



Effectiveness of Hydroalcoholic Extract of *Terminalia ivorensis* on Feet Fungus Disease

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Despite the evolution of modern medicine, traditional medicine remains widespread in developing countries and its use continues to increase in industrialized countries. It is the same way that the effectiveness of the hydroalcoholic extract of *Terminalia ivorensis* was tested on the feet fungus disease of volunteers.

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Objective: The present work is oriented in the preparation of an antimicrobial hydroalcoholic extract of *Terminalia ivorensis*, a medicinal plant in order to enhance it.

Materials and Methods: One hundred (100) grams of powder from trunk bark's *Terminalia ivorensis* were extracted by homogenisation in a solvent mixture of 70% ethanol and 30% distilled water in a blender. After six grinding cycles, the homogenate obtained in each case was first wrung out in a clean white cloth square and then successively filtered twice on cotton wool and on Whatman 3 mm filter paper. The filtrate obtained was dried in a Venticell oven. The powder obtained constitutes the hydroalcoholic extract (or The 70% hydroethanolic extract). The 70% hydroethanolic extract of *Terminalia ivorensis* obtained was mixed with water to obtain a pasty liquid form before being tested on feet fungus disease using a cotton ball.

Results: The extract had activity on these different shapes of feet fungus disease with a marked improvement. The volunteers who finished their treatment have been cured of feet fungus disease.

Conclusion: The treatment results obtained revealed that the hydroalcoholic extract has good antimicrobial activity. The hydroalcoholic extract can be an undeniable source for the development of Improved Traditional Medicines (ITM) against feet fungus disease.

Keywords: *Terminalia ivorensis*; hydroalcoholic extract; feet fungus disease.

1. INTRODUCTION

Despite the evolution of modern medicine, traditional medicine remains widespread in developing countries and its use continues to increase in industrialized countries. According to [1], in Europe, North America and other industrialized regions, more than 50% of the population has used complementary medicine at least once. In Côte d'Ivoire, according to recent studies, more than 80% of the population prefers herbal recipes for their health care [2].

Thus, several measures have been taken to promote traditional medicine, research in pharmacopoeia and the recognition of traditional practitioners in the health system [3]. According to this author, traditional medicine has been integrated into the ivoirien public health system and 2,000 traditional medicine practitioners and 200 practices have been identified. This renewed interest in traditional medicine can be justified by the recommendations of the WHO, which, faced with the resurgence of certain diseases such as arterial hypertension, malaria, bacterial diseases and skin diseases, recommends the use of this medicine to improve patient care [4,5,6].

Faced with the limitations of modern medicine, many hopes are placed in the secrets of plants and the emergence of an alternative plant-based medicine is more relevant than ever. In spite of the numerous scientific works carried out, the rational exploitation of the medicinal virtues of the plants of the pharmacopoeia remains an imperative [7,8]. It is therefore important to

continue ethnomedicinal surveys and scientific evaluations of medicinal plants, in order to valorize the flora of the traditional pharmacopoeia and to know the effectiveness of the active principles of these plants.

On the other hand, infectious diseases remain the main cause of death in the world with approximately 17 million victims each year [9,10]. Infectious diseases include viruses, bacterial diseases and mycosis [11]. Among these infections, feet fungus diseases that are the subject of our study are affections caused by fungi that are dermatophytes, yeasts and molds [12,13].

The means used to fight against the resistance of fungi to antibiotics include the search for new molecules derived from natural substances. Many plants are used in the African pharmacopoeia to treat several fungal diseases. This is the case of *Terminalia ivorensis* A. CHEV which is a plant of the ivoirien medicinal flora whose studies conducted by [14] revealed the antifungal activities of this plant.

The general objective of the present work is to study the effectiveness of the hydroalcoholic extract of *Terminalia ivorensis* on feet fungus disease.

2. MATERIALS AND METHODS

2.1 Materials

2.1.1 Plant materials

The plant material consisted of *Terminalia ivorensis* bark; collected in March 2022 in the

area of ivory coast Pastor institute (IPCI) located in Cocody (Abidjan- Ivory coast). The plant was identified at the National Floristic Center (CFN) under the herbarium number UCJ003137.

2.1.2 Technical materials and extraction apparatus

The extraction material was composed of solvent (Alcohol 96° provided by the laboratory of the National Floristic Center (CFN), distilled water, Binatone brand Blender, China which was used for the extraction of the compounds. The other equipment, provided by the laboratory of Pharmacodynamic-Biochemistry, was used for the filtration of the macerate. Aluminium foil (Sanitex, Ivory Coast) and electric balance (SARTORIUS, Germany) were used for the different weighings.

2.1.3 Subjects

Ten people aged between 17 and 60 years old of different sexes volunteers for the therapeutic trials to verify the effectiveness of the hydroalcoholic extract of *Terminalia ivorensis*. They lived in four (4) neighborhood of the city of Abidjan (Cocody, Yopougon, Abobo and Port-Bouët). These people are from different social classes (underprivileged, average, students...). For children under 18 years old, the agreement was given by the parents.

2.2 Methods

2.2.1 Preparation of the hydroalcoholic extract

The barks of *T. ivorensis* were cut into small pieces and dried in the sun and humidity for 14 days. After drying, the barks were ground and reduced to a fine powder using a Retsch GM300 electric grinder. The 70% hydroalcoholic extract was obtained according to the method developed by [15]. For this purpose, one hundred grams (100g) of plant powder was shaken vigorously in 1L of 70% ethanol using an electric mixer of the brand STPE 1110. The macerate obtained after several cycles of agitation was wrung out on a square of cloth and then filtered four times successively on absorbent cotton and once on whatman 3 mm paper. The filtrate obtained was concentrated in an oven at 50°C for 24 hours. The powder thus obtained constituted the total hydroalcoholic extract.

2.2.2 Treatment methods

The treatment consisted in mixing the powder of the hydroalcoholic extract (a few pinches of fingers) with clean water to obtain a liquid paste form and then apply it with a cotton ball on the affected parts of the feet fungus disease two (2) times a day (morning/evening) during 1 month that we set ourselves. A follow-up was done by a visit from the first two days of treatment and then every week until the end of the treatment. There is no control groups because of the only use of the extract. So if we obtain healing it is thanks to the extract. In other hand we had confirmed scientifically the use of the plant to treat fungus disease in traditional medicine.

3. RESULTS

3.1 Yield of the Extraction

The 70% hydroalcoholic extract prepared from the bark powder of *T. ivorensis* was obtained with a yield of 33.46% or 33.46 g.

3.2 Treatment of Feet Fungus Disease with the Hydroalcoholic Extract

The subjects who applied the extract were able to observe an improvement in the treatment after two to five days. After an average of 30 days, total healing was observed in subjects with less advanced feet fungus disease, subjects with very advanced feet fungus disease had healing beyond thirty days.

Out of 10 people treated with the hydroalcoholic extract, 03 people did not finish their treatment, due to time, travel and / or work reasons, but they experienced an improvement of their condition. The seven subjects who completed their treatment were all cured of their ailments. The results are summarized in Table 1.

Subject A, 28 years old, had feet fungus disease of the intertrigo-inter toe form at the maceration stage which affected the three (3) inter-toe spaces. Indeed, we observed lesions and pearly white parts in the bottom of the interdigital spaces covered with a crumpled and macerated epidermis with thicker and wet scales. After one week of treatment with the extract, we noticed the disappearance of the lesions and the wet scales leaving a dry epidermis. The subject A is cured forty (40) days of treatments (Fig. 1).

Table 1. Results of treatment with hydroalcoholic extract

Number of sick treated	Affections	Duration of treatment	Extent of the condition
9	oozing intrigue	40 days 15 days 5 days	In the 2nd, 3rd, 4th inter-toe space
1	Candidosis	7 days	In the 2nd, 3rd, 4th inter-toe space



Fig. 1A. Before treatment



Fig. 1B. 40 days after treatment

Patient B, 25 years old, presented with feet fungus disease from oozing intriginous form to a vesicular stage. The patient presented in the space and on the back of the 3rd toe thick and keratotic vesicles of dysidrosic type. The patient was cured after five (5) days of treatment (Fig. 2).

Patient C, 26 years old, suffered from feet fungus disease oozing intriginous form at an erythematous and fissural stage located in the fold of the 3rd inter-toe space. He presented feet fungus disease with thickened and moist whitish epidermis without lesions. After seven (7) days of treatment with the extract, we observed the disappearance of the whitish epidermis followed by the healing of the patient (Fig. 3).

The other subjects, for various reasons (travel, non-compliance with the dosage) were not able to complete their treatment as required. However, they had an improvement of feet fungus disease.

4. DISCUSSION

The preparation of the 70% hydroethanol extract of *T. ivorensis* bark powder gave a yield of 33.46%. This extract allowed us to treat the different cases of feet fungus disease of the patients. The treatment required two daily applications on the affected parts. This is in line with the twice-daily applications of existing modern topical antifungals [16]. Out of the ten individuals with feet fungus disease ranging in age from 17 to 60 years who participated in the treatments, four individuals (4) were female. The other six (6) were male. There were no children in our study. The patients were composed of adolescents and adults.

This observation allows us to state that dermatophytosis of feet is a condition that is most often observed in young adults (generally between 20 and 50 years of age), it is more frequent in males, adolescents than in females [17].



Fig. 2A. Before treatment



Fig. 2B. 5 days after treatment

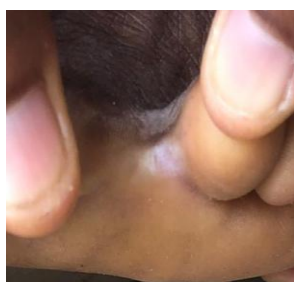


Fig. 3A. Before treatment

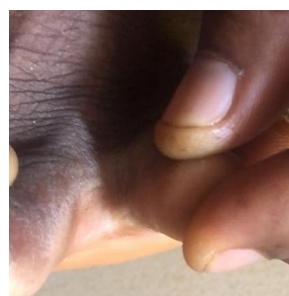


Fig. 3B. 7 days after treatment

Subjects who correctly applied (twice daily morning/evening) hydroalcoholic extract achieved healing after 5, 7, 15, 40 days after treatment. These treatment times are shorter than those of [18] who obtained healing after 21, 28, 30, 60 days after treatment of trichophytic ringworm with an ointment formulated with hydroalcoholic extract of *T. ivorensis*. This difference could be due to the difference in the genus of fungus responsible for the two dermatophyte diseases.

The shortest treatment duration was observed in the case of those with less advanced feet fungus disease (5, 7, 20 days). This result is in agreement with the results of [19] and [20] who used hydroalcoholic extract of *Aspilula africana* and *Terminalia catappa* to treat feet fungus disease, respectively. These teams treated feet fungus disease after 10 to 28 days for the team in [19] and in 21 days for the team in [20] but this duration is clearly not long. Although our extracts were applied in the raw state compared to that of the team of [19] and [20] which was formulated respectively in cream and ointment before application on the feet fungus disease. The duration of this treatment is better and this difference would be attributable to the secondary metabolites present in the extract and the combretaceae family which is known for its antifungal and antibacterial properties. Also, this difference could be due to the difference in the extract.

Out of the ten cases of feet fungus disease treated, only one case of resistance was observed with a duration of 40 days of treatment. This long duration is due to the relapse of the subject during his treatment caused by his environment and the hygiene of the shoes which is the seat of the dermatophyte fungi.

The analysis of this result shows conformity with that of [21]. According to him, in the current therapy (use of local and/or general antifungals),

it is necessary to use a combination of active molecules (antifungal and antiseptic) for a fairly long period of time, i.e. two to six months of treatment to obtain complete eradication of the pathogen. The duration of the treatment and the need for a combination of drugs result in a high cost of treatment; finally, these drugs do not promote rapid reconstitution of the damaged skin, as confirmed by [22] in his work.

Thus, this statement is in line with that of [23] who asserts that the choice and duration of treatment of epidermophyiasis of the feet depend on the type of infection and the severity of the lesions in order to limit the risks of relapse. Treatment is based mainly on the use of topical antifungal agents, which are generally sufficient. Despite their efficacy, the risk of relapse or recurrence should not be minimized, as the transition to chronicity in discrete form is quite frequent, hence the importance of meticulously respecting the treatment modalities (duration and rhythm of application of the products) and the complementary hygiene and prophylaxis measures. These treatment durations (5, 7, 15, 30 days) obtained in this study are approximately equal to the treatment duration of some of the modern antifungal drugs which is 1 to 4 weeks of treatment in general [24].

5. CONCLUSION

The main objective of this study was the valorization of the antifungal properties of the trunk bark of *Terminalia ivorensis* A. Chev (Combretaceae) from its hydroalcoholic extract in order to treat people with feet fungus disease.

The 10 people with feet fungus disease who were treated with the hydroalcoholic extract for an average of 30 days for people with very advanced feet fungus disease and 7 days for people with less advanced feet fungus disease were all cured. These results confirm that the

hydroalcoholic extract of *T. ivorensis* is active on ringworm of the feet.

It emerges from this study that the 70% hydroethanol extract of *T. ivorensis* barks has indeed antifungal properties, virtues granted in traditional environment.

CONSENT

The volunteers gave their written consent to try the hydroalcoholic extract of *Terminalia ivorensis*.

ETHICAL APPROVAL

All authors hereby declare that principles to experiment human beings were followed, as well as specific national laws where applicable. All experiments have been examined and approved by the appropriate ethics committee.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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