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Inhibition of *Staphylococcus aureus ATCC* and *Aspergillus niger* by Extracts of *Terminalia neotaliala capuron* (Combretaceae), Compared to Oxacillin and Fluconazole

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Abstract Therapy by synthetic antimicrobial drugs is increasingly becoming limited by microbial resistance. As a possible remedy, antimicrobials from medicinal plants are being explored. The objective of this work was to compare the activities of extracts of *Terminalia neotaliala capuron*, oxacillin, and fluconazole on the in vitro growth of *Staphylococcus aureus* ATCC and *Aspergillus niger*. The evaluation was made by incorporating the hydroalcoholic extract of the plant (Combretaceae), oxacillin, and fluconazole using the oblique double dilution method with Sabouraud agar into wells cut into Petrie dishes. After 48 hours of incubation at 30^0 C, zones of inhibition were measured. Oxacillin had a greater zone of inhibition than the plant extract on *Staphylococcus aureus* ATCC for all concentrations. The zone of inhibition for fluconazole was lower than that of the extract on *Aspergillus niger* for the concentrations of 200 mg/mL and 100 mg/mL. The hydroethanolic extract of *Terminalia neotaliala capuron* inhibited the growth of *Staphylococcus aureus* ATCC and *Aspergillus niger*.

Keywords: *Oxacillin, fluconazole, Terminalia neotaliala capuron, Staphylococcus aureus ATCC, Aspergillus niger*

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1. Introduction

For millennia, man has drawn from his immediate environment the resources necessary for his survival and for his well-being. Even before possessing the use of writing, he could transmit the experience of medicine and all types of natural remedies to finally develop what we now call traditional medicine [1]. In many developing countries, called developed countries, herbal medicine has gained popularity [2]. Indeed, according to [3], 80% of africans in rural areas use plants as their main source of health care. This enthusiasm is explained by the fact that many diseases are treated satisfactorily and at a lower cost by plants [4]. This recourse to traditional medicine is also due to the distrust of populations with respect to synthetic products and especially to the choice to consume healthy organic products grouped under the term "BIO" [5]. Plants have demonstrated promising pharmacological effects in a wide variety of diseases, such as cancer [6], diabetes [7], and infectious diseases [8]. For example, in the field of treatment of infectious diseases, faced with the multiplicity of antimicrobial resistance to existing antibiotics, plants are positioning themselves as true providers of bioactive molecules for pharmaceutical companies [9]. Moreover, they constitute an alternative therapeutic approach for the populations of disadvantaged countries. In the socio-economic context of developing countries, the study of plants can lead to obtaining adequate therapeutic responses at affordable costs for often poor populations.

In order to contribute to the revaluation and rational exploitation of these plants and their bioactive substances, *Terminalia neotaliala capuron*, a combretaceae used in the traditional environment against gastroenteritis, skin conditions, candidiasis, hypertension blood pressure, diabetes, oral diseases [10].

2. Material and Methods

2.1. Plant Material

Terminalia neotaliala capuron barks were collected in July 2021 on the campus of the University Felix HOUPHOUET-BOIGNY Cocody (Abidjan; Ivory Coast). The plant was identified at the National Center of Floristics of the said university with the herbarium number UCJ003173.

2.2. Germs Used

Staphylococcus aureus ATCC is a bacterial provided by Pasteur Institute of Cocody (Ivory Coast). *Aspergillus niger* is a microscopic fungus provided by the mycology service from Medical Sciences department of Felix Houphouet-Boigny University (Abidjan, Ivory Coast).

2.3. Extraction

Terminalia neotaliala capuron stem bark was harvested, cut into small pieces and dried in the sun at a temperature of 25°C. After grinding and rendered into fine powder, the hydroalcoholic extract was prepared. For this purpose, 1L of solvent comprising 70% ethanol and 30% distilled water was added to 100g of the fine plant powder. The whole was homogenized in a blender. After six (6) cycles of homogenization, the homogenate was wrung out in a square of white cloth then filtered successively twice on absorbent cotton and once on Whatman 3mm paper. The filtrate was concentrated (16%) with a Büchi type rotary evaporator.

2.4. Antimicrobial Tests

Concentration ranges from 200 mg/mL to 1.56 mg/mL of reason ½ were prepared for the hydroethanol extract, fluconazole and oxacillin. On petri dishes on which beforehand, were seeded separately microbial strains. A quantity of 1mL of each extract was introduced in a well (3mm diameter). The observation was done 48h.

3. Results

The inhibition diameters were recorded in each petri dish. The results are recorded in the Table 1 and the different cultures Figure 1, Figure 2, Figure 3 and Figure 4.

Table 1. Inhibition diameters of plant extract, oxacillin, fluconazole *on Staphylococcus aureus* ATCC and *Aspergillus niger*

Concentrations (mg/mL)	200	100	50	25	12,5	6,25	3,12	1,56
Extract on *Staphylococcus aureus* ATCC	29±1.2	27±0.57	24±0.57	22±0.33	21±0.57	19± 0.57	17± 0.57	16± 0.57
Oxacillin on *Staphylococcus aureus* ATCC	35± 0.33	33± 0.33	31± 0,00	29± 0.33	28± 0.00	26± 0.00	22± 0.00	20± 0.00
Extract on *Aspergillus niger*	20± 0.33	14.33± 1.52	8.0±00	8.00±00	8.00±00	8.00±00	8.00±00	8.00±00
Fluconazole on *Aspergillus niger*	15± 0.33	8.00±00	8.00±00	8.00±00	8.00±00	8.00±00	8.00±00	8.00±00

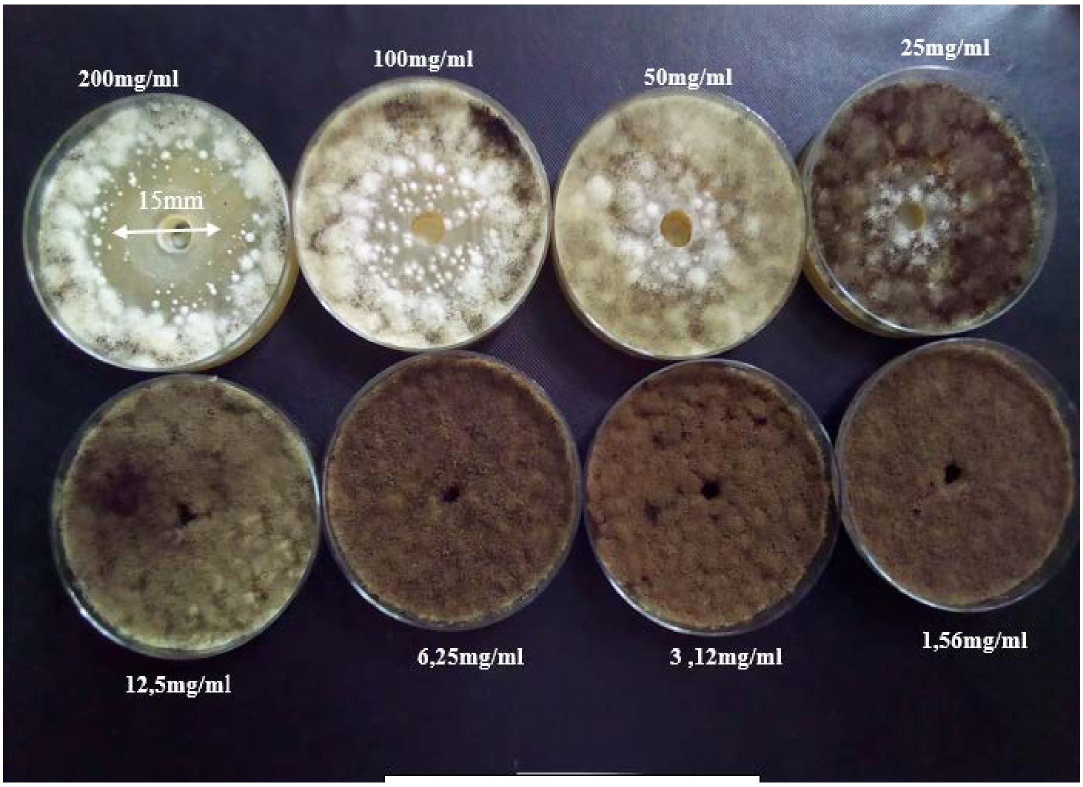

Figure 1. Effect of Fluconazole on *Aspergillus niger*

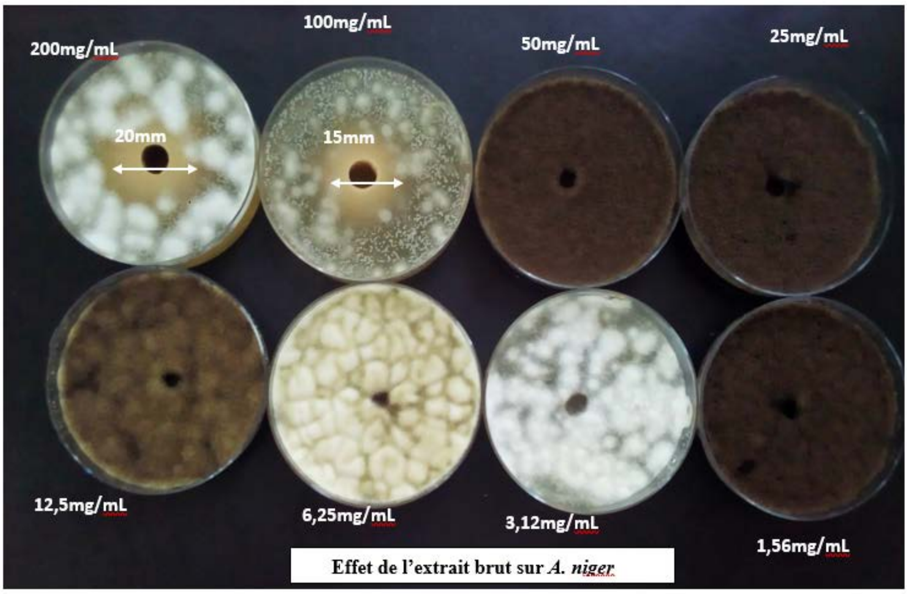

Figure 2. Effect of *T. neotaliala capuron.* on *Aspergillus niger*

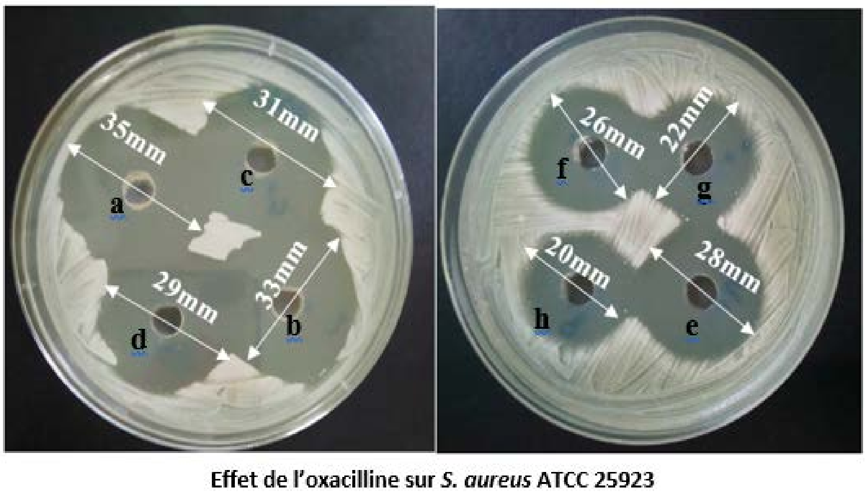

Figure 3. Effect of oxacillin on *Staphylococcus aureus* ATCC

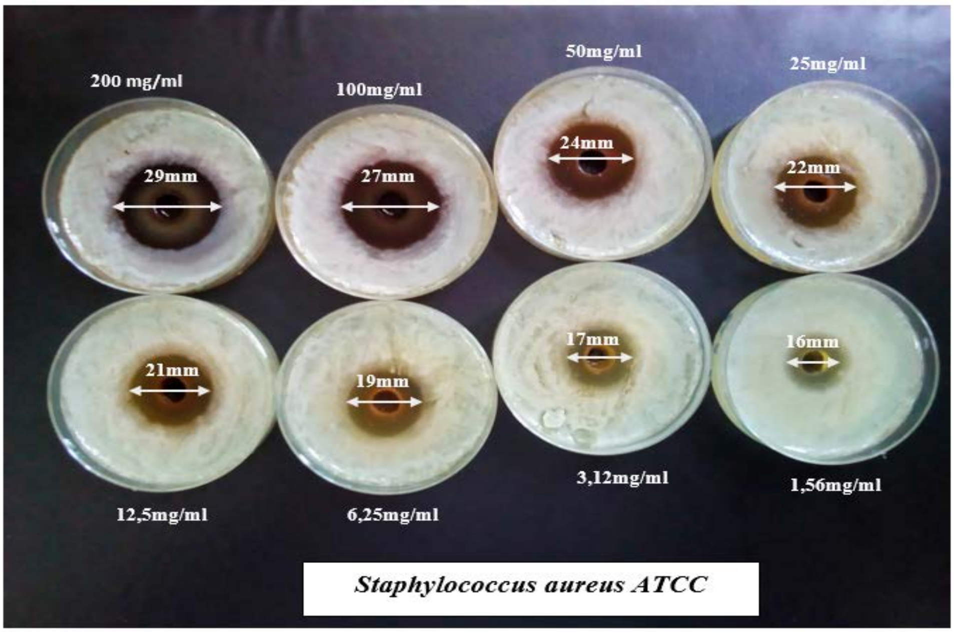

Figure 4. Effect of *T. neotaliala capuron*.on *Staphylococcus aureus* ATCC

4. Discussion

The choice of the barks of the plant and the activities mentioned is linked to the fact that this part of the plant is traditionally used to treat various gastroenteritis (diarrhea, dysentery) and infectious pathologies [11].

The 70% hydro-ethanolic extract of *Terminalia neotaliala capuron* bark powder gave a yield of 16%. The yield obtained is linked to the affinity that the secondary metabolites contained in the bark of the trunk of *Terminalia neotaliala capuron* have for the binary solvent used (Water-ethanol, 30:70, V/V).

This yield is greater than 10.47% obtained by [12] and substantially equal to 15.41% obtained by [13] but lower than 29.08 obtained by [14]. All these authors used the bark of the trunk of *Terminalia mantaly* with the same solvent (Water-ethanol, 30:70, V/V). These differences could be explained by the influence of different abiotic factors (habitat, time of harvest, stage of development, etc.). Indeed, the studies of [15] on the influence of the saponin content of plants by abiotic factors showed that the place and the season of harvest affect the chemical composition and the yield. The yield makes it possible to assess the quantity of extract that can be obtained from the species but does not make it possible to establish a related to therapeutic activity. Also, it makes it possible to consider the quantity of organ to be removed if necessary for a possible similar study. This would make the use of medicinal plants more rational and therefore sustainable for the targeted species.

The antibacterial activities of *Terminalia neotaliala capuron* extract and oxacillin performed against *S. aureus* ATCC showed that the extract and the antibiotic inhibited growth *in vitro* at the different concentrations used. According to the solid medium diffusion method, a substance is considered active when it induces a zone of inhibition with a diameter greater than or equal to 10 mm [16]. The *S. aureus* ATCC strain had inhibition diameters greater than or equal to 10 mm against the plant extract and oxacillin, for all concentrations.

In addition, the better activity of oxacillin observed on the strain of *S. aureus* ATCC compared to the extract would be explained by the fact that the extract being a totum, another compound could act as an antagonist to the action of the compound in the extract responsible for the antibacterial activity related to therapeutic activity. Also, it makes it possible to consider the quantity of organ to be removed if necessary for a possible similar study. This would make the use of medicinal plants more rational and therefore sustainable for the targeted species.

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Furthermore, the antifungal activity of *Terminalia neotaliala capuron* and the antifungal (fluconazole) on *Aspergillus niger* was compared. The best sensitivity was obtained with the plant extract for concentrations of 200 mg/mL. For concentrations below 100mg/mL the plant extract and fluconazole showed the same inhibition diameter value, i.e. equal to 8mm. The antimicrobial effects of the extract observed could be due to saponins, phenols, alkaloids, flavonoids, triterpenes, tannins and anthraquinone [17]. Indeed, these secondary metabolites act on microorganisms by various mechanisms. Tannins bind to proline-rich proteins and interfere with yeast protein synthesis [18]. Regarding flavonoids, they act by forming insoluble complexes with the proteins of the cell wall, weakening it [19]. As for saponins, they cause the lysis of some membrane and plasma proteins [20]. Phenols act by inhibiting and interacting with microbial enzymes [21]. As for quinones, they form irreversible complexes with the nucleophilic amino acids of proteins and neutralize their functions [22]. They also inhibit the activity of microorganism substrates [23]. In addition, other quinones such as anthraquinones inhibit nucleic acid synthesis [24].

5. Conclusion

It emerges by taking into account only the germs that the extract is more effective on *Staphylococcus aureus* ATCC than on *Aspergillus niger*. As for the reference substances, oxacillin is more effective than fluconazole.

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Conflicts of Interest

The author declares no conflict of interest regarding the publication of this article.

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