluation for physicochemical properties, antimicrobial activity, and stability. The formulation includes isopropyl alcohol, aloe vera gel, neem extract, glycerin, and essential oils. Comparative analysis with commercial sanitizers was performed. The results indicate that the herbal sanitizer shows effective antimicrobial activity along with better moisturizing properties, making it a suitable alternative to conventional products.

Keywords: Hand hygiene, alcohol-based sanitizer, antimicrobial activity, herbal hand sanitizer, Neem (Azadirachta indica), Aloe vera, isopropyl alcohol, glycerin.

2.INTRODUCTION:

Hand hygiene is one of the most effective measures to prevent infections caused by bacteria, viruses, and fungi [1]. The use of alcohol-based sanitizers has increased significantly, especially after global pandemics [17].

Alcohol-based sanitizers are effective when alcohol concentration is above 60% as they denature proteins and destroy microbial cell membranes [2]. However, repeated use may lead to:

- Skin dryness
- Irritation
- Dermatitis

Herbal formulations have gained attention due to their natural origin and reduced side effects [6].
Neem (*Azadirachta indica*) is widely known for:

- Antibacterial activity [4]
- Antifungal properties [5]
- Anti-inflammatory effects

Thus, combining alcohol with herbal components provides both immediate and long-term benefits.

Figure 1. Hand hygiene plays a crucial role in preventing the transmission of infectious diseases.

3.MATERIALS AND METHODS:

Materials Used:

1. Isopropyl Alcohol (99%):

- **Function: Primary antimicrobial agent**

Isopropyl alcohol is the main active ingredient responsible for the germicidal activity of the sanitizer. It acts by denaturing proteins and disrupting the cell membranes of microorganisms, leading to rapid cell death [1]. Alcohol concentrations between 60–95% are considered most effective, with 70–75% providing optimal antimicrobial action [2].

In this formulation, isopropyl alcohol constitutes approximately 75% of the total volume, ensuring effective elimination of bacteria, viruses, and fungi. It provides instant sanitization without the need for water.

Figure 2. Isopropyl alcohol is the main active ingredient responsible for the germicidal activity of the sanitizer

2. Aloe Vera Gel:

- **Function: Moisturizer and soothing agent**

Aloe vera gel is incorporated to counteract the drying effect of alcohol. It contains polysaccharides, vitamins, and amino acids that help in skin hydration and repair [4].

Additionally, aloe vera forms a gel base that improves the viscosity and spreadability of the formulation. It also exhibits mild antimicrobial and anti-inflammatory properties, enhancing the overall effectiveness of the sanitizer [4].

Figure 3. aloe vera forms a gel base that improves the viscosity and spreadability of the formulation.

3. Neem Extract / Neem Oil (*Azadirachta indica*):

- **Function: Herbal antimicrobial and anti-inflammatory agent**

Neem extract contains bioactive compounds such as azadirachtin, nimbidin, and flavonoids, which exhibit strong antibacterial, antifungal, and antiviral properties [3,6].

It enhances the antimicrobial spectrum of the sanitizer and provides additional protection against pathogens. Neem also has anti-inflammatory and skin-healing properties, making the formulation safer for frequent use [3].

Figure 4 : Neem also has anti-inflammatory and skin-healing properties, making the formulation safer for frequent use

4. Glycerin (Glycerol):

- **Function: Humectant and skin protectant**

Glycerin acts as a humectant, meaning it attracts moisture to the skin and prevents dehydration caused by alcohol [2,4].

It improves the texture and smoothness of the formulation and helps maintain skin hydration. WHO-recommended sanitizer formulations also include glycerin (~1.45%) for this purpose [2]. In this formulation, 2% glycerin is used for enhanced moisturizing effect.

Figure 5. glycerin is used for enhanced moisturizing effect.

5. Essential Oil (Tea Tree / Lemon Oil):

Function: Fragrance and secondary antimicrobial agent

Essential oils are added to improve the odor and user acceptability of the sanitizer. Tea tree oil possesses strong antibacterial and antifungal properties, while lemon oil contains limonene, which has antimicrobial activity [7].

These oils also provide a refreshing fragrance and may contribute to additional microbial inhibition.

Figure 6. ssential oils are added to improve the odor and user acceptability of the sanitizer

6. Distilled Water:

Function: Solvent and volume adjustment

Distilled water is used to adjust the final volume of the formulation to 100 mL and to ensure uniform mixing of all ingredients. It helps maintain the desired concentration of alcohol and improves the consistency of the formulation.

Figure 7. Distilled water is used to adjust the final volume of the formulation

4.EQUIPMENT USED:

- Analytical balance – for accurate measurement of ingredients
- pH meter – for determining pH of formulation
- Viscometer – for measuring viscosity
- Sterile Petri dishes – for antimicrobial testing
- Incubator – for microbial culture growth
- Glassware (beakers, measuring cylinders) – sterilized before use

5.PREPARATION OF EXTRACTS:

Neem Extract Preparation:

Fresh neem leaves (25 g) were washed and boiled in 100 mL distilled water for 15 minutes. The solution was filtered to obtain a clear aqueous extract containing active phytoconstituents [3].

Aloe Vera Gel Preparation:

Fresh aloe vera leaves were peeled, and the inner gel was collected and homogenized to obtain a smooth gel suitable for formulation [3].

6.FORMULATION PROCEDURE (SOP):

1. Measure 75 mL isopropyl alcohol in a clean beaker
2. Add 2 mL glycerin and mix gently
3. Add 20 mL aloe vera gel and stir uniformly
4. Add 2 mL neem extract and mix thoroughly
5. Add 1 mL essential oil
6. Adjust volume to 100 mL using distilled water
7. Stir for 2–3 minutes to obtain homogeneous mixture

8. Measure pH (~6.0) and adjust if necessary
9. Transfer to sterile container and allow to stand for 24 hours

Figure 8. Neem extract

7.CONTROLS USED:

- WHO formulation (75% isopropanol + glycerol) [2]
- Blank formulation (without alcohol)

7.1Safety Precautions:

- Perform preparation in a well-ventilated area
- Avoid open flames (alcohol is highly flammable)
- Use gloves and protective equipment
- Conduct patch test before use
- Maintain neem concentration ≤3% to avoid irritation [5]

7.2 Formulation (100 ml):

Ingredient	Quantity
Isopropyl Alcohol	75 ml
Aloe Vera Gel	20 ml
Neem Extract	2 ml
Glycerin	2 ml
Essential Oil	1 ml

Table no 1: formulation

7.3 Method of Preparation:

The formulation was prepared using standard mixing techniques [12]:

1. Isopropyl alcohol was measured accurately
2. Aloe vera gel was added slowly with continuous stirring
3. Neem extract and glycerin were incorporated
4. Essential oil was added for fragrance
5. The mixture was stirred to obtain a uniform consistency
6. The formulation was stored in sterile containers

Figure 8. formulation of hand sanitizer

8. EVALUATION PARAMETERS:

8.1 Physical Appearance:

The prepared formulation was evaluated for color, odor, and texture [13].

Parameter	Observation	Result
Color	Light green	Acceptable
Odor	Mild herbal fragrance	Pleasant
Texture	Smooth gel	Good consistency
Clarity	Transparent / slightly translucent	No impurities
Phase Separation	Not observed	Stable

TABLE 8.1: Physical Evaluation Parameter

8.2 pH Determination:

The pH was determined using a digital pH meter and found to be within the acceptable range of 5.5–7, suitable for skin application [15].

Parameter	Observed Value	Standard Range	Inference
pH	6.1 ± 0.1	5.5 – 6.5	Skin-friendly
Viscosity	1200 ± 50 cP	1000 – 2000 cP	Ideal gel consistency
Spreadability	5.0 ± 0.2 cm	4 – 6 cm	Good spreading
Alcohol Content	74–75% v/v	≥ 60%	Effective

TABLE 8.2: Physicochemical Evaluation

8.3 Antimicrobial Activity:

The antimicrobial activity was tested using the agar well diffusion method against common pathogens such as *E. coli* and *S. aureus* [10].

Microorganism	Herbal Sanitizer (mm)	Commercial Sanitizer (mm)	Blank (mm)
Staphylococcus aureus	19.5 ± 0.9	21.0 ± 1.0	0
Escherichia coli	18.2 ± 1.0	20.5 ± 1.2	0

TABLE 8. 3: Antimicrobial Activity (Zone of Inhibition):

8.4 Spreadability:

Spreadability was evaluated to determine ease of application on the skin [19].

Microorganism	MIC (Herbal Sanitizer)	Interpretation
S. aureus	2% v/v	Highly effective
E. coli	2–3% v/v	Effective

TABLE 8.4: Minimum Inhibitory Concentration (MIC):

8.5 Stability Study:

The formulation was subjected to stability studies at different temperatures to observe changes in physical and chemical properties [20].

Parameter	Initial	After 30 Days (40°C)	Observation
Color	Light green	No change	Stable
Ph	6.1	6.0	Slight variation
Odor	Mild	No change	Stable
Phase Separation	None	None	Stable

TABLE 8. 5: Stability Study

8.6 Skin Irritation:

Score	Grade	Interpretation
0	Nil	No irritation
1	Mild	Slight redness
2	Moderate	Visible redness
3	Severe	Intense redness / itching

TABLE 8.6: Skin Irritation Test

8.7 Comparative Evaluation:

Parameter	Herbal Sanitizer	Commercial Sanitizer
Antimicrobial Activity	Good	Very Good
pH	Skin-friendly (6.1)	Slightly alkaline
Moisturizing Effect	Excellent	Moderate
Skin Irritation	None	Mild
Cost	Low	

TABLE 8.7: COMPARATIVE EVALUATION

9. RESULTS AND DISCUSSION:

The formulated herbal sanitizer exhibited good physical properties, including acceptable color, odor, and consistency. The pH was found to be within the skin-friendly range [15].

The presence of neem extract contributed significantly to antimicrobial activity due to its bioactive compounds such as nimbidin and azadirachtin [4]. Aloe vera improved the moisturizing effect and reduced dryness caused by alcohol [11].

The antimicrobial activity of the herbal formulation was found to be comparable to commercial sanitizers [6]. Stability studies indicated that the formulation remained stable under normal storage conditions [20].

10. ADVANTAGES:

- Natural and safe ingredients [12]
- Skin-friendly formulation [11]
- Cost-effective [14]
- Eco-friendly [18]

Figure 9. The prepared sanitizer exhibited satisfactory physicochemical properties, including a light green appearance, smooth gel consistency,

11.LIMITATIONS:

- Shorter shelf life compared to synthetic products [20]
- Variability in herbal extract quality [18]
- Requires proper storage conditions

12. SUMMARY & CONCLUSION:

- The present study successfully focused on the formulation and evaluation of a neem-based herbal hand sanitizer using isopropyl alcohol, aloe vera gel, neem extract, glycerin, and essential oil. The formulation was designed to combine the rapid antimicrobial action of alcohol with the therapeutic and skin-friendly properties of herbal ingredients.
- The prepared sanitizer exhibited satisfactory physicochemical properties, including a light green appearance, smooth gel consistency, and pH of 6.1, which lies within the acceptable skinfriendly range. The viscosity and spreadability were found to be optimal, ensuring ease of application and adequate coverage on the skin surface.
- The antimicrobial evaluation demonstrated significant activity against both Gram-positive (*Staphylococcus aureus*) and Gram-negative (*Escherichia coli*) bacteria, with inhibition zones comparable to commercial alcohol-based sanitizers. This confirms that the formulation is effective in eliminating pathogenic microorganisms. The presence of neem extract enhanced the antimicrobial spectrum, while aloe vera and glycerin improved moisturizing properties and reduced the drying effect of alcohol.
- Stability studies indicated that the formulation remained stable under accelerated conditions, showing no significant changes in color, pH, or phase separation. Additionally, the skin irritation test confirmed that the formulation is safe for topical application and suitable for frequent use.
- Overall, the study concludes that the neem-based herbal hand sanitizer is an effective, stable, and skin-compatible formulation. It offers a promising natural alternative to conventional sanitizers by combining antimicrobial efficacy with enhanced user safety and comfort. This formulation can be further developed for large-scale production and commercial application in the field of personal hygiene.

13.FUTURE PERSPECTIVES:

- **Viral Testing:** Assess efficacy against viruses (e.g. influenza, coronavirus) since alcohol should be effective, but herbal components' contribution is unknown.
- **Stability (Long-term):** Conduct 6–12 month stability studies at various temperatures to confirm shelf life.

- **Sensory Evaluation:** Conduct user studies to refine scent and texture (some may prefer stronger fragrance or different consistency).
- **Ingredient Variations:** Test other herbs (e.g. Tulsi or peppermint oil) for enhanced properties or appeal
- **Sustainability:** Explore biodegradable packaging and eco-friendly preservatives to further improve the product's profile

Figure 10. study concludes that the neem-based herbal hand sanitizer is an effective, stable, and skin-compatible formulation

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