

Original Research Article

Evaluation of the Combination Effects of Extracts of *Jatropha tanjorensis* and *Adansonia digitata* on Clinical Fungal Isolates.

ABSTRACT

Introduction: The proliferation of fake drugs and the multiple resistance seen in conventional fungicidal drugs has led to the use of medicinal plants to treat fungal infections. There are claims that *Jatropha tanjorensis* and *Adansonia digitata* have fungicidal potentials, hence this study.

Aim: To evaluate the combination effects of the extracts of *Jatropha tanjorensis* and *Adansonia digitata* on clinical fungal isolates. **Study design:** Randomized sampling of the plants was done by harvesting the plants from different farms in Nsukka Enugu State.

Place and duration of study: This study was conducted in Enugu State, South East of Nigeria, from November 2023 to March 2024.

Methodology: Phytochemical screening was done on the two plants. The methanolic and aqueous (cold and hot) extracts of these plants bark and stem were assessed for their antifungal activities against six fungal isolates using agar diffusion method. The minimum inhibitory concentration (MIC) and minimum fungicidal concentration (MFC) were done according to standard methods.

Result: The plants contain alkaloids, terpenoids, saponins, flavonoids, tannin, glycoside and phenol. The hot water extracts of *J. tanjorensis* stem gave higher zones of inhibition diameter (IZD) than the methanolic extracts and the methanolic extracts of *A. digitata* bark gave higher IZD than the aqueous extracts. The combination of these two potent extracts showed greatest inhibition on *Aspergillus niger*, *Candida albican* and then least inhibition on *Trichophyton schoenleinii*, this was found to be statistically significant at ($P < .05$), the P value was ($P = 0.001$). The lowest (MIC) and (MFC) were recorded in *A. niger* and *Candida albican* at (1.5625mg/ml) while the highest (MIC) and (MFC) were recorded in *T. schoenleinii*, at (25mg/ml).

Conclusion: This study revealed that the combined plant extracts were more effective against opportunistic fungi than the dermatophytes.

Keywords: *Jatropha tanjorensis*, *Adansonia digitata*, Fungi organisms, Antifungal susceptibility, Minimum inhibitory concentration.

INTRODUCTION

Jatropha tanjorensis is a common weed of field crops and a gregarious shrub of about 1.8 m in height and it belongs to the family Euphorbiaceae. It is usually grown in rainfall forest zones of West Africa. *Jatropha* is known for its purgative and laxative potentials; it has other medicinal values. All parts of the plant including seeds, leaves and bark; fresh or as a decoction, are used as treatment regime in traditional and folk medicine [1]. While *Adansonia digitata* is a big, long-lived, deciduous tree that can be found in the sub-Saharan Africa [2]. It grows to a height of approximately 15 m and has a hugely swollen, unevenly folded trunk [3].



Fig. 1. *J. tanjorensis*(uguoyibo) or (hospital too far). [4].



Fig. 2. *A. digitata* (oyili-akpu) tree. [5]

These plants have been reported by [6] to be used for medicinal purposes in the treatment of various diseases. [7]observed *in vitro* and *in vivo* investigation of the antifungal properties of *Jatropha curcas* and *Ricinus communis* seed extracts against the mycelia growth and rot development of yam caused by *Fusarium verticillioides* and *Aspergillus flavus*.

The high cost of conventional drugs, adverse drug reactions and the proliferation of fake drugs has brought about resistance of some organisms to the conventional drugs[8],and that has led to the use of medicinal plants so as to curb this menace. *Jatropha tanjorensis* and *Adansonia digitata* have been used by many traditional healers to

treat various non-communicable and communicable diseases, such as Eczema, Candidiasis, Aspergilosis, *Tenia capitis*, *Tenia corporis*, malaria, diarrhea and anaemia, hence the aim of this study; To evaluate the combination effects of the extracts of *Jatropha tanjorensis* and *Adansonia digitata* on clinical fungal isolates.

MATERIALS AND METHODS

This study was conducted in Enugu State, South East of Nigeria, from November 2023 to March 2024.

Collection of Plants materials and Phytochemical screening: The bark and stem of the plants were obtained from a farmland in Nsukka, Enugu State and the Phytochemical screening and authentication were done in Herbarium unit of the Department of Pharmacognosy, University of Nigeria, Nsukka. Enugu State.

Preparation of plant extract: The various plant parts were rinsed in running tap water and sun-dried and then grounded to fine powder using a mechanical grinder. The powdered plant materials were extracted using methanol, cold and hot water by method of [9-10] with little modification.

Test microorganism: Clinical isolates used in the study were obtained from Mycology Unit of the University of Nigeria Teaching Hospital, Ituku-ozalla, Enugu State. They include *C. albican*, *A. niger*, *A. fumigatus*, *Penicillium* spp, *T. schoenleini* and *T. tonsurans*. These isolates were confirmed by standard mycological methods [11].

Susceptibility testing: The Antifungal susceptibility testing of the extracts were done using agar well diffusion method [11-12]. Freshly prepared Sabouraud dextrose agar (containing chloramphenicol) was allowed to solidify and using a swab stick an overnight broth of fungal culture was swabbed all over the surface of the plate, 4 holes of 6mm diameter were bored in the plate and the different concentration (100mg/ml, 50mg/ml, 25mg/ml and 12.5 mg/ml) of the different extracts were seeded in 40ul amount into the holes, Fluconazole and DMSO were used as positive and negative control respectively, they were incubated at 26°C for 48 hours and the zones of inhibition diameter were measured and compared with the positive and negative controls.

Determination of minimum inhibitory concentration (MIC): The minimum inhibitory concentration (MIC) value of the combined extracts of *J. tanjorensis* and *A. digitata* against fungal isolates were determined using

Modified dilution method [13]. The initial concentration of plant extracts (100mg/ml) was serially diluted by transferring 2ml from (stock) solution into 2ml of sterile SDA broth and mixing the content in a test tube and then serially diluting in five other test tubes, giving concentrations of 50mg/ml, 25mg/ml, 12.5mg/ml, 6.25mg/ml, 3.125mg/ml and 1.563. Then 0.2ml of the standardized broth culture of fungi was inoculated into the tubes and were incubated accordingly. The lowest concentration that inhibited growth of test organisms was noted as the minimum inhibitory concentration.

Determination of minimum fungicidal concentration (MFC):

The content of the tubes from the MIC were subcultured into freshly prepared Sabouraud dextrose agar and incubated at room temperature for 48 hours and the concentration that showed no growth is the minimum fungicidal concentration.

Data analysis: The data collected was analyzed and graphed using Minitab Version 20.4 and Microsoft Excel 2016. Kruskal Wallis test was performed on the data, followed by a post-hoc analysis (Dunn's test) using a level of significance of 0.05 (P value <0.05).

RESULTS

The data obtained from this study revealed that phytochemical analysis of both plant extracts had secondary metabolites such as alkaloids, flavonoids, terpenoids, tannins, saponins, steroids, reducing agents, phenols and glycosides.

Table 1: **Phytochemicals present in methanol extract of *Jatropha tanjorensis* and *Adansonia digitata*.**

Phytochemicals	<i>Jatropha tanjorensis</i>	<i>Adansonia digitata</i>
Phenols	+	++
Flavonoid	++	+
Saponins	+	+
Alkaloid	++	++
Tannins	+	+
Steroids	++	+
Glycoside	+	++
Terpenoids	++	++

Present = +, Highly Present = ++.

Table 2: Anti-fungal Susceptibility Pattern of Hot Water Extract of *J. tanjorensis* Stem (JTS).

Fungal Isolate	Extract (mg/ml)			
	100mg/ml	50 mg/ml	25 mg/ml	12.5 mg/ml
<i>Aspergillus niger</i>	42	38	31	27
<i>Candida albican</i>	38	34	29	21
<i>Aspergillus fumigatus</i>	40	36	30	23
<i>Penicillium spp</i>	36	29	23	17
<i>T. schoenleinii</i>	22	23	19	13
<i>T. tonsurans</i>	34	27	23	19
P-value	0.007			

Table 2 presents the inhibition zone diameter (IZD) of the fungal isolates at different level of concentrations, 100mg concentration had the highest mean IZD among the four levels of concentrations. The differences in IZD across the concentrations compared using Kruskal Wallis test which gave a P-value of 0.007 at ($P < .05$) indicating a significant difference of IZD across the different levels of concentrations.

Table 3: Anti-fungal Susceptibility Pattern of Methanolic Extract of *A. digita* bark.

Fungal Isolate	Extract (mg/ml)			
	100mg/ml	50mg/ml	25mg/ml	12.5mg/ml
<i>Aspergillus niger</i>	42	40	37	28
<i>Candida albicans</i>	42	37	33	27
<i>Aspergillus fumigatus</i>	44	40	37	30
<i>Penicillium spp</i>	36	31	25	22
<i>T. schoenleinii</i>	27	23	20	13
<i>T. tonsurans</i>	31	28	22	17
P-value	0.032			

Table 3 shows the inhibition zone diameter (IZD) of the fungal isolates at different level of concentrations for the methanolic extract of *A. digita* bark. Here, 100mg/ml concentration had the highest mean IZD among the four levels of concentrations. The differences in IZD across the concentrations compared using Kruskal Wallis test which gave a P-value of 0.032 at ($P < .05$) indicating a significant difference of IZD across the different levels of concentrations.

Table 4: The combined hot water Extract of *J. tanjorensis* Stem and Methanolic Extract of *A. digitata* bark.

Fungal Isolate	Combined Extracts (mg/ml)			
	100mg/ml	50mg/ml	25mg/ml	12.5mg/ml
<i>Aspergillus niger</i>	61	55	52	50
<i>Candida albicans</i>	58	54	48	43
<i>Aspergillus fumigatus</i>	56	50	47	37
<i>Penicillium</i> spp.	54	51	46	39
<i>T. shoenleinii</i>	53	47	42	36
<i>T. tonsurans</i>	56	51	45	40
P-value	0.001			

Table 4 shows the inhibition zone diameter (IZD) of fungal isolates at different level of concentrations for combined hot water extract *J. tanjorensis* stem and methanolic extract of *A. digitata* bark. The IZD was highest at 100mg/ml concentration of the extracts. The differences in IZD across the concentrations compared using Kruskal Wallis test which gave a P-value of 0.001 at ($P < .05$) indicating a significant difference of IZD across the different levels of concentrations.

Table 5: Minimum Inhibitory Concentration (MIC) of the Combined Extracts of Hot water Extract of *J. tanjorensis* Stem and Methanolic Extract of *A. digitata* bark. (JTS + ADB).

Organisms	Different concentrations of the combined extract (Jts+Adb).						
	100mg	50mg	25mg	12.5mg	6.25mg	3.125mg	1.5625mg
<i>A. niger</i>	-	-	-	-	-	-	+
<i>C. albican</i>	-	-	-	-	-	-	+
<i>A. fumigatus</i>	-	-	-	-	-	+	+
<i>Penicillium spp</i>	-	-	-	-	+	+	+
<i>T. shoeneleinii</i>	-	-	+	+	+	+	+
<i>T. tonsurans</i>	-	-	-	+	+	+	+

- No growth + Growth

According to table 5, the combined extract was able to inhibit the growth of all the opportunistic fungi even at very low concentration, while the dermatophytes were not inhibited at very low concentrations,

Table 6: Minimum Fungicidal Concentration (MFC) of the Combined Extracts of Hot water Extract of *J. tanjorensis* Stem and Methanolic Extract of *A. digitata* bark. (JTS + ADB).

Organism	Different concentrations of the combined extract (Jts+Adb).						
	100mg	50mg	25mg	12.5mg	6.25mg	3.125mg	1.5625mg
<i>A. niger</i>	-	-	-	-	-	+	+
<i>C. albican</i>	-	-	-	-	-	+	+
<i>A. fumigatus</i>	-	-	-	-	-	+	+
<i>Penicillium spp</i>	-	-	-	-	+	+	+
<i>T. shoeneleinii</i>	-	+	+	+	+	+	+
<i>T. tonsurans</i>	-	-	+	+	+	+	+

- = no growth, + = presence of growth.

DISCUSSION

Table 1 shows the different phytochemical component present in the two plant extracts, these metabolites have inhibitory properties against fungi bacteria and even viruses. Phytochemicals are bioactive substances found in edible plants, such as fruits, vegetables, seeds, nuts, and cereals, that have been demonstrated to exhibit health benefits, such as antioxidant, antimicrobial, antifungal and anticancer effects [14].

The antifungal activity of the hot water extract of *J. tanjorensis* (JTS) demonstrated in table 2 showed that at 100mg/ml, both *A. niger* and *A. fumigatus* were most susceptible followed by *C. albicans* and *Penicillium* spp while the least susceptible fungi was *T. shoeleninii*. This is in agreement with the previous research of some authors who also isolated *A. fumigatus* [7]. The differences in IZD across the concentrations were compared and P-value of 0.007, which indicated that there is a significant difference in their IZD, hence the *J. tanjorensis* significantly inhibited the growth of these fungi.

The antifungal activity of the methanol extract of *A. digitata* bark (ADB) against the test isolates were shown in table 3. It revealed that *A. fumigatus* was the most susceptible at 100mg/ml, followed by *A. niger* and then other fungi as some authors have already proved, where the methanol extract of *A. digitata* stem- bark inhibited mycelial development of *Aspergillus* spp [16].

Table 4 showed that the combination of the two plant extracts were highly inhibitory to *A. niger* and *C. albicans* and such was also recorded by some scientists [4].

Table 5, showed the minimum inhibition concentration (MIC) of the combined extracts on *A. niger* and *C. albicans* to be low (1.5625mg/ml), this is not in agreement with the findings of Abiona *et al* [17], whose values were higher. Table 6 shows the minimum fungicidal concentration (MFC) of the combined extract. The MFC for opportunistic fungi ranges from 1.5625mg/ml to 6.25mg/ml this depicts susceptibility, such values were recorded in the work done by Ouafae *et al* [16], while the MFC for dermatophytes ranged from 25mg to 50mg which depicts resistivity by the dermatophytes. This study shows that the hot water extracts of *J. tanjorensis* and the methanol extracts of *A. digitata* gave the highest inhibition on these fungal organisms than cold water extracts, this is

because the hot water made the plant compound to be soluble hence hot water and methanol aided solubility, this is in line with the results of Sharma *et al.*[15].

CONCLUSION

The result of this study revealed that *J. tanjorensis* extract has significant inhibitory action on *Aspergillus species* and some other fungal organisms more than *A. digitata*, however the combined extracts of *J. tanjorensis* and *A. digitata* is a better inhibitor of the fungal organisms therefore they can be used in combination as a potential source of antifungal agent for the treatment of opportunistic fungal diseases such as eczema, aspergillosis and candidiasis. The extracts were not very inhibitory to the dermatophytes, hence they cannot be used to treat infections caused by dermatophytes. We recommend that molecular study of the plants should be done in future works to check for more potency.

Disclaimer (Artificial intelligence)

We the authors' hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

CONSENT AND ETHICAL APPROVAL

There was no ethical approval because the clinical samples that were used were the already identified samples collected from the laboratory section of the University of Nigeria Teaching Hospital Enugu.

COMPETING INTERESTS

There was no competing interest.

REFERENCES

1. Oladele J. O., Oladele O.T., Ademiluyi A. O., Oyeleke O. M., Awosanya O. O., and Oyewole O. I., Chaya (*Jatropha tanjorensis*) leaf protect against sodium benzoate mediated renal dysfunction and hepatic damage in rats. *Clinical Phytoscience*, 2020, 6(13).
2. Petruzzello, Melissa. "baobab". *Encyclopedia Britannica*, 2024, <https://www.britannica.com/plant/baobab-tree-genus>.
3. Van Wyk A.S. and Prinsloo G., A review of the ethnobotanical uses, pharmacology, toxicology, management and cultivation of selected South African protected multi-purpose tree species. *South African Journal of Botany*; 2019, 124, 258-269.
4. Sankara Rao, K., Deepak Kuma. India Flora Online, 2023, http://indiafloraonline-ces.iisc.ac.in/plants.php?name=Jatropha_tanjorensis.
5. Andrew Hankey, Walter Sisulu. National Botanical Garden. updated 2017. <https://pza.sanbi.org/adansonia-digitata>.
6. Jamshidi - kia, F. Lorigooini, Z and Amini - Khoei, H. Medicinal Plants: past history and future perspective. *Journal of Herbmed. Pharmacology*. 2018;7(1), pp. 1 – 7.
7. Arendrup MC, Guinea J, Meletiadiis J. Twenty Years in EUCAST Anti-Fungal Susceptibility Testing: Progress & Remaining Challenges. *Mycopathologia*. 2024 Jul 11;189(4):64. doi: 10.1007/s11046-024-00861-2. PMID: 38990395.
8. Dar, R. A., Shahnawaz, M. and Quazi, P.H. Natural Product Medicines: A Literature update. *Journal of Phytopharmacol*. 2017, 6 (6), pp.349-351.
9. Samatha, T., Shama, N., Chandrakaka, G., Thirupathi, K., Ramaswamy, N. Antibacterial Activity of *Adansonia digitata* L. A Globally Endangered Tree. *International Journal of Pharmacognosy and Phytochemical research*. 2017, 9(11). pp. 1410 - 1413.
10. Udoh, I.P., Eleazar, C. I. ,Aladenika, S.T, Azubuike, N.C, Onyebueke, E.A. , Okwuosa, C. N., et al. Antifungal properties of methanol leaf extract of *Anacardium Occidentale* L (cashew) against Fusarial isolates from human and plant origin. *Pharmacology online*. 2019, 118, pp. 117-135.
11. Cheersbrough, M. District Laboratory Practice in Tropical Countries. part 2. 2006. 2nd Edition. Cambridge University Press. pp. 234-247.

12. Rahul, J. Jain, M. K. Singh, S. P. Kamal, R.K., Anuradha, Naz, A. and Mrityunjay, S. K. *Adansonia digitata* L.(baobab), a review of traditional information and taxonomic description. *Asian Pacific Journal of Tropical Biomedicine*. 2015, 5(1), pp.79-84.
13. Habton, S. and Gehrehiwot, S. In vitro Antimicrobial Activities of Crude Extracts of *Vernonia amygdalina* and *Croton Macrostachyus* against Some Bacterial and Fungal Test Pathogens. *The Journal of phytopharmacology*. 2019, 8 (2), Pp.57-62.
14. Yao Hu, Qianzhu Lin, Hui Zhao, Xiaojing Li, Shangyuan Sang, David Julian McClements, et al., Bioaccessibility and bioavailability of phytochemicals: Influencing factors, improvements, and evaluations. *Food Hydrocolloids*, 2023: 135. <https://doi.org/10.1016/j.foodhyd.2022.108165>
15. Sharma, A. and Rangari, V. Antibacterial, Antifungal and Antitubercular Activity of Methanol Extract of *Adansonia digitata* L. *Journal of Pharmacy and Biological Sciences*. 2015,10(4). Pp.52- 60.
16. Ouafae El Yahyaoui, Bahia Bouabid, Nabil AitOuaaziz, Mohamed El Bakkali, Hanae El Harche, et al. The antibacterial activity and biochemical composition of *Adansonia Digitata* edible parts. *Arab Gulf Journal of Scientific Research*. 2023, 41(1)
17. Abiona, D. L, Adedapo, Z, Suleiman, M. K. Proximate Analysis; Phytochemical Screening and Antimicrobial Activity of Baobab (*Adansonia digitata*) Leaves. *IOSR Journal of Applied Chemistry*. 2015, 8(5), pp 60– 65.