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Assessment of Antifungal Potential of Selected Plants Extracts on Human Dermatophytes

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ABSTRACT

Introduction: Treatment of fungal infections have become increasingly challenging recently, as there are limiting treatment options due to emerging resistant pathogenic fungi. This has also led to increase in the search for alternatives. Botanical preparations have been in use for ages for treatment of some infectious diseases; while many have proven efficacious, the potentials of others are yet to be elucidated.

Aim: This study was aimed at determining the antifungal potential of some selected plant extracts on human dermatophytes.

Methodology: Previously identified and fully characterized isolates of *Microsporium spp*. *Trichophyton spp*., and *Epidermophyton spp*., were obtained from the Medical Microbiology Laboratory, Department of Medical Laboratory Science, Rivers State University, Port Harcourt, Nigeria. Freshly harvested leaves of *Jastropha curcas*, *Erigeron sumtrensis*, *Tridax procumbens* and *Emilia sonchifolia*, were used for the preparation of crude extract. These plants were selected based on the traditional claim of their efficacy against dermatophytes. Extraction of their leaves were done using ethanol, methanol, n-hexane and dichloromethane (DCM). The discs were prepared with crude extracts obtained from the four plants in concentrations of 400mg, 200mg, 100mg and 50m, using 1.0 ml of dimethyl Sulfoxide (DMSO) for each. These were tested for antifungal activities against the test dermatophytes using standard procedures. Fluconazole (200mg) was used as control. Phytochemical analyses were also performed on extracts that showed inhibitory activity against the dermatophytes.

Results: Among the plants, only *Erigeron sumatrensis* showed zones of inhibition with mean standard deviation of 8.44±6.43, 7.78±5.93 and 7.00±5.34 in (mm) against *Microsporium spp*., *Trichophyton spp*. and *Epidermophyton spp*. respectively ($p<0.05$). Extracts from *Jastropha curcas*, *Tridax procumbens* and *Emilia sonchofolia* did not show any inhibition against the dermatophytes. The phytochemicals from Erigeron *sumatrensis* were alkaloids, flavonoids, terpenoids, saponin, tannin and steroids.

Conclusion: The plant, *Erigeron sumatrensis* showed promising antifungal potential against dermatophytes and therefore needs further elucidation as a source for antifungal agent.

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Introduction

Background

Advancement in science and medicine has made it possible in elucidating the composition and biological activities of several plant parts and plant products. Majority of plant materials used in traditional medicine are found in rural areas, and are widely used by the locals for treatment of different ailments. In Nigeria, before orthodox medications arrived, plant extracts were used by many as a result of their economic cost and versatility in the treatments of various ailments. The therapeutic properties of plants have been attributed to the presence of photochemical and essential oils they possess, which when tested on fungal isolates, were found to be effective as antifungal agents [1].

Management of fungal infections remains a critical challenge worldwide. In the last few decades, humans have witnessed a significant increase in the occurrence of fungal infections including superficial mycoses (affecting the nails, hair, skin, and mucosal membranes) and systemic mycoses (affecting major organs of the body) [2-3]. Among the fungal infections, incidence of dermatophytosis is on its surge, especially among school children in rural communities [4].

There is also the challenge of emergence of drug-resistant pathogens which is on the increase, rendering many chemically-derived antifungal agents ineffective and limiting therapeutic options [5-6]. Therefore, there is need to explore for new antifungal agents, derivable from medicinal plants with different chemical orientations and novel mechanisms of action [7]. The first step in this direction is to evaluate the antifungal potential of selected plant and to determine the phytochemical constituents before further evaluation. Some plants, for example, *Tridax procumbens,*

Erigeron sumatrensis and *Jastropha curcas, Emilia sonchifolia*, within our locality, has been suggested to have antifungal activities on dermatophytes.

Erigeron sumatrensis, commonly called tall fleabane are found on cultivated lands, weed of pasture, road side and wasteland in Africa and around the world. It is an annual, erect branched, hairy and leafy distal plant of about two metres high when fully grown [8]. Reports suggest that some species of Erigeron are endowed with analgesic, anti-inflammatory, antibacterial and antifungal potential [9-10]. *Emilia sonchifolia* also known as cupid's shaving brush, naturalize in Africa, Australia, America and various oceanic islands. The plant is erect and sparingly hairy, soft-stemmed and grows 20-70cm high with branched tap root [11]. It is reported to be used in folk medicine and has applications in inflammation, analgesic, cough, rheumatism, dysentery and as antibacterial [12-13]. *Tridax procumbens* is an annual herb commonly called coat button. It is a flowering plant in the family of the *Asteraceae*, native to the tropical America including Mexico but has been introduced to tropical, subtropical and mild temperature regions globally [14]. The plant is known for various pharmacological activities such as immunomodulatory, anti-diabetic, anti-hepatotoxic and antioxidant, anti-inflammatory, analgesic and marked depressant action on respiration [15-17]. *Jatropha curcas* is a valuable multi-purpose crop belonging to the family *Euphorbiaceae*; originally a native to Mexico and subtropical America, but now grows naturally in most tropical areas of the world. *Jatropha* stem is woody, erect cylindrical, solid and branched with a short tap root with 3-7m height [18]. It is globally used for healthcare management of humans and domesticated animals, hence it is reported to serve as anti-malarial and wound healing, and its oil, used as biodiesel. However, different solvent extracts of *J. curcas* root and bark have been reported to inhibit the growth of both gram-positive and gram-negative bacteria [19]. Its activity has also been shown against *Aspergillus fumigatus, A. flavus, A. niger, Bacillus subtilis*, *Candida albicans* and many other human pathogens [20-22].

Despite the claim and use of the plants - *Tridax procumbens, Erigeron sumatrensis* and *Jastropha curcas*, *Emilia sonchifolia* - for the treatment of different superficial mycoses, amongst the locals, there is paucity of scientific evidence and literatures on their antifungal efficacy. This study was therefore aimed at assessing the antifungal potentials of these selected plants on human dermatophytes.

Materials and Methods

Sample Collection and Culture

A total of 27 previously identified dermatophytes (*Microsporium spp*., *Trichophyton spp*. and *Epidermophyton spp*) were obtained from Rivers State University, Faculty of Science and used for antifungal susceptibility testing. Healthy selected plants leaves were collected from uncultivated farms in Khana Local Government Area of Rivers State, Nigeria. The plants were taken to the Herbarium, Department of Plant Science and Biotechnology, Rivers State University for proper identification. Their names were *Erigeron sumatrensis, Tridax procunbens, Jatropha curcas* and *Emilia sonchifolia* (Figure 1).

Plant Extraction

Freshly harvested leaves of *Jastropha curcas*, *Erigeron sumtrensis*, *Tridax procumbens* and *Emilia sonchifolia*, were used for the preparation of crude extract. These plants were selected based on the traditional claim of their efficacy against dermatophytes. The plant leaves were collected and washed with sterile distilled water, dried, crushed and extracted using ethanol (bulk extraction method) and thereafter, solvent-solvent extraction method using methanol, n-hexane, and dichloromethane. Shade dried plant materials were crushed into a coarse powder in a mix-grinder. 60g powder of each plant material was taken into 500ml conical flask containing 300ml ethanol. The solutions were prepared in ratio of 1:5 w/v and were allowed to stand for 48 hours before filtering through Whatman no. 1 filter paper. The filtrate was dried to get the concentrated extract and stored at 4°C until further use [7].

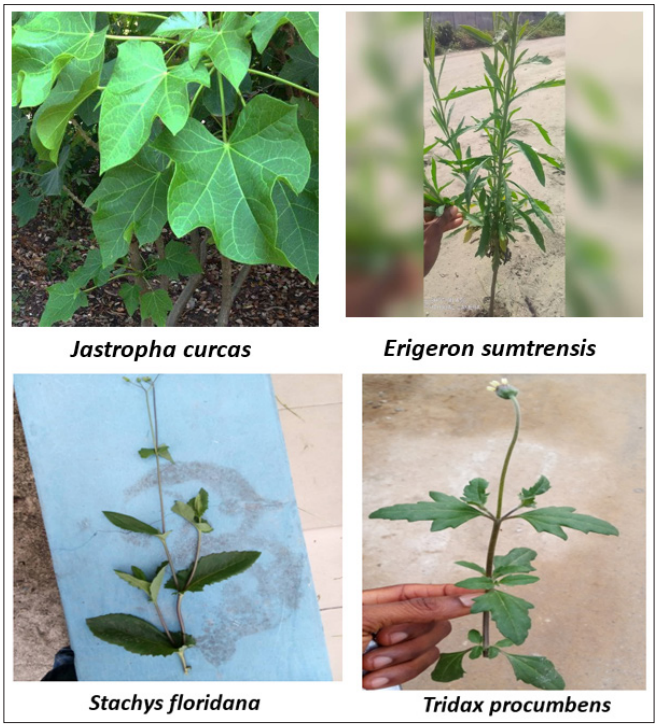

Figure 1: Selected Plants for Study

Antifungal Susceptibility Testing

Preliminary assessment was performed using disc diffusion method to check if the dermatophytes were susceptible. The susceptibility of dermatophytes to plants extract were then assayed using disc diffusion procedure. The inocula were prepared with density of 3×10^6 CFU/ml and inoculated on Sabouraud Dextrose Agar (SDA). The discs were prepared with crude extracts obtained from the four plants in concentrations of 400mg, 200mg, 100mg and 50m, using 1.0 ml of dimethyl Sulfoxide (DMSO) each. The discs were immersed in each concentration before being placed on the agar plates and incubated at room temperature (at about 30^oC) for up to 6 days. Fluconazole (200mg) was used as control. The concentration of inhibition was defined as the concentration of the plants extract that cause 60% inhibition of fungi growth. Visual evaluation and measurements were employed [23-24].

Phytochemical Analysis

The plant active fractions were subjected to preliminary phytochemical analysis following the method described and used by researchers [25-26]. Phytochemical tests for tannins, flavonoids, steroids, alkaloids and terpenoids, were analyzed.

Statistical Analysis

Microsoft Excel and Statistical Package for Social Science (SPSS) for statistical analysis were deployed for data analysis. SPSS version 21 was used to analyze for mean, standard deviation, percentage, prevalence and Chi square. Significant value was accepted at $p \leq 0.05$ levels.

Results

Table 1 shows the Susceptibility test of *Erigeron sumatrensis* and zones of inhibition of isolates. It was observed for *Epidermophyton spp*. with concentration of 400mg, 200mg, 100mg, 50mg and fluconazole control (200mg) to have zones of inhibition of 24.50±1.29, 12.75±1.26, 6.50±1.29, 0.0±0.0 and 10.50±1.29 respectively. *Trichophyton spp*. tested against similar respective concentrations, had zones of inhibition- 400mg=25.80±1.92, 200mg=14.0±1.0, 100mg=7.40±1.14, 50mg=0.0±0.0 and 17.40±2.07 for fluconazole control. *Microsporium spp*. was 400mg=27.86±1.35, 200mg=16.29±1.79, 100mg=7.71±0.76, 50mg=0.0±0.0 and 19.43±1.72 for fluconazole control.

Table 2 shows the antifungal susceptibility testing of *Jastropha curcas, Tridax procumbens,* and *Emilia sonchifolia* on *Dermatophytes*. All the dermatophyte isolates were resistant to each plant extracts at the various concentrations tested.

Table 3 shows the overall Zone of Inhibitions of *Erigeron sumatrensis* extract on *Microsporium spp*., *Trichophyton Spp*. and *Epidermophyton spp*. with mean ±SD zones of inhibition of 8.44±6.43, 7.78±5.93 and 7.00±5.34 respectively. The fluconazole control was 10.0±1.0a for *Microsporium spp*, 8.33±0.58a for *Trichophyton spp* and 6.67±0.58b for *Epidermophyton spp*.

Table 4 shows the Bioactive (Phytochemical) constituents of extracts contained in each fraction of solvents. The methanol fraction has alkaloids, flavonoids, saponins, tannins, and quinones. The steroids and terpenoids were absent, while the dichloromethane fraction has terpenoids and steroids as it active component. The alkaloids, flavonoids, saponins, tannins, and quinones were absent.

Table 1: Susceptibility Test of *Erigeron Sumatrensis* and Zones of Inhibition of Isolates from Head and Skin in (mm)

Dermatophyte	400mg Serial Dilution (n=7)	200mg Serial Dilution (n=7)	100mg Serial Dilution (n=7)	50mg Serial Dilution (n=7)	Control (fluc) 200mg	F Value	P value	Rmk
Microsporium spp	27.86±1.35^{a}	16.29±1.79^{b}	7.71±0.76^{c}	0.0±0.0^{d}	19.43±1.72^{e}	471.5	<0.0001	S
Trichophyton. Spp	25.80±1.92^{a}	14.0±1.0^{b}	7.40±1.14^{c}	0.0±0.0^{d}	17.40±2.07^{e}	233.3	<0.0001	S
Epidermophyton Spp	24.50±1.29^{a}	12.75±1.26^{b}	6.50±1.29^{c}	0.0±0.0^{d}	10.50±1.29^{e}	248.1	<0.0001	S

Keys: NS=Not Significant, S=Significant (at p<0.05), n=no of occurrences. Post-Hoc: Values within the same row with different alphabet (a, b, c, d, e) differs significantly when compared.

Table 2: Antifungal Susceptibility Testing of Plant Extracts on Dermatophytes

Plant Extract	*Microsporium spp* (n=7)		*Trichophyton spp* (n=7)		*Epidermophyton spp* (n=7)		Summation
	R	S	R	S	R	S	R
Jastropha curcas	7	0	7	0	7	0	21
Tridax procumbens	7	0	7	0	7	0	21
Emilia sochifolia	7	0	7	0	7	0	21
Summation	21	0	21	0	21	0	63

R=Resistance, S=Sensitive, N= No of experiments

Table 3: Overall Zone of Inhibitions of *Erigeron Sumatrensis* Extract (Solvent-Solvent Extraction) on Dermatophytes

Extract	*Microsporium spp.*	*Trichophyton Spp*	*Epidermophyton spp*	F value	P value	Remark
Plant Extract	8.44±6.43	7.78±5.93	7.0±5.34	0.1344	0.8749	NS
Fluconazole	10.0±1.0^{a}	8.33±0.58^{a}	6.67±0.58^{b}	15.00	0.0046	S

Keys: S=Significant, NS=Not Significant (at p<0.05), n=no of occurrences.

Post-Hoc: Values within the same row with different superscripts (a, b) differ significantly when compared at p<0.05.

Table 4: Bioactive (Phytochemical) constituents of Extract

Phytochemical	Solvent Fraction	
	DCM	Meth
Alkaloids	Neg	Pos
Flavonoids	Neg	Pos
Steroids	Pos	Neg
Saponins	Neg	Pos
Tanins	Neg	Pos
Terpenoids	Pos	Neg
Quinones	Neg	Pos

Key: DCM=Dichloromethane, Meth=Methanol

Discussion

Many plant extracts have been reported to have antifungal properties [27]. However, the increasing demand for effective, safe, natural and easily accessible products have necessitated more quantitative data on different plant extracts. The present study agrees with study of Ramya and colleagues, who reported that *E. sumatrensis* has antimicrobial effect [26]. In their report, there was a significant activity of the extract on *Mucor, Rhizopus, Aspergilus, Penicillium* and some bacteria genus. There is dearth of data concerning the activity of *E. sumatrensis* on human dermatophytes. Consolacion and colleagues have given a report of the activity of *E. sumatrensis* on some human pathogenic fungi such as *Candida, Aspergillus* and *T. mentagraphites* [10]. However, in this study, the plant extract was active against all three dermatophytes genera. This will also add a positive impact for Pharmaceutical industries as extract of *Erigeron sumatrensis* could serve as alternative to synthetic fungicide where resistant fungal novel species have emerged. At present, there is need to develop new antifungal agents that will reduce the problem of resistant species of human dermatophytes.

Tridax procunbens, Emilia sonchifolia. Jatropha curcas and *Erigeron sumatrensis* are among the plants suggested to have different medicinal values especially as antifungal agent. Whereas this study supports that *Erigeron sumatrensis* has antifungal potential to inhibit the growth of different dermatophytes genera, no antifungal activity was observed with *Tridax procunbens, Emilia sonchifolia* and *Jatropha curcas*. However, James and Martha reported that *Jatropha curcas* has antifungal effect on different species of *candida* [29]. *Tridax procumbens* have also been reported to have antifungal effect against *Candida* spp. and *Saccharomyces cerevisae*. In similar vein, other reports have shown that *Emilia sonchifolia* is used in folk medicine and its clinical implication include inflammation, analgesic, cough, rheumatism, dysentery and antibacterial [30].

The results obtained from phytochemical screening as seen in Table 4 revealed the composition of Dichloromethane (DCM) and methanol fractions of the Erigeron extract. In the DCM fraction, terpenoids and steroids only, were positive while in methanol fraction, alkaloids, flavonoids, saponins, tannins and quinones were present except terpenoids and steroides. This is an indication that bioactive compounds belonging to both groups of phytochemicals are present in the test plant and could be exploited for medicinal and other advantages. This agrees with report of Consolacion and colleagues, who elucidated the structural composition of different steroid and terpenoids in *E. sumatrensis* using dichloromethane as a solvent. According to their work, the steroids identified were spathulenol and spinasterol, while terpenoids identified were β-farnesene-1 and nephytadiene-2 using NMR spectroscopy [10]. Studies have shown that these compounds are antifungal. Moreover, many other antifungal compounds have also been identified in *E. sumatrensis* and other species [31-32]. In the methanol fraction, alkaloids, flavonoids, saponins, Tanins and quinones were positive. This agrees with report by Ramya and colleagues, who also identified similar phytochemicals from the same plant and plant parts, using similar solvent extraction method [26]. Hence, out of the four selected plants, only extract from *Erigeron sumatrensis* showed the potential to inhibit the growth of human dermatophytes isolates.

Conclusion

In the present study, extracts from leaves of four plants were evaluated for antifungal activity against *Microsporium spp*., *Trichophyton spp*. and *Epidermophyton spp*. The plants, *Jastropha curcas*, *Erigeron sumatrensis*, *Tridax procumbens* and *Emilia sonchifolia* were investigated and subjected to biochemical analysis. The analysis of these plants revealed the antifungal activity of *Erigeron sumtrensis* against isolated dermatophytes while *Jastropha curcas*, *Tridax procumbens* and *Emilia sonchifolia* did not show activity against the tested organisms.

The use of some solvents for plant extraction has been reported to have the capacity to extract different phyto-constituents depending on their solubility or polarity. The use of methanol for plant extraction and other aqueous extract might have higher solubility for more phytoconstituents. It was noted that antifungal activity of three extracts using ethanol, methanol and dichloromethane were more against *Microsporium spp*., *Trichophyton spp*. and *Epidermophyton spp*. while n-hexane phyto-constituent was not effective. High antifungal activity was seen against *Microsporium spp*. than the other fungal organisms.

Finally, the phytochemicals responsible for the activity of *Erigeron sumatrensis* were alkaloids, flavonoids, terpenoids, saponin, tannin and steroids. The plant, *Erigeron sumatrensis* needs further elucidation as a source for antifungal agent.

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