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NATURE'S TOUCH: THE POWER OF HERBAL HANDWASHS WITH NEEM, TURMERIC, AND TULSI

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ABSTRACT
The growing demand for safer and more environmentally friendly personal hygiene products has led to increased interest in herbal handwash formulations. This review article explores the pharmacological properties, formulation advantages, and antimicrobial effectiveness of medicinal herbs commonly incorporated in herbal handwashes. Key plant ingredients such as neem (Azadirachta indica), turmeric (Curcuma longa), tulsi (Ocimum sanctum), and aloe vera (Aloe barbadensis Miller) are widely recognized for their therapeutic potential and skin-beneficial properties. These herbs provide a natural alternative to synthetic chemical agents traditionally used in commercial hand cleansing products. Neem is well known for its strong antibacterial, antifungal, and antiviral activities, attributed to bioactive compounds such as azadirachtin, nimbidin, and flavonoids. These constituents inhibit the growth and multiplication of pathogenic microorganisms commonly present on the skin surface. Regular use of neem-based handwash formulations may help reduce microbial load effectively while minimizing the risk of irritation often associated with chemical disinfectants. Turmeric contributes significant antioxidant and anti-inflammatory effects due to the presence of curcumin, a biologically active polyphenol. Curcumin supports skin repair, reduces inflammation, and enhances protection against oxidative stress, while also exhibiting antimicrobial properties that strengthen the germicidal action of herbal handwashes. Tulsi, commonly known as holy basil, possesses antimicrobial, antifungal, and adaptogenic properties. Its essential oils and phytoconstituents enhance microbial resistance and promote skin resilience. Tulsi also exhibits soothing and protective effects that make herbal formulations suitable for frequent daily use. Aloe vera plays a supportive yet essential role in these formulations by acting as a natural moisturizer and skin-conditioning agent. Rich in polysaccharides, vitamins, and enzymes, aloe vera helps maintain hydration, prevent dryness, and soothe irritated skin after repeated washing. This combination of cleansing and moisturizing action makes herbal handwashes particularly suitable for individuals with sensitive or dry skin types. In addition to primary herbal extracts, several commercial formulations incorporate complementary natural ingredients such as lemon extract, cajeput oil, and clove oil to enhance antimicrobial activity and provide a mild, refreshing fragrance. Product evaluations indicate that certain herbal handwashes are capable of providing rapid germ protection, with some claiming up to 99.9% microbial reduction within seconds of application. Unlike many synthetic formulations containing harsh surfactants, parabens, triclosan, or artificial fragrances, herbal handwashes are generally considered safer for long-term use and more biodegradable, thereby reducing environmental impact. Consumer studies and product assessments suggest that herbal handwashes effectively cleanse without excessively stripping the skin's natural oils. Their fragrance intensity is typically mild, making them appropriate for individuals sensitive to strong scents. Furthermore, herbal formulations are often competitively priced and packaged to maintain product stability and hygiene. Although existing evidence supports their antimicrobial and skin-protective benefits, further research is required to evaluate long-term efficacy, stability under different storage conditions, and optimization for various skin types to ensure maximum effectiveness and safety.

KEYWORDS: Herbal handwash, Neem, Turmeric, Tulsi handwash, Natural handwash, Ayurvedic handwash.

I. INTRODUCTION

Hands are the major route of microbe and illness transfer; hand cleanliness is the most efficient way to prevent the spread of hazardous germs and diseases. In healthcare, hand cleanliness is the best and most effective, simplest, and affordable technique to prevent nosocomial infections. Contaminated hands can function as vectors for the spread of germs. Outbreaks are conveyed from one human to another when a food handler contaminates his or her hands and then transfers these bacteria to customers via hand contact with food or drinks. The user is exposed after ingesting these germs, which might cause gastrointestinal disease.[1,2]

The hands of healthcare providers are the main cause of the spread of multidrug-resistant bacteria and sickness to patients. As an outcome, it presents the issue of hygienic hand cleansing. Various antimicrobial compounds are now accessible as alcohol-based hand wash, detergent, and other items on the market. These soaps or solutions aid in the prevention of health-care associated microbiological contamination, although they come with certain disadvantages or adverse reactions. Their usage on a regular basis might promote skin irritation and infection resistance.[3]

Natural ingredients make up herbal hand cleanser. Thus, if left in the ecosystem, it can overcome pathogenic resistance and won't harm the environment. Since ancient times, plants have provided mankind with a variety of medicinally useful chemicals, making them the original source of pharmacologically active molecules.
Herbal remedies have long been used to prevent and treat a wide range of ailments.[4,5]

Neem

- Azadirachta indica is a tree of the Meliaceae family of mahogany, also referred to as neem, nimtree, or Indian lilac. It is indigenous to much of Africa and the Indian subcontinent, and it is one of two species in the genus Azadirachta. Typically, tropical and semi-tropical climates are used to cultivate it. In southern Iran, neem trees may also be found on islands. Neem oil comes mostly from its fruits and seeds.[6]
- Neem is a quickly growing tree that is 15–20 metres (49–66 ft) tall, with an occasional height of 35–40 m (115–131 ft). It is deciduous, with much of its leaf fall in dry winter. The spreading branches are wide. The relatively dense crown is roundish and can have a diameter of 20–25 m (66–82 ft). The neem tree is similar.[7]
- The fruit is smooth (glabrous), olive-like drupe that is elongate oval to almost roundish in shape, measuring when ripe at 14–28 mm (1/2–1 1/8 in) by 10–15 mm (3/8–5/8 in). The fruit skin (exocarp) is thin in nature, with yellowish-white and highly fibrous, bitter-sweet pulp (mesocarp). The fruit's mesocarp is 3–5 mm (1/8–1/4 in) in thickness. The hard, white inner shell (endocarp) of the fruit contains one, rarely two, or three elongated seeds (kernels) with brown seed covering.[8]

Figure No. 1: Neem Leaves.

TRADITIONAL MEDICINE

Neem tree products have been used for millennia in Indian traditional medicine; nevertheless, there is not enough clinical data to support the use of neem for therapeutic reasons. There are no known dosages for neem in humans, and while short-term usage seems safe, long-term use may damage the kidneys or liver; neem oil is poisonous and can be fatal in young children. Low blood sugar, infertility, and miscarriages are more side effects of neem.[9,10] Despite the limitations in clinical evidence and the potential adverse effects associated with improper or prolonged use, neem continues to be widely studied for its pharmacological potential. Phytochemical investigations have identified several active constituents, including azadirachtin, nimbin, nimbidin, gedunin, and various flavonoids, which contribute to its broad-spectrum antimicrobial, anti-inflammatory, antioxidant, and immunomodulatory properties. Experimental studies have demonstrated that neem extracts exhibit inhibitory effects against a wide range of Gram-positive and Gram-negative bacteria, fungi, and certain viruses. These findings provide a scientific basis for its continued inclusion in topical formulations such as herbal handwashes, soaps, and dermatological preparations.

In cosmetic and hygiene products, neem is typically incorporated in standardized extract form and in carefully controlled concentrations to minimize toxicity risks while maximizing antimicrobial efficacy. Topical application differs significantly from systemic consumption, as the absorption through intact skin is limited, thereby reducing the likelihood of systemic adverse effects such as hepatotoxicity or nephrotoxicity. Furthermore, formulation strategies often combine neem with other soothing and moisturizing agents, such as aloe vera or glycerin, to counteract any potential skin dryness and enhance user safety.

It is also important to distinguish between traditional crude preparations and modern formulated products. While neem oil ingestion has been associated with toxicity, particularly in infants and young children, externally applied and quality-controlled herbal formulations are generally regarded as safe for short-term and routine hygiene purposes. Nevertheless, comprehensive clinical trials, toxicological evaluations, and long-term safety assessments remain necessary to establish standardized therapeutic dosages, clarify mechanisms of action, and develop evidence-based guidelines for safe human use. Continued research will help bridge the gap between traditional knowledge and modern scientific validation.

PEST AND DISEASE CONTROL

Neem offers a natural substitute for synthetic pesticides and is a crucial component of non-pesticide management (NPM). The crop is sprayed with a powdered neem seed that has been steeped in water for the whole night. It needs to be administered frequently, at least once every 10 days, in order to be effective. Neem doesn't kill insects directly. It shields the crop from harm by acting as an anti-feedant, repellant, and egg-laying deterrent. Within a few days, the insects die from starvation. Additionally, neem prevents their eggs from hatching later. Fertilizers based on neem have been successful in combating southern armyworm.[11]

You may use neem cake as fertilizer. Because of its anti-desertification qualities and potential as an excellent carbon dioxide sink, the neem tree is very important. Maintaining soil fertility is another application for it.[12]

Azadirachtin, the major bioactive compound in neem, interferes with insect growth regulation, molting, and reproduction. It disrupts hormonal balance in pests, thereby reducing their population without causing immediate toxicity like synthetic pesticides.

- Neem-based formulations reduce the chances of resistance development in insects because they act through multiple mechanisms such as anti-feedant action, growth inhibition, and reproductive suppression.
- Unlike chemical pesticides, neem products are biodegradable and leave minimal toxic residues in soil and water, making them environmentally safer and suitable for sustainable agriculture.
- Neem seed kernel extract (NSKE) has shown effectiveness against a wide range of agricultural pests including caterpillars, aphids, beetles, and leafhoppers, and is widely used in integrated pest management (IPM) systems.
- Neem cake, a by-product obtained after oil extraction, acts as an organic fertilizer and soil conditioner. It improves soil structure, enhances microbial activity, and increases nutrient availability to plants.
- Neem cake also functions as a natural nitrification inhibitor, helping to reduce nitrogen loss from soil and improving fertilizer efficiency. Additionally, it provides protection against soil-borne pathogens and nematodes.
- The neem tree contributes to environmental sustainability by preventing soil erosion through its deep root system and dense canopy. It plays a role in combating desertification and acts as a potential carbon dioxide sink, supporting climate change mitigation efforts.
- Due to its adaptability to arid and semi-arid regions, neem is valuable for restoring degraded lands and maintaining long-term soil fertility in sustainable farming systems.

OTHER USES

- Fertilizer: As a nitrification inhibitor, neem extract is applied to fertilizers (urea).
- Tree: The neem tree is significant because it prevents desertification and may be an excellent carbon dioxide absorber.
- Maintaining soil fertility is another application for it.
- Animal feed: ruminants and rabbits can occasionally eat neem leaves as fodder.
- Fertilizer: As a nitrification inhibitor, neem extract is applied to fertilizers (urea).
- Teeth cleaning: Neem has long been used as a kind of twig that cleans teeth.[13]
- Neem-coated urea fertilizers help in slowing down the release of nitrogen into the soil, thereby improving nitrogen use efficiency and reducing nutrient loss through leaching and volatilization. This enhances crop productivity while minimizing environmental pollution caused by excess nitrogen runoff.

The nitrification inhibitory property of neem extract suppresses the activity of soil nitrifying bacteria, ensuring gradual nutrient availability to plants and promoting sustainable agricultural practices.

The neem tree plays an important ecological role due to its strong adaptability to drought-prone and semi-arid regions. Its extensive root system stabilizes soil structure, reduces erosion, and supports land restoration in degraded areas.

As a fast-growing evergreen species, neem contributes to carbon sequestration by absorbing atmospheric carbon dioxide, thereby assisting in climate change mitigation and improving air quality.

Neem leaves used as animal feed contain certain bioactive compounds that may exhibit antiparasitic and antimicrobial properties, potentially improving animal health when used in controlled and limited quantities. However, proper dosage and veterinary guidance are recommended to avoid toxicity.

In traditional dental hygiene practices, neem twigs have been widely used as natural chewing sticks (datun). The mechanical action of chewing combined with neem's antibacterial properties helps reduce dental plaque, prevent gum infections, and maintain overall oral hygiene.

Neem extracts are also being studied for their potential incorporation into modern oral care products such as toothpastes and mouthwashes due to their antimicrobial and anti-inflammatory effects.

Beyond agricultural and medicinal uses, neem wood is valued for its durability and resistance to termites, making it useful in furniture and rural construction applications.

b) TULSI

A fragrant perennial plant belonging to the Lamiaceae family, Ocimum tenuiliforme is sometimes referred to as holy basil, tulsi, or tulasi. Native to the Indian subcontinent, it is widely grown as a plant in the tropical regions of Southeast Asia. Tulsi is grown for its essential oil as well as for use in traditional and religious medicine. It has a position in the Vaishnava tradition of Hinduism, where followers worship holy basil plants or leaves, and is extensively used as herbal tea and in Ayurveda.[14]

The three primary morphotypes grown in India and Nepal are the ubiquitous wild vana tulsi (e.g., Ocimum gratissimum), the less common purple greenleaved (Krishna or Shyam tulsi), and the most common Ram tulsi (broad, bright green, somewhat sweet leaves).[15]

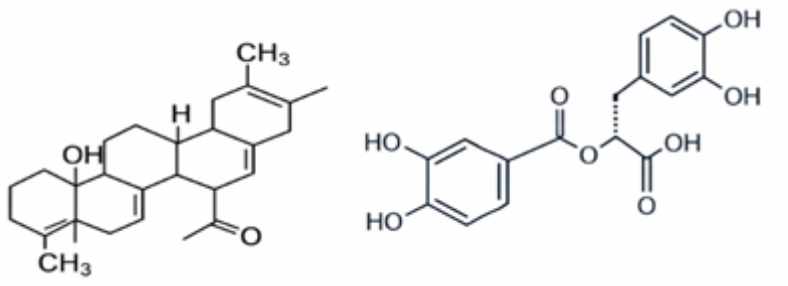
Figure No. 2: Tulsi Leaves.

MORPHOLOGY

Holy basil is an erect, many-branched subshrub, 30–60 cm (12–24 in) tall with hairy stems. Leaves are green or purple; they are simple, petiole, with an ovate blade up to 5 cm (2 in) long, which usually has a slightly toothed margin; they are strongly scented and have a decussate phyllotaxy. The purplish flowers are placed in close whorls on elongated racemes.[16]

The three most prominent cultivated morphotypes in India and Nepal are Ram tulsi (most widely grown, with wide bright green leaves with a sweetish flavor), less widespread purplish green-leaved (Krishna or Shyam tulsi) and common wild-growing vana tulsi (e.g., Ocimum gratissimum).[17]

CHEMICAL COMPOSITION OF TULSI



Oleanolic acid **Rosmarinic acid**

Figure No.: 3 Chemical Structure of Oleanolic acid and Rosmarinic acid.

The main constituents of tulsi essential oil include eugenol (~70%), β-elemene (~11.0%), β-caryophyllene (~8%), and germacrene (~2%). The remainder is composed of other trace chemicals, primarily terpenes.[18]

USES

- Ayurvedic and Siddha systems have utilized tulsi (Sanskrit: Surasa) for the purported cure and management of various illnesses, including respiratory disorders, fever, cough, cold, asthma, bronchitis, and digestive disturbances.
- In traditional medicine, tulsi is regarded as a "Rasayana" herb, meaning it is believed to promote longevity, enhance immunity, and improve overall vitality and well-being.
- Tulsi possesses antimicrobial, anti-inflammatory, antioxidant, and immunomodulatory properties due to the presence of bioactive compounds such as eugenol, ursolic acid, rosmarinic acid, and flavonoids.
- It has been traditionally used to relieve stress and anxiety, as tulsi is considered an adaptogen that helps the body cope with physical, chemical, and emotional stress.
- Tulsi extracts are commonly used in the management of skin disorders, wound healing, and minor infections because of their antibacterial and antifungal activities.
- In addition, tulsi is used in herbal teas, decoctions, and extracts to support cardiovascular health, regulate blood glucose levels, and improve metabolic function.
- Modern research has also explored tulsi's potential role in supporting respiratory health and enhancing immune response during seasonal infections.

c) TURMERIC

Curcuma longa is a flowering plant that belongs to the Zingiberaceae family of gingers. Its rhizomes are used in cooking. Native to the Indian subcontinent and Southeast Asia, the perennial, rhizomatous, herbaceous plant needs temperatures between 20 and 30 °C (68 and 86 °F) and a significant quantity of rainfall each year in order to flourish. Every year, plants are harvested for their rhizomes, some for eating, and some for multiplication the next season.[19]

The main ingredient in turmeric, curcumin, gives the rhizomes their color and flavor. They can be used fresh or boiled in water and then dried before being ground into a deep orange-yellow powder that is frequently used for coloring and flavoring in many Asian cuisines, particularly for curries, as well as for dyeing. The earthy, mustard-like scent of turmeric powder is accompanied by heated, bitter, black pepper-like flavors.[20]

The United States Food and Drug Administration, European Parliament, and World Health Organization have all authorized curcumin, a brilliant yellow compound produced from the turmeric plant, as a food ingredient.[21]

Figure No. 4: Turmeric.

ORIGIN AND DISTRIBUTION

Despite being used for a long time in Ayurvedic medicine, where it is also referred to as haridra, there is no solid clinical proof that taking turmeric or curcumin may cure any illness.[22]

India has the highest number of Curcuma species (between 40 and 45) in the world. There are around 30 to 40 species in Thailand. Numerous wild species of Curcuma can also be found in other tropical Asian nations. Curcuma longa has a dubious classification; only specimens from South India can be identified as C. according to recent investigations.[23]

It is still necessary to identify and authenticate the phylogeny, relationships, intraspecific and interspecific variation, and even the identification of other species and cultivars in other areas of the world. It has been demonstrated that some species that are now used and marketed as "turmeric" in other regions of Asia really belong to a number of visually identical taxa, sharing local names.[24]

PHYTOCHEMISTRY

India has the highest number of Curcuma species (between 40 and 45) in the world. There are around 30 to 40 species in Thailand. Numerous wild species of Curcuma can also be found in other tropical Asian nations. According to recent research, Curcuma longa has a dubious taxonomy; only specimens from South India can be identified as longa. It is still necessary to identify and authenticate the phylogeny, relationships, intraspecific and interspecific variation, and even the identification of other species and cultivars in other areas of the world. It has been demonstrated that some species that are now used and marketed as "turmeric" in other regions of Asia really belong to a number of visually identical taxa, sharing local names.[25]

Based on their long-standing traditional usage, the European Medicines Agency came to the conclusion in 2019 that turmeric herbal teas or other forms taken orally might be used to treat moderate digestive issues such flatulence andsensations of fullness. In South and Southeast Asian woods, turmeric grows wild and is harvested for use in traditional Indian medicine (Siddha or Ayurveda).[26]

Along with young plantains or banana plants, taro leaves, barley (jayanti), wood apples (bilva), pomegranates (darimba), Saraca indica, manaka (Arum), or manakochu, and rice paddy, the plant is utilized as one of the nine ingredients of nabapatrika in Eastern India. People of Indian culture all throughout the Indian subcontinent celebrate their weddings with the Haldi ritual, known as gaye holud in Bengal (meaning "yellow on the body"). A Thali necklace is made from dried turmeric tuber wrapped with string as part of the Tamil–Telugu marriage ceremony in Tamil Nadu and Andhra Pradesh.[27]

In western and coastal India, the Marathi and Konkani people, who are Kannada Brahmins, bind turmeric tubers to their wrists with threads at a rite known as Kankana Bandhana. The influence of adopting an easily accessible alcohol-based hand antiseptic on health care workers' handwashing compliance was examined by Bischoff WE, Reynolds TM, Sessler CN, Edmond MB, and Wenzel RP. In 1896, Friedrich Ratzel wrote in The History of Mankind that turmeric powder was used in Micronesia for ceremonial purposes as well as for body, garment, and utensil decoration.[28]

Anatomy and physiology of skin

1. The biggest organ in the human body, the skin is a layer of typically soft, flexible exterior tissue that acts as a physical barrier between the internal and external environments and performs homeostatic and protective functions. Skin pH ranges from 4 to 5.6. Three layers make up the skin:[29]

a) Epidermis
b) Dermis
c) Subcutaneous Tissue

a) Epidermis

A thin layer of skin is called the epidermis. It is the skin's outermost layer. It is made up of tissue called epithelium. The epidermis serves both protective and tactile purposes. This skin is further separated into five layers, which are as follows:

1. **Stratum Corneum:** The outermost layer of the epidermis, known as the stratum corneum, is composed of 10 to 30 thin layers of dead keratinocytes that are constantly shedding. Because its cells are as rough as an animal's horn, the corneum is known as the "Horny layer."
2. **Stratum Lucidum**: Only seen on the skin of the palms, soles, and fingertips, it is made up of four to six rows of flat, transparent, dead keratinocytes that contain a lot of keratin.
3. **Stratum Granulosum**: Between the stratum spinosum and the stratum lucidum lies a thin layer known as the stratum granulosum. This layer aids in creating a waterproof barrier that keeps the body from losing fluids. Keratin, the primary component of skin, is produced in this layer.
4. **Stratum Spinosum:** Between the stratum granulosum and the stratum Basale is the stratum spinosum layer. This layer gives the skin its strength and flexibility.
5. **Stratum Basale (Stratum germinativum):** There are melanocyte and intraepidermal macrophage projections among the eight to ten rows of multi-sided keratinocytes with bundles of keratin intermediate filaments.[30,31]

b) The Dermis

The middle layer of skin is called the dermis. The dermis is located underneath the epidermis. Because blood vessels were present, the skin was nourished by nutrients and oxygen and assisted in the removal of waste. It has nerves that

aid in the transmission of impulses from the skin. Various sensations, such as touch, pressure, temperature, etc., are included in these signals. Additionally, it includes collagen, a protein that gives skin its resilience.[32]

c) The Subcutaneous Tissue / Hypodermis / Subcutis

It is the skin's deepest layer, composed of connective tissue and fat cells. In order to shield internal bodily organs and muscles from shock and temperature fluctuations, the Subcutis serves as an insulating layer. Since our skin is the area of our body that is most exposed, it needs to be protected from skin infections. Microbes of the transitory and resistant flora type are typically seen on the hands. Transient flora, such as Gram-negative bacilli, colonize the superficial skin layers, whereas resident flora, such as Staphylococcus aureus, populate the deeper skin layers. These microorganisms are readily eliminated by hand washing.[33]

Because natural medicines are seen to be safer and have less negative effects than synthetic ones, they are more acceptable in the current scenario of a mechanized lifestyle. The need for herbal formulations is rising globally. In light of this directive, an effort has been made to search the ancient library for plants having antibacterial qualities. It has been discovered that Mentha Piperita (Pudina) and Azedarach indica (Neem) possess these qualities.[34]

II. Scientific Evidence and Research

A. Review of Current Research on Topical Uses of Tulsi, Turmeric, and Neem

Because of their bioactive components, neem, turmeric, and Tulsi have all been well researched for their potential medical benefits, especially when applied topically.

- **Neem (Azadirachta indica):** Studies show that neem has antibacterial and anti-inflammatory qualities that are ascribed to substances such as nimbin, nimbidin, and azadirachtin. Studies that show neem's effectiveness against bacteria (Staphylococcus aureus, Escherichia coli), fungi (Candida albicans), and even some viruses include those that were published in Phytotherapy Research (e.g., Biswas et al., 2002). Handwash applications may benefit from topical neem formulations, such as lotions and oils, which Latino demonstrated promise in treating skin infections and accelerating wound healing.[35]
- **Antimicrobialibris Action:** Neem's wide-ranging antimicrobial action is active against bacteria *Enterococcus faecalis, Streptococcus mutans,* as well as fungi, and parasites. A study conducted in 2016 revealed neem's antibacterial action against *E. faecalis* to be as good as that of chlorhexidine, validating its application in topical antiseptics. Soaps and face washes of neem (such as Apollo Life فرنسNeem Tulsi Face Wash) utilize such ᓚᘏ action to ward off acne and preserve a clear skin.[36]
- **Scabies and Dermatitis:** The previously mentioned pilot study proved the effectiveness of neem, in combination with turmeric, to treat scabies, with no adverse effects reported. Neem's anti-inflammatory and healing activity further increases its value in dermatology.[37]
- **Wound healing:** Neem extracts in form gel induced healing of orthodontic extraction sockets, as with that of turmeric, and better than that of betadine in a few cases. Its antimicrobial and anti-inflammatory activity fosters tissue regeneration.
- **Applications of Nanoemulgel**: Like that of turmeric, that of本道 neem nanoemulgels also promises topical antimicrobial delivery. A 2024 study noted their stability, biocompatibility, and synergistic action with turmeric against microbial infections.[38]

- **Skin and Oral Health:** Neem is employed in mouthwash and gels to combat plaque and gingivitis, although the evidence is variable in comparison with chlorhexidine. Topically, neem oil and creams are safe for short durations (up to 2 weeks) for the treatment of conditions such as psoriasis and the treatment of lice.[39]
- **Turmeric (*Curcuma longa*):** Turmeric's main active ingredient, curcumin, has a well-established antibacterial, antifungal, and antioxidant profile. Curcumin's capacity to suppress prevalent skin infections *Pseudomonas aeruginosa* and *Staphylococcus epidermidis* was highlighted in a 2016 study published in the Journal of Clinical and Experimental Dermatology Research. Topical therapies based on turmeric have also been investigated for their potential to improve skin health during frequent handwashing by lowering oxidative stress and inflammation.[40]
- **Properties of Antibiosis**: Turmeric's curcumin shows antibacterial as well as antifungicidal activity, acting against many pathogens such as *Enterococcus faecalis.* Turmeric has been found to be as effective as 5% sodium hypochlorite and 2% chlorhexidine in suppressing E. faecalis.[41]
- **Wound Healing:** Curcumin reduces inflammation and oxidation, promoting faster wound closure. A 2014 study recommended optimized curcumin formulations for cutaneous wounds due to its effects on tissue and collagen regeneration. A 2019 study showed turmeric and neem extracts in gel foam enhanced healing in orthodontic extraction sockets compared to betadine.[42]
- **Treatment of Scabies:** An Indian village pilot study of 814 individuals treated with a 1:4 mixture of turmeric-neem paste resulted in a 97% cure in 3 to 15 days. This brought into prominence the antimicrobial and anti-inflammatory synergism of the turmeric and neem as a low-cost, synthetic agent replacement.[43]
- **Nanoemulgel Formulations:** Recent studies (2024) investigated neem- and turmeric-based nanoemulgels as topical drug carriers against microbial infections. These nanoemulgels, prepared with olive oil and Carbopol 934, exhibited good antimicrobial action, biocompatibility, and penetration to the deeper epidermis, counteracting antibiotic resistance.[44]
- **Skin Disorders:** Turmeric can help conditions such as alopecia, acne, and psoriasis because of its anti-inflammatory effect. The National Psoriasis Foundation advises topical oringested turmeric for the control of flares, although additional clinical trials are necessary. A 2023 review mentioned that turmeric can be used in the treatment of eczema and radiodermatitis in patients with cancers.[45]
- **Tulsi (Ocimum sanctum):** The essential oils of tulsi, which contain ursolic acid and eugenol, have broad-spectrum antibacterial properties. A 2014 study published in the Indian Journal of Experimental Biology supported the usage of tulsi in skin care products by confirming its efficacy against *Aspergillus niger* and *Bacillus subtilis.* Ethnobotanical studies have investigated its antiviral qualities, especially against encapsulated viruses suggesting that it is relevant for hygiene products. Although the majority of these research concentrate on more general dermatological uses rather than handwashes particularly, taken as a whole, they provide a solid basis for the topical administration of these herbs.[46]
- **Antimicrobial Action:** Tulsi has broad-spectrum antimicrobial activity against viruses, fungi, and bacteria, such that it is a potential candidate for topical use in the form of hand sanitizers and dressings. A 2017 review mentioned its use as a hand sanitizer and a mouthwash because of its action against human pathogens.[47]
- **Acne treatment:** Tulsi's antibacterial action can stop acne by combating follicle-blocking bacteria. A 2014 literature review reported experimental findings indicating tulsi's effectiveness against acne-inducing bacteria, although high-quality human trials do not exist. Both tulsi and neem find their way into products such as Apollo Life Neem Tulsi Face Wash, in which they are used to clear pores and prevent recurrence of acne.[48]

- **Skin Inflammation and Aging:** A study in 2019 proved that the application of tulsi extracts results in strong antioxidant action, promoting healthy skin aging by neutralizing free radical damage. Its anti-inflammatory action can decrease inflammation and erythema in ailments such as eczema, although more work is necessary.[49]
- **Wound Healing:** Tulsi's anti-inflammatory and antimicrobial action facilitates healing of wounds. Ayurvedic preparations of tulsi are usually combined with other drugs such as neem for synergistic action.[50]
- **Safety:** Tulsi is safe in low doses when applied topically but must be used with caution by those allergic to the herb or pregnant/breastfeeding without consulting a physician. Patch testing is advisable in the case of sensitive skin.[51]

B. Gaps in Current Research and Need for Further Investigation

The promising Despite properties of neem, turmeric, and tulsi, several research gaps hinder a comprehensive understanding of their efficacy in handwashes:

- **Lack of Standardized Formulations:** It is challenging to evaluate results or create ideal formulations since studies seldom ever employ consistent concentrations or combinations of these plants.
- **Limited Clinical Trials:** Human trials evaluating real-world handwashing scenarios, such as frequent usage or preventing the spread of pathogens, are scarce, and the majority of research is conducted in vitro or using animal models.
- **Synergistic Effects:** Although neem, turmeric, and tulsi are frequently used together in traditional practices, little is known about their combined antibacterial and skin-protective properties in a single handwash.
- **Long-Term Safety:** Although these herbal extracts are typically harmless, further research is needed to determine the cumulative effects of everyday exposure (such as the possibility of skin sensitization).
- **Viral Efficacy:** Research on the antiviral effectiveness of these herbs in handwashes is desperately needed, especially for tulsi and neem, given the growing attention being paid to viral transmission. Standardized testing procedures, randomized controlled trials, and studies of synergistic formulations should be the main focus of future research in order to verify claims of herbal handwashes.[52]

C. Herbal Handwashes' Drawbacks

Although tulsi, turmeric, and neem have many health advantages, there are a few drawbacks to using them in handwashes:

- **Potency:** In order to achieve equivalent pathogen elimination, herbal extracts may need larger concentrations or longer contact durations than synthetic antimicrobials (such as triclosan or alcohol).
- **Stability:** Bioactive substances that are susceptible to light, heat, and pH variations, such as curcumin and the essential oils of tulsi, might shorten the shelf life or decrease the effectiveness of liquid handwash formulations.
- **Standardization:** Disparities in the quality, source, and processing of herbal extracts might result in products with varying antibacterial activity.
- **Customer Perception and Usefulness:** According to some consumers, herbal handwashes are slower-acting or less foamy than standard brands, which may have an impact on compliance. Some customers may also be put off by overpowering herbal odors.
- **Regulatory challenges:** In the absence of strong clinical evidence, herbal handwashes may find it challenging to satisfy strict safety and effectiveness requirements (such as FDA or EU recommendations). Clearer regulatory

channels for herbal products and formulation technological advancements like microencapsulation or stabilizers are needed to overcome these constraints.[53,54,55]

III. Useful Implementations and Customer Views

A. Creation Innovations and Difficulties in Herbal Handwashing

Since neem, turmeric and tulsi are complex phytoconstituents, creating herbal handwashes with them that are effective poses special hurdles. Advances are being made to bypass these hurdles, enhancing product efficacy and customer appeal:

Stability of Active Ingredients: The vital oils of turmeric, neem, and tulsi are all prone to degradation by alterations in pH, heat, and light. Curcumin's antibacterial properties, for instance, could be lost in aqueous environments through degradation.[56]

Such compounds are stabilized through developments like liposomal delivery techniques and microencapsulation techniques to ensure that its activity persists throughout the shelf life period of the product.

Solubility and Dispersion: Due to the hydrophobic nature of neem and turmeric extracts, it is sometimes hard to incorporate them into liquid products. Natural surfactants like soap nut saponins, nd optimization of emulsification processes make solubility better and provide uniform handwash textures.[57]

Balancing Efficacy and Skin Comfort: Sensitive individuals can cause dryness or redness in skin when subjected to high concentrations of either tulsi or neem. As a counter to this, these herbs are blended with moisturizing components like glycerin or aloe vera to maintain the antibacterial aspects with enhanced skin moisture.[58]

Preservation issues: handwashes will oftentimes avoid the artificial preservatives, but natural stand-in options like rosemary oil or grapefruit seed extract may not provide broad-spectrum protection. Advances in controlled manufacturing environments and natural blends of preservatives help to promote shelf life without compromise on aesthetics.[59]

Sensory Appeal: Sensory appeal plays an important role in customer acceptance. Users are likely to be deterred by the strong odor associated with neem or by the discolouration property of turmeric. To enhance the overall wash experience, more current developments include the addition of stabilized turmeric extracts to counteract discolouration and aromatherapy oil combinations (such as lavender or lemongrass) to mask the odor of neem. Such innovations illustrate the growing convergence of modern-day formulation science and ancient herbal tradition to enable herbal handwashes to compete on functionality and appearance with synthetic counterparts.[60,61]

IV. CONCLUSION

The present review comprehensively emphasizes the therapeutic relevance, formulation advantages, and growing scientific validation of herbal and polyherbal hand wash gels as effective alternatives to conventional synthetic cleansing agents. With increasing global awareness regarding the adverse dermatological and environmental effects associated with prolonged exposure to alcohol-based sanitizers, parabens, triclosan, synthetic fragrances, and harsh surfactants, there has been a significant shift toward plant-based hygiene solutions. Herbal medicines have traditionally been regarded as safer due to their natural origin, biocompatibility, and relatively lower incidence of severe side effects

when used in appropriate concentrations. This transition toward herbal formulations reflects not only consumer preference but also a broader movement toward sustainable, eco-friendly, and holistic healthcare practices.

Medicinal plants such as neem (Azadirachta indica), tulsi (Ocimum sanctum), turmeric (Curcuma longa), aloe vera (Aloe barbadensis), and Argemone mexicana possess diverse pharmacologically active constituents including alkaloids, flavonoids, terpenoids, phenolic compounds, glycosides, and essential oils. These phytochemicals contribute significantly to antimicrobial, antifungal, antiviral, anti-inflammatory, antioxidant, and immunomodulatory activities. The synergistic combination of these plant extracts in polyherbal formulations enhances their overall therapeutic efficacy, as multiple active compounds target microorganisms through different mechanisms of action. Unlike synthetic antimicrobial agents that may lead to resistance development and microbial adaptation, herbal bioactives often exert multi-targeted effects, thereby reducing the probability of resistance and ensuring sustained antimicrobial performance.

Experimental evaluations have demonstrated that well-formulated herbal hand wash gels exhibit significant inhibitory activity against common pathogenic microorganisms such as *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa*, which are frequently associated with skin infections and cross-contamination. In vitro antimicrobial assays, zone of inhibition studies, and microbial reduction analyses indicate that these formulations are capable of effectively reducing microbial load without causing cytotoxic effects on human skin cells. Furthermore, the presence of natural moisturizing agents such as aloe vera and glycerin enhances skin hydration, prevents transepidermal water loss, and maintains the integrity of the epidermal barrier. This dual functionality—simultaneous cleansing and skin conditioning—distinguishes herbal hand wash gels from conventional alcohol-based preparations that may cause dryness, irritation, redness, or dermatitis upon repeated application.

The physicochemical evaluation parameters such as pH, viscosity, spreadability, homogeneity, stability, and foaming capacity also confirm that herbal gel formulations can achieve desirable cosmetic acceptability and consumer compliance. The uniform composition and stable gel matrix ensure proper dispersion of active phytoconstituents, thereby maintaining consistent antimicrobial activity throughout the product's shelf life. Moreover, these formulations are generally biodegradable and produce minimal environmental toxicity, supporting ecological sustainability. The use of plant-derived raw materials further reduces dependence on petrochemical-based ingredients, aligning with global initiatives aimed at reducing carbon footprint and promoting green chemistry in cosmetic and pharmaceutical industries.

According to global health perspectives, particularly in developing and Asian countries, a significant proportion of the population continues to rely on traditional medicinal systems for daily health maintenance and hygiene practices. The incorporation of scientifically validated herbal extracts into modern hand wash formulations bridges the gap between traditional knowledge and contemporary pharmaceutical technology. The development of polyherbal hand wash gel containing standardized plant extracts aims to ensure effective hand cleansing, inhibition of microbial growth, long-lasting skin protection, and suitability for diverse skin types including sensitive skin. Special consideration during formulation design minimizes irritancy potential and enhances dermatological safety, making these products appropriate for frequent daily use.

Despite the promising findings and growing commercial acceptance, it is essential to acknowledge the need for further standardized clinical trials, toxicological profiling, stability testing under varied environmental conditions, and long-

term safety evaluations to strengthen evidence-based validation. Future research should also focus on optimizing extract concentrations, exploring novel synergistic combinations, and employing advanced formulation technologies to enhance bioavailability and efficacy. Regulatory standardization and quality control measures are equally important to ensure consistency, safety, and therapeutic reliability across different herbal hand wash products available in the market.

In conclusion, polyherbal hand wash gels represent a scientifically promising, dermatologically safe, environmentally sustainable, and therapeutically effective alternative to conventional soaps and synthetic hand wash preparations. Their multi-faceted pharmacological properties, reduced side-effect profile, compatibility with various skin types, and ecological advantages position them as superior options in modern personal hygiene management. With continued research, technological advancement, and standardization, herbal hand wash formulations have the potential to play a significant role in global public health and preventive healthcare strategies.

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