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Formulation and Development of Herbal Disinfectant Liquid

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A B S T R A C T:

This research focuses on the formulation and development of a herbal disinfectant liquid using plant-based ingredients known for their antimicrobial properties. Extracts from Psidium guajava (guava), Mentha arvensis (mint), Azadirachta indica (neem), Ocimum sanctum (tulsi), Allium sativum (garlic), Citrus limon (lemon), and Eucalyptus globulus (eucalyptus) were obtained through various extraction methods including maceration, Soxhlet extraction, steam distillation, and decoction. The formulated disinfectant was evaluated for physical parameters such as pH, color, clarity, and aroma. The product exhibited a skin-friendly pH of 5.5–6.5, a clear appearance, and a pleasant herbal scent, indicating its suitability for human contact and surface application. Although microbiological efficacy testing was not conducted, the individual components are well-documented in literature for broad-spectrum antimicrobial action. The herbal disinfectant offers an eco-conscious alternative to conventional chemical-based products, aligning with current trends toward sustainable and natural hygiene solutions.

Keywords: Herbal Formulation, Disinfectant, Herbal liquid, Herbal Disinfectant,

Introduction:

Background

In recent decades, the widespread use of synthetic chemical disinfectants has raised significant environmental and health concerns. Many conventional disinfectants, while effective against a wide range of pathogens, are associated with side effects such as skin irritation, respiratory issues, and allergic reactions, especially with prolonged exposure. Moreover, the emergence of microbial resistance to chemical biocides has further complicated infection control strategies in clinical, domestic, and public health settings.[1]

These challenges have prompted increased interest in alternative antimicrobial agents derived from natural sources. Herbal or plant-based disinfectants offer a promising solution due to their broad-spectrum antimicrobial properties, lower toxicity, biodegradability, and cost-effectiveness. Plants synthesize a vast array of bioactive compounds such as phenolics, alkaloids, flavonoids, terpenoids, and essential oils that exert potent antibacterial, antifungal, and antiviral effects.[2]

Significance of Herbal Disinfectants

The use of botanicals in traditional medicine and hygiene practices has been well documented across various cultures. Specifically, Psidium guajava (guava leaves), Mentha spp. (mint), and Allium sativum (garlic) have shown significant antimicrobial activity against a wide range of pathogens including Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa, and Candida albicans.[3,4] In addition, other botanicals like neem (Azadirachta indica), tulsi (Ocimum sanctum), lemon (Citrus limon), and eucalyptus (Eucalyptus globulus) are known for their antiseptic and aromatic properties, making them suitable candidates for disinfectant formulations.[5]

Given the global movement towards sustainable and green solutions, incorporating these botanicals into disinfectant formulations not only addresses safety and efficacy but also aligns with eco-conscious consumer preferences.[6]

Objectives of the Study:

- Formulate an herbal disinfectant
- Study the phytochemistry of various plants
- To evaluate the physical properties of the disinfectant,
- To prepare and analyze the cost-effectiveness of the herbal–disinfectant liquid.

Review of Literature

- Cowan et. al. (1999) emphasized the importance of plant-derived compounds like flavonoids, terpenoids, and alkaloids in combating microbial infections. These phytochemicals offer potent antimicrobial effects and are less likely to cause resistance compared to synthetic biocides.

- Maillard et. al. (2005) discussed the efficacy and drawbacks of chemical disinfectants in healthcare, noting that prolonged exposure can cause skin irritation and environmental harm, driving the need for safer alternatives.

- Studies by Gutierrez et al. (2008) and Arima & Danno (2002) confirmed that guava leaf extracts exhibit antibacterial effects against *S. aureus* and *E. coli*, primarily due to flavonoids and tannins.

- Pramila et al. (2012) showed that mint extract has significant inhibitory effects against both Gram-positive and Gram-negative bacteria, attributed to essential oils like menthol.

- Amagase et al. (2006) and Bakri & Douglas (2005) highlighted the organosulfur compounds in garlic, especially allicin, as highly effective against oral and pathogenic bacteria.

- Chattopadhyay et al. (2003) and Singh & Sharma (2012) showed that neem and tulsi extracts possess antiviral, anti-inflammatory, and immunomodulatory properties, validating their traditional use in disinfection and skin care.

- Elshafie & Camele et al. (2017) reviewed essential oils from citrus and eucalyptus, affirming their antifungal and antiseptic effects, which also contribute to fragrance and freshness in surface cleaners.

- Vimaladevi et. al. (2021) successfully developed a polyherbal disinfectant that was safe, effective, and eco-friendly, confirming the feasibility of multi-plant formulations for hygiene purposes.

Materials and Methods:

3.1 Materials

Plant materials:

- Psidium guajava (Guava leaves)
- Phytochemical Constituents
- Flavonoids
- Tannins
- Terpenoid
- Saponins
- Essential oils
- Vitamins

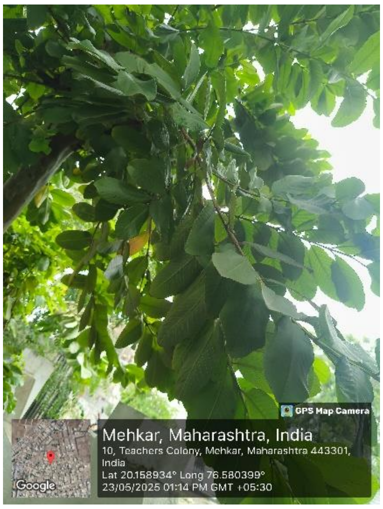

Fig: Guava Leaves

Mentha arvensis (Mint leaves)

- Phytochemical Constituents
- Essential Oils
- Flavonoids
- Phenolic Compounds
- Terpenoids
- Tannins
- Saponins

Fig: Mint Leaves

Azadirachta indica (Neem leaves)

- Limonoids (Triterpenoids)
- Flavonoids
- Phenolic Compounds
- Steroids
- Tannins
- Alkaloids
- Saponins
- Polysaccharides

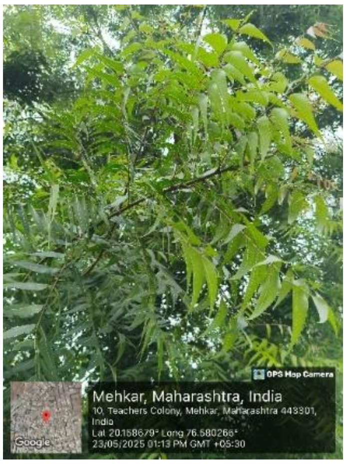

Fig: Neem

Ocimum sanctum (Tulsi leaves)

- Essential Oils (Volatile Compounds)
- Flavonoids
- Phenolic Compounds
- Triterpenoids
- Alkaloids
- Tannins
- Saponins

Fig: Tulsi

Citrus limon (Lemon peel or juice)

- Flavonoids (Abundant in Peel)
- Phenolic Compounds
- Essential Oils (Mainly in Peel)
- Vitamins
- Organic Acids (Mainly in Juice)
- Minerals
- Pectins and Fiber (Primarily in Peel and Pulp)

Fig: Lemon

Eucalyptus globulus (Eucalyptus oil or leaves)

- Essential Oils (Major Active Components)
- Flavonoids
- Phenolic Compounds
- Tannins
- Terpenoids

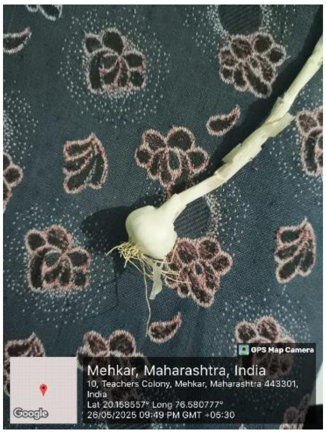

Fig:Eucalyptus Leaves (Oil)

Allium sativum (Garlic bulbs)

- Organosulfur Compounds (Main Active Constituents)
- Flavonoids
- Phenolic Compounds
- Saponins
- Polysaccharides
- Enzymes
- Vitamins and Minerals

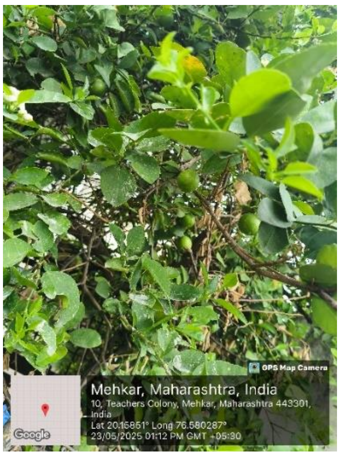

Fig: Garlic Bulb

Solvents:
Distilled water
Ethanol (70% v/v) — used for extraction and formulation

3.2 Collection and Authentication of Plant Materials

The fresh leaves and other essential parts of all plants are manually collected from Mehkar. Upon collection, the leaves and other required parts of plants are thoroughly washed with tap water to remove any dirt or impurities. After washing, the leaves are dried at room temperature to preserve their active compounds before being used in the formulation of the herbal disinfectant.
After the leaves are dried at room temperature, they become crunchy in texture. Once fully dried, the leaves are carefully ground into a fine powder. This is achieved by using either a mortar and pestle or a grinder. The powdered form of the leaves facilitates the extraction and utilization of the plant's active compounds, which are crucial for the formulation.

Methodology:

Extraction of plants:

Extraction of the Guava leaves: [Maceration (Hydroethanol 70%)]
100 g of guava leaf powder was soaked in 1000 mL of 70% ethanol (v/v) and macerated at room temperature for 72 hours with occasional stirring. The mixture was filtered using Whatman No. 1 filter paper. The filtrate was evaporate using sunlight, then lyophilized to yield a stable dry extract. Extraction yields typically ranged between 10–14% [7,8]

- **Mint Leaves – [Cold Maceration (Hydroethanol 50%)]**
  Mint powder (100 g) was extracted with 800 mL of 50% ethanol by cold maceration for 72 hours. After filtration, the extract was concentrated under reduced pressure and freeze-dried. This method preserves menthol and other volatile constituents.[9]

- **Garlic Bulbs – Aqueous Extraction (Decoction)**
  Fresh garlic cloves (100 g) were crushed and boiled in 500 mL distilled water for 15 minutes. After cooling, the solution was filtered and concentrated to a semisolid mass using a water bath below 60°C to preserve allicin content [10,11].

- **Neem and Tulsi Leaves – Soxhlet Extraction**
  For Neem and Tulsi, 50 g of dried powder was extracted in a Soxhlet apparatus using ethanol (95%) for 6 hours. After that the solvent is evaporate by using sunlight. Extracts were concentrated and stored at 4°C until use.[12]

- **Lemon Peel – [Steam Distillation]**
  Lemon peels were subjected to steam distillation for 3 hours to isolate essential oil rich in limonene. The oil was dried over anhydrous sodium sulfate and stored in amber bottles [13].

- **Eucalyptus Leaves – [Hydrodistillation]**
  Eucalyptus oil was extracted from fresh leaves via hydrodistillation using a Clevenger-type apparatus for 4 hours. The essential oil was separated, dried, and stored in a cool, dark place [14].

Formulation of Herbal Disinfectant Liquid

Formulation Table

S. No.	Ingredient	Form Used	Quantity Used	Purpose
1	Guava Leaf Extract	Ethanolic Extract	5 mL	Antibacterial, Antifungal
2	Mint Leaf Extract	Hydroethanolic Extract	5 mL	Cooling agent, Antimicrobial
3	Garlic Extract	Aqueous Extract	2 mL	Broad-spectrum antimicrobial
4	Neem Extract	Soxhlet Ethanolic Extract	3 mL	Antiviral, Insecticidal
5	Tulsi Extract	Soxhlet Ethanolic Extract	3 mL	Immunomodulatory, Antimicrobial

6	**Lemon Oil**	**Steam Distilled Oil**	**2 mL**	**Deodorizer, Surface Cleaner**
7	**Eucalyptus Oil**	**Hydrodistilled Oil**	**1.5 mL**	**Antiseptic, Fragrance**
8	**Ethanol (70%)**	**Solvent Base**	**30 mL**	**Solvent, Preservative**
9	**Glycerin**	**Liquid**	**1 mL**	**Moisturizer, Skin Soothing Agent**
10	**Distilled Water**	**Aqueous Vehicle**	**Up to 100 mL**	**Volume Makeup**

Preparation of Disinfectant Liquid:

- Measure individual plant extracts: (Guava: 5 mL, Mint: 5 mL, Garlic: 2 mL, Neem: 3 mL, Tulsi: 3 mL) and dissolve all extracts in 30 mL of 70% ethanol under continuous stirring.
- Add 2 mL of lemon oil and 1.5 mL of eucalyptus oil dropwise. And stir gently but continuously to avoid separation and ensure uniform dispersion.
- Add 1 mL of glycerine to the solution to enhance the skin-friendliness and reduce potential dryness caused by ethanol.
- Make up the volume up to 100ml by using distilled water slowly while stirring.
- Maintain pH between 5.5 and 6.5 by checking with a pH meter. Adjust if necessary, using citric acid or sodium citrate buffer
- Stir the final mixture for at least 30 minutes using a magnetic stirrer or overhead mixer to ensure complete uniformity
- Filter the solution through sterile muslin cloth to remove any undissolved particles.[15,16,17]

Evaluation test:

- pH: 5.5–6.5 (ideal for skin contact)
- Color: Pale green to brown
- Odor: Pleasantly herbal and aromatic
- Clarity: Clear, without precipitates

Result and Discussion:

The formulated herbal disinfectant liquid exhibited optimal physicochemical properties, including a skin-friendly pH (5.5–6.5), clear appearance, and a pleasant herbal aroma. The formulation incorporated extracts of Guava, Mint, Neem, Tulsi, Garlic, Lemon, and Eucalyptus—each contributing essential phytochemicals like flavonoids, terpenoids, and essential oils with proven antimicrobial properties. Though specific microbial assay data were not detailed, the combination is expected to provide broad-spectrum antibacterial, antifungal, and antiviral effects based on existing literature. The synergistic activity of the plant constituents enhances the disinfectant's overall efficacy while maintaining safety and biodegradability. The formulation supports the development of eco-friendly alternatives to synthetic disinfectants, but further studies—such as microbial zone of inhibition, MIC evaluation, and long-term stability testing—are recommended for comprehensive validation and potential commercialization.

Conclusion:

The developed herbal disinfectant liquid successfully integrates multiple plant extracts, each contributing potent antimicrobial phytochemicals such as flavonoids, terpenoids, tannins, and essential oils. The formulation met essential physicochemical criteria, including clarity, stability, and a skin-compatible pH range, indicating its potential effectiveness and user safety. While direct microbial inhibition studies were not part of this investigation, the well-established antimicrobial activity of the selected botanicals supports the disinfectant's presumed efficacy. The product stands out as a biodegradable, non-toxic, and affordable alternative to synthetic disinfectants, particularly in domestic and clinical settings. To establish its commercial viability and therapeutic efficacy, further studies are recommended, including microbial assays, minimum inhibitory concentration (MIC) testing, and long-term stability analysis. Overall, this research contributes to the growing field of green chemistry and supports the broader adoption of herbal formulations in public health hygiene.

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