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Formulation and Evaluation of Herbal Hand Sanitize

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Abstract: *Hand hygiene remains the most crucial role for reducing transmission of infectious microorganisms. Alcohol-based hand sanitizers are widely recommended due to their rapid antimicrobial activity mediated through protein denaturation and lipid membrane disruption. However, frequent use high alcohol concentrations have been associated with disruption of the stratum corneum barrier and irritant dermatitis. Plant-derived antimicrobial agents, including phenolics, flavonoids, and essential oils, have ability of broad-spectrum antimicrobial activity via membrane permeabilization, enzyme inhibition, and oxidative stress mechanisms. This review critically synthesizes published literature on the formulation techquies, physicochemical considerations, antimicrobial evaluation methods, and stability assessment of herbal hand sanitizers. Hydroalcoholic gels, alcohol-free systems, essential oil-based formulations, and nano emulsion approaches are comparatively analysed based on pharmaceutics principles. Evaluation parameters including pH, viscosity, spread ability, antimicrobial activity, and accelerated stability testing are discussed in accordance with validated methodologies reported in formulation studies. Limitations identified include variability in phytochemical standardization, lack of uniform antimicrobial testing protocols, and insufficient long-term stability data. Based on this, herbal hand sanitizers suggest pharmaceutical potential when rationally formulated and systematically evaluated using validated analytical methods.*

Keywords: Herbal hand sanitizer; Hydroalcoholic gel; Phytochemicals; Essential oils; Carbopol; Antimicrobial evaluation; Rheology; Stability studies; Pharmaceutical formulation; Dermal compatibility

I. INTRODUCTION

Hand hygiene is universally known as the most effective measure for preventing health related issues and community transmission of pathogens [1,2]. Alcohol-based hand rubs containing 60–80% ethanol are recommended by international guidelines due to rapid bactericidal and virucidal activity [2]. The antimicrobial mechanism involves protein coagulation and membrane lipid dissolution [1].

Regardless of proven performance, prolonged exposure to alcohol-based formulations has been associated with disruption of stratum corneum lipids, leading to dryness and irritation [13]. This limitation has given rise to plant-derived antimicrobial agents as adjuncts or alternatives.

Medicinal plants contain secondary metabolites such as phenolics, flavonoids, alkaloids, tannins, and essential oils with documented antimicrobial properties [3–7,19,20]. These phytochemicals show antimicrobial activity primarily through disruption of microbial cell membranes and interference with metabolic enzymes [4,5].

From a pharmaceutics perspective, topical gel formulation requires careful selection of gelling agents, solvents, and excipients to ensure stability, appropriate rheology, and dermal compatibility [9–11]. Carbopol polymers are widely used due to their ability to produce high-viscosity gels at low concentration following neutralization [9].

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Phytochemical Basis of Antimicrobial Activity

Cowan [3] described phenolic compounds as major contributors to plant antimicrobial activity. Essential oils have demonstrated efficacy against both Gram-positive and Gram-negative organisms [4,7,19].

Hammer et al. [7] reported that essential oils compromise bacterial membrane integrity, resulting in leakage of intracellular constituents. Nostro et al. [5] proposed that phenolic compounds disrupt membrane permeability and inhibit enzymatic activity. Bassolé and Juliani [6] discussed synergistic interactions among essential oil components enhancing antimicrobial effect.

Dhakad et al. [20] further summarized biological activities of essential oils, reinforcing their relevance in topical antimicrobial formulations.

METHOD OF PREPARATION:

1. Accurately weigh all the required ingredients using a calibrated analytical balance as per the formulation design.
2. Disperse the required quantity of Carbopol in a measured volume of purified water with continuous stirring to avoid lump formation. Allow the dispersion to hydrate and swell for approximately 2 hours to obtain a uniform gel base.
3. Dissolve the weighed quantity of neem extract in a suitable volume of ethanol to obtain a clear solution.
4. Add glycerine and aloe vera gel to the alcoholic solution and mix thoroughly to ensure uniform distribution.
5. Gradually add the alcoholic mixture into the hydrated Carbopol dispersion under continuous stirring to ensure homogeneous mixing.
6. Add triethanolamine dropwise with gentle stirring to neutralize the dispersion and adjust the pH to the range of 6.0–6.5, thereby facilitating gel formation.
7. Make up the final volume with purified water, if required, and homogenize the formulation to achieve a smooth and uniform consistency.
8. Transfer the prepared gel into suitable, clean, and airtight containers, properly label, and store under appropriate conditions.

FORMULATION TABLE

SR.NO	INGREDIENT	FUNCTION	QUANTITY
1	Ethanol	Antimicrobial solvent	6ml
2	Neem extract	Herbal antimicrobial agent	0.5ml
3	Alovera gel	Skin smoothing agent	0.5ml
4	Carbapol 940	Gelling agent	0.08g
5	Glycerine	Humectant	0.3g
6	Tri ethanol amine	Neutralizing agent	q.s
7	Water	Vehicle	Up to 10g

EVALUTION METHOD

1 pH

Maintained within 5–7 for skin compatibility .

2 Viscosity

Measured using Brookfield viscometer thus; carbapol gels exhibit pseudoplastic behavior.

3 Spreadability

Evaluate using glass slide method in herbal gel evaluation studies .

4 Antimicrobial Activity

Agar diffusion method is used to determine zone of inhibition.

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5 Stability Studies

Accelerated stability testing under elevated temperature and humidity described in formulation studies [14].

RESULT: -

- The formulated herbal hydroalcoholic hand sanitizer gel was **smooth, translucent, and light green** with a characteristic herbal Odor. No phase separation, turbidity, or particulate matter was observed.
- pH: **6.2 ± 0.1**, within the acceptable skin range (5.5–6.5).
- Viscosity (Brookfield viscometer, Spindle 64, 20 rpm, 25°C): **4520 ± 120 cps**, showing pseudoplastic flow behaviour.
- Spread ability: **625 gm./sec**, indicating good spreading capacity.
- Drying time (1 mL application): **38 ± 3 seconds**, demonstrating rapid evaporation.

II. CONCLUSION

Based on cited literature, herbal hand sanitizers incorporating plant-derived antimicrobial agents demonstrate promising potential as dermo-compatible sanitizing systems. Effective formulation requires appropriate polymer selection, solvent compatibility, and validated evaluation methodologies. While antimicrobial efficacy of essential oils and plant extracts is well documented [3–7,19,20], further standardization and extended stability investigations are required for large-scale pharmaceutical adoption.

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