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FORMULATION AND EVALUATION OF HERBAL OINTMENT FOR THE TREATMENT OF FUNGAL INFECTION

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1. INTRODUCTION

Fungal infections of skin, such as athletes foot, ringworm and candidiasis are common dermatological conditions that affect millions of people worldwide. These infections as typically caused by dermatophytes, yeasts, or molds, and can leads to symptoms such as itching, redness, and scaling.

While conventional anti-fungal treatments, including topical creams, powders, and oral medications, are widely used, they often come with side effects, such as skin irritation or allergic reactions.

The increasing resistance of fungal pathogens to synthetic anti-fungal drugs poses asingnificant challenges in treatment effectiveness.

The response to these concerns, there has been growing interest in alternative treatments using herbal remedies. Many plants have demonstrated antifungal, antimicrobial, and anti- inflammatory properties that can help to treat and prevent fungal infections. For centuries, traditional medicine has utilized herbs such as neem (Azadirachta indica), turmeric (Curcuma longa), and garlic (Allium sativum) for their healing properties, especially in skin-related disorders.

These plant contain bioactive compound like terpenoids, flavonoids, and alkaloids, which exhibit strong antifungal activity and can effectively inhibit the growth of common skin fungi. Herbal ointment offer a natural, safe, and effective alternative to chemical-based treatments. They not only provide therapeutic benefits but also have fever side effects, making them more suitable for long-term use, especially in indivuals with sensitive skin.

The formulation of herbal ointment combines these active herbal ingredients with an ointment base, creating a product that is easy to apply, nourishing, nd capable of treating fungal infections effectively.

This study focuses on the formulation of an herbal ointment using ointment using a combination of Neem, Tea Tree Oil, Tumeric, and Garlic extracts, known for their antifungal and healing properties. The primary aim is to evaluate the ointment's effectiveness in treating fungal infections, its stability, and its safety profile, offering a potential alternative for individuals seeking natural remedies.

2. Literature Review

Herbal ointments have garnered significant attention in the treatment of fungal infections due to the increasing preference for natural remedies. Many plants contain bioactive compounds with antifungal, antimicrobial, and anti-inflammatory properties that make them effective in treating superficial fungal infections such as athlete's foot, ringworm, and candida infections.

Dr. Sakthivel M et.al. 2022

derived substances and herbal medicines have recently attracted the great interest towards theirversatile application, as medicinal plants are the richest source of bioactive compounds used intraditional and modern medicine. The present work is to formulate and evaluate the herbal ointment containing Neem (Azadirachta indica) and Turmeric (Curcuma longa) extract.

The ethanolic extracts were prepared by using maceration method. The ointment base wasprepared and formulation of herbal ointment.

For its physicochemical parameters like colour, odour, ph, spreadability, extrudability, consistency, solubility, washability.

Shubhangi E. Sawant*, et.al 2016

Even in areas where modern medicine is available, the interest on herbal medicines and their utilization have been increasing rapidly in recent years. Plant derived substances and herbal medicines have recently attracted the great interest towards their versatile application, as medicinal plants are the richest source of bioactive compounds used in traditional and modernmedicine.

Aravinda Nalla et.al 2017

The present work is to formulate and evaluate the ointment of garlic bulb extract for anti-microbial activity. The benzene extract was prepared by Soxhalation method. The ointment base was prepared and fourformulations of ointments were done by incorporating the extract in the base by levigation method. From four ointments, F4 was found to be the best formulation as it shows 98% drug release within 6hours, drug content 98.8% and it shows more zone of inhibition against Bacillusas compared to other there.

Telange – Patil P.V et.al 2022

Herbal medicines has become a global important for both medical and economical. The antibacterial ointment prepared from herbal plant are more efficacious than synthetic medicines and which showsome adverse effect.

Ointments are semisolid system which behave as viscoelastic materials when shear stress is applied. Indigenous people are known to widely use the crude extract of many plants. Neem has become valuable plant in the world which shows the solution for hundreds and thousands problems. This herbal ointment ofneem and turmeric extract can be used in the treatments of skin infections.

Vishal*, Shourya et.al. 2023

The current inventions garlic and neem ointment is effective in treating fungal and bacterial skin infections intropical regions. By utilising all of the components of garlic and neem, this ointment seeks to maximize the advantages. Allin and Allicin are stabilised by the ointment. Neem powder, freeze-dried garlic, and a deliverysystem that has received pharmaceutical approval make up the mixture. It can be applied topically to treat common skin conditions. A base for an ointment was produced, and the extract was then added to the base using the levigation process to create the ointment.

Stuti Pandey3*et.al January 2024

Even in places where modern treatment is readily available, the utilization of herbal remedies has witnessed a significant surge in fascination over the past few years. A lot ofpeople are interested in phytochemicals and herbal medicines lately because these substances are derived from medicinal plants, which are a source of bioactive compoundsutilized in both convention

3. AIM AND OBJECTIVE

This following study aimed to formulation and evaluation of Antifungal herbal ointment containing Neem, Amla, turmeric and garlic oil for topical administration used in the treatmentof the fungal infection like atheletes foot.

3.1 Aim

- Formulation of the ointment using the trituration (incorporation) method.
- Formulation and evaluation of the ointment
- Characterization of the ointment

3.2 Objective

- Topical root is more suitable for infection.
- The main aim of our research was develop an antifungal cream formulation Consisting of herbal ointment for the treatment of antifungal infection

4. Athlete's foot infection

Many people will have athletes foot at some points in their lives. It usually affects the gaps between the toes. Athletes foots (Tinea pedis) is particularly common between the little toe and the toe next to it. The fungus can cause the skin to redden and crack. The affected areas are flaky and sometimes itchy. This skin can also turn white and thicken, and is then often slightly swollen.

If the inflection spreads across the sole of the foot it is reffered to as moccasin athaletes foot. The sole of the feet, the heels and the edges of the feet are then dry, scaly, and may be itchy. Moccasin athletes foot is sometimes mistaken for other conditions such as eczema. A rare kind of athletes foot cause an acute.

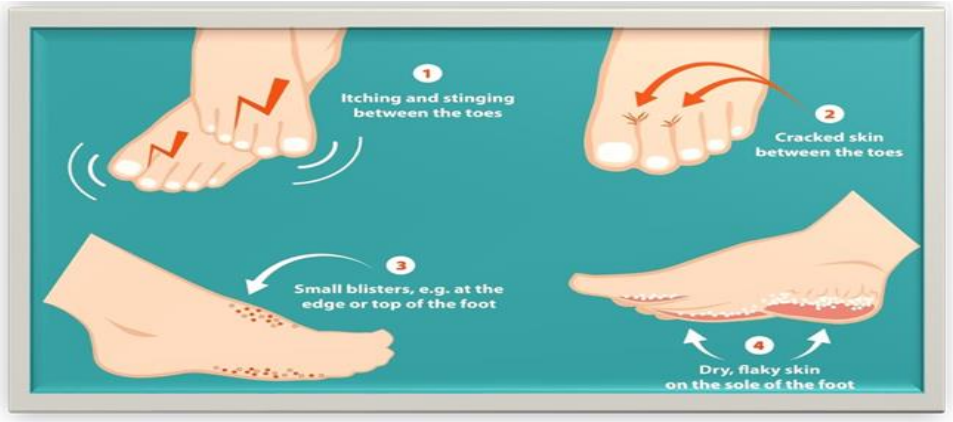

Fig. 1: Athlele's foot infection.

4.1 Causes

Athletes foot **is** usually caused by fungi that infect th skin (Dermatophytes). They can enter the skin through small cracks or wounds, and infect the top layer. The fungi are passed on through direct skin contact or through with flaskes of skin. That can happen if, for instance you step on infectious flake of skin in communal shower. The same fungi can also cause fungal nailinfections.

Fungal skin infections need moisture and warmth to spread. Our feet offer a perfect environment for them, because we wear shoes for most of the day and so our feet often warm and moist. The skin on our feet also contains a lot of keratin a protein that can be found in the top layer of skin. the fungi feed on this.

4.2 Risk factors

These are the main ones: a genetic predispotion (If a lot of people in your family have it), allergies and eczema, particurly sweaty feets, a weak immune system, for instance due to a serious illness or the iong-term use of medication that's weakens the immune system, circulation problem in legs, for example as a result of diabetes or narrowed blood vessles, some sports, especially running and swimming.

4.3 Prevention

Prevention of Athlete's Skin and Fungal Infections

Athletes are particularly prone to skin and fungal infections due to the nature of their physical activity, sweating, close contact with others, and frequent use of communal spaces such as locker rooms, gyms, and sports facilities. These infections can include common conditions like athlete's foot, ringworm, jock itch, and nail fungal infections. Preventing these infections is crucial for maintaining an athlete's health, performance, and overall well-being.

Here are effective prevention strategies to minimize the risk of athlete's infections.

5. Prevention of Athlete's Skin and Fungal Infections

Athletes are particularly prone to skin and fungal infections due to the nature of their physical activity, sweating, close contact with others, and frequent use of communal spaces such as locker rooms, gyms, and sports facilities. These infections can include common conditions like athlete's foot**,** ringworm**,** jock itch**,** and nail fungal infections. Preventing these infections is crucial for maintaining an athlete's health, performance, and overall well-being.

Here are effective prevention strategies to minimize the risk of athlete's infections:

5.1 Personal hygiene practices

- Shower right after activity: Fungal spores thrive in warm, moist environments like sweaty skin. Athletes should shower immediately after exercise to wash away sweat, bacteria, and fungi.
- Use mild antifungal soap**:** Consider using soaps containing antifungal ingredients like tea tree oil or sodium bicarbonate, which can help reduce the risk of fungal growth on the skin.
- Dry off properly: Fungi love moist environments. After showering, ensure all areas of the body—especially between toes, underarms, and the groin—are thoroughly dried. Use a clean towel for drying.
- Use a blow dryer: For those prone to fungal infections, using a blow dryer on a low setting can help dry areas like toes and Underarms that are hard to reach with a towel.

5.2 Foot care

- Choose proper shoes: Athletes should wear breathable shoes made of materials such as mesh**,** leather, or canvas to allow air circulation. This helps prevent the build-up of moisture inside the shoe, which can lead to fungal growth.
- Avoid tight shoes: Tight shoes create friction and warmth, which are ideal conditions for fungi. Opt for properly fitting footwear that allows the feet to breathe.
- Wear moisture-wicking socks: Choose socks made from synthetic fibers or wool to wick moisture away from the skin, keeping feet dry. Avoid cotton socks as they trap moisture.
- Change socks frequently: If your socks become sweaty during exercise, change them immediately to reduce moisture exposure, which is conducive to fungal infections like athlete's foot.
- Apply antifungal powder: Sprinkling antifungal powder (such as one containing clotrimazole or miconazole) on the feet helps to keep them dry and reduces the likelihood of infection.
- Spray antifungal foot sprays: Use antifungal foot sprays, especially if you're prone to conditions like athlete's foot. These sprays prevent fungal growth and help keep feet dry.

5.3 Avoid shared personal items

- Keep personal items separate: Never share towels, socks, shoes, or personal hygiene products with others. Fungi can spread easily through these shared items.

- Use personal water bottles: Always carry your own water bottle and avoid drinking from communal bottles or cups.
- Clean equipment regularly: Sports equipment, mats, and gym machines should be wiped down with disinfectant wipes before and after use. Fungal spores can survive on surfaces and be transferred to the skin.

5.4 Use of antifungal products

- Apply topical antifungal creams: Athletes who are frequently in contact with public spaces like gyms or locker rooms may benefit from applying a preventive antifungal cream (e.g., clotrimazole**,** terbinafine) on areas prone to infection, like the feet, groin, and underarms.
- Use medicated foot powder**:** In addition to antifungal creams, athletes can use antifungal foot powders to prevent infections like athlete's foot**.**

5.5 Keep the Skin Clean and Healthy

- Inspect your skin regularly: Check for early signs of fungal infections, such as itching, redness**,** scaling, or blisters, especially in areas that are prone to moisture (e.g., between toes, groin, or underarms).
- Treat skin infections early: If you notice any signs of a fungal infection, begin treatment immediately. This can prevent the infection from spreading and becoming more severe.
- Clean and Cover wounds: Any cuts, scrapes, or abrasions should be cleaned and treated with an antiseptic and covered with a clean bandage. Fungi can easily enter through broken skin.
- Avoid picking at skin: Refrain from scratching or picking at areas of the skin, as this can spread fungi and lead to secondary infections.

5.6 Wear Clean, Dry Clothing

- Change Clothes Post-Workout: After exercise or competition, change into clean, dry clothes. Washing workout clothes after every use prevents the accumulation of sweat, bacteria, and fungi.
- Wash Gear Regularly: Wash sports gear, including uniforms, socks, and undergarments, after each use to eliminate potential fungal spores.

5.7 Use shower shoes in communal areas

- Protect Against Contaminated Surfaces: In communal spaces such as locker rooms**,** pools**,**

and showers**,** always wear flip-flops or shower shoes to protect your feet from coming into direct contact with the floor, which may harbor fungi and bacteria.

5.8 Maintain a healthy immune system

- Eat a balanced diet: A diet rich in fruits**,** vegetables**,** whole grains**,** and lean proteins supports the immune system, which plays a crucial role in preventing infections.
- Stay hydrated: Adequate hydration helps maintain skin health and supports the body's natural defenses against infections.
- Rest and Recover: Overtraining can suppress the immune system, making athletes more susceptible to infections. Adequate rest and recovery are essential for maintaining a strong immune defense.

5.9 Educate Athletes and Coaches

- Training programs**:** Educational programs on hygiene practices, skin care, and infection prevention should be provided to athletes, coaches, and sports staff. This ensures everyone is aware of the risks and preventive strategies.
- Promote safe practices: Encourage athletes to report any suspicious skin conditions or infections to a coach or medical professional immediately. Early intervention helps prevent outbreaks.

5.10 Regular Skin Checks and Medical Attention

- Inspect skin for changes: Coaches and athletes should perform regular skin checks for signs of fungal infections or other skin conditions, especially in contact sports or team settings.
- Prompt treatment: If an athlete develops a skin infection, it is important to seek medical treatment immediately. Fungal infections can be treated effectively with antifungal medications, and early treatment can prevent spread to teammates.

6. Treatments

Herbal ointments have gained popularity in recent years as a natural alternative for treating various skin conditions, including fungal infections. Fungal infections are common in athletes due to factors like excessive sweating, sharing equipment, and close contact in sports. Ointments with antifungal properties, derived from herbal ingredients, can offer effective treatment with fewer side effects compared to synthetic antifungals.

Below is a comprehensive outline of the process for an herbal ointment aimed at treating fungal infections.

7. OBJECTIVES

- Identification of active herbal ingredients: The formulation should include herbs with known antifungal properties, such as *Neem*, *Turmeric*, *Garlic*, *Tea Tree Oil*, or *Aloe Vera*. These ingredients are selected for their ability to inhibit fungal growth, reduce inflammation, and promote skin healing.
- Formulation development: Creating an ointment that ensures proper delivery of the active herbal ingredients to the site of infection, with good spreadability and adherence. This involves selecting suitable excipients (Such as emulsifiers, preservatives, and bases like beeswax or petroleum jelly) to create a stable and effective formulation.
- Safety and Efficacy: The herbal ointment should be formulated to ensure minimal irritation, allergic reactions, or toxicity. Its antifungal efficacy should be validated through in-vitro or in-vivo tests, where the activity against common fungal pathogens (e.g., *Candida albicans*, *Trichophyton rubrum*) is evaluated.
- Skin Penetration and Bioavailability: Ensuring that the herbal active compounds can penetrate the skin layers effectively to exert their antifungal effects at the site of infection. The formulation should enhance the bioavailability of the herbal actives.
- Stability and Shelf-life: The formulation should be stable over time, maintaining its effectiveness and safety under various environmental conditions (Temperature, humidity, light). The shelf-life should be evaluated to ensure the ointment remains potent throughout its use.
- Patient Compliance and Comfort: The ointment should be easy to apply, non-greasy, and preferably odorless or mildly fragranced to ensure patient compliance. Comfort in use is an important factor for ensuring that patients can apply it regularly.
- Cost-effectiveness: The formulation should be cost-effective for both production and end-users while maintaining high standards of quality, making it accessible to a larger population.
- Regulatory compliance: The formulation must comply with regulatory standards for herbal products to ensure it is safe and authorized for use in treating to fungal infection.

8. Selection of herbal ingredients

The first step is selecting the herbal ingredients known for their antifungal properties. These

can include:

8.1 Neem (Azadirachta indica)

- Known for its antimicrobial, antifungal, and anti-inflammatory properties.
- Contains compounds like azadirachtin and nimbidin that are effective against fungi.

8.2 Tea tree oil (Melaleuca alternifolia)

- Widely used for its broad-spectrum antifungal, antibacterial, and antiviral properties.
- Effective against fungi like *Candida* and *Dermatophytes* (Ringworm, athlete's foot).

8.3 Garlic (Allium sativum)

- Contains allicin, a powerful antifungal agent that helps fight infections caused by fungi.

8.4 Turmeric (Curcuma longa)

- Curcumin, the active ingredient in turmeric, has antifungal and anti- inflammatory properties.
- Useful for treating skin fungal infections like ringworm and athlete's foot.

8.5 Lavender (Lavandula angustifolia)

- Known for its antifungal, anti-inflammatory, and soothing properties, which can help with the discomfort associated with fungal skin infections.

8.6 Aloe vera (Aloe barbadensis miller)

- Contains compounds with antifungal properties and also helps to soothe irritated skin.

9. Formulation of the herbal ointment

The herbal ointment can be formulated in a few key steps, combining the selected ingredients in a suitable base. Here's a basic formulation:

Ingredients

1. Active herbal extracts (With antifungal properties**)**
   - Neem extract**:** 5–10% (Depending on extract concentration)
   - Tea tree oil: 2–5%
   - Garlic oil or extract: 2–3%
   - Turmeric extract: 2–5%
   - Lavender oil: 1–2%
   - Aloe vera gel: 5–10%

2. Ointment base
- Beeswax**:** 5–8% (Acts as a thickening agent)
- Petrolatum or Mineral Oil: 30–50% (Provides the base texture)
- Lanolin**:** 5–10% (Softens and Nourishes the skin)
- Coconut Oil or Olive Oi**l**: 10–15% (Helps in Absorption and Enhances skin penetration)

3. Preservatives (If necessary**)**
- Vitamin E (Tocopherol**)**: 0.5–1% (Acts as an antioxidant and preservative)
- Phenoxyethanol or Ethylhexylglycerin: 0.5–1% (Preservatives to prevent microbial growth in the ointment)

4. Water Phase (Optional, for creamier consistency):
- Distilled water or Rose Water: 10–15% (for hydrating properties

Fig. 2: Formulation on herbal ointment.

10. Preparation method

1. Extract preparation
- Prepare or purchase the herbal extracts in the desired concentration. If using fresh herbs, you can make the extract using a solvent (e.g., alcohol or glycerin) and allow it to steep for several weeks.

2. Melt the base
- Heat the beeswax, Lanolin and Oils (e.g., coconut oil, olive oil) in a double boiler until they are completely melted.

3. Incorporate herbal extracts
- Once the base is melted, add the herbal extracts (Neem, Tea Tree, Garlic, Turmeric, Aloe

Vera, Lavender) to the mixture and stir thoroughly to combine. Add Vitamin E and preservatives at this stage.

4. Cool and Mix

- Allow the mixture to cool slightly before adding essential oils (like Tea Tree and Lavender), as they can evaporate at high temperatures.
- Once the ointment has cooled to room temperature, transfer it to clean, sterilized containers for storage.

5. Final product

- The resulting herbal ointment should be smooth, Creamy and Easy to apply to the affected areas.

Fig. 3: Preparation of herbal ointment.

11. Evaluation of the herbal ointment

Once the herbal ointment is prepared, it should undergo thorough evaluation to ensure its effectiveness, safety, and stability.

1. Physical evaluation

- Appearance: The ointment should be uniform in color, smooth in texture, and free from any grittiness or lumps.
- Odor**:** There should be no unpleasant odor, though the fragrance from essential oils (e.g., Tea Tree, Lavender) should be noticeable.
- Viscosity: The ointment should have an appropriate consistency – not too runny or too thick – for easy application.

2. **pH and Stability**

- pH**:** The pH of the ointment should be measured to ensure that it is skin-friendly (typically between 4.5 and 6.5).
- Stability testing: Store the ointment at different temperatures (room temperature, heat, and cold) for a few weeks to assess its stability. The consistency, color, and smell should remain unchanged. Any separation or phase change could indicate instability.

3. **Microbial testing**

- Microbial limit test: It's important to ensure that the ointment is free of harmful microorganisms. This can be done through total microbial count testing and testing for pathogens like *E. coli*, *Staphylococcus aureus*, and *Candida albicans*.

4. **Antifungal efficacy evaluation**

- In vitro antifungal test: Conduct an antifungal test like the Disk Diffusion Test **or** Broth Dilution Test against common dermatophytes (e.g., *Trichophyton rubrum*, *Candida albicans*, *Microsporum canis*).
- Place the ointment on a culture plate infected with fungal spores and measure the zone of inhibition (clear area around the ointment, indicating antifungal activity).
- Minimum Inhibitory Concentration (MIC)**:** Determine the lowest concentration of the ointment that inhibits fungal growth.
- Patch Testing: Perform a patch test to evaluate the potential for skin irritation. Apply a small amount of the ointment on a small area of healthy skin and observe for any allergic reactions (e.g., redness, itching, swelling) for 24–48 hours.
- Application on Fungal Infections: Perform clinical trials or case studies by applying the herbal ointment on fungal infections like athlete's foot, ringworm, or candidiasis. Observe for clinical improvement, including reduced itching, redness, and scaling.
- Sensory Evaluation: Collect feedback from users regarding the scent, texture, and effectiveness of the ointment. This will help refine the formulation, if necessary.

12. CONCLUSION

Herbal ointments offer a promising alternative to conventional antifungal treatments due to their natural origin, safety profile, and growing consumer preference. Tea tree oil, garlic, neem, turmeric, and other herbs have demonstrated significant antifungal properties in both laboratory and clinical studies. However, the efficacy and safety of herbal ointments still

require further validation through well-designed clinical trials. Standardization, proper formulation, and comprehensive clinical evaluation are essential for making herbal ointments a reliable choice in the treatment of fungal infections. Despite some limitations, herbal ointments hold promise for providing a natural, cost-effective, and safer alternative to synthetic antifungal agents. 4o mini.

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