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# Comparative Efficacy of *Aloe vera* (Linn) and *Aloe schweinfurthii* (Baker) Powdered Leaf Extracts in the Control of Some Plant Fungal Pathogens

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***Authors' contributions***

*This work was carried out in collaboration among all authors. Author AOA performed the statistical analysis and managed the literature searches. Authors AOA and AMA wrote the first draft of the manuscript and also managed the analysis of the study. Author BOA designed the study. The protocol of the study was written by authors BOA and AOA. All authors read and approved the final manuscript.*

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## ABSTRACT

Evaluation of the relative efficacy of powdered leaf extracts of *Aloe vera* (Linn) and *Aloe schweinfurthii* (Baker) in the control of some plant pathogens was undertaken in this work. Antimicrobial activities of the extracts obtained using cold water, hot water and ethanol were tested against four fungal spp., namely, *Alternaria solani, Colletotrichum lindemuthianum*, *Sclerotium rolfsii* and *Trichophyton rubrum*. The phytochemical screening of the leaf extracts of the two aloe species revealed the presence of bioactive compounds such as alkaloids, tannins, saponins, flavonoids, cardiac glycosides, phytates and oxalates. The extracts were observed to exhibit varying inhibitory effects on the selected fungi. Ethanolic extract of *A. vera* at 50 mg/ml and 100 mg/ml had the greatest impact on *A. solani* and *C. lindemuthianum* respectively. Similarly, cold water extract of *A. schweinfurthii* at 100 mg/ml was the most effective against *S. rolfsii* and *T. rubrum.* However, hot

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water extract of *A. vera* was least effective against *C. lindemuthianum*. Also, the efficacy of cold water extract of *A. schweinfurthii* at 50 mg/ml was very low against *T. rubrum* and *A. solani.* The hot water extract of *A. schweinfurthii* at 20 mg/ml also showed the least effect against *S. rolfsii*. Consequently, extracts from both Aloe species can be recommended in the management of the four fungal pathogens evaluated in this study. It is hoped that in no distant future, botanical fungicides would be developed from the two Aloe species.

*Keywords: Alternaria solani; Colletotrichum lindemuthianum; phytochemical screening; inhibitory effects.*

## 1. INTRODUCTION

Plants have been sources of preventive as well as therapeutic medicine among indigenous peoples of various communities for ages [1]. In the past, most of the dwellers of the third world countries rely solely on indigenous plant-based medicines as remedies for various health challenges [2]. In fact, it was reported that in South Africa, over 60% of the population consults the traditional healers [3]. World over, the business interest in these plant species for their proposed medicinal attributes, is on the increase despite the fact that little or no scientific information is available to back the claim of potency attributed to most of them.

The determination of the composition of these plants has been the focus of researchers in recent past [4]. Their efforts have been channeled towards the extraction and classification of biologically active components and subsequent development of drugs as well as herbal products as supplements [5]. Analysis of different species of medicinal plants for biologically active components known to have pharmacological properties had been conducted and most of the studied plants have shown antimicrobial property [6].

*Aloe vera* (Linn), for example, is known to have many bioactive and antipathogenic components and extracts from the Aloe specie can be used in the management of various ailments [7]. The specie is succulent and it has no naturally occurring populations in Nigeria, hence, can only be found in cultivation [8]. When examined, the DNA of *A. vera* shows that it is similar to that of *A. perryi*, a specie endemic to Yemen [9]. Preparations made from *A. vera* are commercially advertised for skin conditions such as sunburns, cold sores and frostbite. *Aloe vera* gel is also used commercially as an ingredient in yoghurts, beverages, and some desserts [4].

*Aloe schweinfurthii* is one of the indigenous Aloe species in West Africa [10]. It is a tropical plant that is customarily used for the treatment of different ailments. These include chronic skin ulcers, coughs, dysmenorrhea, food poisoning, intestinal worms, difficult delivery, dysentery, general stomach aches, and lumbar pain. Other traditional uses for *A. schweinfurthii* include antiseptic usage, purgative, decoagulant, larvicide, vermifuge, stomachic tonic and as a stimulant [11].

The use of plant extracts in the control of pests and diseases as well as in the preservation of food is as old as mankind [12]. Ancient Egypt had developed the use of extracts from plants in the preservation of food, as antimicrobial agents and in embalming the dead [13]. For example, the Egyptians were using garlic extract in food preservation. There is a continuous rise of interest in the search for antimicrobial agents from plants [14].

Numerous scientific studies have been conducted on *A. vera*, the result of which has shown the plant to have medicinal attributes, hence its relevance to cosmetic, pharmaceutical, nutraceutical and food industries [15]. Some of these companies are left with no choice but to import the components of this plant with attendant financial implications. Consequently, efforts are made by stakeholders to partially replace active components imported from other countries with those of indigenous Aloe species, so as to bring about increased utilization of indigenous plants. In the present work, effort was made to compare one of the Aloe indigenous to Nigeria with *A. vera* in terms of its antifungal properties.

## 2. MATERIALS AND METHODS

*Aloe vera* and *A. schweinfurthii* were collected from Stateline area not too far from Federal University of Technology, Akure (FUTA) campus and Ore environs, both in Ondo-State. The help of a botanist was enlisted in the identification process and the plants were potted in the screen

house of the Department of Crop, Soil and Pest Management, FUTA.

## 2.1 Collection and Preparation of Fungal Isolates

The four fungal pathogens evaluated in this work, namely; *Alternaria solani, Colletotrichum lindemuthianum*, *Sclerotium rolfsii* and *Trichophyton rubrum* were obtained from the culture collections of the pathology unit of the Department of Crop, Soil and Pest Management Federal University of Technology, Akure. Inoculation of each fungus was done separately on freshly prepared Potato Dextrose Agar (PDA) following standard procedure. The pure culture of each fungus was evaluated for susceptibility to the phytochemical components of the Aloe species.

## 2.2 Preparation of Extracts

Eight leaves each of the two species were collected, washed in running tap water and chopped. The chopped pieces were oven dried under a controlled temperature of 65°C for 72 hours. These oven dried leaves of the two Aloe species were crushed separately and ground into powder using a sterile mortar and pestle.

Extracts from the two samples were obtained using cold water (at 25°C), hot water (at 65°C) and ethanol. For cold water extraction, 100 ml of sterile distilled water at room temperature were dispensed into conical flasks containing 10 g of powdered samples. This was allowed to stand for 24 hrs with intermittent agitation. The mixtures were filtered separately using muslin filter cloth. They were thereafter kept in an incubator (under a controlled temperature of 65°C for 12 hours) so as to obtain solid extracts. With the aid of scalpel, these solid extracts were scrapped and divided into three portions of 0.2 g, 0.5 g, and 1.0 g. Each portion was dissolved in 10 ml sterile distilled water to make three different concentrations of 20 mg/ml, 50 mg/ml and 100 mg/ml. The same procedure was repeated for hot water extraction at 65°C. For ethanol extraction, 10 g of powdered samples of each species were separately soaked in 100 ml of ethanol inside 400ml conical flasks. The mixture was allowed to stand for about 72 hours after which it was filtered using muslin filter cloth.

These filtrates were dried inside an incubator under a controlled temperature of 65°C to obtain solid extracts. With the aid of scalpel, these solid extracts were scrapped and weighed into 0.2 g, 0.5 g, and 1.0 g portions. Each portion was also dissolved in 10 ml distilled water to make different concentrations.

## 2.3 Phytochemical Screening

Screening was carried out for the presence of the following phytochemicals: oxalate, alkaloids, saponins, flavonoids, cyanide, phytates and tannins. The standard procedure as described by Sofowara and Harborne was adopted to identify and quantify the bioactive constituents [16,17].

## 2.4 Evaluation of Extracts against Fungal Pathogens

Two (2) ml of each extract was aseptically transferred into the Petri dishes. 20 ml aliquots of molten potato dextrose agar (PDA) at 50°C were poured into the Petri dishes containing each extract concentrate and swirled gently such that the extracts and the PDA mixed properly to form a homogeneous mixture. The PDA/extract mixtures were allowed to set at room temperature. A sterile 5 mm diameter cork borer was used to punch out agar discs from one-week old cultures of the four fungi separately and inoculation was done at the center of each Petri dish containing PDA/extract mixture. Each extract concentration represented a treatment and each treatment was replicated thrice for the dry leaf samples as well as the three extraction methods.

Two control experiments were set up. The first control involved the use of a standard fungicide i.e. Carbendazim (at 1.0 mg per 2 ml of sterile distilled water as recommended on Carbendazim 500 Fungicide WP label), while the second control was made up of fungal pathogens on PDA with no extract incorporated.

## 2.5 Data Collection

Data were collected on the mycelial growth of the four fungal pathogens. The zone of mycelial growth was measured after 48 hours of inoculation. All measurements taken were recorded. Percentage mycelial growth inhibition was determined using the formula:

$$\% \text{ mycelia growth} = (a-b)/a \times 100$$

Where:

a = Zone of mycelia growth on non treated sample

b = Zone of mycelia growth on treated sample

All data were subjected to analysis of variance (ANOVA) and means were separated using Duncan's multiple range test (DMRT).

## 3. RESULTS

This study showed that Aloe leaves have alkalsoids, tannins, saponins, flavonoids, cardiac glycosides, phytates, and oxalates. The results also showed that there is a significant difference in the proportion of phytochemicals in *A. schweinfurthii* and *A. vera*. This can be seen in Fig. 1. In terms of proportion, oxalate, saponins, flavonoids, and cyanide were observed to be more in *A. schweinfurthii* than in *A.vera.* However, alkaloids, phytates, and tannins were observed to be more in *A. vera* than in *A. schweinfurthii.* These differences are significant.

Also, the result on the percentage mycelial growth inhibition of the selected fungi by the leaf extracts of the two Aloe species are presented in Figs. 2 to 4. Significant differences exist among the extracts with regards to inhibition of mycelial growth in the fungi species.

For example, the mycelial growth of *Trichophyton rubrum* was seen to be highly inhibited when tested against 20 mg/ml S2, whereas the same fungus was observed to be more resistant to the effect of V1. Similarly, 100 mg/ml S2 had the highest efficacy against *Sclerotium rolfsii* while V1 showed no inhibitory effect against the fungus. In contrast, 50 mg/ml and 100 mg/ml of EA had the greatest effects against *Alternaria solani* and *Colletotrichum lindemuthianum* respectively. Highest inhibitory effects were observed in both cases. However, S1 and ES had mild to moderately high effects against the fungi.

## 4. DISCUSSION

This work showed that powdered leaf extracts of the two aloe species have a varying degree of inhibition of mycelial growth against the selected fungi pathogens. *Alternaria solani* has been reported to cause dark concentric rings on the fruits, stems and leaves of tomatoes. Early blight

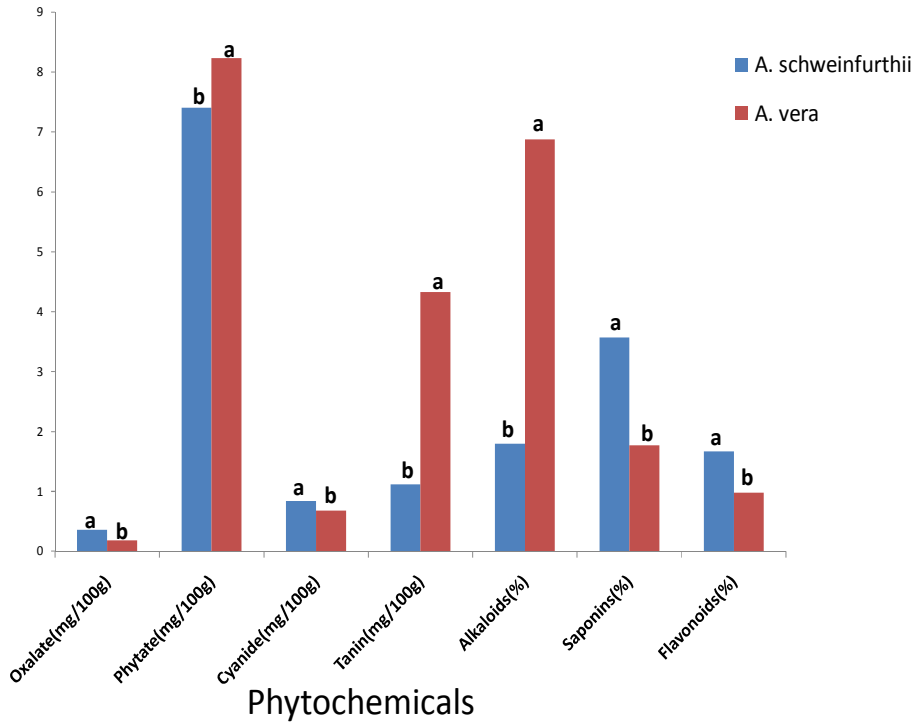


**Fig. 1. Quantitative analysis of phytochemical constituents of the two aloe species**
*NOTE: Mean values followed by different letters are significantly different from one another (p<0.05)*

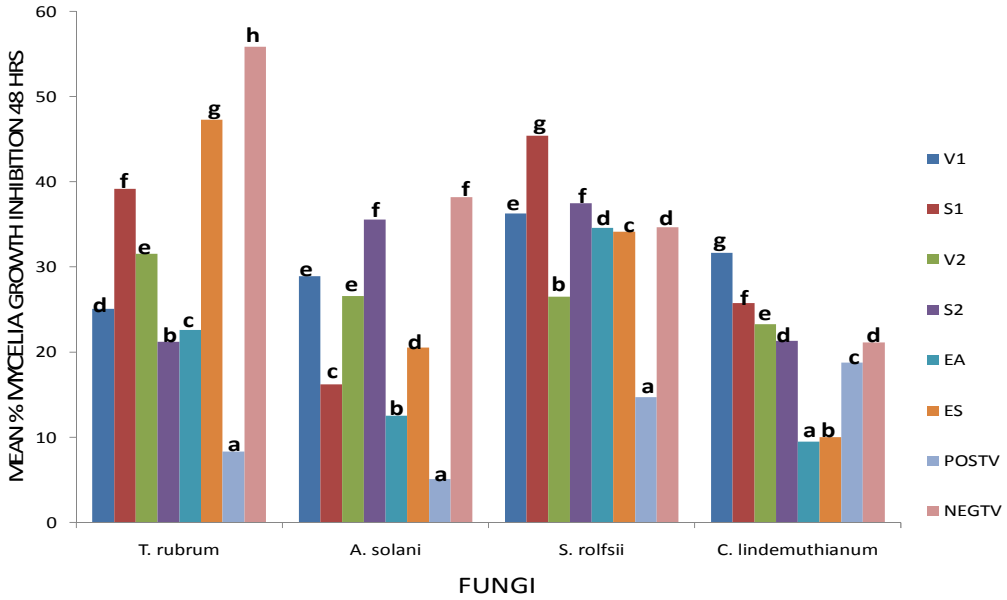


**Fig. 2. Effect of the extracts at 20mg/ml against the fungi after 48 hours**

*Notes: V1=Hot water extract from powdered Aloe vera, S1=Hot water extract from powdered Aloe schweinfurthii, V2 =Cold water extract from powdered Aloe vera, S2 =Cold water extract from powdered Aloe schweinfurthii, EA =Ethanolic extract from powdered Aloe vera, ES= Ethanolic extract from powdered Aloe schweinfurthii, POSTV= Standard, NEGTV= Control*

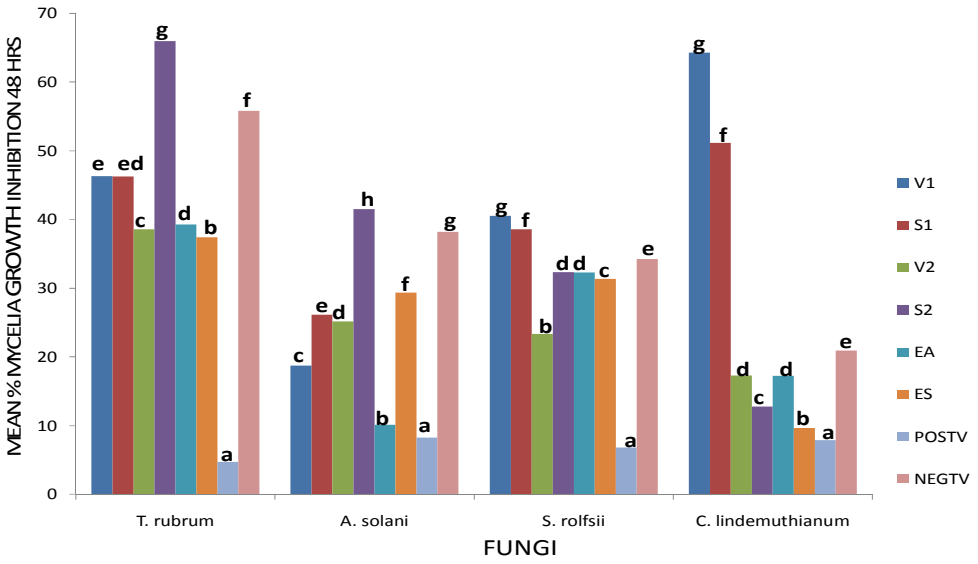


**Fig. 3. Effect of the extracts at 50mg/ml against the fungi after 48 hours**

*Notes: V1 = Hot water extract from powdered Aloe vera, S1=Hot water extract from powdered Aloe schweinfurthii, V2=Cold water extract from powdered Aloe vera, S2=Cold water extract from powdered Aloe schweinfurthii, EA=Ethanolic extract from powdered Aloe vera, ES= Ethanolic extract from powdered Aloe schweinfurthii, POSTV= Standard, NEGTV= Control*

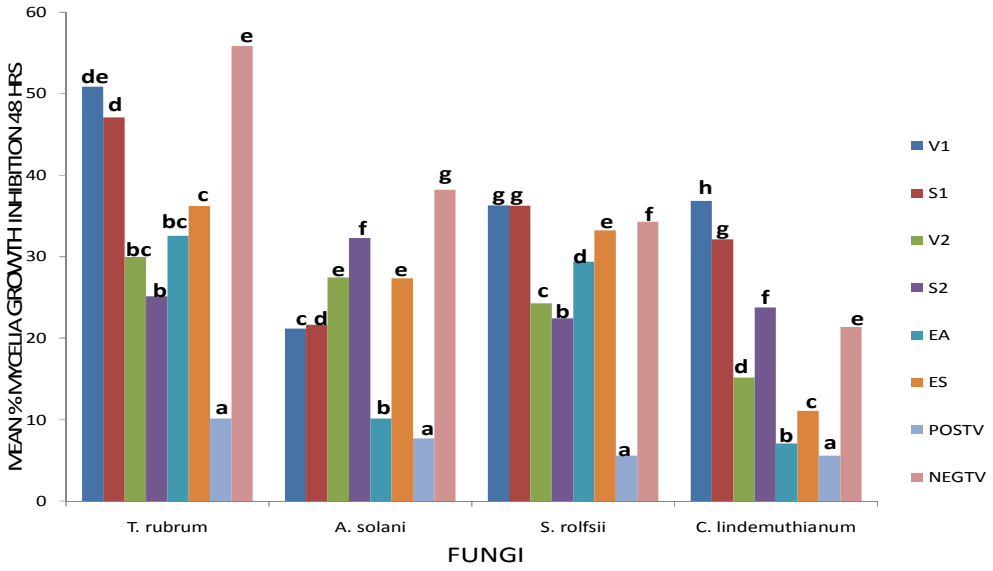


**Fig. 4. Effect of the extracts at 100mg/ml against the fungi after 48 hours**

*Notes: V1=Hot water extract from powdered Aloe vera, S1=Hot water extract from powdered Aloe schweinfurthii, V2=Cold water extract from powdered Aloe vera, S2=Cold water extract from powdered Aloe schweinfurthii, EA=Ethanolic extract from powdered Aloe vera, ES=Ethanolic extract from powdered Aloe schweinfurthii, POSTV= Standard, NEGTV= Control*

of tomatoes is also known to be caused by the same fungus [18,19]. All the extracts except S2 had significant inhibition on the mycelial growth of the fungus. The inhibitory effect of the ethanolic extracts from *A. vera* was more when compared to other extracts. One can, therefore, say that ethanol was more efficient in the extraction of phytochemicals which are effective against the fungus. This is in line with the claim that the amount of an active ingredient in an extract is a principal function of the solubility of the active ingredient, which in turn is influenced by the type of solvent used in the extraction [20]. This is the underlying factor responsible for the variation of efficacy in assayed extracts [21,20]. EA at 50mg/ml exhibited the greatest effect against the fungus. This is in consonance with the discovery made when the extract of *Aloe vera* was tested against pathogenic species of genus *Alternaria* [22]. The inherent ability to induce a toxic effect on mycelial growth and proliferation of these fungi was said to be responsible for the efficacy of *A. vera* extract [23]. The presence of alkaloid which was found to be more in *A. vera* extract could also be responsible for this. One of the major properties of alkaloids is their toxicity against the cells of foreign organisms [24]. Extracts of *A. schweinfurthii* also inhibited the growth of the fungus except for S2 which was of no effect against the pathogen. The aqueous extracts that demonstrated the least activity against *Alternaria* spp. could be explained by the fact that when plant materials are ground in water, some phenolases and hydrolases are released and could have modulating effects on the activity of the compounds in the extracts. It could also be due to incomplete extraction of the active principles. This finding is in tune with a study carried out in Uruguay, where it was observed that a high proportion of the test plant extracts in water (80% of them) did not inhibit the fungus *Alternaria* sp [25].

*Trichophyton rubrum* is known to inhabit different environment including animals, humans and soils. It is a dermatophyte fungus that is economically important in hair, skin and nail infections in human [26]. The result of this study agrees with the previous study which shows *A. vera* extracts to have consistent inhibitory effects on *T. mentagrophytes* and *T. rubrum* [27]. However, in the current work, the effect of the extract of *A. schweinfurthii* on the pathogen was observed to be more when compared to that of the *A. vera*. The cold water extract of *A. schweinfurthii* followed by ethanolic extract of *A. vera* was seen to have a significant inhibitory

effect (62.01% and 59.47% respectively) on *T. rubrum* at 20 mg/ml concentration. This study revealed that cold water extract from powdered *Aloe schweinfurthii* at 20 mg/ml have the greatest inhibitory effect. The low water temperature, unlike hot water, could also be said to maintain the nature of the bioactive ingredients. Saponin which was observed to be present in a higher proportion in *A. schweinfurthii* could also be responsible for this high activity of S2. This is in line with the report which states saponins to be important in plants as antifeedant and in protecting plants against microbes and fungi [28]. The presence of biologically active compounds in plants makes them be of medicinal importance especially for antimicrobial activity against pathogenic organisms.

Similarly, the cold water extract from powdered *A. schweinfurthii* at 100 mg/ml concentration proved to be very active against *Sclerotium rolfsii.* Flavonoids, which are present in a higher proportion, could be responsible for this. Flavonoids have antimicrobial properties [29] and have been shown to exhibits cytotoxic antitumor, antioxidant and anti-inflammatory activities [30]. The secondary metabolite shields the DNA, lipids, and carbohydrate of biological systems from oxidative processes [31].

V2 was also seen to have a significant effect on the fungus. The fungus has been known to infect a wide range of agricultural and horticultural crops. In Nigeria, cocoyam is seriously affected by tuber rot caused by *S. rolfsii* [25]. It has also been reported that the attacks from this fungus could cause a drop in production figures of cocoyam by 11% [32]. Although no worldwide compilation of host genera has been published, over 270 host genera have been reported in the United States alone. Susceptible agricultural hosts also include sweet potato (*Ipomoea batatas*), pumpkin (*Cucurbita pepo* L.), corn (*Zea mays*), wheat (*Triticum vulgare*) and peanut (*Arachis hypogea*). Horticultural crops infected by the fungus are included in the genera *Narcissus*, *Iris*, *Lilium*, *Zinnia*, and *Chrysanthemum* [33]. This work revealed S2 at 100 mg/ml and S1 at 20 mg/ml, to show the greatest and least efficacy against *S. rolfsii*.

*Colletotrichum lindemuthianum* is the causal agent of anthracnose of *Phaseolus vulgaris*. It produces red to brown, irregular-shaped blotches on pods. Small, thin lesions of the same colour can be seen on the stem. The fungus causes irregular seed development [34]. The attack by the fungus may lead to total loss of crop if left unchecked [35]. The highest percentage inhibition of the fungus was by EA (66.79%) at 100 mg/ml, followed by the same extract at 20 mg/ml and ES (53.91%) at 50 mg/ml. The ability of ethanol to extract the active ingredients that are potent against this fungus could have been responsible for this. On the other hand, hot water extract from powdered *A. schweinfurthii* and hot water extract from powdered *A. vera* proved to be less effective against *C. lindemuthianum*. The reason for this is explained by the fact that the structure of the phytochemicals is unstable when exposed to high temperature [20]. Hence, plant extracts, notwithstanding their increasing relevance in therapeutic treatment, have the limitation in being rapidly degraded by high temperature and ultra-violet radiations [20,21,36]. The least effective extract against the growth of the fungus out of the extracts of *A. vera* and *A. schweinfurthii* is V1.

## 5. CONCLUSION

This research work clearly suggests that *Aloe schweinfurthii* may be a good substitute for *Aloe vera* in the area of plant protection. The result showed that cold water extract from powdered *A. schweinfurthii* at 20 mg/ml and 100 mg/ml were the most effective against *T. Rubrum* and *S. rolfsii* respectively. On the other hand, the efficacy of ethanolic extract from powdered *A. vera* at 50 mg/ml and 100 mg/ml was observed to be the greatest against *Alternaria solani* and *Colletotrichum lindemuthianum* respectively. Further work should be done on the identification and quantification of the active constituents of each species of Aloe. The appropriate mix ratio of active constituents that will be most potent against fungal pathogens should also be investigated.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. Shinwari ZK. Medicinal plants research in Pakistan. Journal of Medicinal Plants Research. 2010;4(3):161-76.
2. García-Casal MN, Peña-Rosas JP, Malavé HG. Sauces, spices, and condiments: Definitions, potential benefits, consumption patterns, and global markets. Annals of the

New York Academy of Sciences. 2016;1379(1):3-16.
3. Thring TS, Weitz FM. Medicinal plant use in the Bredasdorp/Elim region of the Southern Overberg in the Western Cape Province of South Africa. Journal of Ethnopharmacology. 2006;103(2):261-75.
4. Sakkas H, Papadopoulou C. Antimicrobial activity of basil, oregano, and thyme essential oils. J. Microbiol. Biotechnol. 2017;27(3):429-38.
5. Bernal P, Molina-Santiago C, Daddaoua A, Llamas MA. Antibiotic adjuvants: Identification and clinical use. Microbial Biotechnology. 2013;6(5):445-9.
6. Ongsakul M, Jindarat A, Rojanaworarit C. Antibacterial effect of crude alcoholic and aqueous extracts of six medicinal plants against *Staphylococcus aureus* and *Escherichia coli*. J. Health Res. 2009; 23(3):153-6.
7. Patel DK, Kumar R, Prasad SK, Hemalatha S. Pharmacologically screened aphrodisiac plant-A review of current scientific literature. Asian Pacific Journal of Tropical Biomedicine. 2011;1(1):S131-8.
8. Akinyele BO, Odiyi AC. Comparative study of vegetative morphology and the existing taxonomic status of *Aloe vera* L. Journal of Plant Sciences. 2007;2(5):558-63.
9. Darokar MP, Rai R, Gupta AK, Shasany AK, Rajkumar S, Sundaresan V, Khanuja SP. Molecular assessment of germplasm diversity in Aloe species using RAPD and AFLP analysis. Journal of Medicinal and Aromatic Plant Sciences. 2003;25(2):354-61.
10. Burkill HM. The useful plants of west tropical Africa. Families EI. Royal Botanic Gardens. 1994;2.
11. Tan PV, Enow-Orock GE, Dimo T, Nyasse B, Kimbu SF. Evaluation of the anti-ulcer and toxicity profile of *Aloe buettneri* in laboratory animals. African Journal of Traditional, Complementary and Alternative Medicines. 2006;3(2):8-20.
12. Temikotan T, Akinyele BO, Odiyi AC, Arotupin DJ. Phytochemicals of some members of the family Hyacinthaceae and their significance in plant protection. In Proceedings of the World Congress on Engineering. 2013;2:3-5.
13. Rojas JJ, Ochoa VJ, Ocampo SA, Muñoz JF. Screening for antimicrobial activity of ten medicinal plants used in Colombian folkloric medicine: A possible alternative in the treatment of non-nosocomial infections. BMC Complementary and Alternative Medicine. 2006;6(1):2.
14. Mahieux S, Nieto-Bobadilla MS, Houcke I, Neut C. How to study antimicrobial activities of plant extracts: A critical point of view. In Natural Antimicrobial Agents. Springer, Cham. 2018;55-71.
15. Rajeswari R, Umadevi M, Rahale CS, Pushpa R, Selvavenkadesh S, Kumar KS, Bhowmik D. *Aloe vera*: The miracle plant its medicinal and traditional uses in India. Journal of Pharmacognosy and Phyto-chemistry. 2012;1(4):118-24.
16. Harborne JB. Phytochemical methods: A guide to modern techniques of plant analysis. Chapman & Hall Pub. London, UK; 1998.
17. Sofowora A. Screening plants for bioactive agents. In: Medicinal Plants and Traditional Medicine in Africa; 1993.
18. Chaerani R, Voorrips RE. Tomato early blight (*Alternaria sol*ani): The pathogen, genetics, and breeding for resistance. Journal of General Plant Pathology. 2006;72(6):335-47.
19. Abada KA, Mostafa SH, Hillal MR. Effect of some chemical salts on suppressing the infection by early blight disease of tomato. Egyptian Journal of Applied Science. 2008;23:47-58.
20. Enyiukwu DN, Awurum AN, Ononuju CC, Nwaneri JA. Significance of characterization of secondary metabolites from extracts of higher plants in plant disease management. Int J Adv Agric Res. 2014b;2:8-28.
21. Gurjar MS, Ali S, Akhtar M, Singh KS. Efficacy of plant extracts in plant disease management. Agricultural Sciences. 2012;3(3):425.
22. Bajwa R, Shafique S, Shafique S. Appraisal of antifungal activity of *Aloe vera*. Mycopath. 2007;5(1):5-9.
23. Palou L, Valencia-Chamorro S, Pérez-Gago M. Antifungal edible coatings for fresh citrus fruit: A review. Coatings. 2015;5(4):962-86.
24. Cushnie TT, Cushnie B, Lamb AJ. Alkaloids: An overview of their antibacterial, antibiotic-enhancing and antivirulence activities. International Journal of Antimicrobial Agents. 2014;44(5):377-86.
25. Enyiukwu DN, Awurum AN, Nwaneri JA. Efficacy of plant-derived pesticides in the control of myco-induced postharvest rots of tubers and agricultural products: A

review. Net Journal of Agricultural Science. 2014a;2(1):30-46.
26. Hayette MP, Sacheli R. Dermatophytosis, trends in epidemiology and diagnostic approach. Current Fungal Infection Reports. 2015;9(3):164-79.
27. Adejumo TO, Bamidele BS. Control of dermatophyte-causing agents (*Trichophyton mentagrophytes* and *Trichophyton rubrum*) using six medicinal plants. Journal of Medicinal Plants Research. 2009;3(11):906-13.
28. Sahu R, Saxena J. Screening of total phenolic and flavonoid content in conventional and non-conventional species of curcuma. Journal of Pharmacognosy and Phytochemistry. 2013;2(1).
29. Choesrina R, Suwendar S, Mulqie L, Mardliyani D. POTENSI AKTIVITAS ANTIBAKTERI DARI FRAKSI ETIL ASETAT DAUN JAMBU AIR [Eugenia aqueum (Burn F.) Alston] TERHADAP *Sthaphylococcus aureus* DAN Escherichia *coli*. Jurnal Ilmiah Farmasi Farmasyifa. 2019;2(1):33-9.
30. Tapas AR, Sakarkar DM, Kakde RB. Flavonoids as nutraceuticals: A review. Tropical Journal of Pharmaceutical Research. 2008;7:1089-1099.
31. Atmani D, Nassima C, Dina A, Meriem B, Nadjet D, Hania B, Flavonoids in human health: From structure to biological activity. Current Nutrition & Food Science. 2009;5:225-237.
32. Nwachukwu EO, Osuji JO. Evaluation of plant extracts for antifungal activity against *Sclerotium rolfsii* causing cocoyam cormel rot in storage. Research Journal of Agriculture and Biological Sciences. 2008;4(6):784-7.
33. Farr DF, Bills GF, Chamuris GP, Rossman AY. Fungi on plants and plant products in the United States. APS Press; 1989.
34. Jain P, Singh SK, Sharma HP, Basri F. Phytochemical screening and antifungal activity of *Semecarpus anacardium* l. (An anti-cancer plant). Int J Pharm Sci Res. 2014;5:1884-91.
35. Onifade AK. Antifungal effect of *Azadirachta indica* A JUSS extracts on *Colletotrichum lindemuthianum*. Global Journal of Pure and Applied Sciences. 2000;6(3):425-8.
36. Eno IP. Field trial on the potential of *Anacardium occidentalis* for the control of cowpea anthracnose disease in Nigeria. A MSc Thesis Presented to the Department PHM, MOUAU; 2011.



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